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

White Paper Executive Summary

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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 industry, 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%).

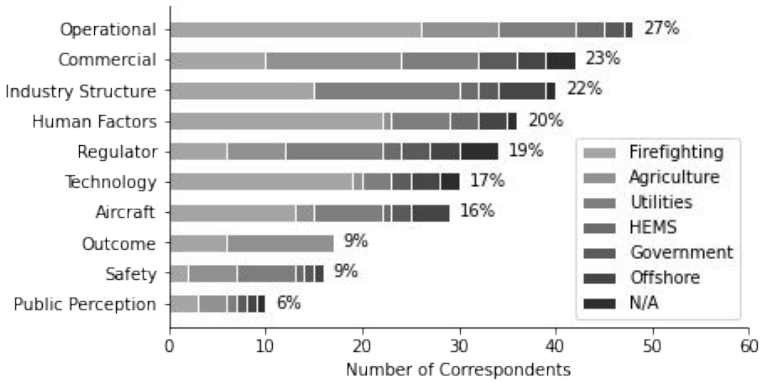
150 hours
of engagement with 180 industry participants

148
1-on-1 interviews during 2021 and 2022

27
presentations and conference proceedings

5
site visits to helicopter operators and customers

The 10 Biggest Challenges



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 adapt to **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 must be **compatible with existing operations and equipment**. Technology should improve outcomes without requiring changes to existing operating procedures.
- ✓ Systems must be r**eliable and maintainable in the field** with consistent support from the manufacturer. Crews need to trust the equipment.
- ✓ Aircraft tools must 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 reduce workloads and increase operational efficiency.

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Wildland Firefighting Case Study

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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

A case study on aerial firefighting with helicopters typifies many of the challenges faced by helicopter aerial work operators and customers today, and sheds light on the technologies that could make a difference across the 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 used today can collect better data; integrating these is a step forward.

> "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

Night & Degraded Visual Environment (DVE) Operations

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

> "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

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 carry sensor arrays that allow flight in DVE, opening up a new front for aerial suppression.

Communications

Effective real-time communications underpin many of these technologies. Reliable systems such as geostationary satellites exist, but these lack the bandwidth to make an impact. Communications systems that use modern technologies such as band-hopping and low earth orbit satellites to provide high bandwidth reliably in dynamic environments might do better.

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 is a VC-backed aerospace R&D company. We are passionate about building next-gen flight technology for helicopters that will extend the flight capabilities of pilots, enhance customer outcomes, and fundamentally 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 inquiries@rotor.ai.