

CADFEM JOURNAL

DIGITAL ENGINEERING

SIMULATION

EDITION — 2024



DIGITALIZATION

ALL GOOD THINGS COME IN THREES

Performance, costs, sustainability: how to use digital engineering to find the optimum balance right from the design stage.

OPTICS SIMULATION

LANTERNS FOR PARIS

How Lenzi has adapted its entire product range to comply with stricter regulations.

QUANTUM TECHNOLOGY

DRASTICALLY FASTER

How the startup Miraex uses Ansys simulations to make quantum computers even faster.

ARTIFICIAL INTELLIGENCE

HUGE POTENTIAL

Simulation and AI/ML are a perfect match. Discover what makes the solution from PI Probaligence and CADFEM so exciting.

Ansys
APEX
CHANNEL PARTNER



**SIMULATIONS
WITH ANSYS
HAVE BECOME
AN INTEGRAL
PART OF OUR
DEVELOPMENT
PROCESS.**

MARTIN BAER

Team Leader Structural Mechanical Computation, ebm-papst;
cadfem.net/ebm-papst



DR.-ING. CHRISTOPH MÜLLER

CEO
CADFEM International GmbH

EMPOWERING DIGITAL ENGINEERING WORLDWIDE

It was almost 40 years ago that CADFEM was founded by my father Günter Müller. Back then, the two-man company was known in the Munich commercial register as the “CAD-FEM Gesellschaft für computerunterstützte Konstruktion und Berechnung mbH” (“CAD-FEM Company for Computer-Aided Design and Analysis Ltd.”). Despite the somewhat unwieldy name, the family business was very active and successful abroad. One can say that we were an international company from day one.

The small company has long since evolved into an ecosystem of many national companies around the globe, whose members share a fascination for technology (preferably from Ansys) as well as the same values and convictions.

CADFEM has remained true to its core competencies of “simulation” and “digital engineering” while keeping its finger on the pulse of the times. While the first years were mainly about “digital engineering” in the sense of mechanical dimensioning and optimization of products using FEM, the spectrum has grown rapidly and continuously. This is still the case today, given that artificial intelligence, end-to-end data management and aspects of sustainability and the circular economy are further increasing the effectiveness of digital engineering.

This issue of the CADFEM Journal provides a brief overview. Find out, among other things, how the Swiss startup Miraex is advancing quantum computing (page 20), how the team at the Technical University of Munich is realizing the vision of the hyperloop (page 26) or how the Irish biotech company APC is working on a breakthrough in the field of gene therapy (page 18). With simulation. With digital engineering. With CADFEM.

Best regards,
Dr.-Ing. Christoph Müller



DR.-ING. MADHUKAR CHATIRI

CEO
CADFEM – APAC

CADFEM APAC has grown into a strong team of 270+ employees across six countries.

We are proud to be part of CADFEM Global and have significantly invested for customer-centric solutions. We have expanded into key territories in India and ASEAN and aligned ourselves with Ansys and Digital Engineering Solutions.

Looking ahead, we are focusing on transformative areas like Silicon-to-Systems Design and AI/ML-Driven Digital Engineering and plan to expand further into APAC. In the next five years, CADFEM APAC aims to be the go-to partner for simulation-driven innovation, seamlessly integrating with digitalization strategies.

Our goal is to establish a digital labs where virtual simulations drive product development, empowering customers to innovate, design sustainably, and achieve a competitive edge for growth. Our commitment remains steadfast-to provide world-class Ansys solutions and empower our customers to maximize the value of their investments in Digital Engineering.

Best regards,
Dr. -Ing. Madhukar Chatiri



CADFEM Conference

In 2024, professional conferences for simulation and Digital Engineering returned to the live, in-person format; the response was overwhelming.

The largest European CADFEM Conference took place on April 10-11 at the Science and Congress Center in Darmstadt. With support from Ansys as a platinum

sponsor and partners AMD, AWS, HPE, HP and the Open Telekom Cloud, the CADFEM team was able to put together a first-class information program on the present and future of Digital Engineering for the more than 700 participants.

A special thanks goes to the speakers who presented the practical and strategic value of technology using real-world application examples.

Many of the keynotes and technical presentations, including those from Ansys, AWS, Bühler, Pankl Racing Systems and Wago, are available on the CADFEM YouTube channel.





EMPOWERING DIGITAL ENGINEERING - INTERNATIONAL

The CADFEM Conference is the annual event where the Ansys and simulation communities from all over the world meet - as a multi-day event or as part of the CADFEM Conference Series. For a complete overview of past and upcoming conferences, including those in Germany, France, Austria and Switzerland, please visit

[CADFEM.NET/CONFERENCES](https://www.cadfem.net/conferences)



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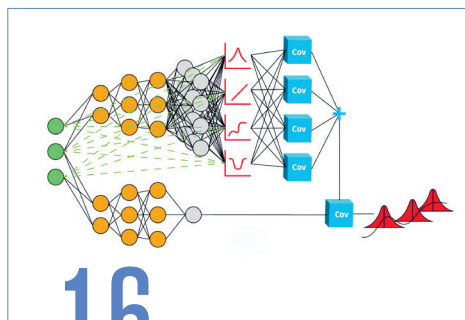
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SUSTAINABLE PRODUCTS

How the collection, linking and evaluation of all relevant information makes it possible to incorporate the environmental impact of future products into the development process at a very early stage.

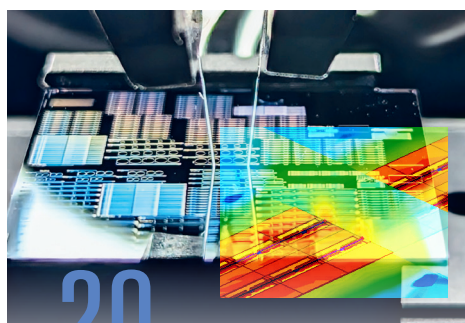


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LIGHT FOR METROPOLITAN AREAS

In record time, Lenzi, the manufacturer of striking outdoor lighting in Paris and other cities, has redesigned its entire product range using optical simulations. Each product now complies with the new environmental compatibility regulations.

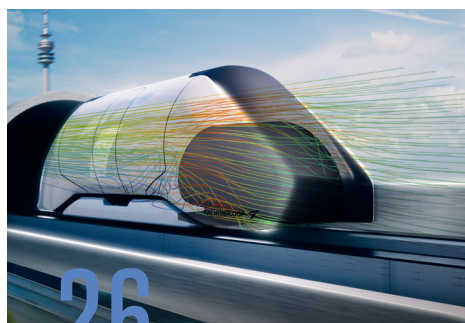


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CADFEM AND ANSYS

Not many names in the global Ansys community are more well-known than that of Erke Wang, Technical Director at CADFEM. A conversation with him and Matthias Hörmann.



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ARTIFICIAL INTELLIGENCE

PI Probaligence GmbH has been part of the CADFEM Group since the end of 2023. Its Managing Director Nils Odenthal summarizes the first experiences and outlines why the PI solution called STOCHOS is predestined for AI/ML applications in simulation.

QUANTUM COMPUTING

The startup Miraex is one of over 15 high-tech companies that are working with Ansys and CADFEM to further develop quantum technology. Miraex has succeeded in enabling a drastic increase in performance.

FAST, FASTER, HYPERLOOP

At the Technical University of Munich, a team of around 100 people from over 25 countries are working on realizing the ultra-high-speed transportation system of the future - the Hyperloop. Simulations are carried out with Ansys tools and support from CADFEM.

IMPRINT

PUBLISHER CADFEM Germany GmbH | Am Schammacher Feld 37 | 85567 Grafting b. München | T +49 (0)8092 70 05-0 | info@cadfem.de | www.cadfem.net **MANAGING DIRECTORS** Matthias Alberts | Dr.-Ing. Matthais Hörmann | Josef Overberg | Dr.-Ing. Jürgen Vogt | Erke Wang **COMMERCIAL REGISTER NUMBER** HRB München Nr. 75979 **EDITOR** Alexander Kunz | akunz@cadfem.de (v.i.S.d.P.) **CONCEPTION, LAYOUT & ILLUSTRATION** b.lateral GmbH & Co. KG | www.blateral.com **PRINT** Print India | Amruthaville | Raj Bhavan Rd | Opp Yashoda Hospital | Hyderabad - 500082 | Telangana | www.printo.in **APPLICABLE** worldwide **COPYRIGHT** © 2024 CADFEM Germany GmbH | All rights reserved | Printed in Germany. The publication was also released as an ePaper.

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Digital Engineering, Simulation, Ansys, and CADFEM

With the digitalization of development processes and entire product life cycles, companies are securing the efficiency, quality, flexibility and resilience they need to remain competitive. Simulations with Ansys are a key to this, especially those that are understood and used as an integral part of the development chain rather than a rigid link. CADFEM supports its customers in making this transformation a success.

Simulations with Ansys solutions provide answers to countless physical questions from the entire life cycle of products – quickly, transparently and reliably – from initial brainstorming to variant comparisons, concept finding and material selection to aspects such as manufacturability, operation and recycling.

SIMULATION DOES MORE

Simulations are an important component of the digitalization strategy in research and development. They become a driver in companies that no longer view simulations in isolation, but instead scale them and their benefits – above all time, cost and resource savings – to new areas of application and user groups.

Behind this are defined workflows, the individualization and automation of applications, systems engineering and digital twins, as well as optimization through linking with new technologies, especially artificial intelligence or high-performance computing. In short, simulation fuels Digital Engineering.

THE VALUE OF DATA

All of this is made possible by the immense amount of data that digitalization processes generate. This is another reason why data is often referred to as the “oil of the

21st century”. However, just like crude oil, data must first be “refined” in order to realize its true value. Only as a reliable, up-to-date and consistent “single source of truth” can the company’s wealth of data be used in a wide range of processes and applications. Using AI and ML to determine correlations and optimizations also requires this foundation.

SPDM

This is where SPDM (Simulation Process & Data Management) comes into play. A centralized and efficient SPDM with Ansys Minerva™ integrates and structures data from a wide variety of sources and lays the infrastructure for implementing an effective digital engineering strategy with a direct connection to the company-wide PLM world.

INDIVIDUALITY AS STANDARD

Digitalization and Digital Engineering are not off-the-shelf solutions. Their success depends on how well the technologies that are used represent the individual prerequisites and requirements of an organization. CADFEM provides its customers with expertise based on Ansys solutions, covering everything from implementation and customization to integration into the company process.

