THE MAN MACHINE INTERFACE

Maj. Chris Backus, a pilot-physician, stands in front of his airframe, a C-17 Globemaster III, on Joint Base Elmendorf-Richardson, Alaska, March 9, 2016. Pilot-physicians are involved in the research, development, testing, and evaluation of new and current Air Force systems and missions. Backus is currently assigned to the 673rd Medical Group.

PILOT-PHYSICIANS USE DUAL EXPERTISE TO SAVE LIVES IN AIRCRAFT

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REFERRED TO BY PILOTS AS THE "BADDEST JET ON THE PLANET," THE F-22 RAPTOR HAS A FACTSHEET THAT READS LIKE A FUTURISTIC SPACECRAFT AND BOASTS THAT IT "CANNOT BE MATCHED BY ANY KNOWN OR PROJECTED FIGHTER AIRCRAFT." ON PAPER, ITS CAPABILITIES GIVE PILOTS COMPLETE DOMINANCE OF THE BATTLESPACE.

Yet, in May of 2011, the Air Force grounded its entire fleet of F-22s for four months after pilots reported unexplained episodes of disorientation, nausea and shortness of breath during flight.

Investigators and engineers from the Air Force and Lockheed Martin, the developer of the world's most advanced fighter jet, were stumped as to the cause.

When the Raptors resumed limited operations with flight altitude restrictions, there were still dozens of documented accounts of pilots suffering from hypoxia-like symptoms.

That's when the Air Force turned to its cadre of pilot-physicians.

Lt. Col. Jay Flottmann, pilot-physician and 325th Fighter Wing chief of flight safety, explains how a valve in the upper pressure garment and the shape and the size of oxygen delivery hoses and connection points contributed to previously unexplained physiological issues during F-22 flights.
PHOTO // SENIOR AIRMAN CHRISTINA BROWNLOW

Sprinkled strategically around the world, pilot-physicians combine their experience as pilots with their expertise as medical doctors to scrutinize the physiological interaction of humans and the aircraft they fly. In a case like that of the F-22, the technologically bilingual skillset of the pilot-physician played an essential role in investigating aerial incidents and mishaps.

With enough data to form generalized theories, a group of current and former pilot-physicians sat down with engineers and aerospace physiologists to test the F-22's life support systems. Within a short time, evidence indicated the smoking gun was actually a two-part problem: the upper pressure garment of the G-suit assembly was inflating at improper times, which restricted the pilots' breathing, and a faulty hose and valve connection inside the onboard oxygen generating system unexpectedly reduced oxygen levels during high-G maneuvers.

"With any new airframe there will be issues. The F-22, which had concerns with the oxygen generating equipment, was a great example of this," said Maj. Christopher Backus, a C-17 Globemaster III pilot-physician. "(Lt. Col.) Jay 'Bones' Flottmann was the F-22 pilot-physician who worked the problem. Given his credibility as a pilot and his knowledge as a physician, he was able to rapidly rule out problems, which really aided in the determination."

Because Lt. Col. Flottman was a qualified F-22 pilot and extremely familiar with the aircraft's operating procedures and life support equipment, the investigative team diagnosed the root causes of the incidents more quickly. A redesign of the valve system was recommended and the Raptor soon returned to its full operational capability.

"Through great physiology research and the integration of the equipment during the centrifuge trials, (the F-22 investigative team) discovered that because of the valve problem, pilots were experiencing a buildup of carbon dioxide, which explained the symptoms," said Col. Kathryn Hughes, a 15-year pilot-physician who heads the Human Systems Integrations Directorate with the 711th Human Performance Wing at Wright-Patterson Air Force Base, Ohio. "The findings were preventative and detective medicine at their finest. This is exactly the reason why the pilot-physician exists."

Pilot-physicians, who average 12 years of study and training to qualify as both a pilot and doctor, have saved the Air Force billions of dollars, while thwarting the potential loss of aircrew lives.

