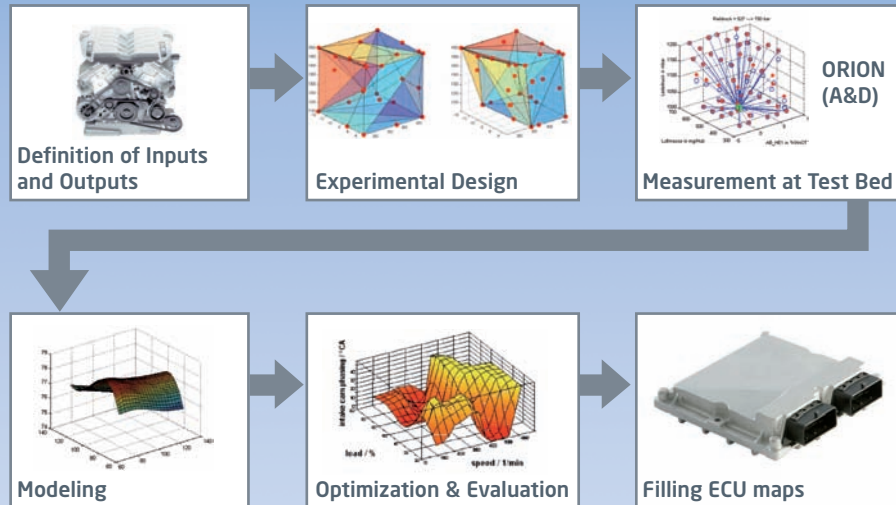


# EasyDoE Toolsuite

## Engine Optimization using Design of Experiments



### EasyDoE Toolsuite for Design of Experiments

Design of Experiments (DoE) is a methodology widely used to plan experiments and identify optimum parameter settings for the entire operating range of combustion engines.

EasyDoE Toolsuite guides engineers through all steps of the DoE process:

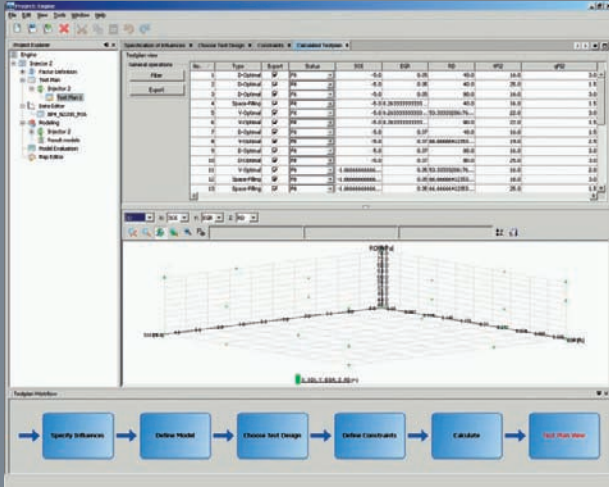
1. Defining the inputs and outputs while planning the required tests
2. Downloading the test plan to a test bed automation software, such as ORION from A & D Company, Ltd.
3. Importing the measured data, modeling the engine behavior and using the resultant models to optimize engine maps

EasyDoE Toolsuite supports these tasks by creating and visualizing test plans, models, optimized engine settings and smooth engine maps.

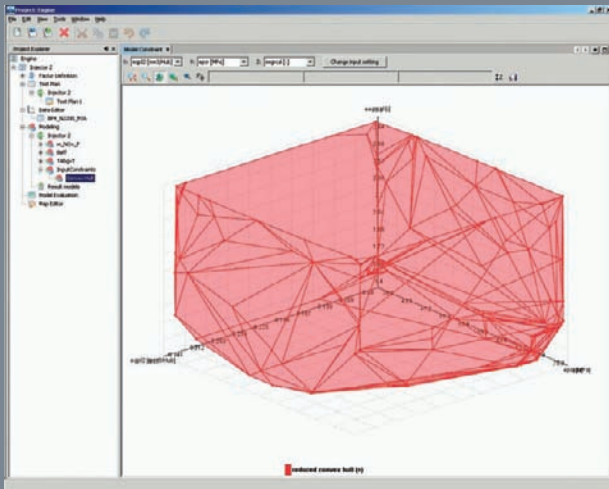
IAV has been using DoE in production calibration projects for more than ten years. Facing real-world requirements, a team of DoE experts at IAV has developed and refined its in-house tools. These formerly single-task tools have now been redesigned and integrated into the EasyDoE Toolsuite, achieving an intuitive user interface consistent throughout the process and enabling engineers to design and evaluate test designs and models without the need of in-depth DoE knowledge. Advanced users can employ more sophisticated options to adapt the process to their needs - EasyDoE Toolsuite can even be customized with additional user functions programmed in MATLAB®.

### Features

- ▶ Offline optimization of complex engine behavior using DoE
- ▶ Visual guidance through the entire DoE process in one tool
  - Factor definition
  - Test planning
  - Processing measurements
  - Modeling
  - Model evaluation (optimization)
  - Filling ECU maps
- ▶ Based on the IAV in-house tools EasyDoE & ModelAnalyzer
- ▶ Intuitive usage through easy workflow
- ▶ Integration of MATLAB® scripts
- ▶ Process automation with templates



EasyDoE Toolsuite: Test planning and modeling



EasyDoE Toolsuite: Visualization and optimization

### EasyDoE Toolsuite: Test Planning and Modeling

Based on IAV's sound experience, the newly developed EasyDoE Toolsuite guides engine calibrators through the entire DoE process. An intuitive graphical user interface explains each required step.

IAV has developed numerical methods to build representative models of engine behavior. Several types of models are implemented to meet different signal types and applications. Future releases will contain additional modeling options.

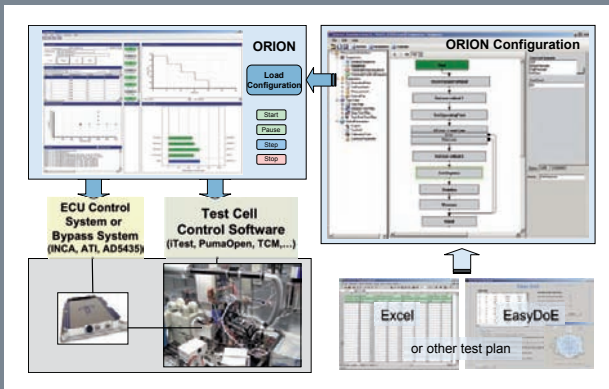
### EasyDoE Toolsuite: Visualization and Optimization

Visualization enables engineers to inspect the models generated with EasyDoE Toolsuite or to import models from similar tools such as the MATLAB®-based MBC toolbox from The MathWorks™. The tool contains 2D and 3D plots to visualize engine behavior which show the boundaries of the design space.

The tool can generate multiple optimizations from one set of models. Optimizations may have different objectives and constraints.

### ORION

For several years, IAV has been using an in-house tool called MPI² for conducting automated measurements on the engine test-bed. This expertise has been combined with the needs of other test-bed users. IAV and test-bed producer A&D Company, Ltd. have developed the ORION software, which can be used with several test-bed systems.



ORION: Automated measurements