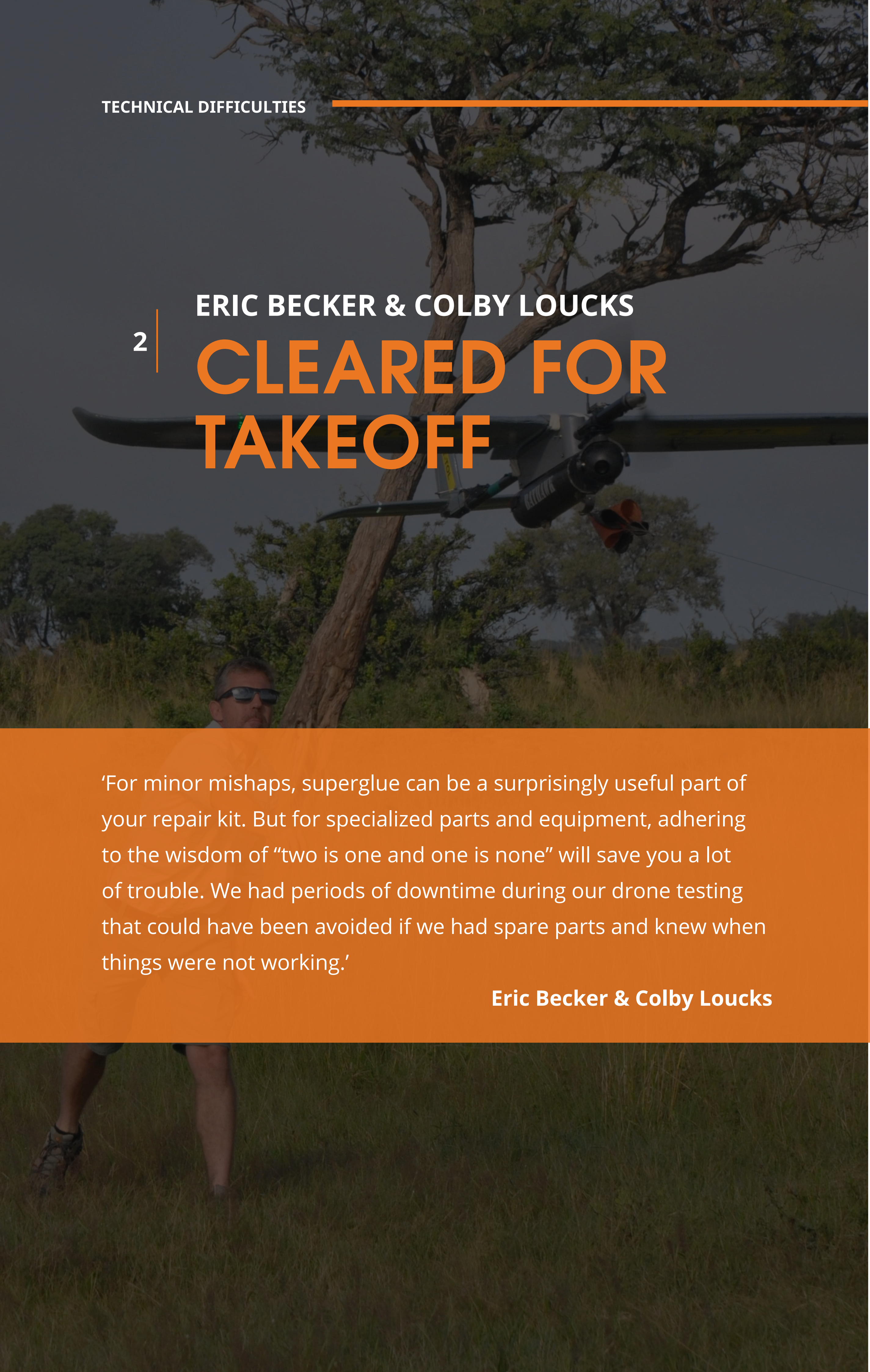

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ERIC BECKER & COLBY LOUCKS

CLEARED FOR TAKEOFF

‘For minor mishaps, superglue can be a surprisingly useful part of your repair kit. But for specialized parts and equipment, adhering to the wisdom of “two is one and one is none” will save you a lot of trouble. We had periods of downtime during our drone testing that could have been avoided if we had spare parts and knew when things were not working.’

Eric Becker & Colby Loucks

In their second case study, **Eric Becker** and **Colby Loucks** discuss the unique challenges presented by working with drones, and their advice for effectively incorporating drones into projects.

