

# SIEMENS

*Ingenuity for life*

Automotive and transportation

## Magna Steyr Engineering

Leading partner for OEMs implements model-based systems engineering for hybrid vehicle development

### Product

Simcenter

### Business challenges

Improve vehicle fuel efficiency in hybrid vehicles

Reduce CO<sub>2</sub> emissions

Enhance return on investment

Cope with increasing complexity of vehicle and powertrain variants

### Keys to success

Implement virtual development through mechatronic system simulation

Analyze different hybrid vehicle architectures and operating strategies

Improve validation accuracy of simulation models

Boost simulation time efficiency

### Results

Reduced simulation interpretation effort

Optimized simulation process

Boosted components sizing

Maximized design efficiency with minimum development cost



*The latest vehicle concept MILA Plus, an innovative hybrid sports car, was designed and tested with the help of Simcenter Amesim.*

**Magna Steyr Engineering implemented Siemens Digital Industries Software in its development process to optimize fuel consumption and driving performance analysis for new product conception and validation**

### Coping with complexity

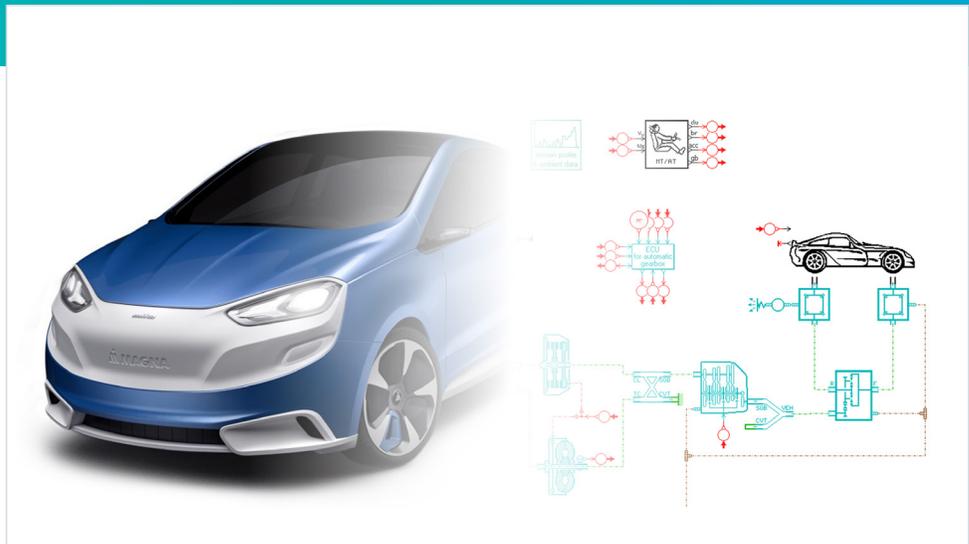
Taking into account the rising prices of gasoline, the harmful effects of climate change and the resulting regulations for the limitation of carbon dioxide (CO<sub>2</sub>) emissions, automotive customer demand has considerably evolved in the recent years. These conditions have set new rules for original equipment manufacturers (OEMs), making both products and processes much more complex.

Due to all of these conditions, the interest in vehicle electrification (especially for hybrid vehicles) is increasing, as well as is the interest in methods for their virtual development and simulation, which has proved to be a very effective answer to the overall situation.

Engineers must now cope with an increasing number of vehicle and powertrain variants for which key attributes – such as performance, drivability, reliability, safety and comfort – must be preserved or even improved. All of these parameters, which are driven by regulation and market expectations, should be balanced and considered as early as possible in the design cycle for maximum design efficiency and minimum development cost.

**“What we like the most about Simcenter Amesim is the fast support.”**

Michael Martin  
System Simulation Manager  
for Driving Performance  
and Fuel Efficiency  
Magna Steyr Engineering



*Virtual development at key point for cost efficient development.*



This is why the integration of mechatronic system simulation in the vehicle design process has become the most efficient way to address these challenges.

#### **Developing new technologies**

Over 100 years of experience in vehicle production and a broad range of services make Magna Steyr Engineering the world-leading brand-independent engineering and manufacturing partner for OEMs. Based in Graz, Austria, Magna Steyr Engineering was founded in 2001 after Magna International Inc. acquired a majority of the shares in Steyr-Daimler-Puch AG (founded in 1864) three years earlier.

