RISC Software GmbH

Leonardo da Vinci
Universal scholar
(1452–1519)

PIONEER NOW.

COMPANY REPORT 8.0

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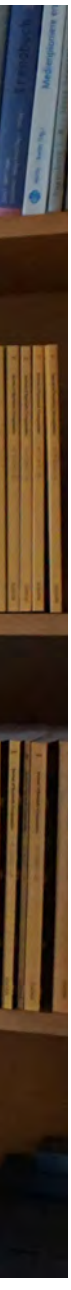

PREFACE

PROF. DR.DR.H.C.MULT. BRUNO BUCHBERGER.

You're at the forefront!

Why is your company, with RISC as a partner, also at the forefront in the age of AI? Let me take you on a brief intellectual journey: Since the dawn of mathematics, the goal has been to tackle difficult problems by inventing methods ("algorithms") that allow each individual instance to be solved without further thought. For about 300 years now, mathematics has also been striving — soaring to breathtaking heights by "viewing the mathematical invention process from above" — to create algorithms that automate the invention of algorithms. For roughly 70 years, this endeavor has been known as "Artificial Intelligence." Two fundamentally different approaches have been pursued in this field: "Symbolic Computation" and "Machine Learning."

Symbolic Computation

- **Advantage**: guaranteed correctness
- **Disadvantage**: too complex for many practical problems (such as natural language translation).

Machine Learning

- **Advantage**: tremendous success in recent years with practical problems
- **Disadvantage**: no guarantee of correctness

The following trend is becoming increasingly clear: More and more leading research institutions and AI developers that had previously focused exclusively on machine learning are now "rediscovering" symbolic computation and striving for a "grand unification": using machine learning to rapidly generate solution proposals, and symbolic computation to verify their correctness. RISC (Research Institute for Symbolic Computation) played a pioneering role in shaping the field of symbolic computation when it helped to found the discipline in 1985 through its groundbreaking research contributions and the establishment of the Journal of Symbolic Computation. Since then, RISC has been a major force in advancing the field and remains one of the world's leading institutions pursuing this "grand unification" today. With RISC, you are at the forefront of both major branches of AI. I extend my congratulations to the institute's leadership — Professor Carsten Schneider and Dipl.-Ing. Wolfgang Freiseisen — and to the entire teams at RISC and RISC Software, for continuing to deliver top-tier research and cutting-edge applications to our research and business partners, even in the age of AI. Because one thing holds true:

When surfing,
you have to stay ahead of the wave!

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PREFACE

RECTOR UNIV.-PROF. DR. STEFAN KOCH AND VICE-RECTOR MAG.A CHRISTIANE TUSEK.

RISC Software, a spin-off of Johannes Kepler University Linz majority-owned by the university, has been a success story since its founding by the JKU RISC Institute. This success is built on the implementation of applied research projects and the transfer of technology from the academic environment to industry — particularly to strengthen the competitiveness of Upper Austria's export-oriented industrial sector.

The successful development of RISC Software GmbH is also reflected in its continuous growth in operational performance: from €4.2 million in 2014 to €7.4 million in 2023, representing an overall increase of +76%.

In addition to its successful corporate strategy — which contributes to strengthening Upper Austria as an industrial hub — and the solid development of RISC Software GmbH's financial KPIs, one highlight is the recent successful collaboration in the field of artificial intelligence combined with medical research. Numerous success stories have emerged from this joint research area between JKU and its research company, RISC Software GmbH.

Three successful JKU-RISC collaborations will be highlighted in more detail:

LIT Law Lab Under the direction of Univ.-Prof. Dr. Philipp Homar, the LIT Law Lab — working in cooperation with RISC Software GmbH — focuses on exploring the legal questions and visions surrounding digital transformation.

MC3 – Medical Cognitive Computing Center The MC3 brings together the knowledge, expertise, and experience of the partners Johannes Kepler University Linz (JKU), Kepler University Hospital Linz (KUK), and the Medical Informatics research division of RISC Software GmbH. Initiated by the Province of Upper Austria, this center aims to research and implement innovative methods in the field of artificial intelligence to ensure optimal patient care.

AI Call by the Province of Upper Austria – November 2024 As part of a funding initiative, eleven innovative research projects were selected with the goal of establishing Upper Austria as a model region for artificial intelligence. Of these eleven projects, three are based at RISC Software GmbH, further underscoring the research-driven success of this JKU-affiliated company.

These selected examples demonstrate that RISC Software GmbH not only excels in its traditional core areas of computer science and mathematics but also creates interdisciplinary value for both science and industry in collaboration with JKU. Johannes Kepler University Linz aims to continue on this path together with its highly successful applied research company, RISC Software GmbH.

PREFACE

UNIV. PROF. DR. CARSTEN SCHNEIDER.

Since the founding of the Research Institute for Symbolic Computation (RISC) in 1987, algorithmic mathematics in the field of symbolic computation has advanced rapidly. The institute's founder, Bruno Buchberger, made a landmark contribution to mathematics with the development of Gröbner basis theory. Often referred to as the "Swiss Army knife" of algebraic mathematics, this method enables the simplification and solution of algebraic equations. It allows for a precise description, complete analysis, and resolution of numerous mathematical and technical problems.

In recent years, increasingly powerful algorithms have been developed to solve differential and difference equations or to simplify complex sums and integrals. These methods are essential for analyzing and computing expressions that play a central role in technical and scientific applications.

A remarkable example is RISC's long-standing collaboration with DESY (Deutsches Elektronen-Synchrotron). In this project, highly complex three-loop diagrams were simplified into known functions. The calculations required intermediate steps that generated expressions occupying several terabytes of main memory. These included recurrences up to order 100, with printed forms spanning up to 40,000 A4 pages. Through symbolic methods, this vast amount of data was transformed into compact results that can be represented on just a few pages. These results are now being compared with data from the Large Hadron Collider (LHC) at CERN to gain deeper insights into the Higgs boson (the so-called "God particle") and the potential unification of the four fundamental forces into a single primordial force at high energies.

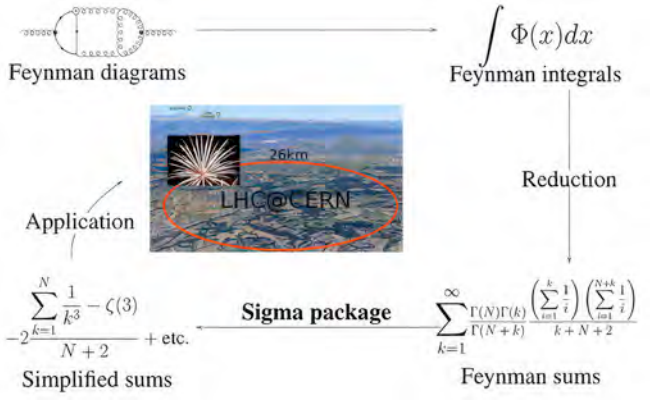
In addition to symbolic manipulation of algebraic structures — a core area of computer algebra — RISC also focuses on the automated development and verification of algorithms, as well as the proof of mathematical theorems. These approaches make it possible to automatically prove mathematical conjectures and to develop new algorithms supported by formal correctness proofs. RISC methods can also be used to detect errors in software or to optimize code, for example, by identifying and eliminating redundant code segments.

$$
\begin{aligned}
f_3(n) = {} & \\
& -\frac{2^{1-4n}T_3}{27(1+n)(2+n)(3+n)(1+2n)^2(3+2n)^2(5+2n)}\binom{2n}{n} - \frac{\left(349+1164n+612n^2\right)2^{5-2n}}{27(1+2n)(3+2n)} \\
& -\frac{\left(41967+66774n+32884n^2+5768n^3\right)2^{1-4n}\binom{2n}{n}}{27(1+n)(2+n)(3+n)}S_{\{2,1,2\}}(n) - \frac{1}{27}2^{8-2n}\sum_{i_1=1}^{n}\frac{2^{-2i_1}\binom{2i_1}{i_1}}{\left(1+2i_1\right)^2} \\
& +\left[-\frac{5}{27}2^{6-2n} - \frac{3\left(-7+4n+4n^2\right)2^{5-4n}\binom{2n}{n}}{(1+2n)(3+2n)} - \frac{5}{27}2^{6-2n}\sum_{i_1=1}^{n}\frac{2^{-2i_1}\binom{2i_1}{i_1}}{1+2i_1}\right]S_{\{2,1,1\}}(n) \\
& -\frac{5\left(65+220n+116n^2\right)2^{5-2n}\sum_{i_1=1}^{n}\frac{2^{-2i_1}\binom{2i_1}{i_1}}{1+2i_1}}{27(1+2n)(3+2n)} - \frac{71}{27}2^{5-2n}\sum_{i_1=1}^{n}\frac{2^{-2i_1}\binom{2i_1}{i_1}S_{\{2,1,1\}}(i_1)}{1+2i_1}, \qquad (4.44)
\end{aligned}
$$

Symbolic Computation and Machine Learning
The methods of symbolic computation, enriched by algorithmic theories from mathematics and computer science, are a central component of artificial intelligence (AI). In recent years, machine learning has made tremendous progress. This technology enables computers to learn from data, recognize patterns, and make predictions or decisions without being explicitly programmed. Applications range from pattern and speech recognition to complex tasks like automated programming.

Despite its impressive achievements, machine learning reaches its limits when tackling more complex tasks such as proving mathematical theorems or developing sophisticated algorithms. In such cases, these approximate methods can yield incorrect results.

There is significant potential in combining the two main branches of AI: symbolic computation and machine learning. Symbolic computation can verify and, if necessary, correct the results produced by machine learning. At the same time, machine learning methods can help make symbolic computations more efficient. Additionally, symbolic methods offer a way to reduce the high energy consumption associated with machine learning by using more resource-efficient techniques that can run on simple hardware, such as laptops.



Future outlook
The optimal combination of symbolic computation and machine learning forms the foundation for the next generation of artificial intelligence. This synergy will not only revolutionize automation in the software industry but also provide correctness guarantees for complex applications. Together, these technologies are driving progress in science and industry, opening up new possibilities for precise, efficient, and sustainable solutions.

PREFACE

MAG. PHILIPP KIENBAUER.

For more than thirty years, RISC Software GmbH has been an indispensable part of Upper Austria's research landscape. As a member of the UAR Innovation Network, the company makes a significant contribution to applied research and product development at an internationally competitive level. Its range of expertise spans artificial intelligence, symbolic computation, digital twins, simulation, and optimization — enabling RISC Software to deliver solutions that companies from a wide variety of industries can rely on.

RISC Software consistently demonstrates its innovative strength in the fields of health and medical technology. Topics such as an aging population and the optimization of medical care are among today's key challenges. With interdisciplinary expertise and a strong research focus on medical technology, the company develops internationally recognized specialized software — from neurosurgery to intensive care.

Particularly noteworthy are flagship projects funded by the Province of Upper Austria. The SPA project is developing an innovative modeling concept to optimize industrial processes through machine learning.

The project MEDUSA is creating a simulation system that assists neurosurgeons in planning highly complex brain surgeries.

With projects like ARES, which improves risk assessment for cerebral aneurysms, and MIMAS.ai, which analyzes medical imaging, modeling, and simulation based on AI, RISC Software is setting new standards.

The project IASON, which is developing AI-based simulation tools for intracranial aneurysms, further highlights its contribution to improving patient safety.

MEDI-DOK provides support for intensive care through AI-based evaluation of free-text data.

The ability to translate scientific knowledge into practical innovation is RISC Software's trademark. This recipe for success secures the company a leading role in the research community and long-term prospects.

I would like to extend my sincere congratulations to the entire RISC Software team on these accomplishments, thank you for your dedication, and look forward to continued collaboration and future success.

PREFACE

CHIEF TECHNOLOGY OFFICER.

The Role of Artificial Intelligence in the Modern IT World

AI has been the defining topic in recent years, turning the entire IT world on its head. Every day, new (language) models are released that are becoming increasingly powerful and intelligent. These innovations enable companies and developers to make impressive strides in areas such as machine learning, natural language processing, and autonomous systems.

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The impact of these technologies is far-reaching and is fundamentally changing how we work, communicate, and live.

The integration of artificial intelligence across a wide range of industries has elevated efficiency and productivity to unprecedented levels. Our Medical Informatics research division has long relied on AI, for example, in reconstructing blood vessels from CT and MRI scans or in developing surrogate models for simulations. But AI is not limited to this area — we apply AI methods across all domains to enhance efficiency and productivity.

