Flownex Student Rocketry Highlights

Chris Settanni December 15, 2023

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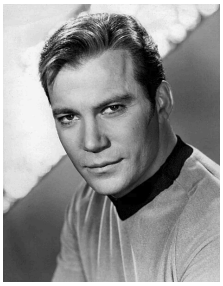
Tags: Engine Cycle Design, Launch Canada, SACUP, Student Rocketry



Space: The final frontier. These are the stories of the next generation of starship engineers.

PADT is excited to share highlights from our partnerships with student-teams taking part in the 2023 Launch Canada (LCRA) and the Spaceport America Cup (SACUP) competitions.

Rocketry Competition Overview

y teams competing in the Launch Canada and SACUP are developing st (SRAD) rockets using Flownex to explore cycle design, component sizing, pum d more!

Below are so key features make Flownex an ideal tool for engine fuel cycle design:

- Implicit solver – fast and slow transients.
- Two-phase fluid and multi-fluid mixture modelling
- CEA Adiabatic Flame modelling
- Joule Thompson effect and choking predictions – based on fundamental principal calculations.
- Exit Thrust modeling
- Integrated controls modeling
- Native ANSYS Coupling (Fluent, CFX, Mechanical, and Workbench)

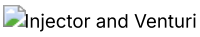
Competition Highlights

The Flownex partnership with Launch Canada began in 2022. As we close out 2023 there have been a total of 16 Canadian teams taking advantage of Flownex Simulation Environment for design and analysis. This years competition saw very impressive simulation implementation from several teams which we'd like to highlight.

The effort by the Metropolitan Aerospace & Combustion Hub (MACH) team, was especially notable. A special thanks to Shivesh Maraj and Umar Shabir (Former Team Director), for helping the team get access to the software.

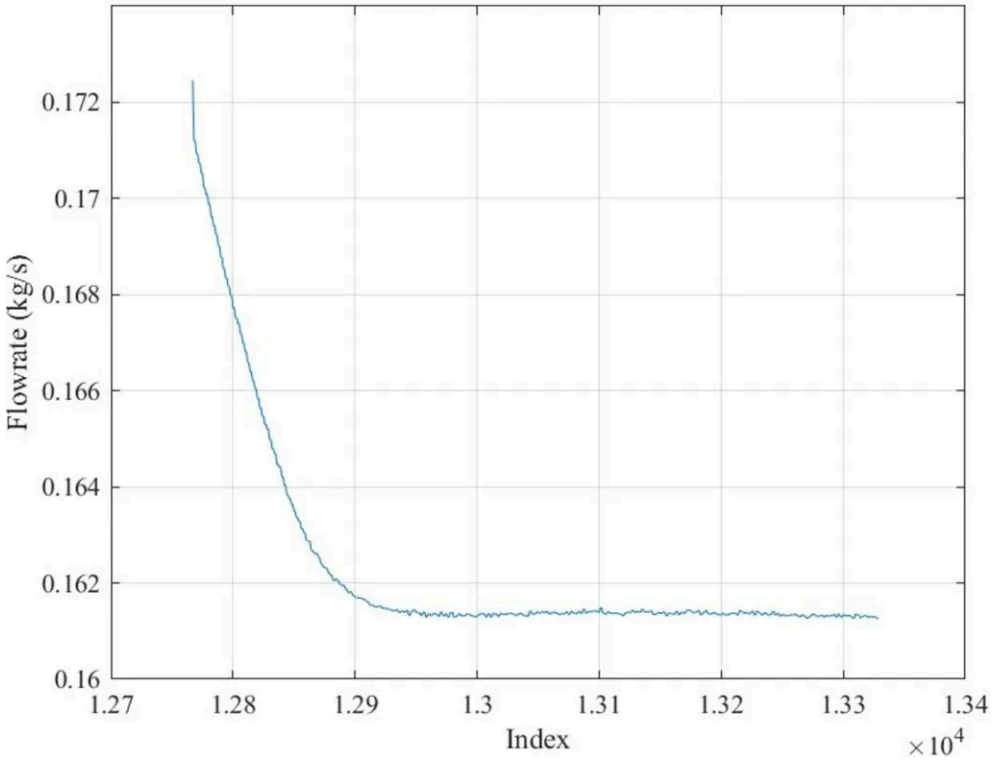
We were fortunate to be able to talk with Ben Kubica (Technical Director) and Shivesh, who had recently interned at Pratt and Whitney Canada, to learn how the team was able to use Flownex in this competition. The MACH team had used Flownex to develop a full system model of the liquid run lines to evaluate system performance, and size components for their liquid bipropellant engine.

MACH team-members saw opportunities to implement Flownex to design their fuel delivery system. Members used Flownex to predict the onset of cavitation and resultant flowrates of venturis to control fuel flow. The team leveraged these predictions to design venturis to achieve target flows and evaluate diffusor efficiency.



Injector and cavitating venturi design

The MACH team was able to conduct successful inert fluid cold flow tests on their completed components. This is an integral step in their component design validation. The test resulted in successful flow and pressure data collection, which was processed for later analysis.



Ethanol Mass Flowrate

Injector inlet pressure (P20), venturi back pressure(P22), tank pressure (P21) vs time

The Mach team compared fuel side data empirical data to their simulation results. They reported that they were able to predict the fuel choked flowrate in the fuel lines within <15% of initial test results and Injector pressure drops deviated <3% from test results from their early design phase simulations.

The MACH team was also able to perform their first hot fire attempt at the Launch Canada competition. While they experienced an ignition failure, they were able to collect valuable dual cold flow data during the competition.

