Whic
is

Trick question. Both are “Melvins,” created in the world’s first doggie clone factory. And they’re only the beginning

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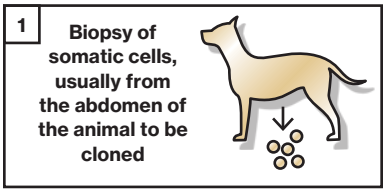
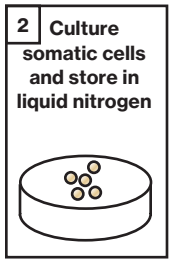
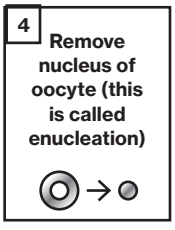
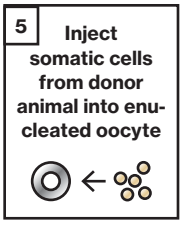
By Josh Dean
Photograph by Thomas Prior

Dogs, Soamm Style









Behind glass in a never-before-used operating room inside a just-built cabin at the end of a freshly paved road, Dr. Hwang Woo Suk is chasing rogue flies with an electrified bug swatter that looks like a small tennis racket. He wears baby blue scrubs branded with the logo of his South Korea-based research company, Sooam Biotech, on the left breast and is making final checks of this temporary facility, erected from scratch in eight days in the Chinese coastal city of Weihai. Here, in a few hours, he'll deliver the first cloned puppies in the country's history.

Originally the procedure had been scheduled for Sooam's headquarters in Seoul, where Hwang, 61, runs the only facility on earth that clones dogs for customers willing to pay $100,000. He led the team that cloned the first dog in 2005, and he's produced more than 550 cloned puppies since, increasing the efficiency of a complicated process to a point where he can guarantee an exact genetic copy of a client's dog, provided he has healthy tissue to work with. Today's delivery, however, was a special case, and at the last minute, Chinese officials asked Hwang to relocate the operation to Weihai, in Shandong province.

For starters, the puppies are Tibetan mastiffs, a breed of ancient, aloof guard dogs so hallowed in China that owning the best specimens is an assertion of status almost without rival. The donor of the cells used to clone these puppies, for instance, was an eight-year-old champion stud from Qinghai province whose owner turned down a $5 million offer for him last year because he can earn nearly that much in a single breeding season. Earlier this year, a developer paid $2.6 million for a single, gold-colored puppy; a scarcity of top-quality puppies in China means that the run on mastiffs costing more than mansions is unlikely to abate anytime soon.

Beyond the symbolic importance of the breed, Chinese officials wanted the operation staged in Weihai because it provided a backdrop for the announcement of a partnership between Sooam and BoyaLife, a fast-growing Chinese biotechnology company with 28 subsidiaries and operations in 16 provinces. Sometime early next year, ground will be broken for a 667,000-square-foot research laboratory on a spectacular plateau of yellow grass and scrubby pines facing the Yellow Sea. There, scientists from both companies will operate China's first commercial animal cloning facility on grounds landscaped to look like a park. "The point is to expand cloning in China," says Dr. Xu Xiao-chun, chairman and chief executive officer of BoyaLife, whose excellent English is the product of 17 years in the U.S.

Rare breeds, dogs cloned for devoted owners, and specialized working dogs (for police and bomb-sniffing work, as well as cancer detection) will be a part of that business, he says, but only a small one. "Dogs are the entry point," he says. The far larger and more important focus will be cloning cows to help China deal with a growing appetite for beef. Currently the Chinese favor pork and consume just 5 kilograms (11 pounds) a year of beef per capita, half the global average and one-tenth what Americans consume. But the population is acquiring a taste, so Xu wants to "expedite the production of high-quality beef" through cloning.

Beyond that, he imagines a renowned research facility to explore the various biomedical applications of cloning and stem cells, another area of research at both Sooam and BoyaLife. "In China we do things on a massive scale," he says. "But we want to do all this not just for profit, but also for history." He smiles. "Maybe we can deliver the first cloned giant panda in Weihai." (Back in 2004, the Chinese government actually built a special gene bank and began collecting cells from existing pandas with the idea that just such a thing might one day be possible.)

As of this September, though, the lab exists as a collection of architectural drawings and a plot of land selected for optimal feng shui, so Hwang and his surgical team would make do with the temporary facility tucked into a wooded hollow. It's a handsome three-room structure with cedar paneling, hardwood floors, and a fully equipped operating room, but construction had finished only the previous night, and cleaning was still under way. Thus the dust and a few rogue insects. "My apologies. This is temporary," Hwang says, his fly zapper in hand. "Don't ask how we did it."

