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If you've ever seen a rocket launch, flown on an airplane, driven a car, used a computer, touched a mobile device, crossed a bridge or put on wearable technology, chances are you've used a product where ANSYS software played a critical role in its creation. ANSYS is the global leader in engineering simulation. We help the world's most innovative companies deliver radically better products to their customers. By offering the best and broadest portfolio of engineering simulation software, we help them solve the most complex design challenges and engineer products limited only by imagination.

CHANGE MANAGED

By *Dimensions* Staff

After GE Power's acquisition of Alstom, Sigurd Kubel took the reins of a massive software conversion. This "switch" required integrating GE's simulation-based workflow into Alstom's best-practice production processes. Without interrupting steam turbine development, Kubel's team — aided by its expert partners — retrained 80 engineers and service analysts, and successfully implemented the workflow.

Change can be horribly disruptive or powerfully constructive: It depends on how it's managed and received.

Poised to tackle change with a capital "C," lead engineer Sigurd Kubel understood this all too well. He had been charged with a critical software conversion and the subsequent retraining of 80 Alstom steam turbine engineers and analysts. They and he had come to GE Power after GE's 2015 acquisition of Alstom's power and grid businesses. Together, they were to deliver on daily production goals while adapting to an unfamiliar workflow with new simulation software.

"In the simplest terms," says Kubel, "replacing one simulation workflow with another is a bit like switching email providers. At the end of the day, you'll be able to send and receive emails, but you'll have to figure out the functionality, learn and integrate the new features, customize your settings, etc."

This analogy falls apart, of course, when dealing with power equipment, where the margin for error is slim at best. Failure to perform an accurate analysis of a turbine exposed to temperatures of up to 620 C can severely compromise plant safety. Crafting a successfully delivered email does not involve meeting strict quality control measures, nor does it necessitate years of best-practice experience.

GE Power has long employed finite element analysis (FEA) simulation to predict how its turbines and other power plant machinery will behave under variable operating conditions. "Making these predictions accurately is becoming more critical due to greater fluctuation in the electric grid," says Kubel. "Renewable energies like solar and wind, which are harder to align with consumption, have made plant operations more cyclic to balance out the fluctuation. Machines that once operated under relatively constant conditions are now subjected to many more starts, stops and load changes. Without FEA simulation, we would be guessing at safety thresholds and inspection schedules, and unable to demonstrate to customers that we have met their requirements."

After the acquisition, Kubel and his team had to determine which option was optimal: continuing with Alstom's familiar FEA workflow or transitioning to GE's. A key consideration was his engineers' considerable experience with the commercial code favored by Alstom. Moving to GE's ANSYS-engineered workflow, however, promised many more potential benefits. Cost and efficiency savings could be gained through greater collaboration and sharing of models and analyses. Software maintenance would also be more time-efficient. With each new release, GE Power would only have to test, install and roll out one set of updates.

Asked how the one-code decision was received by would-be users, Kubel says: "No matter how experienced you are in your field, at first you are going to feel like a beginner, like you are back in school. In a new programming environment, things are not going to work the way you expect them to work. You must be flexible and adapt, so it is natural that we would hear some less-than-enthusiastic voices. In informatics, there's a well-known sentiment: You never change a running system." In other words: If it isn't broken, don't fix it.

For most, however, tackling the switch was a welcomed skill-building opportunity. The transition was viewed as more than an even exchange: It was an opportunity for process improvement.

Executing the Switch

Once the decision was made, Kubel's team inventoried the many FEA-related steps within the analysis workflow. These included steps where FEA was integrated and where there was an integration or exchange with other (often in-house) codes. There were also features such as in-house material laws (e.g., routines that calculated convection based on local condensation) that had to be incorporated.

The team assigned each prioritized step to a small working group composed of GE and former Alstom engineers, plus members from the ANSYS ACE team (global support experts) and CADFEM (an ANSYS elite channel partner).

"In a transition like ours, you cannot move forward by simply repeating an old process with a new tool," says Kubel. "We communicated what we wanted to accomplish, then let our ANSYS colleagues show us the best way to do it. This was an extremely positive and productive way of working."

Kubel estimates that 90% of the overall effort involved demonstrating that the new simulation results matched the old-code results. "When you are dealing with very large models and solving them," says Kubel, "you always find small differences that have to be either explained or mitigated. This validation process is a valuable refinement exercise, which offers hands-on user learning over many improvement iterations."

"IN A TRANSITION LIKE OURS, YOU CANNOT MOVE FORWARD BY SIMPLY REPEATING AN OLD PROCESS WITH A NEW TOOL."

Before any of the new code could be put into production, local regulators and in-house reviewers had to approve the results. And, for customer-specific requests, "We had to demonstrate that our machines, according to our best knowledge and our best simulations, would fulfill our customers' operational and efficiency requirements," says Kubel.

The software rollout occurred in stages, as steam turbine development continued uninterrupted. Throughout much of the conversion, there were teams running the new code and others operating with the old.

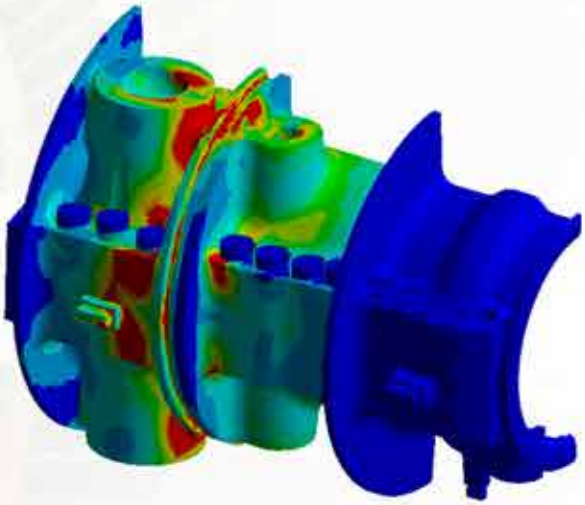
All received extensive training. Experts in ANSYS structural software led weeklong, on-site sessions for both the product development and the service teams. Learning continued online with webinars, topical videos, self-paced modules and downloadable resources available on the ANSYS-supported, GE Power–dedicated portal.

According to Kubel, there are two keys to summiting an exceptionally steep learning curve. The first is direct access to great customer support. "Using new software with an unfamiliar user interface, we naturally had a lot of 'beginner' questions … questions we were a little uncomfortable asking in a formal way," he says. "Instead of having to file an online support ticket or search an hour for an answer, we were able to pick up the phone and have questions like 'Where is that button that you showed me during training?' answered in half a minute. The technical resources provided by ANSYS proved invaluable."

The second is ample training time. "You can't skimp on training," says Kubel. "You need to set aside a week or two for uninterrupted education. With good trainers and partners, you can accomplish so much more in a concentrated period of time than you could in once- or twice-a-week sessions. The latter is ineffective and, ultimately, more costly."

Unexpected Gains

Ninety-five percent of the proposed three-year conversion was completed in the first 11 months. While management applauded this success, users expressed great satisfaction with the software. They cited its quick calculation times, intuitive interface and powerful capabilities (high-performance computing, parameterization, meshing, geometry editing, etc.). Most of all, they were pleasantly surprised at how quickly they mastered the new functionality.



Material deformation (creep) analysis of an inner casing of a combined high-pressure/ intermediate-pressure (HP-IP) Turbine

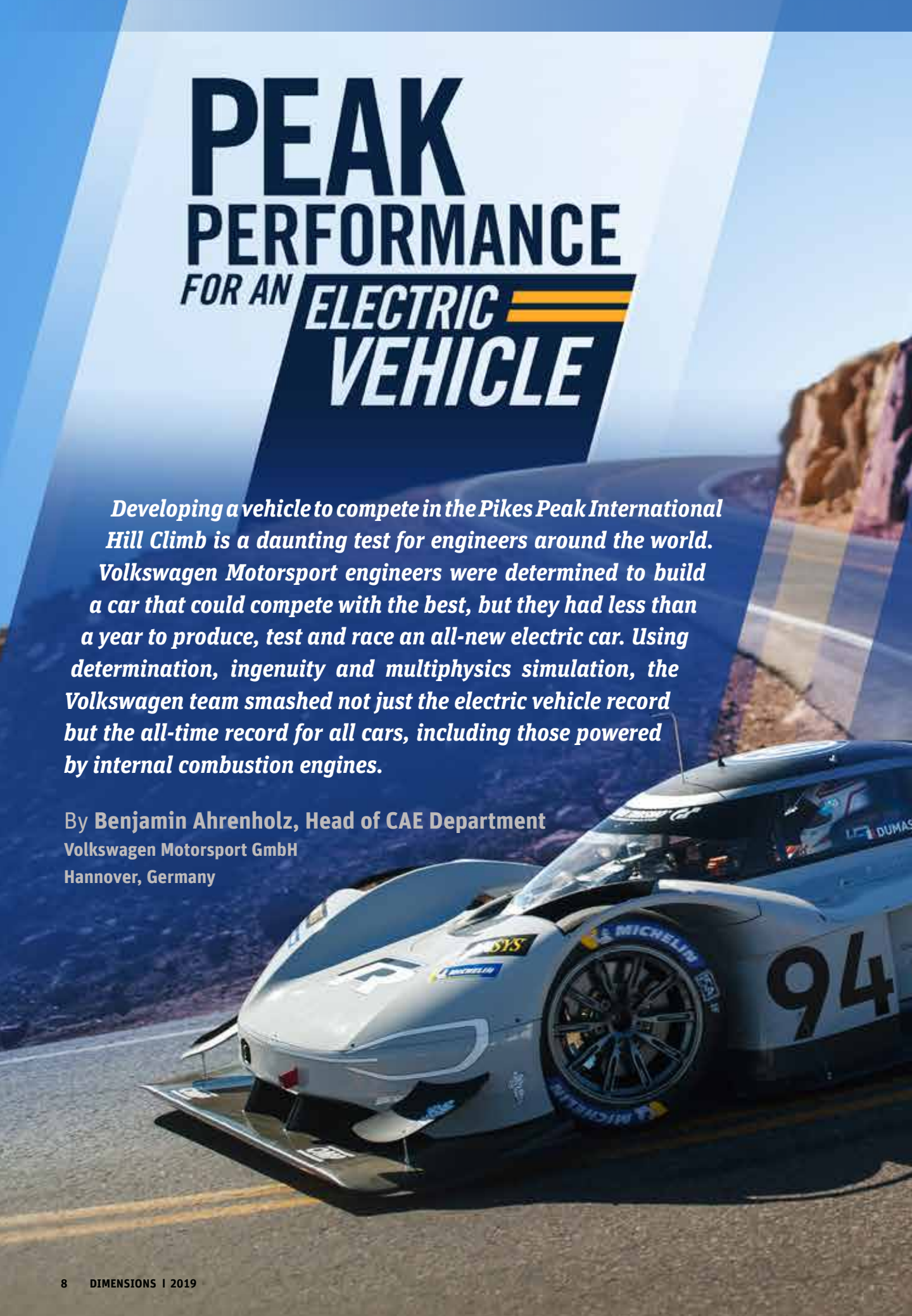
"YOU CAN'T SKIMP ON TRAINING."

