

SIEMENS

Ingenuity for life

Automotive and transportation

Karma Automotive

Karma Automotive resurrects iconic electric vehicle using Siemens solutions

Product

Simcenter, Polarion

Business challenges

- Develop a luxury electric hybrid sedan
- Optimize NVH performance
- Reduce the number of design iterations

Keys to success

- Digitalize development processes
- Expert assistance from Simcenter Engineering services
- Use a combination of simulation and testing in vehicle development
- Adopt Polarion ALM for software development

Results

- Went beyond vehicle NVH optimization and improved the overall development process
- Improved NVH with a minimum number of design iterations
- Combined both test and simulation in one platform
- Enabled collaboration among teams and divisions with streamlined data exchange

Simcenter services, simulation and testing solutions help Karma Automotive go above and beyond NVH optimization

The emergence of EV sports cars

The time when electric cars were considered part of some distant, exotic future (due to our limited technological capacity or the perceived dominance of oil) is long gone. A little more than two decades ago, the iconic Prius seriously changed the game. Today, more than 12 million hybrid or electric cars have been sold worldwide and the numbers keep climbing: not only is electrification now considered one of the biggest revolutions of the automotive industry, humanity has begun to conceive a future without gasoline and combustion altogether.

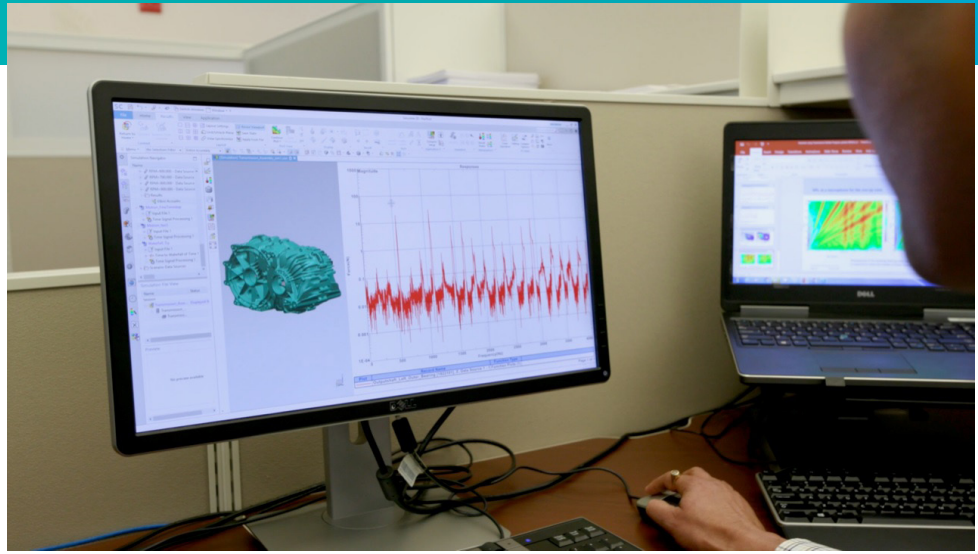
Electric or hybrid cars aren't taking over the roads just yet for a number of reasons, including their elevated price tags and still limited autonomy. In addition, while many consider that the real beauty resides on the inside, a key differentiator for people who choose a new car remains its appearance. Tesla was the first to understand this when releasing its Model S onto the market in 2012. With it, Tesla managed to reach a distinct market segment that had previously been excluded from the game of electrification: customers who preferred a luxury, sporty design.

In the meantime, many OEMs have added at least one high-end, luxury hybrid or electric car to their fleets – examples include the Honda NSX, Lexus LC500h, BMW i8, Jaguar I-Pace and Porsche Panamera.



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Erik Keipper
Director of Vehicle Integration
Karma Automotive



Many startups are trying their luck in this segment (Tesla also started small). While many companies died or were eaten along the way, some emerged as new, respectable e-brands, ready to put their prototypes nose-to-nose with the establishment.

