

courtesy of



case STUDY

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

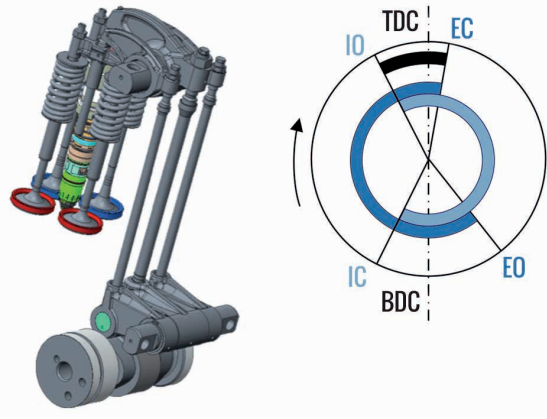
When designing piston engines, timing when opening and closing inlet and exhaust valves is a **crucial parameter** impacting the fuel consumption / power output ratio. Typically, delaying the **Exhaust Valve Closing (EVC)** and anticipating the **Intake Valve Opening** reduces Exhaust Gas Residuals, 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.





01

Valve train components.

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.

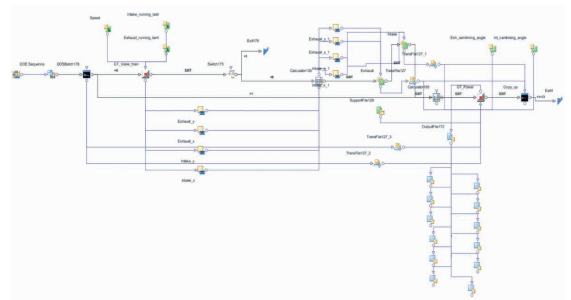
[1] BSFC is used for determining at what load and RPM an engine is making the most power out of the given fuel quantity.

ABOUT ESTECO

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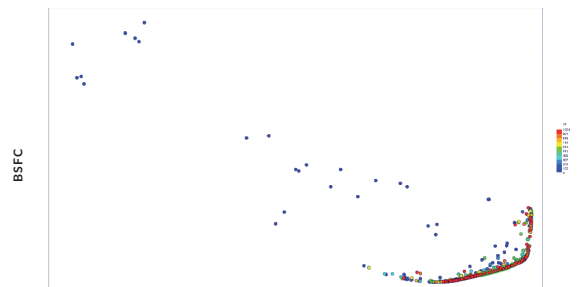
BENEFITS

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."



02

Valve event optimization workflow with Hybrid algorithm.



03

Pareto Front (HYBRID Algorithm).

ABOUT CUMMINS

Cummins Inc., a **global power leader**, is a corporation of complementary business units that design, manufacture, distribute and service **engines and related technologies**, including fuel systems, controls, air handling, filtration, emission solutions and electrical power generation systems. Cummins serves customers in **190 countries** and territories through a network of more than 600 company-owned and independent distributor locations and approximately 6,500 dealer locations. cummins.com



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