These advancements are evident in a wide array of industrial applications. The methods used range from image recognition and forecasting models to time series analysis and the use of language models to automate and optimize industrial or business processes.

However, this field also presents challenges. Continuous knowledge development is vital for the success of these technologies, as are the hardware resources required to support them — whether on-premises or in the cloud. We must constantly evolve and adapt to keep pace with the speed of innovation. Moreover, it is essential to cultivate a strong ethical awareness to ensure that AI is used responsibly. Key issues such as data protection, algorithmic bias, and the future of work are being actively discussed and regulated. One example is the AI Act, which is setting the course at the European level for responsible use of artificial intelligence.

Overall, AI has the potential to sustainably improve our world — provided we face the associated challenges with intention and make wise use of the opportunities. At RISC Software GmbH, all these developments are continuously monitored and applied to remain a reliable partner for digitalization and AI projects.

PREFACE

CHIEF EXECUTIVE OFFICER.

Innovation, Excellence, and Partnership – A Behind-the-Scenes Look at RISC

What do brain surgery, production automation, and aircraft manufacturing have in common? At first glance, not much. But a closer look reveals a shared driving force behind all three: the innovative power of RISC.

"Pioneer now!" – it's more than just a slogan, it's our motivation. We aim to blaze new trails and help our partners do the same. As both a software company and a research institution, we combine scientific excellence with practical impact, laying the foundation for innovations that change the world. Curious how we do it?

Application, Research, and Education – A Dynamic Power Triangle

At RISC Software GmbH, we bridge the gap between research and practice. As a unique research institution, we develop professional software applications and products ready for the market — drawing on years of experience and in-depth industry expertise.

Our research — spanning both fundamental and applied science — focuses on areas such as artificial intelligence, symbolic computation, and software development. Of special note is our Medical Informatics division, where we've been pioneering for nearly 20 years in areas such as burn treatment, eye surgery, and intensive care.

With initiatives like the RISC AI Academy, we train highly qualified specialists and inspire the pioneers of tomorrow.

This close integration of research, education, and application enables us to transform scientific insights into practical solutions. This dynamic cycle is the foundation of innovation and value creation.

Excellence, Innovation, Partnership

What drives us is not just the pursuit of technical solutions, but a vision to make a lasting contribution to business and society. Our work is guided by excellence, innovation, and partnership.

This company report offers insights into our work, our projects, and our successes. Discover how we harness the power of this dynamic triangle to drive innovation and pioneer progress together with our partners.

Pioneer now!

DI Wolfgang Freiseisen
Chief Executive Officer

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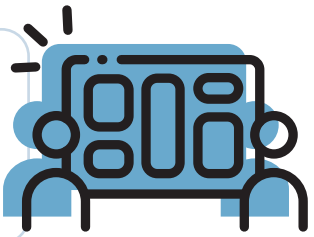
Welcome to the world of RISC!

Finance: RISC Software GmbH's Success at a Glance

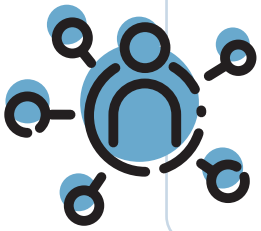
RISC Software GmbH generated approximately €8.4 million in operating performance in 2024. Over the past three years, this figure has grown at an average annual rate of around 12 percent. In total, RISC Software GmbH achieved an operating performance of approximately €22 million over the past three years.

8.4 Mio. EUR
Operation performance

On average over the past three years, around 70 percent of total operating performance came from business revenues. Of that, approximately two-thirds were generated in collaboration with partners based in Upper Austria.



70 % Revenues
from business sources



In 2024, RISC Software GmbH successfully completed around 80 projects in collaboration with over 100 partners. A key focus was on strengthening the regional economy, with approximately half of all projects carried out in cooperation with business partners from Upper Austria.

At the same time, RISC Software GmbH is also widely recognized beyond national borders and conducts numerous research and contract research projects with clients from Germany, Switzerland, and the United States.

More than 100
Cooperation partners

To promote knowledge dissemination, a total of 34 publications were released in 2024, including two completed academic theses (master's and diploma theses). In addition, employees participated in over 70 round tables, platforms, and opinion boards, reaching audiences in both the academic and business sectors.

34
Publicationens

Since its founding, RISC Software GmbH has increased the proportion of women from as low as 0% to an average of 29% in 2024. The company continues to pursue a long-term strategy to further raise this percentage, alongside the development of a sustainable diversity strategy. As a non-university research institution, our goal is not to maximize financial profit, but to contribute our part to building a better world.

29 %
Proportion of women

As of January 2025, RISC Software GmbH employs around 85 staff members from 9 different nations, making it a highly significant employer in the region.

85
Employees from 9 nations

Mag.ª Dr.in Waltraud Öller
Chief Finance Officer

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Research: Growth, Success, and Strategic Direction

RISC Software GmbH looks back on an exceptionally successful year in 2024. A total of 22 research proposals were submitted to national and international funding bodies, including the Austrian Research Promotion Agency (FFG) and the Horizon Europe program. Of these, 13 proposals were approved, while decisions on two others are expected by mid-2025. RISC Software GmbH assumed the role of consortium leader in nine of the submitted projects, underscoring its strategic position as a leading research player.

Thanks to these successful 2024 submissions, RISC now has an additional research budget of approximately €2.6 million for the next three years.

A standout highlight was summer 2024: under the "AI Region Upper Austria" call, five projects were submitted, three of which were approved for funding. Two of them — IASON and MEDI-DOK — are coordinated by RISC Software GmbH. Two other projects involving RISC participation — SOLAR-SKIES and SmaChaCo, both in the field of energy research — also received funding, rounding out a highly successful summer of research.

RISC Software GmbH is also part of two ongoing EU projects:

Platform-ZERO
Focused on improving production quality in photovoltaics through zero-defect manufacturing.

MetaFacturing
Digitization in metal processing through the implementation of digital twins.

With this track record, RISC Software GmbH strengthens its position as a key player and research partner in technologically advanced research and development projects.

A selection of successful research projects in 2024:

QML4Med
Research on quantum machine learning to optimize personalized medical applications.

HEART
Development of an AI-based system for monitoring body fluid levels using ECG signals.

IASON
Improving neurosurgical treatment through AI-powered simulation and analysis tools.

MEDI-DOK
Digitization and automation of medical documentation processes through the use of artificial intelligence.

Cand.Scient.
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Sales and Partner Management: Innovation, Trust, and Long-Term Partnerships

RISC Software GmbH develops software and AI systems and conducts applied research at the highest level for logistics, industry, medicine, and IT. It is both a non-university research institution and a software company — an exceptional combination in Austria at this scale.

The focus is not primarily on developing new methods, but on applying the latest technologies and methodologies to ensure they are practical and profitable in real-world settings.

RISC Software GmbH is not profit-driven, which means that profits remain within the company and are reinvested in research and development, as well as training and education. This enables employees to stay up to date with the latest technologies and maintain a cutting-edge skill set.

Thanks to its independence from specific manufacturers and technologies, the company always recommends the most suitable methods and technologies for each specific use case to its clients and partners.

A remarkable 70% of the company's research projects are directly financed by corporate partners, demonstrating its unique development capabilities — including the delivery of customized products with maintenance support. The remaining 30% consists of publicly funded research projects, which form the foundation for state-of-the-art R\&D innovations that commissioned projects can build upon.

Long-standing partnerships — some spanning more than 20 years — with renowned clients such as Airbus, voestalpine, Doka, and Austrian Post confirm the success of this unique combination of applied research and the development of highly professional software and AI systems.

This success is rooted in the latest innovative R\&D results, made possible by close collaboration with educational and research institutions — first and foremost Johannes Kepler University Linz, which holds an 80% stake in the company, and institutions like the University of Applied Sciences in Hagenberg.

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MEDICAL INFORMATICS

HIGHLY SPECIALIZED SOFTWARE FOR MODERN MEDICINE

Research Unit Medical Informatics.

The Medical Informatics research division has been focused for over 20 years on the systematic processing of data, information, and knowledge in healthcare. Its goal is to develop sustainable solutions for patients, physicians, and the healthcare system through the integration of computer science, mathematics, physics, business, and medicine.

Key areas include improving diagnostic methods, optimizing clinical processes, and applying innovative IT solutions to support medical care. The vision: to use multimodal medical data for personalized, evidence-based diagnosis, treatment, and prognosis — creating new knowledge in close collaboration with medical professionals. Modern technologies are employed to sustainably enhance quality of care, patient safety, and support.

Long-standing collaborations with regional, national, and international partners are the foundation of the division's success — including partnerships with Shriners Hospital Galveston (USA), BG Klinikum Berlin, the Medical University of Graz, and the Faculty of Medicine at Johannes Kepler University Linz.

From the collaboration with JKU's medical faculty emerged pioneering projects such as MEDUSA, a training and planning platform for neurosurgeons, and AIMS, an AI-powered early warning system for detecting patient deterioration.

The division's strength lies in applying cutting-edge scientific methods to medical challenges. This is grounded in years of experience, interdisciplinary expertise, and a strong partner network spanning research, industry, and healthcare.

Its scope of work ranges from basic research to clinically deployable software. Techniques used include medical image analysis, modeling, simulation, as well as data analysis and prediction. Results are shared with partners and presented at international conferences.

This unique blend of non-university research, entrepreneurial innovation, and scientific excellence makes the Medical Informatics division a sought-after partner for national and international research projects — many of which are funded by the Province of Upper Austria.

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MIMAS.ai: Medical Image Processing, Modeling and Simulation based on Artificial Intelligence

The research area Medical Image Processing, Modeling and Simulation based on Artificial Intelligence (MIMAS.ai) covers a cross-section of highly dynamic research topics that are gaining significant importance in medical applications — especially due to recent technological advances.

Medical Image Analysis and Segmentation
Medical imaging data is used in various forms for diagnosis, treatment planning, surgical guidance, monitoring changes in condition, and documentation. Common imaging modalities range from 2D images (X-rays, wound photos, etc.) to 3D scans (CT, MRI, digital subtraction angiography, etc.) and even videos (2D+t, 3D+t) that capture temporal progression.

To process this multimodal imaging data for medical diagnosis, treatment, and documentation purposes, the Medical Informatics research division develops a variety of image analysis and segmentation methods. Using AI-based techniques, these images are registered (aligned), enabling the segmentation (extraction) of patient-specific anatomical structures such as blood vessels, tissue, or skin. These segmented structures form the foundation for medical models and subsequent simulations.

The success of machine learning methods for registration and segmentation depends largely on the quantity and quality of available training data. In medicine, such data with appropriate ground truth is often scarce or inaccessible due to privacy concerns. Therefore, this research area also focuses on developing methods that simplify and support interactive ground truth creation. These include techniques such as CycleGANs to generate synthetic training data, one-shot learning with augmentation to create diverse training sets, transfer learning to apply existing models to new problems, and domain adaptation to adjust learned models to new data distributions.

Medical Modeling and Simulation
Modeling generally refers to the simplified representation of reality. In medicine, models must be aligned with clinical relevance, applicability, and data availability. These range from 3D body surface models to blood flow simulations that describe physical interactions between blood and vessel walls.

In many areas of medicine — such as burn care, chronic wound management, or forensic science — the affected body surface is a key diagnostic basis. This research focus involves creating virtual 3D patient avatars that closely match real patients, enabling objective diagnosis and longitudinal documentation. For example, wound size and location can be precisely measured and treatment progress tracked over time.

Biomechanical simulation allows for the modeling of processes within the human body (e.g., blood flow). Based on registered and segmented imaging data, anatomical structures are modeled (e.g., vessels, tissue, skin), meshes are generated, and material properties (e.g., elasticity,

viscosity) are determined. These models enable the calculation of both geometric features (e.g., maximum vessel diameter) and simulation-based metrics (e.g., vessel wall stress), supporting clinical diagnosis and treatment decisions. For instance, blood flow simulations can assess aneurysm rupture risk and evaluate the effectiveness of interventions such as clipping or stent-graft placement.

