



success story



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## Optimizing a perfect race engine. ESTECO Academy Design Competition winner

modeFRONTIER enabled Michael Bambula of the University of Florida to run the workflow, integrate third-party software, automate the design exploration process and perform post-process analysis.

The winner, Michael Bambula of the **University of Florida**, presented a top-notch design project, in which he achieved significant performance improvements (64.2 hp @16500



**modeFRONTIER saved weeks of manual iteration and helped identify a better solution.”**

rpm) while developing a **complete model for a Moto3 bike** and realistic simulations that also considered the specifics of the race track. Organized **in partnership with Aprilia Racing and Gamma Technologies**, the competition was open to teams of undergraduate and graduate engineering students. The challenge was to improve the design of a 4 stroke single cylinder engine through multidisciplinary optimization (using **modeFRONTIER**) and **1-D simulation of the engine system with GT-SUITE**. The competition award included an internship opportunity at the **APRILIA Racing team**, which counts several World Championship Awards.

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The goal of the project was to maximize engine power. Due to the **constrained engine architecture**, an **optimization of the Intake/Exhaust system** was performed. **Gamma Technologies** supplied a set of simulation tools (**GT-Suite**) to develop the 1-D model of the high-performance engine.

Various aspects of the base engine architecture were constrained such as Bore, Stroke, Con Rod Length, Engine Speed, Max Valve Diameters, Max Valve Lift, Max Throttle Diameter, Max Compression Ratio, Non-variable Cam Timing, and Naturally Aspirated. Considering these constraints, the **optimization of the cylinder filling** (Wave Dynamics) was seen as the logical design direction.

**modeFRONTIER workflow** was used to automate the design exploration process and integrate Excel and **GT-Suite** for computing lifts value intake and exhaust valve lift profiles and simulating the engine power output.

During the development of the **1-D Engine Model** there were inherently many unknowns, therefore Michael made assumptions supported by rigorous research.

The **design variables related to the intake/exhaust system** were **automatically found by modeFRONTIER** to optimize the output results: sum of engine power across engine speeds speeds from lowest to highest respectively (11500 rpm to 17500 rpm). **“modeFRONTIER ran 1000 different designs** that varied the input parameters.

**The Hybrid Algorithm did an amazing job at finding the optimum solutions based on the objective of maximizing the engine power”** said Michael Bambula, University of Florida Racing Team.

“The analysis went beyond just determining the most powerful engine”, continued Bambula, “in fact the final objective, aimed at determining whether a certain design is sufficient for motorsports, was to compare it to lap times.

This is why it was decided that the final group of optimum results from **modeFRONTIER** would be simulated in **OptimumLap** software considering, among other assumptions, a Moto3 motorcycle model traversing the Phillip Island Grand Prix Circuit in Australia”.

Learn more about the **ESTECO Academy Membership** including **modeFRONTIER** license and access to the online learning portal an onsite training.



**MICHAEL BAMBULA (KYLE BEGGS TEAM, UNIVERSITY OF FLORIDA)**

Michael Bambula was born in Fürth, Germany and initially moved to the Bahamas and then to South Florida with his twin brother Alex and mother Karin. He completed his Bachelors of Science in Mechanical Engineering with a focus on Energy Systems at the University of Central Florida in Orlando, Florida. During his time there he was heavily involved in the Formula SAE team; helping to design Brakes, Drivetrain, and Powertrain systems. He eventually managed the team in the 2014 - 2015 season to 2 national competitions. Michael is currently pursuing his Masters of Science in Mechanical Engineering with a focus on Thermal Sciences and Fluid Dynamics at the University of Florida while working in the Systems Analysis Team at Cummins Inc.

## ESTECO Academy

ESTECO Academy is an innovative community of practice built around **Design Optimization** and the **modeFRONTIER** multidisciplinary optimization platform. With a rich collection of media and training material and a complementary calendar of events, it supports students and researchers who wish to learn about optimization in engineering.

## About ESTECO

**ESTECO** is an **independent technology provider** that delivers first-class software solutions aimed at **perfecting** the simulation-driven design process. With more than 15 years' experience, the company specializes in customer-focused solutions for **numerical optimization, CAE integration, process automation and simulation data management**, and supports over **250 international organizations** in designing better, more efficient products across a wide spectrum of industrial sectors.

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