
Artillery shells awaiting shipment at the Scranton Army Ammunition Plant (Hannah Beier / Getty)

POLITICS

# THE CRUMBLING FOUNDATION OF AMERICA'S MILITARY

The U.S. failed to produce weapons and ammunition fast enough to supply Ukraine. Could it equip its own armed forces in the event of war?

By Mark Bowden

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HERE, IN THE THIRD DECADE of the 21st century, the most sought-after ammunition in the U.S. arsenal reaches the vital stage of its manufacture—the process tended by a young woman on a metal platform on the second story of an old factory in rural Iowa, leaning over a giant kettle where tan flakes of trinitrotoluene, better known as the explosive TNT, are stirred slowly into a brown slurry.

She wears a baggy blue jumpsuit, safety glasses, and a hairnet. Her job is to monitor the viscosity and temperature of the mix—an exacting task. The brown slurry must be just the right thickness before it oozes down metal tubes to the ground floor and into waiting rows of empty 155-millimeter howitzer shells, each fitted at the top with a funnel. The whole production line, of which she is a part, is labor-intensive, messy, and dangerous. At this step of the process, both the steel shells and the TNT must be kept warm. The temperature in the building induces a full-body sweat in a matter of minutes.

This is essentially the way artillery rounds were made a century ago. Each shell is about two feet high and six inches wide, and will weigh 100 pounds when filled with the explosive. At the far end of the production line, after the shells are filled and fitted with a fuse—or, as the military has it, a “fuze”—the rounds, hundreds of them, are loaded on railcars for the first step in their journey to war. Each train carries such a large concentration of TNT that there’s a solid concrete barrier, 20 feet high and 20 feet wide, between the rails and the building. The finished shells are delivered from plant to port by rail and by truck, under satellite surveillance.

The young woman works in the melt-pour building. It is the tallest structure on the grounds of the Iowa Army Ammunition Plant, which sits on 30 square miles of prairie, forest, and brush in the southeastern corner of the state, not far from the Mississippi River. Built in 1940, it's a relic. It's also currently the only place in America for high-volume production of 155-millimeter artillery shells, the key step of which is known as LAP (for "loading, assembling, packing")—turning empty shells into live ordnance. The building looks perfectly mundane, like many old factories in rural towns. There's only one clue to what's going on inside: giant chutes, like water slides, slope down to the ground from the upper floors. These are for escape, although one doubts that anyone could clear the blast radius of a building where TNT is stored in tons. There hasn't been a serious accident at the Iowa plant in years, but 70 names are inscribed on a memorial at the entrance for men and women killed on the job, most of them by explosions.

The Iowa production line is at once essential and an exemplar of industrial atrophy. It illustrates why the richest military on Earth could not keep up with the demand for artillery ammunition after Russia invaded Ukraine in February 2022. At that time, the U.S. was manufacturing about 14,000 shells a month. By 2023, the Ukrainians were firing as many as 8,000 shells a *day*. It has taken two years and billions of dollars for the U.S. to ramp up production to 40,000 shells a month—still well short of Ukraine's needs. A big part of the reason is that we still make howitzer rounds the way our great-grandparents did. There are better, faster, safer ways. You can watch videos online of automated plants, for example, operating in Europe. Some new American facilities are starting up, but they are not yet at capacity.

The problem isn't just howitzer shells. And it isn't only that the U.S. can't build drones, rockets, and missiles fast enough to meet the needs of Ukraine. America itself lacks stockpiles of the necessary components. A massive rebuilding effort is now under way, the largest in almost a century, but it will not—cannot—happen fast. And even the expanded capacity would not come close to meeting requests the size of Ukraine's, much less restore our own depleted reserves. Take drones, for instance. In December 2023, Ukraine's president, Volodymyr Zelensky, called for the domestic production of 1 million annually to meet war needs—and Ukraine has met that goal. In the meantime, the supply of drones provided by the U.S. to Ukraine has numbered in the thousands, and many of those have not fared as well on the battlefield as Ukraine's homemade, often jerry-rigged models and off-the-shelf

Chinese drones. Other allies have stepped up with materiel of many kinds—artillery, armored vehicles, aircraft—but fighters in Ukraine are still coping with disabling shortages.

> "It's a miracle the U.S. military has anything that blows up, ever."

At stake here is more than the fate of Ukraine. As a new administration prepares to take power—led by a man, Donald Trump, who has been hostile to Zelensky and his country's cause, and who admires Russia and Vladimir Putin—the future of American aid to Ukraine is at best uncertain. It could very well diminish or even come to an end. But the obstacles the U.S. has faced in trying to supply Ukraine during the past two years have revealed a systemic, gaping national-security weakness. It is a weakness that afflicts the U.S. military at all levels, and about which the public is largely unaware. The vaunted American war machine is in disarray and disrepair.

"*Shocking* is not overstating the condition of some of our facilities," said Representative Donald Norcross, chairing a House Armed Services subcommittee hearing on munitions manufacture a month after the Russian invasion of Ukraine. Ted Anderson, a retired Army officer who is now a principal partner of Forward Global, a defense consultancy, told me, "You would stay awake all night if you had any idea how short we are of artillery ammo."