At around 1 p.m., the various dignitaries are ushered into the cabin and scramble for spots along the windows. Only the ranking party secretary, as well as Xu and his father, Xu Zhihong, the only two-time president in the history of Peking University, are given scrubs and allowed into the operating room. Every single person raises a smartphone and makes a video as Hwang, wearing a Madonna-style headset mic, assesses the sleeping surrogate, which lies on a surgical table, belly up, in preparation for a Caesarean delivery, which Hwang insists is safer "for both mother and babies" in the case of large breeds. Sooam uses large mixed breeds to gestate his clones because they have the largest wombs and are better able to handle the stress of surgery.

Eleven minutes later, Hwang pulls the first puppy out of the uterus, followed by the second, and finally, after some rooting around, the third. "They've already started to cry," he says, and

PHOTOGRAPH BY KA XIAOXI FOR BLOOMBERG BUSINESSWEEK

In 2005, Hwang was named Korea's ... Scientist." By 2009, he was "pennile...

Seoul
Hwang with a Yorkie clone in a play area outside Sooam's lab

passes them to an assistant, who cleans them and places them near a microphone so that the crowd outside the windows can hear the adorable whines and whimpers. Each is given a tiny bow and laid on a metal tray that a nurse holds up to the window.

"This is too magic," my translator says. "Wow."

Hwang is a handsome, publicity-savvy veterinarian and animal reproduction specialist famous, and some might say infamous, in the world of genetics. He became one of the most celebrated scientists in the world a decade ago when he published two studies in the journal *Science* that announced the first successful cloning of a human embryo. Hwang, then a Seoul National University (SNU) professor, said he'd been able to extract stem cells from the embryo, apparently creating a new and potentially unlimited source for these important cells, which were becoming recognized as a possible treatment for all kinds of diseases.

first "Supreme ss and devastated"

Time magazine named him one of its "People Who Mattered" in 2004, and in June 2005, Korea's Ministry of Science and Technology declared Hwang the first "Supreme Scientist" in the country's history. He was honored on a postage stamp.

Then it all came undone. An American researcher who'd been one of co-authors on the *Science* papers disavowed the work. This sparked a media firestorm in Korea, causing a member of Hwang's team to go public claiming that he'd paid women, including underlings at the university, for their eggs—a major ethical breach. An inquest launched by SNU subsequently discovered that Hwang's group hadn't actually achieved a single cloned embryo, despite harvesting cells from 288 different human eggs. Pictures of the results, investigators learned, were fakes—merely multiples of the same photo—and government funds had been misallocated. Hwang called a news conference to apologize and announced that he would resign from his numerous posts. "I was blinded by work and my drive for achievement," he said.

It wasn't over. The government assigned a prosecutor to the case and eventually convicted Hwang of fraud and embezzlement of $700,000 in public research funds. It also stripped him of his license to practice stem cell research. In 2009 a judge gave Hwang a two-year suspended prison sentence, claiming that he had owned up to his crimes and hadn't used the misappropriated funds for personal use; he'd used them to pay women for their eggs. Hwang refuses to talk about the scandal and leaves it to Kwoun Young Chul, executive director at HBion, Sooam's commercial division, to address the matter. Kwoun, 43, asserts that the fabrication of the data at SNU's partner institution, MizMedi Hospital, was the result of poor oversight on Hwang's part as principal investigator and wasn't part of some intentional plot to falsify data and fool the public. The episode "sank Dr. Hwang to an abyss," Kwoun says.

Hwang was, in his own words, "penniless and devastated" after the scandal, but a sizable portion of the Korean public never turned against him and continued to support him and his work. Donors included sympathetic citizens, who mailed in checks for as little as $100 and sent him food, and also larger investors, who still believed in his ability to do important research. "Thanks to all of them, I was able to start Sooam," he says.

At Sooam he resumed his work on animal cloning, using a technique known as somatic cell nuclear transfer (SCNT), in which the nucleus of an oocyte (egg cell) is removed and replaced by a somatic cell from the mature specimen being cloned. Typically, these cells are fibroblasts, the cells that make up the body's connective tissue. They're taken via skin biopsy from the abdomen and are cultured in a lab (and often stored). Once the somatic cell nucleus is in place, a lab worker uses electricity to fuse the nucleus and oocyte together into a reconstructed embryo that's implanted into a surrogate mother.