Photograph of the MACH team after the 2023 Launch Canada Competition

MACH full fluid system with test stand

We were also able to ask Ben how the use of Flownex impacted his project timeline. Ben Commented that **Flownex allowed projected timelines to be cut in half** with verification and manufacturing reduced from 6 months to 3 months, advancing the GAR-E Engine development process. Ben Concluded:

> "With Flownex in our toolbelt, we were able to shorten our test campaign by months, allowing us to nail our optimistic deadlines."
>
> ***Ben Kubica*** – *MACH Team Director*

Ben and Shivesh informed us that the team planned to characterize the oxidizer system and preform another hot fire attempt this coming year. We are thrilled to see the MACH team's progress and look forward to their future developments!

New Team Highlights

Flownex is also gaining momentum with US teams as well. Flownex does not have an official affiliation with the Spaceport America Cup, but we have formed academic partnerships with several US teams to launch 2024 projects. We are excited to see how these teams use Flownex to propel their design process.

Ben Kamer, the Vice Director of Boston University Rocket Propulsion Group (BURPG) reached out to PADT to acquire Flownex for the BURPG fluids team. Although Ben's team has only had access to Flownex for a few months, they have used it to model flows in their Icharus flight vehicle.

The BURPG team has also started to use Flownex to verify hand calculations for their initial pressure drop calculations. Ben stated that the tool was quickly utilized by members of the fluids team. The rapid adoption and reliability of the tool has expedited the BURPG ten's design process. Ben commented on how Flownex is helping move their team's testing forward:

> "Flownex lets me verify my pressure drop calculations so much faster than having 3 other people check them. It's been wonderful, verifying my pressure drop calculations with only 0.2% error"
>
> ***Eric Zhao*** *– BURPG*

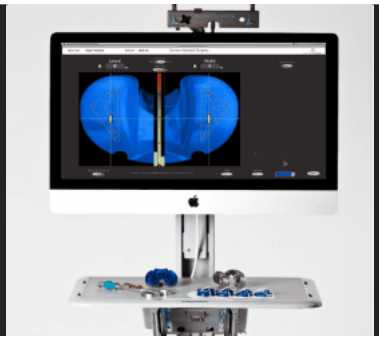
> "Using Flownex for my tank draining simulations saved me so much time, I didn't have to make a whole MATLAB program. It probably saved me 3 days of work."
>
> ***Benjamin Kamer*** *– BURPG*

Ben added that the BURPG team plans to eventually compare data to a future cold flow attempt to Flownex results.

New Horizons

We are excited to provide the next generation of thermohydraulic systems engineers with resources for designing safe, robust, and efficient propulsion systems. We hope to provide these students with modelling skills and experience that will propel their team projects forward and prepare them to engineer the next Starship Enterprise.

If you are interested in using Flownex to launch your design process, please contact us at flownex@padtinc.com



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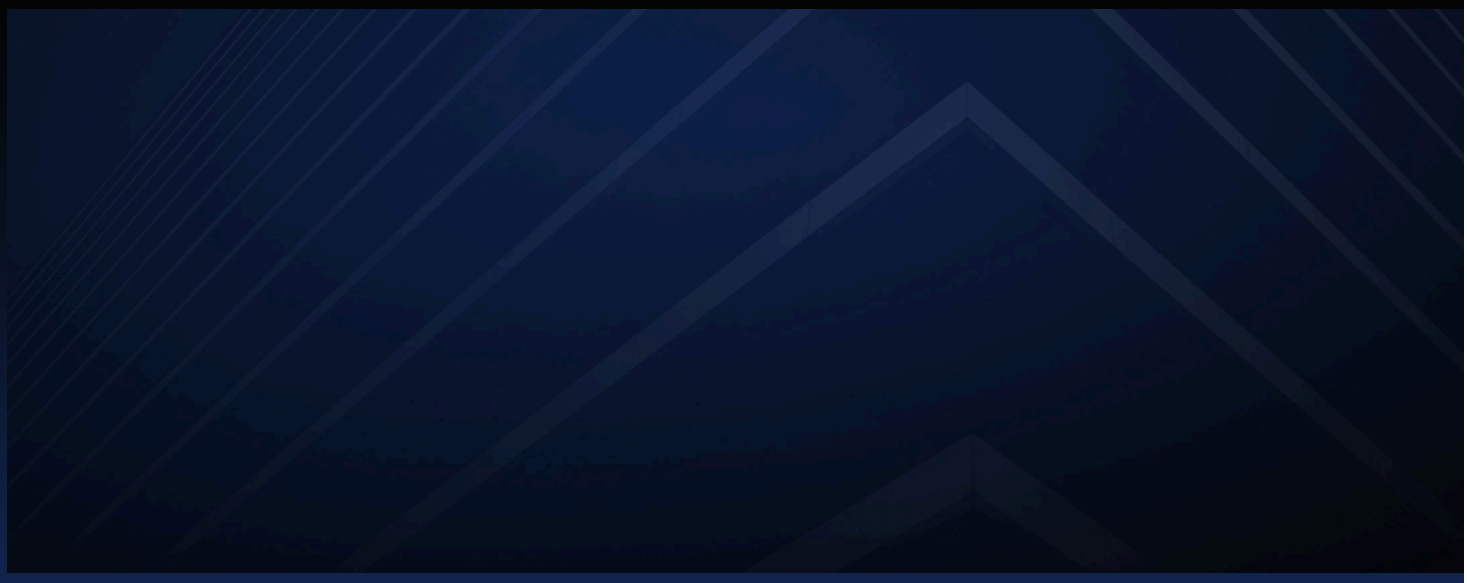

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