In 2023, the U.S. Army Science Board expressed concern that the nation's industrial base "may be incapable of meeting the munitions demand created by a potential future fight against a peer adversary." Mackenzie Eaglen, a defense analyst at the American Enterprise Institute (AEI) and one of the authors of the Science Board's report, immersed herself in this world of procurement and manufacturing for nearly a year. "When I was done," she told me, "the only thing I could think was *It's a miracle the U.S. military has*

*anything that blows up, ever.*"

## II. What Happened?

THIS IS NOT just a bump in the road, and it is not just about munitions. The U.S. military, the richest in the world, confronts a deep, institutional deficiency. If that truth is hard to accept, it's partly because the reality is so profoundly at odds with our history. In December 1940, President Franklin D. Roosevelt called on America to become "the arsenal of democracy." He had the foresight to gear up the arms industry almost a year before the Japanese attacked Pearl Harbor. The war machine then performed astonishing feats. The Navy outbuilt every other country in the world combined, launching more than 1,000 new warships along with fleets of cargo vessels, troop carriers, and tankers. Production of aircraft was even more astonishing. In all the years prior to 1939, only about 6,000 aircraft had been manufactured in America. Over the next five years, American factories rolled out 300,000. They also built 86,000 tanks and more than 2 million trucks. Production of ammunition accelerated so fast that by 1943, there were 2.5 billion rounds on hand, and the volume was creating storage problems. American arms won the war.

A Chrysler factory in Detroit producing M3 tanks rather than cars or trucks, 1941 (Library of Congress)

That mighty manufactory was scaled back markedly when the war ended, then geared up once more during the Korean conflict and the Cold War. By 1961, it was again such a colossus that President Dwight Eisenhower warned about the growing influence of the "military-industrial complex." This is how many of us think of it still: menacingly big, cutting-edge, professional, vigilant, lethal, and outrageously expensive. The Pentagon's nearly $1 trillion annual budget is more than the defense spending of the next nine biggest militaries combined. It is a preposterous sum that pays for an industrial infrastructure that includes mining operations, chemical plants, factories, storage depots, arsenals, ships, trains, aircraft, launching pads, and research labs. It is less an industry than an ecosystem. Today it is global and so complex and mutable that it has become nearly impossible to map.

From the April 2023 issue: Jerry Hendrix on the end of American naval dominance

Leaving aside an enormous privatized service sector that supports government operations, the military's industrial infrastructure has three overlapping parts. The first and oldest is the military's own organic industrial base: factories, depots, and arsenals scattered all over America. Some of these, particularly those considered most vital or secret, are owned and operated by the military itself. Most, like the Iowa plant, are so-called GOCOs (government owned, contractor operated). This organic industrial base supplies the basics: ammo, vehicles, equipment.

The second part of the industrial war machine is the corporate manufacturing sector, dominated today by the Big Five contractors: Lockheed Martin, Northrop Grumman, Boeing, General Dynamics, and Raytheon. These companies enjoy profitable deals to develop and build sophisticated weapons systems.

The third, and newest, part of the war machine is the tech sector, including Microsoft, Google, Amazon, Palantir, SpaceX, Anduril, and a large number of smaller firms. These are responsible for the software and hardware that have become a crucial element of modern war—drones and associated technology, as well as AI and systems for electronic surveillance, communications, data analysis, and guidance. The rapid evolution of drones in the Russia-Ukraine war, where automated attack and defense strategies change almost daily, illustrates how vital the tech sector has become.

Together these sectors support what remains the most potent fighting force on the planet. But the foundation is crumbling. Much has been written about the Pentagon's devotion to big, expensive, and arguably outdated weapons platforms: fighter jets, bombers, guided missiles, aircraft carriers. Little notice has been paid to the deterioration of its industrial base, which underpins everything. There are plenty of reasons for what has happened. Strategic planning failed to foresee a sudden demand for conventional arms. The post–Cold War "peace dividend" put most military contractors out of business. Budget wars in Congress have created funding uncertainty that dissuades long-term investment in arms manufacture. As for munitions, much of the dirty and dangerous work of making them has been outsourced overseas, to countries where labor is cheap and regulations—environmental, safety—are few. Meanwhile, in every kind of military manufacture, from the most to the least sophisticated, we depend for raw materials and components—uranium, chemicals, explosives, computer chips, spare parts, expertise—on an expansive

global supply chain, in some cases involving the very countries (China, Russia) we are most likely to fight.

## III. A Case Study

THE HOWITZER ROUND, a relatively simple munition, illustrates the problems we face. The howitzer itself is a centuries-old weapon, a mobile firing tube bigger than a mortar and smaller than a cannon. It is often mounted on wheels and is usually used in groups. It is convenient for throwing substantial shells over an army's own forces and into the ranks of a nearby enemy. A 155-millimeter howitzer shell has a blast radius of more than 150 feet, sends fragments even farther, and can damage or destroy vehicles and fortified positions.

