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WAVE / WAVE-RT

HIGH FIDELITY 1D CFD ENGINE MODELLING

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WAVE and its faster than real-time component WAVE-RT are at the forefront of 1D CFD technology for the analysis of Internal Combustion Engines (ICE). Our approach, combining precision and user friendliness, empowers engineers globally to forge intricate digital engine twins that epitomize design concepts. This capability proves invaluable for tasks such as analysis, optimisation, calibration, diagnostics, and maintenance of IC engines. Prioritising the precision of simulation and including targeted capabilities aimed at sustainable and non-carbon fuel modelling, WAVE finds applications across diverse industrial sectors such as automotive, aerospace, rail, motorsport, marine, and power generation. The paramount commitment of WAVE to customer satisfaction propels the transition towards virtual product development, enabling engineers to embrace cutting-edge innovations and accelerated R&D, all while curbing development costs.

What is WAVE ?

WAVE is the technology leader in the 1D engine plant model analysis supporting a wide range of applications. From concept studies to detailing engine performance and cooling system inputs, from optimization of engine components to acoustic analysis and noise level optimization; from fuel composition sensitivity to fault analysis and maintenance - WAVE can provide accurate answers to complex questions facing engineering analysis teams.

What is WAVE-RT?

WAVE- RT is the industry's leading faster than real-time engine plant modelling solver. Created from WAVE models with a single click export, it has been developed for fast comprehensive virtual calibration and validation. WAVE-RT is used to model advanced control strategies that need to be designed, tested and validated for integration into new engine control units. Furthermore, current generation WAVE-RT has fidelity approaching full 1D CFD modelling and can provide a drop-in engine plant replacement in many pre-development tasks, such as transmission calibration. Calibrated WAVE-RT engine plant models also enable system level simulations for applications such as digital monitoring, fault analysis, drivability and OBD system improvement in Model-in-the-Loop, Software-in-the-Loop and Hardware-in-the-Loop environments.
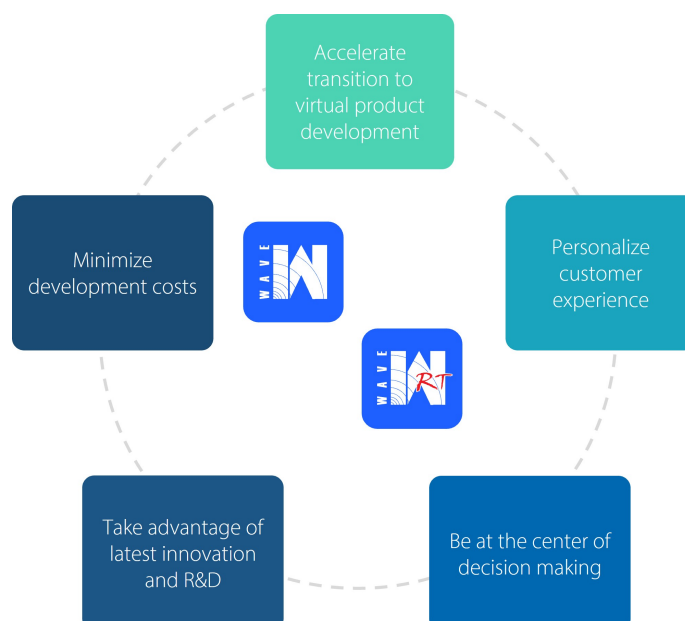
Key features

The WAVE product suite plays a pivotal role throughout the entire engine life cycle, improving the way we design, develop, and maintain engines. From inception to operation and maintenance, WAVE seamlessly integrates into your workflow, delivering unmatched precision and efficiency. From the initial design stages, encompassing performance and component design, control systems development through virtual calibration, and comprehensive performance verification for IC engines, powertrains, and finally - delivering the accurate real-time heart for complete vehicle simulation environments.

Going beyond engine design and production, WAVE and its faster than real-time WAVE-RT engine model helps our customers enhance engine operation and maintenance workflows enabling fault detection and online performance monitoring based on digital twin technology.

Our customers across diverse sectors benefit from WAVE's unparalleled usability and accuracy, spanning the spectrum of Internal Combustion Engines. From compact utility engines to marine and power generation giants WAVE equips our customers to tackle pressing challenges in today's business landscape.

From cost optimisation, performance enhancement, and emissions reduction to embracing hybridisation, synthetic fuels, and achieving overall carbon neutrality.

