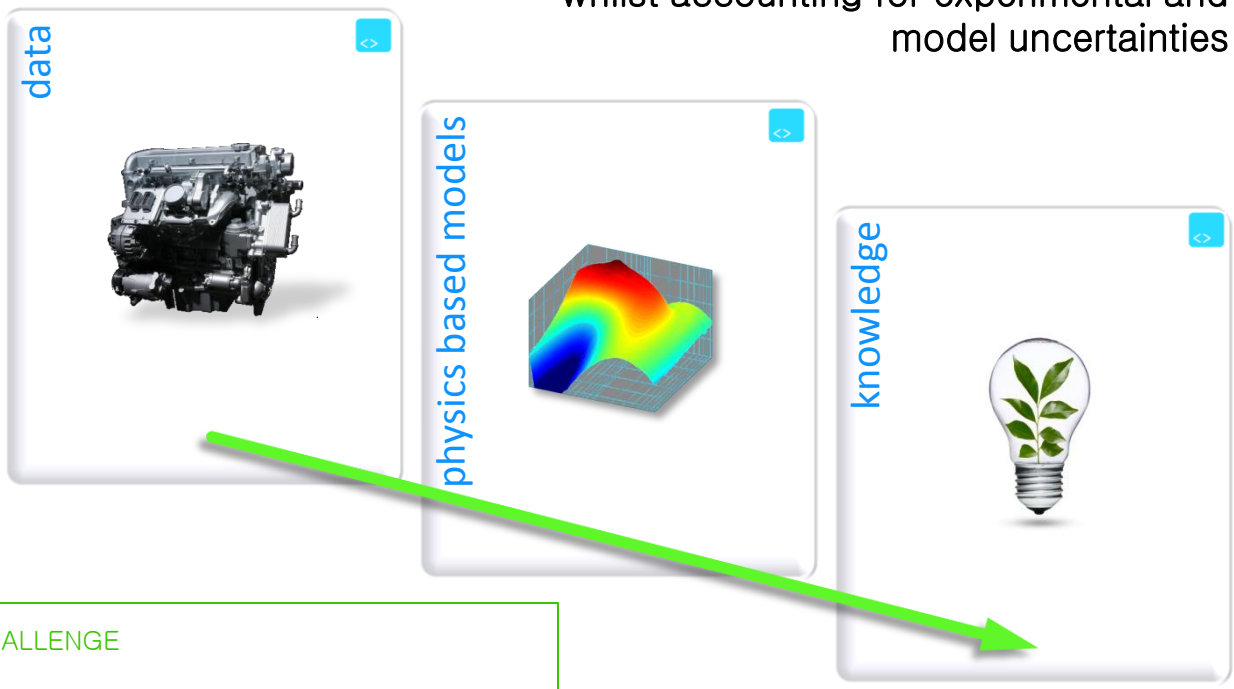
user story

Transforming data into knowledge –automated model development for IC engines

model optimisation, design of experiments whilst accounting for experimental and model uncertainties



THE CHALLENGE

To develop more robust models by integrating experiments and models such that model parameters can be obtained automatically using novel optimisation techniques.

THE SOLUTION

Using our data model and set of tools to automatically optimise model parameters against a database of engine data.

THE RESULTS

•A methodology to couple experimental data to models has been developed

•A model has been optimised automatically with respect to a database of experimental data

•The uncertainty associated with the experiments and the model has been included into the results.

•The final model can be used to identify the next most-effective experiment to carry out for intelligent design of experiments

Analyzing the combustion characteristics, engine performance, and emissions pathways of the Internal Combustion (IC) engine requires management of complex and an increasing quantity of data. With this in mind, effective management to deliver increased knowledge from these data over shorter timescales is a priority for development engineers.

At cmcl innovations we have combined conventional engine research methods with the latest developments in process informatics and statistical analysis. Process informatics enables engineers to combine data, instrumental and application models to carry out automated model development including optimisation and validation against large data repositories of experimental data.

