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Ups and Downs of Jetpacks

Daredevil jetpack travel has never really caught on with commuters, and for good reason. But is all that about to change?

By day Stuart Ross is an airline pilot. By night he dreams of flying. The sort of flight he has in mind is a million miles from his daily routine: no air traffic control, no passengers, and definitely no wings. He dreams of leaping into the air from a standing start, jumping clear over his house, halting motionless hundreds of meters up to admire the view, and then descending gracefully back onto his lawn.

Ross is tantalizingly close to that goal. He has spent two years and £50,000 building his own shiny jetpack. Along the way, he has scorched his clothes and garden with a fuel so unstable that in a recent accident it turned a section of the United Kingdom's busiest motorway into a blazing inferno. And he has almost broken his neck. But at last he's nearly ready to step outside and take to the air.

The first jetpack flew more than 40 years ago, so you might expect that by now designs would be impressively slick—perhaps even ready for daredevil commuters who want to feel the wind on their cheeks. Yet you still can't buy or even rent one. Those that exist remain firmly in the hands

of a few diehards like Ross, one of a rare breed of self-taught engineers struggling to overcome the technology's inherent limitations and immense dangers. Their story is itself a white knuckle ride, a tale of lethal rocket fuel, technological bravado, and death-defying bravery but also of greed, kidnapping, and even murder. So what has gone wrong? And will the jetpack ever live up to its promise?

The story begins in the late 1940s with Wendell Moore, chief engineer at the Bell Aircraft Company. Moore was given the task of designing small thrusters to help control the Bell X-1 rocket plane, the first craft to smash the sound barrier. He decided that the best fuel for these thrusters was hydrogen peroxide—a powerful oxidizing agent and bleach. Peroxide decomposes into oxygen and steam when it comes into contact with certain metal catalysts such as silver or copper. Liquid peroxide is easier to handle than most rocket fuels, and the exhaust gases emerge at a few hundred degrees centigrade rather than the thousands that other fuels generate. As a low-thrust fuel, it's hard to beat.

It didn't take long for Moore to think of strapping his thruster onto the back of a man and using it to lift him off the ground. When he patented the idea in the early 1960s, the U.S. army became interested and gave him $150,000 to build a prototype.

Moore's design looks uncannily like the fictional jetpacks used by Buck Rogers and the Jetsons. However, his device is strictly speaking a rocketpack, powered by a peroxide rocket engine rather than a jet. The pilots who flew it during its early tests called the device a rocketbelt, and the name stuck.

The pilot carries the peroxide fuel in two steel tanks mounted on a backpack. A third tank holds pressurized nitrogen that forces the peroxide through a stack of silver mesh disks. The silver catalyzes the decomposition of perox-

ide into steam and oxygen at 600°C, producing a more than 600-fold increase in volume. This rapid expansion forces the gases through two steel hoses aimed toward the ground at a slight angle behind the pilot's back. The expanding gases accelerate downward and force the machine off the ground, carrying the pilot into the air.

Initial demonstrations stunned the U.S. army. The rocketbelt could reach speeds of up to 100 kilometers per hour in seconds, just the thing to leapfrog soldiers from one spot on the battlefield to another. In its contract with Bell, the army even stipulated that an average GI should be able to fly a rocketbelt with minimal training. So Moore asked Bill Suitor, a friend's teenage son, whether he wanted to try it out. He jumped at the chance, and Suitor eventually became the most famous rocketbelt pilot in the world. He flew the device for American presidents, doubled for Sean Connery in an escape scene in the James Bond movie *Thunderball,* and performed at the opening ceremony of the 1984 Olympics.

Wherever he flew, Suitor won rapturous applause. But these stunt flights glossed over the rocketbelt's one serious disadvantage. The flight at the 1984 Olympics was brief, not because of TV scheduling or modesty on Suitor's part, but because even with full tanks, the rocketbelt can fly for only 25 seconds. Its optimum fuel load is very limited, says Mark Wells, an engineer and rocketbelt expert at NASA's Marshall Space Flight Center in Alabama. "Adding more gives increasingly diminished returns since you must use fuel to lift the extra fuel you carry."

Not only do rocketbelts have limited fuel capacity, but they use this fuel inefficiently compared with a propeller engine, says Wells. A propeller works by accelerating a large amount of air to relatively low speed—a few hundred kilo-

meters per hour—whereas a rocket accelerates a smaller amount of gas to several thousand kilometers per hour. A rocket engine is most efficient at converting its fuel into thrust when moving close to the speed of its exhaust velocity—when the relative velocity of the exhaust and the atmosphere is a minimum. But a rocketbelt is used to simply hover or move relatively slowly, so this is a very inefficient way to fly.