Today, the company possesses an extensive range of services, divided into three groups: 1) engineering services, from

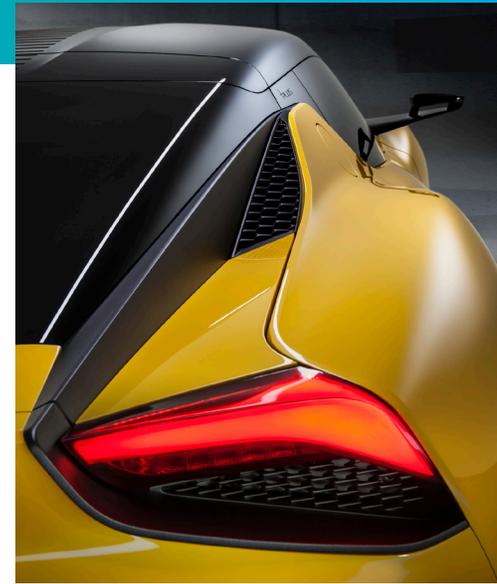
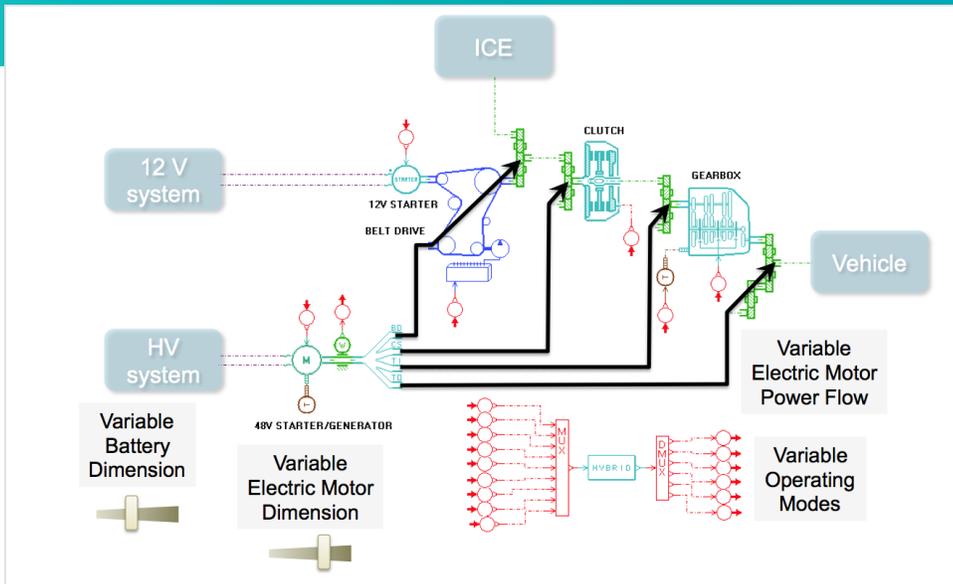
systems and modules to complete vehicle engineering; 2) vehicle contract manufacturing services, from niche to volume production and 3) production of fuel systems made of steel, plastic and aluminum.

The engineering services department develops and integrates modules and systems, focusing specifically on entire vehicles – from the first design idea through to serial production readiness – as an engineering service provider or one-stop shop, depending on the customer's needs.

In order to adapt itself to market trends, Magna Steyr Engineering focuses its work on projects that aim at making individual mobility more eco-friendly. In that case, hybrid vehicles have shown their potential for reducing fuel consumption and CO<sub>2</sub>

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Customizable modeling and variable parametrization for different hybrid configurations.

emissions, while increasing performance and comfort, particularly in combination with downsizing concepts; for in the future, alternative systems will reduce our dependence on fossil fuels or even replace them altogether.

### Defining hybrid

A hybrid vehicle uses both an internal combustion engine (ICE) and an electric motor to achieve maximum power and fuel economy with minimum emissions. In short, hybrid vehicles can produce electric current, which is stored in a large battery, and use this current to help drive the car. Other unique aspects of hybrid systems are the capacity to capture electrical energy produced by a regenerative braking system, and the possibility to power a generator with its own engine.

Hybrids possess many other eco-friendly features such as the capacity to shut down the ICE when the vehicle is not moving or when the electric motor's energy is sufficient to drive the entire system.

In comparison to conventional vehicles, modeling hybrid electric vehicles differs in three ways: they possess higher degree of freedom in architecture and components; they have many more influencing parameters and increased system complexity; and they are more difficult to evaluate in terms of fuel consumption.

This complexity led Magna Steyr Engineering to implement model-based systems engineering (MBSE) in its internal product development process.

### Optimizing simulation and model design

Given the huge complexity introduced by new and more efficient technologies, most automotive companies have been forced to change the way they conceive their vehicles, their processes and their design and testing procedures.

It is now a fact that CO<sub>2</sub> emissions increase vehicle costs. Companies must now take into account production CO<sub>2</sub> certificates, recycling rates and cities' environmental taxes. For example, in 2020, the penalty in Europe for exceeding emissions limits will be 95€ per gram, a significant amount of money that needs to be taken into consideration.

Nevertheless, Magna Steyr Engineering did not see these challenges as obstacles. Instead, the company saw opportunities to develop brand-new and innovative solutions. The company had to find cost-efficient measures to reach fleet consumption targets. To overcome this challenge, Magna Steyr Engineering implemented MBSE in the Energy Management and Drivability department to develop a simulation environment for the evaluation of fuel consumption and vehicle driving performance.