Eric Becker, WWF's Conservation Engineer, holding a drone in his lab at home in North Bethesda, MD, United States. © WWF-US/Nathan Mitchell

In part one of this series, we discussed the importance of choosing the right technology to solve the right problem, and just as importantly, at the right time. Not every technological solution, regardless of the hype or promise surrounding it, will be ready to live up to your biggest ideas yet. When we tested drones for the WWF-US Wildlife Crime Technology Project as part of our poacher detection efforts, consumer drone technology was still in its infancy. But as we previously shared, just because technology has not yet caught up to your idea doesn't mean your idea will never be possible. A realistic sense of what is achievable right now with the tools available to you will help you avoid disappointment down the road.

With drones, as with most conservation tech, things have come a long way since then and continue to improve. We're seeing these tools become more accessible for conservation, with greater possibilities for usage in the field. At the time of our work, drones were limited by battery life and short flight times, cost, available sensors, type of airframe, and payload capacity (how much they can carry). In particular, battery life and short flight times severely limit what you can achieve across a vast landscape in need of broad and consistent monitoring.

For protecting vast areas, most people think of the capabilities brought by large, multi-million dollar military drones that can fly for hours or days at a time, and carry expensive sensors. While these types of drones would be able to monitor areas like the ones in which we work, they are unrealistic for conservation teams to acquire and operate. Again, maintaining realistic expectations not only about what technology exists, but what technology is actually available to you at this time will keep your projects within reason. For conservationists looking to use drones, a critical point in expanding your options is to look beyond consumer drones and consider open source, customizable, and industrial platforms.

There will be pros and cons to any drone options you choose, and there will be uses for each option that make sense, while others don't fit as well. Flight time is constantly improving for newer drones, and a wider variety of power options exists than you may expect. There are hybrid electric/combustion engines that can power drones for hours. Likewise, fuel cells can also improve battery life for drones, but are expensive. Tethered drones that are powered from the ground can fly for almost indefinite amounts of time, but are limited by the location of the ground power generator. (As we shared in part one, this option, despite the long flight time, won't be of any use if it gives away the location of a ranger team or can't effectively survey the area.)

The options for the types of drones and airframes themselves are also diverse and accompanied by pros and cons depending on the ease of use, flight time, and necessary payload. There are several airframe configurations, but the main ones are fixed wing (airplane) or multi-rotor (helicopter). Hybrid airframes, on the other hand, take off like a helicopter and fly like an airplane. Fixed wing drones are more efficient than their counterparts because they move through the air to generate lift, and only require power to propel the plane forward. On the other hand, they require an area to take off and land, so you must have the space to create a makeshift runway. This type of drone can typically carry heavier payload; however, they need to be constantly moving through the air to generate lift, so depending on your monitoring needs, this may not allow you to focus on one small area effectively.

Meanwhile, multi-rotors require constant power to maintain lift and movement in any direction. This is typically what limits flight time, and those limitations are important to note since these are the types of drones people tend to buy. This type of drone is extremely easy to operate compared to the alternatives. They can take off and land vertically requiring little to no runway, and they can stop and hover over an area, allowing them more mobility within the space you're monitoring. In spite of this, because of their power restraints, they do have a limited coverage area, the very issue we encountered in our work.

Trying to really understand how you're using this technology and why will help you maintain those realistic expectations and work within them, not against them.

Finally, hybrid airframes combine the benefits of both fixed wing and multi-rotor drones. Their ability to take off vertically like a helicopter and fly like an airplane provides the best of both worlds in terms of mobility, and improves crucial factors like flight time and payload capacity.

Another factor to consider about your conservation technology tools is what actually makes them useful. Trying to really understand how you're using this technology and why will help you maintain those realistic expectations and work within them, not against them. We think of drones as flying tripods, not as a stand-alone technology. The payload is really what makes them useful. Drones move your camera or sensor around in 3D space, allowing you to collect data, track wildlife, or monitor and patrol an area. At the same time, the exact thing that makes drones useful can also become part of their limitations. In this case, if the drone is a tripod for carrying other technologies, that tripod has limitations due to payload capacity and flight time, regardless of whether that technology is capable of doing exactly what you need it to do.

For example, in my [Eric's] experience using drones to map a lake region in a protected national park, the software used was more than capable of returning beautiful, accurate maps and 3D models of the surveyed area. But the limitations of flight time and battery power complicated what seemed to be a straightforward project, with the drone requiring frequent trips back to base and running through 24 batteries. Because the drone could only fly for approximately 15 minutes at a time before the batteries were drained, and because the time and distance needed to return the drone to base also had to be taken into account for the batteries' lifespans, the effort took far longer than anticipated: six hours of flight time. In this case, the chosen drone was capable of serving as a tripod for the needed technology, but its limitations resulted in an inefficient process. Considering the pros and cons of different models and uses could help you maximize efficiency and minimize the impacts of current limitations. For this particular project, a fixed wing drone may have resulted in less flexibility of movement, but would have provided more efficient flight times and used less battery power.