Karma Automotive – the story of a phoenix

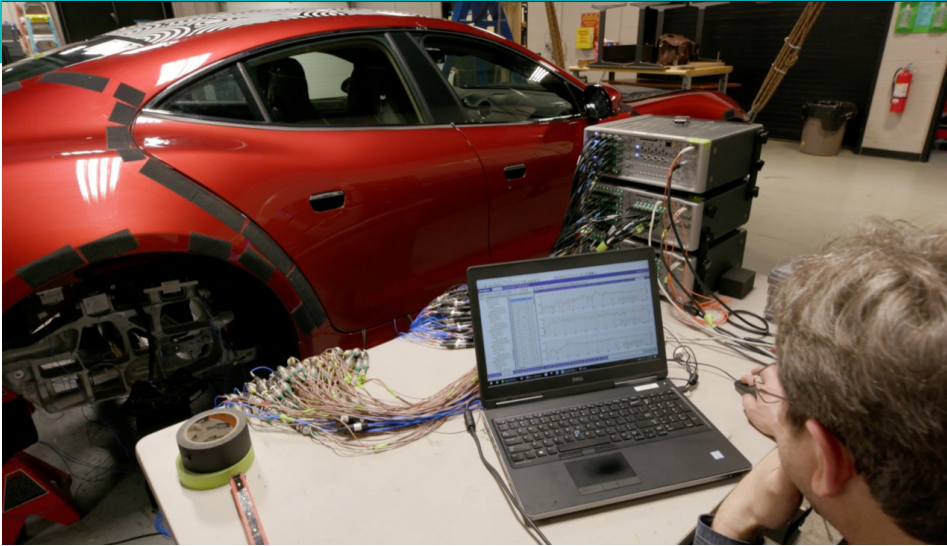
One of these startups is Karma Automotive, a California-based carmaker that rose from the ashes (or rather assets) of Fisker Automotive in 2014. In the resurrection process, Karma managed to preserve the good and overcome the bad: they retained the beautiful Italian design of their cars, which held a lot of appeal to their customers, but significantly upgraded the technology. The result is a luxury electric hybrid sedan that maintains much of the original exterior and

interior of the Fisker Karma, but incorporates an A123 battery, charger and electrical controls. It is “the car you drive when you want to be seen,” says Bob Kruse, chief technical officer of Karma Automotive.

As a startup, Karma had to address some of the typical consequences of limited resources. For one, time is more expensive for startups than for established players. Also, there are hardly, if any, second chances. As a result, digitalization truly has become a matter of life and death. “It is now of more crucial importance than ever that models and analytics properly duplicate what happens in the physical world, so that when we do go back to the actual vehicle, the virtually obtained solutions fit with a high degree of confidence – and they actually are going to work,” Kruse confirms.

“By using the Siemens consulting services and software tools, we were able to get it right with a minimum amount of iterations.”

Bob Kruse
Chief Technical Officer
Karma Automotive



“Polarion is one tracking tool to cascade targets down from vehicle level all the way to component level, then goes back up to validate the car at each of the intermediate and full-vehicle levels.”

Garren Salibian
Lead of Vehicle Integration
Karma Automotive

A relentless pursuit of excellent NVH

With a hybrid-electric sports car, engine noise is a key performance attribute to manage throughout the entire development process. Engine noise needs to be brand-specific. This isn't an easy task, because “there is no history of what an electric sports car engine should sound like,” says Jud Knittel, noise, vibration and harshness (NVH) lead engineer at Karma Automotive.

The main issue with hybrid-electric cars is that the lack of the noise-masking effect of a combustion engine makes a lot of other sounds more apparent, such as road or HVAC noise. Much more effort must be applied to reduce these noise sources than for traditional cars. In addition, efforts to optimize NVH can actually become counter-productive if they have a negative impact on other attributes such as weight, strength, durability and ride comfort.

Using testing and simulation (sometimes simultaneously) is essential in maintaining this balance. Karma understood this at the very beginning of the development project.

A well-oiled tandem of simulation and test

“When we took this project on, it wasn't only about the development of the product, but also of the process that we were building at

Karma,” explains Erik Keipper, director of vehicle integration at Karma Automotive. “The partnership we put together with Siemens really allowed seamless interaction from the program managers, engineers and technicians.”

One of the keys to success for such an overarching vehicle development program – featuring not just product but also process – is to frontload the vehicle design definition phase as much as possible, such that last-minute, expensive corrections in the validation phase can be reduced to their absolute minimum or even avoided. Karma selected Simcenter™ 3D software for this task. Combining all the necessary high-end solutions and solvers, Simcenter 3D also allows for optimization of different attributes, with best-in-class computer-aided engineering (CAE) pre- and postprocessing capabilities and the software's unique CAD-integrated and managed environment. In particular, Karma used Simcenter 3D's hybrid modeling method to frontload the overall vehicle optimization effort across multiple performance attributes. In this approach, components under development are modeled with 3D CAE and existing ones with accurate reduced representations derived from tests results, such as frequency response functions (FRFs) and modes.