Today's howitzer round has a variety of parts, each requiring its own production process. The steel casing is made with a specially formulated alloy called HF-1 (the initials stand for "high fragmentation"), designed to withstand the tremendous pressure of being shot out of a cannon but also frangible enough to shatter into shards when it explodes at the target. Most of this kind of steel is imported from Japan and Germany, but some of it also comes from China. Into each steel casing is poured explosive material—what the military calls "energetics"—that today is generally TNT: 24 pounds of it per round. Currently, no TNT is manufactured in the U.S. Nearly all of what we use is imported from Poland and is made with chemical precursors from other countries—including, again, China. To increase U.S. production tenfold would require 2.4 million pounds of TNT monthly, which is why the military is shifting to a newer explosive, IMX, that will ultimately replace TNT entirely, but not anytime soon. The U.S. already has stockpiles of this material, and more of it is being made: The Army has nearly tripled its IMX order from the Holston Army Ammunition Plant, in Tennessee.

Then there's the need for copper, a band of which is wrapped around the base of each shell to seal it tightly inside the firing chamber; this enables the shell to spin out of the rifled tube, improving its accuracy. To propel the round, there is another energetic at its base, nitrocellulose, which is manufactured at the Radford Army Ammunition Plant, in Virginia. Its chemical ingredients are imported from all over the world. To ignite the propellant, each round has a primer, essentially a small brass cup and a copper pin with its own small amount of explosive powder. At the tip of the round is the fuze, which

contains a battery that is activated when the round begins spinning. The small mechanical and electronic components of the fuze determine when and where the round explodes, whether on impact or in the air above the target. Each of these components must be mass-produced, and each has its own complex manufacturing story.

Rolls of steel (*left*) stored at the Scranton Army Ammunition Plant (*right*) (Hannah Beier / Getty; Aimee Dilger / SOPA / Getty)

At the Scranton facility, 155-millimeter howitzer shells drying on a conveyor belt (Aimee Dilger / SOPA /

Getty)

Making energetics, in particular, is expensive, difficult, and, traditionally, a major source of pollution. In the U.S., old Army-ammunition plants figure prominently in the more than 600 military facilities the EPA has designated as Superfund sites—priority cleanup areas. Today the Iowa plant is clean enough that the land around it is used for recreational hunting and fishing and is considered a haven for some endangered species. But in years past, after the plant was steam cleaned to prevent the buildup of explosive dust and residue, the streams in nearby Burlington ran pink, which is the color TNT turns when exposed to sunlight. The plant is still regularly steam cleaned, but with strict and expensive runoff controls—the cost of environmental stewardship is steep. So, on top of other obstacles that stand in the way of a rapid surge in production—not just of howitzer shells but of any military ordnance and equipment—you can add the legitimate demands of "good government": environmental regulations, safety regulations, and all the built-in safeguards against waste and fraud.

One more thing: Workers capable of handling jobs at the military's industrial plants don't just walk in off the street. "Generally, it takes two years for an average line worker in munitions to be effective," the Science Board report noted. "For energetics, that timeline is extended to seven years."

Ramping up existing plants, like the one in Scranton that forges the steel casings for howitzer shells, is done by doubling and then tripling the number of eight-hour work shifts. This has been accomplished in the two years since the invasion of Ukraine; generous overtime benefits and new hires keep plants running around the clock. But the facilities themselves are antiques. A small fire broke out at the Scranton Army Ammunition Plant in September, forcing the evacuation of the affected building. No one was injured, but the incident raised concerns about vulnerability. Portions of the plant date back to the 19th century. Originally built to maintain rails and railcars—it still sits astride a rail line in the city center—it became a giant steel foundry during the Korean War. Today many of its union workers are long-tenured and are second- and third-generation employees. Its dark and cavernous interiors could be sets for a Hollywood horror movie. Inside are giant vats where heavy billets of HF-1 steel are melted down and stretched into elongated cylinders. Glowing bright orange, they descend on metal rollers one by one to a noisy production line as they gradually cool to a dull gray. Each is then reheated

until malleable inside a large device that pounds and tapers the top, creating an aerodynamic, bulletlike contour. To work as intended, the casings must exactly fit the firing tubes, so they are inspected and measured repeatedly along the line. The casings are then buffed to a high sheen. Much of this is hands-on work. Suspended from a wire, each shell passes through a spray-paint station, where the bright surface is coated a dull, army-issue green.

In Iowa, where the casings go for the LAP stage, shells are hoisted one by one onto an assembly line. Workers engrave ID numbers and the initials TNT on each. The shells are then stacked in neat rows on carts that hold about 50. A funnel is placed atop each, and workers guide the carts into a long wooden shed that stretches a few hundred yards to the melt-pour building. On the way, the shells are heated and cooled repeatedly, curing the metal for the TNT pour. One at a time, the carts are rolled into position beneath the melt-pour kettle, two stories above. The slurry flows down through the steel tubes to completely fill each shell. From there, the shells are rolled through a covered walkway to a building where each round is separately X-rayed. Technicians behind computer screens scan each image for imperfections in the pour.

