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[Back to previous page](#)

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## Rise of the drone: From Calif. garage to multibillion-dollar defense industry

By [Peter Finn](#), Published: December 23

Lake Forest, Calif. — In 1980, Abraham Karem, an engineer who had emigrated from [Israel](#), retreated into his three-car garage in Hacienda Heights outside Los Angeles and, to the bemusement of his tolerant wife, began to build an aircraft.

The work eventually spilled into the guest room, and when Karem finished more than a year later, he wheeled into his driveway an odd, cigar-shaped craft that was destined to change the way the United States wages war.

The Albatross, as it was called, was transported to the Dugway Proving Ground in Utah, where it demonstrated the ability to stay aloft safely for up to 56 hours — a very, very long time in what was then the crash-prone world of drones.

Three iterations and more than a decade of development later, Karem's modest-looking drone became the Predator, the lethal, remotely piloted machine that can circle above the enemy for nearly a day before controllers thousands of miles away in the southwestern United States launch Hellfire missiles toward targets they are watching on video screens.

The emergence of hunter-killer and surveillance drones as revolutionary new weapons in the [wars in Iraq](#) and [Afghanistan](#), and in [counterterrorism operations](#) in places such as [Pakistan](#) and [Yemen](#), has spawned a multibillion-dollar industry, much of it centered in Southern California, once the engine of Cold War military aviation.

Over the next 10 years, the Pentagon plans to purchase more than 700 medium- and large-size drones at a cost of nearly \$40 billion, according to a [Congressional Budget Office study](#). Thousands more mini-drones will be fitted in the backpacks of soldiers so they can hand-launch them in minutes to look over the next hill or dive-bomb opposing forces.

This booming sector has its roots in the often unsung persistence of engineering dreamers who worked on the technology of unmanned aviation when the military establishment and most major defense contractors had little or no interest in it. Innovators such as Karem were often sustained by grants from the [Defense Advanced Research Projects Agency \(DARPA\)](#) and a handful of early believers, including the [CIA](#).

Karem said he imagined his drones involved in a “tactical conflict with the Warsaw Pact, be it on the

plains of [Germany](#) or as part of our Navy and Marines.” He had to sell his company, and with it the prototype of the Predator, long before it became the icon of a new kind of warfare.

“I did not envision the collapse of the Soviet Union and the rise of warfare with non-state adversaries,” said Karem, an aeronautical engineer who served for nine years in the Israeli air force before settling in the United States in 1977.

In the past decade, drones have become an integral part of U.S. military doctrine — so much so that it is difficult to recall how marginal they once seemed. The military had less than 200 drones the day before the attacks of Sept. 11, 2001; today it has more than 7,000, including mini-drones.

Before Sept. 11, drones weren’t “on the road map,” said Tim Conver, chairman and chief executive of [AeroVironment](#), which builds close-in surveillance drones for the military. “It wasn’t something that [the [Defense Department](#)] had said: ‘We need this. Let’s build a program around this.’”

Before 2001, [AeroVironment](#), through various small contracts, sold a drone called the Pointer in small numbers to the military. “Nobody ever really used them,” Conver said. Since the invasion of Afghanistan, the company has sold the military thousands of small drones.

The companies that design and manufacture drones have experienced massive growth that shows no sign of slowing, even with the [end of the war in Iraq](#) and the planned drawdown in [Afghanistan](#). The technology is significantly cheaper than traditional aircraft, and its potential uses increase as the craft become faster and stealthier.

[Teal Group](#), a Fairfax market analysis firm, estimates that nearly \$100 billion will be spent globally on drones between now and 2019.

“The needs for [unmanned aerial vehicles] are unsatisfied,” said [Phil Finnegan](#), Teal Group’s director of corporate analysis. “The military wants a lot more. Worldwide you have very limited adoption of UAVs, but foreign militaries have seen the success in Iraq and Afghanistan, and they want them.”

The rise of drones has been a small boon for Southern California, where the aerospace industry has contracted painfully in the past two decades. About 10,000 state residents are directly employed in the drone sector. And for national security reasons, much of the supply chain is kept onshore, generating jobs among contractors and subcontractors.

[General Atomics Aeronautical Systems](#), which makes the Predator and the next-generation Reaper drone, is in Poway, north of San Diego. AeroVironment, which makes an array of backpackable mini-drones, such as the Raven and the Wasp, is in Simi Valley.

[Northrop Grumman](#) is testing the X-47B, a carrier-based fighter drone, for the Navy in Palmdale. The RQ-170, the stealth drone manufactured by [Lockheed Martin](#) and used by the military and the [CIA](#), is believed to have emerged from the company’s classified facility, the Skunk Works, also in Palmdale, near [Edwards Air Force Base](#).

## **The Gossamer Condor**

In the mid-1970s, [Paul MacCready](#), an aeronautical engineer and the first American to become a world gliding champion, needed cash fast to cover a bad loan he had guaranteed. MacCready, the founder of AeroVironment, and a team of engineers at the company decided to chase the Kremer Prize, the reward

for besting a challenge that had gone unmet for 20 years: a human-powered aircraft capable of flying a figure eight around two markers half a mile apart. In 1977, MacCready's Gossamer Condor, piloted by Bryan Allen, took the prize, then worth about \$100,000. Two years later Allen flew another version of the bird across the English Channel.

AeroVironment, which consulted on air quality, began a sideline in aviation firsts.