In addition to Simcenter 3D CAE software, Simcenter Testlab™ software and Simcenter SCADAS hardware were selected to carry out NVH testing. The seamless combination of these tools enables coverage of a wide range of testing capabilities such as experimental modal analysis, operational data collection and sound quality assessment. Besides fast and accurate data acquisition and test results, Simcenter Testlab software also provides a lot of engineering know-how and user guidance. Karma especially appreciated how the software's intelligent data viewing capabilities and displays allowed the company to look at the same data from multiple angles. "We have a huge number of functionalities we have to go through for the same dataset, and all of these are available at the click of a mouse in Simcenter Testlab," Knittel confirms.

Testing is not only important during the benchmarking, target setting and prototype performance validation phase; it also plays a crucial role in leveraging simulation to its fullest potential. Especially in cases like Karma's, where certain components are still under development and being explored in Simcenter 3D, and other parts already exist as prototypes, test-based validation through FRFs and modes in Simcenter Testlab is of paramount importance to the success of the larger vehicle development process, in terms of both speed and accuracy.



Like many OEMs, Karma realizes that simulation cannot replace physical testing entirely, but Karma staff are convinced that it helps them to achieve better NVH performance in less time. A proper combination of test and simulation allows engineers to determine whether a simulation model represents the reality as closely as possible. But it also yields more detailed insights, such as how to include damping in the model, or how to deal with so-called hybrid approaches.

Simcenter Engineering and Consulting services

The project involved development of process as much as product. For this reason, both Simcenter software and Simcenter™ Engineering and Consulting services proved to be a perfect fit. Simcenter personnel were on site throughout most of the development, assisting with the benchmarking and target setting of the project, and with the

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Jud Knittel
NVH Lead Engineer
Karma Automotive

Solutions/Services

Simcenter 3D
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Simcenter Testlab
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Polarion
[siemens.com/polarion](https://www.siemens.com/polarion)

Customer's primary business

Karma Automotive is a luxury electric automaker based in Irvine, California with manufacturing operations in Moreno Valley, California. The company is owned by Chinese automotive supply company Wanxiang Group.
www.karmaautomotive.com

Customer location

Irvine, California
USA

analyses and validation of the targets through CAE and test. It was the specialized services that enabled Karma "to use math and science, as opposed to trial and error, to get it right with a minimum number of iterations," Kruse explains.

In addition to the technology and software, Karma appreciated the in-depth knowledge of Simcenter consultants. "They also supplied the know-how and expertise to allow Karma to continue the process and analysis by themselves," says Knittel. "They are the ones who not only facilitated seamless operation of the software involved, but also of interaction between the program managers and the technicians. They supplied the expertise we need, so that we can continue the processes and analyses ourselves in the future."

Expert knowledge, collaboration and technology transfer are the differentiating pillars upon which Simcenter engineering services were built and operate today. All three are vital in comprehensive vehicle development processes like Karma's.

The added perk of Polarion

Dealing with many software capabilities across multiple attributes, divisions and teams requires a powerful data tracking and management tool. Polarion ALM™ software, another solution in the extensive Siemens Digital Industries Software portfolio, addresses the challenge. "Polarion is one tracking tool to cascade targets down from vehicle level all the way to component level, then goes back up to validate the car at each of the intermediate and full-vehicle levels," says Garren Salibian, the lead of vehicle integration at Karma. "It has a lot more depth to it than a regular spreadsheet that ticks boxes. You can dive in on each

level and get access to all the required data and analytics. Polarion enables you to have full control over your entire application life-cycle, without losing any of the agility that is often required within separate teams." As part of the larger Siemens software family, Polarion works seamlessly with the Simcenter software that was used for NVH optimization and multi-attribute balancing campaign by Karma.

Going above and beyond

"By using the Siemens consulting services and software tools, we were able to get it right with a minimum amount of iterations," Kruse says. "From a technical point of view the targets weren't only met, but beaten."

It may be bold but perhaps fair to say that Karma has succeeded where Fisker failed: on the hard business side of things. With the Karma Revero, superior design not only meets economics, but does so in an environmentally friendly and acoustically enjoyable way. These features are considered to be among the most important success parameters of the 21st century.

Using the Simcenter tools and services for more than four years, Karma went beyond NVH optimization to optimize its overall development process. Combining both test and simulation in one platform uniquely enables collaboration among teams and divisions with streamlined data exchange.

"Now that we have a process in place at Karma, and we've successfully put our project on the market by utilizing this process, we're excited to take on the next challenge," Keipper concludes. "Soon, hopefully, a whole host of electric products and vehicles will fill the dealership."

Siemens Digital Industries Software

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