Simcenter Amesim™ software – a simulation solution from product lifecycle management (PLM) specialist Siemens Digital Industries Software – stood as the right choice for improving Magna Steyr Engineering’s virtual development processes. It not only helped to improve the accuracy during the validation phase of model simulation, but it also streamlined the creation process. Simcenter Amesim was first used to assess the general energy management of vehicles and perform sensitivity analyses of several parameters such as aerodynamics, tires, powertrain, shifting strategies and gear ratio selection, among others. “Simcenter Amesim has notably reduced simulation analysis effort,” says Michael Martin, system simulation manager for driving performance and fuel efficiency at Magna Steyr Engineering. “Enabling seamless cost reduction and time savings, Simcenter Amesim is now being used to address more projects.”

As Magna Steyr Engineering saw the potential of hybrid vehicles, Simcenter Amesim became a trusted tool for the development of operating strategies, including power limitations, state of charge (SOC) balance, electric driving, thermal engine driving, recuperation and load point shifting and charging.

To manage system design of a hybrid vehicle, a general architecture over a



single test cycle must be defined. This enables several architectures and parameters to be easily tested, such as location and size of the electric motor or the size of the battery.

In the second phase, design optimization of the chosen system architecture across a wider range of test cycles and situations must be performed using a much more detailed model. In this phase, batch simulations are needed, as well as some design exploration tools, both of which are available via Simcenter Amesim.

The type of automobiles that mix regular vehicle capacities with electrical vehicle capacity are not quite as easy to model, simulate and analyze. For a conventional vehicle, only a single driving cycle simulation is needed to study the overall energy consumption performance; for hybrid vehicles, up to six or more simulation cycles are needed, depending on the local

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## Solutions/Services

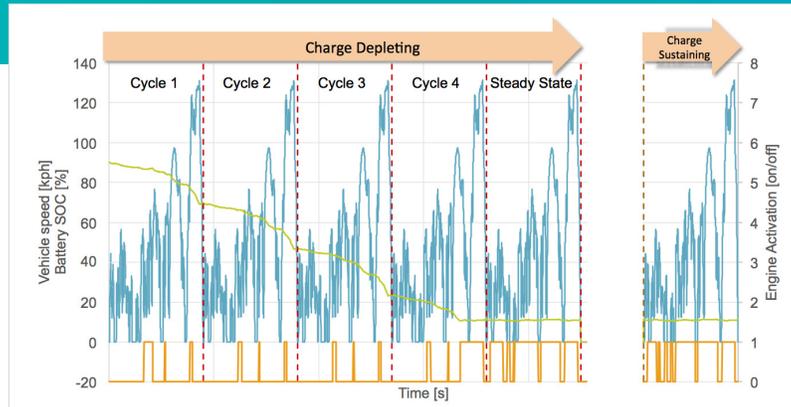
Simcenter Amesim  
siemens.com/simcenter-amesim

## Customer's primary business

Magna Steyr's broad range of services – from engineering to diverse product capabilities to full-vehicle contract manufacturing – helps support its customers as the company continues to address the challenges of a dynamic automotive industry.  
www.magnasteyr.com

## Customer location

Graz  
Austria



*Simcenter Amesim allows Magna Steyr Engineering to simulate charge depleting and sustaining in hybrid vehicles.*

regulations and the electric driving range of a hybrid vehicle. The first five cycles are dedicated to battery depletion, and the final cycle to charge sustainment. This simulation effort benefits most from the accuracy and performance of Simcenter Amesim, which enables its users to obtain valid results and determine electric driving range, electric consumption and fuel consumption. The customization capabilities of Simcenter Amesim have enabled the engineers at Magna Steyr Engineering to develop scripts in order to run, analyze and summarize simulation cycles in a highly efficient way.

In addition, the focus of hybrid vehicle simulation during serial development is in the functional test of the operating strategy itself. In this case, Simcenter Amesim is used to provide the plant model for the vehicle, which is possible thanks to a co-simulation utilizing the Matlab® environment and the Simulink® environment, which provide the controller configuration for optimal results. As a complement to the solution, Magna Steyr Engineering employs the Simcenter Amesim submodel editing tool, which allows users to develop their own components, as well as use LMS Test.Lab™ software, also from Siemens Digital Industries Software, to generate validation data to better calibrate the numerical models.

## Delivering innovation and efficiency

“What we like the most about Simcenter Amesim is the fast support,” says Martin. “If a problem comes up, the support service is really capable of solving it.” Some other characteristics that got Magna Steyr Engineering focused on Siemens Digital Industries Software technology is its comprehensive library of validated models, well-documented and open components, and the possibility of performing both thermal and energy management simulation in one tool.

One of the latest creations of Magna Steyr Engineering is its MILA Plus hybrid vehicle, which was designed and tested with the help of Simcenter Amesim. MILA Plus is an innovative, two-seat hybrid sports car that combines sophisticated, lightweight construction with intelligent, alternative-drive technology to produce maximum performance as well as eco-friendliness. With an all-electric range of 75km and a vehicle weight of 1,520kg, using the New European Driving Cycle (NEDC) ECE-R 101, Simcenter Amesim has helped Magna Steyr Engineering to reduce CO<sub>2</sub> emissions by 32g/km in the MILA Plus.

Magna Steyr Engineering plans to continue using Simcenter Amesim to deliver new, intelligent and innovative solutions, contributing to the development of cleaner and more efficient technologies.

## Siemens Digital Industries Software

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