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This painstaking process is eliminated in newer plants in other countries, where TNT is inserted with a more efficient method called "screw extrusion," one very thin layer at a time. The process virtually eliminates imperfections. It is not new. The modern form of the process was developed in the 1960s, and is yet another example of how static U.S. production methods have remained. The Army opened part of its first automated shell-production facility in

Mesquite, Texas, early this year, and a new LAP plant is under construction in Camden, Arkansas. Crucial expansion of energetics production is under way at Holston, and of propellant production at Radford. Most of these projects are years from being completed. They will require skilled workers and customized new equipment. And once they are all fully operational, which could take years, they will need a lot of energetics. For that, in September 2023, the Army signed $1.5 billion in new contracts. Some of the contracts have gone to companies in the U.S., but others have gone to firms in Canada, India, and Poland.

The Pentagon hopes that this expansion will bring production of 155-millimeter howitzer shells to 100,000 rounds a month by 2026—up from the current level of 40,000 a month. NATO countries are also expanding production. All of this will help, but it will also increase competition for scarce minerals and explosives. Poland, for instance, has its own 144-mile border with Russia, and is engaged in its own military buildup. It may be one of the world's largest manufacturers of TNT, but it isn't going to sell all of it.

Ukraine is also desperately in need of missiles (Javelins, Stingers), anti-missile systems, and rocket-launching platforms such as the High Mobility Artillery Rocket System, better known by its acronym, HIMARS. These are far more sophisticated weapons, and for most of them, American manufacture has been at an all-time low. Production of Stingers, chiefly an anti-aircraft weapon, was off and on until 2023, when the manufacturer, Raytheon, called in retired engineers and production was fully resumed. Production of Tomahawks, the Navy's premier cruise missile, is anemic. When American ships began striking Houthi targets in Yemen in January, they fired more Tomahawks on the first day than were purchased in all of last year. The Navy has stockpiles, but clearly that rate of use is unsustainable. And missiles are far more complex than artillery rounds. They require a greater variety of scarce explosives as well as highly intricate electronics. While one howitzer round draws on about 50 different suppliers, a single missile depends on as many as 500, from dozens of countries.

From the June 2023 issue: Anne Applebaum and Jeffrey Goldberg on Ukraine's fight against Russia and the future of the democratic world

Imagine, as the Science Board did, that America was drawn unexpectedly into another significant war. If we are years behind meeting the demands of

Ukraine, how would we fare if we had to provide naval support and ground troops to defend Taiwan? Or if a NATO country was invaded by Putin's Russia? Or if an expanding Middle East conflict draws the U.S. in more deeply? Worried about possible abandonment of Ukraine by Donald Trump, the Biden administration has stepped up deliveries of weapons and equipment —inevitably prompting concerns about the adequacy of our own stockpiles.

A Ukrainian soldier fires a howitzer against Russian troops, 2024. (Tyler Hicks / *The New York Times* / Redux)

America's lack of preparedness crept up on the country gradually. Ammo production reached a low after 2001, when the 9/11 attacks shifted the military's focus to al-Qaeda and other nonstate enemies. Arms manufacture had already slowed. Factories were closing. The brevity of the Gulf War, in 1991, when Saddam Hussein's army was swept from Kuwait in five days, had reinforced a belief that stocking and maintaining prodigious supplies of weapons and ammunition was no longer needed. Even the years of fighting in Afghanistan and Iraq, after 9/11, mostly involved intelligence, surveillance, and the small mobile infantry units of Special Forces. There was a brief upsurge in the production of heavily armored vehicles to counter mines and roadside bombs in Iraq, but even that long war did not halt the overall

downward trend. An official Army history of the American weapons industry, completed in 2010, noted that "the current industrial base is the smallest it has been." And it has continued to shrink.

## IV. The Last Supper

THE HOLLOWING-OUT of America's arms-manufacturing capacity is partly a granular story about factories and supply chains and the labor force. The size and complexity of the industrial base are important to understand. But the forces that shape manufacturing efforts in Iowa and Pennsylvania and elsewhere trace back to Washington, D.C. They involve politics, policy debates, military doctrine, expert predictions, taxpayer money, and, ultimately, the application of national will.

The way we've envisaged—and planned for—future wars has led us down a dangerous path. There were always voices warning of the need to anticipate the possibility of a protracted ground war *somewhere*—and warning, too, of the strain that such a war would place on U.S. arms production. For instance, in his 2020 book, *The Kill Chain*, Christian Brose, a former staff director of the Senate Armed Services Committee, considered how a U.S. clash with China over Taiwan—"peer competitors fighting with most, if not all, of the same weapons"—could easily erode into a brutal stalemate. Testifying before Congress in 2021, Admiral Philip Davidson, then the retiring head of the U.S. Indo-Pacific Command, cautioned that such a conflict could occur within the next six years—the so-called Davidson window.

But U.S. military doctrine emphatically was not focused on fighting or supporting a major ground war, and the prospect of such a war in Europe in the 21st century seemed especially unlikely. So did the potential need for millions of conventional artillery rounds in an age of missiles. It would be as if, after World War II, there had been a sudden call for mounted cavalry. "There was always some bit of a protracted-conflict scenario," Bill LaPlante, the undersecretary of defense for acquisition and sustainment, told me, using strategic jargon for bloody fighting on a massive scale with no end in sight. "But the idea that we would be spending or sending to another country 2 million rounds of 155"—the howitzer shells—"I don't think was really thought through." And if someone had raised the possibility, the response would have been: "I don't see that scenario."

