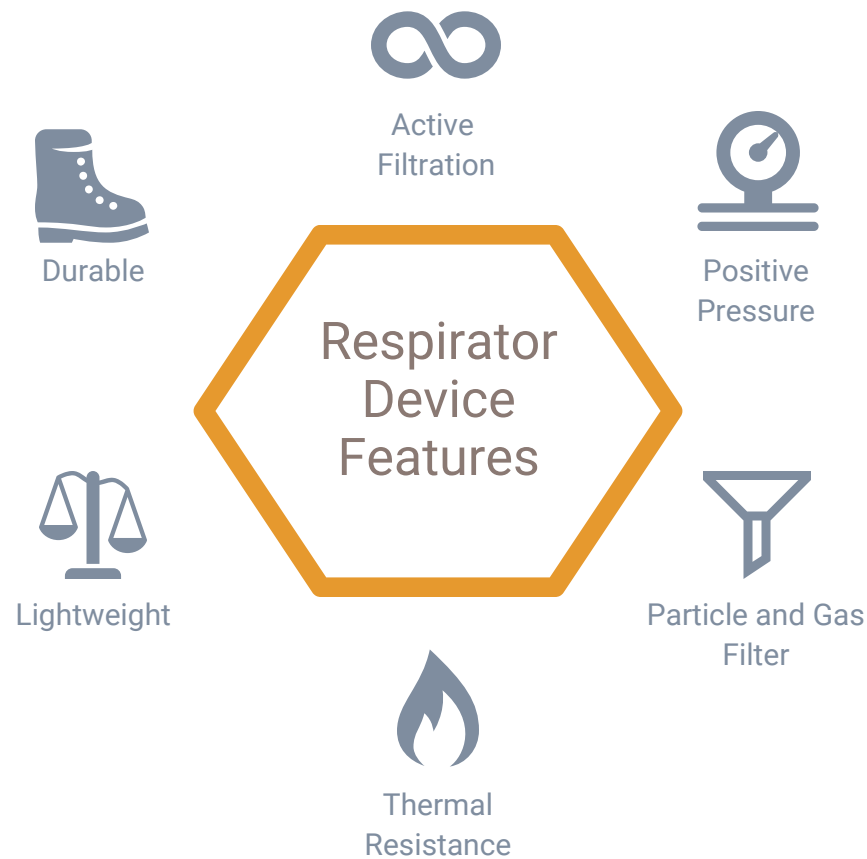


# Protecting the Health of Wildland Firefighters

Saving the lives of those who fight to save us





Today's wildland firefighters are subjected to highly toxic environments with little to no respiratory protection. This lack of protection leads to short-term and long-term health effects, with cancer being a prominent consequence. This team, partnered with Quality of Life Plus, is committed to mitigating respiratory health effects for firefighters by developing an actively filtered respiratory protection device.

Wildland fires present highly hazardous conditions as the environment contains toxic gases and carcinogens. Fine particulate matter in the smoke are easily absorbed by the skin and into the lungs, which cause significant damage to the respiratory system. When particles infiltrate the circulatory system, inflammation occurs so the effect of exposure is not just limited to the respiratory organs and many health problems may arise.

The demand for a lightweight, portable, and comparatively cheap respirator is especially prevalent in society today. By incorporating an existing PAPR product and retrofitting it for the wildland fire setting specifically, this solution will mitigate acute and chronic health effects for firefighters.

## Impact Overview

The following statistics motivated the team to design and fabricate this device.



**0%**  
of wildland firefighters wear proper respiratory protection



**30%**  
increase in wildland fires across the United States



**38%**  
of all homes in the United States are susceptible to wildfires



**73%**  
of firefighters develop respiratory complications due to smoke inhalation injury

A NIOSH study reveals that there is an increase in exposure-related health effects among wildland firefighters



**9%**  
increase in cancer diagnosis among wildland firefighters<sup>[1]</sup>



**14%**  
increase in cancer related deaths among wildland firefighters<sup>[2]</sup>

[1] "NIOSH Science Blog." Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, [blogs.cdc.gov/niosh-science-blog/2017/05/10/ff-cancer-facts/](https://blogs.cdc.gov/niosh-science-blog/2017/05/10/ff-cancer-facts/).