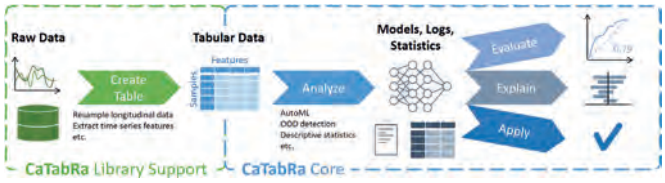
These models are also used in simulators for medical training, allowing for realistic practice of complex surgical procedures (e.g., brain surgery).

Medical Data Analysis and Prediction

A key success factor for using machine learning in medicine is the trust of both clinicians and patients in the data and the predictive models derived from it. This trust depends on methods for data validation, model interpretation, and deviation analysis. By providing and operationalizing these methods in a comprehensive data processing and analytics framework, the Medical Informatics division supports clinical decision-making.

These capabilities are developed through specific application scenarios, including ICU transfer management, optimization of the Manchester Triage System in emergency rooms, optimal blood product administration, and prediction of cardiac instability.

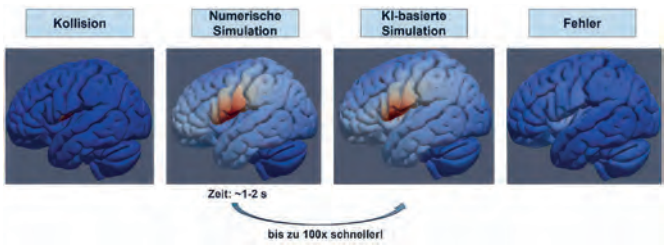
The focus is on researching a generic, easily configurable data processing pipeline for both established and emerging methods to meet future demands. In addition to structured data, imaging, video, and signal data — as well as combinations of these — serve as the foundation for analysis. Specialized feature extraction plays a critical role. Research emphasizes interactive, interpretable analysis of diverse data types, with a strong focus on traceability and explainability — key requirements in medicine under the umbrella of "Explainable AI."

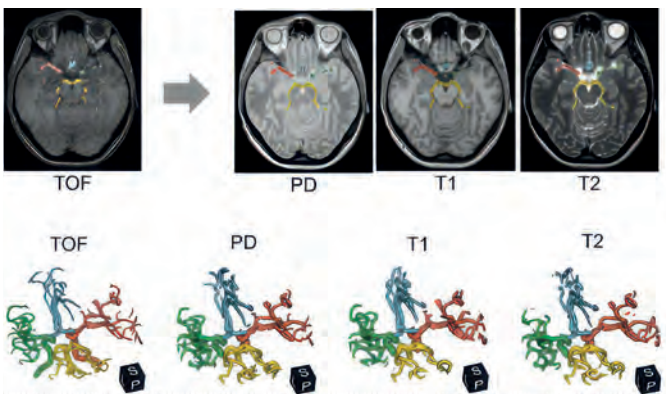


Interaction Between Research Fields

The research areas within the Medical Informatics division are tightly interconnected. Medical imaging often serves as the basis for modeling, which in turn underpins image processing, information extraction, and simulation of physiological processes. The foundational technologies and methods across these fields also overlap significantly.

GPU-based computing has driven the rise of deep learning in image analysis and simultaneously supports simulations of bodily processes. Simulating physiological interactions requires detailed anatomical models (e.g., organs, vessels), which are obtained via segmentation of medical imaging data. Registration — calculating a transformation that geometrically aligns multiple datasets (models, images, volumes) — enables multi-source data integration and information transfer across domains. Feature extraction occurs across all research areas in various forms.





The following medical application examples illustrate the interconnectedness of these research areas:

Aneurysm rupture risk

Aneurysms are diagnosed using CTA scans (computed tomography angiography). The segmentation of the aneurysm and surrounding blood vessels is used to create a volumetric model (mesh) for blood flow simulation. This simulation allows for the calculation of pressure and vessel wall stress. For a patient cohort (e.g., aneurysm patients from the past ten years), these features can be analyzed using machine learning-based data analysis to assess rupture risk and subsequently select an appropriate treatment strategy.

Burn classification

A patient with burn injuries receives initial treatment in the emergency department. Using medical modeling methods, a virtual 3D body surface model is adapted to the patient based on an RGB-D scan. Photos of individual wounds are analyzed using image processing methods to classify burn depth. The wounds — both their extent and depth — are documented on the body surface model. The progression of the wounds and subsequent treatment is also documented on this model, providing valuable data for improving the care of future patients through medical data analysis and prediction.

The shared goal of all these efforts is the continued advancement of personalized and evidence-based medicine. To achieve this, current research methods must be further developed in close collaboration with medical experts at an early stage. Only in this way can it be ensured that, in the medium term, state-of-the-art techniques are effectively translated into clinical practice for the benefit of patients.

Research Project MEDUSA: "Flagship Medical Technology Project" of the State of Upper Austria

The goal of the MEDUSA consortium is to develop a groundbreaking training and planning platform for neurosurgeons, enabling detailed and holistic simulation of complex brain surgeries. MEDUSA's top priority is to protect patients' lives.

The project "Medical EDUcation in Surgical Aneurysm clipping (MEDUSA)" emerged from four proposals submitted under the "Flagship Medical Technology" initiative by the State of Upper Austria. The Medical Informatics research division of RISC Software GmbH serves as the lead coordinator for this flagship project, which is funded with €2.3 million.

The goal of the MEDUSA consortium is to develop a groundbreaking training and planning platform for neurosurgeons, enabling highly detailed and holistic simulation of complex brain surgeries. MEDUSA's top priority is to protect patients' lives. Simulating complex medical procedures both qualitatively and quantitatively in a realistic environment creates optimal training and education opportunities that enhance patient safety.

The surgical simulator VIRTUAL ANEURYSM, a predecessor of the MEDUSA project, was developed to train clipping procedures in virtual scenarios. It combines stereoscopic visualization, haptic force feedback, and realistic simulations to represent blood vessels and tissue resistance in real time using optimized finite element methods. Trainees can choose from various difficulty levels, geometries, and instruments to develop surgical skills. The simulator also allows for objective evaluation of training based on criteria such as blood flow analysis and the precise placement of clips. Building on these achievements, the MEDUSA project is setting new standards in neurosurgical education.

Hybrid Simulator for Neurosurgeons

The brain is the most complex human organ, and disease-related damage can have severe consequences for patients. Surgical treatment of neurological disorders such as brain hemorrhages is extremely challenging because target areas are often embedded within highly functional and layered tissue structures. Successful interventions are only possible through advanced technology and the extraordinary cognitive and motor skills of neurosurgeons. Strengthening both components is at the core of the MEDUSA research project.

Due to the complexity of neurosurgical procedures, simulators must combine several technical skills. Proper handling of instruments, the use of imaging techniques, and sensitive haptic feedback are all essential – requirements that current simulators do not fully meet. Based on a hybrid approach, the MEDUSA consortium developed an innovative neurosurgical simulator consisting of a physically fabricated skull with artificial brain tissue, combined with virtually overlaid images that extend the simulation environment in real time. Surgeons can physically feel the artificial patient and visually perceive internal, otherwise hidden anatomical structures as virtually generated holograms. The real and

virtual worlds merge to create versatile and realistic training opportunities for neurosurgeons.

Far-Reaching Impact

To strengthen scientific exchange within the consortium, a regular journal club was launched under the leadership of OA Dr. Matthias Gmeiner (Kepler University Hospital, Neuromed Campus). In the winter semester of 2021/22, this journal club was offered for the third time as a university course titled "Literature Clubs, Project Presentations and Guest Lectures – Modern Concepts in Neurosurgical Operation Planning and Training: Technological Innovations and Clinical Applications" at Johannes Kepler University Linz, open to medical students as well.

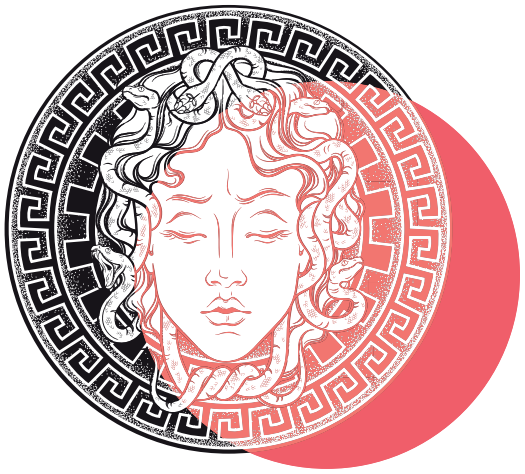
In the medium term, MEDUSA aims to establish a simulation and cooperation center in Upper Austria. Core technologies will be transferred into future medical products — such as surgical planning and navigation systems — that will significantly expand the accessible market, giving the project outcomes a wide-reaching multiplier effect.

Combining Core Competencies

This ambitious undertaking is made possible not only by advanced technologies but above all by the outstanding expertise of the consortium, which includes seven research institutions and six corporate partners. Leveraging synergies in the fields of neurosurgery, neuroscience, artificial intelligence, medical technology, materials science, and medical device regulation has created a lighthouse project that raises Upper Austria's profile on the global stage and establishes a strong presence in future-oriented and profitable markets.

Summary of Highlights:

- **Presentation of the Final System in Tübingen**: On May 4, 2024, the MEDUSA prototype was presented to neurosurgeons for the first time during the "Aesculap Clipping Course Zurich" in Tübingen. This marked the beginning of the first validation phase.
- **Innovation Award Recognition**: In 2023, the MEDUSA project earned second place in the prestigious Upper Austria Innovation Award in the "Research Institutions" category — underscoring the project's relevance and research excellence.
- **Project Video Production**: In collaboration with students from the Media Technology and Design program at the University of Applied Sciences Upper Austria, an informative project video was created. The video is available online and clearly illustrates the key aspects of the MEDUSA project.
- **Seamless Integration of Virtual and Real Worlds**: Through innovative registration techniques, an exceptionally precise alignment between virtual and real elements was achieved — exceeding the original project goals.
- **Simulation Workflow as a Foundation for Follow-Up Projects**: The developed fluid-structure interaction workflow proved to be so robust that it has already been successfully implemented in two follow-up projects: BRAD and ARES.
- **Use of Artificial Brain Models in the OR**: MEDUSA phantoms were tested under real surgical conditions. Neurosurgeons gave highly positive feedback on the haptics and visual realism of the models, which allowed for realistic access to aneurysms.