MORE INFORMATION

[CADFEM.NET/CONNECT](https://www.cadfem.net/connect)
[CADFEM.NET/DIGITALENGINEERING](https://www.cadfem.net/digitalengineering)



© WAGO

“Simulation technology at WAGO is evolving from being a rigid part in the R&D process chain, to a technology that accompanies the complete product lifecycle and can be used by everyone involved in the engineering process. Having a comprehensive simulation-based digital model of each product (a “Digital Twin”) is a huge advantage and that is where we are going to with the expert advice of our partner CADFEM.”

KARSTEN STOLL

former CTO of WAGO Interconnection, now Senior Advisor
Source: www.tech-execmagazine.com

More information:
3 questions to
Karsten Stoll:



© Liebherr

The objective of Liebherr-Aerospace & Transportation SAS with sites in Lindenberg, Germany and Toulouse, France, among others, is to deploy an innovative model-based enterprise approach and implement digital continuity across the entire development and product lifecycle, including efficient data exchange with customers and suppliers.

“Liebherr-Aerospace develops products consistently and completely digitally. The implementation of the model-based approach behind this confirms that the right partners have been chosen.”

ELKO VAN BALEN UND OLIVIER BANESSY

Heads of Model Based Enterprise, Liebherr-Aerospace.

Learn more: Simulation
without limits – CADFEM
and Ansys at Liebherr.



© Pankl Racing Systems

“We have expanded our engineering and our level of digitalization over the last few years. This includes digitalization activities relating to all of our material data, which is integrated into a comprehensive material database using Ansys Granta software. So far, we have already reached a high level. However, we will continue to work closely with CADFEM and Ansys to test new simulation tools and jointly explore further areas of application in order to tap into additional potential benefits.”

STEFAN SEIDEL,

CTO Pankl Racing Systems, Austria

CADFEM meets Stefan
Seidel: A conversation
about Digital Engineering
at Pankl Racing Systems



The significance and intensity of simulations are rapidly increasing. Maximum efficiency in the design of processes and the allocation of resources is therefore more important than ever – for global players as well as for medium-sized companies. Digitalization provides the necessary technologies for this, and in the Ansys Connect product family, they are tailor-made for simulation. CADFEM competently accompanies you on the way to a customized Ansys Connect solution.

Learn more about Ansys Connect solutions and CADFEM services.



Lighting The Metropolis: stylish, ecological, economical

At night, when monuments, streets, parks and bridges are illuminated, metropolises like Paris take on a very special flair. To ensure that the intense artificial light is also environment-friendly, Lenzi, the manufacturer of striking outdoor lighting in Paris and other cities, has redesigned its entire range of about a hundred products in record time.



Brightly lit cities offer spectacular, unique backdrops for residents and visitors. However, what is often forgotten is that the elaborate artificial lighting of metropolitan areas is energy-intensive and leads to unnatural light pollution that harms the environment and biodiversity. To counteract this, authorities are taking appropriate measures.

In France, the regulation issued in 2018 to reduce light pollution has given manufacturers of lighting solutions very little time to adapt their products to the new strict requirements. Among other things, they must reduce the proportion of blue light and deal with restrictions on the direction of light radiation.

For Lenzi, not only did the tight time frame pose a challenge during implementation, but also the huge range of lighting solutions. The company is very well-known for its typical style-defining lanterns of the French capital. Lenzi has been its most important supplier since 1953. Because

Lenzi has always succeeded in combining the unmistakable traditional design of the lamps with the latest technology such as LED, the products have long been export hits and light up communities in over 50 countries worldwide.

HOW DO YOU REVALIDATE THE COMPLETE PRODUCT CATALOG?

Similar to its products, Lenzi combines a traditional culture with a great openness to innovation and technology. A digital approach was the key to mastering the giant task of adapting and validating each of the more than one hundred models to the new, mandatory requirements within a tight timeframe.

As already mentioned, the stricter rules related in particular to

- the reduction of the particularly intense blue light components in the emitted spectrum,

- maximizing the luminous flux emitted in a cone of 151° below the horizontal relative to the total luminous flux
- reducing the proportion of light emitted towards the sky to less than 1% of the total light emitted.

These measures lead to a significant reduction in air pollution while at the same time reducing energy consumption for urban lighting.

For a small number of products, a classic modification process based on the revision of CAD models, prototype construction and experimental measurements - possibly in several iterations - in a photometric laboratory would be a common and feasible approach. For Lenzi, this option was out of the question for reasons of cost and time. The sheer number of different products, each of which depends on compliance with the modified standards, would take an estimated three to five years in the best-case scenario.

Timelessly beautiful, optimized for the times:
The lanterns by Lenzi on the Alexandre III bridge
in Paris © Adobe Stock



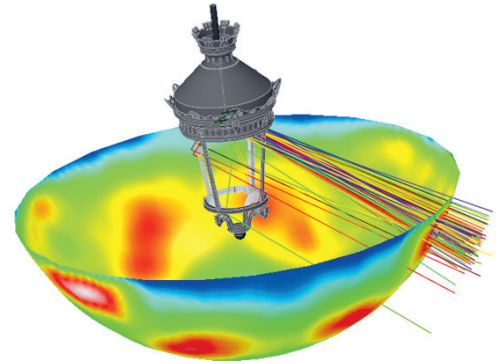
With Ansys Speos, the Lenzi engineers have successfully
converted existing lighting systems digitally to LED.
© Lenzi

VIRTUAL INSTEAD OF PHYSICAL PROTOTYPES

Instead, Lenzi opted for a digitalized process with virtual prototypes. The product configurations updated on screen no longer need to be built, transported and tested. Instead, the detailed product models form the basis for digital analysis, testing and optimization. Enriched with additional information, they can be flexibly modified until the virtual prototype confirms that a variant meets the new specifications in all relevant scenarios.

The tool used for this is the physics-based simulation software Ansys Speos®. Developed for solving a variety of optical tasks, Ansys Speos can be used to objectively compare different configurations, identify design problems and reliably design optical systems. Lenzi has simulated the spectrum, emissivity and power of the LEDs in various realistic scenarios and systematically determined the best variant under the existing boundary conditions. Undesirable radiation - in this case the light directed upwards - was also detected and corrected with Ansys Speos. This meant that the entire product catalog, i.e. one hundred different lighting products, could be provided with the required properties in a year and a half - a time savings of three years, plus enormous financial benefits and a drastically reduced use of resources.

The Lenzi team was supported by the simulation experts from CADFEM France during the implementation, familiarization and use of Ansys Speos. The resulting transfer of know-how will benefit Lenzi in similar follow-up projects, and given the various regulations on light pollution in the many countries and continents where Lenzi products set the scene in cities, the wait won't be long.



Ray path of the lantern model in Ansys Speos © Lenzi



**WE DON'T HAVE A PRECISE ESTIMATE OF
OUR CUSTOMERS' ENERGY SAVINGS, BUT
WE HAVE MADE SIGNIFICANT SAVINGS ON
THE COST OF PHOTOMETRIC TESTS IN THE
LABORATORY FOR EACH LANTERN AND EACH
OPTIC.**

SYLVAIN SEFROU

Development Engineer, Lenzi

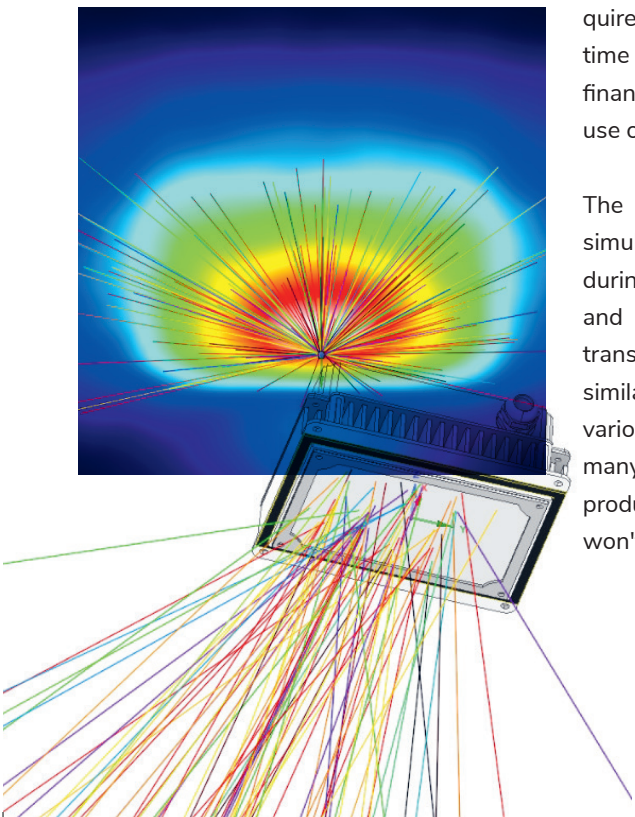


MORE INFORMATION

Lenzi
Lanternes de Paris
LENZI.FR



Optical Simulation
CADFEM.NET/OPTIK



Empowering Digital Engineering

Better performing and more sustainable. Digital engineering involves tapping the full potential of technical creativity, precise data models, and clever workflows. This ensures that a good idea results in an excellent product – for manufacturers, customers, and the environment.

Simulations are a pivotal technology for this. They support every stage of the process, from initial brainstorming and variant comparisons to concept development and material selection. Additionally, simulations address aspects such as manufacturability, operation, and recycling, providing quick, transparent, and reliable answers to countless physical questions throughout the entire life cycle of products and processes.

The name CADFEM has been synonymous with simulation since 1985 and has been supporting companies, researchers, and universities in the successful use of Ansys and other simulation products ever since. This is made possible by the CADFEM team of over 600 employees worldwide. Through training offers, support, project work, contract calculations, and IT services, they ensure a seamless implementation of the simulation software.

Moreover, data management solutions, automation, workflows, customization, and AI-integration by CADFEM make simulation an integral part of highly efficient, tailor-made digital engineering.



CADFEM & ANSYS

Ever since CADFEM was founded in 1985, it has been a close sales and technology partner of Ansys, the world's largest developer of simulation software.

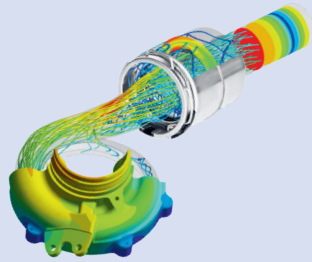
As **Ansys Apex & Elite Channel Partners**, CADFEM belongs to the highest Ansys partner categories and represents maximum customer satisfaction and Ansys technology competence.

Furthermore, as an **Ansys Services Partner** for Digital Engineering, CADFEM is certified to support customers in the digitalization of their engineering processes.

Last but not least: As an **Ansys Systems Integrator Partner**, CADFEM meets all the requirements to implement and operate complex IT environments for HPC applications for customers. This ranges from local hardware as a private cloud to public cloud solutions from Ansys based on AWS or Azure.

