aras

TOYOTA
TOYOTA MOTOR EUROPE NV/SA

CASE STUDY

How Toyota Motor Europe Developed A Flexible Digital Thread With Systems Thinking

IN PARTNERSHIP WITH

inensia
Digital Industry Services

COMPANY BACKGROUND

Toyota first began selling cars in Europe under an official distributor agreement in 1963. Since then, the company has matured into the leading Japanese car manufacturer. Based in Brussels, and staffed by 2,700 people of 63 nationalities, Toyota Motor Europe now handles the wholesale marketing of Toyota and Lexus vehicles, parts and accessories, and manages Toyota's European manufacturing and engineering operations.

PROBLEMS & CHALLENGES

The Model-Based Design team relied on complex spreadsheets and the manual exchange of them among the engineering teams to share this data, a process which was unsustainable due to the number of architectural variants and related simulations. Furthermore, these spreadsheets were devoid of any connection to the rest of the product data and were not managed under configuration control. The pedigree, maturity, and connectivity of the data were often unclear. Management at the engineering division leadership recognized that without a new data management platform, the existing process was not sustainable.

SOLUTION

The original spreadsheets are now replaced by the "single source of truth," the digital thread in the Aras Platform that covers the engineering data for vehicle dynamics performance. The variant-design-simulation relationships are managed within this system-centric digital thread regardless of where the system and design details are authored.

BENEFITS

Today, engineers can:

- Separate data from its presentation with Excel-like ease of viewing and editing of the data structure. While manual input is still needed today, this is an initial process step before the integration with each data source to realize an automated data-gathering process going forward.
- Compare different versions of data structures.
- Have access to libraries for reusable data models and their items down to specific data types.

NOTABLE METRIC

The distributed engineering teams of the vehicle performance division can now remotely, rapidly, and efficiently create, review, and edit the data, increasing confidence in the data quality and the consistent simulation models generated by a repeatable automated process. This has also led to a carefully measured:
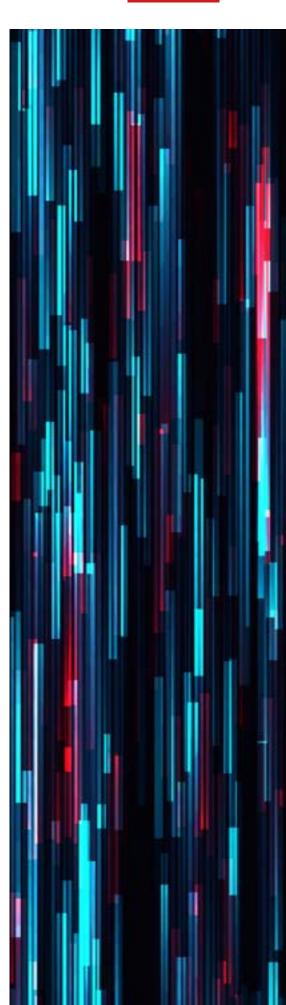
- **Decrease in process lead time by 28%**
- **Reduction in time expenditure by 41%**

Every automotive manufacturer today has been impacted by the increasing complexities that continue to grow inside modern cars. Designing a car is already a complex task. Designing a car that needs to handle tomorrow's requirements is an even more daunting experience, and the approach toward vehicle development must evolve.

To handle the complexities of both present and future car designs at Toyota Motor Europe, their vehicle performance engineering division is working with a system-level Model-Based Design (MBD) approach. Some areas within R&D use a broader model-based systems engineering (MBSE) approach, either as a trial or as an emerging standard. In the future, the application of the model-based systems engineering (MBSE) approach is expected to expand.

When the vehicle performance engineering division started incorporating the MBD into its digital engineering practices, it had already defined the related teams and processes for designing and manufacturing vehicles. This included a systems-centric approach to capturing 150% of the engineering data, representing the mechanical car platforms, including related variations, without the use of formal MBSE modeling tools.

The MBD team relied on complex spreadsheets and the manual exchange of them among the engineering teams to share this data, a process that was unsustainable due to the number of architectural variants and related simulations. Furthermore, these spreadsheets were devoid of any connection to the rest of the product data and were not managed under configuration control. The pedigree, maturity, and connectivity of the data were often unclear. Management at the engineering division leadership recognized that without a new data management platform the existing process was not sustainable.

CONNECTING DATA, CONNECTING PROCESSES, CONNECTING PEOPLE

They needed a way to define and maintain a "single source of truth"—a digital thread—accessible to everyone in the division and with a clear context of the pedigree and accuracy of the data. What they were looking for was the ability to improve modeling lead time and workload and raise the quality of MBD models delivered to the organization.

Toyota Motor Europe's Ernesto Mottola, PhD., Vehicle Performance Engineering, was convinced that to achieve this, they needed a way to directly connect and manage their engineering data to a resilient and scalable system architecture backbone. And once the digital thread for data was established, it would be possible to design digital processes that enable efficient collaborative work among the parties that produce and consume this data. Ernesto's mantra is: "connecting data = connecting processes = connecting people."