Accelerate transition to virtual product development

Personalize customer experience

Be at the center of decision making

Take advantage of latest innovation and R&D

Minimize development costs

Rapid model construction and tuning

For all applications of engine digital twins, the starting point is the creation of a 1D ICE model, including its instrumentation with control / sensoring elements and fine tuning of the model to achieve the desired accuracy. The productivity focused toolchain and clear user interface of WAVE helps engineering teams reduce the development costs by enabling faster creation of accurate models as well as providing troubleshooting and diagnostics tools for any levels of engine and fuel complexity.

- Import of complex engine component geometries from all common CAD platforms
- Efficient automated meshing of complex geometries for 1D simulations using state of the art proprietary Realis algorithms
- Intuitive modern GUI enabling rapid construction of complex engine models
- A comprehensive material database providing rapid access to properties of complex fuels and fuel blends
- A wide range of sensors and reporting variables putting all engine and model parameters at your fingertips
- Extensive control network support required by today's engines
- Support for user libraries and bulk import of actuators from Excel for rapid and efficient engine instrumentation
- Advanced model diagnostics tools
- Built-in state of the art surrogate optimizer allowing rapid tuning of model parameters and delivering models matching test data with minimum effort
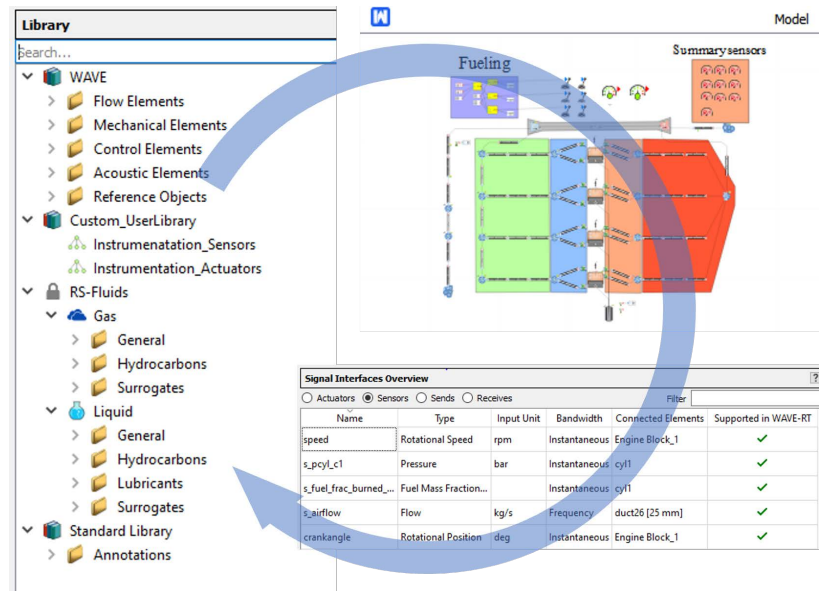
Fast and accurate solvers and physics models

The accuracy of a 1D engine digital twin relies on three aspects :
1. Physics models capable of correctly capturing in 1D the complexity of 3D flow, thermal and combustion phenomena occurring in internal combustion engines
2. The accurate discrete solver providing correct solutions for the resulting equations and flow network
3. The processes for accurate calibration of physical models
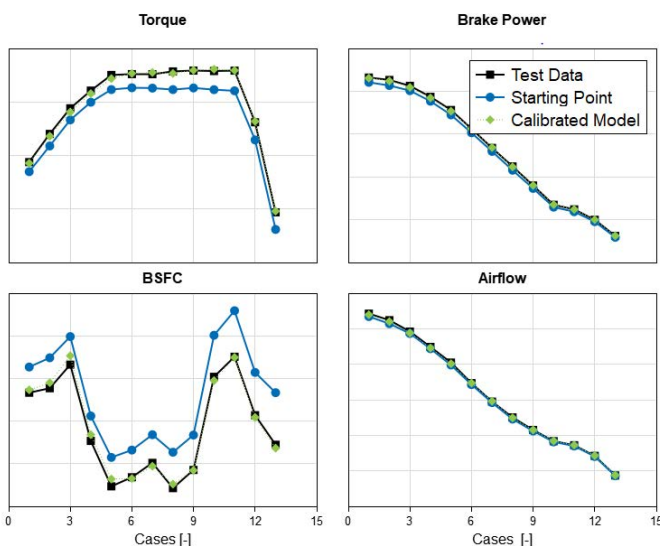
- Fast ICE solver delivering accurate flow and acoustics physics resolution
- Faster than real-time Quasi-Propagatory Model (QPM) solver for real-time applications
- Kinetics solvers for accurate representation of flame propagation and autoignition
- Custom accurate K-k cylinder turbulence model
- Advanced engine combustion models for premixed and non-premixed combustion including classical prescribed burn rate and predictive modelling
- Single and multiple-fuel operation with prescribed and predictive combustion
- Special models for lean hydrogen combustion
- State-of-the-art compressor and turbine physics
- Accurate solid heat-transfer modelling
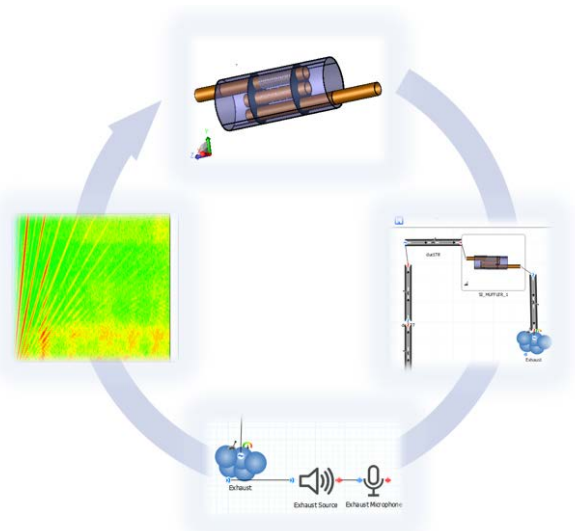
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Efficient workflows across applications

