

Ember Generator for Forest Fire Simulation

Jackson Coleman¹, Caleb Hanson¹, Cassidi Shindler¹, Alec Smart¹, Peter Wieber²
Department of Mechanical Engineering¹ and Department of Chemical and Biological Engineering², University of Idaho, Moscow, ID



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Objective

Design, build and test a portable ember generator for use in wildfire simulations and research

Background

2021 Expo Dragon 1.0 needed improvements

- Leaks embers
- Hopper fires
- Safety concerns
- Poor calibration
- Low ember flux
- Durability issues



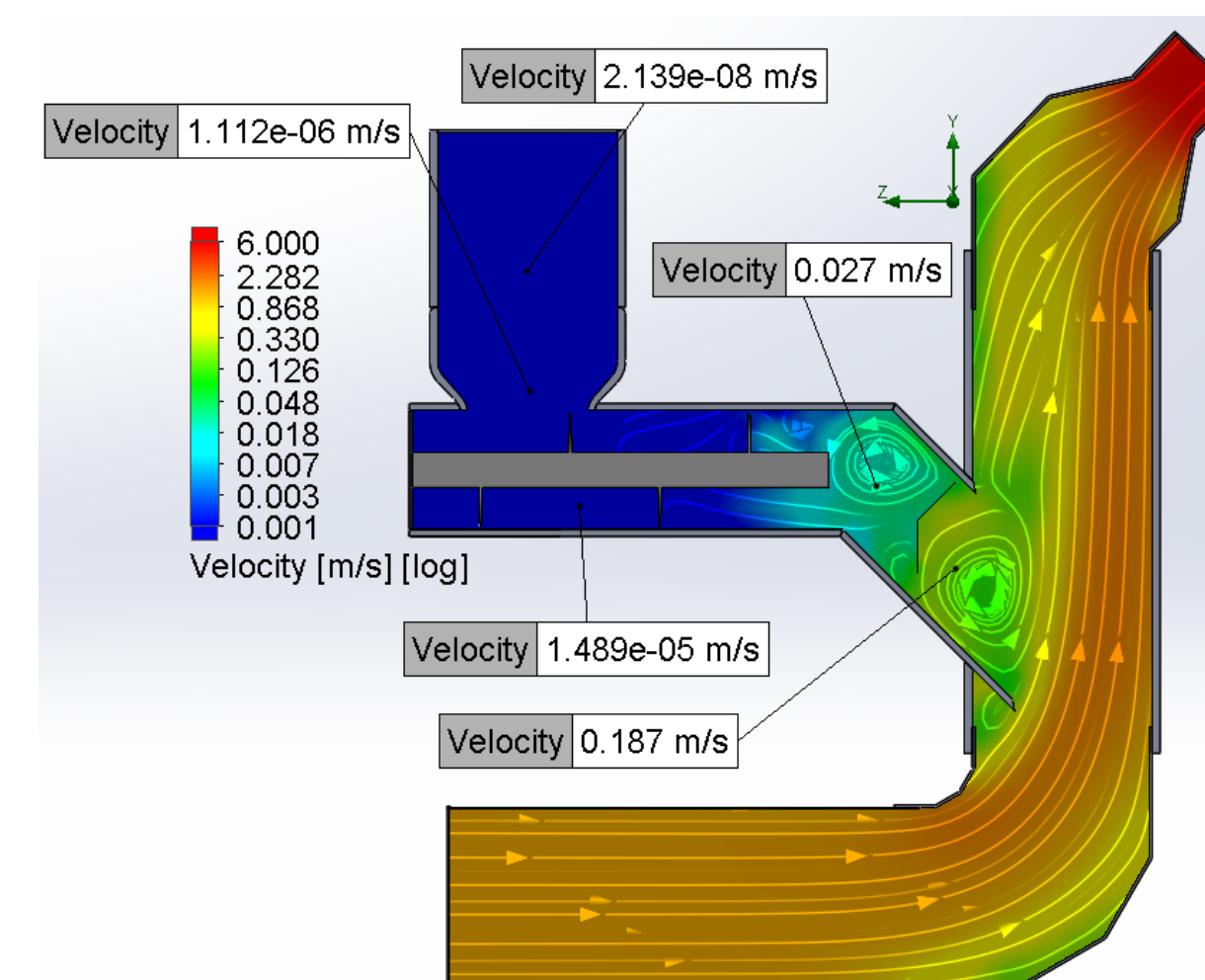
Value Proposition

- Wildfires cost \$394-893 billion annually in the US alone
- Risk to structures at the wild-urban interface
- Require better ember characterization
- Ember generator will allow for wildfire simulation