"You had these incredibly talented people attracted to something this cool," Conver said. "All the airplanes were extraordinarily light. All were focused on things that hadn't been done before."

The group eventually flew a solar-powered craft from Paris to England, built a working model of Leonardo da Vinci's flying machine and created a flying model of a pterodactyl.

In 1987, AeroVironment flew the first backpack-portable unmanned military aircraft, a nine-pound plane with a camera in its nose. It was called the Pointer.

"They were bought for evaluation," Conver said. "They were prototypes."

When the first Special Operations teams went into Afghanistan in October 2001, they brought with them two Pointer systems that they used for low-altitude surveillance. Soon, word was going up the chain that the troops wanted more Pointers for Afghanistan's difficult terrain. High above them, the Predator and Global Hawk were also proving themselves.

"The Predator is my most capable sensor in hunting down and killing al-Qaeda and Taliban leadership and is proving absolutely critical to our fight," Gen. Tommy Franks wrote in a 2003 Air Force background paper.

The drive for drones was on, and the effect on companies such as AeroVironment was profound. In 2001, the company had annual revenue of \$29.4 million. In the decade that followed, that number swelled to nearly \$300 million, nearly 85 percent of it from the sale of drones. The company, which employs 768 people, up from 163 in 2001, went public in 2007.

Since 2003, AeroVironment has won four bidding contests for drone contracts. It now dominates the mini-drone industry with its Raven, Wasp and Puma systems. All are controlled by a common console that looks like a handheld video game. With it, soldiers maneuver the craft and view a stabilized picture of what the drone is circling.

AeroVironment continues to create new models. It recently received a \$5 million contract for the Switchblade, a miniature killer drone laden with explosives that pinned-down troops could activate instead of calling in airstrikes. This flying bomb could be guided to a target from the console and then detonated.

## **The aerial torpedo**

The concept behind the very first drones has a lot in common with that of the Switchblade. Toward the end of World War I, Charles Kettering, an American engineer and inventor, developed what was called an aerial torpedo. It was guided by a gyroscope and could be flown at a target 40 miles away. It never saw action.

During World War II, the Germans deployed drone bombs that were launched from planes and steered

to the target by a pilot using a radio-controlled stick. The United States manufactured 15,000 drones for anti-aircraft practice at a plant in Southern California during the war, and the career of a woman then known as Norma Jean Dougherty, later Marilyn Monroe, was launched when an Army magazine published a photograph of her working in a drone factory. During the Vietnam War, unmanned craft were programmed to fly a particular route and take still photographs.

All this activity took place on the margins of warfare. The great problem afflicting drones was a lack of endurance in the air. The things kept crashing. That was the defect Karem set out to fix.

Karem wanted to increase the endurance of drones, some of which were crashing every 20 hours, by a factor of 100.

Karem was born in Baghdad, the son of a Jewish merchant who moved the family to Israel in 1951. He developed an early fascination with building aircraft and gravitated toward drones in the early 1970s when Israeli aviation engineers tried to satisfy an operational need for real-time, front-line intelligence.

“My preoccupation with UAVs continued for 30 years,” Karem said.

After leaving the Israeli air force and working for a defense contractor, Karem grew frustrated at his efforts to start his own business building drones in Israel and thought he would have more success in California.

The flight of the Albatross led Karem, with the support of DARPA, to develop the Amber drone, which was stocked with custom-built components, including a powerful flight control computer, and could be configured for surveillance or attack missions. He also developed a lower-technology, export version called the Gnat 750.

Karem’s drones were met with some skepticism. The military, he said, thought “they were skinny in shape” and unlikely to be robust enough for operations.

“Luckily for me, industry didn’t take my efforts all that seriously until Amber” proved successful, Karem said.

Karem began to scale up to full production but found himself overextended financially when the military decided not to pursue large-scale development of the Amber. Karem sold his company to Hughes Aircraft, which, in turn, sold it to General Atomics, a privately held firm that earns an estimated \$600 million per year from defense contracts. Karem remained on as a consultant.

In 1993, James Woolsey, then the new director of the CIA, found himself frustrated by the intelligence from satellites flying over [Bosnia](#). He had known Karem for several years and turned to General Atomics and Karem for a vehicle that could provide what drone builders call a “persistent stare.” Pentagon experts had said it would take years and many millions to develop a prototype.

The Gnat 750, operated from an abandoned airfield in Albania, first flew over Bosnia in February 1994.

“I could sit in my office, call up a classified channel and in an early version of e-mail type messages to a guy in Albania asking him to zoom in on things,” Woolsey said.

The data had a long way to go to reach Woolsey. It was relayed from the Gnat to a manned aircraft and then to the ground station and then to a satellite and from there to CIA headquarters in Langley.

To streamline the process, and fit in a satellite communications system, General Atomics enlarged the airframe and added a bulbous nose to the Gnat's fuselage.

The Predator A was born. It first flew in July 1994.

By then, Karem had moved on. He later helped develop a drone helicopter, the A160 Hummingbird, a venture that was acquired by [Boeing](#) in 2004.

He has abandoned drones to pursue a new dream at his offices in Lake Forest: A Boeing 737-size passenger plane capable of taking off vertically and landing like a helicopter. Such an advance, Karem said, would scupper the need for high-speed rail and allow planes to commute between the downtowns of different cities.

Karem calls it an "aerotrain," and the 74-year-old wants it built before he retires.

"I never fail," he said.

Staff researcher Julie Tate contributed to this report.

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