[2] Butler, Corey, et al. "Wildland Firefighter Deaths in the United States: A Comparison of Existing Surveillance Systems." NCBI: National Center for Biotechnology Information, U.S. National Library of Medicine, Apr. 2017, [www.ncbi.nlm.nih.gov/pmc/articles/PMC5702908/](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5702908/).

## Six ways this engineering solution can help provide maximum protection for wildland firefighters



### **Active Filtration**

Rather than incorporating an oxygen tank, this device delivers actively filtered air to the user for an extended period of time.

### **Positive Pressure**

The device provides positively pressurized airflow to the firefighter in order to ease his/her breathing during exertion.

### **Particle and Gas Filter**

Particulates of 2.5 microns and greater in size are filtered out by the PAPR, as well as toxic gases and organic vapors.

### **Thermal Resistance**

The device resists up to 140 F to prevent damage to internal components and reduce safety risks.

### **Lightweight**

Firefighters carry a lot of equipment in the field, so the device does not impair or burden the firefighters in any way.

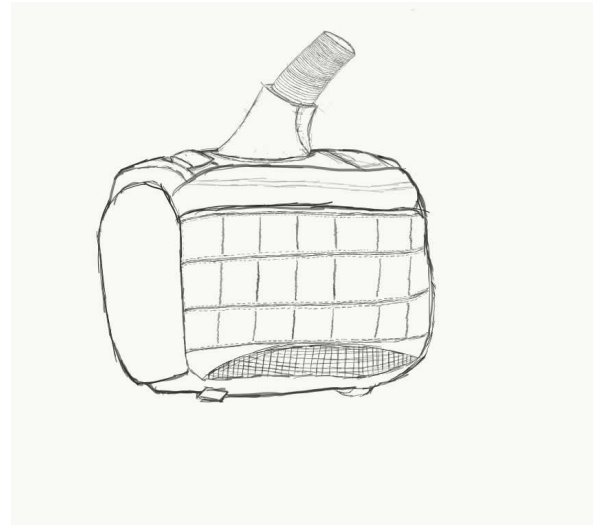
### **Durable**

Wildland environments are extremely harsh, so the device must withstand the rugged conditions in that setting.

## Our Contributions



After performing calculations, we iterated the design to incorporate a back plate rather than a full housing enclosure. The back plate has four connection points which secures the device within the sleeve. A strap feeds through the upper and lower slots of the plate and tightens down onto the PAPR. This relieves the stress at the connection points between the battery and blower. These points at which the components latch into are the weakest points and most likely to fail first when subjected to an impact force of 8ft.



The 3M Company recommends their system not to be used in environments with temperatures greater than 129 degrees Fahrenheit. When operating at a high temperature a battery alarm will activate and immediately shut off the system. The 3M company has stated the "TR-600 PAPR respirator and battery pack are not rated for intrinsic safety/hazardous locations" and that the system is to be used only in nonhazardous locations.

The most practical solution to preserving the PAPR was to design a sleeve that acts as a thermally protective blanket for the device. The sleeve was made from thermally resistant material to prevent embers from burning through the respirator. This innovative sleeve allows the respirator to be strapped to various locations along the firefighter's backpack so that it can be used with a variety of gear.

## Conclusion

Wildland firefighters nationwide, perhaps worldwide, will benefit from the innovation of a respirator device that can be utilized in the line of duty. The respirator actively removes unwanted pollutants and toxins from ambient air and then delivers the clean air to a face mask. Our team seeks to develop a respiratory protection unit to potentially be used in a wide variety of applications for several occupations and in extreme environmental conditions, in addition to wildland firefighting.

