Managing Quality in a Virtual World

Application of quality assurance for virtual vehicle development

As the complexity of modern vehicles continues to grow, so does the effort involved in their development. In particular, with advanced driver assistance systems and autonomous driving functions spreading, it has become almost impossible to perform all relevant test cases in real-world test drives using physical prototypes. Virtual prototypes open up the possibility of massively reducing this effort in order to increase the efficiency and cost-effectiveness of vehicle development. For a smooth process, the quality of the simulation must be ensured at all times. In this success story, Groupe PSA gives insights into their quality assurance framework for virtual prototype development.

Engineers today face the challenges associated with a vehicle development marked by contradictions. On the one hand, there is a necessity to bring new vehicle models and variants to market in ever shorter intervals. On the other hand, the number of prototypes of increasing complexity is expected to be kept to a minimum in order to keep the development as cost-efficient as possible.

Replacing real-world test drives requires physical prototypes to be reliably modeled in the system simulation. One prerequisite is the validation of the models.

This, however, poses a great dilemma for developers since validation only becomes possible once the physical system is available, which is usually the case towards the end of the development process.

For the validation of the models, therefore, it is absolutely essential to define requirements regarding their possible areas of use.

In addition, the goal is to perform and guarantee quality assurance for the system simulation based on the previously defined requirements.

What is quality?

According to the general definition of quality within the quality management standard ISO 9000, an object must fulfil certain specified characteristics. Due to the abstract nature of this definition, there is the additional standard ISO 25000 which serves the software and systems domains as a guideline for quality criteria and the assessment of software products.

By this standard, the quality of a system is measured by the degree to which the product fulfils the customer's requirements. The quality properties to be fulfilled comprise nine characteristics defined in the ISO standard such as efficiency (how are the resources used?) and reliability (how often do system failures occur?).

All requirements that must be met are discussed with the internal “customers” that will access the models or simulation frameworks.

Throughout the development process, the defined quality characteristics can be used to take measures that will ensure a certain degree of quality. This is realized by observing which of the quality characteristics have been fulfilled.

The steps of quality assurance

Quality assurance can be divided into different steps. First, there is organizational quality assurance which is of no relevance to this use case, however, and will not be further discussed.

Second, there is constructive quality assurance, which comprises all measures directed towards the prevention of errors from the start. This is based on errors which have previously occurred, for example, and from which conclusions were drawn. Established processes, models, components and structures can also be used as a basis for constructive quality assurance. When developing a new vehicle, this makes it possible to start with a tested stage of development and adapting it to the respective purpose instead of needing to start the development from scratch.

Third, there is analytical quality assurance, which comprises measures that can be taken once a product, i.e. the model in this case, has been created. At this point, certain criteria can be analyzed and measured in order to ensure the desired level of quality. This measure can be adopted by both developers and non-developers.

Overview

Customer

Groupe PSA

Country

Germany

Product

AXIOM (**A**utomotive **X** in the Loop **O**bject-oriented **M**odel framework)

Challenge

Quality assurance for virtual prototype development

Solution

Application and combination of different tools in order to achieve quality assurance similar to real-world development processes

Constructive quality assurance at Groupe PSA

Groupe PSA employs the method of constructive quality assurance. A framework has been developed to this end, which is based on the open integration and test platform CarMaker by IPG Automotive as well as MATLAB Simulink and which features several interfaces.

Groupe PSA calls this framework "AXIOM" (**A**utomotive **X** **i**n the Loop **O**bject-oriented **M**odel framework).

It is based on agreements as well as model and naming conventions. Implementing this framework ensures that developers from different specialist departments are able to read and understand all signals.

In addition, it enables the exchange of libraries and models across different domains. The basis for this is the continuous usage of the same concept.

Exchanging models and adapting parameters is made possible using the Model Configurator. So-called model templates are used for this which are based on predefined architectures. Here, for example, components within a subsystem are distinguished from isolated components.

Staff members involved often work in different departments and therefore have a different focus on the vehicle. The approach described enables the creation of separate templates for all areas of application. When doing so, the key to success is the fact that all templates access the same library, ensuring that the same models are used at all times. The models can be used in early stages (MIL) as well as for new ECU codes (SIL) and at the end of the development process (HIL).

This results in a continuous flow throughout the entire development process based on the same models. Version control, in this case, serves as a type of quality assurance measure that is indispensable particularly when several teams simultaneously base their work on the same library.

In order to implement this approach, Groupe PSA employs different tools. A centralized filing of model structures, parameters and architectures is achieved using GitHub. This ensures that each stage of development is available both online and offline. In the event of server failure, no data is lost as a result as the repository can simply be restored. This allows both feasibility and a high level of usability. Users additionally benefit from highly detailed traceability as all changes can be tracked including notes on the time and date as well as the reason for the change, building part of the groundwork for parallel work. The entire development of a model can be traced in this way.