"A huge, greater-than-anticipated gain for us is that we now have this large, in-house community of ANSYS software users all over the world," says Kubel. "We can now ask questions and share data in chat rooms — proprietary things that we wouldn't want to share outside our walls. We also have ANSYS representatives or GE personnel conducting web-based meetings and training sessions, to which our whole community is invited. And working in a common software environment allows us to easily import or employ data from other ANSYS simulation tools that we use."

Kubel says GE Power is working to meet the challenges of big data storage and leverage digital twin technology to create virtual copies of industrial assets like turbines and power plants. Using operational data, engineers will be able to better predict damage accumulation and schedule maintenance checks in advance of unexpected outages.

"The success of this transition opens up the possibility of combining many more types of physics in our analyses. For example, we can now pair computational fluid dynamics simulation with our mechanical explorations," says Kubel. "This — with the support of our software partner — will allow us to design, manufacture and maintain better products with even greater efficiency."

PEAK PERFORMANCE FOR AN ELECTRIC VEHICLE



Developing a vehicle to compete in the Pikes Peak International Hill Climb is a daunting test for engineers around the world. Volkswagen Motorsport engineers were determined to build a car that could compete with the best, but they had less than a year to produce, test and race an all-new electric car. Using determination, ingenuity and multiphysics simulation, the Volkswagen team smashed not just the electric vehicle record but the all-time record for all cars, including those powered by internal combustion engines.

By **Benjamin Ahrenholz, Head of CAE Department**
Volkswagen Motorsport GmbH
Hannover, Germany

If there is one message to take away from Volkswagen Motorsport's stunning electric vehicle performance in the 2018 Pikes Peak International Hill Climb, it is that things do not always work out as planned. Sometimes they work out better.

The plan — launched only nine months before the 96th running of the renowned race on June 24, 2018 — was to beat the all-time electric vehicle (EV) record that year, and then improve the design and try to break the overall record established by an internal combustion automobile the next year. Instead, race car driver Romain Dumas negotiated the 156 sharp bends on the 12.42-mile course in the VW I.D. R Pikes Peak car in less than 8 minutes at 7:57:148, smashing not only the electric vehicle record by more than a minute but also the overall record by over 16 seconds.

This successful result in such a short development time was due to the hard work of a team of VW employees across the company, along with some help from ANSYS, who consulted with VW on the design and validation of the battery pack that powered the car to victory.

Going Electric

When VW officials decided in 2017 that their long-term strategy would focus on building and selling EVs as passenger cars, they wanted to make a bold demonstration of this commitment — and soon. Not in 2025 or even 2020, but in 2018. Searching for a place to make this statement, they noticed that the 2018 Pikes Peak International Hill Climb, which finishes at an altitude of 14,115 feet, was scheduled for the following June — a tight squeeze. Who could design an electric-powered car from scratch in nine months? The motorsports team is used to changing car designs from week to week, so the task fell to VW Motorsport.

WHO COULD DESIGN AN ELECTRIC-POWERED CAR FROM SCRATCH IN NINE MONTHS?

By deciding to employ an existing race car monocoque, the Norma M20 created by Norma Auto Concept in France, the team eliminated the need to design the body of the car. But the monocoque, which typically houses an internal combustion engine, had limited space available for batteries, even when the engine was removed. Volkswagen Motorsport had little experience designing batteries, so when the ANSYS team offered to help design and validate the battery modules using simulation, Volkswagen accepted.

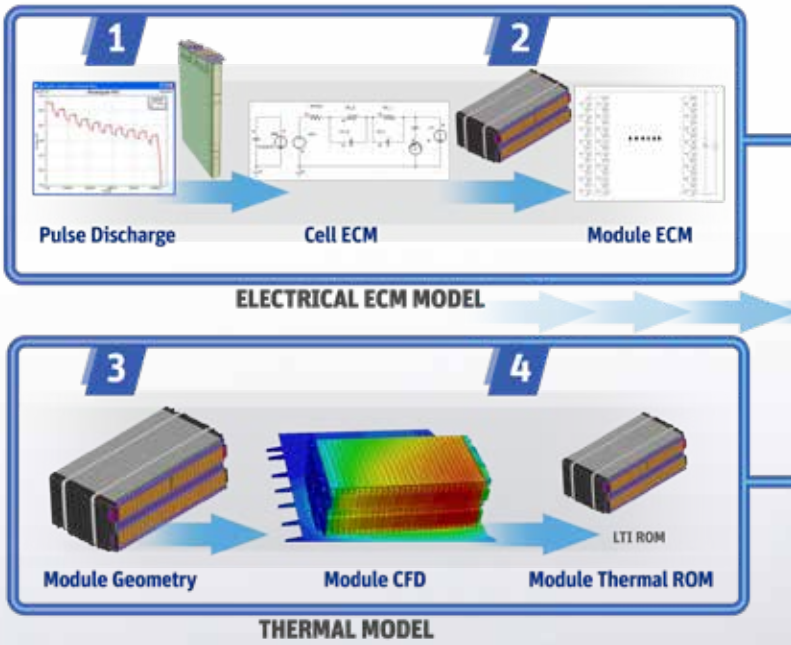
The Challenges of Battery Design

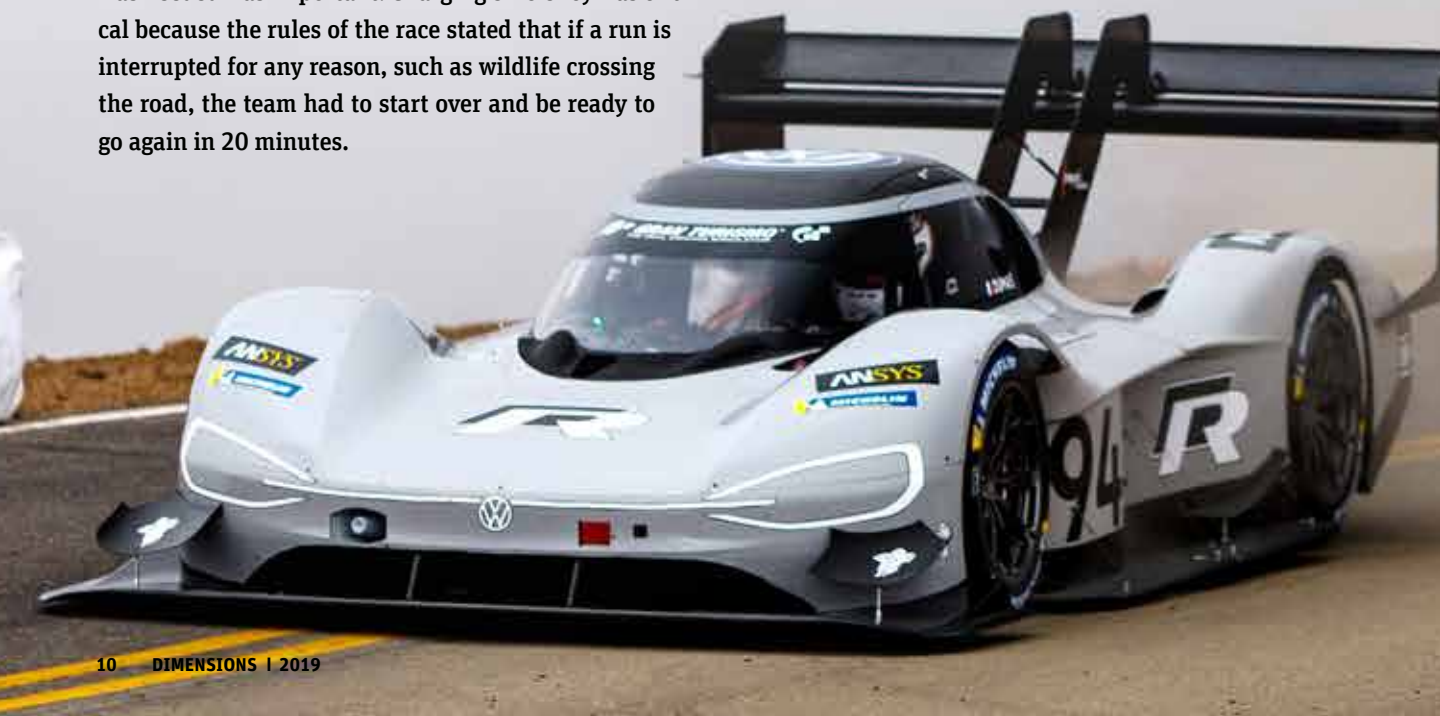
Primarily, the battery modules had to store enough energy to reach the peak speed that Dumas would need to drive on the course's straightaways, while ensuring that there would still be energy left at the end of the race. Running out of power short of the finish line would not do. Solving this challenge involved issues of cell selection, sizing of the battery pack, cooling of the pack and charging efficiency, among others.

Optimizing these parameters was key to success. The battery packs had to fit the space available in the chassis while providing sufficient power. Adding more battery modules than necessary would increase the vehicle's weight and slow it down. Battery temperature would affect the amount of energy available — the state of charge (SoC) — so determining if air cooling, water cooling or no cooling at all was needed was important. Charging efficiency was critical because the rules of the race stated that if a run is interrupted for any reason, such as wildlife crossing the road, the team had to start over and be ready to go again in 20 minutes.