Key Design Criteria

- Prevent ember leaking
- Protect hopper from backburn
- Improve the safety of the ignition procedure
- Allow for a greater level of control over propane input
- Run continuously for 15 minutes
- Budget: \$2600

Concept Development



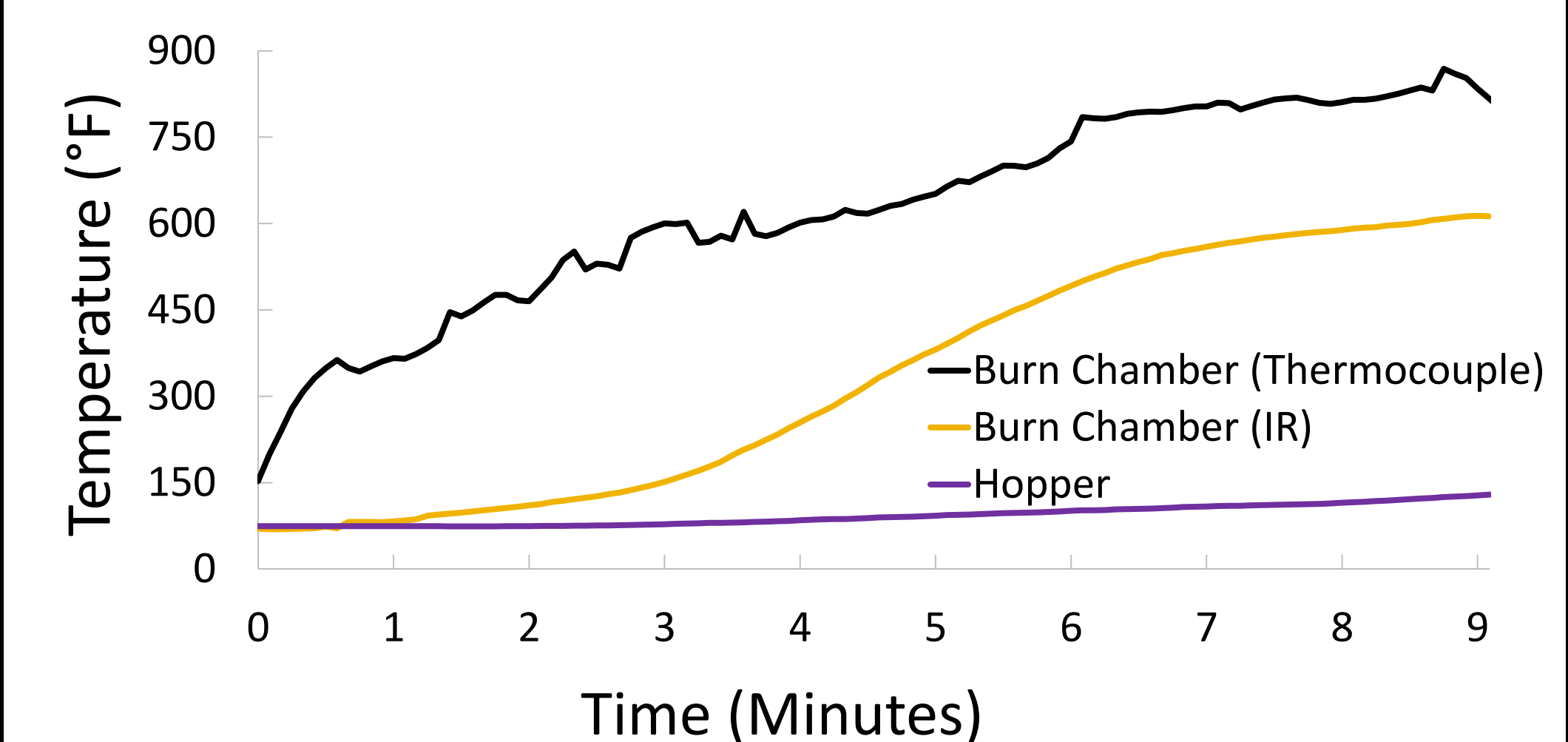
	Velocity (m/s)	
Location	Dragon 1.0	Dragon 2.0
Mid Hopper	0.001	2.139E-8
Hopper Auger	0.016	1.112E-6
Mid Auger	0.058	1.489E-5
Auger Outlet	0.109	0.027
After Damper	N/A	0.187

Prevention of backburn

- Reduce airflow in hopper
 - Tighter auger clearance
 - Damper blocks embers from reaching hopper
 - Solidworks Fluid Simulation for validation
- Sloped fuel chute
 - Create discontinuity between hopper and torch
- Improved lid seal
 - Increase back pressure in the hopper

