Engineer Innovation

Maya HTT Edition

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Content

GO FASTER

Propelling a greener future

How CFD is driving the development of the most efficient propulsion systems.
By Luke Morris

Oceans cover more than 70% of the Earth.
So, it's not surprising that 80% of global trade goods are transported by sea.

Add passenger ships to those large carriers and tankers and you have approximately 100,000 vessels in the entire world.

We typically think of cars and planes in relation to pollution, but these ships can also be incredibly damaging to the environment. The marine industry is estimated to contribute 2-3% of global greenhouse gas emissions, 5% of nitrogen oxides (NOx) and 4-9% of sulfur oxides (SOx). (Source: Statista)

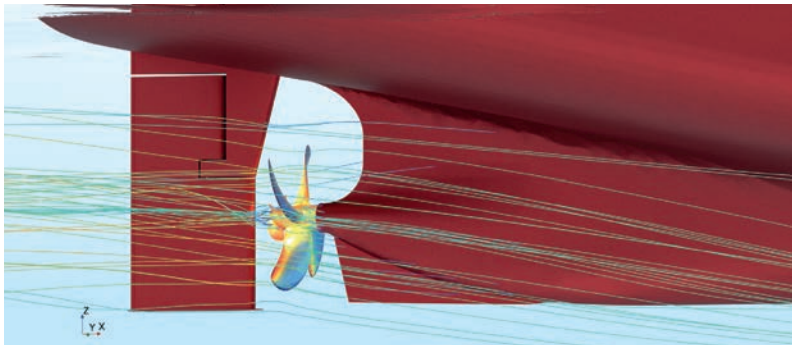
As a result, the maritime industry is urgently prioritizing the enhancement of sustainability practices to prepare for impending stringent regulations. According to the International Maritime Organization, optimizing the propulsion system can improve a ship's efficiency by as much as 10%. This would lead to a significant reduction in harmful emissions.

Saving the oceans with simulation

"If you want to save the planet, save the oceans," says Saeed Javdani, Innovation and Technology Manager at Teignbridge Propellers International, which has almost 50 years of experience in designing propellers and shaftlines.

But this isn't straightforward, as ships can harm the environment in different ways. First, the type and amount of fuel used contributes to carbon emissions. Second, noise pollution can do serious damage to marine life and biology.

To become a world-leading and reliable supplier of high-performance propulsion systems, Teignbridge uses both Simcenter™ STAR-CCM+™ software and



HEEDS™ software to optimize propeller designs and make them as efficient and environmentally friendly as possible.

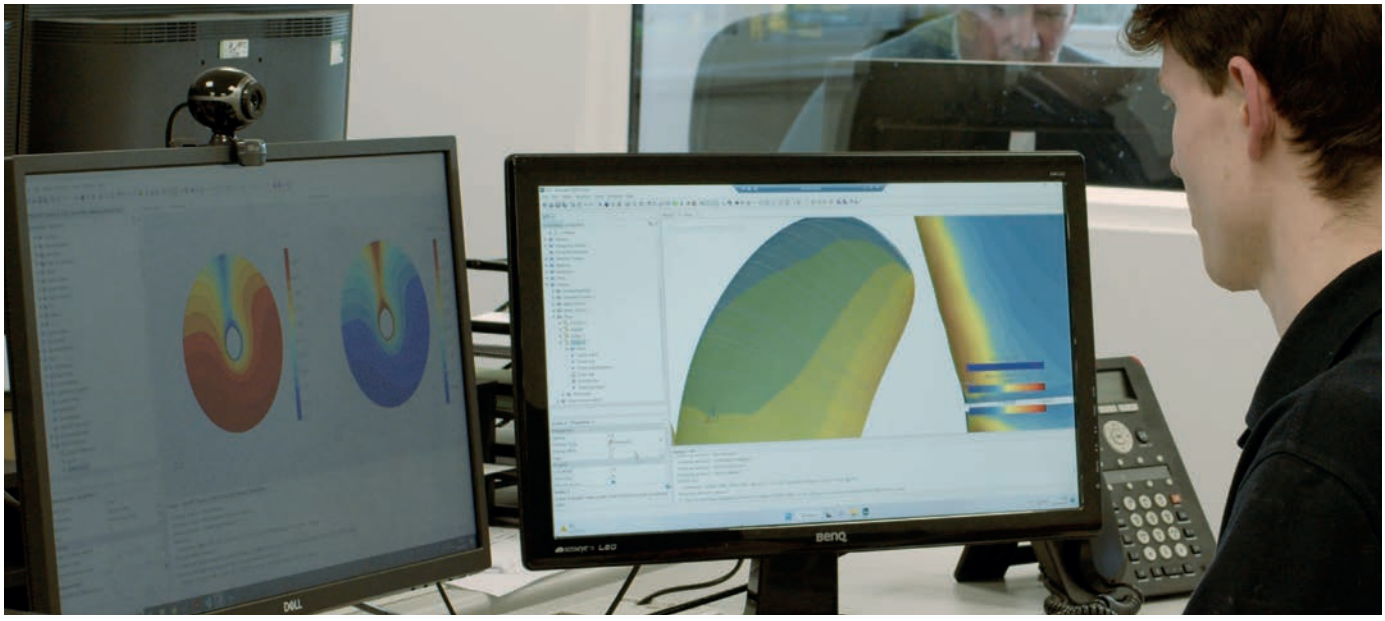
Working with Siemens Digital Industries Software solution partner, Maya HTT, Teignbridge has carried out fast and accurate CFD simulations in Simcenter STAR-CCM+ that allow design engineers to understand the interaction between propulsion systems and the high-velocity water flowing across their surfaces. They can predict performance, durability, and generated noise, then modify designs to optimize each aspect.

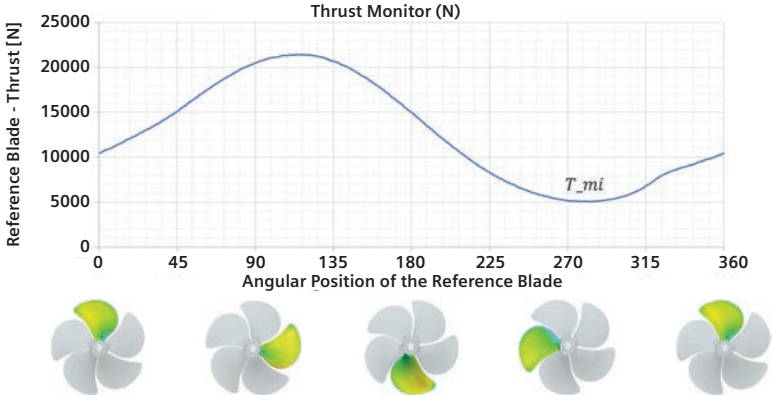
And all this can be done with simulation before any physical components even get wet.

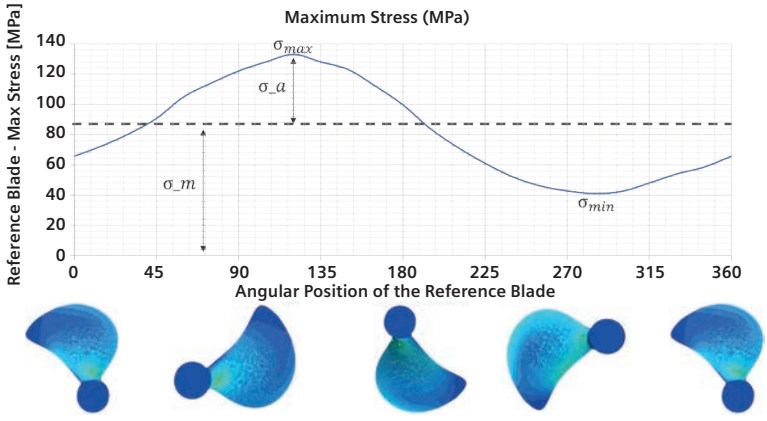
"In the past we used to just consider one or two design points," explains Javdani. "But now with Simcenter STAR-CCM+ we can predict how the vessel will perform at different speeds and in different sea conditions. Simulation makes it possible to explore many more iterations in less time so that we can then come up with the optimal design."

Small changes deliver big results

Tiny alterations in propulsion system design can make huge differences. Even in an 8-meter propeller, a design adaptation of just 1 millimeter can have a noticeable performance impact. So, simulation is key to analyzing design changes and predicting the effect they will have.







In one instance, Javdani's team identified cavitation – a phenomenon where vapor bubbles in a fluid grow and collapse due to local pressure fluctuations – as being caused by areas of low pressure on the leading edge of a rudder. By redesigning the rudder and aligning its leading edge to the downstream rotational flow from the propeller, the cavitation and noise were significantly reduced. And the vessel's top speed was increased by approximately 7%.

In another situation, a customer needed to reduce radiated noise levels by 10 decibels to minimize environmental impact. By exploring hundreds of potential design iterations, Teignbridge was able to achieve a 15-decibel reduction.

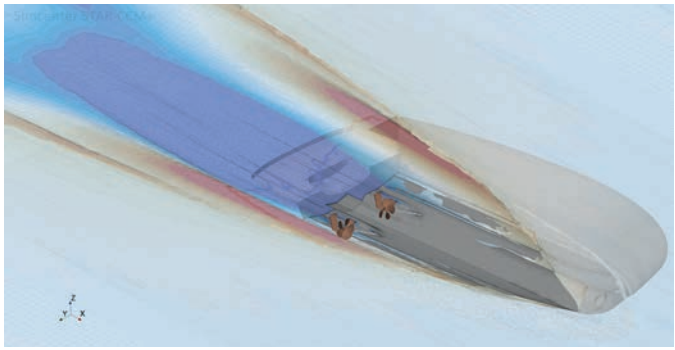
The secret to this is the automation capabilities of HEEDS. "We can test up to 500 iterations in just 48 hours," says Javdani. "Without HEEDS it's simply not possible. It would take far too long and wouldn't be cost-effective."

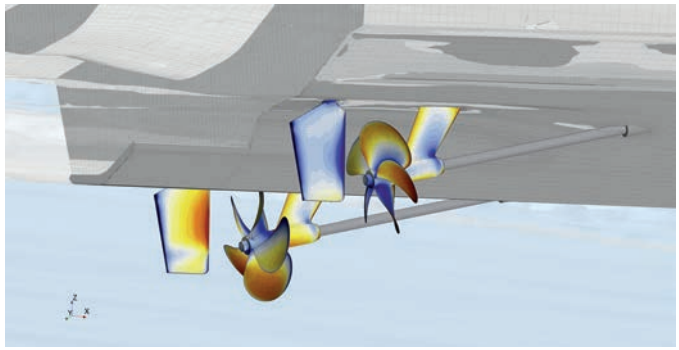
Closer collaboration

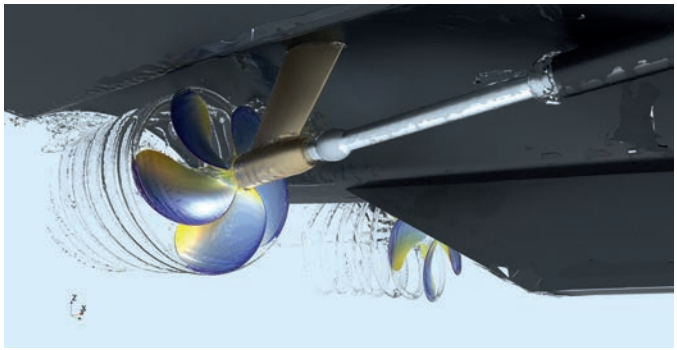
Simulation has also been vital to satisfying classification societies and providing extra reassurance to customers.