It is part of the Pentagon's job to imagine unlikely scenarios.

War always upends expectations. Generals plot for surprise. And once wars begin, they evolve in unexpected ways. "Strategic judgments about future environments are often, one might say predictably, wrong," wrote Richard Danzig, a former secretary of the Navy, in his influential 2011 monograph, *Driving in the Dark*. Today he's an adjunct senior fellow at the Center for a New American Security (CNAS), a Washington think tank. He was previously a member of the Pentagon's Defense Policy Board.

At the Ukraine war's outset, most analysts in the defense community believed that it would last only days or weeks. Russia would roll over its smaller neighbor, oust Zelensky, and install a compliant regime. Instead, the invasion triggered a valiant defense that rallied the Western world. Two years later, the war has evolved into a stalemate, one that has been called "World War I with technology." Ukraine's army has mounted an effective defense in part by the heavy use of artillery, especially howitzers. LaPlante described a recent tour of World War I battlefields and the immediate resonance he felt with the war in Ukraine—the men dug into trenches, the continual bombardment, the relentless attrition. There had been an assumption, LaPlante said, that stealth and precision weaponry would somehow preclude this type of warfare, but "it turns out it didn't."

War planning occurs in a political and strategic context bigger than the Pentagon, which is another reason the U.S. finds itself where it is. Much of the reduction in America's arms-manufacturing capacity was deliberate—a consequence of the collapse of the Soviet Union and the end of the Cold War. In 1993, the heads of some two dozen of the military's biggest contractors were invited to a dinner at the Pentagon by then–Defense Secretary Les Aspin. Details of the meeting eventually emerged in press accounts. Such a gathering was unusual, and no agenda was announced, so the executives were understandably curious as they were shown into a plain, white-walled dining room off Aspin's office.

As a representative from Wisconsin, Aspin had, in 1990, led efforts in Congress to begin shrinking defense spending. The Berlin Wall had come down in 1989. The Soviet Union was fracturing. It was a heady time. The U.S. was no longer squared off against another superpower. Aspin had called for "a new kind of defense," and now, with Bill Clinton in the White House,

he was charged with shaping it. Everyone at the dinner knew change was coming. No one was sure exactly what it would look like.

Norm Augustine, then the CEO of Martin Marietta and a onetime undersecretary of the Army, was seated next to Aspin at the dinner table. He asked what was going on.

"Well, in about 15 minutes you're going to find out," Aspin replied, "and you probably aren't going to like it."

After the meal, the group was led to a briefing room, where William Perry, Aspin's deputy, stood beside a screen and presented the plan: a dramatic reduction in defense spending. Perry explained that there were too many private contractors, and the Pentagon could no longer afford them all. The fallout would be drastic, he said. Charts showed various categories of purchasing. In some, only one contractor would likely be left with enough business to survive.

Augustine paid particular attention to the forecast for the aerospace industry. It showed that out of more than a dozen existing contractors in his field, perhaps only two or three would remain viable. He was stunned. For many of those in the room, it meant their companies were doomed. They would either go out of business or be sold or absorbed by a competitor. Augustine came to refer to the meeting as the Last Supper.

Perry, who would succeed his boss as defense secretary, was not wrong. Within a decade, the number of prime defense contractors—large companies that typically employ scores of subcontractors on big projects—fell from 51 to five. In terms of personnel, the military shrank by 15 percent. The effect on defense manufacturing was drastic: According to Augustine, the aerospace industry alone lost 40 percent of its employees in the 1990s. Of course, Pentagon spending cuts were not the only factor—American manufacturing in general had been in a long decline as lower wages overseas and the effect of free-trade agreements drained jobs away. But the impact of spending cuts was deep.

For the past three decades, the U.S. war machine's private sector has been dominated by the Big Five, confirming a 1997 prediction by John Mintz of *The Washington Post*: "By the end of his second term, it may emerge that

President Clinton's most enduring legacy in national security will be his role in creating a handful of extraordinarily powerful defense contractors." Fewer players meant less competition, and because the five were so big, they undermined one of America's greatest strengths—its seemingly inexhaustible bounty of bright entrepreneurs with new ideas. The Big Five spent a lot on research and development and had the capacity to rapidly expand if a product took hold, but the galaxy of small entrepreneurial players was diminished. It became harder for start-ups to compete and thus to remain alive.

Some held on by gaming the system. Bill Greenwalt, a defense analyst with AEI, explained to me that many companies became experts at "just getting a couple million dollars doing a science project" floated by the Pentagon, and then, when that speculative R&D project was done, "raising their hand" for another. They were accustomed to the concepts they developed going no further. If they did, the next step, turning the idea into a prototype, needed a steeper level of funding. If the concept cleared that hurdle, an even bigger one loomed: winning the funds to expand production. These obstacles became known as "the valley of death," because so many promising ideas and even proven prototypes died trying to make the leaps. The Big Five were better positioned to succeed than were smaller upstarts. And the Pentagon, like all large bureaucracies, is inherently cautious. Bigness meant being able to underwrite prototypes and expand production lines quickly. The upshot was both to curtail innovation and to deflect attention away from basic needs.