A Six-Step Simulation Approach

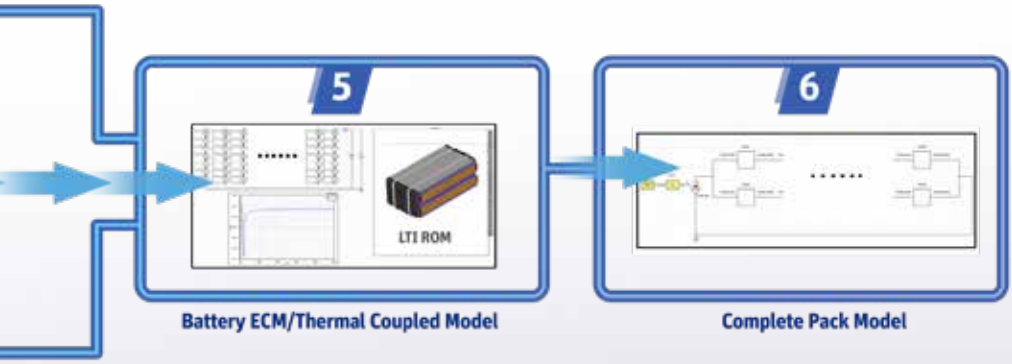
Using ANSYS Twin Builder, the Volkswagen Motorsport and ANSYS teams conducted a six-step multiphysics simulation involving electrical and thermal parameters to design and validate the battery model. The first step was to develop an equivalent circuit model (ECM) for a single battery cell. The ECM simplifies a complex circuit to aid analysis.





Engineers used test data from a pulse discharge to get all the parameters needed to calibrate the ECM. The first step was done on a single cell to verify that the cell model was created correctly. If anything was wrong, the validation would have revealed the problem. Engineers concluded from step 1 that the ECM is a function of SoC and temperature. The Twin Builder simulation of the ECM was super-fast, requiring only seconds to simulate one full drive cycle of the race car through the entire race course.

Step 2 combined all the ECM cells serially to form an ECM module. Step 3 involved computational fluid dynamics (CFD) simulation of the thermal properties of a battery module using ANSYS Fluent. Running a CFD simulation was necessary because the electrical performance of a battery is a function of temperature, and a thermal model is needed along with the ECM to predict battery temperature.



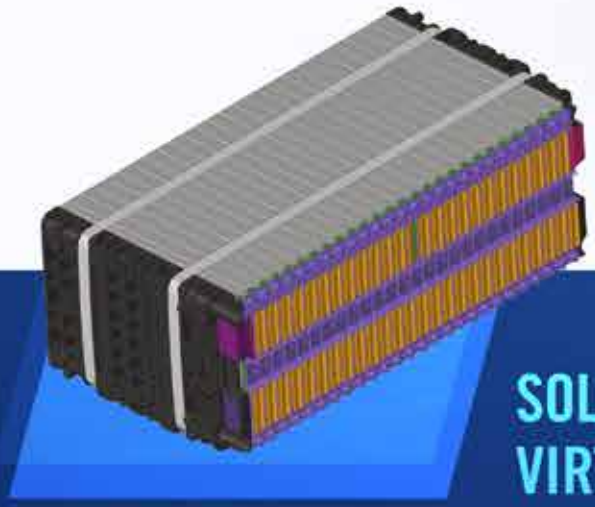
THE TWIN BUILDER SIMULATION OF THE ECM WAS

SUPER FAST.

The simulation model for a full CFD analysis of a battery model is typically extremely large. In this case, after importing the geometry of the proposed battery module and housing, and performing the meshing process, the engineers had a mesh containing 67 million cells. With so many calculations to perform, it took approximately 48 hours using 100 CPUs to run a thermal simulation of one full drive cycle.

This presented a new challenge because, eventually, the ECM and the thermal model would have to be run together in a two-way coupled multiphysics simulation. The discrepancy between the few seconds it took to run the ECM simulation on one CPU and the 48 hours to run the thermal simulation on 100 CPUs made it impossible to couple these simulations.

The solution came in step 4. Using Fluent, the engineers extracted key thermal characteristics of the system to create a reduced order model (ROM) for the thermal simulation. The ROM is linear and time invariant (LTI), and orders of magnitude smaller than the full CFD model. It yields results that correlate well with the full CFD model, but it runs 10,000 times faster.



In step 5, the ECM and the thermal LTI ROM models were coupled to run a two-way coupled multiphysics simulation in Twin Builder. The ECM predicts the electrical performance and how much heat is created. The LTI ROM thermal model takes this heat generation value and predicts temperature, then the temperature is transferred back to the ECM model to determine its effect on electrical performance. This cyclical iteration process continues until the simulation converges on a solution.

Step 6 involves putting the individual battery modules into the full 10-module battery pack that will power the whole EV. Volkswagen used a third-party simulation tool for this final system-level step. The complete battery model predicts the voltage and current relationship to ensure that the battery has sufficient energy for the task at hand — in this case, enough charge to finish the race. It also helps to predict the peak power output of the battery system, and therefore the top speed that the race car can go. Step 6 also predicts battery temperature, making sure the peak temperature is not exceeding the limit.

The result of the complete simulation process was to give Volkswagen Motorsport engineers confidence that the battery pack had enough charge to get them to the finish line, and that thermal properties were not a concern in this short race. Solving the battery challenge virtually through simulation instead of building a series of physical prototypes helped them accomplish their goal in the short time frame they were given.

SOLVING THE BATTERY CHALLENGE VIRTUALLY THROUGH SIMULATION INSTEAD OF BUILDING A SERIES OF PHYSICAL PROTOTYPES HELPED THEM ACCOMPLISH THEIR GOAL IN THE SHORT TIME FRAME THEY WERE GIVEN.

Watching a live stream of the race from their offices in Hannover, the Volkswagen team cheered Dumas and the I.D. R Pikes Peak race car as they climbed the mountain, and erupted in celebration when the car crossed the finish line in record time. But some of them were not entirely surprised by the result. From practice runs in a driving simulator, the mean time for finishing the race was around 7:57, with a possible faster finish if everything went perfectly and a slower one if they ran into difficulties. Dumas brought the car home in 7:57 — right on the button.

Looking Ahead

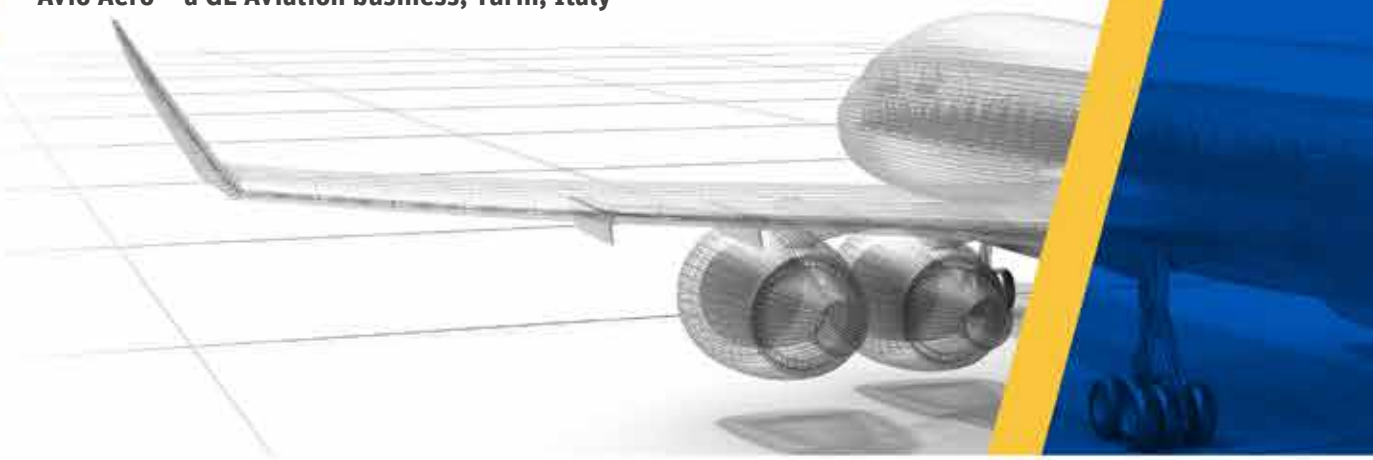
Having accomplished two years' worth of goals in the first year, Volkswagen was momentarily at a loss as to how to proceed — a great problem for engineers to have. Should they go back to Pikes Peak to try to improve on their record next year, try to break the record in another race or switch their focus to the consumer line of I.D. cars that they hope to be selling to the public within a few years?

Whatever they decide, ANSYS engineers are happy to have played a role in Volkswagen Motorsport's outstanding 2018 Pikes Peak victory, and stand ready with their suite of ANSYS simulation solutions to help them solve the challenges ahead.

COMMON THREAD

Aerospace leader GE Aviation is pioneering an innovative concept: creating a "digital thread" that follows designs from their earliest ideation through real-world operation. By centralizing all data related to a specific design, the company is not only accelerating the pace of development and increasing staff productivity, but also significantly and consistently improving product quality. Even more exciting, soon digital twins will create a closed-loop process that feeds operating data back to engineers.

By Luca Bedon, Senior Engineering Section Manager
Avio Aero – a GE Aviation business, Turin, Italy



LUCA BEDON

Pressured by new environmental and safety regulations, rising fuel costs and consumer price concerns, commercial airlines are demanding highly innovative product solutions — delivered faster than ever.

Designing systems and components for commercial jet engines has always been a difficult task, characterized by engineering complexity, strict industry regulation and zero tolerance for product failures. Today, aerospace engineering is even more challenging.

Pressured by new environmental and safety regulations, rising fuel costs, and consumer price concerns, commercial airlines are demanding highly innovative product solutions — delivered faster than ever. In recent years, the number of days until delivery mandated by aerospace customers has decreased by an order of magnitude as jet manufacturers struggle to keep pace with market demand.

Avio Aero — a GE Aviation business and a global leader in manufacturing jet engine systems and components — realizes that meeting these growing demands can only be achieved by identifying and applying best-in-class engineering technologies. A user of engineering simulation for over 20 years, the business has recently increased the impact of this technology by training more people and expanding its applications beyond the engineering function.