"The Pilot-Physician Program provides a unique capability to ensure we are the world's greatest Air Force by applying the principles of Human Systems Integration to our five core mission areas: air and space superiority; intelligence, surveillance, and reconnaissance; rapid global mobility; global strike; (and) command and control," said Col. Bill Mueller, the director of the Air Force Pilot-Physician Program. "Pilot-physicians are Airmen with dual expertise in medicine and operations who can integrate health in the context of mission and optimize human performance."

Each of the 10 active members of this unique career field leaves behind a personal legacy that benefits the Air Force as a whole.

Backus checks a patient at the flight medicine clinic on Joint Base Elmendorf-Richardson, Alaska, March 9, 2016.
PHOTO // MASTER SGT. BRIAN FERGUSON

FINDING THEIR NICHE

One such legacy is that of Hughes. Aside from being a graduate from the Air Force Academy, she became a first assignment instructor pilot, flew on exchange with the Royal Air Force, and later supported operational testing of the F-35 Lightning II and the F-22 in her role as the 412th Aerospace Medicine Squadron commander and the chief of Aerospace Medicine at Edwards AFB, California. Becoming the first and only female pilot-physician in the Air Force, "FOG," as her aviation brethren call her, has led a five-year effort to eliminate aircraft accidents due to gravity induced loss of consciousness (G-LOC).

"Even before attending the Air Force Academy and becoming a pilot, I had an immense passion for medicine and always wanted to attend medical school; however, at the time of graduation, that was not an option," Hughes said. "I spent the next seven years as a T-38 (Talon) instructor pilot and flying reconnaissance missions on the RC-135 (Rivet Joint), but toward the end of that period, I knew that it was time for a change.

"When I was stationed at Offutt AFB, (Nebraska,) my father was living in Des Moines, Iowa, working as a forensic pathologist, and I'd go home to visit and assist in autopsies with him," she continued. "I told myself, if I'm interested watching autopsies on the weekends, medicine is something I must pursue."

Pursuing that passion, Hughes traveled to Washington, D.C., to interview for medical school knowing that, if selected, she would have to hang up her pilot wings. While there, she was quickly singled out by a sharp-eyed colonel who noticed the wings on her uniform.

"You there, with the wings on, we need you in the Pilot-Physician Program," said Peter Mapes, the pilot-physician colonel. Reluctant at the opportunity, Hughes replied, "Thanks anyways sir, I'd rather not go to medical school (just) to become a pilot again."

Hughes' application was accepted and she headed off to med school.

"Once I completed medical school and was back operational as a flight surgeon at Mountain Home AFB, (Idaho,) I realized there was an interesting dynamic and (trusting) relationship the pilots and I shared," she said. "When pilots saw that their flight surgeon wore pilot wings, they really knew they could trust me."

With that realization, Hughes applied for the program that Mapes had recruited her for seven years earlier.

When Hughes was accepted to the Pilot-Physician Program, she was given an assignment to the 190th Fighter Squadron at Gowen Field Air National Guard Base in Boise, Idaho, as an A-10 Thunderbolt II pilot-physician. It wasn't until her next assignment at the Royal Air Force Center of Aviation Medicine at RAF Henlow, United Kingdom, that she found her niche.