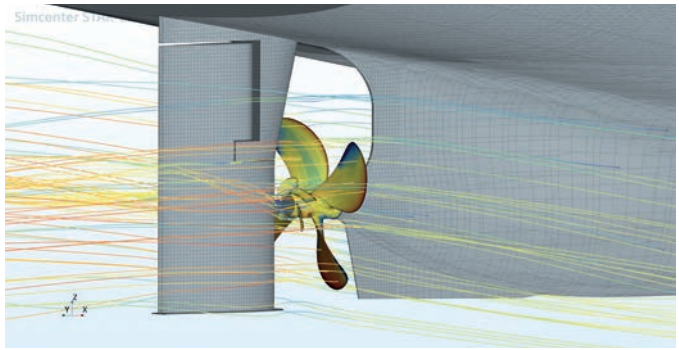
"Simcenter STAR-CCM+ enables us to show authorities that new designs will meet their standards before they are even built," says Javdani. "We can show that new components will perform within the safety factor required under dynamic loading."

Group Managing Director, Mark Phare, explains that simulation has been essential to Teignbridge's progress. "Naval architects expect propulsion designers to have CFD capabilities and to offer an analysis of the underwater equipment at the design stage. Many of our customers use Simcenter STAR-CCM+ which means we can easily share data and talk the same language when evaluating new projects."









Becoming the best

Phare's vision for the future of Teignbridge is straightforward but challenging: "We want to be the world-leading designer and manufacturer of propulsion equipment."

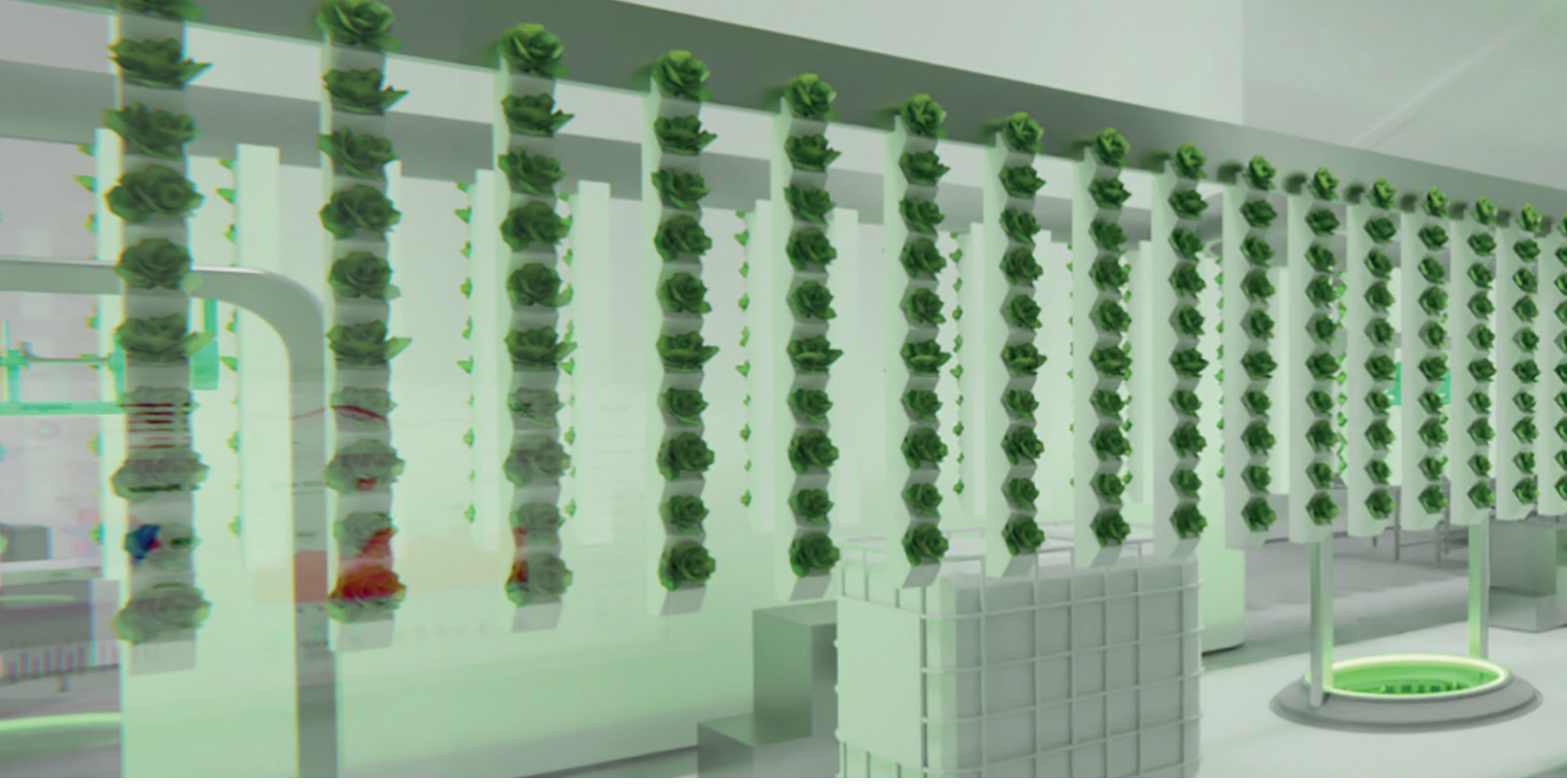
And there's no doubt that simulation will play a key role in making that a reality.

"Simcenter STAR-CCM+ has enriched the scope of work and sparked a great deal of innovation at Teignbridge," says Javdani. "It helps us to better understand exactly what customers need, and helps us solve problems they didn't even know they had. We can now design and supply products that we weren't able to previously, opening up new markets and establishing ourselves as the go-to company within the industry."

EXPLORE THE POSSIBILITIES

We’re gonna need a bigger farm

Solving global food shortages with subsurface agriculture



In 2022, the population of Earth reached 8 billion and it shows no signs of slowing down its growth - the United Nations estimates that we will reach 10 billion as soon as 2050.

While this population increase is a testament to modern civilization and the advances in healthcare that keep more people alive for longer, it also presents problems. A major one being how to grow enough food for everyone.

Agriculture already takes up 50% of the world's habitable land so it's impossible for it to grow indefinitely in line with the population. And with traditional farming accounting for 70% of global freshwater withdrawals, a water shortage is inevitable at some point if methods remain the same.

Not only is there a limited amount of agricultural land suitable for crops, but climate change is making farming more challenging in some parts of the world. There are already regions where millions go hungry due to unequal distribution, political instability, and environmental changes. If we don't plan adequately for the future, this century could see a gradual spread of food shortages to even the richest, most equal countries. The Earth simply isn't capable of producing enough food for an ever-increasing population.

Not with current farming methods anyway.

What if we weren't limited by the amount of farmland available? And what if we could take the climate and weather out of the equation?

Going underground

GreenForges was founded to combat food shortages by moving agricultural production underground. The idea was initially sparked by much older technology – the water well. This takes up very little space on the surface but provides a steady, regular supply of water. Why not do the same with crops?

The first designs take their shape from wells – cylindrical vertical shafts with a diameter of 1.5 metres. The current model is 15 meters deep which allows for a surprisingly large number of plants to be grown. These 'forges' are then arranged in a grid system and scaled up as much as needed. Each provides 15 metres of growing space but only takes up 1.5 metres of surface space. Except they won't really be taking up any extra surface space at all as they're designed to be installed within the foundations of buildings. So as

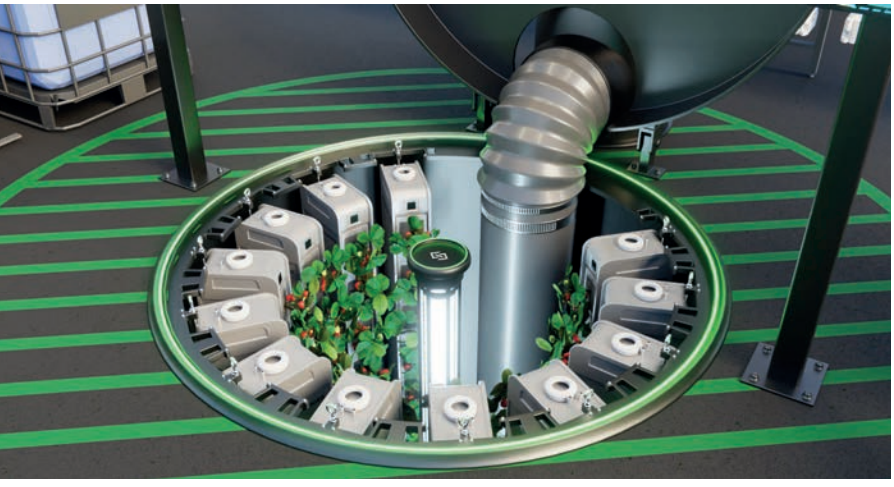
the population grows, we can increase both living space and agricultural output at the same time.

The casing of the forge is made of specially coated steel that is non-corrosive, antimicrobial, and light reflective. It uses a hydroponic system – water mixed with nutrients and oxygen – in a continuous loop system. Nutrient and oxygen levels are constantly monitored and replenished while at least 90% of the water is recycled back into the system. Not only does this save on water usage but it also creates a barrier to prevent pest contamination.

Temperature and light are fully managed too, giving much more control over plant growth – harvest cycles can be expedited, and more precise and refined flavours can be developed. So, instead of being reliant on the seasons and subject to extreme weather, food production can be maintained at the same levels all year round, whatever is happening in the atmosphere.

Leafy greens and herbs were chosen as the first crops as they require less nutrients, energy, and light, and have faster harvest cycles. They also tolerate variations in the environment much better. This means that GreenForges can iterate on their design much faster, regularly improving the overall performance of their structures while still having a high production success rate.

"In the first two weeks of growth, we assume almost no humidity generation," says CTO, Jamil Madanat. "Evapotranspiration is very low and then increases exponentially in the majority of crops . Also, at different sizes, these crops breathe differently and have different humidity,



temperature, and light requirements. Leafy greens and herbs have a much narrower window of variation, so they are easier to work with initially. As we validate each type of crop, we will be able to gradually build on top and add a wider variety."

Simulation-accelerated development

So how did GreenForges go about developing their solution?

