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Recommended Citation
USU College of Engineering, "Meet Micro Joe | College of Engineering" (2015). *College of Engineering News*. 35.
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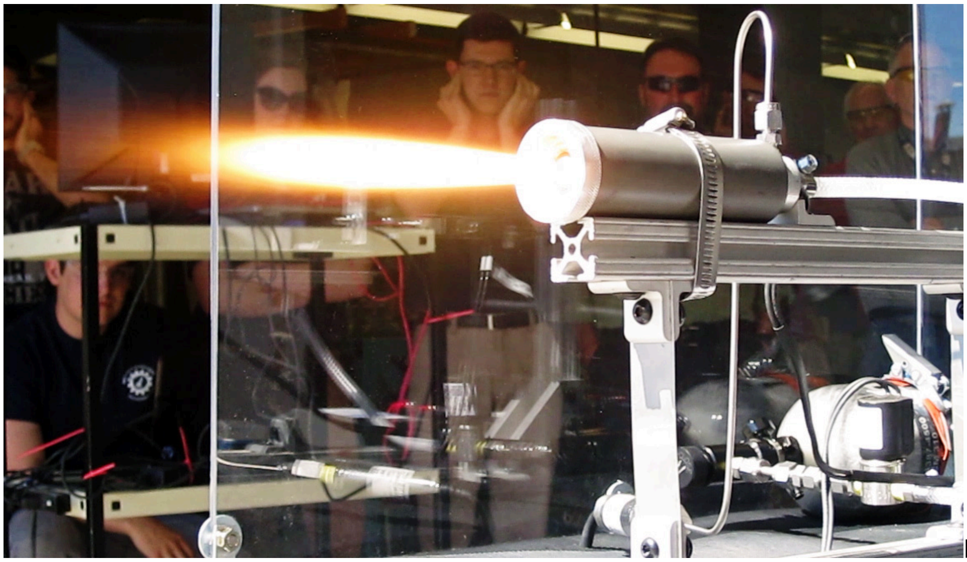
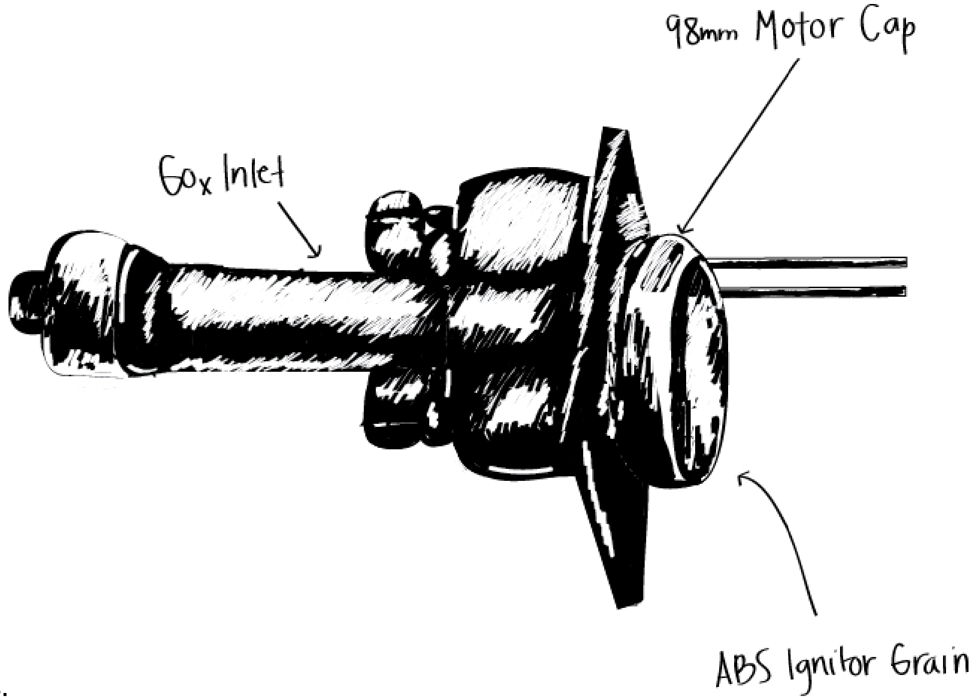
Hydrazine is an unstable, flammable liquid that has been used as a propellant in small spacecraft for decades. But the cost of this unique fuel, its transport, storage, servicing and cleanup of accidental releases can be very high, making it difficult for the commercial space industry to expand.



Finding a green alternative is imperative for safe future space travel. Utah State University professor of mechanical and aerospace engineering Stephen Whitmore, Ph.D., and USU graduate Zachary Peterson took on the challenge to investigate possible replacements for hydrazine as rocket fuel.

What they found was that hybrid rocket motors with use of additively-manufactured Acrylonitrile Butadiene Styrene (ABS) – a moldable plastic material – is a promising alternative. Hybrid rocket motors can be safely stored and operated without risk of explosion or detonation, and since ABS does not have a true melting point, it's a better candidate for additive manufacturing known as Fused Deposition Modeling, or FDM, which supports high production rates, improvement of hybrid fuel grain quality and consistency and performance with lower costs. When fully developed, FDM manufacturing overcomes development problems usually associated with hybrid rocket systems. FDM can offer a wide variety of space propulsion applications that can replace existing hydrazine-based



systems.

The discovery of ABS's unique electrical breakdown prompted Whitmore to invent an ignition system that takes advantage of hydrocarbon seeding. Two fundamental generations of prototypes were built and tested. The first was designed as an external "strap-on" ignitor for existing 98mm diameter hybrid motors that would replace pyrotechnic charges. The second reconfigured the "strap-on" ignitor to move inside of the combustion chamber with the ignitor fuel grain section- and essential part of the main motor fuel grain. In order to lower cost, an existing 98mm motor cap was adapted to fit into a short 10.2 cm hybrid motor section, this smaller adaptation became the Micro Joe. "The long term commercial potential for this technology is almost limitless. If successful, this project introduces a "game-changing" technology," Whitmore said.

So what's next for the Micro Joe? In the short run after an upgrade, the team can do larger scale research funding. Eventually leading to spaceflight demos. Long run potential rises as demand for communications grow and available bandwidth shrinks. The proposed technology can provide a solution enabling inexpensive space-based communication networks to support growth. The partners could be at the beginning of a potentially multi-billion-dollar commercial, civilian, and military communications market.