With support from the Italian government's National Industry 4.0 program — aimed at maintaining the competitiveness of technology leaders like Avio Aero — today the company is at the leading edge of digitalization, pioneering new ways to gather, analyze and apply engineering data. The majority of the product development engineers in Turin, Italy, and in all the other company's sites are trained to use simulation. This creates a sense of shared ownership and collaboration that can lead to dramatic innovations.

This commitment to innovation positions the company for continued leadership, even as the business environment grows more and more challenging.

Digital Thread: A Cutting-Edge Concept

GE Aviation has pioneered an innovative concept called the "digital thread" — a common set of engineering and product performance data that is expanded daily and shared by all key stakeholders in the business.

What led GE Aviation to embrace this idea? The company recognized that, by making its engines more digital and more connected over time, it was generating and gathering a huge volume of performance data. In fact, data generated and collected from today's fleet of smart engines is growing exponentially compared to the traditional designs before 2010, in the "no digital" era. An extensive use of analytics, combined with physical models enabled by advanced simulation capabilities, would allow GE Aviation to get meaningful insights that could be employed to improve product performance and reliability, profitability, and customer-oriented solutions — optimized according to how engines actually operate.

Engineering simulation data plays a central role in the digital thread strategy at Avio Aero. Simulations of jet engine components and systems are numerically large — encompassing multiple physics, complex reactions and transient forces. Simulation was making a significant contribution to the speed, cost and quality of the company's product development processes, but Avio Aero recognized that the benefits of simulation would be amplified if all simulation data were collected and made accessible to all stakeholders.

It means that every future design benefits from the lessons of the past.

Today, information is gathered for each product design at the earliest stages of ideation — and that data follows the design throughout its lifecycle, as the component is verified, tested, redesigned and released to the manufacturing function. Any design rework is simplified because all existing information related to that design is immediately available and univocally identified by the same part number. Costly and time-consuming repetitive handoffs have been eliminated. Anyone, anywhere in the business, can see at a glance where each design stands, and easily contribute to the product's ultimate success.

Increasing Data Availability and Access

Avio Aero calls this process "creating a single source of the truth," and the benefits cannot be overstated. Increased information access means that every single product design moves more quickly and cost-effectively through the development cycle, eliminating unnecessary redundancies and streamlining incremental improvements to that design.

But, equally important, it means that every future design benefits from the lessons of the past. Engineers conducting a new simulation can easily see if a similar study has already been carried out. They can start with accurate product geometries and operating parameters, based on what has worked — or not worked — in the past. This gives Avio Aero a critical competitive advantage as it meets tighter and tighter product delivery deadlines.

Closing the Loop via Digital Twins

The result of Avio Aero's digitized product development process is a virtual prototype that has been produced through collaborative engineering and is now ready for physical testing. Any physical test results are collected as part of the digital thread, impacting any rework on that product, but also becoming part of the company's general knowledge base.

What's next on the horizon is even more exciting. The next step is the creation of the product's digital twin, developed by partnering with the customer and placing sensors on an actual working product. When this is achieved, Avio Aero will be able to collect real-world operating data in near–real time. By applying the same physical conditions to its virtual prototype, Avio Aero can see the effects of long-term operation. This will enable the business to predict failures, schedule maintenance, order repair parts and otherwise improve each working product's performance over time.

Digital twins will also close the loop on the digital thread — creating, for the first time, a view of a product design's entire lifecycle, from earliest ideation through real-world operation. The insights gathered across this lifecycle will be available and accessible to every stakeholder within Avio Aero, impacting future designs and forming the foundation for high product performance for years to come.

TURNING SPECIALISTS INTO STRATEGISTS

Identifying and applying advanced technology, including simulation, has been critical in Avio Aero's move to digitalize its engineering efforts. But equally important has been the cultural change needed to support this initiative.

"Twenty years ago, everyone in the engineering function was a specialist, with a narrowly defined role," says Luca Bedon, senior engineering section manager. "For example, someone would learn to run a CFD simulation, and that's all they would do, all day. They didn't have a view toward the ultimate success of the product — because they didn't see what happened after they completed their isolated task."

According to Bedon, the engineering team at Avio Aero today has a completely different mindset. "We completely redefined the role of what we called 'specialists,' shaping a different organization based on a system mindset and showing everyone that they can contribute to the product's success," he explains. "We've trained half the team in simulation, so anyone can pick up a project and work on it. We've eliminated handoffs, increased ownership and given everyone visibility into the end-to-end product lifecycle.

"That has created a strategic perspective and a feeling that every employee is contributing to the shared success of Avio Aero," Bedon adds. "That's a big cultural change, but one that our employees have really embraced. They enjoy their work and believe they really are playing a key role in our top-level business strategy."

ANSYS: A Strategic Collaboration

An ANSYS customer for over 20 years, Avio Aero has relied heavily on ANSYS to help implement its vision of the digital thread. Since ANSYS is the acknowledged leader in simulation technology, it only makes sense for Avio Aero to leverage its advanced solutions as it creates a next-generation digital architecture.

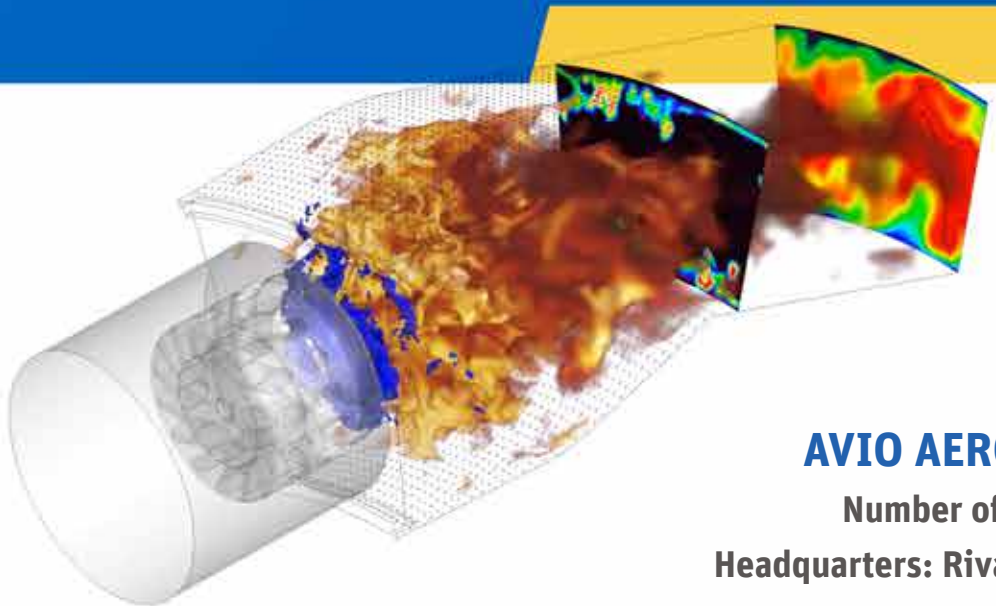
ANSYS has not only provided best-in-class simulation solutions that cross multiple physics and engineering functions, it also offers a unified platform that supports easy collaboration. ANSYS experts consulted with Avio Aero on the best ways to integrate ANSYS solutions with the company's data architecture, as well as its suite of in-house and third-party tools.

Avio Aero defined its vision of how engineers would work together in the future, and ANSYS helped the company achieve that vision. Over time, Avio Aero's relationship with ANSYS has evolved into a true strategic partnership.

Digitalization Takes Off

To meet growing customer demands, new environmental standards and stricter regulatory protocols, GE Aviation must support the development of the most innovative, high-tech jet engine ever produced. Realizing this goal means employing the most innovative, high-tech product development strategy. This rationale led GE Aviation to embrace the concept of an end-to-end digital thread that collects and leverages insights at every stage of the product lifecycle.

Not every company makes products as complex as jet engine systems, or competes in an industry as demanding as the global aerospace business. But every engineering team can benefit from the concept of the digital thread — a single source of data and a shared version of the truth for every product design. Making a commitment to gathering and leveraging simulation data speeds the development process, maximizes staff productivity, minimizes rework and ultimately improves product quality. This concept is taking off — and with good reason.