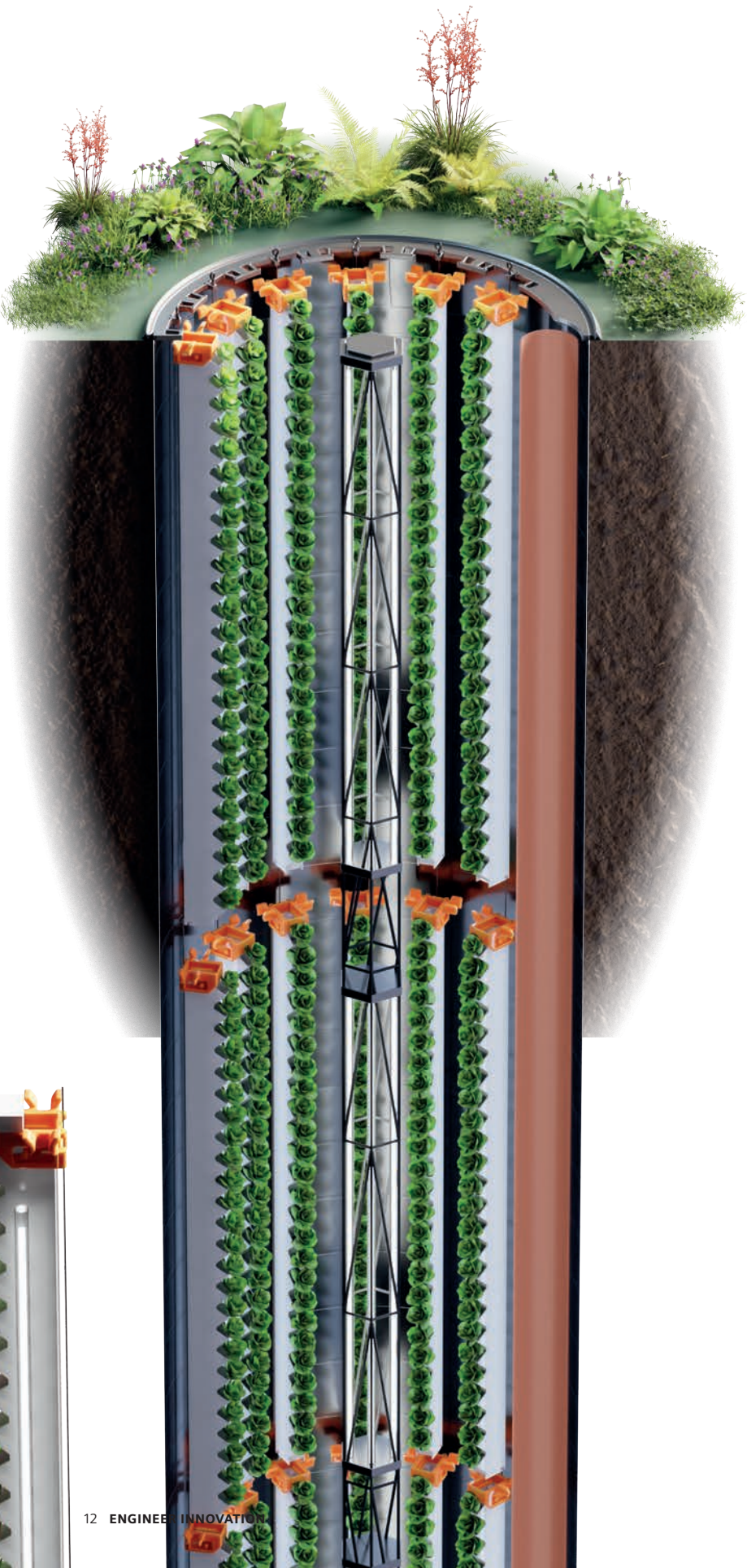
Madanat explains that they split the design into structural, mechanical, electrical, and digital systems. "The biggest challenge was in creating the climate control system," he says. "It must be very finely tuned, especially as we expand to a wider variety of crops. We need to understand how heat transfer happens at different soil levels, with different soil types, and in different humidities."

Of course, they couldn't dig hundreds of holes to experiment on – that would be far too inefficient and costly. So, they utilized simulation to refine and optimize the design before anything went underground. As the simulations were so complex, Madanat turned to Siemens partner Maya HTT for their expertise.

Using Simcenter 3D, Maya HTT created virtual prototypes of the thermal and flow interactions within the forge. Specifically focused on energy efficiency and water usage, they predicted the cooling load based on both the conduction to and from the surrounding soil and the heat caused by the lighting.

Carl Poplawsky, engineering services manager at Maya HTT, explains that "you have a temperature gradient as you go down below the surface until the earth reaches a relatively constant temperature. So, you need a heating, ventilation, and air conditioning (HVAC) system to control the temperature and remove the condensation that collects at the bottom."

Simcenter 3D can accurately predict the condensation that collects on the walls as well as the relative humidity distribution throughout. So, Poplawsky and his team were able to simulate all of this to inform the optimum design of the forge before anything was manufactured. "The great thing is that it doesn't require any additional coding," he says. "Straight out of the box the



software can handle temperature gradients and humidity distributions. So instead of drilling hundreds of holes to test on, we're drilling all the holes in a virtual environment and simulating the thermomechanical performance flow performance. GreenForges then only need to drill a couple of actual holes because they'll have a much higher probability of success thanks to the virtual prototyping."

Combined expertise

It's been a close-knit collaboration between Maya HTT and GreenForges. Madanat and his team are the experts in the mechanics of underground farming – they provided Poplawsky's team with all the necessary boundary conditions: the cylinder of earth that each forge sits in, the heat dissipation of the LED lights, the transpiration of the vapour from the plants. Maya HTT then created the simulations that show how all the parameters interact. They can then change the locations of elements such as air ducts, inlets, and outlets in the virtual environment, and simulate how this will affect the performance of the HVAC system.

The simulations found that the effectiveness of the underground farm is heavily dependent on both the soil type and the amount of moisture it contains. It was important to understand how the size of the earth domain around each forge would affect the performance, so a full analysis was carried out to show the temperature with a certain size of cylinder. This also informed how close together the forges could be placed without impacting each other.

As well as predicting the temperature at different depths, the simulations needed to produce a velocity profile of the air. The air pumped around the forge by the HVAC system can't travel too fast as it would tear the leaves off the plants. You can set the force with which it is pumped down the forge, but then you need to understand how fast it will come back up. By accurately predicting this, the simulations can show if the design needs to be adjusted to limit the speed to protect the plants.

First the Earth, and then?

When you start to think about all the possibilities that underground farming offers, it's incredibly exciting.

Consider the acres of farmland currently required for growing crops. If you can move a significant proportion of this below cities, then all that freed-up surface space can be regenerated.

By installing farms within the foundations of buildings, urban development will have a linear relationship with increased agricultural output. Homes of the future could be completely self-sufficient – not only powering themselves with solar energy but providing all the food their residents need. This would also cut the energy consumption of supply chains that transport food from farms to shops and houses.

With stable temperatures beneath the surface, inhospitable areas such as deserts, mountain regions, and extremely cold regions could become food production powerhouses. Communities in these areas will need to rely less on importing food and become healthier and wealthier. There will be no need to sacrifice forests and jungles to create space for traditional farms.

And if this can be successfully proven on Earth, why stop there? With the exploration of the Moon and Mars targeted over the coming years, it seems only a matter of time before off-world colonies are created. Keeping them fed will be one of the biggest challenges, but if they can grow their own food underground that will be one less thing to worry about.

As long as we need food to survive, innovative farming solutions such as this will be vital to life on Earth and beyond. Visit www.greenforges.com for the latest developments and to find out when your food could be coming directly from under your floor.

GO FASTER

Luxury refrigeration begins with a lettuce for a llama

In a windowless lab in Madison, Wisconsin, Sub-Zero Group, Inc. grows 105 heads of Nevada lettuce every three weeks. It harvests the mild, sweet variety to test different models of its namesake refrigerators. Yet it's simulations using Simcenter Amesim, constant adjustments to functionality, and collaboration with designers that advance a Sub-Zero refrigerator beyond a cold box and into a luxury appliance.

With over seven decades of history behind its name, Sub-Zero knows the value of distinguishing its brand as a monument to food preservation and a means to beautify the kitchen. The company is internationally recognized for its commitment to performance and aesthetics.

Anderson Bortoletto, Principal Engineer of Advanced Product Development for Sub-Zero, says the company's goals include building appliances that use less energy, with as high a percentage of recyclable materials as possible. The specifications must be tailored to refrigerator models that offer proper humidity, precise temperature control, and purified air, and give customers a choice of elegant, customized designs.

Sub-Zero's decades of work have resulted in spectacularly evolved machines: refrigerator models with a wide and spacious interior, clear compartments, and neatly fitting shelves and drawers. The exteriors are smooth and brushed with hand-finished surfaces. The models' hinges, handles, and doors close gently and easily.

"Since our products are top of the line, we need to justify the cost to the customer. We can't afford design that will deliver the most freshness but doesn't look good. We're going for a clean look that promotes and preserves the aesthetic. That ensures the longevity of the brand," says Bortoletto.

A decade down the road, a Sub-Zero refrigerator still needs to be identifiable as a model made by the company. It has to showcase high-end refrigeration and sustainability. It must also communicate, to owners and guests, that it is a premium product.

It's fitting that Sub-Zero has been meeting this challenge since 1945. That year, founder Westye F. Bakke built his first freezer prototype, from salvaged scrap metal, to store his son's insulin at a consistent temperature. Bakke later asked architect Frank Lloyd Wright, for whom he had done work in the 1930s, to customize the first Sub-Zero models.

As today's Sub-Zero's product engineers focus on components, parts, and air flow, the company's designers are equally hard at work. They're busy

crafting numerous desirable features, including flush installation, a wide variety of sizes and configurations, and a choice between the classic stainless steel Sub-Zero look or a panel-ready model with a custom finish.

They're also making it possible for refrigerator models to be customized. This means the appliances can be flush with cabinets and drawers around them. They lack visible hinges and grilles. The refrigerator designs give a kitchen a seamless look. They also make it easy for an owner to move about in the kitchen.

After weeks of tests, when the lettuce finally wilts, a Sub-Zero employee takes the heads home to feed to their pet llama. It's the data that the product engineering and design teams gather, from a head's first day to its last, that become the focal point.

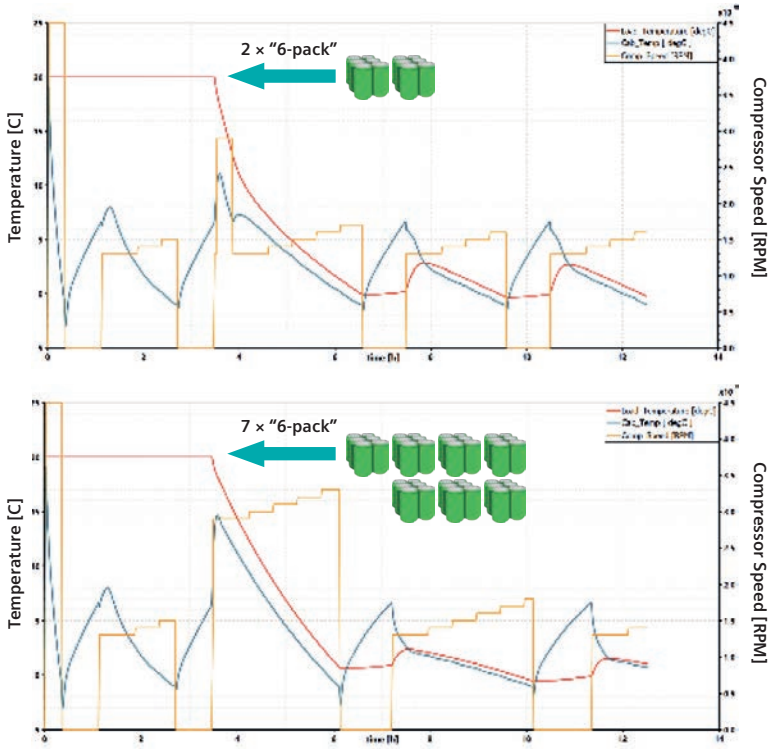
One of the difficulties in finding the balance between aesthetics and performance is that most Insulating materials are opaque. That means they're unattractive, says Terry Hardesty, Corporate Manager of Advanced Development at Sub-Zero.

