

THE PARALYZED PILOT

FPV TECHNOLOGY KNOWS NO BOUNDS

BY LUCIDITY, ROSWELL FLIGHT TEST CREW



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Henry Evans, who woke up one morning to find himself trapped inside his own body by an extremely rare and undiagnosed birth defect, learns to fly using First-Person View (FPV) technology to exceed the limitations of his physical self — just like the rest of us.



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1 Like all new RC pilots, Henry Evans crashed when he was just getting started. Here, his Parrot AR Drone came to rest at the base of a rock that proved to be beyond the range of his video transmitter. Photo courtesy of Henry Evans

2 Henry Evans sits in the foreground wearing a pair of Oculus Rift video goggles, which also serve as his primary control system for his aircraft. In the background, this Parrot AR Drone lifts off and heads out for another adventure. Photo courtesy of Henry Evans.

3 Here, Henry Evans sports another of his innovations attached to the side of his hat: the Laser Finger. Henry wanted to find a way for a quadriplegic to be able to turn lights on and off without help, so he teamed up with the Palo Alto High School Robotics Team, mentored by Chris Tacklind. The project was funded by MIT/Lemelson in 2007. Photo courtesy of Henry Evans.



4 Henry shaves himself for the first time in 10 years with help from the PR2 robot, which he uses as a body surrogate. Photo courtesy Henry Evans.



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5 Bryan Galusha selected the inexpensive Parrot AR Drone to serve as Henry Evans's aerial avatar, owing to its extremely stable flight characteristics, hands-free hover capability, and the ease of adapting its control inputs to work with the Oculus Rift video goggles.

None of us can fly — not like a bird, not like Superman. We cannot through willpower or physical exertion claw our way into the sky. If we want to experience flight — or avail ourselves of its many advantages, such as high-speed travel or an aerial perspective — we must rely on technology, whether it's a Boeing 747, a wingsuit, or an FPV multirotor.

So, in that regard, Henry Evans is pretty much like the rest of us. However, he is different from most of us in that he is paralyzed below the neck and unable to speak, but he didn't let that stop him from learning how to fly.

Henry's restless spirit of adventure and his dedication to showing how the emerging fields of low-cost robotics and personal drone aircraft can improve all of our lives is perfectly embodied in a quote that he sends out at the bottom of all of his e-mails:

"If you want something, you look for options. If you don't want it, you look for excuses."

THE AMERICAN DREAM

Up until the fateful morning of August 29, 2002, when he woke to discover that he could neither speak nor move, Henry lived a life that could fairly be described as the American Dream: he attended Notre Dame University, where he graduated with bachelors' degrees in Accounting and German, then went on to Stanford and earned his Masters in Business Administration (MBA).

After college, he married his beautiful high school sweetheart, Jane, and the couple had four happy, healthy children. Henry went to work in Silicon Valley and climbed the career ladder — eventually becoming the Corporate Financial Officer (CFO) for a high-tech firm.

On December 13, 2001, Henry and his family purchased their first home in Los Altos Hills, on an acreage only about three miles south of Palo Alto. The house was a bit of a fixer-upper, but the family was looking forward to working on it together.

Less than a year later, Henry stood on his own two feet for the last time.

He felt fine when he went to bed on the evening of August 28, having just seen his doctor for his annual physical and received a clean bill of health.

Henry was brought down by a stroke-like condition called basilar artery dissection — a birth defect that had gone unnoticed throughout his entire life, and is as rare as it is devastating.

While I was exchanging e-mails with Henry in preparation for writing this story, I asked him if he would like me to include some information about a charity doing research or looking at treatment for the condition.

"It's too rare to have its own foundation," he told me.

In 2013, Henry gave a TED talk about his story and his use of robotics to exceed the limitations of his own body. He delivered that speech from his home via a telepresence system, using a voice synthesizer that rendered his words in the style of famed quadriplegic physicist Stephen Hawking.

During that talk, he recalled the aftermath of that life-altering night. >>



When it is released, Henry Evans's engineering team is planning to upgrade him to the Parrot Bebop, which will provide a much more powerful on-board processor and a 1080p high-definition video camera.

» "It took me several years, but with the help of an incredibly supportive family, I decided that life was still worth living," he told a rapt audience. "I became fascinated with using technology to help the severely disabled."

ROBOTS FOR HUMANITY

To get himself back in touch with the world, Henry first deployed a head tracker. Capable of detecting the small movements he was still able to make with his head and neck, the device allowed him to interface with a computer to write, send e-mail, and surf the web.

"One day I was lying in bed watching CNN when I was amazed by Professor Charlie Kemp of the Healthcare Robotics Lab at Georgia Tech, demonstrating a PR2 robot. I e-mailed Charlie and my friend Steve Cousins of Willow Garage, and we formed the 'Robots for Humanity Project,'" Henry told the TED audience. "For about two years, Robots for Humanity developed ways for me to use the PR2 as my body surrogate."

Using the PR2 as his arms, legs, hands, and feet, he was able to accomplish many of the daily tasks that most of us take for granted, like opening the refrigerator, shaving, tidying up the house, and handing out Halloween candy to trick-or-treaters.

"I saw new and previously

unthinkable possibilities to live, and contribute — both for myself and others in my circumstance," Henry said.

He then explained that all of us share his circumstances: we're all limited to the physical capabilities of our own bodies. He may be slightly more limited than most of us, but all of us need technological assistance to accomplish many of the tasks we take for granted each day.

"All of us have disabilities in one form or another," he said. "For example, if either of us wants to go 60 miles an hour, both of us will need an assistive device called a 'car.' Your disability does not make you any less of a person, and neither does mine."