This is how Dolly the sheep was created in 1996, and it's the way scientists have replicated cows, pigs, goats,

mice, and many other animals since. Every scientist who does mammal cloning, including Hwang, licenses the so-called Dolly patent from ViaGen, a U.S. company that acquired the intellectual property from Dolly's creator, Dr. Ian Wilmut.

Hwang used SCNT to create Snuppy, the world's first cloned dog, born in April 2005 at Seoul National University. In the process he added a few steps specific to canines that he subsequently patented. Snuppy was an Afghan hound clone, gestated in a Labrador retriever surrogate, and he's still alive. His arrival at Seoul University was somewhat lost in the excitement and furor over Hwang's stem cell work, but it was a major achievement, as no one had ever before successfully cloned a dog.

Dogs have some peculiar and complicated reproductive traits that make the species particularly difficult to clone; most problematic, their ovulation cycles are irregular, and the eggs are in a mature state and optimal for cloning for only a few hours, so the timing is difficult. In the case of Snuppy, it took 123 attempts to produce a single viable puppy, and that inefficiency led most observers–and even Hwang–to suggest that this wasn't something likely to scale for pets.

In 2007, Hwang met an American named Lou Hawthorne who had led the unsuccessful effort to clone a border collie mix named Missy in the late 1990s through a now-defunct company called Genetics Savings & Clone. Despite several years and millions of dollars devoted to the so-called Missyplicity project, scientists failed to clone Missy before she died in 2002. They had collected and stored samples of her cells, however, and when Hawthorne met Hwang, he asked if Sooam could try again. Hwang took the samples back to Korea and cloned Missy on the first attempt in his modest laboratory an hour from the center of Seoul.

One year later, Sooam sold its first cloned dog to Edgar and Nina Otto, a Florida couple so distraught over the death of Lancelot, their beloved Labrador, that they were willing to pay $155,000 in an auction for the opportunity to receive the world's first commercially cloned dog. They named him Lancelot Encore. Six years and hundreds of cloned dogs later, Sooam has streamlined the process enough that anyone with $100,000 and the patience to wait in line for a year or more can have a dog cloned. A team of scientists works under Hwang with the ability to carry out every part of the painstaking process, and the lab has the capacity to produce 150 to 200 commercial clones a year for clients who so far have included Hollywood celebrities, Middle Eastern royals, and a few proud, non-anonymous buyers such as Dr. Philip DuPont, a veterinarian in Lafayette, La.

DuPont and his wife saw Hwang's work on a Discovery Channel program called *I Cloned My Pet* and were so taken with the idea that they immediately called Sooam and arranged to have Melvin, their Catahoula leopard dog mix, cloned. DuPont had paid $50 for Melvin to a guy on a dirt road deep in the bayou, and the puppy was so sickly that he lost a full pound of worms in the first 24 hours. "I thought about putting him to sleep a few times, and he turned out to be the best dog I ever had," DuPont told me. "You feel like you're talking to a person. The dog does things that are weird." DuPont was using the present tense, even though Melvin had passed just a week before our conversation–but not before he enjoyed nearly two full years with his clones, Ken and Henry. "It's like having two Melvins running around all the time," DuPont says.

To prove its work, Sooam instructs clients to take a tissue sample and send it to the University of California at Davis for genetic analysis. The DuPonts did that, but they didn't need to; it was obvious to them just by hanging around the clones that they were for real. "These puppies are just like him," DuPont says. "They love to hunt moles. They love to hunt field rats. They will come in and sneeze on command when we say, 'You got a cold?' Melvin did that. It's like having Melvin around the house, but two. Sometimes, too much Melvin."

Sooam's headquarters sits at the foot of a hill in the western suburbs of Seoul, in the shadow of a towering, multilevel golf driving range and across the road from another. The facility looks like a series of department-store shirt boxes stacked irregularly

CLOCKWISE FROM LEFT: PHOTOGRAPH BY THOMAS PRIOR FOR BLOOMBERG BUSINESSWEEK

Sharpsville, Pa.
Brannon holds special-purpose dogs Ghost and Echo between bite-training sessions

atop one another. The front yard, about a half-acre of manicured grass, is fenced so that the clones-in-residence have a place to chase Frisbees and act like normal puppies.

All visitors must remove their shoes just inside the foyer and switch to a set of borrowed sandals, which is a matter of Korean custom and not some sterility protocol. (If you want to use the bathroom, you change footwear a second time, from the sandals to a special set of toilet slippers.)