The half-mask design will allow the device to be used more comfortably with less bulkiness, better visibility, and provide options for those who are restricted by the current full hooded default design. The innovative sleeve absorbs shock and consists of straps, pockets, and a pouch attachment ladder system for a better ergonomic design.

In addition, the sleeve is composed of thermally protective materials designed to protect the device from embers and other sudden flashes of heat. This straightforward respirator design provides a wildland firefighter the opportunity to limit exposure to particulates in the air that are unhealthy and thereby, live a prolonged healthy life.



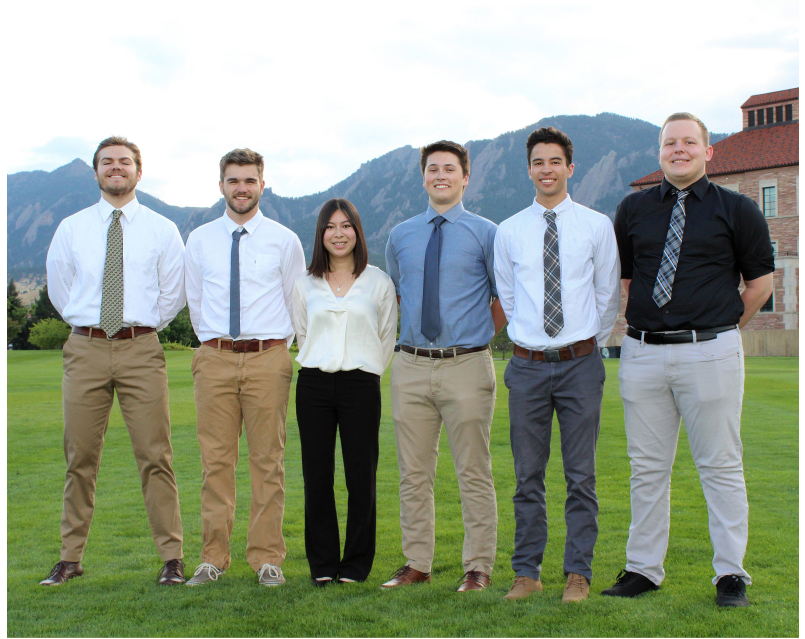
## Meet the Team

**Grant Juul** - *"In this project, the skill set that I exercised the most overall would be my ability to create objects in SolidWorks as well as helping in the prototyping phase of the project. I have learned a great deal through this process about the importance of design iterations and being able to move from prototype to prototype without taking failure too hard."*

**Dalton Kipp** - *"I am always eager to work with new technology whether it is a computer, 3D design or an engineering project. Using my technical background along with my passion for technology has motivated me to explore new opportunities for careers based on my experience. Integrating systems and prototyping iterations of designs excites me and tests my skills as an engineer."*

**Conan McHugh** - *"I have always enjoyed the outdoors and I have a passion for serving others, so the opportunity to give back to the wildland firefighting community was something of which I very much wanted to be a part. I was lucky to be able to use my skills as an engineer and develop my understanding of project financing, and I am glad that I was able to do so while creating a device that would help save lives. I am looking forward to continuing serving others in the future in whatever areas I can."*

**Lauren Strand** - *"This project has been an extraordinary pleasure to work on, as I am passionate about pursuing a career designing medical devices and equipment. Throughout this process, I have learned the significance of designing primarily around the user's needs. Ease and simplicity is many times better than complexity."*



**Kevin Vandeveld** - *"I had a vested interest in the project due to my prior outdoor experience through the Boy Scouts of America. I sought to help the firefighters who protect the land I've spent so much time on. My skill set during the project was focused around manufacturing due to my prior experience in the field. The project was a great opportunity to learn about designing for manufacturability of respirators to allow a large quantity to be made inexpensively."*

**Giordan Thompson** - *"As an engineer, I enjoy the design process and understand the patience it takes to make an idea feasible. I am intrigued by innovation and quality assurance, in which this project allowed me to fully exercise. I have learned a significant amount about the engineering process and plan to pursue a career towards design and creation."*