Defying Gravity

A small Swiss firm develops an innovative G suit for fighter pilots BY MICHAEL BEHAR

Col. Hank Morrow, commander of the 149th Fighter Wing of the Texas Air National Guard, has been flying for more than two decades. In that time, he has seen aircraft push the high-performance envelope: planes today are so fast and nimble that standard evasive maneuvers can add nine times the weight of gravity, or nine g's, to the mass of a pilot's body. That amount of force causes fatigue, blackouts, even death as gravity drives blood and oxygen from the brain, lungs and heart. G suits are supposed to protect pilots by filling with compressed air and squeezing the lower extremities to shove bodily fluids upward. Yet G-suit technology has stagnated for almost half a century, while rapid innovations in aircraft design have put many pilots at the mercy of their machines. All that could change if the air force chooses to outfit its aviators with a revolutionary liquid-filled G suit called the Libelle.

PILOTS sing the praises of the Libelle G suit.

The suit is the brainchild of Andreas Reinhard, a former Swiss Air Force fighter pilot turned inventor and founder of Life Support Systems, a company he launched in 1996 to develop the Libelle. Instead of using air, the Libelle forms a liquid barrier around the pilot, much like a baby is protected in the womb. Morrow recently tested the suit at Edwards Air Force Base in California and was so ecstatic with the results that he told the members of the Libelle team he would write them a personal check on the spot if they would sell him one.

Reinhard says he first got the idea for the Libelle—the German word for "dragonfly"—in 1987, when he was still in the Swiss Air Force. He was inspired by the dragonfly because it is the only animal that can withstand 30 g's of force, because its cardiac system is encased in liquid. "After a dogfight training session, I was extremely exhausted," he recalls. "I imagined filling the whole cockpit with a fluid that had the same viscosity and density of blood."

In crafting the Libelle, Reinhard revived a concept developed in the 1940s, when antigravity suits first appeared. The first suit was developed in Canada by Wilbur Franks of the University of Toronto. Franks found that when he suspended glass test tubes in water, they didn't break in the centrifuge. He applied this observation to a crude prototype suit by sandwiching a layer of water between two rubber panels. Later he devised a workable suit with air bladders; his basic design is more or less identical to what pilots currently use.

In seeking to improve today's suits, one of the first challenges for Reinhard and his engineers was to find a liquid that could absorb g forces but that was nontoxic and nonflammable. After making several prototype suits, including one filled with silicone ("like what's in breast implants," Reinhard notes), the team settled on distilled water spiked with a secret "special material" that prevents the Libelle from freezing should the pilot eject at high altitudes. The liquid—housed in two-inch-wide channels that run the length of the arms, legs and torso—is harmless enough to drink, even serving as an emergency ration for a downed pilot, Reinhard says.

Another task was finding a fabric that could dynamically respond to sudden changes in gravity. "We had to cover the whole body with a material that wouldn't stretch under pressure," Reinhard remarks. "At the same time, the suit had to be flexible so the

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pilots could move." After unsuccessfully searching fabric mills, the Libelle's engineers decided to make their own material. They devised a hybrid weave, blending Du Pont's flame-resistant Nomex fabric with tough Kevlar aramid fibers, that is "rigid on the horizontal axis but flexible vertically."

As g forces intensify during a hypersonic turn or downward spiral, the Libelle's liquid tubes compress, pulling with them the surrounding fabric. Imagine a self-contained hydrostatic vise in which water progressively squeezes the pilot as he hits the afterburner. A conventional G suit takes a few seconds to respond, because air must be pumped into various bladders from the plane's onboard pneumatic system. "With the Libelle, you didn't feel it working," says Lt. Col. Christian Ledet, a senior flight surgeon with the Iowa Air National Guard who also tested the suit at Edwards. "It was just kind of there, responding to the laws of physics, doing its job before you even knew it."

The Libelle suit is the first of its kind to reach production and has proved a worthy competitor to the most advanced air-filled suits, such as the U.S. Air Force's Combat Edge system. During several test flights at Edwards, one pilot wore the Libelle, while another, seated in the rear cockpit, donned the Combat Edge. "We went up to 18,000 feet, hit the afterburner and started 9-g spirals until the guy in the backseat said uncle," Morrow remembers. "It was easier to breathe and easier to communicate" in the Libelle suit, Ledet confirms. "When I came back, I didn't feel like a wrung-out wet rag. With a regular G suit I can't even get out of the cockpit."

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Two years after starting the Swiss-based Life Support Systems, Reinhard formed an alliance with Autoflug, a German producer of aircraft rescue and safety equipment, to help handle the final development and marketing of the Libelle. Besides the U.S. tests, a number of test pilots in the German and Netherlands air forces have flown in the suit, trials that proved a success. The company's aim now is to convince Britain, Germany, Italy and Spain to put the Libelle on the Eurofighter, a next-generation aircraft that the

four countries are building to eventually replace the Mig-29, the Phantom and the Tornado.

In October the U.S. Department of Defense chose the Libelle for its foreign comparative testing (FCT) program. Reinhard contends that "the Pentagon process is too slow." But in this case, patience could pay off: the yearlong evaluation will begin this spring. Assuming it passes with high marks, the "Libelle could be recommended for an air force–wide buy," says Maj. John Ryan, program manager at the air force FCT office. There are no guarantees, but air force procurement of the Libelle would most likely make Reinhard, Autoflug and the Libelle's private investors a bundle of cash.

Although first-round trials at Edwards and in Europe were promising, Ulf Balldin, a senior scientist at the Wyle Laboratories unit in Houston, Tex., and president of the International Academy of Aviation and Space Medicine, feels that medical evidence establishing the Libelle's outright superiority is lacking. "I have been working with G suits for many years, and as far as I'm concerned it has not been tested and proven properly," he says. But Reinhard does not agree: "After a few hundred centrifuge rides and hundreds of test flights with more than 80 different subjects, we believe we are ready to go to market."

Any doubts about the Libelle should be sorted out by the rigorous FCT program, when pilots, physicians and engineers will poke and prod the suit to ensure that it is the best technology available. "We'll do sortie after sortie to see where the suit has merit, where it's better and where it's not as good," explains Col. Peter Demitry, chief of the U.S. Air Combat Command's Human Systems Integration Division.

In the meantime, Reinhard and teams at Life Support Systems and Autoflug are tweaking the Libelle design to satisfy the demanding specs mandated by potential customers (U.S. pilots want more pockets) while continuing to make their pitch to the Eurofighter contingent. As for a windfall sale to the Pentagon, Reinhard and company will have to wait until at least 2003. But if the exalted testimony from test pilots is any measure, it's hard to believe that the Libelle won't come out on top. SA

Michael Behar is a Washington, D.C.–based science and technology journalist and a former senior editor at Wired *magazine.*