Medusa

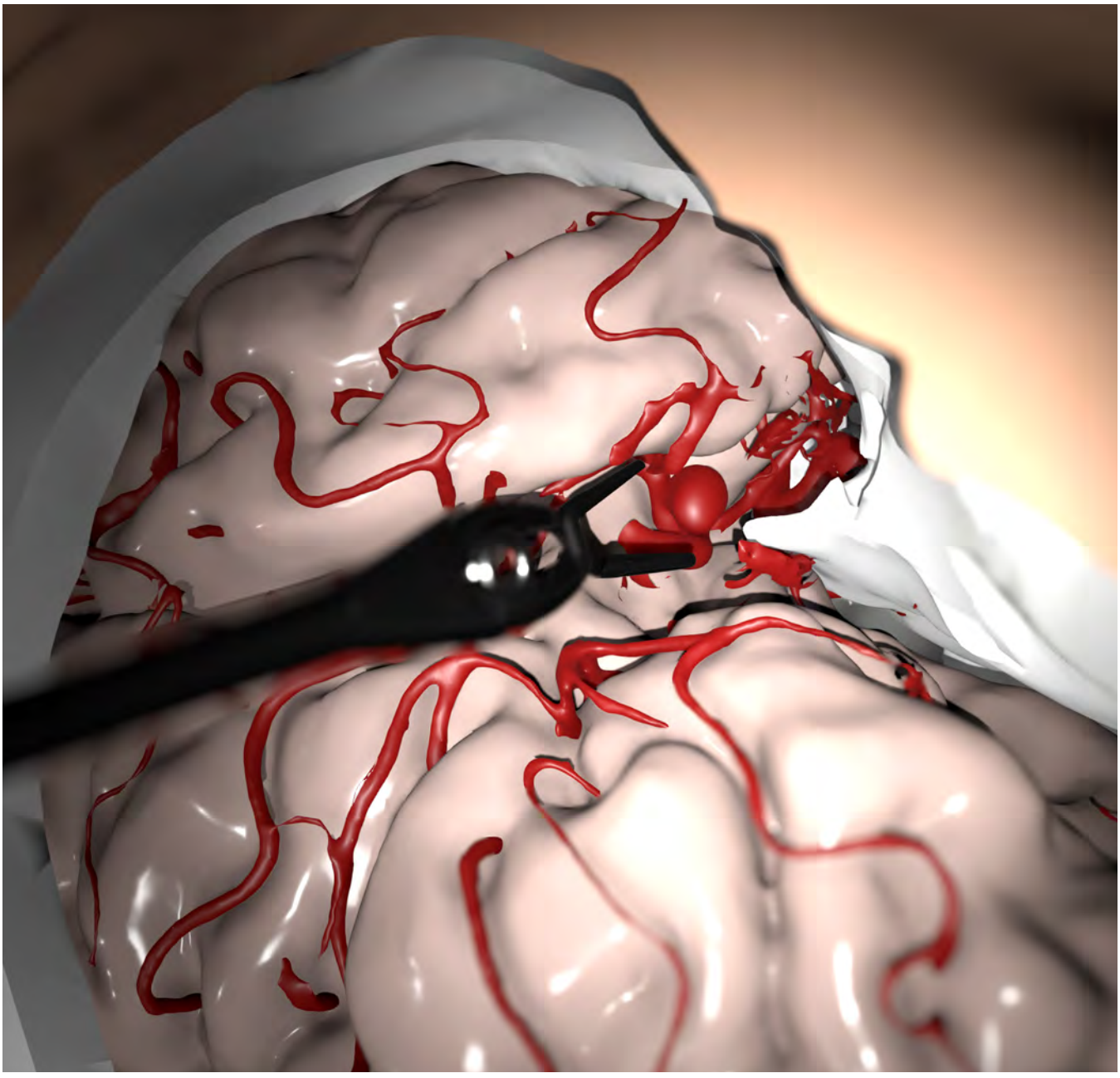
- **AI-Based Video Analysis in the OR**: An AI-driven system for automated motion pattern analysis was successfully tested in the operating room. The results were visualized in a user-friendly way, providing valuable insights for medical documentation.
- **Formal Conclusion of the Research Project**: The final MEDUSA project meeting took place on June 12, 2024, in the elegant setting of JKU's medLOFT. The event provided an opportunity to reflect on the achievements of the past five years and to showcase the latest developments.

The follow-up project IASON aims to use cutting-edge AI methods to calculate realistic deformations of detailed anatomical models in real time. This includes the simulation of nonlinear material models and rupture events. Central to the project are deep learning-based surrogate models and Physically-Informed Neural Networks (PINNs), which have already been successfully applied to accelerate fluid and structural mechanics simulations.

A unique feature of IASON is the novel combination and integration of optimized methods from fluid-structure interaction (FSI) and machine learning (ML). This enables more accurate predictions for treatment strategies, optimized resource allocation, and improved risk assessment.

Additionally, fast and accurate collision detection is a key component of the project to ensure realistic interactions between surgical instruments and deformable anatomical models – striking the optimal balance between realism and computational efficiency.

VIDEO MEDUSA



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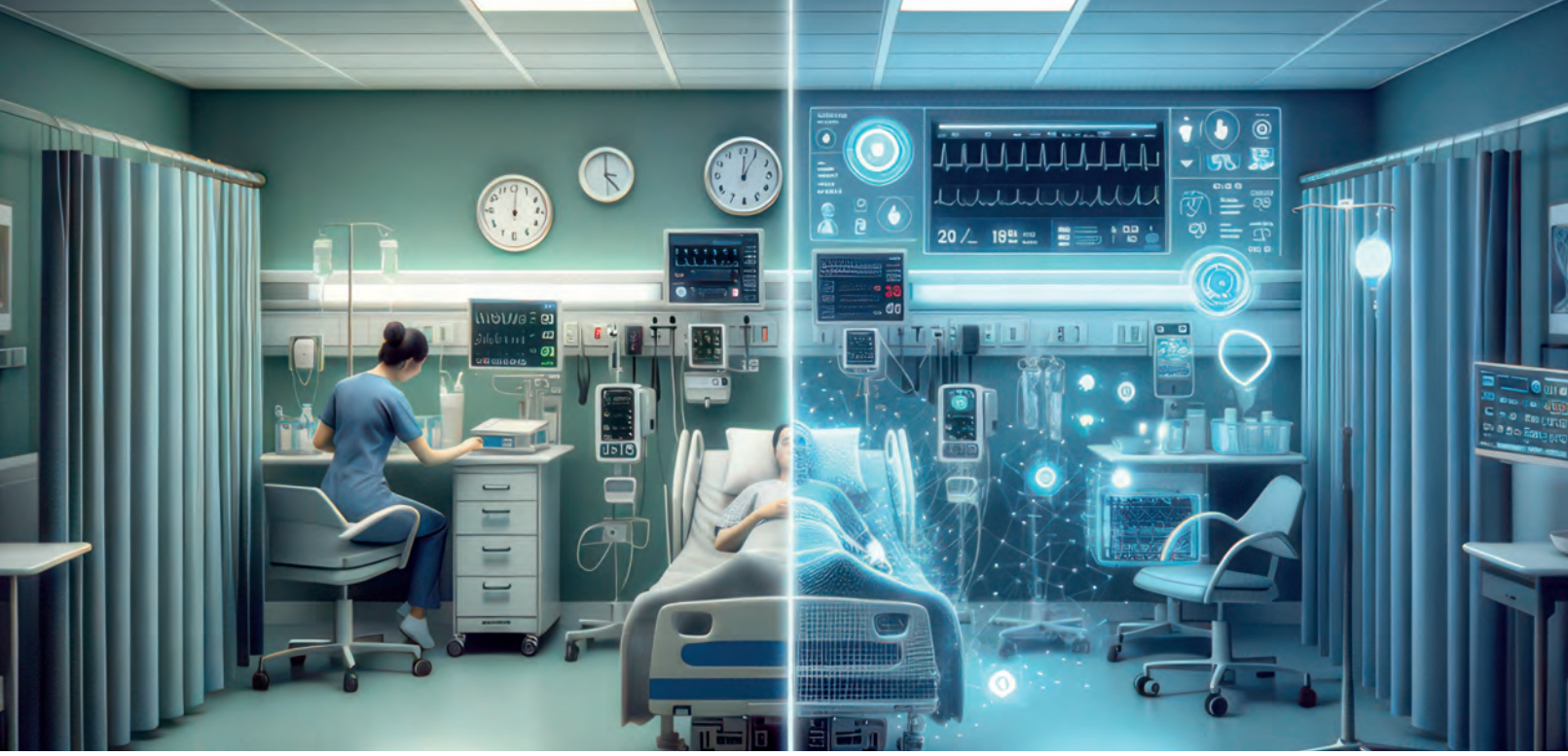
It's fantastic that we have this flagship project here in Upper Austria. MEDUSA is propelling us to the forefront of research and development.

Univ.-Prof. Dr. Andreas Gruber – Head of the Department of Neurosurgery at Kepler University Hospital, Linz



Research Project AIMS: AI-Based Monitoring and Early Warning for Patient Safety

The goal of AIMS is to develop and validate an early warning system powered by artificial intelligence to detect signs of patient deterioration on hospital wards before they occur.

Artificial Intelligence for Patient Safety: Early warning systems that save lives, boost efficiency, and strengthen European technologies.
Despite major advancements in surgery, the risk to patients remains high. In Europe, an average of 4% of all surgical patients die during hospitalization — more than half of them unexpectedly on general wards without intensive care monitoring. The AIMS (Artificial Intelligence-based Monitoring and Early Warning for Patient Safety) research project directly addresses this issue. Its goal is to develop and validate an AI-powered early warning system that can detect patient deterioration at an early stage, enabling timely interventions and preventing complications. The aim is to enhance patient safety and reduce unexpected deaths.

AIMS builds on the MC3 (Medical Cognitive Computing Center) project, which has already demonstrated how innovative approaches such as predictive modeling, explainable AI, and robust data management can elevate patient care to a new level that is both safer and more efficient.

Data-Driven AI Models
Retrospective data from intensive care units — including physiological signals and health records — are used to train a powerful predictive AI model.

Innovative machine and deep learning methods are combined with uncertainty quantification and model interpretation techniques.

Development of a Sensor System
A non-invasive sensor system is being developed and validated for continuous monitoring of physiological data (e.g., ECG, blood oxygen) on regular hospital wards.

Live data is fed into the AI model, which then generates predictions and alerts.

Ethics-by-Design
Given the direct impact of the technology on patient safety, the project is guided by ethical principles from the outset.

Clinical Benefits:

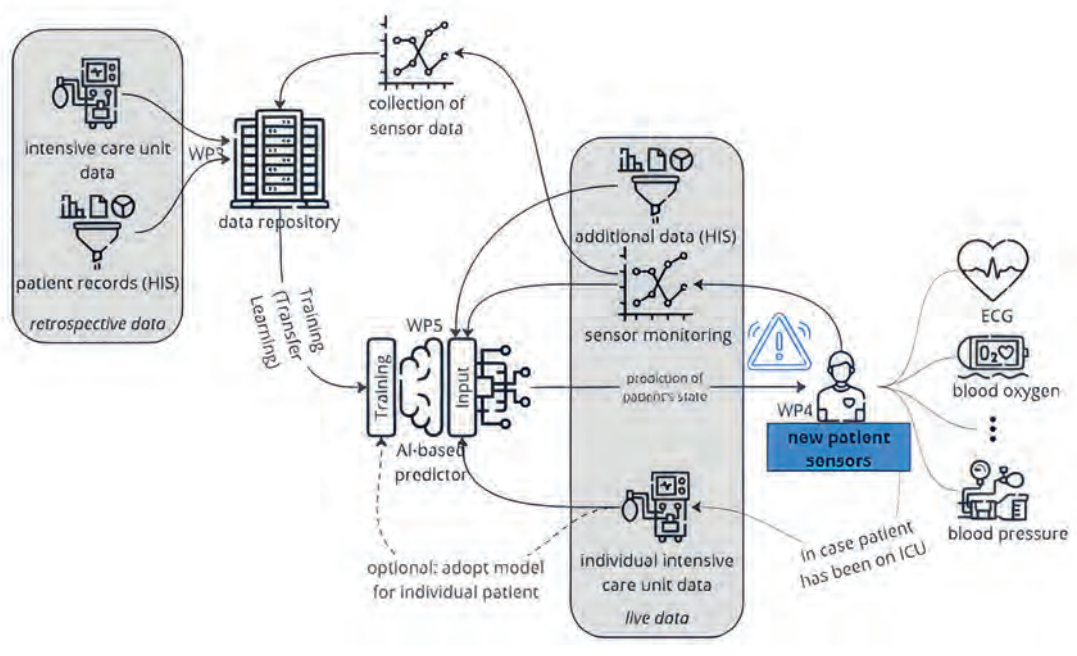
- **Patient Safety:** Early alerts enable timely medical intervention, which can prevent unexpected deaths.
- **Increased Efficiency:** The number of ICU admissions and overall hospital stays can be reduced.
- **Support for Clinical Staff:** The system helps make decisions more objective and systematic.

European Perspective and Value-Based Approach:

- **Technological Sovereignty**: AIMS develops AI solutions based on European data and values to minimize risks from data bias in non-European models. Large public datasets like MIMIC-IV or VitalDB primarily contain non-European data, limiting the applicability of such technologies in Europe. With the data collected by the University Hospital Linz, AIMS holds a key advantage in developing a European AI model.
- **Sustainable AI Integration:** AIMS supports the integration of AI technologies into clinical practice across Europe, increases the availability of high-quality health data, and strengthens European research.

The long-term vision of AIMS is to extend the early warning system across the entire patient care pathway – from hospital admission to home care. By combining world-leading technologies with the use of European data, AIMS lays the foundation for future medical applications that are independent of non-European providers.

AIMS brings together cutting-edge AI technologies, sensor development, and ethical guidelines to fundamentally improve patient safety and care. Through the fusion of innovation, a European data foundation, and technological independence, the project makes a vital contribution to the advancement of clinical practice and to establishing European leadership in medical AI.



Research Project Surface 3D: Patient-Specific Models

Inaccurate estimations of burn severity can lead to suboptimal medical decisions with serious consequences for patients. Surface 3D enables precise calculation of burn size, thereby enhancing patient safety and supporting clinical staff in their daily work.