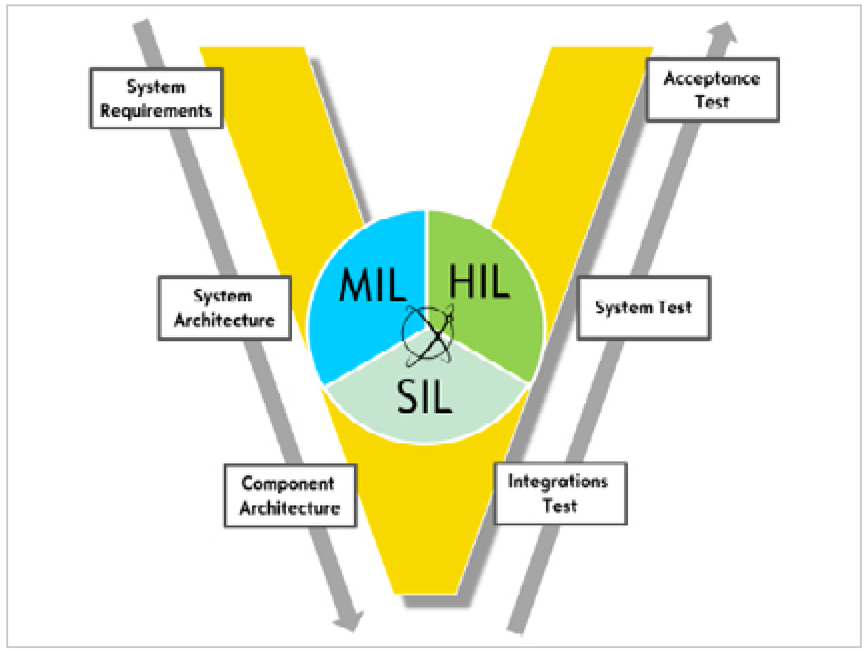
Analytical quality assurance at Groupe PSA

Following the completion of the product, analytical quality assurance is carried out. In reality, quality assurance is performed from one station to the next in the production process of a vehicle. Measurements are taken in order to verify that the vehicle complies with the defined specifications and tolerance values. This approach can also be transferred exactly into the virtual world.

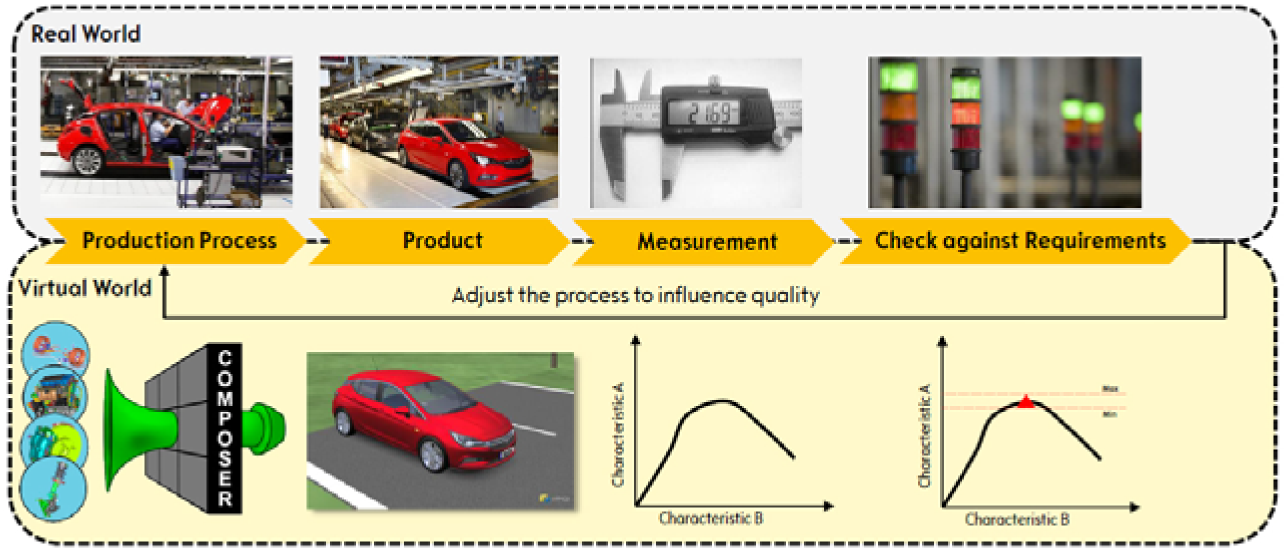
In simulation, also known as virtual world, this is achieved by taking measurements of the virtual prototype. The virtual prototype is composed of models provided by suppliers as well as internally built models. When measuring the virtual prototype, properties, i.e. objective characteristic values, can be analyzed. Subsequently, these requirements can be used to identify whether the vehicle's characteristics are within the desired range. The tool TeamCity is used for this application.

This approach in the virtual world involves developers making any changes they carry out available on a server. TeamCity is triggered as a result, which initiates the next quality assurance steps and runs certain predefined maneuvers or a specified analysis. In order to perform this analysis, the AXIOM described above is adopted and the simulation is subsequently carried out. When the simulation is finished, the results are retrieved from the AXIOM in the form of a logfile.

This logfile can serve to identify errors or indicate that the simulation was error-free. In the latter case, the logfile is forwarded to the model users / "customers" enabling them to get started on their actual project without having to check whether the simulation environment is robust. Major savings in time are achieved as a result.



Constructive quality assurance using a collaborative simulation environment called AXIOM



Approach to analytical quality assurance for virtual prototypes

In the event of a problem, a third tool called Jira is used. Following the input of the error, this tool informs the model developer about the problem that has occurred, giving the model developer the opportunity to fix the error.

Ultimately, the results are visualized using Kibana which serves tracking and monitoring purposes.

Summary

One single tool that fulfils all quality characteristics does not exist. A variety and the interplay of different tools ensure quality in the virtual development process on par with the real-world development process at Groupe PSA.

Sources:

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