Validation

Test Burn Temperature Validation



- Temperatures never exceed 900 °F
- Thermocouples closely aligned with IR
- Hopper temperature stayed under 150 °F
 - No back burn during tests

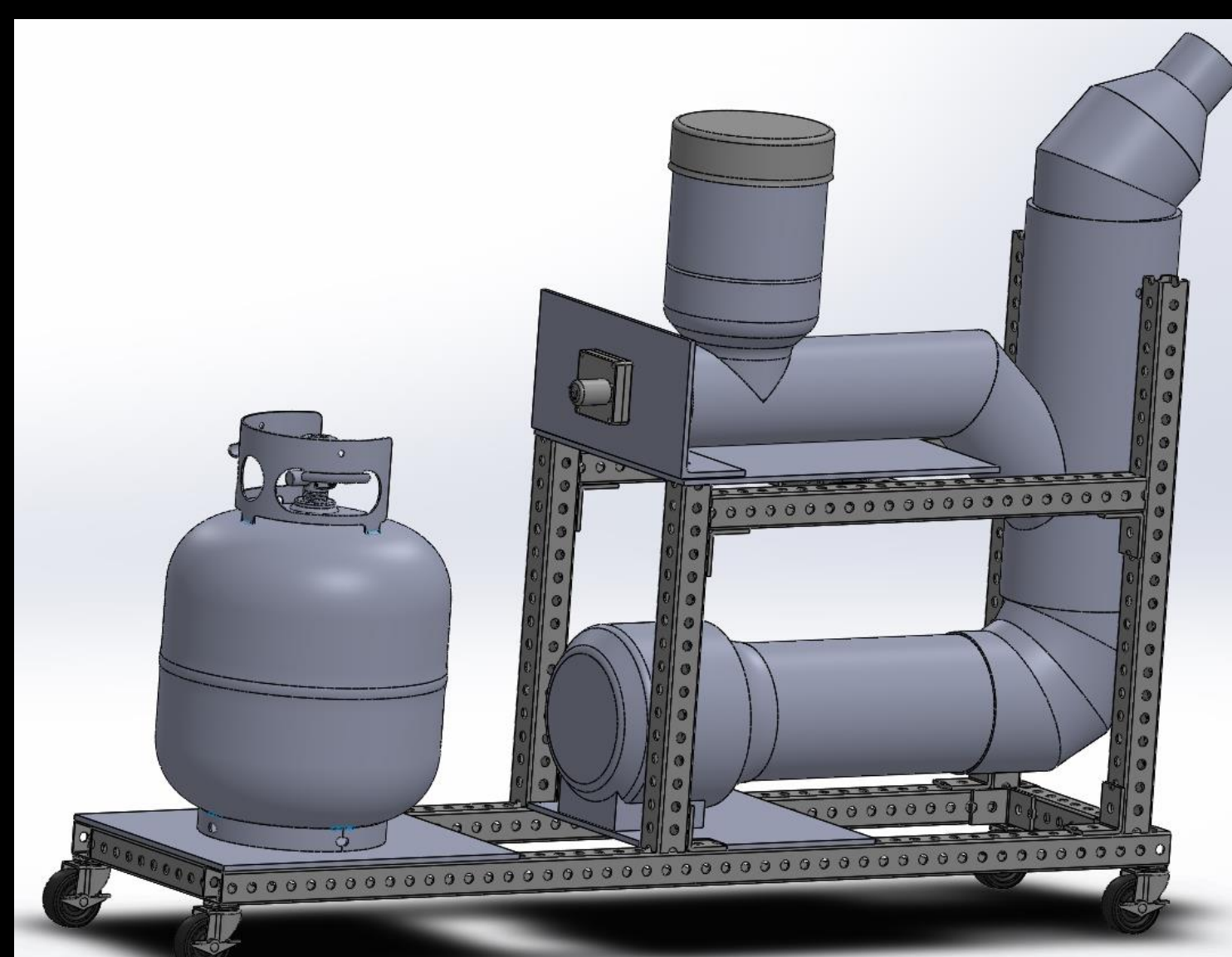
Recommendations

- Improve fire suppression system
 - Implement solenoid for remote activation
- Test for system durability
- Quantify ember flux at different wood chip feed rates, fan speeds, and propane flows

Acknowledgements

- Doug Hardman – Client
- Dr. Alistair Smith – Client
- Dr. Mark Roll – Lead Instructor
- Nagendra Tanikella - Mentor

Final Design



Key Features

- Schedule 40 welded design for durability
- HVAC duct to reduce weight
- Thermocouples allow for monitoring of system and data collection
- CO₂ suppression system to improve safety
- Spark igniter to simplify ignition procedure



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2024 Capstone Project