Patient-Specific 3D Models for Accurate Calculation and Documentation of Burn Injuries

In burn medicine, the percentage of burned body surface area relative to the patient's total body surface area is a critical parameter for ensuring appropriate treatment and therapy. However, estimating total body surface area is a major challenge due to individual variations in body size and proportions. Inaccurate estimations of burn extent can lead to suboptimal medical decisions with serious consequences for patients.

Surface 3D enables precise calculation of burn size, thereby ensuring patient safety and providing essential support for clinical staff in their daily practice.

For nearly 20 years, the Medical Informatics research division at RISC Software GmbH has been developing objective 3D methods in close collaboration with numerous medical partners to optimize burn treatment and documentation.

One of the key outcomes of this research is Surface 3D — an interactive, web-based tool for high-precision annotation of burn injuries on patient-specific 3D body surface models. In addition to automatically determining burn depth and calculating wound size in real time, Surface 3D allows for comprehensive documentation of wound healing over time.

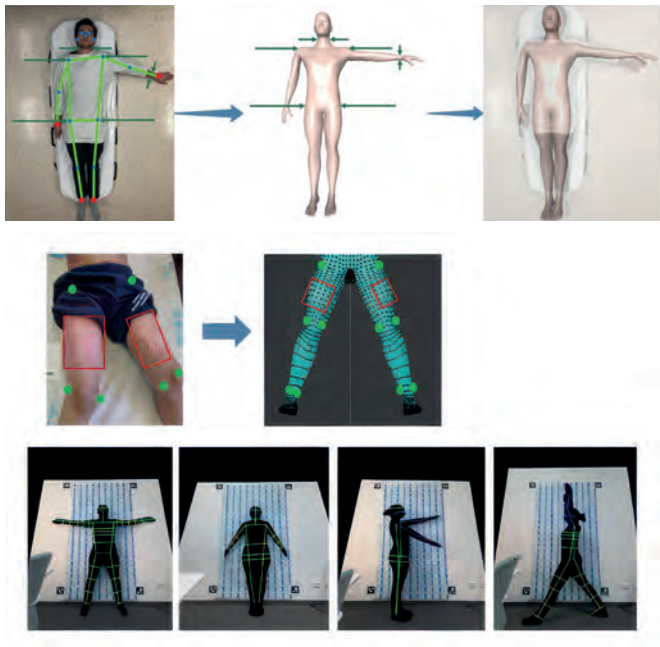
- **Patient-Specific 3D Models**: In Surface 3D, base 3D models from a model library can be customized to match patient-specific parameters such as gender, weight, and height. These models enable continuous documentation of burn injuries.

- **Precise Mapping of Wound Areas**: Surface 3D will include intuitive tools for transferring burn areas onto the virtual patient avatar. This allows burns to be marked with high accuracy — even the smallest regions can be captured effortlessly. As a result, every change over time can be documented clearly and in detail.

- **Keypoint Detection**: Wound images present specific challenges, as they often depict only small, isolated body regions such as hands, feet, or sections of the back. These images also vary in skin color, texture, and perspective. As part of the project, datasets will be enhanced through precise annotation of landmarks (keypoints) and cropped to focus on relevant body regions. The goal is to optimize data quality to meet the requirements of wound documentation — including reliable detection of anatomical keypoints on small body parts. Building on this foundation, a system will be developed that uses detected keypoints to automatically map affected areas onto a 3D avatar.

- **Comprehensive Documentation**: Surface 3D enables users to directly attach information or photos related to wounds at specific body or wound locations on the 3D patient model. This allows for consistent and structured documentation of details such as wound infections or complications. Such comprehensive documentation ensures high traceability of wound healing over time.

- **Platform Independence**: Surface 3D is a web-based application built with modern web technologies such as Angular and three.js, ensuring cross-platform compatibility. The software runs on Android, iOS, Windows, Linux, macOS, and directly in a web browser – no installation required. Depending on the use case, it offers tailored user interfaces and, thanks to its modular architecture, can be easily adapted for other applications.



BurnCase 3D

The BurnCase 3D research project, a predecessor to Surface 3D, aimed to improve the diagnosis and documentation of severe burn injuries using virtual patient models. Through computer-assisted analysis, the extent of injuries is determined objectively, treatment outcomes are documented in a structured way, and scientifically valuable data is generated. The software offers suggestions for medical coding, enabling standardized and efficient documentation – enhancing treatment quality while reducing workload for medical staff.

BurnCase 3D is used worldwide in burn medicine and serves as a foundation for clinical studies and the development of a global expert system. Insights from the project are now also applied in chronic wound care to improve the evaluation of current therapies. Special thanks go to Senior Physician Dr. Herbert Haller, whose initiative and support made the project possible.

Embodied Perceptions

The follow-up project *Embodied Perceptions* focuses on developing diversity-sensitive 3D visualizations that adapt avatars to individual characteristics such as gender, age, and body shape. Intersectional factors such as ethnicity and social background, as well as gender-specific and cultural differences in symptom perception, are taken into account.

The system enables dynamic documentation of pain and other symptoms, making it possible to track fluctuations over time or changes caused by medication. This allows patients to communicate their symptoms more precisely, and for individuals with language or communication barriers, the system provides a visual alternative to verbal communication.

It supports collaboration among healthcare professionals and facilitates the exchange of information, for instance during shift changes. With the integration of machine learning, the system improves precision and pattern recognition. Chronic symptoms can be tracked over time, promoting self-management for affected individuals.

CaTabRa: Analyze, Validate, and Train Machine Learning Models

CaTabRa is a versatile platform for secure, locally executed data analysis and visualization — designed to support a wide range of industries in efficiently leveraging and evaluating their data.

Smart Data Analysis and Modeling at the Push of a Button: Automated, explainable, local, and flexible!
CaTabRa is an open-source tool that automates the analysis of tabular data and the development of predictive models. It is designed for both domain experts without technical knowledge and data scientists seeking efficient insights from their data.

Key Features of CaTabRa:

- **Data Analysis**: Generation of descriptive statistics to provide an overview of the dataset.
- **Model Development**: Training of machine learning models to predict defined target values.
- **Model Explanation (Explainable AI)**: Identification of the importance of individual features to make model decisions transparent and understandable.
- **Input Data Validation**: Detection of data points that deviate from the original training data distribution to ensure the reliability of model predictions.

Use Case: COVID-19 Detection in Blood Tests
In 2022, researchers from Johannes Kepler University Linz, Kepler University Hospital MedCampus III, and RISC Software GmbH investigated whether COVID-19 infections could be diagnosed using routine blood tests. CaTabRa was used to attempt a reproduction of the results using only this tool.

CaTabRa successfully covered large parts of the data science workflow with minimal manual effort. This included:

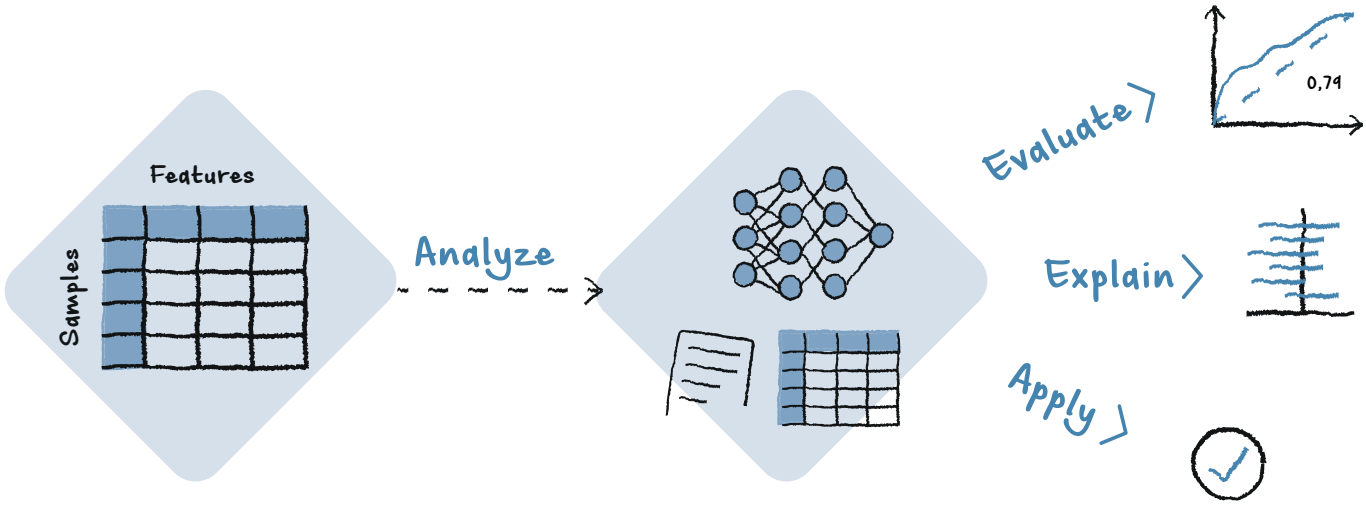
- **Analysis**: Generation of descriptive statistics for each feature (e.g., blood values).
- **Model Development**: Training of a classification model to distinguish between "infected" and "not infected" using AutoML methods.
- **Model Explanation**: Identification of the most important features contributing to predictions using SHAP values.
- **Validation**: Evaluation of model performance on a separate test dataset and detection of input data that deviates from the training data distribution (Out-of-Distribution Detection).

Benefits of CaTabRa

Simplifies and speeds up data analysis, enabling quick decisions on whether machine learning methods are appropriate. Generates visually appealing graphics that can be used directly in publications.

- Generates visually appealing visualizations that can be used directly in publications.
- Unlike cloud-based solutions, no sensitive data is uploaded; all analyses are performed locally.
- High flexibility: CaTabRa can be easily extended and customized to meet specific requirements.

CaTabRa thus offers a comprehensive solution for automated data analysis and modeling, suitable for both technical and non-technical users.



We recently used CaTabRa in a large study on [unruptured intracranial / brain] aneurysms. Specifically, the goal was to predict surgical outcomes \[based on preoperative metrics] in order to better assess treatment risk.

Thanks to CaTabRa, we were able to thoroughly analyze the data and train and evaluate a wide range of AI models in a short time. Even external validation — requested by reviewers as a requirement for publication — was easily achievable with the tool.

OA Priv.-Doz. Dr. Matthias Gmeiner

Research Project nARvibrain: Improved Brain Tumor Diagnostics and Treatment

The project nARvibrain aims to improve brain tumor diagnostics and treatment, raise patient awareness, and enhance the quality of medical education by combining cutting-edge methods from artificial intelligence (AI) and extended reality (XR).

Augmented Reality – Assisted Neuronavigation and Real-Time Simulations

The nARvibrain project (Augmented Reality Supported Functional Brain Mapping for Navigated Surgery Preparation and Education) aims to fundamentally improve brain tumor diagnostics and treatment by leveraging cutting-edge technologies such as augmented reality (AR) and neuronavigation.

In collaboration with project partners MEDUNI Graz, FH Joanneum, and CORTEXPLORE, the initiative is developing innovative methods to enhance the precision of neurosurgical procedures, optimize patient care, and elevate the standard of medical education.

Optimizing Brain Mapping

Before resecting a brain tumor, brain mapping is performed to identify the functions of the affected brain regions. Established methods such as functional MRI (fMRI) before surgery or Direct Cortical Stimulation (DCS) during surgery are commonly used.

nARvibrain is advancing transcranial magnetic stimulation (TMS) as a complementary mapping technique. TMS involves using a coil to generate electromagnetic fields that temporarily deactivate specific areas of the brain. During TMS, patients are asked to perform tasks like object naming or motor tests. Changes in performance provide insights into the function of the stimulated brain regions.

AR-Assisted Neuronavigation

A high-precision neuronavigation system is integrated with augmented reality to visualize the stimulation points and directions for TMS directly on the patient's head. This allows for an intuitive application of the procedure and ensures effective, minimally invasive stimulation.

Traditionally, numerical simulation methods such as finite element models (FEM) require significant computing time. However, by combining deep surrogate models with data-intensive numerical methods, these processes can be drastically accelerated. Machine learning algorithms are used to train a neural network on FEM data, enabling it to deliver simulation results in just milliseconds.

Using surrogate models, the electric fields generated by the TMS coil can be calculated and visualized almost in real time.

