CASE STUDY

How Aras Supports Nissan Motor’s In-Vehicle Software Variants via Digital Thread
BUSINESS CHALLENGE

- The move to electric car production has led to the management of in-vehicle software variants becoming increasingly complex.
- Efficient management of complex in-vehicle software variants between Nissan Motor and its alliance partners is critical to effectively compete in the market.

“Aras Innovator’s low-code and model-based platform allows accommodating changes in business and technology by dynamically evolving the model without disrupting the users and with minimum code. This is what makes building and configuring custom functionality so easy to accomplish.”

“Engineers in various domains and teams are now using the same platform to build a digital thread that enables traceability to requirements while working on design details in highly specialized tools. Ten years ago, this idea was so grand and difficult that I couldn’t find any capable solutions. Today, Aras Innovator allows step-by-step realization of these goals via its ‘easy to build,’ ‘easy to align,’ and ‘easy to connect’ characteristics.”

- Nissan Motor Co., Ltd., Engineering & Design Systems Department, Global IS Delivery Headquarters, Hiroaki Nemoto

BENEFITS ACHIEVED

- Consistent, quick, and error-free configuration of functional software variants
- Improved compliance with ISO26262
- Reduction of user errors from manual entries
- Elimination of multiple systems with a single solution
- Extended digital thread and process integration with partners
- Improved quality, reduced development time, and optimization of resources
- Elimination of the MATLAB/Simulink simulation silo

WHY ARAS

Nissan cited three ‘easy to’ characteristics of Aras Innovator as the reason for selecting the platform:

- ‘Easy to build’ Aras model-based architecture makes development of custom solutions easy to manage
- ‘Easy to align’ Aras data model allows easy mapping to external data structures
- ‘Easy to connect’ Aras’ open API enables a flexible and easy to manage coordination with external tools and systems
OVERVIEW

Nissan Motor Co., Ltd is a car manufacturer that designs, manufactures, and sells cars globally. To ensure long-term competitiveness in the market driven by the electrification of cars, the company established a business transformation plan, “NISSAN NEXT,” with the goal of full implementation by 2023.

Nissan expects to increase the production of electric cars by 60% in Japan, 50% in Europe, and 23% in China. To achieve their goals, Nissan is continuously expanding its cars’ electronic and software controls which allows them to introduce advanced capabilities that cannot be achieved with the physical movement of mechanical parts. For example, Nissan is introducing next-generation autonomous driving using its ProPilot advanced driver assistance technology with a planned expansion to 1.5 million installations by 2023.

The electrification trend has resulted in a significant configuration management challenge of the in-vehicle software functionality. As the scope of electrification grows, so does the amount of the related source code, which now exceeds 100 million lines per car. In fact, its scale and complexity is said to be larger than Windows, Android, or jet fighter operating systems. To address this complexity, Nissan set up a working group in 2012 to design an information management platform for in-vehicle software development along with selecting a PLM solution that could implement it. The company considered five PLM candidates. In 2013 announced the selection of Aras Innovator to implement the new information system, integrate the solution with their alliance partner, and establish digital thread traceability with their partners.

Why Aras? According to Nissan, Aras Innovator’s key advantage is that it is model-based. Using the platform’s low-code capability, new applications can be quickly developed by modeling business issues, and any changes in requirements can be quickly accommodated by changing the model, all with a minimal amount of coding. Innovator’s modeling approach is easy to understand and explain, allowing the parties involved reach a consensus in a short time. It also helps to identify and resolve problems early in the solution planning and development processes.
REPLACING MULTIPLE SYSTEMS WITH A SINGLE PLM PLATFORM

With Aras Innovator, Nissan was able to implement a unifying solution for managing complex in-vehicle software variants that replaced multiple in-house systems.

Nissan’s automotive software controls are developed concurrently by different teams in their specific product and project contexts. The challenge is maximizing reuse of these assets by all teams in their specific project contexts. Effective reuse requires managing each software configuration, software function, usage history, and context separately.