300 +

ANSYS EXPERTS



5800 +

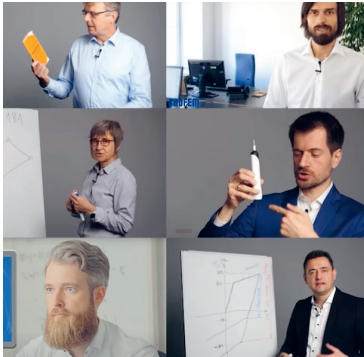
CUSTOMERS



© Adobe Stock

110 +

SEMINAR TITLES



500 +

UNIVERSITY SITES



9000 +

SEMINAR PARTICIPANTS
2023



35

LOCATIONS



Ansys

APEX
CHANNEL PARTNER



All other images: © CADFEM



We have always had an international mindset

In the global Ansys community, not many names are more well-known than that of Erke Wang.

In the following interview, Erke Wang (EW), along with Matthias Hörmann (MH) (both technical directors of CADFEM Germany) discuss the close ties between Ansys and CADFEM, a few key highlights, the importance of AI and the value of ecosystems.

Erke, when and how did you join CADFEM?

EW: Back in 1988, the VDI and the Ministry of Mechanical Engineering in China wanted to promote the exchange of young engineers. I was selected and my first stop was CADFEM. In fact, Günter Müller picked me up at Munich-Riem airport. Beijing to Grafing was a huge culture shock. Nevertheless, on my first day in the office, I encountered familiar things: computers from DEC, a Tektronix terminal and Ansys 4.2. I have fond memories of my first colleague, Peter Tiefenthaler, whose warm Bavarian demeanor was a tremendous help to me. I am so grateful that Ansys has connected me with so many fantastic people around the world.

How long have you been familiar with Ansys?

EW: In 1984, I was a simulation engineer at the computer center in Beijing and Ansys chose us as a local partner. However, hardly anyone in China spoke English back then. So I translated all of the Ansys manuals into Chinese. Maybe that's why I still know most of the APDL commands today. Maybe that's why I still know most of the APDL commands, i.e. the Ansys scripting language.

Matthias, what did you think of Erke when you started at CADFEM?

MH: I spent the first eight months at the CADFEM office in Chemnitz, where I became familiar with LS-Dyna and deepened my knowledge of composites, which was the subject of my doctorate. When I moved to the Grafing office, I began having daily contact with Erke, who still impresses me with his knowledge and enthusiasm for Ansys and technology in general. He is driven by the success of our customers and has really left his mark on CADFEM. Moreover, Erke's wise words on all life situations are astounding.

Ansys has now been around for over 50 years. What do you consider to be important milestones on this journey?

EW: The term "milestone" does not do justice to the dynamism that Ansys displays. Where should I start? Ansys has always set standards with automated meshing, CAD integration, multiphysics, system simulation, HPC, the Workbench interface - the list is endless. Millions of engineers benefit from this and are able to develop products faster, more precisely and with fewer resources.

MH: Another remarkable thing is how many physical domains are covered. This makes it easier for companies to use simulation in a strategic way, as does the ability to automate, customize, democratize and integrate it into company processes. There is no way around this in the course of digital transformation. Certified partners such as CADFEM provide support during implementation. Ansys established a partner network early on, which was both forward-looking and customer-oriented - a "milestone", so to speak.

What do you think the future holds?

MH: The topic of sustainability is of paramount importance. Digital simulation-based engineering has already achieved a lot in terms of resource conservation and a functioning recycling economy - but it can and must achieve even more.

EW: One opportunity is AI. We can see that AI and ML (machine learning) are bringing simulation closer to an ideal world, with a perfect balance of time, effort and results. AI utilizes the huge wealth of data generated in engineering and thus raises the efficiency of simulation to a new level.

MH: In order to deliver added value, all these data must be clear, transparent and consistent. This brings us to SPDM (simulation and process data management), whose relevance is massively increased by AI.

How are customers and the industry currently reacting to major shifts such as AI?

EW: We have felt the impact of AI at our conferences. Over 1,000 people attended our Blueprint panel discussion on AI in June - twice the usual amount! The fact that demand for automation and SPDM are growing at the same time shows that our customers see both topics collectively.

MH: Yes, the interest in AI is stunning, not just at events, but in the community in general. However, we are also seeing concerns about whether our own expertise and skills will still be in demand in the future. I say yes! In fact, perhaps more than ever.

Back to Ansys and CADFEM. What connects the two?

MH: As we have already mentioned, Ansys has a strong partner network that is close to its customers. As the largest Ansys partner worldwide, CADFEM has been part of the company from the very beginning. But there's much more that connects us.

EW: That's right. CADFEM has expertise in the entire Ansys portfolio. Our support regularly receives top ratings, and our training program, which consists of over 110 courses and eLearnings, is number one for practice-oriented CAE. Our customers know that they can rely on CADFEM when it comes to Ansys as well as topics in SPDM, AI, new fields of application and special tasks. Ansys also knows this, which is why they recommend us as a channel, service and technology partner.

MH: We also work together with Ansys. CADFEM is the driver of many Ansys initiatives such as Workbench, Digital Twin, AI and ML, as well as the integration of applications and products like optiSLang, Motion and Motor-CAD, just to name a few. This makes us proud. We will continue to help shape simulation in the interests of our customers in the future.

... and everything is international, right?

EW: We have always had an international mindset. The CADFEM Group puts this conviction into practice and CADFEM's expertise, services and technology are used worldwide.

MH: Thanks to our internationality with local presences, customers are served in their language, time zone and culture. Every Group member also benefits from the synergies in terms of knowledge, specialization and capacity management. What also distinguishes the CADFEM Group ecosystem is that, in addition to the connection with Ansys, it includes partners with special simulation expertise in medicine, mobility, urban planning, energy, Big Data and AI, for example.

There it is again, AI. Thank you very much for the interview.



ERKE WANG was born in Shanghai and first came into contact with Ansys in 1984, which has stayed with him ever since. In 1988, Erke went to Germany on a scholarship and quickly became one of the faces of CADFEM. He has been the technical managing director of CADFEM Germany since 2009.



DR.-ING. MATTHIAS HÖRMANN decided to join CADFEM in 2003 after completing his doctorate at the University of Stuttgart. Matthias has worked in various areas of the company and knows from many perspectives of CADFEM, simulation and digital engineering. He was appointed to the management board in 2023.

MORE INFORMATION

Erke Wang and Matthias Hörmann have a lot more to say.

To the detailed interview:

CADFEM.NET/EWMH

PI PROBALIGENCE: FROM AI STARTUP TO GLOBAL PLAYER

PI Probaligence GmbH has been part of the CADFEM Group since the end of 2023. In this guest article, Nils Odenthal, Managing Director of the company, outlines the success story of the young company.

The focus is on the PI software package STOCHOS®, which combines probabilistics and artificial intelligence into a unique and easily accessible solution that is attracting great interest from more than just Bosch.

The starting point for PI is a specially developed method in the field of machine learning, which overcomes known problems of artificial neural networks. From the outset, there were inquiries from well-known German companies for various development projects, plus several research projects analysing the application of artificial intelligence in the fields of medicine, chemistry and aviation, which would keep us busy for some time.

STOCHOS, THE SOFTWARE PACKAGE FROM PI

The original aim of PI was to offer “AI for everyone”, since, in our case, no prior knowledge of machine learning is required to use the algorithms. In the STOCHOS software package, all methods are combined in a universally applicable tool and, unlike neural networks, the ML methods themselves do not need to be adapted to each new problem.

Unfortunately, we were quickly faced with a chicken-and-egg problem: our contacts in the companies that carried out the evaluation of STOCHOS were usually the very people who typically came from classic neural networks and often had no interest in introducing other methods. One exception to this was Bosch, which, as is well known, began investing in artificial intelligence on a broad front at a very early stage.

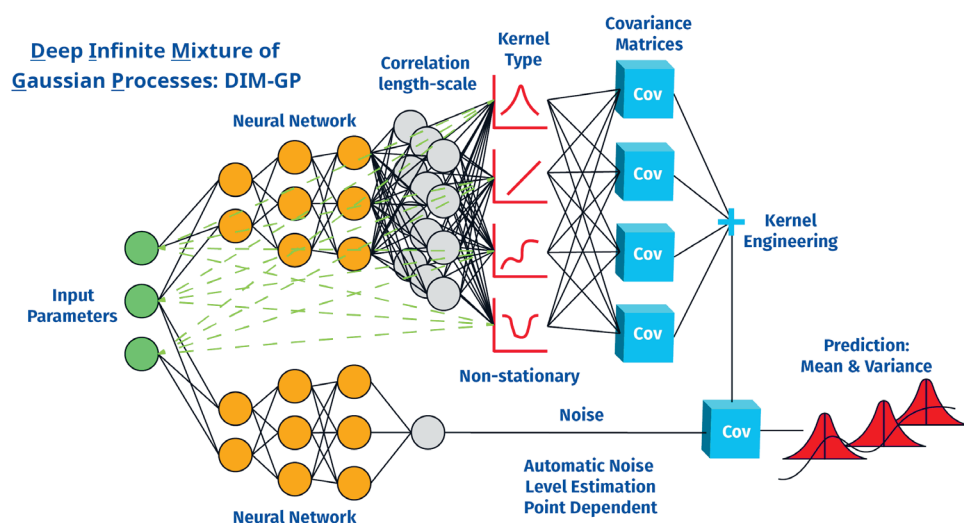
THE WORLD OF SIMULATION VIA CADFEM

At the Ansys WOST conference in Weimar at the end of June 2023, CADFEM became aware of us in its search for partners in the field of artificial intelligence. After that, things actually happened very quickly. Since the end of 2023, we have been a member of the group and, thanks to the long-standing and intensive customer relationships of CADFEM, we are now able to talk directly to potential users of AI in companies. So far, the feedback has been amazing. Perhaps the current AI hype has prompted many leading companies that already use simulation in development to test several solutions, where they have now quickly recognized the benefits of STOCHOS.

Participating in several CADFEM conferences was another important step and we are extremely pleased that we have since been able to talk to the engineering and AI specialists of many international market



Huge interest: The sessions on AI with contributions from PI Probaligence were very well attended, as shown here at the CADFEM Conference in Darmstadt.



