

Consulting Ramps Up Successfully

Making calibration of complex embedded systems more efficient

In addition to the traditional embedded software tools portfolio, ETAS is offering consultancy services for calibration. ETAS consultants are experts and project managers with long-term practical experience in the calibration of powertrain and chassis systems. Calibration consultants support the complete development and calibration process, including smart and virtual calibration methods. The focus for Andreas Gerhardt, Head of ETAS Calibration Consulting, and his team is to identify possible areas of improvement for ETAS customers. After consultant supported implementation, customers will benefit from a sustainable value in the day-to-day calibration business.

ETAS has a network of calibration experts and managers worldwide continuously exploring new approaches, methods, and technologies for better managing calibration complexity and improving calibration efficiency. Continuous improvement of existing calibration processes is frequently applied to master the complexity in calibration. The objective of the calibration process is to organize, manage, and control calibration-related activities in a structured, efficient, and reproducible way.

Various aspects are taken into account:

- Calibration project organization
- Resource planning including test cells and vehicles
- Data exchange with suppliers
- Definitions of tuning guides
- Handling of new features with impact on calibration
- Calibration data management
- Reuse of experience gained in earlier projects

A well-defined calibration process is a prerequisite and results in a framework to manage these aspects efficiently, thus allowing for the end result to be on spec, on time, and on cost.

ETAS offers a 3-level approach for process analysis (see Table). Based on the result, the consultancy experts propose a solution concept and define it together with the customer. This is followed by the implementation supported by our consultants.

Andreas Gerhardt explains consulting as the transfer of proven methodologies to a new or different field of activity. As an example: Design of Experiment (DoE) is a widely used methodology for base calibration of modern internal combustion engines (ICE) at an engine test bench. A customer of ETAS is using permanent magnet synchronous machines (PMSM) in different hybrid powertrain configurations. Due to the variance in system specifications, it is important to use the PMSM as

efficiently as possible in terms of system-specific performance and required reliability for today's automotive market.

To achieve this, the customer would find the optimal setting by following an iterative process that included a well-defined, step by step optimization sequence at a test bench. This resulted in an unnecessarily high number of measurement points and test bench hours for a fairly simple physical system behavior.

By integrating the ETAS ASCMO DoE suite for this specific calibration task at the customer, the overall number of measurement points was reduced to a third. In addition, the customer received a precise data-based model which allowed the optimization under different perspectives and criteria to find the best setting. In any instance where data during the post-processing may have been missing, it could automatically be generated without the necessity of additional test bench measurements.

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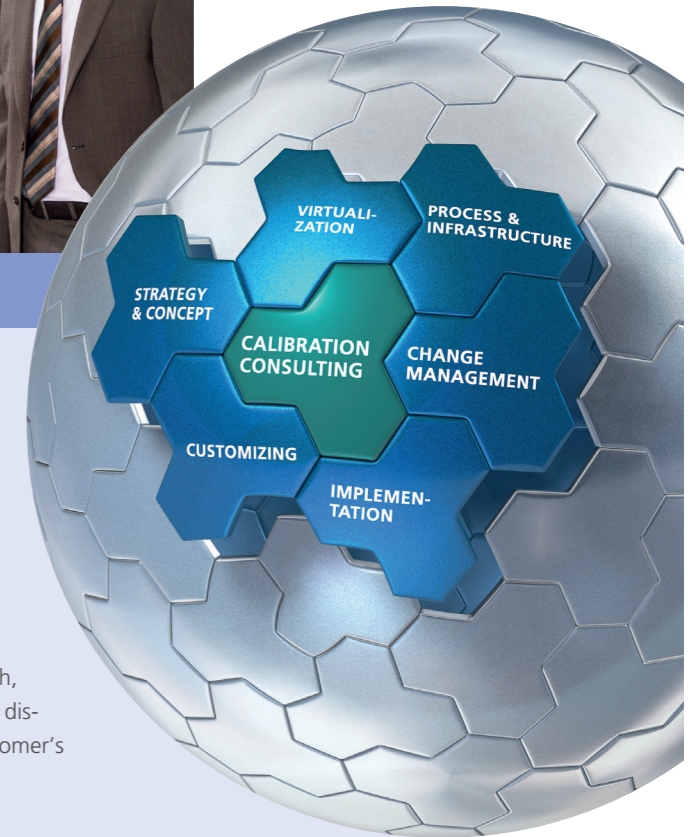
Christoph Heller,
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and **Rainer Pientsch**
are Senior Consultants
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Approach on managing a typical customer request

An engine supplier requested help with a typical calibration consulting task from ETAS experts: He wanted to identify possible areas to streamline the calibration approach and receive recommendations for changes to meet internal efficiency targets. Christoph Heller and Peter Hertkorn, both Calibration Consultants at ETAS, visited the customer for several days in order to obtain a deep understanding of the customer's situation. Interviews with the relevant stakeholders were arranged, including engineers, the lead calibrator, and management.

Different calibration teams were accompanied during their daily work. The goal was to get as much information as possible concerning the calibration approach, the methodology, and the tools in use. In Christoph Heller's words: "We have discussed the strengths and weaknesses derived from a benchmark with the customer's management. The discussion led to several improvement steps."



| | Level 1 | Level 2 | Level 3 |
|-------------|---|---|--|
| Goal | <ul style="list-style-type: none"> ▪ Quick understanding ▪ General appraisal ▪ Basic positioning of customer | <ul style="list-style-type: none"> ▪ Basic understanding of current calibration process with identified key areas for improvement | <ul style="list-style-type: none"> ▪ Deep understanding of current calibration process with detailed feedback of all sub areas |
| Input | <ul style="list-style-type: none"> ▪ Standardized questionnaire | <ul style="list-style-type: none"> ▪ Interviews with stakeholders from each main area | <ul style="list-style-type: none"> ▪ Detailed interviews with stakeholders in identified sub areas ▪ Deep dive analysis of process (variance analysis) |
| Output | <ul style="list-style-type: none"> ▪ Brief summary ▪ General feedback on strengths and weaknesses | <ul style="list-style-type: none"> ▪ Summary for main areas ▪ Benchmark ▪ Identification of areas for improvement based on strengths and weaknesses | <ul style="list-style-type: none"> ▪ Detailed summary of sub areas ▪ Detailed benchmark ▪ Detailed description of strengths and weaknesses |
| Realization | <ul style="list-style-type: none"> ▪ Questionnaire filled out by one or several persons | <ul style="list-style-type: none"> ▪ Management meeting ▪ Kick-off with stakeholders ▪ On-site group interviews (2-3 persons) with main areas ▪ Final presentation of results | <ul style="list-style-type: none"> ▪ Management meeting ▪ Kick-off with stakeholders ▪ On-site one-to-one interviews with main and sub areas ▪ Final presentation of results |

ETAS 3-level calibration process consulting approach