Helicopter Aerial Work: Technology to Meet Growing Needs in Critical Missions

In 2021, Rotor joined an MIT program to research helicopter aviation. We spent over 150 hours interviewing hundreds of helicopter fleet operators, helicopter pilots, and customers of helicopter services from around the world. Our goal was to learn what the industry needed from engineers and companies developing new technology for the helicopter industry.

Our focus was the helicopter aerial work community which delivers critical services such as construction, agriculture, medical evacuation, firefighting, and government services. We talked to operators (21%), customers (59%) and other industry professionals (20%) from North America (73%), Europe (13%), Oceania (6%) and elsewhere (7%). There was a particular focus on Wildland Firefighting (54%), Agriculture (22%), and Utilities (21%).

When asked what their biggest challenges were, our correspondents talked to us about the same issues again and again. Common themes emerged that looked like they were structurally hindering the industry's ability to be successful.

It seemed that many of the industry's challenges could be solved with better technology. We worked with correspondents to identify what kind of technologies they thought would make a difference in real missions out in the field.

“"If you're trying to find a solution, make damn well sure it's a solution. This is an industry where we've had so many shiny solutions slammed down our throats over the years. People are very wary.”
- Operator, MN

- Helicopter aerial work missions are diverse and complex, resulting in operational challenges not seen in commercial air transport.
- The industry structure requires operators to be multi-service and multi-mission to survive; they must cope with commercial challenges such as low aircraft utilization rates, seasonal demand, and tough contracting structures.
- Human factors issues are exacerbated by complex, risky, and rapidly changing operating theaters, creating safety challenges and corresponding regulatory challenges and constraints.
- Technology and aircraft aren't always designed to meet the needs of the mission at hand.
- Operators struggle to meet the outcome requirements that customers expect – many outcomes are not easy to achieve or even measure.

✓ New tech should be compatible with existing operations and equipment. Technology should improve outcomes without requiring changes to existing operating procedures.
✓ Systems should be reliable and maintainable in the field with consistent support from the manufacturer. Crews need to trust the equipment.
✓ Aircraft tools should be designed for pilots, presenting mission-relevant data, reducing information overload and keeping heads out the cockpit and on the mission.
✓ Specific applications need mission-specific integrated tools designed for deployment that take into account human factors, operational challenges, and improve outcome quality.
Wildland Firefighting Case Study

Wildfire is a growing challenge driven by global climate crisis; it is challenging the ability of wildland firefighters to prevent, contain, and mitigate the incidence of extreme fires.

- Of the twenty largest fires ever recorded in California, twelve happened in the last five years
- The 8-year rolling average of burned acreage in the US has increased from 2.75 million acres in 1990 to 7.49 mission acres in 2021
- The cost of wildfire is 350 billion USD per year in the US alone
- The UN expects a global increase in extreme fires of 30% by 2050

This case study of helicopter aerial firefighting exemplifies many of the challenges faced by helicopter aerial work operators and customers today; it sheds light on the technologies that could make a difference not just in wildfire, but across the aerial work industry.

"When you go out on an incident you hear three questions all the time: Where is it? How big is it? Where’s it going?"
- Airtac, CA

Enhanced Situational Awareness (SA)

Poor SA on incidents threatens the lives of even experienced ground crews. Fires and assets move quickly, so maps become stale fast. Today, a real-time, unified operating picture between ground crews and resource planners is rare. Sensors that integrate with systems like ARENA and CoFire’s TAK program may help firefighters.

Efficacy Monitoring

It is difficult to measure aerial suppression’s true effectiveness. However, the AFUE reflected well on helicopters, suggesting drops met objectives over 80% of the time. Drop efficacy is complex, but flight data monitoring (FDM) and infrared sensors could in theory collect better data, especially if integrated with mapping.

“Communication is the challenge. Even where there’s good coverage, infrastructure gets destroyed in fires. Line of sight is tricky with valleys and so on. Latency problems can mean that all the kit is basically unusable.”
- Customer, OR

Communications

Wildland firefighting occurs in areas where there is little ground-based infrastructure, but operations rely heavily on real-time communications. Moving from analog radio comms to richer and higher bandwidth communications systems such as satellite communications could enable improved SA, monitoring, and operational effectiveness, but reliability, low-latency, and trust are open problems.

Uncrewed, Optionally-Piloted, & Remotely-Piloted Aircraft Systems (UAS, OPA, RPAS)

UAS complement helicopters for some missions, but cannot replace the planning capabilities of pilots. However, UAS and OPA may have a role in expanding night and DVE capabilities by rebasing the risk envelope. Full-scale OPA/RPAS flown by trained helicopter pilots could be combined with sensor arrays that allow flight in DVE, opening up a new front for aerial suppression.

Night & Degraded Visual Environment (DVE) Operations

Night flying is hazardous, with a high accident rate and high capital and training costs. Sensor-equipped aircraft or UAS might facilitate “X-Ray vision”, enabling pilots to see through smoke while mitigating the illusory sensory cues these conditions create. This would help aircraft suppress fire at its weakest at night, giving ground crews the best chance during the day to get fires under control.

"The fire is working 24/7. So should we. No matter where, no matter what the conditions are. We need the capacity to identify and attack at night and in smoke"
- Fire Chief, CA

We would like to thank the Massachusetts Institute of Technology I-CORPs for supporting this research. We also owe a debt of gratitude to our friends across North America and the world who took time from “keeping the rotors turning” to tell us what they do. Aviators, mechanics, and operators like you are unsung heroes providing an invaluable service that keeps society moving; we hope that our research results will stimulate more thoughtful technology development to make your lives better in the future.

Rotor Technologies, Inc. is a VC-backed aerospace R&D company. We are passionate about building flight technology for helicopters that will extend the flight capabilities of pilots, enhance customer outcomes, and rebase the risk envelope of helicopter missions.

We are currently flight testing prototype systems and growing a world-class team. If you are a pilot, mechanic, engineer, or firefighter and interested in our mission, joining us, or would just like to learn more about our program, please contact us on +1 (603) 450-0890 or at greg@flyrotor.com.