The core of STOCHOS is the DIM-GP algorithm (DIM-GP = Deep Infinite Mixture of Gaussian Processes). This globally unique algorithm combines the benefits of two normally opposing AI approaches, neural networks and Gaussian processes. The resulting non-steady-state, probabilistic model is arbitrarily scalable. It no longer requires hyperparameter tuning and processes data of any dimensionality with minimal hardware requirements and without cloud computing. (© PI Probaligence GmbH)



WE CONSISTENTLY RECEIVE FEEDBACK THAT IMPLEMENTING AI WITH STOCHOS IS EXTREMELY EASY

leaders at eye level about the implementation of ML in their work processes. In fact, we have since been able to conduct a wide range of PoCs on simulation and experimental data as well as combinations of both in areas such as component optimization, process control, chemical simulations and many other applications. We have consistently received positive feedback that implementing AI with STOCHOS is extremely easy and that companies can quickly and independently incorporate it into further internal development.

ON THE WORLD STAGE

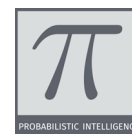
Since the beginning, our international team of employees has always had a strong interest in projects with companies outside the D-A-CH region. With the help of the many branches of the CADFEM Group, we have now been able to start projects with companies in Europe, the USA, India and Southeast Asia in just a few months, which we are extremely pleased about.

Looking back after six months, we can confidently say that, thanks to support from CADFEM, we have made the leap from software startup to the world stage of artificial intelligence in a very short time and are certain that probabilistic methods will continue to prevail.

ABOUT PI PROBALIGENCE

PI Probaligence GmbH was founded at the end of 2018 by Prof. Dr.-Ing. Dirk Roos and Dr.-Ing. Kevin Cremanns as a spin-off of the Niederrhein University of Applied Sciences for the technology transfer of research results to industry and has been an AI partner within the CADFEM Group since the beginning of the year. The word "Probaligence" is a blend of probabilistic and intelligence.

[PROBALIGENCE.COM](https://probaligence.com)



NILS ODENTHAL
Managing Director at
PI Probaligence GmbH
and author of this article.

MORE INFORMATION

Artificial intelligence at CADFEM
[CADFEM.NET/AI](https://cadfem.net/ai)

CADFEM Group
[CADFEMGROUP.COM](https://cadfemgroup.com)

A workflow for effective transfections

Transfections, i.e. the introduction of foreign DNA or RNA into human cells to manipulate human genetic information, is a promising approach to help people with rare or incurable genetic diseases. For this to be possible, the high complexity and susceptibility of the procedure must be mastered. An innovative workflow developed by APC makes an important contribution here. It relies on simulations and artificial intelligence.

The clients of APC, a highly innovative, bioscience-driven company based in Dublin, Ireland, share a common mission: to save lives. APC's team of process development experts - chemical and bioprocess engineers, organic and process chemists, bioprocess scientists, and modeling and simulation specialists - use their unique knowledge to help these biopharmaceutical companies develop new processes based on the latest science and technology.

A current project, which has attracted a great deal of attention at several specialist conferences, is concerned with gene therapies. The APC team also used simulation and AI tools.

TRANSFECTIONS: A KEY TO ADVANCE GENE THERAPIES

Gene therapy seeks to modify or manipulate the expression of a gene or to alter the bio-

logical properties of living cells for therapeutic use (FDA & Cber, 2020). Transfection is the process by which nucleic acids (DNA or RNA) are introduced into eukaryotic cells utilizing means other than viral infection (Mancinelli et al., 2021).

Although transfections are promising to treat incurable, rare, and inherited genetic diseases, they are complex and most commonly display low productivity. Furthermore, they are difficult to scale, and display high levels of impurities.

Thus, the APC team opted for a model and simulation workflow for transfection development as an alternative to increase process understanding and reduce the time and cost of process development.

PROJECT OVERVIEW

Every transfection process development has always typical objectives, e.g. ensuring the quality and quantity of DNA going into the cells or maximizing recovery of transfected viable cells.

The model-driven workflow gives new options to gain additional important insights, that are not possible with traditional approaches based on experiments, or only with disproportionate effort. Examples:

- Ensure good mixing conditions for cell health by using Computational Fluid Dynamics (CFD) simulations
- Identify process conditions that maximize the likelihood of transfection by coupling CFD simulations with Discrete Element Methods (DEM) to model cells and complexes of plasmids and PEI as particles
- Further optimize the process by using artificial intelligence (AI) models

The model-based workflow is closely inter-linked with the experimental approach at every point. This is partly because the experimental data is an important input, and partly for validation reasons. The experimental calibration and validation was supported by the Irish Research Council EBPPG/2022/38. The workflow diagram also shows where simulations and artificial intelligence were used. Their contribution is outlined below.

CFD/DEM SIMULATION RESULTS

CFD and DEM simulations were used to accelerate development by replacing some experiments. CFD and DEM simulations were performed using the Ansys Fluent® and Ansys Rocky™ software on AWS cloud computers. CADFEM UK & Ireland supported the model setup and the execution of the simulations.

CFD SIMULATION GOALS OVERVIEW:

- Mixing time determination
- Shear and energy dissipation quantification and control to avoid cell damage
- Oxygen distribution characterization and optimization
- Investigation and elimination of classification and poorly mixed internal zones

DEM SIMULATION GOALS OVERVIEW:

The hypothesis was that the process conditions that display the highest number of collisions between cells and complexes in the simulations, would display the highest transfection efficiency in the real system.

BAYESIAN OPTIMIZATION

Neural Networks and Gaussian Processes were tested against traditional DoE and provided faster insights to reduce the experimental burden and accelerate data analysis. The AI model used was developed in collaboration with PI Probabiligence, using their STOCHOS platform. Two models were developed:

Using experimental data: optimization goal was to maximize the percentage of cells that contain GFP (green fluorescent protein) and cell viability after transfection.

Using in-silico data: optimization goal was to maximize the CFD-DEM simulated cumulative number of collisions

Additional statistical analysis was then performed to infer if the results obtained from the in-silico data resulted in the same optimization suggestion as the experimental study would.



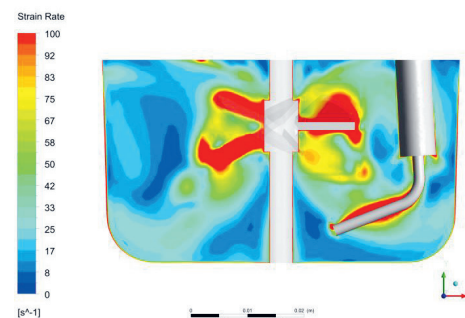
THE FEEDBACK FROM THE PD2M CONFERENCE WAS ENCOURAGING. EXPERTS CONFIRMED THAT THE WORKFLOW WAS WELL-ROUNDED, FROM PLANNING TO MODEL SELECTION AND EXECUTION OF EXPERIMENTAL AND SIMULATION WORK.

ANA LUIZA PINTO QUEIROZ

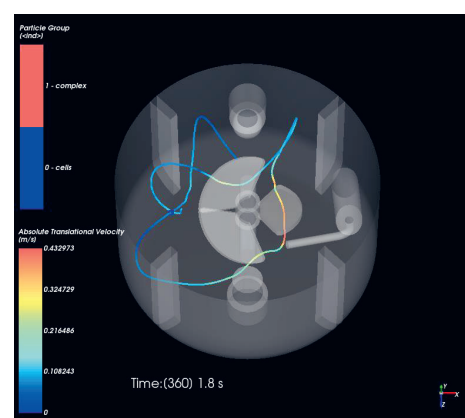
Digital Engineering Lead, APC

LESS EXPERIMENTS, INCREASED PROCESS KNOWLEDGE

The proposed workflow identified the optimized critical process parameters (CPPs) set-point that maximizes the number of collision cells/complexes while ensuring cell viability. CFD/DEM was used for designing the process, increasing process understanding, and to accelerating development. This workflow is transferable to other transfection systems and reduces typical process development costs by replacing expensive physical experiments with simulations, reducing the number of experiments required to achieve target yield and increased mechanistic understanding of the process.



CFD: Simulation of hydrodynamic shear stress



DEM: Simulation of the trajectory of individual particles

ABOUT THIS ARTICLE

This article summarizes the presentation "Model and Simulation workflow for Transfection Development" of Ana Luiza Pinto Queiroz, Digital Engineering Lead, APC, held at the The Pharmaceutical Discovery, Development and Manufacturing Forum 2024 (P2DM).

DISCOVER MORE ARTICLES
CADFEM.NET/BLOG

MORE INFORMATION

APC
APPROCESS.COM





Game changing RF-photonic interconnects for Quantum computers

Swiss Quantum technology Startup Miraex develops RF-photonic interconnects that provide a bridge between the microwave and optical portions of the electromagnetic spectrum. These sophisticated interconnects require a careful design that balances circuit and material losses with coupling strength. Simulations with Ansys tools were used to optimize the design of the prototypes for fabrication.

Microwave technologies are at the heart of some of the most promising quantum computing technologies today. But at the same time, the microwave domain is the biggest bottleneck for the scalability of these systems. By bridging to the optical domain, where applicable, these disadvantages can be bypassed by using optical interconnects, e.g. for connecting quantum computers together in a cluster through optical fibers. This can boost their scalability dramatically. This can be thought of as analogous to the optical MPI technology used in classical computing clusters.

