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Ingenuity for life

Velaro Novo

Interview with expert Martin Krause
on the subject of aerodynamics

With a PhD in aerospace engineering, Dr. Martin Krause played a key role in the development of the Velaro Novo platform. As a Train Architect, he specializes in aerodynamics and is one of the engineers who managed to reduce the Velaro Novo's energy consumption by more than 30 percent. In this interview, he explains why he finds aerodynamics to be one of the most exciting fields in the work with high-speed trains and what makes the Velaro Novo aerodynamically unique.



Train Architect Dr. Martin Krause, specialist for mechanics and aerodynamics, looks at the Velaro Novo from the viewpoint of the wind.

Since mid-June of 2018, the Velaro Novo has literally picked up speed. How did you become involved in the project?

I have already worked on the aerodynamics in projects like Velaro D, Velaro RUS, and Desiro RUS – all precursor projects to the Velaro Novo. In the case of the Velaro Novo, I was involved from the very beginning, and as a Train Architect, I was responsible for all the mechanics and thus also for the aerodynamics.

From an aerospace engineer to a train designer. Why trains, when you could be working on rockets?

Actually, I initially thought working on high-speed trains was somewhat boring – 300 to 400 kilometers per hour is pretty slow compared to speeds in the air. But it turned out that the aerodynamics of trains is much more complex than the aerodynamics of airplanes, for example. Also, many service providers can offer simulations for planes or cars, but when it comes to developing the same thing for trains, they are limited – because trains don't just go forward, they also go backward. No airplane in the world is expected to do that. But a train has to operate bidirectionally. That's why it takes so much skill.

Can't you just produce "half" a train and make the second half a mirror image?

It would be nice if it were that simple, but it isn't. Due to differences in flow, there's a risk that the train will run twice as badly in reverse as it runs well when moving forward. That's why you always have to look at every aerodynamic measure from both sides and, insofar as possible, precisely calculate every aerodynamically challenging situation.

How does the Velaro Novo set new benchmarks compared to competitor rail vehicles?

In the past, we have often been envious of Japan's aerodynamics. With the Velaro Novo, we've achieved a great success that far exceeds anything that was possible before. I believe, in terms of aerodynamics, we're building the best train in the world. Why? When you look at trains from the past, there are always certain things that aren't smooth. Either the bogies are exposed, or there are hollow spaces between cars at the intercar gangways. For the first time, we've succeeded in addressing all these areas and significantly improved them. We've improved the aerodynamics by more than 30 percent compared to our earlier products.

What makes the train so great in terms of aerodynamics?

We managed to enclose the pantograph and high-voltage equipment as much as possible. That wasn't possible in the past because various insulators were installed on the roof that had to be exposed due to the required electrical clearances, which meant they couldn't be enclosed. Using new technologies, we managed to eliminate this necessity. The only thing that still has to be exposed is the raised pantograph. It is now located inside a cutout compartment on the roof where there used to be a large open surface. With this fact alone, we improved the aerodynamic drag by about eight percent. The greatest innovation is the full bogie housing. There's never been anything like this anywhere in the world before. Thanks to the inside bearings and the full housing, we've succeeded in improving the aerodynamic drag by 15 percent.

**Why wasn't that done before?
Why now?**

Like presumably many other designers, we'd already worked on it in the past. In the end, we always failed because we couldn't comply with the European vehicle loading gauge. Think of it this way: Most of the housing is attached to the car body. This means that when taking curves, for example, the bogie has to stay within the contours of the car body. In other words, the bogie has to be significantly narrower to leave enough room for the housing. When designing the Velaro Novo, we wrangled over every millimeter, sometimes even over half a millimeter. That's why, in my opinion, the greatest challenge was to create a design that ultimately worked within all boundary conditions.

The aerodynamically optimized front section is also striking. Are you satisfied with the results?

When we developed the front section, everyone participated: the aerodynamics expert, the designer, the front-section designer, the crash design expert, and so on. Everyone contributed their own ideas, plus we had to comply with certain regulations. The scope for design and aerodynamics is relatively small. The designer has to be satisfied with the design and the aerodynamics expert with the aerodynamic drag. For example, at first the designer wasn't satisfied with the front section's expression because it looked so "sad" – so the coupler doors had to be redesigned to make it "smile". In terms of aerodynamics, we modeled, among other things, the angle of inclination, bulges, and edges. Based on all these boundary conditions, we ultimately settled on the front section design as a team. I think we're all happy with the results.

Given all these strict specifications, how did you manage to invent a new train?

First of all, by examining the requirements and considering which regulations were relevant for approval and had to be observed. When we were done, we saw that we would have to remain inside a tight framework but there was still a little room, which we then systematically exploited. We deliberately steered away from the previous design and developed our own design. This new design now meets our requirements for aerodynamic improvement without completely losing its identity. That's what the Velaro Novo is about: implementing the new without losing the old.

So the approach was to apply a new way of thinking to solve problems?

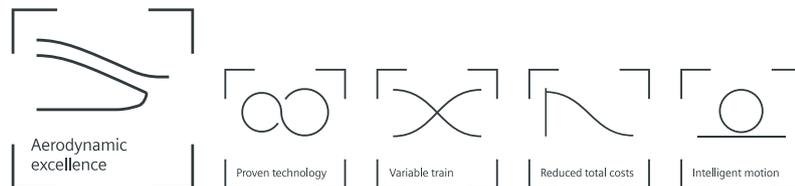
Every time we started to think, "That's the way we've always done it", we questioned it. We put every area to the test and then considered whether we should go with plan A or plan B, or maybe even plan C. We carefully weighed which things would bring us the most benefit and which were too risky. We also evaluated each individual measure this way. In cases where it made sense, we risked doing something new. In other cases, we stuck with the tried-and-tested.

What does the Velaro Novo have that you could only dream about a few years ago?

Everything that I've been talking about so enthusiastically. When I first started out in aerodynamics, it was assumed that much of what we have now been able to implement was physically impossible. Thanks to the many innovations of the Velaro Novo, we've implemented everything that previously seemed impossible for us, for Siemens. We've pushed the boundaries of what was conceivable, and I consider it a tremendous accomplishment, one that we can be proud of.

Thank you for the interview, Dr. Krause.

This interview is part of our series of expert interviews about the Velaro Novo.



Read the other interviews and let our experts behind the Velaro Novo tell you what it means to rethink what already exists.

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