Other areas of activity within nARvibrain include applying the results to:

- **Interactive Patient Education**: A virtual reality (VR) system based on the Pepper's Ghost effect is being developed as an interactive tool to help visualize brain anatomy in an accessible way. This system enables physicians to clearly explain complex medical concepts — such as tumor location or treatment strategies — to patients.

- **Use in Medical Education**: An AR platform based on the Meta Quest 3 is being specifically designed for neuroanatomy education. Through interactive visualizations and innovative instructional methods, the platform supports the teaching of complex learning content. Features like gesture control and smartphone integration make the learning experience intuitive and efficient.

Benefits and Advantages:

- **Precision**: By integrating simulations, AR, and neuronavigation, procedures can be planned and executed with greater accuracy.

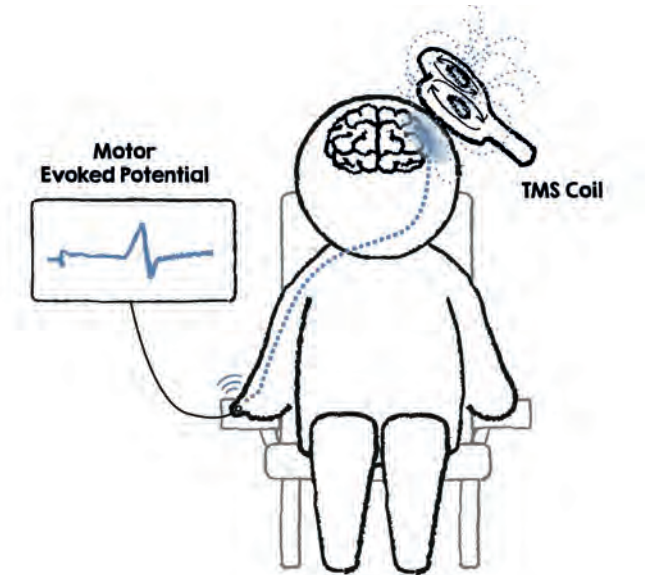
- **Speed**: Simulation results are delivered almost in real time, optimizing clinical workflows.

- **Patient-Centered Care**: Interactive visualizations improve communication between physicians and patients, enhancing understanding and informed decision-making.

- **Educational Support**: Didactic innovations and immersive technologies promote comprehension of complex neuroanatomical concepts.

- **Flexibility**: The developed technology is not limited to neurosurgery and can be extended to other medical specialties.

Transcranial Magnetic Stimulation (TMS)



nARvibrain

Federal Ministry
Republic of Austria
Climate Action, Environment,
Energy, Mobility,
Innovation and Technology

FFG
Promoting Innovation.

INTELLIGENT DATA SOLUTIONS FOR PRODUCTION, ENERGY, AND MOBILITY

Unit Data Intelligence.

In today's digital age, data intelligence means far more than simply collecting and storing information. Through a holistic approach — from structured preparation and integration to intelligent analysis — we refine data using advanced technologies such as artificial intelligence and machine learning. The result: valuable insights and predictive models that detect patterns, enable precise forecasting, and adapt flexibly to change. Whether time series, images, or text — smart use of data opens up new perspectives and drives innovative solutions.

Data Preparation and Management: The Foundation of Intelligent Analysis

The quality of underlying data is crucial to the success of any analysis. Modern methods for data integration, cleaning, and preprocessing enable efficient consolidation and accessibility of heterogeneous data sources. This includes both structured and unstructured data, as well as large volumes of data (Big Data), which are processed through optimized data pipelines.

Innovative Analysis Methods for Diverse Data:

- **Time Series Analysis**: Algorithms for detecting trends, patterns, and anomalies in continuous data streams are essential for forecasting and monitoring applications.
- **Image and Video Processing**: Classification, segmentation, and object detection using state-of-the-art neural networks are applied in areas such as quality assurance and production monitoring.
- **Text Analysis**: Natural Language Processing (NLP) techniques and the use of powerful language models (LLMs) enable automated text analysis, structured content preparation, and extraction of complex information — from documents and news articles to social media posts.

Scientific Excellence Meets Practical Implementation

The combination of scientific excellence and practical implementation is key. Through interdisciplinary collaboration with partners from research, industry, and public administration, innovative solutions are created that cover the entire development cycle — from concept and implementation to final system integration.

This approach specifically supports sectors such as production, energy, supply networks, mobility, and public administration, fostering data-driven decision-making and driving sustainable innovation.

Mag.ª Stefanie Kritzinger-Griebler, PhD
Head of Unit Data Intelligence

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DiTwin: Revolutionizing Road Management Through Digital Twin Technology

The project is revolutionizing road management with digital twin technology for optimized asset management.

Integrated Monitoring, Innovative Forecasting, and Intuitive Representation of Road Conditions in a Digital Twin

The DiTwin project aims to precisely assess and predict the condition of road sections using digital twin technology. By integrating modern sensor systems and advanced predictive models, the project seeks to usher in a new era of road and asset management.

Innovative Condition Monitoring and Forecasting

DiTwin is developing novel approaches to capture the condition of existing road sections (real-world testbeds) by incorporating material and structural data. The collected data is automatically analyzed to generate optimized condition prediction models, with the goal of enabling more efficient resource use in road and asset management.

Use of Advanced Sensor Systems

Material and condition data from the testbeds are collected through both existing stationary sensors and newly installed technologies. These include weigh-in-motion stations to record traffic load and sensors to determine the structural integrity of the road surface. Additionally, bearing capacity is assessed using a falling weight deflectometer, alongside laboratory testing of extracted core samples.

Digitalization and Visualization

Digitalization of the testbeds includes 3D photogrammetric methods. A central component of the digital twin is a database that stores various road graphs and enables all sensor and measurement data to be referenced accordingly. Different visualization methods — including 2.5D, 3D, and dashboard views — are being evaluated to determine the most effective format in consultation with stakeholders.

Potential for the DACH Region

Another key focus of the project is analyzing the scalability and transferability of the developed approaches to the major road networks of the DACH region (Germany, Austria, Switzerland). The project highlights the potential to reduce user costs and emissions through material selection in optimized maintenance strategies — contributing to climate goals.

By developing and implementing DiTwin technology, the project is expected to make a significant leap forward toward sustainable and cost-efficient infrastructure management strategies.

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SafeRoadWorks: Enhancing Safety at Highway Construction Sites

The project SafeRoadWorks aims to enhance safety at highway construction sites by developing innovative technologies and methods to minimize risks for both road users and construction personnel.

Challenges at Highway Construction Sites
Highway construction zones pose significant safety risks for both drivers and workers. In 2022 alone, around 10,000 short-term and 300 major or long-term construction sites were reported — resulting in 12 accidents and one fatality.

Project goals:

- **Driver Stress Reduction**: Identification of construction zone configurations that cause elevated stress and development of measures to mitigate it.
- **Real-Time Safety Alerts**: Development of methods to immediately warn workers in hazardous situations.
- **Site Condition Analysis and Documentation**: Detection of discrepancies between the current and previous versions of the construction site setup.
- **Increased Risk Awareness**: Raising awareness among workers, road inspectors, and drivers about potential hazards.

Innovative solutions:

- **Real-Time Traffic Monitoring System**: Implementation of a system that detects critical scenarios at high-risk construction zones, such as work zone entry points and highway on- and off-ramps.
- **Camera-Based Object Detection System**: Development of a method to identify relevant roadside objects (e.g., lane markings, traffic cones, road signs) to create a detailed documentation of the site's current condition during inspections.
- **Extended Reality (XR) Simulations**: Execution of XR simulation experiments using real construction site configurations and dynamic scenarios to identify especially stressful situations based on biometric measurements.

Expected Impact
By optimizing construction site planning and improving guidance, SafeRoadWorks aims to reduce driver stress and decrease accidents at highway construction zones. Workers benefit from targeted alerts in critical situations. As a result, SafeRoadWorks contributes to enhanced safety at highway construction sites and supports technological independence in the European mobility sector.

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POWERCAST: Electrifying Impulses for Tomorrow's Energy Sector

The POWERCAST project aims to enhance the cost and supply efficiency of power grids by using AI-driven forecasting models.

Challenges in the Energy Sector
The integration of volatile renewable energy sources such as wind and solar power presents major challenges for Austria's electricity grid. Traditional modeling techniques are too static to accurately represent dynamic factors like photovoltaic systems and electromobility. This leads to inaccuracies in load forecasts, necessitating costly adjustments that burden both energy providers and consumers.

Innovative AI Models for More Accurate Forecasts
POWERCAST is developing adaptive AI models that integrate multiple updatable information sources to generate precise load forecasts and identify key influencing factors. These models are based on adaptive learning and take into account the dynamic nature of consumption and production patterns within the energy system.

Project Objectives:

- **Improved Short-Term Forecasts**: Provide accurate load forecasts for grid operators to support daily assessments of safety standards compliance, particularly within the transmission grid, to ensure grid stability.
- **Integration of Renewable Energy**: Facilitate the approval of photovoltaic systems through precise forecasts, minimizing risks to grid reliability and supporting the transition to sustainable energy.

Proposed Solutions:

- **Adaptive AI Models**: Development of forecasting models that can adapt to dynamic changes in consumption and production structures within the energy system, and can be transferred to new but similar scenarios.
- **Integration of Diverse Data Sources**: Utilization of multiple updatable information sources to generate accurate load forecasts and gain insights into key influencing factors.
- **Collaboration with Energy Providers**: Incorporation of expertise and high-quality data from the energy sector through partners such as Linz Netz GmbH and Austrian Power Grid AG to ensure the development of practical, real-world solutions.

By providing more accurate forecasting models, POWERCAST helps facilitate the integration of renewable energy sources, reduce system costs, and enhance the sustainability of the energy system. The project aligns with the EU's goals of increasing the share of renewables and achieving climate neutrality by 2050.

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Promoting Innovation.

PRM 4.0 / iam4rail: Model-Based Condition Monitoring & Predictive System for Rail Networks

The Predictive Railway Monitoring 4.0 (PRM 4.0) project aims to enhance the safety and availability of railway infrastructure through innovative technologies. At its core is the development of an "intelligent switch" that uses sensors and artificial intelligence (AI) to monitor the condition of track switches and enable predictive maintenance.

Challenges in Railway Operations
Switches are critical components of the rail network and essential for operational stability. Traditional maintenance approaches are often based on fixed intervals, without considering the actual condition of the components. This can result in unnecessary maintenance or unexpected failures that disrupt rail traffic.

Project Goals:

- **Improved Safety**: Early detection of wear and potential malfunctions reduces the risk of disruptions and accidents.
- **Increased Availability**: Scheduled maintenance based on actual condition data minimizes downtime and maximizes operational readiness.
- **Lifecycle Cost Optimization**: More efficient maintenance strategies reduce long-term costs and extend the lifespan of infrastructure components.

Innovative solutions:

- **Real-Time Data Fusion**: PRM 4.0 integrates data from the track and vehicles as well as external sources such as weather information and timetables. This comprehensive data collection enables an accurate picture of the current infrastructure condition.
- **Energy-Autonomous Sensors**: The use of innovative, energy-autonomous sensors continuously captures relevant parameters at the switches without the need for external power sources.
- **Artificial Intelligence and Machine Learning**: By applying AI and machine learning, precise predictions of the short- and medium-term condition of switches are derived from the collected data. This enables condition-based and predictive maintenance.

Building on the results of PRM 4.0, the ongoing EU follow-up project iam4rail is further developing and broadly implementing the technologies created. The goal is to establish an integrated asset management system for the European rail network, which will enhance the efficiency and safety of rail transport through intelligent switches and advanced monitoring technologies.

FFG
Promoting Innovation.

3e AG: Optimal Order Recommendations Through AI-Driven Optimization

RISC Software GmbH developed a customized, AI-based software solution for 3e AG to optimize their procurement process. The goal was to generate optimal order proposals by accurately forecasting stock levels, thereby increasing efficiency in order processing.

Challenges in the Procurement Process
3e AG, a leading association of hardware and tool retailers with over 300 member businesses in Austria and other international markets, faced the challenge of automating its complex ordering processes. The goal was to reduce manual orders, optimally manage inventory, and streamline the supply chain.

Solution Approach: AI-Based Optimization
The developed software uses historical sales data to accurately forecast future inventory levels using Artificial Intelligence. Machine Learning methods were integrated into the software architecture. The components communicate via a central message bus and are containerized on on-premise servers.