On the research floor, a junior scientist directs us to put on scrubs, then leads us through an air lock, where jet fans blast stray particles off our clothing, and into the lab, where men and women carry vials and peer into microscopes. A camera atop one microscope projects the invisible work going on. A technician on the canine team uses two joysticks to do the delicate work of enucleating an embryo and injecting the nucleus of a live cell in its place—the key components of cloning an egg that would soon be implanted into a surrogate in the operating theater downstairs.

Work at Sooam is divided into three sections: canine, porcine, and bovine. The canine team focuses on commercial cloning, as well as on transgenic clones, which are genetically engineered to express certain traits. Last year scientists on that team successfully manipulated the genes of one beagle clone to develop Alzheimer's disease, and all 18 clones from that cell line since have been born with the disease. The project remains in the study phase, but if it can be commercialized, it would allow Sooam to produce dogs with Alzheimer's on demand, potentially opening up a huge business catering to pharmaceutical companies doing research in that space—which use 7,500 beagles a year in the U.S. alone, according to Sooam. A second project is under way to produce clones born with diabetes, another epidemic disease that affects both humans and dogs.

Transgenic research has tremendous potential for Sooam, and for the many other scientists pursuing it around the world, but it's expensive and time-intensive. Sooam's bovine team is at work on dairy cow clones engineered to express glycoproteins, such as interferon, which are released by cells in the presence of viruses to trigger immune response. These are widely sought by pharmaceutical manufacturers for obvious reasons but difficult to obtain. Sooam's plan is to create the clones and harvest the proteins via the 10,000 gallons of milk a dairy cow generates in a year. The team managed to produce a single cow that expressed the presence of interferon last year, but the animal didn't survive. Work continues.

Closer to market is Sooam's effort to help restore the Han-woo cow population. The Han-woo is Korea's equivalent of Wagyu or Kobe, and stocks were devastated by an outbreak of foot and mouth disease three years ago. The morning after the delivery of the precious puppies in China, Hwang met on a farm with Nam Kyung Pil, the governor of Gyeonggi, Korea's largest province, to celebrate the birth of the first set of cow clones from a Sooam project sponsored by the provincial government. If the pilot program is successful, Sooam is likely to get a much larger contract to take the program national. "It would be a very big piece of business for us," says Kwoun of Sooam's sister company.

The porcine team is pursuing transgenic clones that could one day provide a safe source of organs for humans in need. Pig organs are similar to ours, which makes them an attractive potential substitute for patients awaiting transplants. The problem: A human body tends to mobilize its immune system to reject foreign organs. One solution is to fuse human genetic material into the pig clone embryo, so that the recipient's immune system doesn't reject the transplanted organ. Eventually, says Jeong Yeon Woo, Sooam's 39-year-old director of research, Sooam will have to collaborate with a hospital or university, because "we are not immune specialists."

One of Hwang's biggest dreams is to revive his work in human stem cells. Sooam still owns the single cell line he was able to create back at Seoul National University—it was verified, but investigators determined it was cultured from an existing embryo, not a cloned embryo—and Hwang has always maintained that the basis of his work was and is valid. There's just one problem: The Korean government, in response to the scandal, banned research on human stem cells. "We will keep knocking on the doors," Hwang says, "not only in South Korea but also in other countries, until we can continue our human stem cell research."

Broadening Sooam's reach is the primary responsibility of Kwoun, a former investment banker. Hwang hired him early this year to put him in charge of all things financial, freeing up Hwang to focus on research, and espe-

Cloning's DNA

1902
German embryologist Hans Spemann uses a hair from his infant daughter to separate a salamander embryo into two. Each develops normally.

1938
Spemann proposes a "fantastical experiment" to clone via nuclear transfer but can't perform the experiment because baby hairs don't cut it.

1958
Oxford's John Gurdon clones tadpoles using the intestinal cell of a African clawed frog.

1981
Karl Illmenese and Peter Hope clone a mouse at the University of Geneva.

1996
Hello, Dolly! Ian Wilmut and Keith Campbell of the Roslin Institute use the nucleus from a sheep's udder cell to replace that of an egg. Only 1 of 277 transfers takes, and Dolly's it.

2001
The first cloned cat, CopyCat, is born at Texas A&M under the direction of Dr. Mark Westhusin, in collaboration with Dr. Taeyoung Shin, later a Sooam founder. Biotech.

2001
Scientists at Advanced Cell Technology use a surrogate to clone the first endangered species: Noah, a bull gaur (wild ox). He dies of an infection unrelated to cloning.