Worse, hydrogen peroxide is a "monopropellant"—it isn't burned or combined with anything else—so pilots must carry all the fuel they need on their back. A jet engine, on the other hand, combines a combustible fuel with oxygen from the atmosphere, which does not have to be carried on board.

So, back in the early 1960s Moore embarked on a project to replace it with a more efficient jet engine, which compresses air between rotating turbines and burns it with kerosene. In 1965, he received $3 million from the U.S. Advanced Research Projects Agency to build a genuine jetpack. His calculations suggested that it should be able to fly at well over 100 kilometers per hour for up to 25 minutes. In 1969, the researchers flew the jetpack for the first time. Its speed and endurance impressed ARPA, but soon after, Moore died suddenly of a heart attack. The project stalled and never recovered.

Over the next 30 years, rocketbelt research continued in a limited way. Copies of Moore's rocketbelt made numerous appearances at major public events, but nobody could find a way round the fundamental 25-second limit, and this killed off almost all military and commercial interest.

The next big hope for personal flight came in 1999, when a company called Millennium Jet based in Santa Clara, California, began building a flying machine called the

SoloTrek. Instead of relying on a rocket or jet engine, the SoloTrek used a piston engine to drive a propeller above the pilot's head. According to company president Michael Moshier, SoloTrek was capable of hovering for up to three hours, flying at 100 kilometers per hour, and traveling more than 200 kilometers.

SoloTrek could hardly be called a jetpack, as the pilot was strapped into a kind of exoskeleton that took the weight of the engine and propeller while the machine was on the ground. But it achieved the same aim. In numerous flight trials at NASA's Ames Research Center in California, the machine appeared to perform perfectly. Then disaster struck.

For safety reasons, the machine was suspended on a retracting tether during test flights. The tether system was designed to automatically reel in as the SoloTrek rose from the ground, so that if the device lost power it could be lowered gently instead of plummeting. But during a flight shortly after a rain shower in 2002, the tether failed to retract and tangled in the propeller blades, which then disintegrated. The machine and pilot dropped to the ground, and while the pilot walked away unharmed, the vehicle was damaged beyond repair. Unable to stick to the tight development schedule that its backers demanded, Millennium Jet lost its funding, and in 2003 it closed down.

You might think that the successive failures of the rocketbelt, jetpack, and SoloTrek would have killed off the dream of simply strapping on an engine and leaping into the sky. Yet a small number of enthusiasts are keeping that dream alive. Part of the reason is that with just a couple of working rocketbelts worldwide, they can command upward of $20,000 per flight for film and publicity appearances. That kind of money focuses the mind. Unfortunately it doesn't always bring out the best in people.

In 1992, onetime insurance salesman and entrepreneur Brad Barker formed a company to build a rocketbelt with two partners: Joe Wright, a businessman based in Houston, and Larry Stanley, an engineer who owned an oil well in Texas. By 1994, they had a working prototype that they called the Rocketbelt-2000 or RB-2000. They even asked Suitor to fly it for them.

But the partnership soon broke down. First Stanley accused Barker of defrauding the company. Then Barker attacked Stanley and went into hiding, taking the RB-2000 with him. In July 1998, Wright was found beaten to death at his home. Police investigators questioned Barker but released him after three days. The following year Stanley took Barker to court to recover lost earnings. The judge awarded Stanley sole ownership of the RB-2000 and over $10 million in costs and damages. But when Barker refused to cough up, Stanley kidnapped him, tied him up, and held him captive in a box. After eight days Barker managed to escape. Police then arrested Stanley, and in 2002 he was sentenced to life in prison, since reduced to eight years. The rocketbelt has never been found.

The story of the RB-2000 has not deterred Stuart Ross, however. Two years ago, Ross, who lives in England in a peaceful Sussex village, began to build his own rocketbelt using photographs of existing designs and some equipment and plans bought from a failed rocketbelt builder in the United States. At the same time, Ross also had to learn to handle the peroxide rocket fuel.

Industrial-strength peroxide has a concentration of roughly 60 percent. To work as rocket fuel, this must be distilled to reach 87 to 90 percent. At this strength, it is hugely reactive: Spill 90 percent peroxide onto a piece of wood and

it can burst into flames. If it touches copper or silver, it decomposes instantly into hot steam and oxygen gas, which can react explosively if it comes into contact with anything flammable.