Ernesto was intrigued by the possibility of overcoming typical limitations related to hard-coded system solutions and traditional file-based approaches that no longer could handle the challenges.

The goal for the vehicle performance engineering division inside Toyota Motor Europe became to initiate a digital reorganization of existing engineering data to be tool-agnostic. This enables automated and reusable system-level MBD engineering data models with full integration to a PLM platform.

What piqued Ernesto's interest in Aras' PLM platform was the ease and flexibility of extending the data model and digital thread scope starting with out-of-the-box (OOTB) functionality baselines. He started by creating a vendor-agnostic, generic engineering data model to capture non-geometric (pre-CAD) engineering data.

Ernesto was convinced that it was necessary to begin with this foundation and build towards a fully automated, robust, and accurate generation of simulation models across large numbers of product variants.

Plus, the guarantee that the ability to support Toyota Motor Europe's continuous improvement processes driven by the Toyota Production System (Kaizen) principles through the flexibility of the Aras PLM Platform, adaptations will remain compatible with future releases of the platform without requiring additional costs.

That was very important since Toyota Motor Europe knew that the initial target was only a starting point for what their future digital thread had to encompass (e.g., design space exploration, link to performance requirements, cross-domain virtual development approach, and others) and that therefore selection of a resilient, flexible, and scalable PLM platform was essential.

WITH KAIZEN, WORK IS NEVER DONE

A detailed plan was developed by the teams from Toyota Motor Europe, Aras, and the integration partner Inensia, working together for the technology validation phase of the project with the initial goal of extending the Aras Platform data model to encompass structures and relationships for Toyota Motor Europe's Engineering Data Management (EDM).

Focus on the key process needs:

Gathering and approval of engineering data

Automatic generation of simulation models

Ability to rapidly make changes to the design to perform what-if trade studies

After identifying the key process needs, the second phase of the plan was to apply the Aras platform to manage revisions, lifecycles, workflows, and access control.

Using the Agile software development methodology, the teams developed a pilot, then continuously improved the solution until they were able to arrive at what Ernesto would characterize as a "minimum viable product". In true "Kaizen"-fashion, the solution will be continuously improved as new needs are identified.

The rapid implementation was made possible with the modeling flexibility of the Aras Platform and the hands-on collaboration between Aras, Inensia, and Toyota Motor Europe experts throughout the process. Benefits included:

- Efficient management of all the engineering specifications usually managed during the development process, including plots, vectors, tables, maps, etc. These data are defined using parameters that capture units in a meaningful way.
- Support of existing car platform sub-system models
- Variability rules for resolving the 150% system models into 100% variants.
- Support for all data needed by simulation models—becoming the single source of truth for certified data (initially low-fidelity simulations in the mechanical domain)—with model generation for multiple CAE solvers.

The original spreadsheets are now replaced by the "single source of truth," which is the digital thread in the Aras Platform that covers the engineering data for vehicle dynamics performance. The variant-design-simulation relationships are managed within this system-centric digital thread regardless of where the system and design details are authored.

The distributed engineering teams of the vehicle performance division can now remotely, rapidly, and efficiently create, review, and edit the data, increasing confidence in the data quality and the consistent simulation models generated by a repeatable automated process. This has also led to a carefully measured decrease in process lead time of 28% as well as a reduction in time expenditure by 41%.

Today, engineers can:

- Separate data from its presentation with Excel-like ease of viewing and editing of the data structure. While manual input is still needed today, this is an initial process step before the integration with each data source to realize an automated data-gathering process going forward.
- Compare different versions of data structures.
- Have access to libraries for reusable data models and their items down to specific data types.

With clear evidence of the benefits, the EDM solution for managing engineering data was deployed into production with the engineers readily warming up to the value of PLM. The key to success was a clear vision of how the digital thread should support MBSE/MBD and engineering data management, and how a flexible PLM platform can support Toyota Motor Europe's continuous improvement processes.

Successful completion of this project now allows Toyota Motor Europe to start focusing on the next phase, which aims to extend the tool-agnostic digital thread to include Simulation Process and Data Management (SPDM). The goal is to fully automate the generation of simulation models from the "single source of truth" to support design space exploration.

Based on the success of the digital thread within this division, other groups in Toyota Motor Europe R&D have started implementing the digitalization of other processes based on the Aras PLM platform.

Aras provides the most powerful low-code platform with applications to design, build, and operate complex products. It's technology enables the rapid delivery of flexible, upgradeable solutions that build business resilience. Aras' platform and product lifecycle management applications connect users in all disciplines and functions to critical product data and processes across the lifecycle and throughout the extended supply chain. Airbus, Audi, DENSO, Honda, Kawasaki, Microsoft, Mitsubishi, and Nissan are using the platform to manage complex change and traceability. Visit www.aras.com to learn more and follow us on Twitter and LinkedIn.