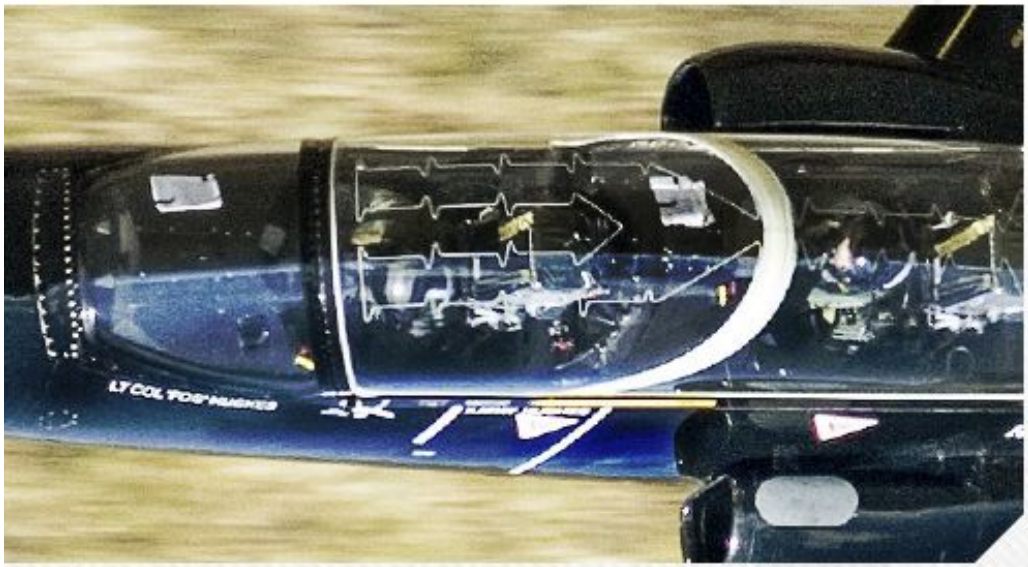
"Each pilot-physician finds where their priorities lay, what projects interest them, and what they are passionate about; then, they really focus on those issues," Hughes explained. "Within the pilot-physician career field, no one's pathway has been the same."

Col. Kathryn Hughes, a pilot-physician and director, Human Systems Integration, 711th Human Performance Wing, sits on the stairs of a centrifuge at Wright-Patterson Air Force Base, Ohio, April 22, 2016. Hughes, an A-10 Thunderbolt II pilot, was instrumental in the integration of the full-coverage G-suit into the Air Force inventory. PHOTO // MASTER SGT. BRIAN FERGUSON

FULL COVERAGE G-SUIT

In 2006, Hughes realized the true potential of the full coverage G-suit to mitigate G-induced loss of consciousness and its need to be integrated into the Air Force's high-G platforms. At that point, the Air Force was using an antiquated five-bladder G-suit that only covered 40 to 50 percent of the lower body.

The F-16 Fighting Falcon and F-15C Eagle regularly pull upwards of 9 Gs during intense maneuvers. That's the equivalent of taking a pilot's body weight and multiplying it by nine, meaning a 150-pound pilot would actually weigh nearly 1,400 pounds.



Hughes flies the Hawk in the "Mach Loop" while on exchange with the Royal Air Force. Hughes, an A-10 Thunderbolt II pilot, was instrumental in integrating the full-coverage G-suit into the Air Force inventory. (Courtesy photo)

Hughes began to question why the Air Force was not using this technology.

"I thought to myself, flying with the full-coverage G-suit feels natural. It reduces fatigue and allows me to easily fly at 9 Gs. This is amazing technology," Hughes said. "Why are we putting seven-decade old technology on fifth generation aircraft? It makes no sense. We were still killing people in the F-15C and F-16. I really needed to convince the Air Force that this technology is going to be a lifesaver."

From that moment on, Hughes began a five-year mission -- advocating for the integration of the new suit.

Sharing her research with a business case analysis perspective, Hughes traveled base to base talking to anyone she could. She contacted the Air Combat Command, Air Education and Training Command, and even reached out to the Pentagon.

Her thorough research showcased a 30-year comparison in aviation mishap data, physiological data analysis between the legacy G-suit and the full-coverage G-suit, and even provided a case study within the F-15C and F-16 community, which produced undeniable justification for the new technology.

It wasn't until five years after Hughes began "beating the drum" that the life support and the fighter community finally started to listen following a deadly crash.

"After the last mishap in 2011, when we unfortunately lost the life of a pilot in addition to the airplane, the Air Force finally said, 'We cannot do this anymore. We know this technology works,'" Hughes said. "And at that time, they made the decision to field full-coverage G-suits."