To help prevent such accidents, peroxide manufacturers add stabilizers to their product. The identity of these stabilizers is a commercial secret, but they work by bonding to the surface of metals to prevent the peroxide decomposing. This is bad news for people like Ross: the stabilizers stop the silver catalyzing the fuel's decomposition, making it useless. In one incident 20 years ago, a rocketbelt pilot who was using peroxide claimed that his machine failed in midflight because traces of stabilizer had somehow contaminated the rocketbelt engine. The pilot then successfully sued his fuel supplier, with the result that manufacturers now refuse to supply concentrated peroxide to individuals.

Fortunately for Ross and other rocketbelt flyers, they can turn to Eric Bengtsson, a chemical engineer based in Sweden. Bengtsson specializes in making peroxide and has developed a stabilizer that does not contaminate the silver catalysts used in rocketbelts. "I know how this class of chemical works and that some stabilizers are less problematic than others. I eventually came across one that stabilized the peroxide without contaminating silver," he says. He removes the manufacturer's stabilizer and replaces the stuff with his own and is happy to supply enthusiasts with fuel or even help them set up their own distillery.

The risk of accident due to spillage remains. Just over a month ago, for example, a delivery of concentrated hydrogen peroxide fuel on its way to Ross sprang a leak on one of the United Kingdom's busiest motorways, the M25. The truck that was carrying it—and a large section of the road—burst into flames, shutting the motorway for hours and causing chaos, though there were no serious injuries.

Ross finally completed his rocketbelt earlier this year, and on April 20 he attempted his first takeoff. Just in case anything went wrong he tethered the rocketbelt to a safety cable, but the device performed perfectly. Over the next few months he flew a total of 12 tethered flights, and all went well. Then in August, on his 13th flight, his luck ran out.

Shortly after Ross lifted off outside his home, the rocketbelt's throttle jammed open. Attached to the ground by a cable, Ross was flung from side to side like a deflating balloon. Eventually he was able to cut the fuel supply, but the incident could easily have killed him. "I was worried that the steel tether would wrap around my neck," he says.

The problem stemmed from the huge pressures needed to make a rocketbelt fly. To pump the peroxide into the decomposition chamber, the liquid is pressurized to about 60 atmospheres. The rocketbelt can only be throttled by controlling this flow, but small changes in the flow can have a dramatic impact on thrust. The most difficult challenge that Ross and other rocketbelt builders face is to construct a throttle that can safely control the amount of peroxide passing into the decomposition chamber. Numerous enthusiasts have fallen at this hurdle, and Ross's accident showed him how badly things can go wrong.

It is no trivial engineering challenge. Fully fueled, Ross and his rocketbelt weigh about 133 kilograms. To create enough thrust to exactly balance this weight, the throttle must allow precisely 0.87 liters of peroxide per second into the decomposition chamber. The maximum safe flow rate, however, is just 0.91 liters per second, which creates 150 kilograms of thrust, enough to accelerate the pilot to substantial speeds. The throttle has to be able to smoothly and reliably control this tiny change. "I know of no other application where the tolerances are so tight," says Ross.

The throttle he used on his August flight consisted of a

piston in a tube that has a row of inlet holes on one side and an exit port on the other. Withdrawing the piston uncovers the holes one after another, increasing the flow of peroxide in small increments.

Ross tested the design in numerous static runs with the rocketbelt anchored to the ground. The flow through the throttle at these pressures is hugely complex, and the tests were designed to find out whether it was reliable under all the conditions the device would be likely to experience during flight. Everything seemed fine.

However, during his fateful flight Ross opened the throttle too quickly. The sudden increase in pressure pushed the piston to its fully open position and held it there, a situation known as hydraulic lock. Ross hadn't realized his throttle could jam like that. "My next flight was going to be untethered," he says. "There's enough fuel to reach 8,000 feet if you fly straight up."

Ross approached Matt Linfield, an engineer who runs Linfield Precision Engineering near Ross's home, to come up with a better throttle. Linfield chose a design based on a needle valve, commonly used in the automotive and aerospace industry, in which a long, tapered needle sits inside a similarly shaped sleeve. The valve is opened by withdrawing the piston, thus opening up a gap between the needle and the sleeve and allowing fuel to flow through. Pushing the piston back into the sleeve closes the valve. The valve is fail safe: fuel flows in at the wider end of the sleeve and out from the narrow end, so it exerts pressure on the piston that ensures the default position is shut. "You always want it to be fail safe," says Linfield.

Ross is now putting the new design through its paces in static tests. So far everything looks good, and Ross believes he will be airborne before the end of the year. Eventually he

plans to fly the device for a fee at high-profile events around the world, just as Suitor did in 1984.

But what about the rest of us? Ross has no illusions about the future of rocketbelts. Their limited flight time and inherent danger mean that few people will ever get to fly one. Ross has little doubt that this can only be a good thing. "Can you imagine if everyone had one of these?" he says. "It would be chaos."