Functionality of the Software:

- **Data Integration**: Daily updates of sales data from the central warehouse and retail locations.
- **Forecasting**: Generation of inventory forecasts per item based on current and historical data.
- **Model Updating**: Regular retraining of machine learning models to incorporate current trends.
- **Optimization**: Calculation of optimal stock levels per item using the internal RISC IBEX optimization framework to ensure ideal inventory levels for expected sales within the planned ordering cycle.

The generated order suggestions can be processed either fully automatically or after manual review. Since its launch, the system has been continuously developed and refined.

Results and Benefits
The implementation of this solution enabled 3e AG to significantly automate its ordering processes, resulting in reduced manual efforts and optimized inventory levels. This led to increased supply chain efficiency and improved customer satisfaction.

This project highlights how the use of artificial intelligence and machine learning in retail can optimize ordering processes and provide a decisive competitive advantage.

KOALA: Maximum Data Security and Intelligent Solutions with an In-House AI Platform

RISC Software GmbH presents KOALA (Knowledge-Oriented AI Language Assistant), an innovative AI-powered knowledge platform that provides companies with a secure and efficient solution for context-based information processing.

Processing challenges
Companies face the task of efficiently managing large volumes of data and making relevant information quickly accessible. Data security and the ability to understand the context of inquiries are crucial.

Solution approach: KOALA
KOALA enables linguistic interaction with internal company data through a familiar chat interface. The platform can be flexibly deployed in cloud, on-premise, or hybrid environments and integrates data sources such as Confluence, Outlook, or file systems. Role-based access ensures that only authorized personnel can access specific information.

Features and benefits:

- **Context awareness**: KOALA understands the context of inquiries and delivers precise results tailored to the user's needs.
- **Data security**: On-premise deployment ensures that sensitive data remains within the company, guaranteeing maximum security without compromise.
- **Flexibility**: The platform can be adapted to specific requirements and seamlessly integrated into existing systems.
- **Future-ready features**: KOALA will soon be capable of utilizing external APIs, identifying contradictions in the data, and autonomously executing actions.

KOALA is designed for companies that prioritize maximum data security and aim to optimize their internal knowledge processes. The platform is especially well-suited for organizations seeking a flexible and customizable solution for processing and analyzing large volumes of data. KOALA offers a powerful platform for the efficient and secure handling of information. With features like context awareness, flexible integration, and high data security, KOALA supports process automation and boosts productivity.

DOMAIN-SPECIFIC APPLICATIONS

AGILE SOFTWARE DEVELOPMENT FOR DATA AND PROCESS MANAGEMENT

Unit Domain-specific Applications.

Driving Business Success Through Agile Software Development
The unit Domain-specific Applications at RISC Software GmbH collaborates with partners from research and industry to develop sustainable, customized solutions tailored to specific requirements. Acting both as a professional implementation partner and as a coach, the unit supports the adoption and consolidation of agile methods through targeted training and consulting.

Custom Software Development
Tailored software solutions offer companies the means to optimize specific processes, integrate existing systems, and boost efficiency and competitiveness. These flexible applications are built to adapt to evolving requirements, providing long-term value.

The unit Domain-specific Applications integrates the latest research from artificial intelligence, automation, and data analytics into bespoke software solutions, ensuring efficient implementation and seamless integration into company structures. Regular maintenance and updates keep the technology up to date, while training ensures long-term support.

Professional Project Execution in Digital Product Development
By leveraging state-of-the-art technologies, the Domain-specific Applications unit develops flexible solutions that can be applied across diverse use cases and adapt dynamically to project needs. These custom-built software solutions grow with the projects and provide the flexibility required to respond to changing conditions and user demands.

A smooth and efficient project flow is ensured through proven agile methodologies that allow structured and goal-oriented handling of complex requirements. Certified Agile Coaches facilitate close collaboration among software developers, data scientists, mathematicians, UI designers, project managers, and users — ensuring clear communication and optimal project outcomes.

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Efficient Mass-Mail Preparation for Swiss Post AG

With the Post Mass Mailing Manager (MSM), RISC Software GmbH optimized the preparation of bulk mailings for Swiss Post AG and its customers. The system ensures error-free, high-performance, and cost-efficient mailing preparation.

Swiss Post: An Indispensable Logistics Partner
Swiss Post has always played a key role in ensuring Switzerland's connectivity. As one of the country's largest employers, it links people and businesses through a nationwide network. Its services range from traditional mail delivery to innovative parcel solutions and digital services. Swiss Post stands for reliability, sustainability, and innovation — values that are also central to RISC Software GmbH. Through their collaboration, Swiss Post leverages RISC Software GmbH's expertise, technical know-how, and commitment to a sustainable future.

Delivery Optimization: Focusing on Efficiency and Sustainability
In recent years, demand for fast and flexible delivery solutions has increased significantly. To meet these rising expectations, RISC Software GmbH works closely with Swiss Post to continuously optimize its logistics processes. A key focus lies on optimizing and sorting address data using specially developed software and algorithms to ensure the efficient distribution of bulk mailings between distribution centers and delivery bases. At the same time, digitalization enables more accurate planning and tracking of shipments, reducing misdeliveries and improving resource efficiency. This ensures a seamless information flow — from the sender through Swiss Post to the print service provider, on to the acceptance points, and ultimately to the final recipient.

Our Partnership with Swiss Post: More Than Just Logistics
The partnership between RISC Software GmbH and Swiss Post goes beyond a traditional business relationship. As a reliable partner, RISC Software GmbH helps Swiss Post serve its customers efficiently while co-developing innovative solutions. With advanced mathematical models and optimized processes, RISC Software GmbH delivers logistics efficiency for mail preparation. Both a local on-premise client-server solution for customers and a cloud-based solution operating within Swiss Post's IT infrastructure are used. By being integrated into Swiss Post's enterprise-wide systems, RISC Software GmbH benefits from a highly developed infrastructure and can offer its services even more efficiently and customer-focused.

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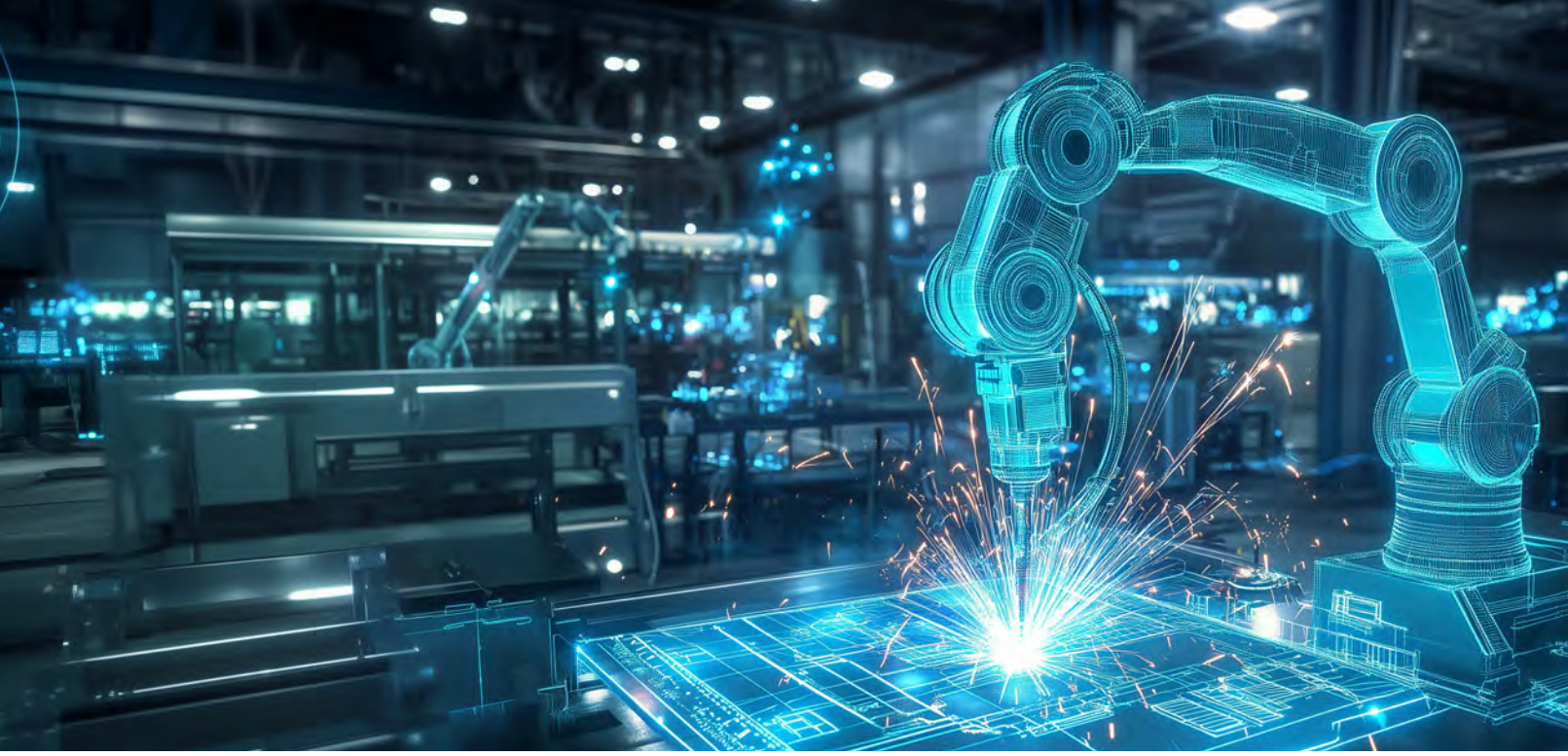
Thanks to the high quality of address sorting in the Mass Mailing Manager / the solution provided by RISC, both Swiss Post and its customers benefit from significant cost savings in mail deliveries.

Our long-standing collaboration with RISC Software as a competent IT partner has proven extremely valuable for us.

Swiss Post AG - Mirjam Werndli, IT Business Analyst, Post Informatik



Voestalpine Böhler Welding: Tradition meets Digitalization

In the project for voestalpine Böhler Welding, RISC Software GmbH developed a central digital platform for structured knowledge utilization in welding technology — laying the foundation for efficiency, quality, and digital process intelligence.

Voestalpine Böhler Welding – a company with over 100 years of tradition setting benchmarks in the welding industry – impresses with a broad product portfolio. The company manufactures high-quality welding consumables, welding equipment, and accessories, and is a leader in areas such as joining welding, repair and overlay welding, and brazing. With more than 40 subsidiaries in 25 countries and over 1,000 distribution partners, Voestalpine Böhler Welding is a global player, supporting its customers with innovative and customized solutions.

Yet, digitalization also poses significant challenges to long-established industrial sectors. The integration of Industry 4.0 technologies — such as connected systems, real-time data analysis, and AI-powered data analytics — promises significant optimization in production processes and quality assurance. On the other hand, this transformation requires substantial investments in modern IT infrastructures and ongoing training for specialists. Balancing tried-and-tested procedures with the adoption of new digital solutions involves risks such as data privacy concerns and cybersecurity challenges. This is precisely where RISC Software GmbH has been supporting Voestalpine Böhler Welding since 2018, contributing its expertise in "Digital Product Development."

Long-standing support in digital transformation

At the heart of this collaboration is the implementation of digital welding solutions in industrial environments. RISC Software GmbH's support in digitizing technological knowledge, capturing large volumes of data, linking with existing digital productivity systems, and expanding the client's product portfolio has been essential for Voestalpine Böhler Welding to fully implement the Industry 4.0 approach in welding technology. Our contribution helped launch the digital platform *weldNet®*, which modernizes and digitizes core welding processes. It consolidates various web-based applications that enable welding engineers, technologists, and other professionals to work faster, more precisely, and more efficiently. Two core components are the *weldNet® Material Manager* and the *weldNet® Equipment Configurator* – each providing specific customer benefits and added value:

weldNet® Material Manager

The Material Manager is a web-based tool providing access to a comprehensive, continuously updated database of materials and standards. With over 35,000 base materials — more than 24,000 of which include chemical analyses — professionals can quickly and accurately find the right base material. In addition, compatible welding consumables and applicable standards (e.g., DIN, EN ISO, AWS) are displayed, greatly simplifying the creation and updating of welding procedure specifications (WPS).