These developments are complemented with the inclusion of experimental error and model parameter uncertainty, to yield confidence regimes on the final model result, hence the impact of specific shortcomings of the model and/or experimental dataset can be identified in a systematic manner.

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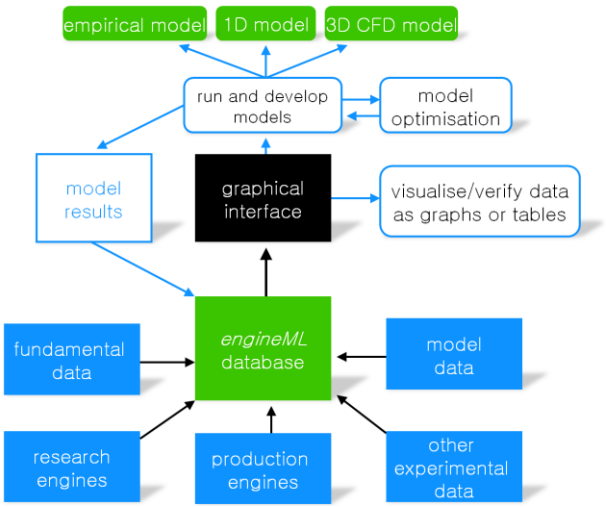


The methodology of the employed software. Here experimental data from multiple sources can be formed into a database which can be updated via a graphical interface. This interface enables engineers to optimise different kinds of models, i.e. 3D CFD, 1D models or empirical models, using state-of-the-art optimisation technique which account for model and experimental uncertainties.

THE RESULTS

•A methodology to couple models and experiments has been developed

The data model, engineML enables engineers and their modelling tools to have easy and reliable access to experimental data obtained from a variety of sources formats and structures.

•A model has been optimised with respect to experimental data

In the example below, forty-two model parameters have been optimised with respect to numerous engine operating points.

•Model uncertainty propagation

Experimental and model uncertainties have been included, in this case preventing model over fitting to experimental data of low certainty, and highlighting those aspects of the model where model parameter uncertainty is limiting the overall model performance.

•What's my next experiment?

Now that the model can be re-optimised as soon as new data comes online, our tool can identify the next most -effective experiment to carry out for intelligent design of experiments.

APPLICATION AREAS

•Commercial 1D or 3D CFD codes

•Multi-parameter optimisation

•Complex modelling problems

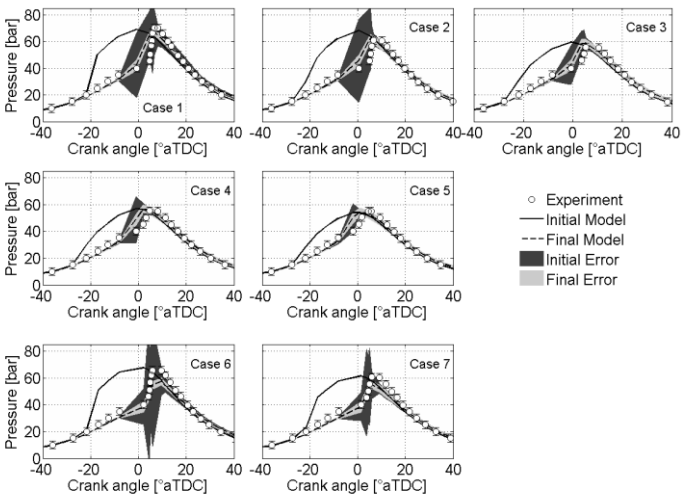
•Empirical expression fitting

•Efficient design of experiments

PRODUCTS USED

•srm suite

•engineML data model and software



In this diagram, the in-cylinder pressure crank angle histories for seven operating points are presented. Data shows those regions of the cycle where the model carries most uncertainty, thus enabling engineers to focus on those aspects of the model where the model is less robust..

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