"Customers expect crystal clear drawers so they can see the food in the fridge. They don't want to have to open two to three hatches to get at items. At the same time, they're looking for high food preservation. We work to ensure that the drawers and open space are beautiful, easy to access, and perform well," says Hardesty.

The temperature of the whole refrigerator is not always as important as the temperature across a compartment. Sub-Zero's team uses simulations to determine how a particular design and adjustments to various parts create a microclimate without a large temperature gradient front to back. The simulations allow Sub-Zero to shorten development time and reduce the amount of capital, expense, and manpower spent on product development.

Data collection and refinement assist engineers with developing a smarter control algorithm that will allow the refrigerator to dynamically respond to perturbations. Examples include opening the main door and adding new items.

"How will the refrigerator react if I put two six-packs of beer into it? How will it react if I load



Dynamic response of the appliance to perturbations

it up with 7 six-packs? The machine may have a different dynamic response for each action. Those are insights we want to have before we build an appliance. We want to get this information early on in the design process," says Bortoletto.

How Simulations Improve Closed-Loop Systems

A refrigerator is a heat pump, continually transferring heat from inside the "box" to the condenser coils outside. It uses many components to accomplish this task, including insulation, an expansion device, heat exchange in the evaporator and condenser, and fans. The compressor is particularly important. Its job is to circulate coolant in the fridge. The electric motor that powers the compressor accomplishes its task by compressing refrigerant gas. The action generates heat, which is eventually released by the condenser.

Since energy efficiency is important to both regulatory agencies and their clients, Sub-Zero looks to minimize the amount of electricity that a refrigerator uses. They work to get every Sub-Zero fridge to use less than the U.S. minimum standard for refrigerators. A U.S. Energy Star certification reduces a refrigerator's carbon footprint, lowers a customer's utility bill, and in some jurisdictions, qualifies for rebates.

Simulations by Simcenter Amesim give Sub-Zero license to explore what parts like a compressor can do, at minimal cost.

"It's a lot easier to test out an idea digitally. When we build a product to try it out, that takes more time and money. Right now we're developing good correlations between the simulations and reality. The relief we get from that has been psychologically transformative. We evaluated a few other tools before using Amesim. They just didn't work for us," says Hardesty.

Variables that Sub-Zero is able to test with Simcenter Amesim include the gasket, or the air-tight seal along the edges of the refrigerator and freezer doors, the speed of fans inside and under the refrigerator, the capacity and efficiency of the compressor, and the suction line heat exchanger, a component that regulates the refrigerant flow and pressure while maximizing the cooling capacity.

The closed loop refrigerating system model has been developed to also decrease the total testing time spent on defining the optimum refrigerant charge and capillary tube restriction leading to maximum energy efficiency. The goal is to decrease design exploration time from two months to one week.

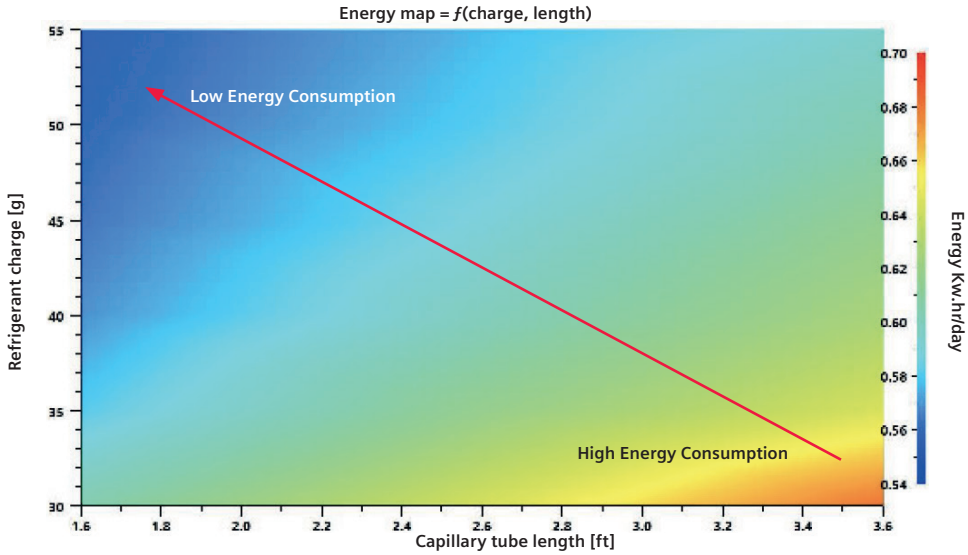
"With simulations, we can test anything from the length of the compressor run time to how long the operator fan is on. We don't have to build prototypes. The various factors affect how much water an exposed head of lettuce will lose over time. Then we can evaluate what the refrigerator is doing and associate the impact on preservation," says Bortoletto.

The Role of Maya HTT

Sub-Zero is able to accomplish a great deal with Simcenter Amesim partly because it works closely with Maya HTT, a long-time partner of Siemens. Its staff frequently collaborates with Siemens to offer clients software, testing, AI, and engineering services. Maya HTT was integral in Sub-Zero deploying Simcenter and leveraging it with their refrigerator development.

Runs	charge of fluid	Presuction length
Run 1	30	19.2
Run 2	30	31.2
Run 3	30	43.2
Run 4	35	19.2
Run 5	35	31.2
Run 6	35	43.2
Run 7	40	19.2
Run 8	40	31.2
Run 9	40	43.2
Run 10	45	19.2
Run 11	45	31.2
Run 12	45	43.2
Run 13	50	19.2
Run 14	50	31.2
Run 15	50	43.2
Run 16	55	19.2
Run 17	55	31.2
Run 18	55	43.2

Batch run of 18 cases with more than 3 cycles ran under 15 mins



Simulation takes over trial and error testing. Bring down design exploration time from 2 month to a week

The first phase involved building a library of components in order to model the entire fridge, including the heat exchanger within the fridge, optimizing the whole system, and making it run better in the simulation. In the second phase, Maya HTT made a library of components for the refrigerant loop, in which coolant circulates to cool the fridge. The third phase saw Maya HTT finishing the fridge component loops, adjusting the heat exchanger and condenser, and optimizing the overall efficiency of the fridge.

The library of custom Simcenter Amesim components was particularly helpful.

"This extensively customized closed refrigerant loop library has allowed Sub-Zero to maximize efficiency, with components tailored precisely to their products," says Garrett Keenan, Maya HTT.

Bortoletto says the beauty of the relationship is that Maya HTT has an in-depth understanding of Sub-Zero's people and appliances.

"Since they're our long-time partner, they've gotten to understand what we've been trying to accomplish over time. Without Maya HTT, we couldn't have gotten closer to the ideal end state for the refrigerators," says Bortoletto.

The 1D simulations that Sub-Zero accomplishes with Simcenter Amesim provide many advantages. These simulations have a low computation cost, offer a system-level/parametric study with a quick turnaround, and provide fast and easy model preparation.

Sub-Zero is transitioning to using simulations as naturally as any physical product development tool, says Scott Wareing, senior vice president of operations and product design for Sub-Zero.

"Engineers will model and simulate components, sub-systems, and entire products prior to being physically built. Simulation becomes a core competency," says Wareing.

Sub-Zero's next move with Simcenter Amesim will involve using the software to refine Cove, its line of dishwashers.

Bortoletto wishes Sub-Zero could have started with dishwashers.

"They're an easier product to model with simulations. After using Simcenter Amesim to improve refrigerators, we know what we'll learn," says Bortoletto.

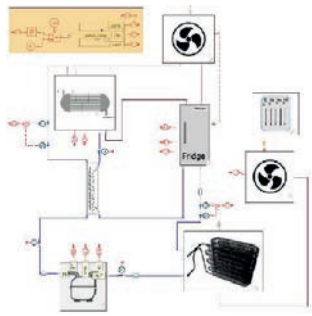
Simcenter Amesim will help with modeling and predicting the behavior of a dishwasher, such as different types of cycles. It will also allow engineers to reduce cycle time and attain minimal water usage.

"These things impact the environment in a positive way and improve the performance of the product," says Bortoletto.

For now, Bortoletto says Simcenter Amesim will remain a "big enabler." The tool boosts Sub-Zero's capacity to adapt to ever-evolving consumer expectations.