Hughes' evidence-based medicine and relentless fight for full-coverage G-suit integration proved to be worth the years of research and work. Since its integration in 2011, the Air Force has not had a Class A or Class E G-LOC while a pilot was wearing the full-coverage G-suit.

PASSION TO APPLICATION

Similarly, Mapes' focus on the Automatic Ground Collision Avoidance System (A-GCAS) has helped save the Air Force aircraft and lives.

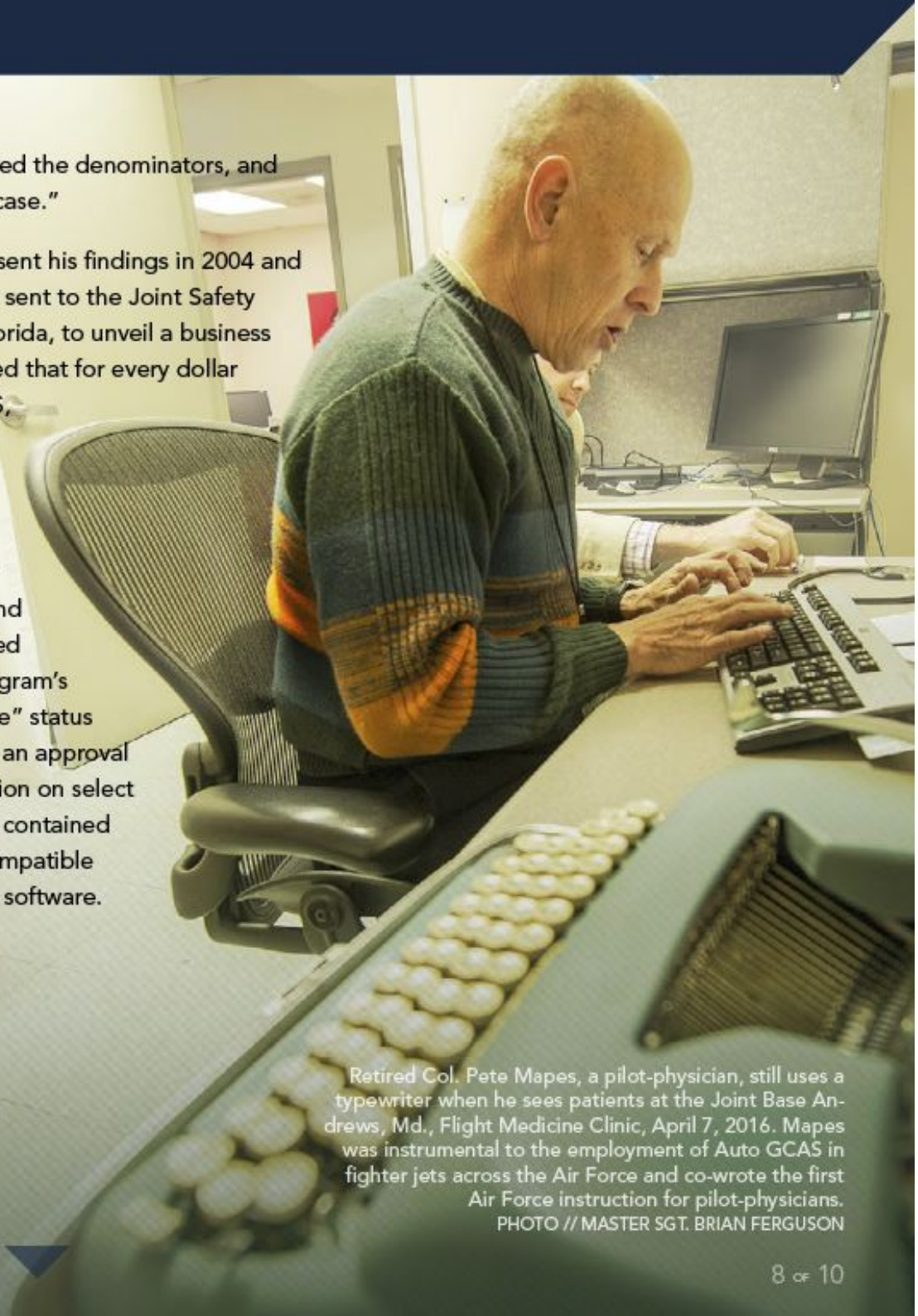
Developed in the 1980s at the Air Force Research Laboratory by five computer scientists who were also aerodynamicists, the system was designed to automatically fly an airplane away from a hazardous situation, preventing the loss of the pilot and aircraft. After years of testing and through technological mapping upgrades, the system became fully functional in the early 1990s.