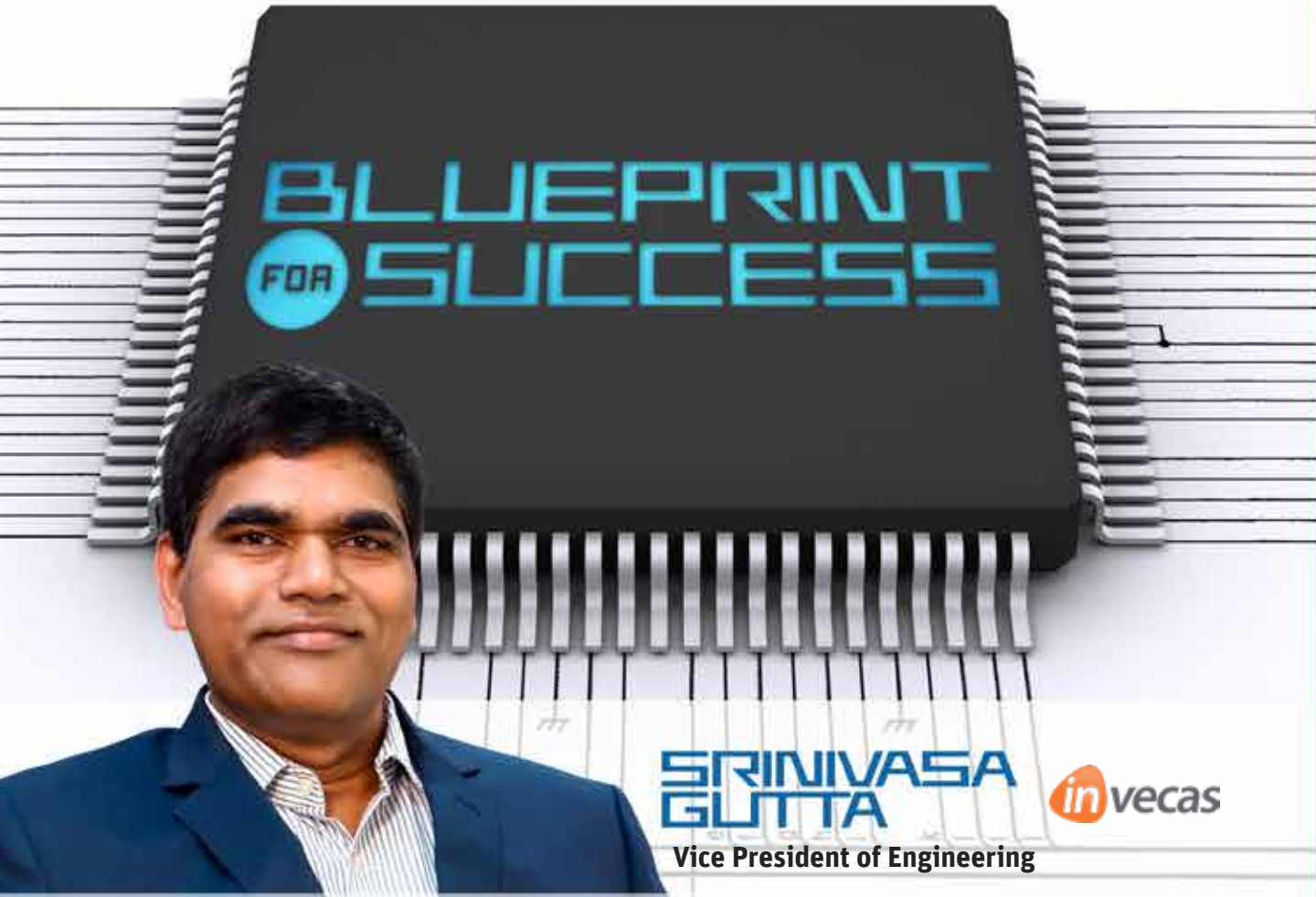


AVIO AERO AT A GLANCE

Number of employees: 4,800

Headquarters: Rivalta di Torino, Italy

Avio Aero
A GE Aviation Business



Tiny yet powerful, semiconductor chips support the success of every futuristic technology you can imagine — from driverless cars and self-guided rockets to 5G-enabled devices and cryptocurrency. Designing these chips with customized functionality for each application is a challenging task, complicated by the need to fit into ever-smaller packages. That is where INVECAS comes in. Only four years old, this India-based startup is a global leader in designing advanced IP and ASICs. Recently, VP of Engineering Srinivasa Gutta spoke with* Dimensions *about the company's challenges and opportunities.

DIMENSIONS: What are the biggest trends today in semiconductor engineering — and how are they impacting INVECAS?

SRINIVASA GUTTA: Certainly the biggest trend is the need to develop more innovative, more customized semiconductor chips that support very specific customer needs. These are called application-specific integrated circuits (ASICs), and demand is growing rapidly as everyday products become smarter and more complex.

If you think about the modern car, there are many technology systems that must work seamlessly together — from mission-critical functions like braking and airbag deployment to entertainment, navigation and comfort systems. Autonomous driving only adds to this complexity. All this diverse functionality — which includes sensing, signaling and communications — is delivered by semiconductor chips. Each chip has to perform optimally on its own and also as part of a larger system.

INVECAS was founded in 2014 by a team of semiconductor experts to serve this market need. We develop a range of intellectual property (IP), including highly specific, extremely customized chip designs that provide targeted functionality. We partner with silicon manufacturing foundries that bring our designs to life. These close relationships ensure that our IP functions ideally not only in isolation, but as part of a larger system.

A related trend is the demand for an accelerated design cycle. If we go back to the autonomous vehicle example, every automaker is in a race to launch new self-driving cars ahead of the competition. This places incredible pressure on INVECAS to come up with standard IP and new chip blueprints very quickly. At the same time, our IP has to go through rigorous testing and certification to meet uncompromising standards and requirements.

AD: How does INVECAS balance design speed with the mission-critical nature of your product applications?

SG: From our company's inception, we have relied on engineering simulation to verify the performance of our IP designs at a very early stage. We've invested $5 million in a 5,000-square-foot physical testing facility, but we need to leverage that resource strategically. Before we invest in costly prototype fabrication and testing, simulation provides us with a very high degree of certainty that our IP and chip designs will perform as anticipated.

BEFORE WE INVEST IN COSTLY PROTOTYPE FABRICATION AND TESTING, SIMULATION PROVIDES US WITH A VERY HIGH DEGREE OF CERTAINTY THAT OUR IP AND CHIP DESIGNS WILL PERFORM AS ANTICIPATED.

Simulation via ANSYS helps us balance an accurate logical design — which delivers the desired functionality — with an optimal physical design in terms of size, thermal footprint and other characteristics. Our engineers can make intelligent trade-offs that optimize power, performance and area, which are our three most important metrics. Our designs are produced in a continuous loop, beginning with the customer's specification — for example, the IP must operate at a 3.6 GHz frequency, or transmit data at 16 gigabytes per second. We simulate these operating parameters, track key performance metrics and conduct iterative simulations that optimize the IP design.

What's unusual about the semiconductor business is that the closed-loop simulation process does not end when we hand off the schematic or graphic data system (GDS) to manufacturing. INVECAS fabrication partners also use a common simulation platform, ANSYS Redhawk, which allows us to easily pass designs and prototypes back and forth.

This seamless design, simulation and fabrication process gives our customers extreme confidence in our intellectual property — and accelerates the design-and-fabricate cycle. The idea of simulating the manufacturing process is gaining ground in other industries, but it has always been foundational to the semiconductor industry. It ensures that performance is verified at every stage.

AD: In just four years, INVECAS has grown to 1,300 employees worldwide. What is the secret to your success?

SG: Engineering excellence is critical, because we are creating intellectual property which has to be better than the solutions of our competitors. Ninety-five percent of our employees are engineers. We have worked hard to hire the right talent and create a collaborative, energized team that is excited about creating cutting-edge designs. From its inception, INVECAS has been focused on building the right company infrastructure, attracting the best people and providing them with best-in-class technology tools.

Our collaboration with ANSYS is a great example. From the beginning, we identified ANSYS Redhawk as the best simulation platform for the kinds of complex modeling we need to accomplish. Today, 50 percent of our analog engineers use ANSYS software to perform challenging tasks like power modeling, and designing for analog and mixed-signal environments. These are not simple simulations, and we've been consistently impressed by the software's capabilities and accuracy. ANSYS simulations form the basis for every one of our designs.

Beyond the quality of the software, what has been important to INVECAS as a startup is that ANSYS has functioned as a true partner, not just a software vendor. The ANSYS team has helped train our people, define new workflows, create new power models and anticipate our evolving simulation needs. ANSYS is invested in our success, and we have felt that from the beginning.

AD: Looking into the future, what lies ahead for the semiconductor industry — and how is INVECAS preparing for that future?

SG: Everyone is betting on 5G to emerge as the backbone of communications in the near future. While household names like Apple and Samsung will drive this transformation, the effects will impact everyone in the electronics industry, including semiconductor designers and fabricators. INVECAS will need to design new ASICs and other intellectual property that meet an entirely new set of operating parameters to support 5G.

The continuing electrification and autonomy of cars is another trend we are watching very closely. As cars become more like data centers — constantly gathering, analyzing and responding to information — we need to design our chips differently. They not only need more capabilities in smaller and smaller packages, they also need to perform reliably in harsh, unpredictable environments. Cars also have a relatively long product life, so we need to account for the aging of our chip designs. We are using simulation right now to replicate the effects of aging, and we need to increase that effort. Eventually we might begin to explore the use of digital twins to capture real-world data and understand the aging process in real time.

Finally, machine learning and artificial intelligence are exciting trends that we are watching. As products become smarter and able to gain knowledge, there's no telling what impact that can have on the world as we know it. At INVECAS, we are looking at the enabling semiconductor technologies and the next-generation IP that will create the foundation for artificial intelligence. None of us are sure what this "brave new world" will look like, but one thing is certain: Chip designs will have a foundational role in making it possible.

ANCA MAKES MACHINE TOOL DESIGN LESS OF A GRIND

By *Dimensions* Staff

Pat Boland was a 25-year-old electrical engineer in 1974 when he co-founded Australian Numerical Controls and Automation (ANCA) with fellow engineer Pat McCluskey in Melbourne, Australia. They had an idea to upgrade existing numerical controlled (NC) tooling machines with hardwired logic by connecting them to a $4,000 AUD "mini-computer" that stood about 5 feet tall. The resulting computerized numerical control (CNC) machine was a flexible, programmable device for grinding and cutting tools and dies used in wood, metal, ceramics, plastics and composites cutting operations.

CNC has increased the precision of machining operations so that parts can be produced with vanishingly small tolerances for a better fit. When the part is a titanium ball-and-socket joint that will be surgically implanted to replace your worn-out hip, a high-precision fit can make all the difference to your future mobility and comfort. Precision machined parts in airplanes experience less wear and tear and will last longer, increasing safety and reducing maintenance requirements. And the repeatable accuracy of CNC machining reduces costs for consumer electronics parts that are produced in great quantities, like smartphone cases.

ANCA CNC Machines is a privately owned, world-leading manufacturer of CNC grinding machines, motion control systems and fabrication solutions, with more than 1,000 employees across the globe and annual sales of around $280 million AUD. ANCA CNC grinders are used for manufacturing precision cutting tools and components for the automotive, aerospace, electronics, smartphone and medical industries. **Dimensions** ***talked with Pat Boland in Melbourne, Australia, to find out what challenges the CNC machining industry is facing today and how ANCA CNC Machines is solving them.***

Dimensions: What is unique about your company that makes you a leader in the field?

Pat Boland: We operate in a narrow niche, and competition is intense. There are two significant aspects that separate us. First, we are known as innovators in the industry. We have developed a lot of products and processes through the years that have changed our industry in significant ways. For instance, we have developed specialized laser gauges inside our CNC machines to very accurately measure key geometrical properties.

Another important attribute is that we are a very vertically integrated company, so we do not rely on outside suppliers for any of our technologies — we can do every step from design to manufacturing in-house. This means that we can adapt our technology to meet requirements faster than would be possible if we were relying on outside people to make changes. For example, we control the machine itself along with the CNC and servo software that operates the machine.

D: What are some of the major challenges in the CNC machining field today?