Present

2023



2023 -Forward

Challenges / Next Steps

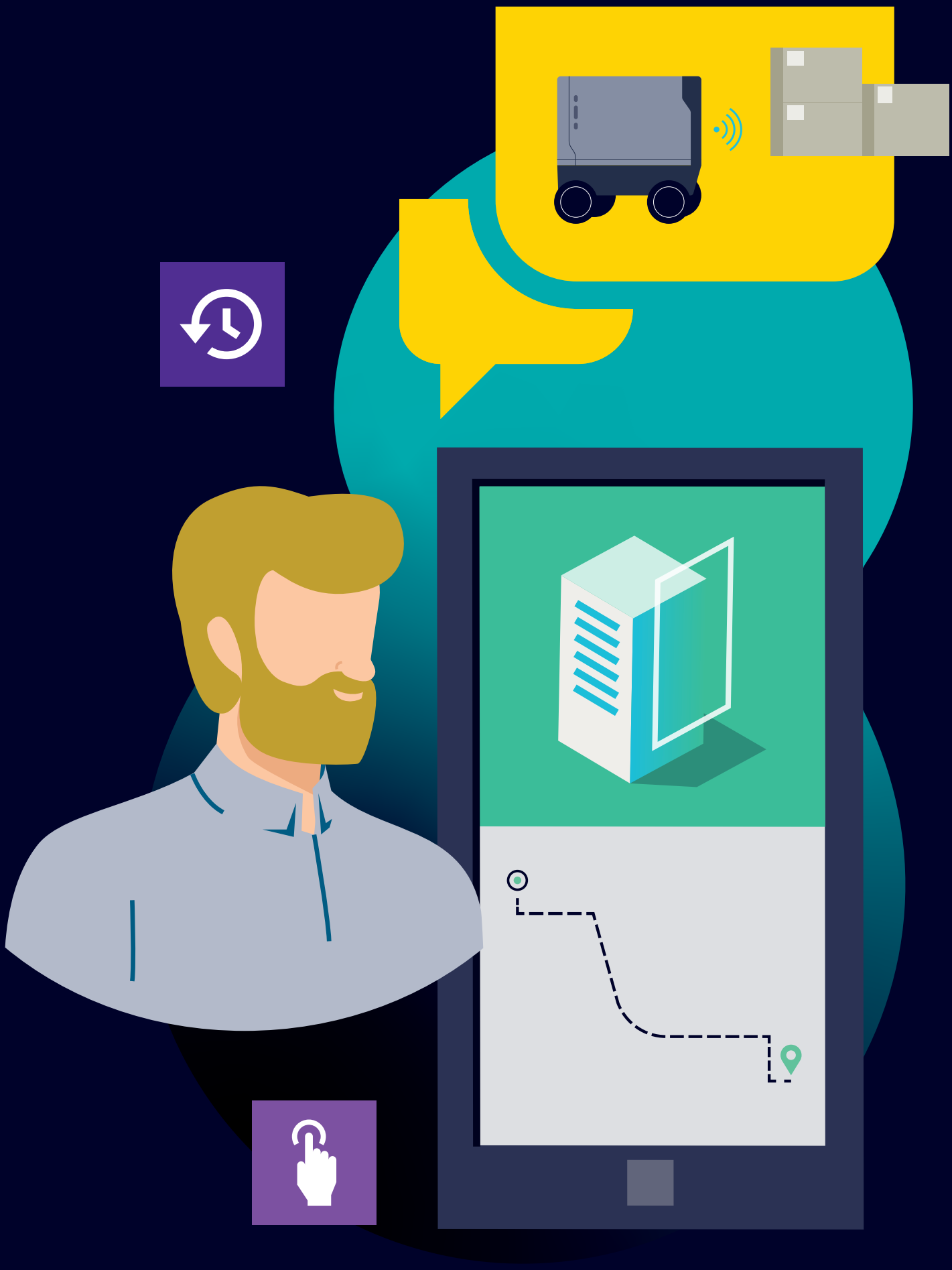
"We always want to find the sweet spot between food preservation, great design, and energy consumption. We try to evaluate those attributes simultaneously. Finding a way to decrease the time and cost to get those insights hasn't led to an enormous design breakthrough. Sometimes that takes years," says Bortoletto.

Bortoletto says Simcenter Amesim currently gives Sub-Zero the chance to clearly define objectives and validate models before implementing changes. Later simulations may help Sub-Zero write better algorithms for software to power smart refrigerators.

Bortoletto foresees refrigerators becoming easier for owners to adjust.

Using an app on a smartphone, a customer may be able to change the machine's settings to preserve a particular type of cheese or beverage in a certain spot. They'll also be able to ensure that a machine is energy efficient overall.

"Currently, customers want a Sub-Zero refrigerator because the machine offers the ability to maintain optimal conditions in refrigerator microclimates, coupled with reduced energy use, green materials, and luxury design. These reasons will remain why a customer will want a Sub-Zero refrigerator for years to come," says Bortoletto.



EXPLORE THE POSSIBILITIES

Robots that **always deliver**

Fully autonomous machines that bring parcels right to your door, no matter which floor you're on.

We've all heard about the work from home revolution that's been accelerated by the COVID-19 pandemic. As companies across the world have seen that staff can be as or even more productive working remotely, many have switched to hybrid offices that give individuals flexibility on where they are based.

But the pandemic and the shift towards remote working have accelerated another trend – home deliveries.

Naturally, when most retail outlets were closed there was a huge spike in online orders as it was the only way to get hold of goods. This levelled out as lockdowns ended, but again, as people have realised the convenience of home deliveries, they are continuing to steadily grow at a much higher rate than before.

For shoppers and delivery drivers alike this is easy enough if you live in a house with your own front door, but what if you live in an apartment block? Either the delivery driver has to spend lots more time and energy getting to each individual door within the building, or goods have to be delivered to a reception area and distributed or collected from there. The latter raises potential security and capacity issues that make it less feasible as time goes on. And delivery drivers want to make their drop-offs as quickly as possible to ensure they get round all their customers.

Soon, there will be another solution available that's ideal for both residents and delivery drivers alike.

Introducing Lu

Lu is the flagship product from Earth Robotics that's set to make apartment block deliveries easier for everyone.

It's a fully autonomous robot that will take packages from the main entrance to the front door of the recipient, all by itself.

"When we say fully autonomous, we mean no human intervention is required at all," explains Earth Robotics COO and co-founder, Amir Emacha.

"Other autonomous robots and vehicles are currently what's known as level 3. This means they can do a certain amount themselves but will require someone to constantly monitor or take over operation at some point. Lu is level 5, as it operates entirely independently, thanks to the ecosystem we create inside the building."

The first stage of implementing Lu is to map the building where it will be installed using lidar. An elevator control system is then installed along with a Wi-Fi mesh to ensure full network and GPS coverage throughout. This enables Lu to call the elevator and be taken to whichever floor it is delivering to. Lu is equipped with six cameras to give it full 360-degree vision, allowing it to identify obstacles and navigate smoothly around the building.

Once all the hardware is setup, residents just need to download an app to receive packages. They get a notification when a delivery has arrived, and they can choose to have it brought to them immediately or schedule it for later. Lu sends another notification when it arrives and the resident simply opens their door and picks up their package, using the app to unlock the secure case.

Similarly, delivery drivers use a kiosk when dropping off packages. They enter the apartment number and any other key details, then place the package inside the robot and take a receipt for proof of delivery. Just as if they were delivering to an Amazon locker, for instance.

Hardware and software in perfect synchronization

Emacha previously worked in software development, and he says the biggest challenge at Earth Robotics has been combining software with hardware. "You need to ensure the development of both is always in sync," he explains. "So, it's vital the technology we use helps the software and hardware be designed together."

He knew that for Earth Robotics to succeed, they would need the very best tools on the market. "We were fortunate enough to find a Siemens partner,

Maya HTT, who guided us in the right direction. They helped us choose the best products for what we are doing and showed us how to get the most out of them."

These tools allow the team to design and test Lu first in a virtual environment, and then to combine physical testing and simulation as they optimize the final design. The simulation environment also enables validation of software updates before they are applied to physical robots.

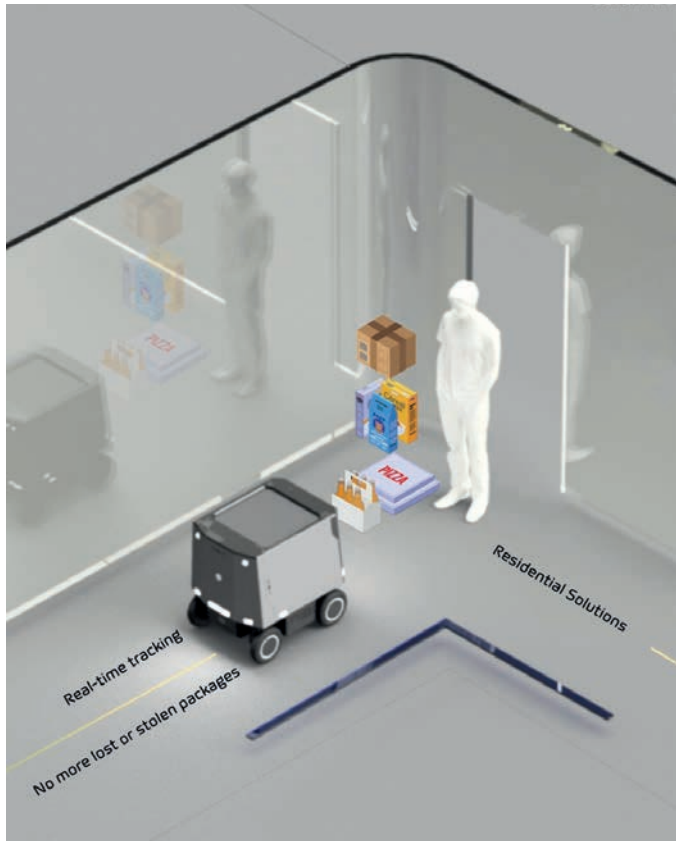
The robot manufacturer also benefitted from Siemens special packaging and pricing which makes these cutting-edge tools more accessible and affordable for small, medium-sized, and start-up companies.

Coming to a building near you soon?

Earth Robotics are currently carrying out the first pilot of Lu in Miami, Florida, where they are headquartered. They have found a building with 700 apartments that typically receives over 400 packages per day - perfect to illustrate how efficient Lu can be. The pilot started with three robots handling deliveries for the first 10% of the building and has since gradually expanded.

The team are working closely with the building owners and residents to ensure a successful adoption of the technology and to overcome any user issues. "It's vital to understand the flow of robots and people around the building, especially in the elevators," says Emacha. "If the robots get in the residents' way then we will only be solving the delivery problem by creating a traffic problem, which is no good. The adoption plan is designed to make sure residents are benefiting and not seeing any downside."

Clearly, deliveries within buildings is a task perfect for autonomous robots like Lu. And it's only a matter of time before they'll be widely available in apartment blocks across the world. It certainly seems as though they'll be with us long before level 5 fully autonomous vehicles that don't need a human ready to take control in an instant. Head to https://www.earthrobotics.co/ for the latest updates on Lu and to find out when it could be coming to a building near you.



Q&A

INTERVIEW

Going underground

An interview with the minds behind GreenForges subsurface farms

As part of our feature on their underground farms I caught up with two key members of GreenForges staff. Chief Technology Officer, Jamil Madanat and Chief Product Officer, Andrew Stride gave me the full lowdown on everything happening below the surface.

Where did the idea for underground farming come from?

Jamil: Our founder, Philippe Labrie, used to work in building development but he's always had an interest in the world of farming. One day he was looking outside and saw a water well and thought, why can't we do the same thing with food? By going as deep as a well you can save lots of land space. And his experience in the building industry also led to the idea of connecting this with the foundations of buildings. That's where the dream started of a symbiotic system where plants feed oxygen to the building and take the carbon dioxide to feed on themselves.

How did it progress from there to becoming a business?

Jamil: I carried out some feasibility studies initially to see if the idea was viable. The results were very promising in terms of energy consumption compared to other vertical farms on the surface. So, once we knew it was something that could work commercially, we started building prototypes and running physical testing.

Can you tell me about how you can grow plants underground? How do you ensure they have the right temperature and enough water, oxygen, light, and CO_2?

Andrew: We've designed individual 'forges' that contain everything the plants need to grow. Each forge houses what is largely a closed system - fresh air has to be brought in but all of the water is continuously recycled around the system. We're also looking at reusing the water from the dehumidification process to minimize waste.

We had custom designed LED lighting systems built specifically for us to deliver optimum light to the plants. They're one and a half meters tall with nine LED bars on each. They have adjustable dimming that gives us the flexibility to grow crops that require different amounts of shade and light.

We also have a full HVAC solution providing complete temperature and humidity control so the plants are never too hot or too cold.

It must be a very complex system. How did you optimize the design to ensure successful plant growth?