The next challenge Henry set for himself was achieving humanity's oldest and most powerful dream: the dream of flight.

"I was lying in bed one day, wishing I could go outside, when it occurred to me that all I needed to bring were my retinas — not my whole motionless body," he told me in an e-mail. "So I decided I would use a camera drone."

He continued: "There were enormous technological hurdles; especially because I am paralyzed, and not even an engineer."

Wanting to accomplish something he wasn't even sure was possible, Henry did what the rest of us do: he went online and started asking questions.

"I was piloting camera drones with my limited head movements a few weeks later," he wrote.

UP, UP AND AWAY!

Bryan Galusha of Fighting Walrus Radio, who lives in the Bay Area, was one of the individuals that Henry got in touch with online.

"I'm on the San Francisco Drone Meetup Group," Bryan said. "Henry posted to the comments section that he was a mute quadriplegic and he wanted someone to help him fly. So I got together with my team and we put together a prototype."

"I knew it was definitely going to be a challenge, but we had already been looking at the Oculus Rift and we had one on order. We thought that might work, basically, by sensing Henry's head movements he could control the drone."

Bryan settled on the ubiquitous Parrot AR Drone as his aerial platform.

"The Parrot was the easiest to integrate with the Oculus Rift for video and the easiest to control," he explained. "It has a great hands-free hover capability — it will hold altitude and position if you don't give it any inputs, and I knew that would be key for this type of interface."

The preliminary control system only allowed Henry to control yaw, pitch and roll, according to Bryan. He could not launch or land the aircraft, nor could he increase or decrease the throttle in order to change altitude.

"It was very simple," said Bryan. "If he twisted his head, that gave the aircraft yaw input. If he tipped his head side-to-side, that controlled roll, and backwards and forwards determined pitch."

Eventually, Bryan handed off the project to Will Hendry, who recently graduated from the Georgia Institute of Technology with a background in biomedical engineering and a professional focus on computational neuroscience.

Will transitioned the control interface away from the iPad Bryan and his team had been using to a laptop computer and added a mouse. Although Henry was incapable of moving the mouse, he could click on one of its buttons with a single thumb that he retained the ability to use.

By pressing and holding the

mouse button, Henry is able to use his front-to-back head tilt to temporarily control the throttle, rather than aircraft pitch. Double-clicking on the mouse allows him to launch and land the aircraft.

By all accounts, Henry has become quite a capable pilot. He recalled a game that he played with Bryan and Will, along with several other friends.

"We wanted to test our dexterity as pilots," Henry wrote. "No one else who was playing was handicapped. The goal was to take off in a sheltered area, fly about 100 feet across an open, but quite windy, field, then hit a 4x4 post."

"I made it into the final, but ultimately lost to Bryan Galusha. I had to take solace in the fact that, one, I convincingly beat three able-bodied people and, two, I only missed the pole by a foot — but hats off to Bryan!"

DREAMING A NEW DREAM

The ultimate result of Henry's terrible personal loss may be to benefit all of humanity, for through that experience, he came to understand that all of us face limitations which are crucial

impediments to achieving our full potential. All on our own, none of us can travel through the air at 500 miles per hour, instantaneously transmit words and images around the globe, peer into the microscopic world, or venture beneath the surface of the ocean for longer than we can hold a single breath.

In that way, Henry is a pioneer — moving out ahead of the rest of us, finding the narrow paths that will one day grow to become trails, roads, and highways. I asked him what he thinks the future will look like.

"Some single-purpose robots will be released commercially in the next few years to perform routine and/or dangerous jobs currently done by minimum wage workers," he wrote. "In general, though, the trend will be towards the development of co-robots which assist, but do not completely replace, humans."

It's a vision that Will shares: "Robots will be absolutely everywhere. As they become cheaper, they will become more prevalent in everyday life. For people like Henry, it will mean a more independent lifestyle, because many

tasks that would require a caretaker could be performed by the robots.

"As for the larger community, there will be large changes in both the everyday way that we make and do things. Think about the Industrial Revolution, but on an individual scale. We're still a long way off, but these changes are coming: look at the ideas to deliver packages with drones or self-driving cars."

Until that future arrives, Henry asked me to carry forth a message to everyone out there who is doing FPV and participating in the home-built drone revolution.

This was his request: "Figure out a way to use this technology to improve the plight of the bedridden, the elderly and the economically underprivileged through tele-tourism."

FPV flying can be a wonderful hobby, but it can also be so much more. Those of us who have the privilege of being active in this pursuit today are literally holding the future in our hands — let's get out there and make sure it's a good one! **RC|SF**

FIGHTING WALRUS RADIO

Bryan Galusha launched Fighting Walrus Radio as a crowd-funding project on Indiegogo in March 2013. His campaign raised more than \$23,000, allowing him to move forward with his plan to develop an attachment for iOS devices capable of sending and receiving signals to Small Unmanned Aircraft Systems (SUAS) using the MAVLink protocol.

Employing this standard allows the system to work with the Parrot AR Drone, as well as with unmanned platforms using the Ardupilot flight control system.

Transmitting on either 915 MHz or 433 MHz, to comply with radio spectrum restrictions in different countries, the Fighting Walrus Radio allows the user to view aircraft telemetry on an iPad or iPhone, as well as logging flight data and updating waypoints in real time using a simple touch-screen interface.

For more information, visit: www.fightingwalrus.com.

The Fighting Walrus Radio transceiver attaches to the charge port on an iPad or iPhone, providing real-time telemetry and waypoint control up to a range of one mile.

This screen capture of the Fighting Walrus Radio user interface on the iPad reveals the system's core functionality: a waypoint navigation system overlaid with Google Earth imagery, as well as real-time aircraft telemetry — including an artificial horizon.