2003
Goodbye, Dolly. The celebrity sheep is euthanized after developing lung cancer.

2004
A group of scientists at Seoul National University (SNU) led by Hwang Woo Suk announce the alleged cloning of a human embryo. This is later exposed as a fraud.

cially to head HBion, the sister company founded to commercialize the technologies developed by Sooam. For now, that means mostly dogs, but also a NASA-discovers-Velcro type spinoff: a high-end skin-care line called Dracell that was created from the patented culture medium in which Sooam grows and stores all of its cloned embryos. In 2012, Hwang and his team cloned a litter of seven rare Asian coyotes using a mutt dog as surrogate, proving that interspecies cloning is possible. That same year he announced a partnership with North-Eastern Federal University in Russia to work on the so-called Mammoth Restoration Project. The National Geographic Channel filmed the initial expedition into Siberia in search of a frozen carcass from which genetic material might be taken and turned the footage into an hour-long special, "Mammoth: Back From the Dead." It's a compelling idea—and not as outrageous as it seems on the surface, Director of Research Jeong explains. "Principally it's possible because we use stem cells stored in nitrogen already," he says. "So they're frozen." Scientists in Japan managed to clone a mouse using cells harvested from a specimen that had been frozen for 10 years, proving that prolonged freezing isn't an insurmountable barrier. What's critical is that the mouse cells were frozen in a steady state. In the instance of the mammoths, the tissues have been through a series of freezes and thaws. That won't cut it.

of hands."

On the morning of my last day in Seoul, Kwoun is late picking me up. "I'm very sorry," he says. "We had a bit of a panic situation." An e-mail arrived overnight from a man in France whose dog had died unexpectedly the previous day. The man wrote that he had "loved this dog very much" and that he wished to be able to "keep some part of him," so he'd put its dead body into his freezer and bought himself a ticket to Korea. He required only instructions on how to proceed from there. Kwoun chuckles. "We told him there was no need to panic and that he should take the dog out of the freezer immediately," he says.

There is no precise rule for how much time an owner has to harvest his dog's cells for cloning after death; it varies depending on the specimen and how it's handled. As a general rule, Sooam tells people they have five days to arrange a biopsy and ship few vials of cells to Korea, though in some cases samples can be viable for days beyond that. The Frenchman was told to wrap his dog in wet towels, refrigerate it—freezing can actually damage cells—and find a vet or hospital to snip a bit of tissue and sign the paperwork stating that the biological material was for research purposes, so that it wouldn't get confiscated in transit. Once a sample has been received, the client can relax and put the clone on what amounts to layaway. Sooam requires only $3,000 to arrange storage of the tissue in

"A tiger has the exact same number chromosomes as a pig, so we might

And where would Sooam gestate a mammoth, if it ever obtained the right samples? "Probably an elephant," Jeong says. The coyote project proved that scientists can use one species as a surrogate for another, and Sooam plans to push this line of inquiry further. It's been suggested that if the Chinese ever allowed the giant panda to be cloned, a dog could be used as a surrogate because the two species are genetically similar enough, and it seems unlikely that Beijing is going to take the risk of offering up full-grown pandas to serve as surrogates. Hwang is also working to persuade the Spanish government to let him clone the rare Spanish ibex, using the Korean black goat as a surrogate. Numerous other endangered species, including African wild dogs and various wolves, are on his wish list. Could they save an animal like the Siberian tiger, which would require a large and likely very dangerous surrogate in the form of some other large and ferocious cat? "A tiger has the exact same number of chromosomes as a pig, so we might try that," Jeong says.

I must look stunned by that, because he laughs. "Our future plan is to clone all extinct animals," says Kwoun, who's been listening. "In the future. But we are out

perpetuity—"so that people can do cloning later on, when they have money," Kwoun explains.

At the lab, the staff is preparing for an important arrival: a group of Americans coming to pick up two special puppies, cloned from the DNA of a Belgian Malinois that's currently deployed with a unit of the U.S. Army Special Forces (which Sooam isn't permitted to name). The donor dog was chosen because he was a standout among Special Forces canines—elite even among the elite, something like the soldier-dog equivalent of LeBron James—and these three-month-old puppies were heading to the U.S. to undergo training as part of an experiment.

At this point, cloning a pet is straightforward for Sooam. Given fresh cells, Hwang says, "we have never failed cloning a specific dog, regardless of its size or breed." In turn, that part of the business is fairly mature. Orders are healthy. There's a waiting list.

