courtesy of

Success story

modeFRONTIER helps Cummins Improve Engine Performance

Using modeFRONTIER to integrate GT-Valve train and GT-Power models for valve event optimization

*Cummins Engine, a leader in the manufacturing of **diesel and natural gas-powered engines** for a wide range of transportation and equipment purposes, has created a **new power module** ready to take on the stringent US - EPA regulations. It is significantly **more compact and cost-effective** than medium-speed engines at the same horsepower. It took **150 engineers** to design it, and modeFRONTIER helped the **High Horsepower group** find the optimal valve timing, hence reducing fuel consumption.*

Challenge

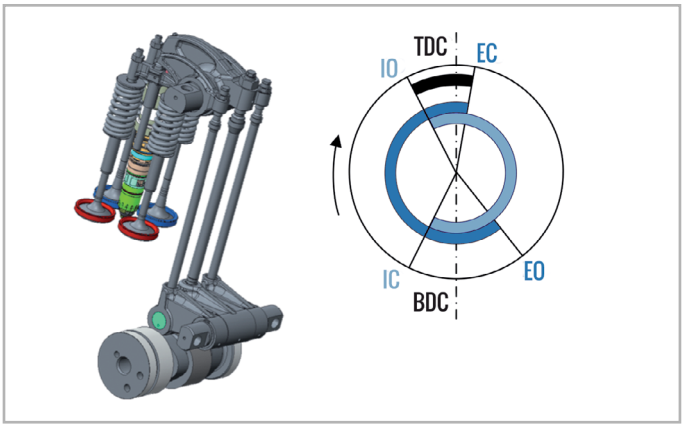
When designing piston engines, timing when opening and closing inlet and exhaust valves is a **crucial parameter** impacting the fuel consumption / power output ratio. Typically, delaying the **Exhaust Valve Closing (EVC)** and anticipating the **Intake Valve Opening** reduces Exhaust Gas Residuals, resulting in **lower fuel consumption**.
Among the complex models composing the 16-cylinder engine, Cummins designers used **GT-Suite** (Valve Train and Power modules) to simulate valve event performance and dynamics. For optimal engine performance, valve timing and lift profile need to be perfected for given **breathing configurations** defined by engine speed, and valve and port geometry and performance.

> **modeFRONTIER helped drastically reduce the time taken for calibrating GT models.**

Solution

Finding the **optimal valve timing configuration** required a **two-step process**; to start, a first workflow was created in mode FRONTIER and used to **automate the calibration process**. Valve train parameters were automatically adjusted with modeFRONTIER to calibrate the GT model and match measured push tube load. The second phase consisted in a second workflow, which was used to **investigate the design space**; initially with response surfaces and subsequently with **the direct optimization algorithms NSGA and Hybrid** - to find the best values for **12 output parameters** measuring the exhaust and intake cam timing angles, the volumetric efficiency and the Brake **Specific Fuel Consumption (BSFC)**[1].

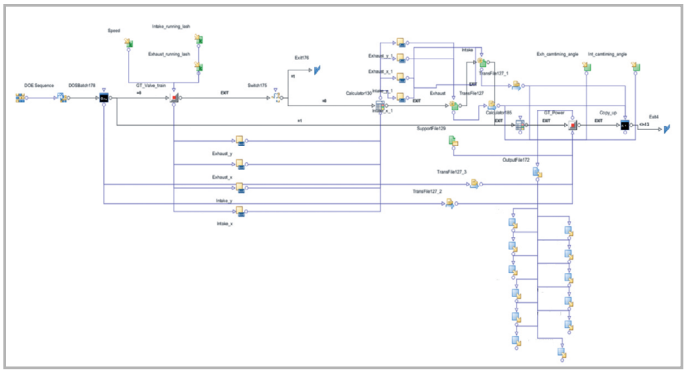
[1] BSFC is used for determining at what load and RPM an engine is making the most power out of the given fuel quantity.



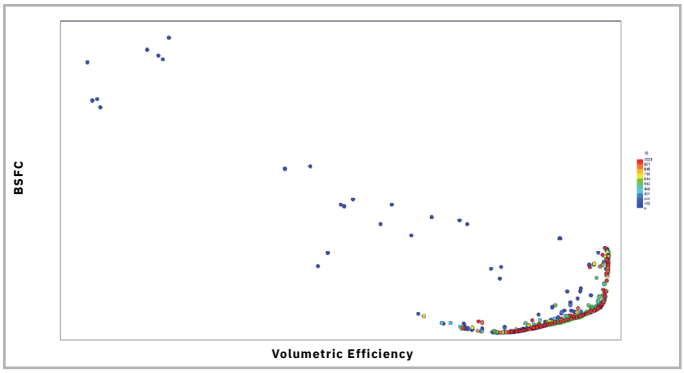
Valve train components.

Benefits

During both project phases, modeFRONTIER proved **highly reliable for reducing design cycle time** and improving the performance of the valve train system. From the outset "it **helped drastically reduce** the time taken for calibrating GT models" said **Ambikapathy Naganathan** (Structural and Dynamics Analysis Engineer at Cummins). "modeFRONTIER has an **excellent capability for integrating** with multiple GT models and post processing tools." Continued Eng. Naganathan: "in fact it helped us link those GT models **more efficiently** and complement the in-house optimization tool, while at the same time maintaining **concurrent use** by different analysts in different locations."



Valve event optimization workflow with Hybrid algorithm.



Pareto Front (HYBRID Algorithm).

About Cummins

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