THE MIRAEX PLATFORM

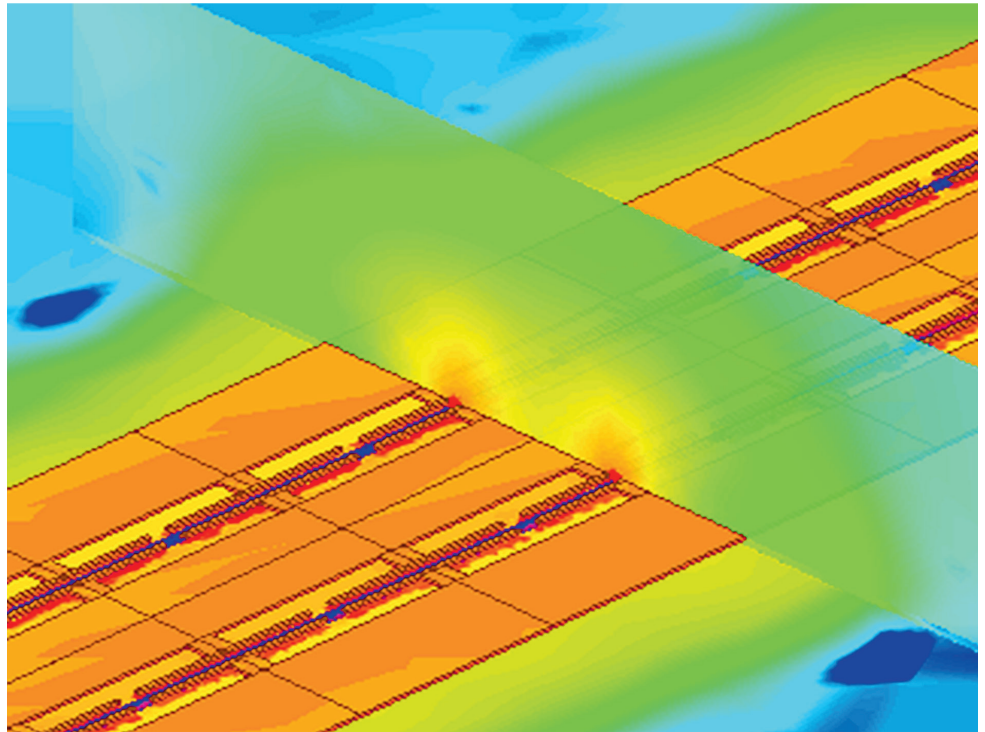
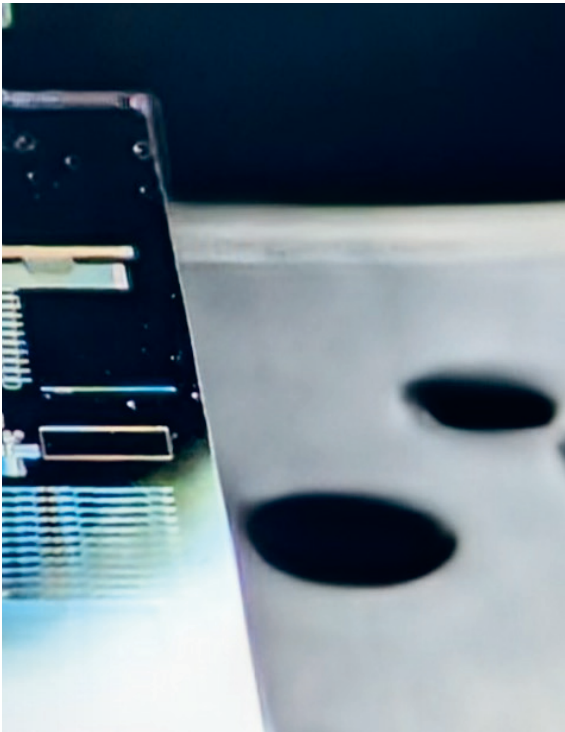
Miraex, a Startup founded 2019 in Lausanne, Switzerland, develops RF-photonic devices for interconnecting quantum computers and bridging quantum networks, letting them scale to reach their maximum potential. Miraex platform uses nanofabricated RF and optical circuits to guide light into structures where photons of different frequencies interact. These devices can convert single photon signals between microwave and optical frequencies. However, their operation requires a careful design that balances circuit and material losses with coupling strength.

DESIGN REFINEMENT WITH ANSYS SIMULATIONS

To refine the design of initial prototypes for fabrication, the Miraex team decided to rely on Ansys tools and CADFEM know-how: Ansys HFSS was chosen to design and characterise microwave circuit elements, while Ansys Lumerical was used to characterise the corresponding optical waveguides. The data was matched together to find an optimal design.

IDENTIFYING THE RIGHT BALANCE

For optimal performance of quantum interconnects, circuit loss must be balanced with the interaction strength over the length of the device. Ansys Lumerical was used to model optical waveguide modes and extract their propagation velocity, which must match the propagation velocity in the electrical circuits determined by Ansys HFSS. Lumerical also provided information about optical plasmonic loss.



Propagation velocity in the circuits calculated with Ansys HFSS

ANSYS SOFTWARE FOR QUANTUM TECHNOLOGY SIMULATION TASKS

Ansys HFSS™

The industry standard for determining the radiation and transmission behavior of RF/microwave circuit components.

Ansys Maxwell®

The simulation tool to analyze and optimize electrostatic electromagnetic field distributions

Ansys Lumerical™

Family of simulation tools to analyze the properties of photonic sources and waveguides.

Electrostatic simulations in Ansys Maxwell produced the electric field's overlap with the optical mode, giving an interaction strength. By performing a parametric sweep over geometry, a suitable balance between optical loss and interaction strength was identified.

DRASTIC COMPLEXITY AND TIME REDUCTION

The cross-domain design performance, achieved by concentrating on individual solvers in parallel streams, leads to a drastic reduction in complexity and preparation time. Furthermore, the extensive Pythonic scripting capabilities of the different Ansys products facilitated efficient data postprocessing and exchange of results. These enhancements contribute to achieve a first-time-right design, faster time to market, and the ability to drive innovation within the business landscape.

QUANTUM TECHNOLOGY, ANSYS, CADFEM

>15

High-tech companies from the quantum technology sector rely on the use of Ansys with the support from CADFEM.



MORE INFORMATION

Miraex
MIRAEX.COM



Electromagnetic Simulation
CADFEM.NET/EMAG

ALL GOOD THINGS COME IN THREES



The classic product development goals of “high performance” and “low costs” have been joined by “sustainability”, which has gone from being an optional “nice-to-have” to a cornerstone when planning new products. A cornerstone that must now be included on an equal footing with the other two goals.

On the one hand, strict and binding requirements from legislators, industry associations and environmental organisations are coming into force, such as the EU's Corporate Sustainability Reporting Directive (CSRD). On the other hand, proven sustainability has become a factor in purchasing decisions - in both B2B and B2C. The environmental climate crisis has finally arrived in the engineering industry and there is an urgent need for action. But there are also opportunities.

PRODUCT DEVELOPMENT TODAY

Change costs increase exponentially later in the product development process. This is where digital engineering comes in: In the earliest development phases, long before they physically exist, engineers optimize future products using detailed digital models.

Ideally, the future "performance" and the costs for components, production and use should be transparent from the outset. The ecological footprint is also defined through the choice of materials, designs and construction methods.

However, sustainability also has other facets that need to be quantified and disclosed - the legislator sends its regards:

- The CO2 footprint for transportation, production and operation
- Other environmental impacts, e.g. through the use of critical substances
- Aspects of disposal and the circular economy
- The social impact

How can such variables be incorporated into digital engineering at an early stage and optimized in line with performance and costs? How does "Design for Sustainability" succeed?

SUSTAINABILITY – THE NEW KID ON THE BLOCK

Today, most of these properties are only recorded, documented, accumulated and evaluated in the course of the product's life. They are recalculated once the product is already there, often with information from mixed sources.

The consequences, i.e. the analysis of what needs to be done better and the implementation, therefore often follow on an uncertain data basis, typically within the next few product generations. This can be risky, and is at the very least a painful loss of time to achieving sustainability goals and a missed opportunity in terms of innovation and sales. What's more, specifications, rules and laws change over time, are not always uniform and may be missed again if properties are updated too late.

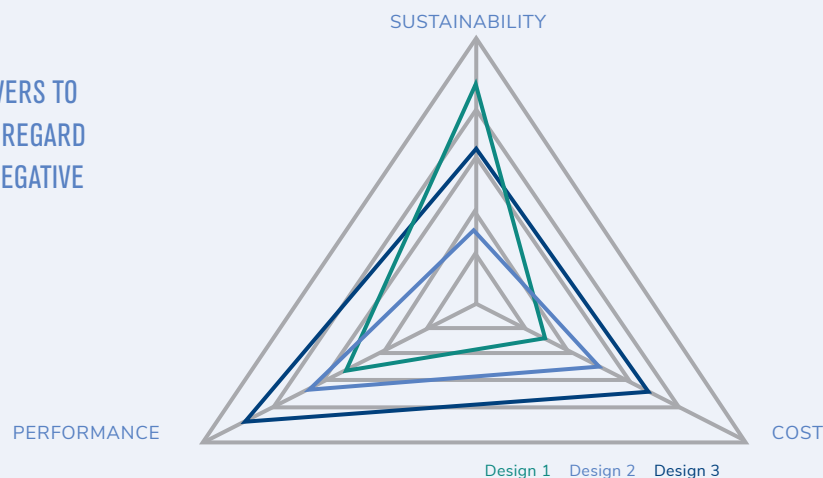
DIGITIZED MATERIAL INTELLIGENCE CREATES TRANSPARENCY

"Design for sustainability" means taking a forward-looking approach to the issue of sustainability. However, the integration of a product's life cycle assessment at a very early stage of the development process is still in its infancy. Apart from the lack of pressure to act, the reasons for this lie in the complexity of such data and the dynamic nature of the criteria.

The materials used to manufacture a product are critical regarding sustainability aspects: Without materials, there

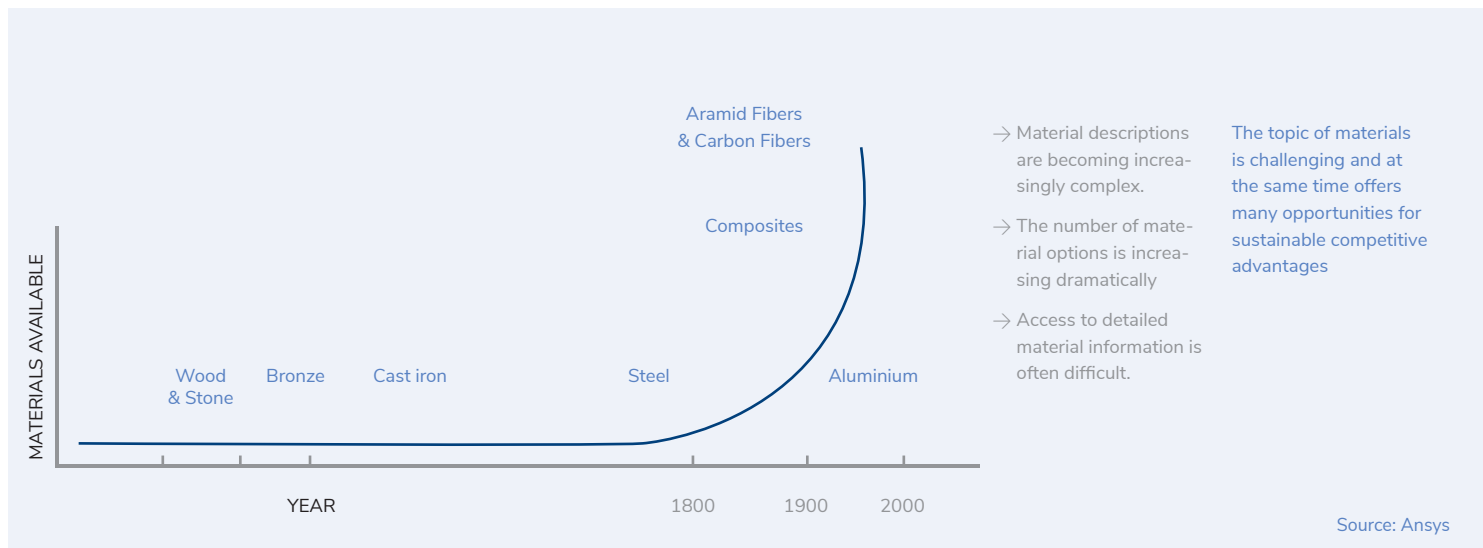


MATERIAL OFFERS MANY LEVERS TO ACHIEVE AN OPTIMUM WITH REGARD TO THE LOWEST POSSIBLE NEGATIVE ENVIRONMENTAL IMPACT



In addition to performance and costs, the sustainability factor also plays a major role in product development

Source: Ansys



PROVEN SUSTAINABILITY IS REWARDED BY THE CUSTOMER.

is no physical product. Materials must be extracted, purchased, transported and processed; Materials shape a product and its "life" - and thus the Life Cycle Assessment (LCA) - right up to the end of its life and the question of whether they need to be reused, recycled or disposed of.