Jamil: The engineers at Maya HTT have been vital to the project. Plants are very sensitive to humidity and temperature so it simply wouldn't work without an HVAC system that allows us to fine tune the conditions. They helped design simulations that answer questions like how much

the soil will absorb the heat generated by the lights, how will condensation affect the plants, how does the type of soil affect humidity and at what depth does it change. The temperature stabilizes further down but you need to understand the range all the way through the length of the farm. It's very complex physics to be able to simulate all of this and we couldn't have done it without Simcenter and Maya HTT.

You also need to consider how the plant's needs change as they grow. As time goes on, they generate much more humidity so there's more water to be extracted. Simulation allowed us to quickly go through many iterations rather than waiting for plants to physically grow. So, we could change various parameters and come up with the ideal solution much faster. For instance, the first design we tried had a 40-inch diameter and was 100 feet deep. The simulations quickly showed this wasn't going to work so we reduced the depth and widened the diameter and got much better results.

As you said, the main benefit is the amount of space saved on the surface, but are there other advantages to underground farming?
Andrew: Yes, the most obvious thing is the amount of surface space you can save, but temperature and climate control is also a big advantage. Once you dig down to around 20 feet the temperature is pretty much the same all year round. Regions that can't support surface farms due to being too hot or too cold could be suitable for underground farms as we're developing a completely controlled environment that will work anywhere. This also means that we're not reliant on weather at all as everything is happening below the surface. We don't need to worry about overnight frost or if it's going to be sunny enough that week as we can guarantee all the conditions the plants are growing in.

Climate change is a big concern for farming, but our system will help combat this as we can keep crops at the ideal temperature. We could even expedite harvest cycles as we don't have to rely on the seasons above ground.

We have much more control over pests too. We can't completely eliminate them as there are still times when the cover has to be opened. But this is only during seeding and harvesting – the rest of the time we have total control over all the air going in and out, so pests are really minimized compared to surface farms.

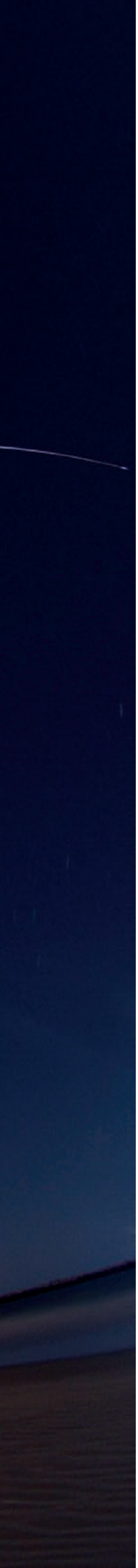
Speaking of harvesting, it must be very different to normal farms. How does it work with an underground farm?
Andrew: Yes, harvesting is very different. There's no need for all the tractors and diggers that surface farms use so there will be a significant reduction in the carbon footprint those create. We've designed a fully automated extraction system that brings the modules up to the surface, puts them onto an overhead conveyor belt within the facility, and takes them to a harvesting station. Then the plants can be harvested manually by people or, depending on the customer's needs this process can also be automated. Then when it comes to seeding, we germinate plants in a separate smaller system and then put them into the modules and the automated system puts them back into the farm.

It sounds like all the pieces are in place. When can we expect to see underground farms in operation?
Andrew: We have a prototype currently running where we're testing all the lighting, cooling, and water supply, and we have another larger prototype currently being built to test that the extraction system works correctly. We're hoping to have a live pilot up and running soon, but it's a case of finding the right site with the right investment. Once we have the site secured and the funding in place, which is a big challenge, we should have the facility up and running within six to nine months.

Fascinating insights, thanks so much to Jamil and Andrew for your time. To find out more about GreenForges, check out our cover feature or head to www.greenforges.com.

"It's very complex physics to be able to simulate all of this and we couldn't have done it without Simcenter and Maya HTT."

Jamil Madanat



GO FASTER

Shooting for the Stars

Launching Satellites with Simcenter
By Luke Morris

Did you know there are currently almost 2,000 individual satellites in low Earth orbit? And this number is expected to increase exponentially as continued miniaturisation in electronics fuels the growth of the small satellite market over the next decade. By 2030 it's predicted that a further 8,600 small satellites (weighing less than 500kg) will have been launched. This equates to a market worth an estimated $42.8B USD, with about 30% going to launch costs, and growth of 22% CAGR.

But to get a satellite into space you need a rocket. And rockets don't come cheap. So how are companies going to launch their satellites at the right time and place whilst keeping costs under control?

Currently, small satellite companies have to book space on a large rocket, tagging along with a big payload. This causes high lead times of up to two or three years and if the main payload has to change orbit, they may have to find another rocket meaning further delays. All in all, it's a frustrating and inefficient process.

Dedicated launch services for everyone

Reaction Dynamics (RDX) was founded in 2016 by CEO, Bachar Elzein, to address this exact issue. The startup has developed a breakthrough rocket technology that provides the means for an eco-friendly launch solution. Leveraging its breakthrough green hybrid rocket engines, the company's launch technology will pave the way towards clean access to Earth's orbit at a fraction of currently available prices.

Hybrid rocket engines are nothing new – they've been around since the 1930s – but previously they have only been able to run at peak performance for a few seconds. As a result, satellite launch companies have used more complex and more expensive liquid fuelled rocket engines. However, RDX's invention provides better performance over longer duration burn times than any previous hybrid rocket engine – and most importantly, good enough to reach orbit. The propulsion system is much simpler than that of other rocket engines, making manufacturing much cheaper and reliability significantly higher as there are fewer parts that can fail. This also means that vehicle production can be scaled rapidly and, combined with the ease of handling of the propellants, enables a rapid and responsive launch service.

RDX will be manufacturing and operating its own orbital rockets for small satellite launch as a service. Priced at $15,000 USD per kilogram this will compete with other small launch companies as well as some heavy launch companies. The key difference is that RDX provide a dedicated ride at a similar price point to a rideshare on a large rocket. Elzein describes it as "Offering customers a taxi service for the same amount you'd pay for a bus. They can decide exactly when and where their satellites are launched rather than waiting for a

Reaction Dynamics' engine test cell

rocket that happens to be going in the right direction." The simplicity of the design means the rockets can be built and launched very quickly, enabling rapid response times which would be ideal for the reconstitution of damaged or destroyed military assets in space. With RDX's dedicated small satellite service, customers will have full control over the schedule and can have their satellite in orbit within a matter of weeks instead of waiting up to three years to ride along on a bigger rocket. RDX can always find the correct launch point for the required orbit as they have access to spaceports across the world. And for smaller operators who can't afford a dedicated rocket, their service can be sold to launch brokers who will aggregate small satellite payloads.

So how have RDX managed to design their new hybrid rocket engine which is set to revolutionise the satellite launch industry?

Maya HTT guides the way with Simcenter

Elzein and his team knew they would need the most robust simulation tools, combined with high-fidelity analysis, which is why they engaged with Siemens and Maya HTT. Maya HTT is a Siemens Solution Partner, working with companies like RDX to help them realize the full potential of Siemens Digital Industries Software. Maya HTT's expert engineers enable them to make the most of simulation and virtual prototyping to improve performance, quality, and efficiency, whilst reducing overall development costs.

"The quality of the support and the versatility of Siemens' suite of industry software made it a clear winner," says Maxime Goulet-Bourdon, Propulsion Test Lead at RDX. "The integration of so many features within the Simcenter platform means that scaling our simulation capabilities as required becomes efficient and realistic, allowing us to step comfortably into simulations to get the confidence that our designs will respect the applicable norms. Furthermore, the quality of the support received whenever small issues popped up was always great and timely. We know that we can count on the team at Maya HTT to guide and help us through the deployment and adaptation to these new and powerful tools, making us obtain results faster."

Christophe Leclerc, structural design lead at RDX points to CAD integration as a key factor: "For

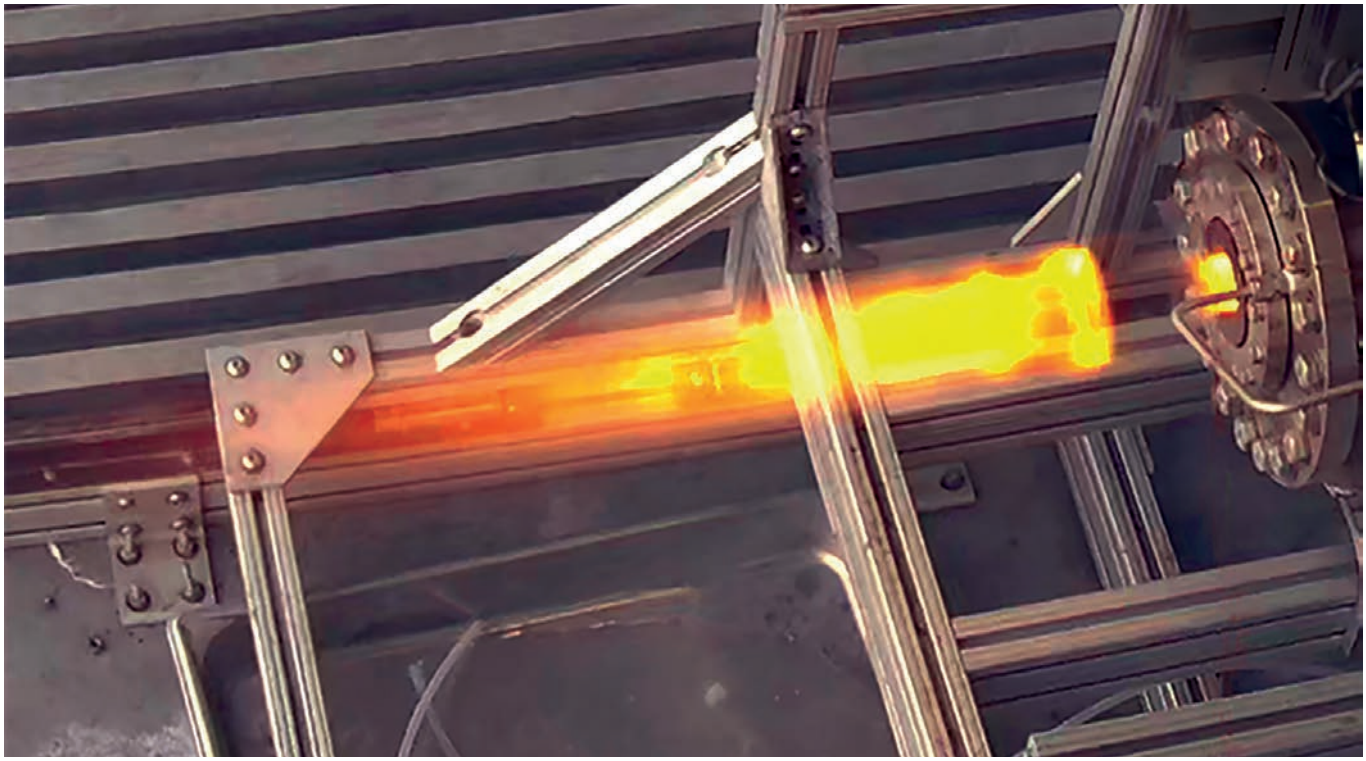
Bachar Elzein, Reaction Dynamics Founder

design and analysis, Simcenter is the best option for us, as it enables seamless transition from CAD to simulation, by streamlining the process of simplifying and cleaning up complex design models to prepare the analysis models. This can help accelerate the design process greatly, during which hundreds of iterations can be necessary. Multiple add-on modules, such as the Laminate Composite module, are also available, enabling us to quickly grow our capabilities when necessary, without having to go through the lengthy process of transitioning toward a new software solution.