After a series of cost analysis reports, however, the Air Force declared the program financially unfeasible. The program was shelved for nearly a decade until Mapes got his hands on the reported data and unearthed the dormant software.

"In 2003, I was given orders to go to the Air Force Research Laboratory at Wright-Patterson (AFB), Ohio, and conduct an extensive review on a paper related to spatial disorientation and flight into terrain," Mapes explained. "In that paper, I found that there were real problems with the reported data, specifically on Auto-GCAS. So, I took their data, conducted my own research, analyzed the denominators, and realized I had a real case."

He was asked to present his findings in 2004 and the next year he was sent to the Joint Safety Summit in Destin, Florida, to unveil a business case, which concluded that for every dollar spent on Auto-GCAS, the Air Force would preserve $65 in airframe acquisition.

Like Hughes, Mapes' extensive research and lobbying finally gained recognition. The program's "financially unfeasible" status had now been given an approval for software integration on select F-15s and F-16s that contained digital computers compatible with the Auto-GCAS software.



Retired Col. Pete Mapes, a pilot-physician, still uses a typewriter when he sees patients at the Joint Base Andrews, Md., Flight Medicine Clinic, April 7, 2016. Mapes was instrumental to the employment of Auto GCAS in fighter jets across the Air Force and co-wrote the first Air Force instruction for pilot-physicians.
PHOTO // MASTER SGT. BRIAN FERGUSON

By 2016, the anti-collision software was installed on more than 600 fighters, resulting in three confirmed reports that A-GCAS had saved both the pilot and aircraft. One of those saved was Capt. Dustin Cochlin, a seasoned F-16 pilot, who wrote the following in a report:

"A-GCAS has singlehandedly become the new paradigm for aviation safety in the 21st century. Within just the first few months following the AGCAS upgrade, we have already seen at least two F-16 A-GCAS saves -- one of which was me. My unexpected A-GCAS recovery prompted me to aggressively recover my aircraft, directly saving both my life and the aircraft. A-GCAS worked as advertised and has allowed me the honor to write this letter. I will gladly shake the hands of the men and women who developed this life saving system if I ever meet them in person."

Although Mapes retired from the Air Force in 2010, he remained steadfast in his pursuit to have ground collision avoidance software or hardware installed on every manned aircraft in the U.S. military. According to predictions based on historical accident rates, the Air Force expects that A-GCAS will save 10 lives, upward of 14 aircraft, and more than $530 million over the projected remaining service life of the F-16 inventory alone.

Because of the contributions made by pilot-physicians to improve the safety of the aviation community, the Air Force is actively looking toward the integration of technical-physicians in other high-demand Air Force specialty codes.

Mapes was instrumental to the employment of an automatic ground collision avoidance system in fighter jets across the Air Force and co-wrote the first Air Force instruction for pilot-physicians.
PHOTO // MASTER SGT. BRIAN FERGUSON

"The Pilot-Physician Program is expanding its reach to include other career fields such as remotely piloted aircraft operations," Mueller said. "This is an important mission area that has many human integration issues."

The 10 Air Force pilot-physicians deployed around the globe are diligently bridging the gap between man and machine. They continually push their bodies to their physiological limit to ensure the safety of the current and next generation of pilots. These selfless Airmen are not only benefitting the Air Force, but also the families of every pilot that climbs into the cockpit.