In order to provide transformational engineering capability, an engine plant modelling toolchain must not only deliver accurate results but also allow for easy integration with the CAE processes of our customers. By providing a platform for the creation of efficient workflows, WAVE and WAVE-RT help drive productivity across a range of applications.
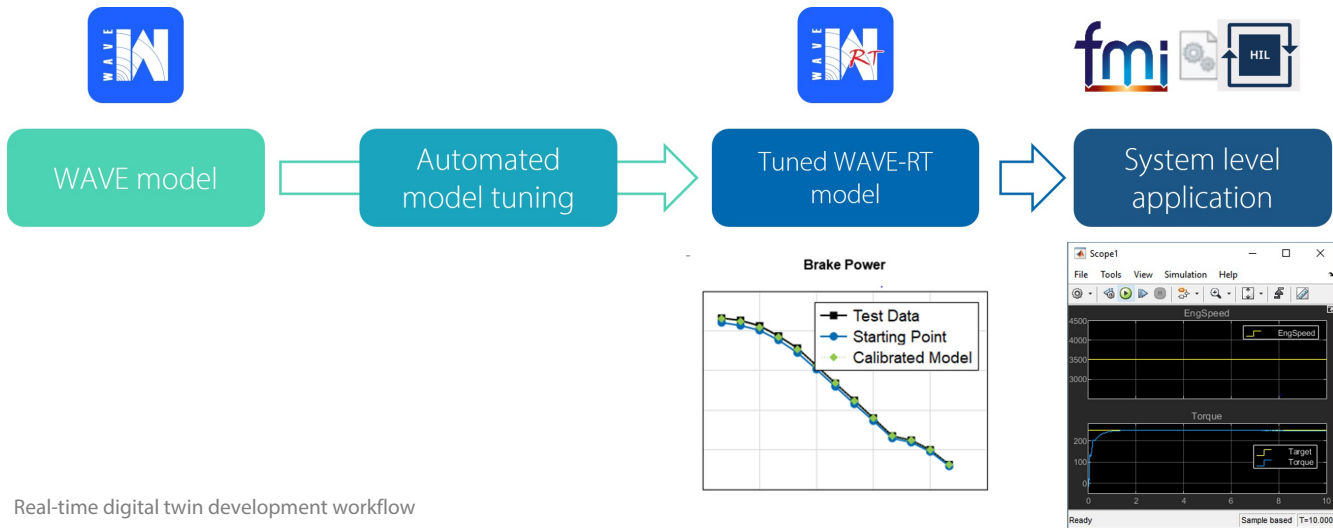
Real-time digital twin development workflow

- Powerful and fast post-processing environment
- Multi-platform computational job management system
- Advanced model calibration capabilities
- 1D/3D co-simulation with Realis and third-party tools
- Open interface with other tools through FMU/FMI technology
- Native support in MATLAB® Simulink
- Productivity automation with Python® scripting
- Compatibility with all major Hardware in-the-Loop environments
- Extensive user programming access
- A comprehensive sample engine models database

Acoustic development workflow

Be at the centre of decision making

At Realis, we understand that each customer is unique and we are offering a close partnership helping our customers build tailored solutions and processes reflecting their workflows and maximizing efficiency of their CAE process.
We put our customers in the centre of decision making by offering :

- Direct interaction with product and development teams through customer driven product development
- Bespoke model development and rapid enhancement development based on customer feedback
- Early access to requested features through customized software versions
- Dedicated and tailored support, customized interactive training
- Process and model building consulting services
- Tailored licensing solutions

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