

# Model-Based Development and Technical Education at SUBARU *Empowered by Modelon*

SUBARU Corporation  
Electrified Drivetrain Development Department

SUBARU empowers the Transmission Model-Based Development through the implementation of Modelica - enabling SUBARU's R&D team to ramp up their expertise of modelling and simulation through the collaboration with Modelon in the short term.



## About SUBARU Corporation

Headquarter:

Ebisu Subaru Bldg. 1-20-8, Ebisu,  
Shibuya-ku, Tokyo 150-8554,  
Japan

Established: July 15, 1953

Main Business: Japanese automobile OEM engaged in the development, manufacture, repair and sale of SUBARU brand automobiles and their components. Other than automobiles, they are a global transportation equipment manufacturer in the aerospace sector.

## About Electrified Drivetrain Development Dept. \*

The department carries out research and development of electric and drivetrain systems (motors, transmissions, and differentials). The team Mr. Kuroda belongs to is in charge of the spread of MBD in the department as well as the system building and advanced development using MBD technology.



### Mr. Kyosuke Kuroda

Mr. Kuroda was assigned to the Power Unit Research & Experiment Dept., the predecessor of the Electrified Drivetrain Development Dept. He has been involved in the reliability development and testing of transmission components.

## What is the role of Model-Based Development and 1D models in product development at SUBARU?

SUBARU Corporation is an automobile OEM, so our main business is to develop and manufacture passenger vehicles and provide them to our customers. We believe that the role and purpose of Model-Based Development at SUBARU is to reduce costs, improve efficiency, and enhance the technical skills of engineers in the process of vehicle development, and we are committed to achieving these goals.

## Why did you incorporate Modelica technology into your team?

Our team started to consider implementing MBD 5 or 6 years ago, and the MBD status that other companies implemented ahead of us as well as the discussion with Modelon helped us in our decision. Of course, we knew about other system modelling and simulation languages, and we had a choice of using the existing tools available within the company. However, one of the main advantages of Modelica was that it was a 1D simulation tool that was relatively easy to use, even for those of us who were not part of the CAE department, which was mainly concerned with analysis, but rather with experiments. Modelica is easy to use, and the various elements that make up a transmission can be represented in easy-to-understand diagrams, and the way of connecting the wires between components is intuitive. Also, it was a good point that we could build it in the same way as we envisage the structure of the object and reproduce its physics. We came to the conclusion that the Modelica language was the best choice, based on an overall assessment of its strengths in terms of visibility and extensibility, as well as the availability of real-world examples.

## Why choose Modelon's products and services?

First of all, it was a milestone that we were able to speak directly with Modelon in the early stages of the implementation process. At the time, we had just started to use a 1D simulation tool and found out that Modelon was the developer of an easy-to-use library that was included in the tool. Furthermore, through the form of workshops, we were able to learn about Modelica technology, case studies and various 1D model building methods - that brought us to an undoubted fact that Modelon's solution was a good service and we decided to implement it.

\*as of June 2021.



## What areas of your product development have you applied our products and services and how have they benefited you?

Our team works on the development of overall drivetrain systems, but we have been using Modelon Base Library, Vehicle Dynamics Library and Hydraulics Library for fuel consumption and power studies. In addition to this, we believe that the project has shown results in terms of improving the accuracy of the initial study, which is the most upstream part of the V process common in the automotive industry, increasing the efficiency of development (eliminating rework), and improving the technical skills of the engineers, which is also one of the purposes of SUBARU's goals.

## How have MBD, Modelica and Modelon's solutions have helped engineers to improve their skills?

Our team combines 1D models with evaluations for drivetrain system development, but without understanding the essential mechanism, it is not possible to build the 1D model properly. At first implemented, a certain number of engineers made evaluation without thinking deeply about which parts of the physical compounding were important, but they were not aware of this situation until they were exposed to the 1D model. Now the understanding of physics has been deepened in the process of creating the 1D model, it has been very effective in improving technical skills in all stages of test planning, experimentation, and analysis of the results. Although we are professionals in the field, the workshop with Modelon revealed that there were some fundamental principles and mechanisms that we did not understand. Apart from the knowledge of the vehicles, sharing and discussing models made us intensified the understanding of the essential mechanisms and the 1D model gave us different perspectives on the experiments we had been conducting.

## Which aspect of the Modelica-based technology works more than you expected?

We have been observing the situation of our team members in the current department, and we believe that we have developed the ability to think about mechanisms more than we expected. As we were originally from an experimental department, the Elemental Evaluation Dept. had to repeat experiments to accurately evaluate performance, and the Actual Vehicle Evaluation Dept. had to repeat test driving to improve the accuracy of the sensory evaluation. Looking back the days of experiments, we tried to cover some of the underlying mechanisms by the number of experiments. When we have clarified the principle of the mechanism, we have been able to confirm that the mechanism is consistent with our existing senses, and we feel that our development has become more reliable.

There was a lot of sensationalism discussion in the earlier development process. However, 1D models allow us to discuss sensory issues quantitatively in the form of numerical information, which is one of the main effects of the MBD implemented we think. It also reveals that 1D models are very useful even in such a situation which telework is required under COVID-19. It brings a significant impact on the need to develop without a hitch that our team members can keep substituting evaluation and learning using 1D models without having to go to the real laboratory.

## What is your company doing to promote Modelica-based MBD?

SUBARU's powertrain unit department is actively involved externally in such as the Transmission Research Association for Mobility Innovation (TRAMI), The Research Association of Automotive Internal Combustion Engines (AICE), and the automotive industry as a whole in initiatives to promote digitization. For the internal activity, our team then proposes and plans education to promote the more practical aspects of MBD and implements this in the department. We believe that there is knowledge about Modelica and how to use Modelon's solutions that we can share from our point of view, and we would like to pass on our know-how to young and mid-career engineers.

## What is next for you?

The implementation of Modelica and Modelon's solutions has not only improved our 1D modeling technology but has also had a significant impact on our human resource development. We also recognise that one of the future challenges will be to quantify the effects of cost reduction and efficiency improvements, which is one of the roles of MBD. We expect Modelon to provide information on new tools and services, to provide industry information on integrated 1D simulation and analysis technologies, to further promote the use of MBD, and to develop a highly detailed library containing many drivetrain elements and a library for electric vehicles that will allow mechanical engineers to learn about electrification.



Members of Electrified Drivetrain Development Dept.  
Masks are temporarily removed for photography.



Modelon understands what SUBARU wants to achieve and will continue to work together with them to give shape to it.

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