PB: Automation is one. Most machines we sell now are autonomous, machine-tending robots. Running in an automated fashion while maintaining high degrees of accuracy is a challenging task. The robot will be loading and unloading components and tools into the machine. You've got robots assembling parts into fixtures and fixtures being loaded into machines, which requires vision systems, laser marking and coordinate measuring devices all integrated into single machines.

Also, the accuracy requirement of cutting tools is increasing all the time. In any machining operation, the accuracy of the final machining is limited by the accuracy of the cutting tool. If there's a geometrical error in your cutting tool, it is going to be transferred to the finished part. So we installed specialized laser measuring equipment inside our CNC machines to measure geometry very accurately. That has enabled unmanned, highly automated manufacturing.

Dimensions: What is driving the requirement for greater accuracy?

PB: Greater accuracy leads to a more consistent finished product. Manufacturers of standard cutting tools are looking for identical performance between a cutting tool made today and one made three years ago. It is no use to customers if one tool has a lifetime of 500 hours and another of the same design lasts only 100 hours. The customer's system relies on the consistency of the product lifetime, and the lifetime is dictated by the microgeometry of the cutting edge. So that is putting tighter and tighter requirements on the accuracy and surface finish of the products coming out of our machines.

"GREATER ACCURACY LEADS TO A MORE CONSISTENT FINISHED PRODUCT."

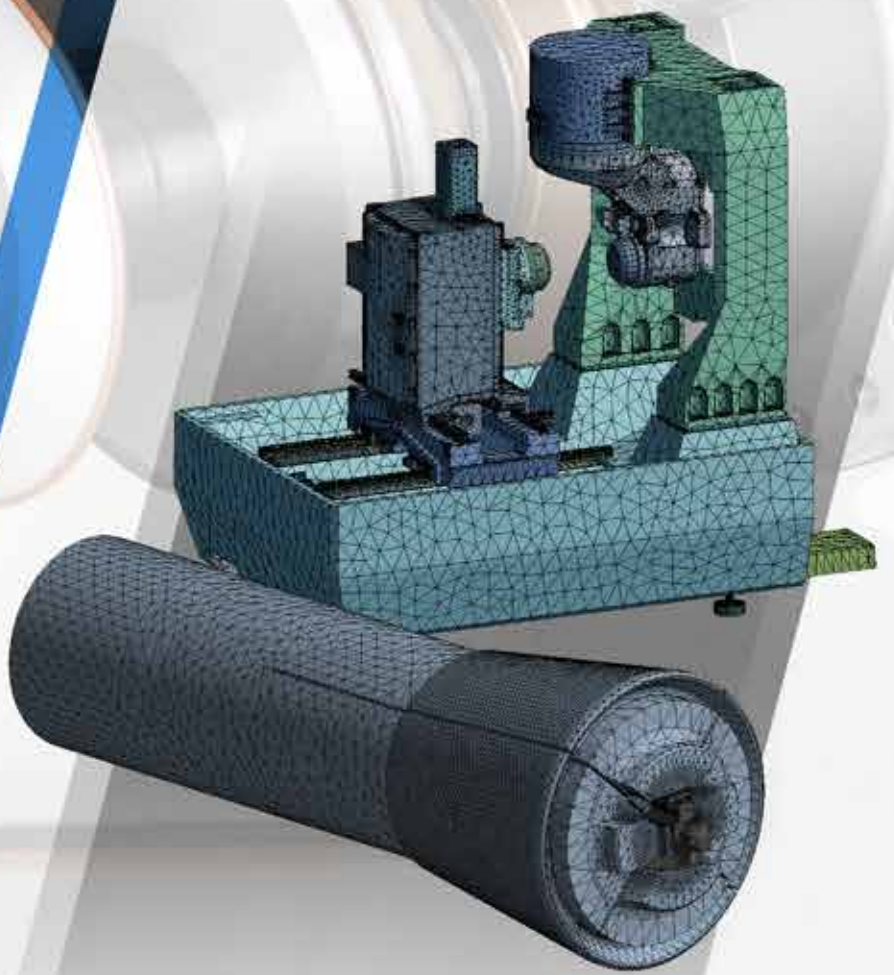
D: Have the skills required of machine tool personnel changed over the years?

PB: Yes, they need more computer skills than the previous generation of manual tool grinders. I have seen skilled manual operators do some amazing things that were almost impossible to believe, but these skills are no longer required. Still, an operator can make a world of difference by optimizing the process. Today's operator must be an expert at setting up the machine — qualifying all the grinding wheels in place and getting them into optimal condition for cutting.

D: Are you using simulation to meet some of the engineering challenges of these machines?

PB: Simulation is a key engineering tool for us. Our design engineering team uses ANSYS Mechanical for things like friction, deformation and rigidity studies, and for harmonic modal analysis of vibrations. Being able to simulate these physical properties of our CNC machines is much faster and less expensive for us than building physical prototypes and testing them. We can detect any potential problems virtually and have confidence that we have corrected them before we begin building. This helps us deliver our product to a customer sooner and at a more competitive price.

More recently, our manufacturing engineers have learned from the design team and have begun to use Mechanical to simulate fixtures, jigs, lifting apparatus and other practical tools they use in the manufacturing process. Besides using ANSYS solutions, we have also developed our own software for downstream simulation of actual machine operation.



D: What does the future of the CNC machining business look like?

PB: We are seeing good trends in most markets, with the exception of China and Korea. A lot of our machines are used in the smartphone supply chain in those countries. But there's been an incredible wave of investment there in the last five years, and they are now overstocked on CNC machines. No new orders coming from that region will have an impact on part of our business. But the advantage we have is that cutting tools are used throughout the world. Besides that, they are used in a diverse range of industries from woodworking, furniture making, metal cutting, mining — all the way through to brain surgery, the medical side of precision cutting tool applications. Increased demand for CNC machines in these other sectors should make up for the cutback in the smartphone sector.

Dimensions: It sounds like as long as people are manufacturing things they will be needing CNC machines like yours.

PB: Yes. As long as people are sitting in chairs, using knives and forks, and getting around in some sort of motor car — electrical, autonomous or whatever — there will be a need for cutting tools.

The key is continuing to deliver reliable products. When we started this business in the 1970s, people were more tolerant of development cycles. Today there's an expectation that things will be designed quickly, and that they will work out of the box, from serial number one through to the last serial number. Quality of design is a critical driver, so we need simulation for design verification. Simulation plays an absolutely critical part — being able to evaluate performance before you actually make a physical prototype is crucial.

ANCA CNC MACHINES AT A GLANCE

2017 revenue: $280 million AUD

Number of employees: 1,000

Headquarters: Melbourne Australia

ANCA CNC Machines is supported by ANSYS Elite Channel Partner LEAP Australia Pty Ltd.

FOOD FOR THOUGHT

By *Dimensions* Staff

Buhler, a global leader in food processing solutions, is committed to applying advanced technology, including engineering simulation, at every opportunity to optimize its machinery for energy efficiency and high performance. According to Chief Technical Officer Ian Roberts, the company is focused not just on increasing sales and customer satisfaction via market-leading technologies, but also on the urgent need to end world hunger, reduce waste and support sustainability across the worldwide food chain.

DIMENSIONS: Buhler's product depth and its global reach are impressive. Do you think it is safe to say that everyone reading this magazine has been impacted by your products?

IAN ROBERTS: That's probably a safe bet. Buhler makes state-of-the-art food processing equipment used around the globe. Sixty percent of the world's grain, 30 percent of its rice and 60 percent of its chocolate are processed from raw materials into finished products via our equipment. Buhler does not produce any food products, but we provide the machinery, services and processing technologies that produce food for consumers in a safe, efficient, affordable way.

D: Recently, Buhler made a bold commitment to its customers, pledging to reduce energy consumption and waste in each customer's value chain by 30 percent. Why is this an urgent requirement — and how do you plan to achieve this goal?

A uniform die-flow is key to ensuring high product quality during the extrusion process. The temperature distribution, as shown here, influences flow behavior and final product properties.

IR: Because Buhler plays a central role in the global food chain, we believe we have a duty to address global problems around food. Today 25% of greenhouse gases are produced by the food industry, including agriculture, and 70% of water usage is attributed to food production. At the same time, one-third of available food is wasted — while people in developing nations are starving.

Engineers make a critical contribution to improving the overall energy and environmental footprint of the global food industry. By decreasing the energy consumption of our equipment, Buhler can make the end-to-end supply chain more productive, more sustainable and more affordable. Not only can we save our customers money, but we can make a significant impact on some serious global problems. That is why we made a public commitment to dramatically cut energy usage.

Of course, delivering on that promise is challenging. One of Buhler's key strategies is to identify and employ the most advanced product development and engineering technologies available today. While Buhler is a 158-year-old business, with proven products, we are now faced with making quantum improvements in our processing solutions to address today's urgent challenges.

D: How is engineering simulation, in particular, helping Buhler achieve its ambitious business goals?

IR: Buhler's product development team leverages simulation to make all our equipment higher-performing in terms of process consistency, reliability, capacity, energy efficiency and other critical attributes. Our extruders, dryers and other machinery benefit from our simulation capabilities, which enable us to safely optimize our processes to achieve our strategic commitments.

It is important to note that food industry simulations are challenging. We need to look not only at how the equipment is working, but at how the physical changes we make will affect the finished food products. Food industry engineering means looking at suspensions, emulsions, mixtures and dynamic phase changes. We're dealing with highly complex and evolving structures.

Since 2006, Buhler has been using ANSYS simulation software, from mechanical solutions to fluids and processing tools. We chose ANSYS because it is widely used by universities and across our industry. We continually evaluate our technology tools, but have seen that ANSYS offers an industry-leading software. ANSYS has been a valuable collaborator that, like Buhler, is committed to technology excellence and continuous advancement.

D: In addition to simulation, Buhler is a leader in applying the concept of digitalization and digital twins. Why is this technology important?

IR: Real-time monitoring — and intervention, when needed — represents the next frontier in achieving the highest performance and optimal energy efficiency for our processing equipment. If we can identify any operating issues and address them in real time, it will make an enormous impact on our ability to deliver on our customer promises. Eliminating downtime, reducing maintenance, monitoring energy usage and minimizing waste are hugely important in developing an efficient, affordable and sustainable global food chain.