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Similarly, factoring in the pros and cons of the technologies you're using with your drone can help you factor in issues like weight and flight time needed for a project. You may also find that not every technology is right for use with a drone, or find that drones open up entirely new possibilities for your technology in spite of any limitations. And like drones themselves, sensors and onboard processing power are constantly improving, making more advanced uses possible in the future.

Testing the ability of drones to identify intruders at a park in Zimbabwe in 2017.

A drone takes flight in Zimbabwe: "We think of drones as flying tripods, not as a stand-alone technology. The payload is really what makes them useful."

Drones are also a unique technological tool because they come with the expectation of one particular type of failure: crashing. All drones tend to crash, and every use of a drone comes with the risk of a costly failure. In spite of your best planning and training, and no matter how much consideration you've given to choosing the right tool, you should still approach every single drone flight with the expectation that it may crash.

Anyone working with drones will learn a lesson about their proclivity for crashing very quickly. I personally absorbed this lesson during my very first on-the-job engineering experience, when an expensive military drone with a 20-foot wingspan took off for my first test flight, and proceeded to nosedive at full-speed into the ground. The state-of-the-art tool was now a splintered wreck. Witnessing a drone's catastrophic failure was clearly not uncommon for those with experience, as demonstrated by the calm, emotionless reaction of my supervisor: "Let's go get the trash can."

While not every crash will result in such disaster, expect repairs for drones to be a constant necessity. With so many moving parts, things are bound to go wrong. This means that any work involving drones requires multiple spares, sources for replacement parts, good communications with the end-user to tell you when things break, and local maintenance capability and expertise. Drone propellers will break, batteries will fry, landing gear won't work, software will go awry; in any case, your advanced preparations will eventually be needed to get your drone functioning again. For minor mishaps, superglue can be a surprisingly useful part of your repair kit. But for specialized parts and equipment, adhering to the wisdom of "two is one and one is none" will save you a lot of trouble. We had periods of downtime during our drone testing that could have been avoided if we had spare parts and knew when things were not working.

Drones also come with a host of restrictions and regulatory issues to navigate, and these vary depending on the type of drone and the region you're working in. Around the same time that we began testing drones, many countries started implementing restrictions on drones. In most cases, a licensed pilot who completed a local drone training course will have to operate the drone. In some regions and countries, however, restrictions may be even tighter, and some places have banned them completely. Before planning a drone-based project, be sure you understand what is and isn't allowed, how much time and effort may be involved in navigating any restrictions and required trainings, and whether the pros and cons of that significantly impact your project's timeline or chances of success.

Similarly, drone regulations may impact the design and functionality of the actual tools you choose. Most off-the-shelf drones are built for aerial cinematography, and are designed to meet the current flight regulations. These regulations require visual line of sight (meaning the pilot can see the drone) and limit the altitude to 400ft. These regulations inform everyone's product design, so most off-the-shelf drones have limited range on wireless connectivity, as well as software limits on altitude.

While working with drones has its challenges, the successes and possibilities that come from finding the right uses for drones are incredibly worthwhile. Lessons learned from struggling with drones in the past inform more successful human-wildlife conflict and wildlife crime efforts now. In one impressive example of using FLIR technology and drones together in Malawi, drones were able to not only detect elephants that had broken through a fence, but herd them away from the area, preventing further damage and conflict. And in an exciting ongoing effort, drones and high-tech radar are being developed to detect snares in the landscape, even through foliage. This project is pushing the boundaries of current drone capabilities and driving forward the potential for effective drone usage in the fight against poaching and wildlife crime, making great use of drone technology's many strengths. And with the right understanding of drones' limitations, realities, and future innovations, you may find a bold, creative, and effective use for drones, too.

Lessons learned from struggling with drones in the past inform more successful human-wildlife conflict and wildlife crime efforts now.

A herd of elephants (Loxodonta africana) in the Maasai Mara, Kenya. © WWF-US / James Morgan

ABOUT THE AUTHORS

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Eric Becker researches and develops sensor based systems to detect poachers in protected areas in Africa and Asia to stop wildlife crime. Eric also leverages advancements in the Internet of Things to find energy-efficient, low-cost methods and systems to scale up technologies to solve the planet's most urgent issues.

COLBY LOUCKS

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Colby Loucks leads WWF's Wildlife Crime Technology Project, harnessing new technologies and the internet to improve our ability to track and manage wildlife, stop poaching, and reduce human-wildlife conflict. Colby has expertise in GIS, conservation biology, and landscape ecology.