Prior to Aras, Nissan used an in-house central system-of-record to capture the original designs and multiple local systems-of-record to capture local adaptations. These local adaptations were then manually copied to the central system to maintain traceability with the original design. Unfortunately, copying was done manually which allowed for human error and data inconsistencies.

In 2014, the central and the local systems-of-record were eliminated, and their functionality was unified on a single Aras Innovator instance. Now details of each adaptation of a software function in a new software configuration are captured and related to the original design of the function without the need for copying data between multiple systems. The result is a single system-of-record with multiple benefits for the entire organization, including:

- elimination of errors and inconsistencies due to manual copy/paste
- ability to instantly identify adaptations that are impacted by a change to the original design
- consistent traceability of requirements-function-verification
- reduction of wasted man-hours, improved quality, and reduced development time
INTEGRATING PROCESSES AND SHARING RESOURCES WITH PARTNERS

In 2017, Nissan began a project to integrate processes and enable resource sharing with an alliance partner to become more competitive in the global market, focusing first on R&D, purchasing, and production. Integration of electronic and software control systems development was particularly important, with the goal to maximize capabilities of both companies without interfering with their on-going R&D capabilities.

After considering various integration options, including linking existing systems, the decision was made to base the solution on Aras Innovator. Driving this decision was Nissan’s previous successful deployment of the Aras platform. Nissan took the lead by building an overlay on the top of its existing Aras Innovator instance under the name Alliance PLM.

Alliance PLM enables the sharing of software control functions and configurations between the two companies, similar to how Nissan already shared them internally, without redefining existing functions and configurations at either organization. This was simple to do by capturing the differences in the data model instead of modifying the software assets of either company. Alliance PLM was designed, developed, and deployed across the companies in less than a year despite the substantial updates and scope of new functionality needed on both ends.

The seamless integration of the processes between the two companies:

- Enables global assets development, traceability, sharing, and visibility across companies’ boundaries.
- Provides both organizations with the ability to globally monitor the utilization and assignment of human resources in the development product process.
According to Nissan, the ability to globally ensure that the right person is at the right place at the right time is a major benefit of the integration.

Nissan believes that their number of global car manufacturers’ development partners will keep expanding worldwide and that seamless integration of development processes and sharing of assets with partners will significantly impact Nissan’s competitiveness. This expansion is why Nissan views Aras Innovator’s ‘easy to’ characteristics as crucial in designing solutions, reaching consensus, and implementing these processes across the companies.

**CONFIGURING IN-VEHICLE SOFTWARE VARIANTS**

Nissan does not develop every new car model’s electronic and software control systems from scratch. Instead, they reuse already developed software functions to configure new variants of software functionality. Software reuse is possible because all individual software functions have already been verified against the original requirements. Reusing mature software assets already used in cars shortens development time and reduces costs-of-quality while ensuring compliance with safety requirements. To this end, over the years, Nissan has enhanced their in-vehicle software variant configurator.

Before the introduction of Aras Innovator, Nissan’s configurator used an in-house system of record based on Microsoft Access to track over 20,000 software assets. The process was manual, time-consuming, and subject to human error due to the manual entry of tag values, visual verification of data consistency, and manual assignment of attributes and tags to each software asset. Tags were the primary way to find a specific item by searching for keywords embedded in the tag’s complex alphanumeric strings.

After replacing Microsoft Access with Aras Innovator, the new configurator continued to use the original tags. This included manual creation, management, and association of the tags with the individual software assets. The process continued to suffer from inefficiency of the tag definition, search, and human errors. The sudden increase in software assets in Aras Innovator from the integration with the alliance partner only worsened matters.
To alleviate these issues, Nissan upgraded the configurator functionality by introducing hierarchical tags in Aras Innovator. This new feature, called “3D shopping,” uses tags with a 3-level hierarchical structure: software series, followed by device specification, followed by vehicle specification.