With data visibility, we will be in a position to model the entire supply chain. We can gather huge volumes of data, store it using cloud technology and study it with today's advanced analytics. We can apply lessons learned from our customers' plants and use those insights to deliver better product systems and optimize the whole value chain. Via simulation, we can apply the governing rules of physics to our virtual models and study their response — leading to continuous improvements of our product designs, as well as predictive maintenance and repairs.

Buhler has used simulation software from ANSYS to improve the performance of key equipment components, including extruder screws like this one.

A number of food industry companies are investing in digital twins because they can help all of us address those urgent problems I mentioned before, such as availability of adequate nutrition and environmental impact. While these problems are daunting, we now have the digital technologies we need to tackle them.

D: Looking ahead, what is the future of the global food industry — and how will technology continue to play a role?

IR: In 2050, we will need to be able to feed 9.8 billion people. If we do nothing to change the way food is produced and distributed globally, there is a risk that not everyone will be able to access safe and affordable food. That is a sobering thought. It creates challenges for companies like Buhler, but it also creates an opportunity for innovation and leadership.

Advanced technology, including solving engineering challenges through simulation, is going to play an enormous role in optimizing the worldwide food supply by addressing operational challenges, efficiency, sustainability and waste reduction. As simulation and digital twins continue to grow in usage, the cost of operating the machinery and the next generation of processing technologies is going to come down, their quality and flexibility are going to improve, and these tools will be used by more companies of all sizes.

We've been encouraged by ANSYS' efforts to continuously improve its simulation solutions, as well as its outreach initiatives like its Startup Program, which place advanced tools within reach of every company. Each year, Buhler supports 60 small companies in the food industry, enabling them to develop innovations and commercialize their products.

The truth is, the problems of world hunger and sustainability are too large for one company to solve. Buhler is fortunate to work with technology leaders around the world like ANSYS who develop transformational technologies. We value companies who function as true partners in improving our products and enabling us to make a greater contribution.

Simulation has helped accelerate Buhler's product development efforts and fuel better financial results. Even more important, simulation, digital twins and other advanced technologies are creating a positive impact on the global food supply chain that improves the health, well-being and quality of life for billions of people.

Extruders are a critical part of the global food supply chain. By optimizing the extrusion process, the energy demands and the overall costs associated with this equipment will decrease while product quality increases.

BUHLER AT A GLANCE

2017 revenue: **CHF 2.7 billion**

Number of employees: **11,000**

Headquarters: **Uzwil, Switzerland**

BÜHLER

CONNECTING THE WORLD WITH MIDDLE-MILE, ELECTRIC-POWERED FLIGHTS

The first era of the jet age began in the 1930s when jet-powered aircraft took to the skies. These engines relied on thrust generated by burning hydrocarbon fuels to carry passengers in comfort. After more than 80 years of incremental innovations in the field, magniX is now planning to revolutionize the industry and launch the next era of aviation by developing electric propulsion for aircraft to carry up to 20 passengers — or a combination of passengers and cargo — as far as 650 miles with no exhaust emissions. This will create a new market for clean, inexpensive, middle-mile commercial passenger and cargo flights. **Dimensions** ***recently spoke with Roei Ganzarski, CEO of magniX, to learn how the company is solving the electric-powered aircraft challenge while redefining the concept of "connectivity."***

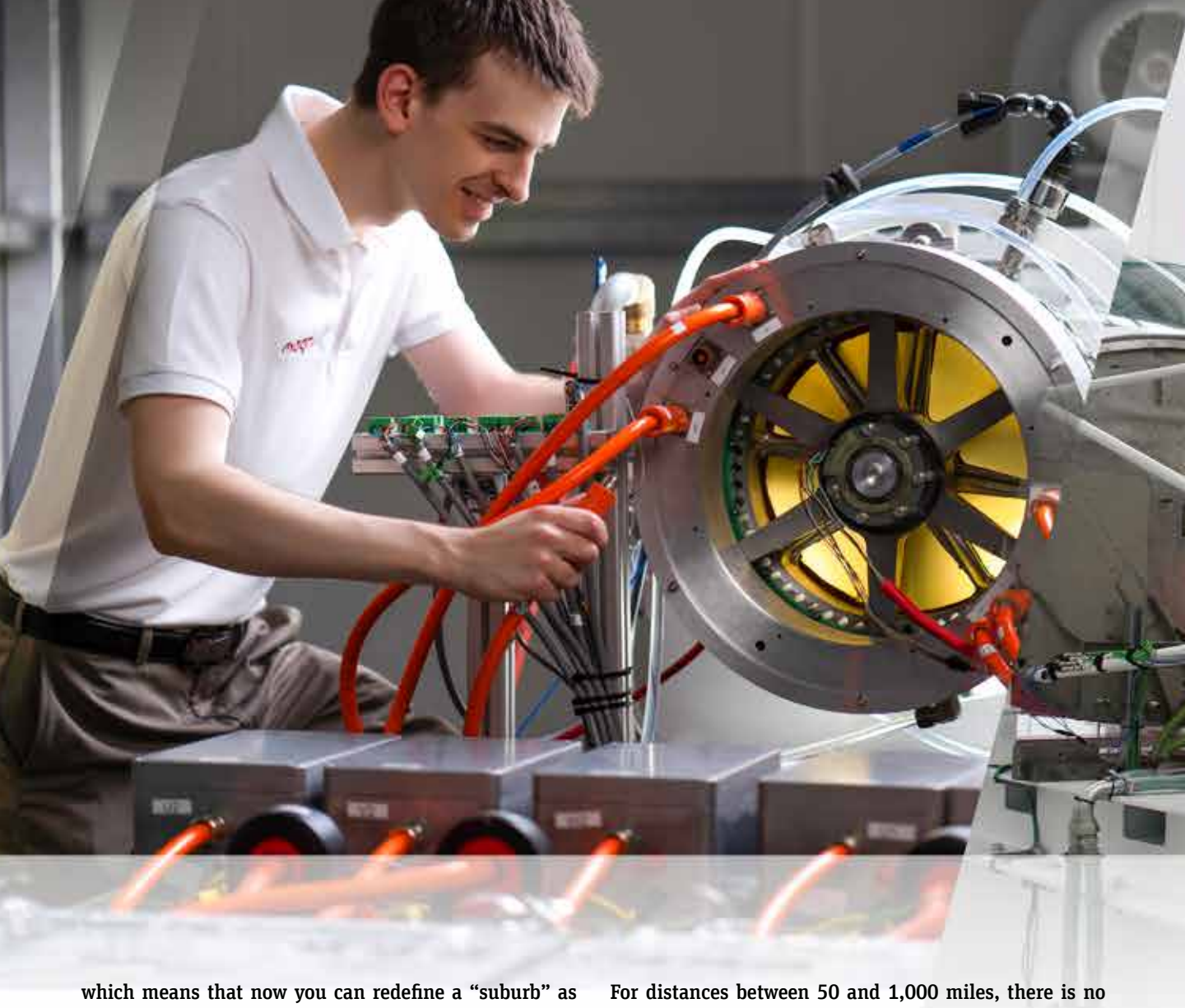
Dimensions: What is your primary goal at magniX?

Roei Ganzarski: Our goal is to enhance prosperity by connecting communities with clean, low-cost electric aviation. To do this, we are developing innovative electric propulsion solutions for commercial aviation.

D: The concept of connecting communities is interesting, given that today "connectivity" has come to be associated more with wireless communications technology. What part does aviation play?

RG: Obviously, all major cities are already connected by large airlines. But when you look at subcommunities — medium-sized or smaller cities, towns, rural areas — there are few low-cost, efficient air connections or rail connections (particularly in the U.S.) because it is not economical. So if someone wants to fly, they may need to drive — many times for hours — just to get to an airport. This limits the movement of people and goods, which in turn limits economic growth and prosperity.

Electric aviation will provide a very clean, low-cost mode of transport between small and medium-sized cities,



which means that now you can redefine a "suburb" as a town that is maybe a 40-minute flight away versus a 40-minute drive away. Suddenly a small company in a small town can export their products to other larger cities and grow. They grow, they hire more people, the economy gets better, prosperity goes up. That is what magniX is all about.

D: Electrification has been applied to the automotive and industrial sectors, but we have not heard much about electric propulsion of airplanes. Why did you decide to bring electrification to the aerospace industry?

RG: We selected commercial aviation to focus on because of the tremendous prosperity effects it can bring. For distances of less than 50 miles, we have plenty of alternatives such as cars, buses, subways, etc. While they may not be the most efficient or clean, they offer service. For distances above 1,000 miles, today's aviation industry provides an efficient and reasonably priced solution. For distances between 50 and 1,000 miles, there is no good, clean, economical solution that provides value. In many cases, the only mode of transport available is driving for hours. With that said, the airport infrastructure, especially in places like the United States, is extensive. So, an electric aviation solution offers increased connectivity while not requiring tremendous investments in infrastructure — like high-speed rail, for example, would require in laying tracks across vast distances.

Even with today's battery technology, we can do short flights — 100 miles in a retrofitted aircraft and 650 miles in an aircraft designed from the start for electric propulsion. But to put that in perspective, 5% of worldwide airline flights in 2018 were less than 100 miles, and 45% were less than 500 miles. These numbers do not even include cargo flights. So there is clearly a need for these ranges. Why not have them be electric? Why not have them be clean and reduce the 4% of emissions worldwide generated by aviation (12% here in the U.S.)?

ROEI GANZARSKI
CEO, MAGNIX

D: What has been your biggest engineering challenge in developing electric propulsion for aerospace applications?

RG: The key elements for aerospace motors are weight, power, efficiency and reliability. We have been able to develop motors that are more powerful and lighter than anything else out there, with levels of reliability and redundancy we have come to expect in aviation. Moreover, the motors rotate at very low speeds. This low speed is very important. If you take, for example, a traditional middle-mile aircraft, the propellers turn at about 1,900 rpm but their turbine or piston engines turn at multiple times that. So you need a heavy gearbox between these elements to match the speeds. We eliminated the heavy gearbox. Our motor turns at 1,900 rpm — the same speed as the propeller — producing the same power level that the traditional internal combustion engines create. That means that we can connect the propeller directly to the motor, eliminating the weight and the maintenance elements of that gearbox.