All of this contributes to the sustainability of the product must be disclosed in accordance with the CSRD and other directives such as REACH or RoHS, with regard to environmental impact and including the supply chain.

At the same time, however, material also offers many levers to achieve an optimum with regard to the lowest possible negative environmental impact: As a trade-off to performance and costs or - keyword: innovation - even as a driver for a competitive advantage through better performance and higher revenues, because proven sustainability is rewarded by the customer.

Digital material intelligence means consistency. Data is recorded and used according to a uniform structure. Decisions are always made on one and the same database, the "single source of truth". This applies to design, when materials are selected, CAE engineers who evaluate variants, purchasing and production, who ultimately realize the products exactly as planned.

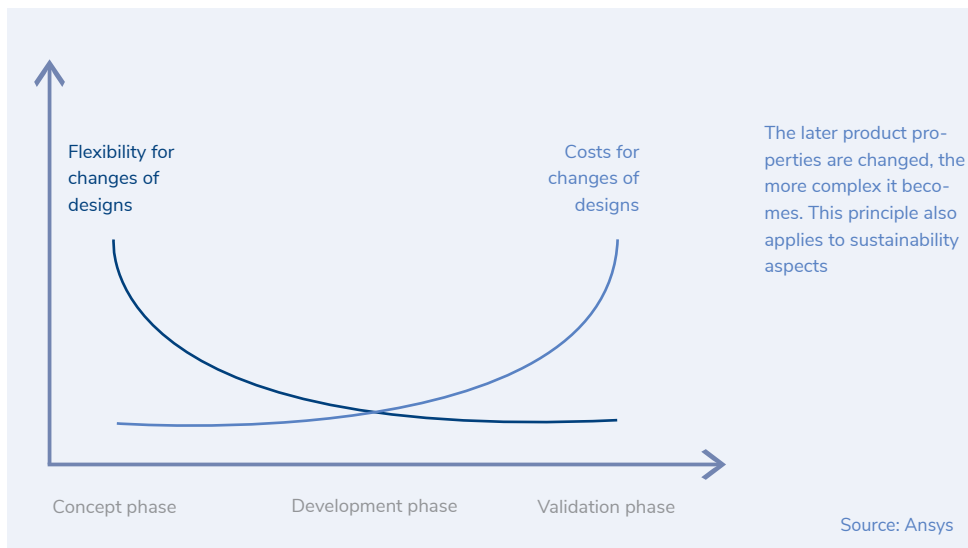
CENTRAL, INTEGRATIVE, INTELLIGENT

With the Ansys Granta MI product - MI stands for "Material Intelligence" - Ansys provides the framework for a central, up-to-date and integrative source of information for all material knowledge within a company. Not as an isolated solution, but interlinked with all other digitized company processes, from CAD and CAE to PLM and ERP. A single, reliable and up-to-date company-wide - intelligent! - source on the subject of materials that all areas use and maintain - from R&D, materials management and testing to production, quality assurance, procurement and legal.



NEW: A MODULE FOR SUSTAINABILITY

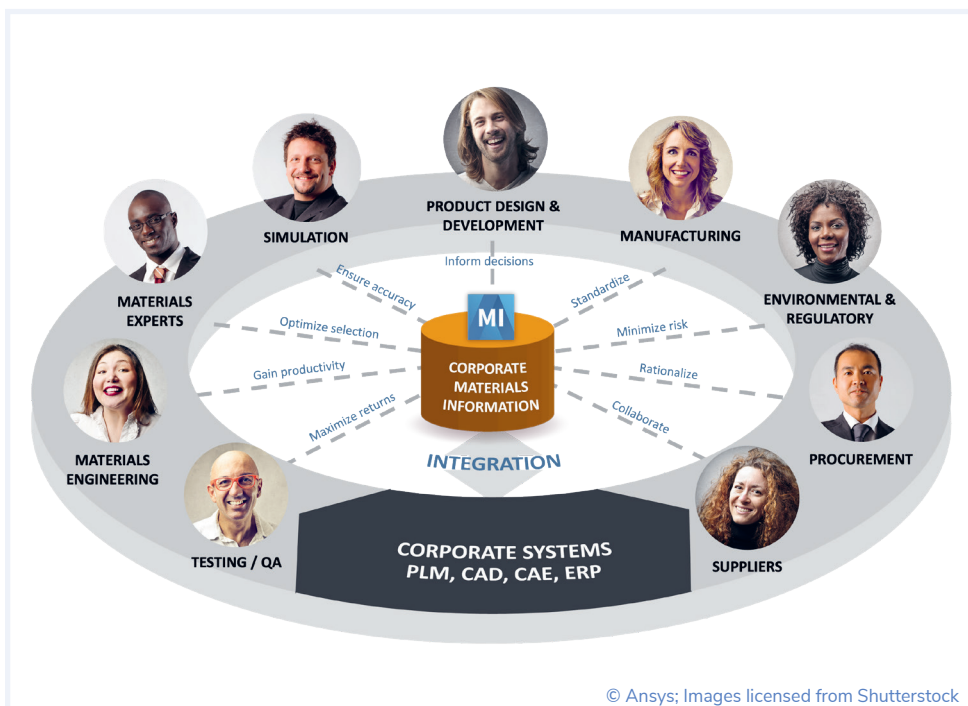
In 2024, Ansys Granta MI received a new module that was developed specifically for the early implementation of important sustainability aspects: Ansys Granta MI Sustainability. The collection, linking and evaluation of all sustainability-relevant information in the context of materials enables companies to incorporate the environmental impact of future products into the development process at a very early stage and to report it as early as the marketing launch. Flexibly, reliably and in accordance with recognized standards and in-house specifications - and without losing sight of the effects on product performance and costs.



COMPANY-WIDE MATERIAL KNOWLEDGE

Ansys Granta MI Enterprise™ is the company-wide center for the entire and always up-to-date digital material knowledge. It is used by all areas for which material-specific information is relevant: Material experts, laboratory, simulation, design, purchasing, quality assurance and sustainability management / CSRD. It can also be connected to the company's own CAD, CAE, PLM and ERP systems.

[CADFEM.NET/GRANTAMI](https://www.cadfem.net/grantami)



STRUCTURED MATERIAL SWARM INTELLIGENCE:

Material information is fundamentally complex and multi-layered; it often has to be painstakingly obtained, and the choice of materials is constantly increasing.

Regulations are constantly changing, they vary from region to region, and the number of substances classified as “harmful” is also growing. This also applies to purchased materials and supply chains.

Cost effects must be taken into account in the sense that the earlier the optimum material is found, the cheaper it is to develop; there are also dependencies on the service life of the product with very different interests among the parties involved.



MORE INFORMATION

WHITEPAPER
FREE OF CHARGE



FAST, FASTER, HYPERLOOP

Around the globe, people are working on the Hyperloop, the incredibly fast transportation system of the future. The TUM Hyperloop team of students, professors, and researchers from the Technical University of Munich (TUM) is at the forefront of this work. The team relies on state-of-the-art development tools, which includes simulations with Ansys as well as know-how transfer by CADFEM.

Hyperloop is an ultra-high-speed transportation system for passengers and cargo. The concept was proposed in 2013 by Elon Musk and is now being made a reality. High-speed mobility has two main components: One is a network of tubes, and the other is transportation capsules, known as pods, in which passengers travel at speeds of up to 900 km/h.

Contactless magnetic levitation and propulsion systems enable a fast, comfortable, and safe travel experience. Powerful vacuum pumps extract air from the tube segments so that the pod travels through the tube with virtually no air resistance.



TUM Hyperloop, the ultra-fast transportation system for people and freight being built in Munich. © TUM Hyperloop.

Energy efficiency and climate-neutral operation make the Hyperloop system a key technology for sustainable transportation in the future.

Hyperloop is not only technologically innovative, but its implementation is also quite unique. Similar to open source software, the initiators have opted for a participatory concept and launched a competition in 2015. In 2017, the finalists were allowed to demonstrate their pod prototypes on the test track in Las Vegas. Among them was the team from the Technical University of Munich, whose pod achieved the highest speed, confirming its success with new records in each of the subsequent three years.

THE TUM HYPERLOOP TEAM

2020 saw the official launch of the TUM Hyperloop program, a research project of the Technical University of Munich. After the Munich student initiative proved in a pitch that it can develop unbeatably fast pods, almost 100 team members from over 25 countries are now officially working on making this high-speed transportation system a reality.

The preliminary highlight was the first fully functional and full-size demonstrator in Europe, presented in Ottobrunn near Munich in summer 2023.



TEAM TUM HYPER- LOOP NUMBERS

86 TEAM
MEMBERS

28 NATIONS

15 ANSYS
USER

Almost 100 team members in Munich are developing the TUM Hyperloop, which has already come to fruition in the form of a demonstrator in Ottobrunn, south of Munich | © TUM Hyperloop

Flow simulations with Ansys Fluent are used to analyze the pressure resistance and determine ways to minimize it. © TUM Hyperloop.

TUM HYPER LOOP



TUM HYPERLOOP, ANSYS, AND CADFEM

As one of the leading institutions for engineer training, the use of simulation technology has always been a high priority at TUM. Among the cross-institutional equipment used at TUM are the Ansys software tools provided by CADFEM. In addition, simulation specialist from CADFEM and TUM have been linked for decades by many joint projects and initiatives in research, teaching, and student support. Plus, many CADFEM employees have a TUM past.

In the TUM Hyperloop project, Ansys tools are used in four technical sub-teams with a total of 15 team members. The main focus is on fluid mechanics, electromagnetics, electronics, and thermal applications. An important factor in a complex system such as the Hyperloop is the analysis of interactions that arise from the interplay of various physical disciplines. Ansys is the perfect tool for this.