One of the most famous examples of this dynamic was an unmanned aircraft invented by the Israeli aerospace engineer Abe Karem originally called Albatross, then Amber, and finally the GNAT-750. He won a Pentagon contract in the 1980s to design something better than the drone prototype offered by Lockheed Martin, known as the Aquila. And he delivered, building a machine that cost far less, required just three operators instead of 30, and could stay aloft much longer than the Aquila could. Everyone was impressed. But his prototype vanished into the valley of death. Although it was a better drone, Aquila looked good enough, and Lockheed Martin was a familiar quantity. But Aquila didn't work out. Neither did alternatives, including the Condor, from another of the Big Five, Boeing. Only after years of expensive trial and error was Karem's idea resurrected. It became the Predator, the first hugely successful military drone. By then, Karem's company had been absorbed into General Atomics—and Karem lost what would have been his biggest payday.

"There are hundreds of Abe Karems out there in America today, and they get frustrated by the department," Greenwalt said. "They move out to the commercial sector. Every one of those companies, I would argue, has probably got someone there who met the valley of death in DoD and is now doing something crazy in the commercial marketplace because that's where the money is."

The flow of defense dollars to the Big Five didn't just stifle innovation. It also concentrated a growing share of available dollars into weapons systems of the costliest and least ordinary kind. If there is one major lesson to be drawn from the war in Ukraine, apart from the need for an ability to produce drones, munitions, and missiles fast, it's that small and cheap beats big and expensive—which is the opposite of the assumptions that underlie much of America's military spending. Drone warfare continues to teach that lesson.

The Pentagon has launched expensive programs, still unfolding, to design and build small drone fleets. Meanwhile, Ukraine and Russia have both been using drones that can be bought off the shelf and adapted to military use, all for a tiny fraction of what the U.S. has spent. With its vibrant tech sector, Ukraine has excelled in configuring commercial drones for the rapidly changing conditions of the battlefield. For instance, the Ukrainians have recently made great strides in autonomous terminal guidance—preprogramming drones with target information so that if the weapon encounters electronic jamming, it will remain on course. Stacie Pettyjohn, the director of the defense program at CNAS, explained that the Pentagon has been working on this technology, too—but with a project that has been years in development and has cost hundreds of millions of dollars. "The Ukrainians are doing it for a few thousand dollars in some guy's garage," she said.

The same cost disparity is evident in defending against drone attacks—what LaPlante has called "the problem of our time." Patriot missiles, which cost $1 million apiece, were not intended for this. The Pentagon is pouring millions into developing countermeasures. But the answers are more likely to come from a tech start-up—from someone like Abe Karem. Over the past half century, the Pentagon has become more of a buyer than an inventor, but it remains a notoriously deliberate customer. Acquisition procedures, legal requirements, and funding issues slow to a crawl on the path from concept to production.

A bulletin board near the furnace area of Scranton's production floor (Michael S. Williamson / *The Washington Post* / Getty)

## V. A Loss of Will

AS SHOCKING as the Last Supper may have been to industry leaders, the larger policy impulse made sense—as much sense as a drawdown did when World War II ended. It was painful, but defense spending has always been a roller coaster. The problem was not the drawdown itself but the structure left in place—heavily corporate in terms of major weapons systems, and yet astonishingly thin in terms of basic manufacturing. If some disaster—an accident, an attack—befell the Holston Army Ammunition Plant, the Army would quickly run out of bombs. All American aircraft carriers and submarines today are powered by small nuclear reactors. A single company makes them: BWX Technologies, in Lynchburg, Virginia.

Less money is only part of the issue. Congress controls the funding, and its dysfunction has had a profoundly negative effect on the military's manufacturing capacity. The decline of the American war machine reflects both corrosive partisanship and a loss of direction and will.

Most of the defense budget—more than 80 percent of it—is essentially allocated before the generals get their hands on it. The budget has, in effect, calcified. Its main expense categories have barely shifted in years. Personnel is the biggest fixed cost, at about 40 percent. The million-person-plus military earns pay and benefits, health first among them. Keeping pace with inflation, those costs steadily grow. More money is spent on health care for military members and their families each year than is spent on building ships. And then there's competition from private employers. Skilled welders, for instance, who have learned their craft in the Navy, can find ready employment in private shipyards when their tour of service ends—for higher pay and greater benefits. "Staying competitive with the private sector," Mackenzie Eaglen wrote in a 2022 AEI paper, "means the 'mandatory' spending bills get larger every year—*whether the overall budget grows or not.*" The Pentagon, she reported, "spends almost ten billion more on Medicare than on new tactical vehicles, and more on environmental restoration and running schools than on microelectronics and space launches combined." The growth in personnel costs is so large that even when the Army has trimmed its ranks, the budget percentage has not gone down.

From the May 2018 issue: Phil Klay on the eroding morale of America's troops

Another huge chunk of the budget goes to operations and maintenance, which also increases as equipment ages. Keeping aircraft, ships, tanks, and troop carriers combat-ready is not optional.