THE KEY ELEMENTS FOR AEROSPACE MOTORS ARE WEIGHT, POWER, EFFICIENCY AND RELIABILITY.

D: What role did engineering simulation play in this innovation?

RG: Simulation is a critical aspect of our development at magniX. We are doing something that no one has ever done before. We can't look around in the literature or at other companies and say, "Hey, show me what you've done, and I'll do the same thing."

So, there were two ways to approach this challenge. We could start building motors, trying them out and learning — the way it used to be done — or we could take advantage of phenomenal simulation technology that allows us to try out different ideas before we actually "turn metal," to use the old manufacturing terminology.

Simulation allows us to try out different ideas, from fluid dynamics to stress to structural properties to electromagnetics in a multiphysics environment to take into consideration all the simultaneous forces at play when an electric motor is working. We can do this virtually, on the computer, before ever creating the actual first article in hardware. Simulation helps to increase the speed in which we can go to market. If we had to build every motor design to test each one, it would take us years before we ever had anything to even try on the ground, let alone in the air. When you are revolutionizing an industry like we are, time is of the essence.

D: What led you to choose ANSYS simulation solutions?

RG: When we looked around, we noticed that ANSYS simulation is being used by many other aerospace companies. So we knew that the tool itself has been proven and has been used successfully within aerospace. Because of the high level of safety necessary in the aerospace industry, you must have levels of simulation that the regulating authorities will approve. We must pass every single test that the FAA, EASA, Transport Canada and every other regulatory body in the world puts us through, and we expect to pass every test with flying colors. By using embedded software development tools from ANSYS for the control code in our motors, we have the utmost confidence that our qualification efforts will be streamlined, allowing us to get to market faster.

We have to have confidence that our partners, our suppliers, our customers and the regulatory authorities can look at our data and say: "We know that simulation model, we understand that what it represents is as close as possible to what is happening in reality and we'll accept the results it generates." There are very few companies in the world with the level of modeling and simulation that meet these high standards, and ANSYS was the choice for us.

D: How has using simulation benefited magniX?

RG: The biggest value that we're getting from ANSYS solutions is time and money. What using ANSYS simulations allows us to do, more than anything, is rule

MAGNIX AT A GLANCE

Number of employees: **60**

Headquarters: **Redmond, WA**

out ideas that would cost us a lot of money and time later on. Simulations can tell us upfront, "It is not going to work, or it is just not going to give you the results that you want."

When you are leading a revolution, like we are doing by electrifying an industry that hasn't really changed for over 80 years, you have to be first to market to make a real change and lead the way. ANSYS helps us to be first to market.

D: What makes magniX different?

RG: It is all about our team. We do not want them to think outside the box — they should simply not see a box. So, when you bring that attitude to bear on the challenge of electric commercial aviation, they can say, "OK, what do we need to do to get there?" versus the traditional approach, which is to look at what we have today and determine what can we do to improve it incrementally. It is a very different approach. As a small company dedicated to commercial electric aviation, we can allow ourselves to follow this different approach and do it very quickly. Our team is bringing back the same level of dreaming, focus and questioning of status quo that propelled aviation in the '20s and '30s and got lost along the way.

As I said, magniX is not about the electric motor itself. Rather, it is about how the motor can connect communities with clean, low-cost air transportation, because if you do that, you open the door to the movement of people and goods like never before — that is really the end game.

PREPARING FOR THE 5G REVOLUTION

As a world leader in wireless and broadcast infrastructure solutions, Radio Frequency Systems is rethinking its most foundational antenna technologies to prepare for the launch of 5G beginning in 2020. The company's advice to others in a transforming industry? Invest in the advanced technologies and smart people that help your product development team rise to the challenge.

By André Doll, Chief Technology Officer
Radio Frequency Systems

The world around us has changed, and continues to change, dramatically because of technology innovations. Artificial intelligence, machine learning and robotics are becoming commonplace. Autonomous cars are just on the horizon. And every day, more and more data is uploaded and downloaded via cloud computing.

While these technologies deliver obvious benefits, they require faster streaming, greater bandwidth, uninterrupted connectivity, secure transmission and larger-scale processing — across an ever-growing user community.

In response, the global tech industry is preparing the next generation of telecom networks: 5G. With greater speeds, higher bandwidth, unparalleled reliability and

low degree of latency, 5G will enable the level of performance needed to support both continuing tech innovations and ever-increasing user density. All this adds up to a huge market opportunity. In fact, according to IHM Markit, the global 5G value chain is expected to generate over $35 trillion in economic output and support over 22 million jobs by 2035 [1].

But, of course, 5G brings challenges. Today, device manufacturers, wireless providers and their entire end-to-end supplier networks are making fundamental changes in their products to succeed in this new era.

The Need for Reinvention

As a world-leading provider of innovative wireless and broadcast infrastructure solutions — from antennas and cables to connectors and other components — Radio Frequency Systems (RFS) is preparing for the launch of 5G networks, starting in 2020.

For RFS, the changes will not be insignificant. For example, while 4G antennas were fixed-beam, off-the-shelf products, new 5G wireless technologies require that the beam is not static but follows a moving object. This means signal and beam tracking. RFS engineers must account for changes in beam direction and movement — while keeping the antenna radiation pattern completely intact. This represents an incredibly complex engineering challenge, one of the greatest since RFS was founded as an insulated wire manufacturer in 1900.

And RFS is not alone. Other companies that supply or partner with the global wireless industry are also tasked with reimagining their core products and services considering the new demands of 5G.

ANDRÉ DOLL
CTO, RFS

RFS AT A GLANCE

Headquarters: Munich, Germany
Number of employees: 2,100
Number of manufacturing facilities: 8 (in Australia, Brazil, China, France, Germany, India, U.K. and the U.S.)

Advanced Challenges Require Advanced Technology

How is RFS preparing for the complete reinvention of its products and solutions in light of new technology innovations? The answer is simple: By using equally innovative technology, specifically engineering simulation.

For 19 years, RFS has been using simulation to design and test antenna arrays in a risk-free, low-cost virtual world. Today, RFS employs more than 180 engineers, and over one-third of them are trained in using engineering simulation software.

Antennas are expensive and time-consuming to build in the physical world. In addition, their performance must be tested in place, to account for interferences from surrounding objects. Simulation has helped RFS create a competitive advantage by eliminating much of the costs and time associated with building and testing physical prototypes.

As the world transitions to 5G, the physical factors that come into play are even more complex. Antenna performance must be simulated in motion and with the beam pointing in different directions. Up to 200 different elements are involved. Complex phased-array beam-forming simulations — made possible only by the most advanced simulation software available today — represent the only practical and dependable solution.

Because of the dramatic increase in product design complexity resulting from 5G network design, antenna simulations that once took just one hour now take three or four days. And, without the use of advanced simulation technology, that engineering work would take weeks or even months. RFS would never be competitive in the race toward 5G without employing advanced simulation technology.

RFS's modular active passive antenna (APA) directly addresses the real-world challenges operators face as they evolve to 5G.

Reference

[1] The 5G Economy: How 5G Technology Will Contribute to the Global Economy, cdn.ihs.com/www/pdf/IHS-Technology-5G-Economic-Impact-Study.pdf

Turning Challenges into Opportunities

Disruptive change will always represent a challenge — but it also represents an opportunity for companies like RFS that anticipate it and prepare strategically. By using advanced simulation technologies for nearly two decades to solve smaller technical challenges, the product development team at RFS is better equipped than competitors to capture the enormous financial opportunities of 5G.

By understanding and answering customers' new needs faster and more effectively than other companies, Radio Frequency Systems is poised for market leadership as the high-tech communications industry transitions to 5G. RFS will remain committed to identifying the best technologies, the best people, the best partners and the best product solutions — so the company will be ready for whatever the future brings.

FIVE KEYS TO THRIVING IN A REDEFINED INDUSTRY

While not every industry is being impacted today as significantly as the wireless community, nearly all businesses must rethink their models to some extent due to the ongoing digital transformation of the world.

Based on its experience in preparing traditional products for the new world of 5G, Radio Frequency Systems has defined five key requirements for succeeding when your entire industry is changing:

1. **Fight fire with fire.** If new technology is upending your industry, look for an equally innovative technology solution to help you. Just as 5G is redefining wireless technology, enhancements to software, solvers and algorithms are making simulation-based product development tools smarter and faster. Turn technology from a challenge to an advantage.

2. **Do not hire more people, hire the right people.** Many companies react to product development challenges by adding headcount. RFS asks, "What skills do we need?" — then recruits people with those specific skills. In the case of 5G, RFS is relying on engineering simulation. RFS hires engineers with a solid understanding of antenna science and physics — coupled with the ability to learn simulation software.

3. **Attack change incrementally.** Big changes like 5G do not happen overnight, but gradually. RFS offers transitional solutions that leverage customers' existing 4G investments, while laying the groundwork for 5G. Engineering simulation and smart product developers help develop an affordable, practical product road map that moves customers ahead incrementally.

4. **Define the new service challenge — and lead in meeting it.** It's not enough to ask, "How must products change technically?" Leaders ask: "What is the biggest new service need — and how can we meet it?" Guaranteed quality of service (QoS) is the most important metric for communication systems. RFS employs the best technologies, including engineering simulation, to deliver the most reliable communication systems to customers.

5. **Never stop looking ahead.** 5G is important, but eventually 6G will bring even greater enhancements. Leaders always look to the future. RFS forms close relationships with both customers and technology partners to anticipate and capture new opportunities beyond 5G. RFS also collaborates with technology providers like ANSYS to remain at the forefront of state-of-the-art engineering.

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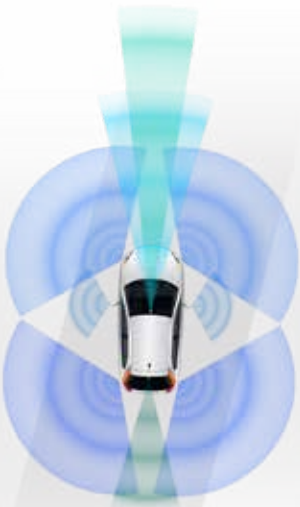

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