THE DECISION IN FAVOR OF ANSYS WAS ULTIMATELY A DECISION FOR ANSYS PLUS CADFEM. BECAUSE ONLY WITH THE RIGHT APPROACH CAN THE POSSIBILITIES OF SUCH POWERFUL SOFTWARE LIKE ANSYS BE FULLY EXPLOITED. THE TIPS AND TRAININGS OFFERED BY CADFEM ARE EXTREMELY HELPFUL IN THIS REGARD.

TIM HOFMANN

Head of Propulsion, TUM Hyperloop

The decision to use Ansys tools was made in large part because of the relationship with CADFEM and their experienced experts. The wide range of trainings offered by the Ansys specialist, which students can use for their own subject matter, is a huge advantage. This constellation is ideal for building up and expanding simulation knowledge in a targeted manner, both in terms of breadth and depth.

YOUNG ENGINEERS, ANSYS, CADFEM

>500

university locations rely on Ansys and the support of CADFEM for teaching and research.

MORE INFORMATION

TUM Hyperloop Use Case Elektromagnetics
[CADFEM.NET/TUMHYPERLOOP1](https://www.cadfem.net/tumhyperloop1)

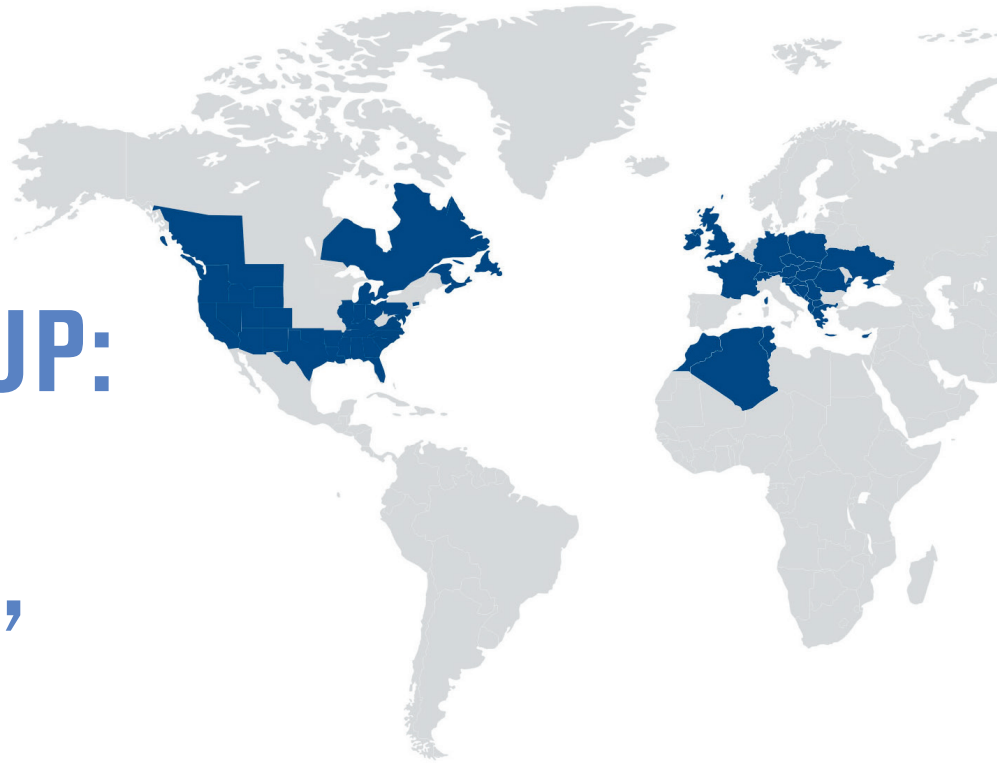
TUM Hyperloop Use Case CFD
[CADFEM.NET/TUMHYPERLOOP2](https://www.cadfem.net/tumhyperloop2)

TUM Hyperloop website
[TUMHYPERLOOP.COM](https://www.tumhyperloop.com)

CADFEM Academic Initiative
[CADFEM.NET/ACADEMIC](https://www.cadfem.net/academic)



CADFEM GROUP: DIGITAL, ENGINEERING, NETWORK



The CADFEM Group connects the largest group of Ansys Channel Partners from different regions. It also supports (and challenges) specialized companies with digital solutions for current megatrends and invests in startups working on the technologies of tomorrow. Insights into a dynamic ecosystem of competencies, technologies and visions.

Together, the CADFEM companies in Germany, Austria and Switzerland, France, the UK and Ireland, as well as many countries in Asia, form the CADFEM Group.

ANSYS EXPERTS

Apart from the CADFEM name, these group of companies shares a common philosophy when it comes to selling Ansys solutions in their respective markets: To ensure that customers benefit optimally from the software, a comprehensive and individualized range of consulting, training, support and services is part of the overall package.

Other members of the CADFEM Group in Eastern and South Eastern Europe and North America do exactly the same. The only difference is that they are not called CADFEM, but operate under their regionally known company names.

ADDED VALUE FOR MEGATRENDS

Other companies in the CADFEM Group are not referred to as CADFEM, nor is their core business the marketing of ANSYS products. In these companies, highly specialized interdisciplinary teams develop innovative products and digital technologies with great added value for current megatrends such as AI, energy, mobility, medicine or energy-saving air conditioning of buildings:

BCE Dynamics

Digital twins for the analysis and optimization of climate systems in buildings and neighborhoods

www.bce-dynamics.de

inuTech

Development of software and algorithms for special simulation tasks

www.inutech.de



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LOCATIONS

30+
COUNTRIES

600+
EMPLOYEES

35+
COMPANIES

INYO Mobility

Autonomous shuttles for the last mile
www.inyo-mobility.com

ITficient

Digital twins for industrial plants
www.itficient.com

PI Probaligence

Probabilistic AI/ML solutions that are especially suitable for simulative applications
www.probaligence.com

SIMQ

Digital twins for medical applications
www.simq.com

3D Mapping

Digital twins of high-precision road maps and infrastructure
www.3dmapping.com

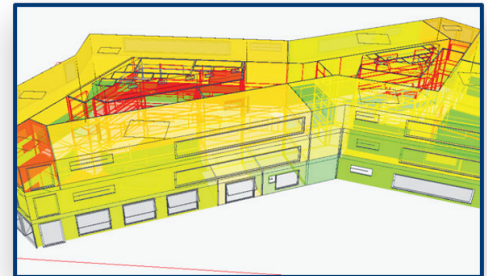
Virtual City Systems

Digital twins of cities and landscapes
www.vc.systems

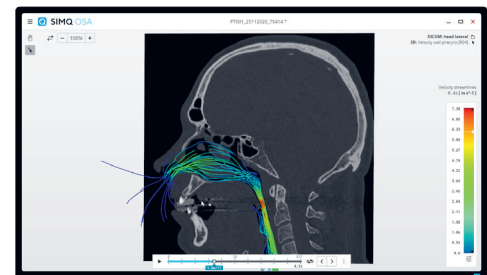
These companies with their unique expertise mostly cooperate actively with other CADFEM Group member companies, depending on the requirements of customers or projects. In addition, each partner also operates independently outside the CADFEM Group ecosystem.

THE WORLD OF TOMORROW

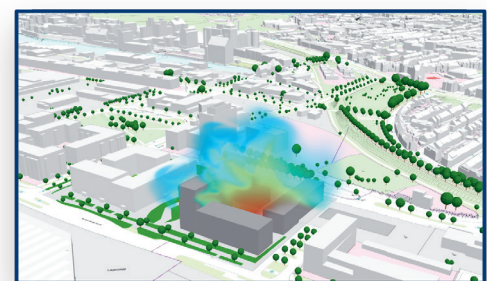
As a mentor and investor of young DeepTech startups, the CADFEM Group promotes the development of promising technologies for the future. The creators behind the innovative solutions thus also benefit from the extensive network of the CADFEM Group family and can be integrated into the ecosystem at an early stage.



BCE Dynamics: Digital twins of building interiors. Temperature development and energy requirements are simulated over the course of the year. The picture shows the CADFEM headquarters in Grafing.



Simq: Digital twins of medical applications. Simulation of air flow in the airways is carried out in connection with obstructive sleep apnea.



Virtual City Systems: Digital twins of cities and neighborhoods. Microclimate is simulated using a detailed city model.

MORE INFORMATION

CADFEMGROUP.COM

SMART MOBILITY FOR SHORT JOURNEYS

The vision of autonomous driving is on the cusp of becoming a reality. The industry is vigorously pursuing the necessary technologies, while this new mobility remains at the top of the agenda at national, regional, and local government levels. CADFEM is also involved. The focus is on short, manageable distances.

The autonomously driving INYO CAB is a central component of the NeMo.bil project, for which the city of Paderborn is currently attracting attention. The electric four-seater, which will either travel in convoy or autonomously and individually to its destination as required, is being developed and built by INYO Mobility GmbH, a CADFEM Group company.

INYO Mobility is also the consortium leader of the mobility project, which is funded by the Federal Ministry for Economic Affairs and Climate Protection. CADFEM Germany is one of the approximately 20 project partners. The task of CADFEM is to optimize the design of the system, control, energy efficiency and overall resistance of the INYO CAB and the convoy and to analyze additional physical effects.