The relatively small slice of the Pentagon budget available for other kinds of spending—at most 15 percent, and possibly half that amount—is still a lot of money, but competition for it is fierce. The manufacture of munitions, arguably the least sexy budget item, falls prey to the infighting. Would the Pentagon brass rather build a new generation of jets and ships and missiles, or instead notch up production of artillery shells that, under scenarios seen as likely, would never be used? Munitions have become known inside the Pentagon as a "bill payer"—something that can always be cut in order to make the budget balance.

Meanwhile, timely, coherent federal budgeting is no more. Congress routinely fails to pass appropriations bills on schedule, resorting to continuing resolutions. This keeps defense dollars coming but limits their use to existing

projects. That would not be a problem if it happened only occasionally, but Congress has given the defense department a fully authorized budget on time only once in the past 15 years. This helter-skelter process constrains the Pentagon from adapting quickly to changing circumstances. New projects are put on hold, and there's no guarantee that money will eventually come. Private contractors need predictable dollar commitments to invest in new product lines, so they simply don't invest. As one senior Pentagon official described it to me, the phenomenon is "an own goal that we do to ourselves every year."

## The U.S. today could not replicate the achievement of World War II. It could not build trucks and tanks and ships and airplanes in such volume.

When the demand for conventional ammo soared in 2022, established players in private industry—skeptical that the war in Ukraine would last long enough to make investment profitable—were reluctant to gear up. Some smaller companies have been tempted to step in but are also nervous about the risk. John Coffman, who owns a small munitions company called Armada Ammunition, based in Greensboro, Florida, is currently eyeing an opportunity to begin manufacturing howitzer ammo. He has hedge funds offering millions for him to begin making the rounds. He knows how to do it and has even lined up suppliers for the raw materials. The demand is clearly there—for the moment. But what happens if it suddenly isn't? Wars do end, or at least subside. "Then you have all this machinery and all this product that you just ordered," he says. And no guarantee that Washington will keep your company whole.

Coffman's situation is a microcosm of the one faced by any private

manufacturer with military contracts. If Congress wanted to get serious about sustaining the military-industrial base, measures could be devised to give companies a cushion, a guarantee of security. Manufacturers nationwide faced the same dynamic during World War II, and the federal government stepped in and smothered the problem with dollars—efficiency or penny-pinching was not as important as getting the job done. The problem today is not the scale of global war. The way Congress works today would not just cripple arms and ammunition supply in a global war; it would cripple it in war on *any* scale.

## VI. Driving in the Dark

JOHN QUIRK, a former Army officer who is now a senior staffer with the Senate Armed Services Committee, has been tracking the shortage of howitzer shells in particular. He told me that the military has made some progress: "What they have done, I would say with large success in the Army and the acquisition community, is the work of a guy by the name of Doug Bush."

Bush appears to be, in the words of one of his friends, "the perfect nerd for the job." Slender, prim, graying hair gone white at the temples, he is obsessively smart about abstruse things—a bureaucrat's bureaucrat. He is also the official who made that "own goal" remark.

Bush is the assistant secretary of the Army for acquisitions, logistics, and technology. It is a mouthful of a title that is usually dispensed with in favor of the spoken acronym ASA(ALT)—rhymes with *basalt*—an important but little-known position in the upper echelons of the Pentagon hierarchy. Bush is also the Army's science adviser and senior research and development official. The job is more than just building or buying what he is ordered to supply. It also means obtaining funding from Congress, which is hardly automatic.

Bush knows the Army (he is a West Point graduate and served for five years as an army officer in an infantry unit), and—perhaps more important—he knows Congress (he was a longtime staff member of the House Armed Services Committee). He became ASA(ALT) two weeks before Russia invaded Ukraine. When war came, he and his team began asking the basic questions: How much ammo would Ukraine need? Of what we had, how much would we need to hold back? Could we make more? How fast? Could we keep up with the demand? The answer to every one of these questions was either "We don't know" or, simply, "No."

Bush worked with Congress on "special authorities" for emergency contracts and helped persuade his old colleagues on Capitol Hill to pass, rapid-fire, a series of supplemental funding bills. One of the biggest challenges was just finding enough explosives. "We're going to use all the TNT capacity in the world we can get access to," Bush told me when we spoke at length this summer. But that addresses only short-term requirements. For the longer term, there needs to be major new energetics production—primarily of TNT and IMX—here in the United States. "So that's going to be hundreds of millions of dollars' worth of investment that we are going to build out as fast as we can," he said. In November, the Army awarded a contract to build a TNT plant in Kentucky. The U.S. has promised Ukraine more than 5 million artillery rounds, 500 million small-caliber ammo rounds, and much more. It has also committed billions of dollars to replenishing stockpiles for American forces. For all their accomplishments, what Bush and others have done is merely stabilize the patient in the ER. Systemic dysfunction remains.

Bill LaPlante, looking at the future from a different angle than Bush does, sees even more to be concerned about. If the U.S. finds itself on a back foot when it comes to 19th- and 20th-century technology, how will it confront challenges that are even more sophisticated? In his role as undersecretary of defense, he is tasked with making the kinds of predictions he knows not to trust. How does a huge institution that spends billions and employs millions make sound plans if its assumptions are consistently wrong? How do you prepare to be unprepared?