Being integrated inside Simcenter, also gives us flexibility in our usage, by enabling the creation of an ecosystem where all of our software needs, from CAD to PLM, and including a wide range of simulation tools, are fulfilled by a single platform. For a startup, this ability of the platform to grow with us is of great importance when choosing the best solution."

Elzein says the development of RDX's revolutionary rocket engines would simply have been more resource intensive without Simcenter and they are continuing to discover more benefits from the software: "After switching to Simcenter for the seamless CAD integration and analysis we've been gradually adding more packages and licenses such as Design Explorer and Simcenter Nastran. Each one reduces both our development time and costs as shorter iterations lead to better products sooner."

RDX will shortly be announcing a demonstration flight using the same rocket engine that will be used to put satellites into orbit. They are then aiming a first orbital commercial launch within the next two years. To find out more, head to https://www.reactiondynamics.space/.



First iteration of the orbital engine tested in early 2021

STAY INTEGRATED

Why your AI strategy needs **more than data**

By Remi Duquette, Vice President Innovation and Industrial AI at Maya HTT

The artificial intelligence (AI) revolution has been underway since about 2016. As a result of great increases in computational power, AI no longer belongs to the realm of media hype and science fiction.

Today, AI offers concrete benefits in all areas of engineering, manufacturing, and operations. From deep neural networks and long short-term memory (LSTM) algorithms to reinforcement and physics informed neural networks (PINN), the possibilities are endless, aand the real-world applications are only just beginning to truly be exploited. Industry data holds gold nuggets; AI is the key to finding and using them.

As companies seek to take advantage of AI, one of the first challenges is how and where to start.

Simcenter partner, Maya HTT have collated insights and advice from leading experts in applied industrial AI to deliver a no-fluff rundown of what you need to know and do to prepare the right way.

By some accounts, as many as 85% of AI projects fail. Many more companies run into problems with their data. Data quantity is important, but so is quality. Having an AI goal is not enough to succeed. Strategy and preparation are key.

Identify goals & establish a strategy

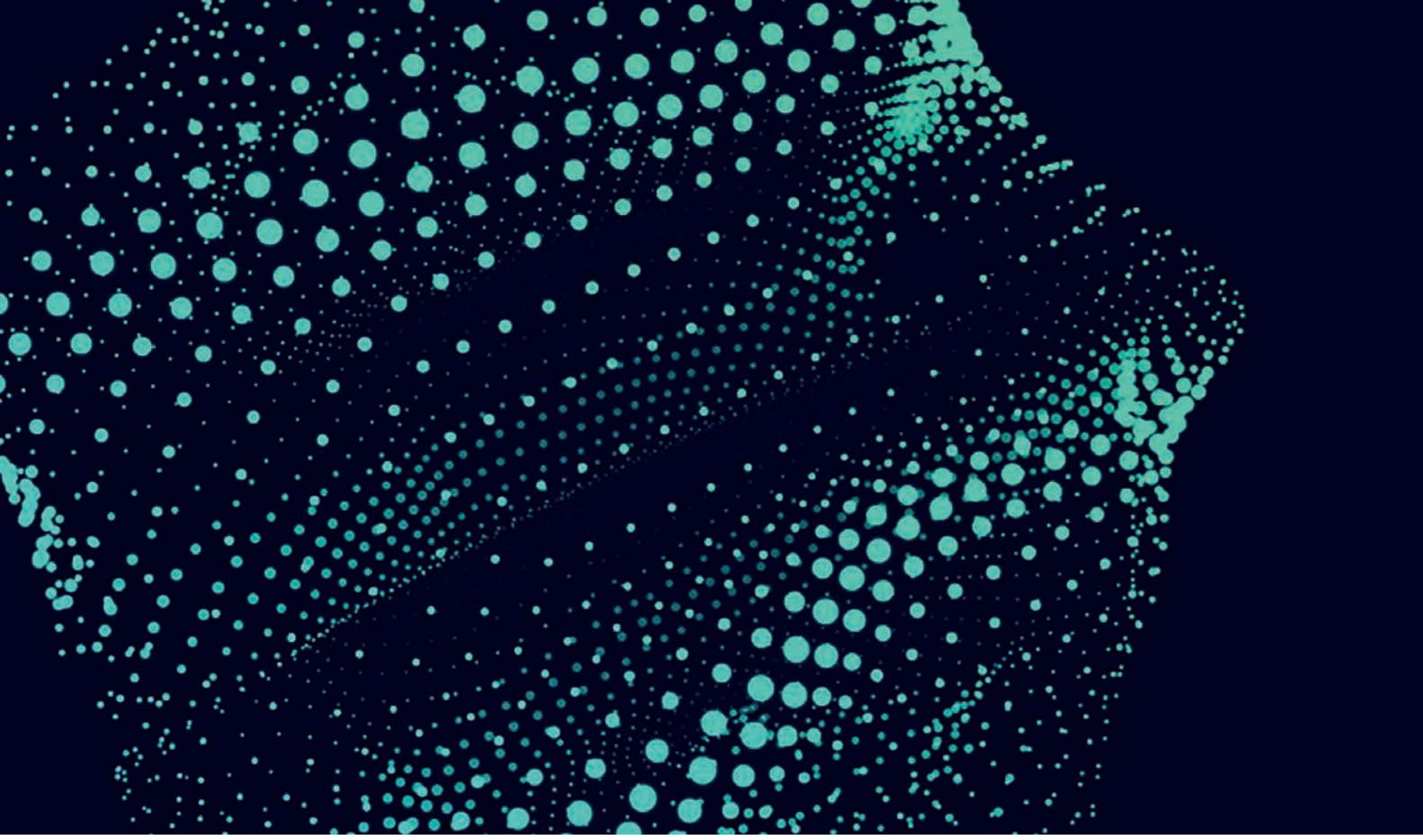
Business goals, not AI technologies, must drive the AI roadmap. Leverage only those AI technologies that align with and serve the business goals throughout the company to increase overall efficiency. Strategy helps AI become a cellular reality across the enterprise. Without strategy, AI remains, at best, a set of more-or-less successful projects.

Start Small: Early Results Are Important

Plan first to apply AI in small ways. Find early business challenges for which an AI approach makes sense and where existing data is good and has few gaps. The end goal is enhanced accuracy, reliability and efficiency, and naturally, innovation.

Choose the Right AI Partner

A great deal of the hesitation organizations have about adopting AI stems from not knowing how to proceed. With the rapid pace of technological



advancement, both in AI and IoT/IIoT, it is difficult for organizations to keep up. Understanding the challenges, pitfalls, and change management preparation required is critical.

The right partner should:

- Provide knowledgeable support,
- Be the right fit, and
- Identify any blind spots.

It's all about data

As many organizations understand that data plays a key role in AI, the primary concern when planning to implement an AI strategy is often to gather enough data and high quality data. Although it's true that the IoT and IIoT produce a staggering amount of data, that alone is not enough to get started. Successfully launching AI, automation, and machine learning requires the right data, and clean data.

Plan for Change Management

Corporate leaders who want to help their organization reap the benefits of AI should incorporate change management considerations in their AI strategy and solution. The assistance of a knowledgeable support partner early in the process can help leaders proactively manage employee expectations about their changing realities and ensure a smooth implementation of their AI strategy.

AI - Now & For the Future

AI, machine learning, and deep learning will have a major impact on all companies in the near future. Successful implementation of this new technology cannot happen with a start-and-stop or piecemeal approach.

AI is a powerful and accessible set of new technologies that organizations of all sizes can use to remain competitive that begins with setting business goals, strategy, and small wins. Don't underestimate the need for change management. With a strategic approach, you can benefit from AI now and in the future Discover the potential AI holds for manufacturing, and find out how you can maximize AI success and ROI.

Take the first step into your AI future.

INTERVIEW

We spoke to Remi Duquette, Vice President of Innovation and Industrial AI at Maya HTT

We talked about what the training of engineers will look like in the future. How should future engineers be educated? Do we need specialized artificial intelligence or generalized humans?

Well, eventually we're going to talk about the engineer of the future, but I wanted to start off by talking about the engineer of the past. Can you tell us a bit about your background and how you got here?

Well, my background is probably not atypical in terms of engineering. In the 90s I did my engineering degrees and graduated from McGill and University of Toronto, and then went into aerospace engineering. That really was my background. Stayed, of course, for probably about a decade in aerospace engineering, and then moved on to the software engineering world and developed all sorts of funky and fun applications. Now I'm in charge of innovation at Maya HTT, and we develop multiple software solutions for different engineering domains not just space, although we did start in space but we now are developing software for about 12 to 15 different industries with experts in each of them. In the last decade, I really moved on to AI and machine learning as a practice within our company.

And it's changing at a really, really rapid pace, isn't it? Whole swathes of existing skills, like learning to drive, are likely to disappear because they're going to be taken over by AI. Is that what you see is or going to happen?

Well, certainly as you mentioned there, there are some skills that will be made obsolete by some of the new technologies that are emerging. Some are a little bit scary and we'll have to see how they evolve and if it's as rapid as we think it will be, but certainly there will be some rapid change. My nine year old is at a summer camp coding today and it's like, "Well, I didn't have a computer at her age because computers were starting out but not really widespread at the time."

So it's kind of an interesting thought to see, and how rapidly these changes will occur. But yes, I'm certainly bracing for a lot more of those changes and that's why I think the future of engineering is important and a really critical topic to address because the engineers we train today... We can't just overspecialize them on specific technologies as we know those may not be available in five years' time because they keep on changing.

How do you think AI is going to affect future engineers' jobs?

AI is really a technology, a new way of dealing with data and learning from data. Engineers have used data in the past whether it's in controllers, in the manufacturing space, or in operations so it's not really a new topic. It's been made a lot more powerful by the computers that we have and the amount of data we have at our fingertips and are able to process, whether it's from telemetry, real-time telemetry, or additional sources that we can tap into.

I think AI will change engineers in a couple ways. One, in augmenting them and two augmenting their capability. It’s going to change the way that we think of a design cycle in engineering, or product design.

Nowadays, that product sends back telemetry back home, so to speak, and tells you new things in the environment that you may or may not have put into your design in the first place. It brings new ways to think about how to intuitively design and put forward some interesting new ways of coming

up with amazing new products that we couldn't conceive before. That kind of feedback loop that's a lot more rapid and real-time, gives us engineers more tools and interesting information to process.

Do we think that the engineering graduates today are having the correct training to play a part in this future of engineering?
Well, certainly, and I've been in many interesting discussions and conferences with a lot of people that are teaching our engineers. In the past the focus was really more in problem solving skills and I'm going to call them mathematical skills, technical knowledge and logical reasoning and thinking. As, we look to the future, we're at a crossroad where we grapple with generalization versus specialization.