CADFEM: THE JOURNEY ITSELF IS THE GOAL

With INYO Mobility and CADFEM Germany, two companies are involved in NeMo.bil, which, together with other partners, form their own ambitious ecosystem for auto-

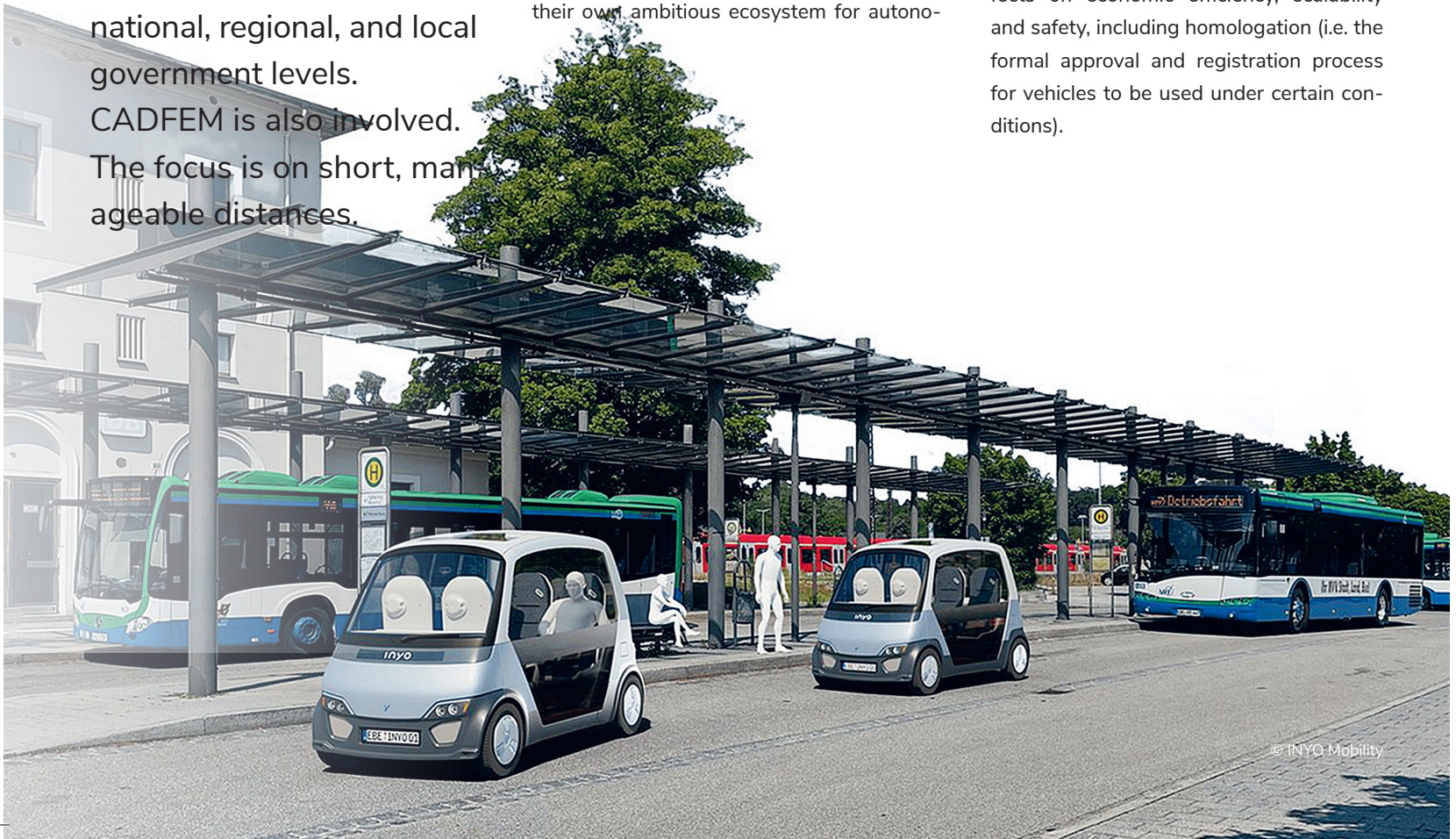
nous driving within the CADFEM Group. As a member of IAMTS (International Alliance for Mobility Testing and Standardization), ASAM e.V. (Association for Standardization of Automation and Measurement Systems) and ASCS e.V. (Automotive Solution Center for Simulation), CADFEM is pursuing a concept that focuses not only on the vehicle but also on its future framework for action.

The development of the shuttle - from hardware to general and situational behavior - and the modeling of the terrain in which it moves are highly digital and simulation-based. CADFEM is very familiar with virtual methods as well as the use of real test environments. In fact, road spaces in Grafing, where CADFEM is located, served as a real test environment in a previous research project.

THE CADFEM GROUP CONCEPT

The modular concept of CADFEM is based on its own core competence – Simulation.

- The exact digital models of the vehicle, infrastructure, and behavior ensure high precision and flexibility, with positive effects on economic efficiency, scalability and safety, including homologation (i.e. the formal approval and registration process for vehicles to be used under certain conditions).



- The intelligent vehicle, the virtual environment, and the software required for autonomy can be provided as a complete system or as individual components (e.g. NeMo.bil).
- Digital development leads to time and therefore cost benefits. It enables efficient scaling of the automated transport solution. The INYO CAB is designed in particular for first/last mile transportation tasks such as
 - Municipalities (i.e. connecting remote destinations to public transportation).
 - Extensive infrastructures (company premises, hotel resorts, urban districts)
 - Facilities for people with limited mobility (retirement homes, hospitals)

THE SHUTTLE: INYO, CADFEM GERMANY, TH AUGSBURG

As is customary in automotive engineering, the entire development process of the INYO CAB is based on a precise virtual data model. CADFEM uses Ansys simulations to ensure that the real CAB is efficient, functional and safe. Among other things, the aerodynamics and weight ("the body") as well as the sensor technology ("the senses") are optimized. The control system ("the brain") of the CAB is being developed by specialists, i.e. the Institute of Electrical Engineering at Augsburg University of Applied Sciences.

THE ROAD SPACE: VIRTUAL CITY SYSTEMS, 3D MAPPING, AVES REALITY

The digital 3D city model in which the shuttle moves is generated by Virtual City Systems. It becomes a realistic virtual image of the operational area by taking into account the characteristics of the road surface, such as its material or existing dips. This data is measured and provided by 3D mapping. In addition, the surroundings (buildings, trees) can be displayed via the AVES Reality software using satellite data and AI.

SIMULATION PROCESS AND DATA MANAGEMENT: ANSYS MINERVA

All information flows into the central data management system Ansys Minerva™, where it is structured, processed, integrated, evaluated and bidirectionally exchanged as a "single source of truth".

THE STEP TOWARDS AUTONOMY

The vehicle and its environment now have precise and interacting digital development models. But how is autonomy achieved, including the ability to react to unplanned situations?

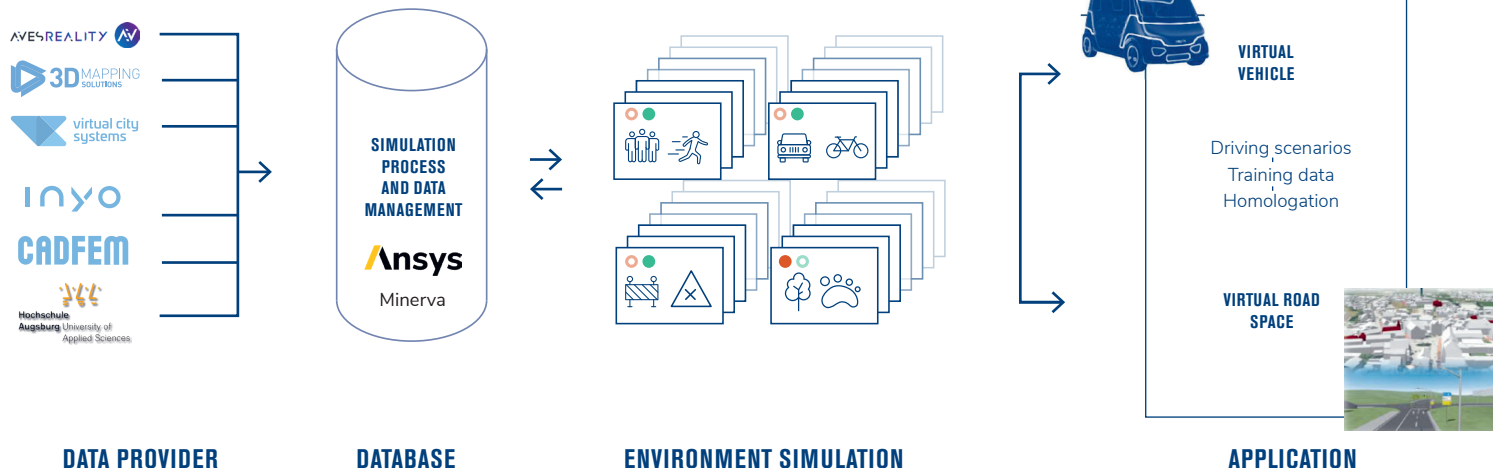
The Federal Motor Transport Authority relies on the five levels defined by the SAE: the INYO CAB currently operates at SAE Level 4 (i.e. a driver still can intervene). The path to Level 4 without security driver or Level 5 (fully automated driving) involves training the "brain", the AD stack from Augsburg University of Applied Sciences. This trains the vehicle to react appropriately to all conceivable scenarios outside the norm.

These scenarios include typical traffic situations, such as the sudden appearance of pedestrians, animals, cyclists or obstacles. Since many combinations and variants are involved here, it is impossible to capture everything using real test drives. There are no limits in the virtual test field, which means that all scenarios can be simulated, analyzed and stored in various constellations using special tools.

Each piece of information improves the system's ability to react predictably and safely to an ever increasing number of traffic situations - right up to the goal of an automated vehicle that takes us to our destination comfortably and affordably.

MORE INFORMATION

Concept, Partner, Initiatives, Events
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CONTACT

APAC

CADFEM India, Hyderabad (HQ)
Tower 2, 6th Floor, Fortune 9,
6-3-191/C/1, Raj Bhavan Rd,
Somajiguda, Hyderabad,
Telangana – 500082
India
+91 9849998435
marketing@cadfem.in

CADFEM India in Pune, Ahmedabad, Chennai, Gurgaon, Bangalore are companies of the CADFEM group.
+91 9849998435
marketing@cadfem.in

CADFEM Singapore
2 Venture Drive, #06-17
Vision Exchange, 608526
CADFEM SEA Pte. Ltd.
Singapore
+65 6572 8886
marketing@cadfem.sg

CADFEM Vietnam Company Limited
No. 26 Duong Dinh Nghe
Street Yen Hoa Ward,
Cau Giay District Ha Noi,
100000
Vietnam
+84 908520788
marketing@cadfem.vn

CADFEM Malaysia
1-01-05 (Suite3A.5),
5th Floor, Block 1
Setiawalk, Persiaran Wawasan,
Pusat Bandar Puchong,
Selangor, 47160
Malaysia
+60173183972
marketing@cadfem.my

CADFEM Thailand
240/39, 19th Floor,
Ayothaya Tower Building
Ratchadaphisek Road, Huai
Khwang Subdistrict, Huai
Khwang District Bangkok
10310
Thailand
+66 65 965 1987
th-marketing@cadfem-sea.com

CADFEM Indonesia
Sampoerna Strategic
Square North Tower Level
17 Jl.Jenderal Sudirman
No.45-46, Karet Semanggi,
Setiabudi Jakarta Selatan,
DKI Jakarta 12930
Indonesia
+62 21 21684115
marketing@cadfem.id



CADFEM.AI



CADFEM.AI/NEWSLETTER



LINKEDIN.COM

INTERNATIONAL

CADFEM Germany GmbH
Am Schammacher Feld 37
85567 Grafing b. München
Germany
+49 (0)80 92 70 05 46
info@cadfem.de