Today the most obvious threat is "high-volume fire"—large numbers of small, cheap kamikaze drones attacking all at once, swarming and overwhelming defenses. This isn't some futuristic scenario. It is happening in Ukraine. Imagine if the Iranians or Houthis could send 300 drones and missiles against one or two American ships in the Persian Gulf. The Defense Department is at work on ways to defeat such attacks—by means of AI-assisted targeting for rapid-fire weapons, for instance, or by directing a strong electromagnetic pulse to destroy the drones' robotic controls. Other potential threats include hypersonic missiles, electronic warfare, and cyberattacks—and these are only the threats that are known. "Just get over the fact that you're not going to predict everything," LaPlante told me. Rather, he advised, we need to "plan for adaptability."

LaPlante cited Danzig's *Driving in the Dark* as a blueprint. He said that its

prescriptions for coping with uncertainty are guiding the Pentagon's thinking, at least for now. Metaphorically, Danzig's approach departs from the traditional fortress concept—a hardened wall of defenses—to embrace a more immunological strategy, more like the way the body defends itself against pathogens. New viruses appear, and the body adapts to counter them. Translating that into national defense means preparing to be surprised and prioritizing weapons systems that can, like antibodies, be altered and mass-produced swiftly. It means leaning on software, particularly AI, that can weigh alternatives and repurpose existing assets faster than people can. To counter the effects of the Last Supper, it means emphasizing shorter-term contracts with a more numerous variety of smaller companies, thereby encouraging both competition and innovation. (Cellphones offer an example of this dynamic; they're designed for the short term because they can so quickly become outmoded.) It means adopting manufacturing methods that can be rapidly repurposed when the need for some product suddenly ends. All of this, taken together, would radically alter the Pentagon's status quo and redraw the military-industrial map. Doing so will not be easy. It will require extraordinary cooperation among Congress, the Pentagon, and the private sector.

"I think we could, I really do," said General Randy George, the Army's chief of staff, and the person charged with making these decisions, when I asked him this spring if the U.S. was truly capable of pursuing a new strategy and way of doing business. "I think it would be painful. People would feel it. But I still am a believer in American ingenuity."

General Randy George (*center, seated*) at the Army National Training Center, Fort Irwin, California, 2024 (Eric Thayer / *The Washington Post* / Getty)

One experiment George mentioned is the Replicator initiative, which is as much an innovation in process as it is in war-fighting. It draws significantly upon what military experts have learned from Ukraine. As Deputy Defense Secretary Kathleen Hicks explains, it will rapidly produce "multiple thousands" of autonomous systems, including relatively small, inexpensive drones. These will also have a modular structure capable of being adapted in the field to a variety of ends. Using existing and planned Pentagon funds, the project will rely on a number of small producers to achieve the volume needed. The idea is to enable a faster jump over the steepest obstacle in the valley of death, the one from proven prototype to mass production.

Creating a more varied and competitive field of military contractors means investing in many that will fail—a high-risk game. Anyone who spends big on arms production needs predictable budgets and certainty of sales. So the Pentagon will have to shoulder some of that risk. And if the government is underwriting the effort, a lot will ride on who is leading the government.

The current push will take a decade or more to become fully functional, and

will cost a lot more than even the generous sums Congress has been shelling out piecemeal over the past few years. The costs and risks of the direction LaPlante defines will meet resistance. The Big Five are a powerful lobbying force and will have allies in Congress and possibly in the new administration, whose plans and ambitions, and basic competence, are question marks. As always, there will be a strong penchant to stick with the familiar.

## VII. The Choice

EVEN IF the current experiments do morph into something permanent, they will represent a change in only one part of the procurement system. They will do nothing to address the fact that our national politics, which traditionally have united around issues of national defense, don't reliably do so any longer. They will not cure congressional dysfunction. They will not change our reliance on foreign supply chains. They will not obviate the need for environmental and safety regulations that add costs and slow down manufacturing. They will not alter the fact that war always confounds expectations, or that people will continue to balk at spending billions based on the proposition "What if?"

Absent a screaming national emergency, the U.S. has never been good at steering steadily in a clear strategic direction. The system for equipping the war machine is "peacetime designed," Douglas Bush explained. "The basis of it is not built for war."

One thing the U.S. should definitely do, he believes, is to stop thinking of America as *the* arsenal of democracy. Perhaps in theory we could go it alone—could press what's left of our manufacturing capacity to the single end of self-sufficient military production. But going it alone is not really an option. The task of supplying, running, and maintaining a modern war machine is beyond the capacity of any one nation. Starting from scratch and given three years to do it, the U.S. today could not replicate the achievement of World War II—could not build trucks and tanks and ships and airplanes in such volume. When we spoke, Bush suggested that it might be better to start thinking about an "arsenal of democra*cies*"—that is, multinational partnerships among the major democracies, with America playing the major role. It would be maddening and messy and require immense energy devoted just to muddling through.

He didn't mention the underlying premise: For the idea to work, we need to have democracies. And they need to stick together.

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Mark Bowden is a contributing writer at *The Atlantic*. His many books include *Black Hawk Down*, *Hué 1968*, and *The Finish: The Killing of Osama Bin Laden*.

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