In a way, an analogy to AI. If you over-train and overspecialize a little model, well, at some point it just does not generalize very well and it can't adapt very well. It's the same thing for training engineers.

If I had told you that we would be contemplating self-driving cars 10 years ago, you would've laughed at me but now we're getting closer and closer to that reality and people are not laughing anymore, and they're investing a significant amount to make it happen. That's really, I guess, the point there on specialization versus generalization of engineers. It's definitely moving from pure mathematics to really adaptive skills that will make you a really good engineer that is able to evolve with the pace of technology and adapt with new technologies as new tools.

There is an argument to say that there is a problem with the sort of engineering current software engineers do, in that you spend your whole career trying to drive the software as much as anything else, and not enough time doing real engineering. Assuming that AI is going to free engineers up to do proper engineering, making decisions, giving insight and not just be "mesh monkeys"; Is that how you see the future going?
I definitely see that as a trend, and certainly AI as a technology does bring those insights that kind of bubble to the surface, those insights that may have been hidden in the data or in the software. Instead of having engineers and humans going through and sifting all of this, they can employ the idea of generative AI programs that will give you the best couple of solutions and then you will apply your engineering judgment to pick the right one. I mean, it's still going to be a probability game where AI brings about what's most probable, and people need to think in a different way in those environments. I do see that trend certainly increasing in the future.

And while we will get some brilliant solutions we will also see some completely unfeasible solutions. We still rely on engineers to spot the things that are completely unfeasible.
It's not just unfeasible but dangerous sometimes. You see it in all sorts of things and that's why AI needs to be understood and harnessed in the proper way. AI, again, is purely and simply a new tool in terms of its power. It's been there in terms of algorithms for machine learning and deep learning has been there for over two decades, in which time we've seen it evolve in some brilliant ways, and not so in others. For example if you look at the data used by social media platforms to train chatbots, it may be deemed as unethical in the way that it uses language.

And not forgetting, of course, that human engineers often make bad decisions, and sometimes you're going to need AI to pick up those decisions, as well.

When we talk about the engineers of the future, actually those are the engineers that we're training today because if you graduate next year, basically you're still going to be working in 2060 or maybe even 2070, by which time the world will have changed completely. We have to start teaching these skills, don't we? I guess it happens naturally, but the future starts now.
It does start now, and actually it starts with even us, you and me. I mean, I graduated two decades ago now, but I keep on learning. Every year I make a point of learning, whether it's small or big, a new skill to put in my arsenal of skills. I hate to kind of quote someone like Einstein but once you stop learning, you start dying.

To listen to the full interview, download the Engineer Innovation podcast

Q&A

INTERVIEW

A Journey from Skyward Dreams to Groundbreaking Wind Turbines

We talk to Jesse Marcell from Airborne Motorworks (AMW) about turning a flying car into a form of power generation

It started with a concept in 2018 – Airborne Motorworks (AMW) co-founder and Chief Design Officer Jesse Marcell envisioned a unique flying vehicle for urban air mobility, utilizing electromagnetic propulsion.

Despite the challenges inherent in developing flying machines, Marcel's team made significant progress, culminating in gyroscopically stable electromagnetic propulsion prototypes. However, the regulatory landscape designed for certifying conventional aircraft presented a host of complexities that impacted the project's timely development and deployment.

So, a change in strategy was needed. While developing its flight prototypes, it became apparent that not only could AMW's technology be used for propulsion, but the reverse was also true: its propulsion technology could be used to generate energy.

AMW shifted its strategy to address a growing need across the planet – the increasing demand for a source of clean, efficient electricity generation. After considerable research into the best fit for its technology, AMW identified the growing microgrid market where it could provide a key component: a midrange wind turbine that could generate electricity in the 100kW to 500kW range.

Shifting focus required adapting their propulsion technology from a flying vehicle into a reconfigured power generation system.

To scale up their electromagnetic motor from 15 inches to a 12-foot diameter wind turbine generator, AMW partnered with Maya HTT. The two teams worked collaboratively, utilizing the simulation capabilities of Siemens Simcenter to balance mass, power output, and rotational speed. The 700% increase in scale came with significant challenges, and the teams explored different materials to balance structural integrity and mass reduction.

John Shew, Simulation Services Director at Maya HTT, led the project with his team. "We started with the electromagnetics and designed the generator. You can't just scale that linearly."

The Maya HTT EMAG team scaled up the size while accounting for other changes required for the new machine and usage, using Simcenter E-machine Design. Additionally, they used HEEDS™ software for optimization studies on the sizing of the machine and the steel and magnet inside.

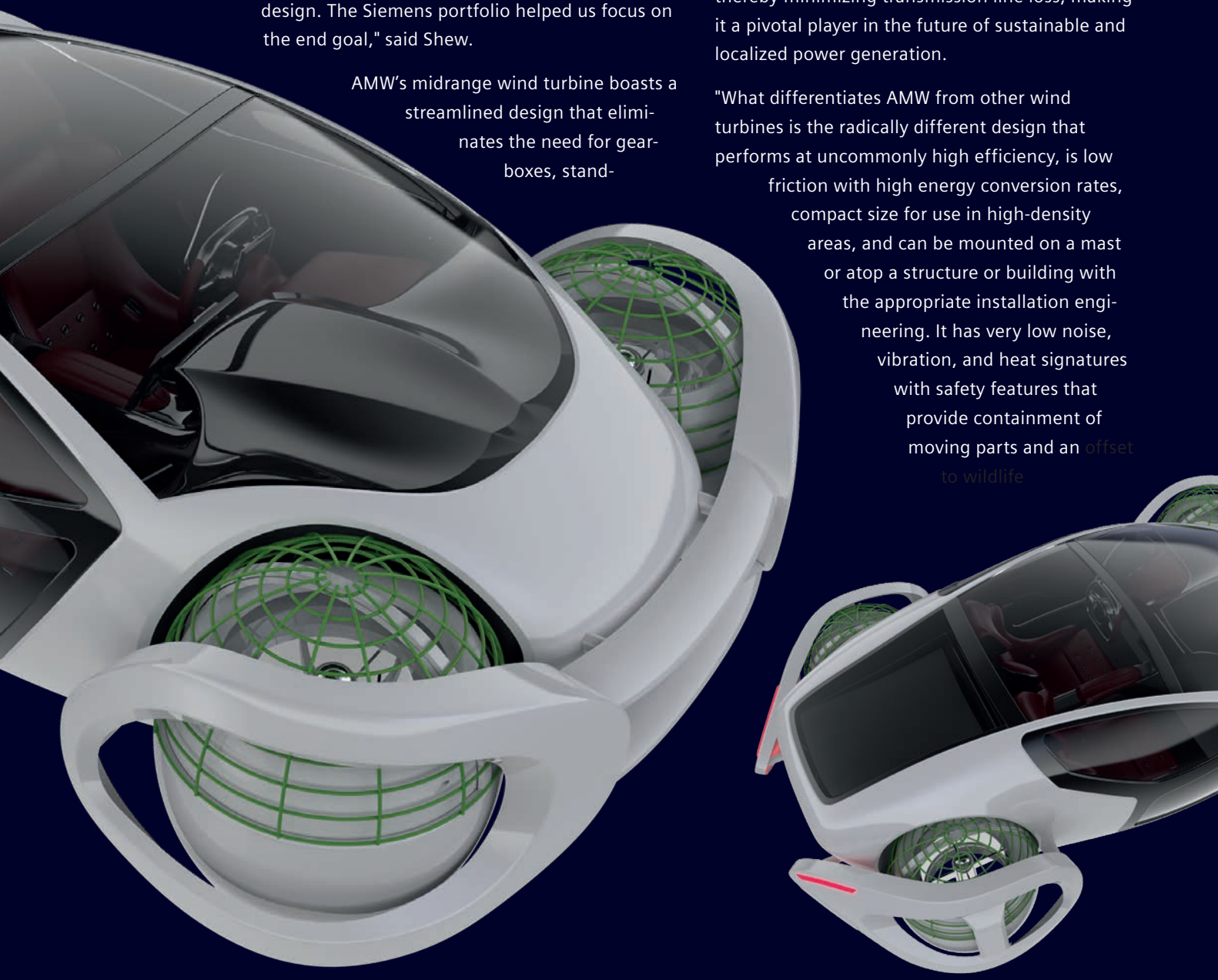
They selected a Halbach array, driven by its distinctive magnetic layout that concentrates a powerful magnetic field on one side while minimizing it on the other. By adopting this arrangement, AMW sought to gain better control over magnetic forces, ultimately leading to increased efficiency in energy conversion.

"From our end, it was entirely simulation-driven design. The Siemens portfolio helped us focus on the end goal," said Shew.

AMW's midrange wind turbine boasts a streamlined design that eliminates the need for gearboxes, standalone generators, and traditional cooling systems, thus reducing the high maintenance and operational costs associated with large, legacy wind turbines. The AMW turbine's ingenious integration of a shrouded duct acts as a static thrust multiplier while doubling down on functionality – from noise reduction to serving as a containment barrier and a safety shield.

The scalability of the AMW wind turbine allows users to tailor their power production to specific needs, seamlessly connecting multiple turbines and integrating alternative power sources. The compact size of the AMW wind turbine enables it to be installed in close proximity to end-users, thereby minimizing transmission line loss, making it a pivotal player in the future of sustainable and localized power generation.

"What differentiates AMW from other wind turbines is the radically different design that performs at uncommonly high efficiency, is low friction with high energy conversion rates, compact size for use in high-density areas, and can be mounted on a mast or atop a structure or building with the appropriate installation engineering. It has very low noise, vibration, and heat signatures with safety features that provide containment of moving parts and an offset to wildlife

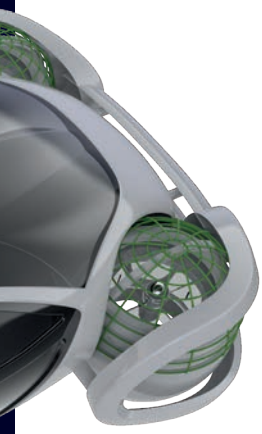


contact." -- Jesse Marcel, Airborne Motorworks, Chief Design Officer

"The AMW design offers the advantages of substantially lower operating cost than legacy designed equipment. Due to its design and operating characteristics, it is adaptable to both new and retrofit installations. It is versatile in application as a primary or backup power source and managed with other power sources to maximize the operating efficiency of microgrids." -- Hugh McElroy, Airborne Motorworks, Executive Chairman and CEO

AMW is preparing to manufacture full-scale prototype wind turbines for field testing during 2024 at functioning industrial sites to assess their durability and installation construction. The goal is to launch a manufacturing production line in early 2025.

While Jesse Marcel's flying car remains a work in progress, AMW's midrange wind turbine design stands out for its streamlined, efficient and innovative features. The company's journey from concepts to groundbreaking wind turbines is a captivating tale of vision, adaptability and collaboration that promises to play a pivotal role in the future of sustainable and localized power generation.



> From our end, it was entirely simulation-driven design. The Siemens portfolio helped us focus on the end goal"
>
> **John Shew,**
> Simulation Services
> Director at Maya HTT