What's most intriguing to Hwang now is the study of clone performance, particularly among what Sooam calls special purpose dogs. He wants to know if a puppy cloned from a truly exceptional working dog will end up performing at that job as well as his genetic twin. If he does, it could seriously disrupt the process of breeding and training police dogs, explosives detection dogs, and other canines that serve in jobs that help save human lives. Recently, Sooam secured a contract to provide 40 cloned explosives detection dogs to the South Korean national police, and several are already in service at the Incheon International Airport near Seoul, but Hwang's scientists lack proof that the donor dogs were truly special.

2005
The first dog, an Afghan hound named Snuppy, is cloned by Hwang and his team at SNU.

2008
Sooam clones the first pet dog for an American couple. They pay $155,000 for the historic privilege.

2009
Closer to Jurassic Park, French and Spanish scientists clone a Pyrenean ibex, extinct since 2000. Ten minutes after her birth, she dies—and the species goes extinct all over again.

2013
An Oregon team led by Shoukhrat Mitalipov achieves what Hwang claimed in 2004: It used SCNT to clone a human embryo that can be used as a source of stem cells.

CLOCKWISE FROM TOP RIGHT: PHOTOGRAPH BY THOMAS PRIOR FOR BLOOMBERG BUSINESSWEEK

Lafayette, La.
Melvin's legacy lives on in Ken and Henry, pictured with owner DuPont

That's why they sought out the Americans, to find empirically great dogs to clone in the world's most sophisticated market for specialized canines. Having the ability to replicate, for instance, the greatest Navy SEAL dog in history, over and over, is a compelling idea. If there's a killer app in dog cloning, that's probably it.

The four Americans arrive in the late afternoon, in the company of some powerful Koreans—Youngham David Kim, chairman of the Daesung Group, a multinational conglomerate that's one of the country's largest companies, and his managing director. Daesung has interests in energy and defense and is invested in this particular project as the Korean liaison to the American company that will, if this experiment proves out, sell cloned super dogs to police departments and military units around the globe.

# of try that"

Known as BioPremium K9, the startup was founded by Peter Hwang, a Korean American who served 25 years in law enforcement, for the Illinois State Police and the FBI. Hwang (no relation to the doctor) has known Daesung's chairman since they were both young men, and Kim came to him with an unusual request: He needed to find "the best working dog in the U.S." for a special project. Hwang recruited an Illinois-based cop and canine specialist named Bert Badertscher to help him, and the two set out to locate just such a dog.

Eventually, they settled on Shallow Creek Kennels, a small facility north of Pittsburgh that trains elite dogs for numerous police departments and U.S. government agencies, including Special Operations. The owner, John Brannon, loved the idea and had just the dog in mind. He arranged for collection of the dog's fibroblasts from Afghanistan, and Sooam cloned him, resulting in Ghost and Echo, the clone brothers that the Americans had all come to Seoul to collect.

Because every day matters when your goal is to turn a puppy with potential into a dependable, battle-ready working dog, Brannon had given Sooam staffers a strict training and socialization regimen to follow from birth, but it isn't until the dogs are bounding around on the front lawn after a short adoption ceremony that Brannon is able to get his first good look at them. He likes what he sees: "I'm impressed. They seem advanced for their age. But you don't really know until a dog is 12 months what you have physically and mentally," Brannon says, which is why he doesn't bother with the imprecise and wasteful process of breeding. It's far more effective for him to travel to Europe a few times a year to source year-old dogs from one of several kennels he knows and trusts.

One of the most challenging things about great police dogs, Badertscher says, is finding the right puppies and then training them, only to have to retire them eight or nine years later. "Now we have a chance, an idea—it's only a theory," he says. Every time you breed a dog naturally, you lose some portion of his greatness, because the genes are diluted by the contribution of the mate. And you're lucky if one or two dogs out of a litter of eight might have the drive and focus to become the kind of dogs who can find bombs, take fire, and work independently on command—let alone jump out of airplanes at night.

"Ghost and Echo are the first research study to see if this idea works: Can we reproduce these top-quality dogs through cloning" and eliminate most of the margin for error, Badertscher says. Beyond that, he believes, "the next step is giving these dogs a chance to live longer" by using cloning to eliminate problems such as cancer, hip dysplasia, and bad eyesight that can prematurely end a working dog's career. Two extra years of work would be an incredible boost in productivity, keeping the best dogs working longer and offset the increased costs of cloning. "The biggest thing we'll have to fight," he says, "is the word 'cloning.' " B