- Series defines the type of car for which the software was made
- The device determines in which car sub-system to install the software.
- Vehicle defines the place in the car in which it will be installed.

Aras Innovator manages the consistency of tags using hierarchical lists. This approach reduces the definition of new tags to selection from a predefined drop-down list, eliminating human errors. Adapting a three-level drill-down selection of a software function made the software variant configuration process consistent, quick, and less affected by the growing number of individual software assets.

**EVOlving PLM PLATFORM IN CONCERT WITH CHANGING ENVIRONMENT**

Ensuring a car’s functional safety is of paramount importance to Nissan. ISO26262, the international standard for functional safety, requires car manufacturers to retain an official record of risk assessment for each function of the car, how the function was implemented, and the process used to develop it. This includes traceability between function requirements, design of the functions, development processes, and the system variants that use the function. The system’s safety must be guaranteed by traceability to the upstream process.

Nissan fulfilled these requirements by building links between Aras Innovator, the upstream requirements management tool, the downstream issue tracking system used by Nissan and the alliance partner, and relationships to the software assets managed by Aras Innovator. This is Nissan’s digital thread, which can expand to connect with whatever upstream and downstream tools are needed.
To further comply with ISO26262, Nissan partnered with Aras to develop integration with MATLAB/Simulink, a simulation tool used to develop electronic and software control systems for cars. The integration utilizes Aras Innovator’s open API. It enables the search and download of a specific software asset from Aras Innovator to MATLAB, and automatic registration in Aras Innovator of newly developed software from MATLAB.

“Because MATLAB and Aras Innovator can work together, information managed by Aras Innovator, such as developers’ skills and authority, can also be used in MATLAB. Work automation has greatly progressed,” says Mr. Hideaki Kobayashi, Software Expert, Engine Management System Control Technology Development Group, Powertrain and EV Control Technology Department, Powertrain and EV Engineering Division.

In the manufacturing industry, simulation often sits in a silo. That makes coordinating information between the design departments and the business department challenging. If the business needs and the software functionality are not fully shared between the departments, goals are misaligned. This leads to a loss of trust between the teams.

According to Mr. Nemoto of Nissan, “What was significant for the information system department was that we created a culture of working together with the development department to build these functions. By taking advantage of the ease of build of Aras Innovator, we were able to design business and system specification processes at the same time, making it possible to create a system where everything works together. I think we can continue to grow with a PLM system that evolves together with changes in the environment.”
Nissan is currently promoting multi-domain data management solutions to meet the company goal of quickly assimilating new advanced technologies. With the increasing sophistication of car controls, software functions for individual design domains such as powertrain systems, chassis systems, and autonomous driving systems, are becoming more complex. Rather than the traditional one-to-one relationships, there are now many-to-many relationships. To develop functions that span multiple domains, it is necessary to manage data beyond the framework of the individual domains. At the same time, development tools used in design domains are also becoming increasingly sophisticated. Engineers rely on this sophistication to improve domain-specific development efficiency, complicating integrating designs in a cross-domain collaborative environment.

Nissan’s solution is using Aras Innovator as a common PLM platform that allows engineers in all domains to extract information as needed and in a way that makes the information compatible with individual authoring tools. Relationships between individual functions and their system context are extracted without changing the system configuration for each domain. In other words, the platform enables traceability by maintaining a tool-agnostic digital thread. Nissan plans to integrate its software variant configurator as one of the tools that interacts with the platform. The resulting digital thread will allow users to check which software functions are included in a specific software variant and trace that back to the original function requirements maintained in an external tool.

“This concept has been around for about 10 years, but it was so grand and difficult that I couldn’t find any capable solutions. However, by taking advantage of the ‘easy to make,’ ‘easy to align,’ and ‘easy to connect’ characteristics of Aras Innovator, the environment which is convenient for Nissan’s development sites, is getting closer to reality” says Mr. Nemoto of Nissan.
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.