Customer Benefits and Added Value:

- **Efficiency & Time Savings**: Intelligent search algorithms deliver precise results in real time, enabling quick and accurate material selection.
- **Reliability & Quality**: The continuously updated database ensures that all information — from chemical compositions to applicable standards — is current and reliable.
- **Optimized Decision-Making**: The tool supports informed decisions by allowing direct comparison of material designations, properties, and standard classifications — leading to improved welding quality.
- **High Flexibility & Availability**: As a cloud-based solution, the Material Manager is accessible 24/7 from any internet-enabled device (PC, tablet, smartphone) — ideal for professionals on the go.

Customer Benefits and Added Value:

- **Tailored Solutions & Customization**: The Configurator enables each welding machine to be configured precisely for its intended use, ensuring optimal machine performance.
- **Ease of Use & Process Optimization**: Thanks to its intuitive interface, configurations can be quickly created, saved, and reused — streamlining planning and accelerating the ordering process.
- **Transparency & Safety**: A clear overview of all components and their compatibility reduces misconfigurations and minimizes risks in the production chain.
- **Flexibility & Constant Access**: As an online application, the Equipment Configurator is available anytime, anywhere — especially valuable for time-sensitive projects.

weldNet® Equipment Configurator

With the Equipment Configurator, welding machines can be individually assembled. The tool enables precise customization of all components — from the power source to the torch, cooling system, wire feed, and additional accessories — according to specific requirements and applications. It supports the entire ordering process by suggesting optimal configurations and even allowing for the reuse of saved settings.

Both applications increase efficiency, support informed decision-making, and significantly enhance quality and cost-effectiveness in welding practice.

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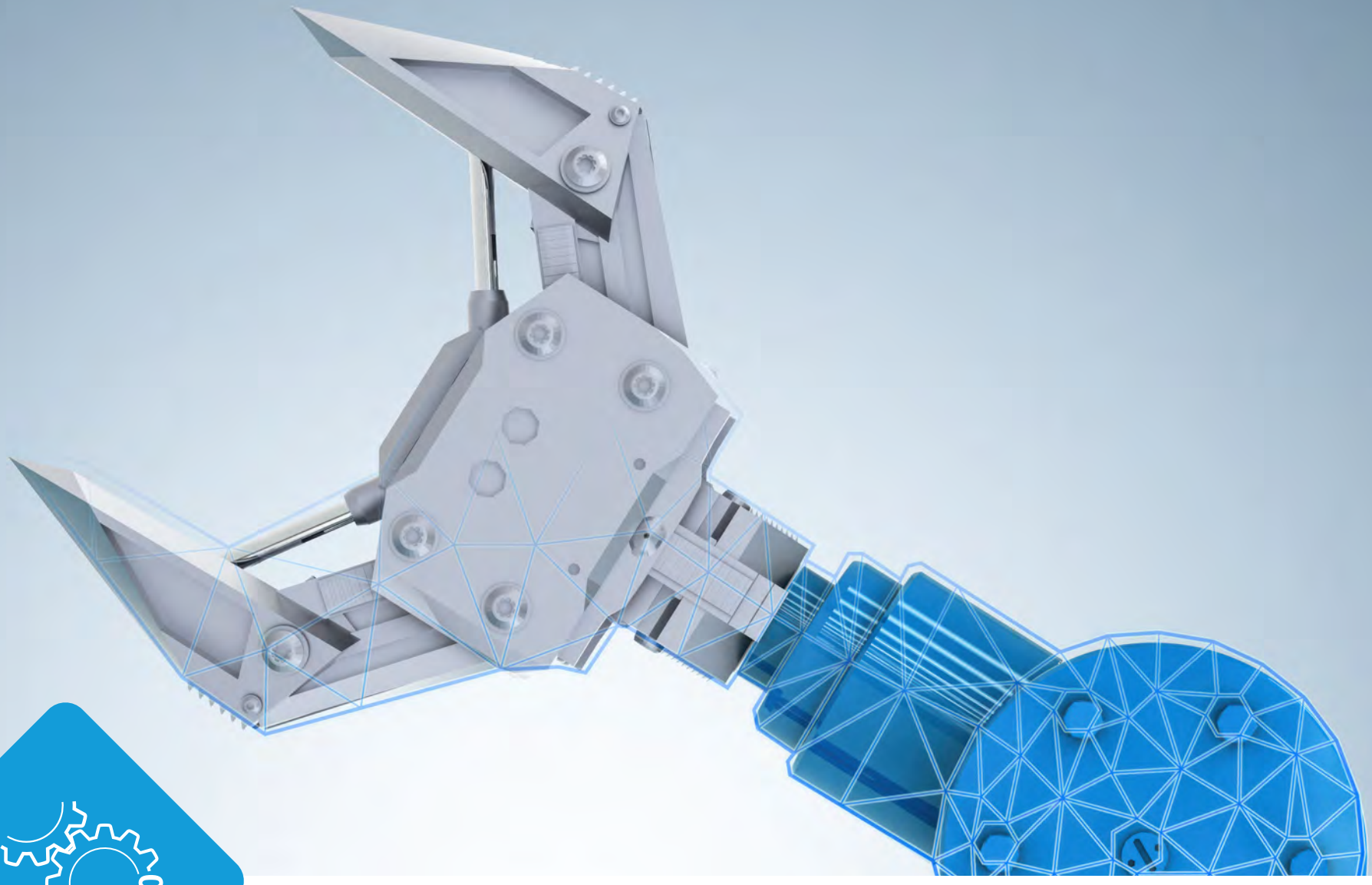
The challenge in this project was to build a centralized, material-based welding knowledge management system that could be used worldwide “24/7” without complex installations — both internally and, to a clearly defined extent, by external materials and welding specialists via a FREEMIUM model.

Thanks to the intensive and highly constructive collaboration with the RISC developers and their agile yet clearly structured approach to digital implementation, the project was successfully completed within the set time and budget constraints.

Gerhard Posch, VP Knowledge & Data Management, voestalpine Böhler Welding



INDUSTRIAL SOFTWARE APPLICATIONS

SOFTWARE SOLUTIONS FOR VISUALIZATION, SIMULATION, AND OPTIMIZATION OF PRODUCT DEVELOPMENT AND MANUFACTURING PROCESSES IN INDUSTRY

Unit Industrial Software Applications.

Modern industrial products are no longer just about hardware — software often provides the key competitive edge. The unit Industrial Software Applications (ISA) at RISC Software GmbH develops tailored solutions for the industry — customized, practical, and technologically advanced.

For over 20 years, the ISA unit has been supporting industrial companies in implementing innovative software projects — from machine tools to autonomous transport systems to aircraft structure development. The solutions developed are in use worldwide, including more than 200 installations at WFL, over 150 at DS Automotion, and over 100 at Airbus. Long-standing partnerships with average project durations of over ten years, along with a dedicated research share of around 15%, are hallmarks of sustained project success.

Key focus areas of unit ISA:

- **Smart Industrial Systems**: This focus area centers on optimizing production processes through comprehensive digital twin simulations. This includes software libraries for simulating machining processes and complete simulation environments for computer-controlled machine tools. In addition, solutions are developed for controlling, simulating, and optimizing material flows of autonomous transport systems in complex production environments.
- **Engineering Intelligence**: Engineering Intelligence focuses on domain-specific modeling of production processes to make them more efficient and flexible. This is complemented by AI-supported simulation methods that elevate virtual product development to a new level. The goal is to integrate multidisciplinary simulation systems with mathematical optimization and to provide tools for integrated, decentralized product development processes.
- **AI Optimization**: This area expands the performance portfolio through the targeted use of machine learning methods. Innovative technologies such as Physics-Informed Neural Networks (PINNs) and deep surrogate models significantly enhance process reliability, efficiency, and product quality. Additionally, the use of symbolic computation strengthens the interpretability and transparency of AI systems — an important focus for future-oriented, data-driven software solutions in the industrial domain.

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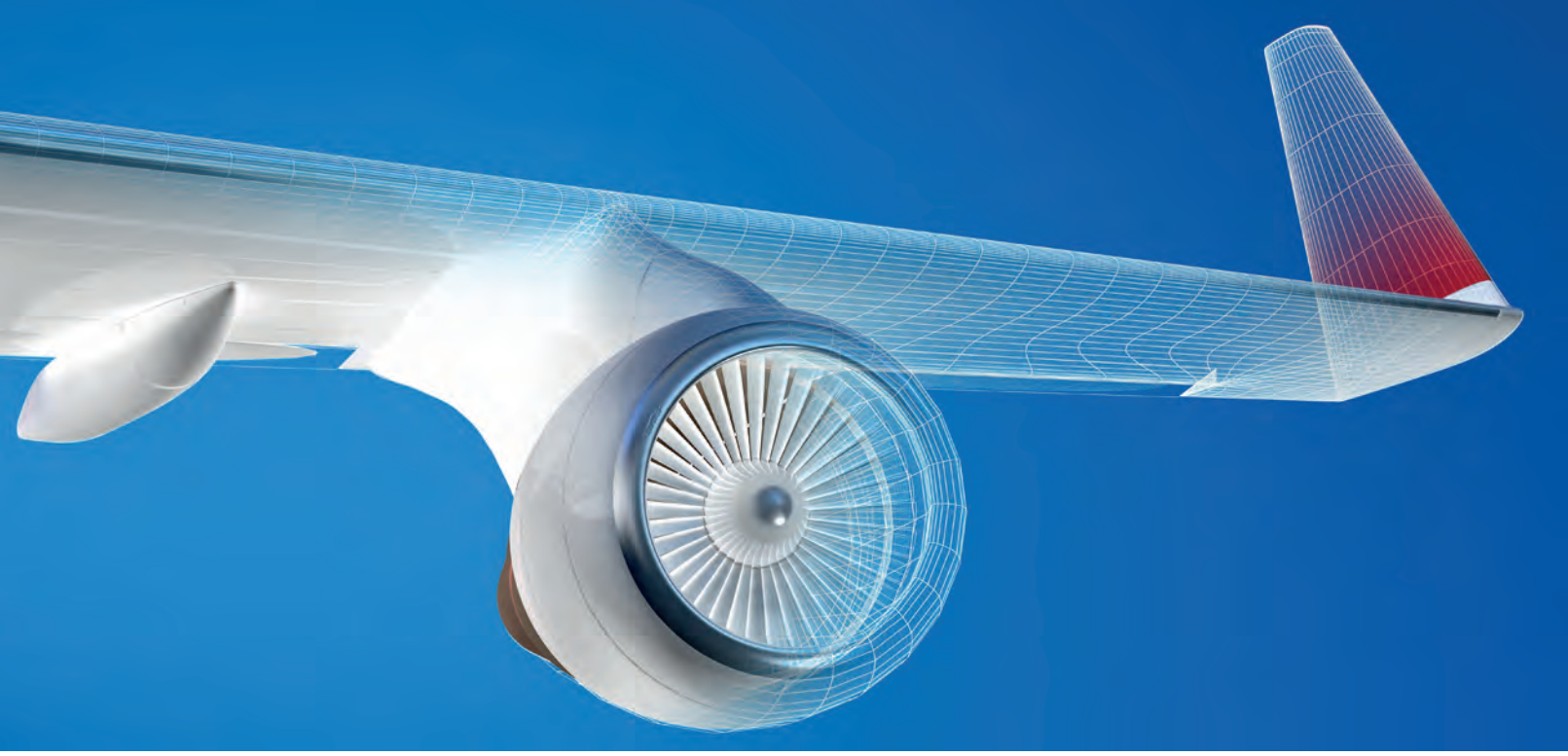

Airbus Defence & Space: Multidisciplinary Optimization System for the Detailed Design of Lightweight Composite Structures

Since 2009, RISC Software GmbH has been the main development partner for the redevelopment of key system components of Lagrange. A particular focus has been on implementing cutting-edge, efficient computational methods and making the best possible use of modern hardware platforms, especially with regard to parallel and distributed computing architectures.

Lightweight Design as the Key to Increased Efficiency in Aviation

From the very beginning, no other topics have shaped the development of aviation as significantly as advances in lightweight structural components and efficient propulsion systems. Improvements in either of these areas directly enhance the performance of an aircraft, for example in terms of payload, range, or fuel consumption.

For over ten years, RISC Software GmbH has been collaborating with engineers at Airbus Defence and Space to further develop a software system for the calculation and design of weight-optimized aircraft structure concepts.

Early Design Phase as an Opportunity for Maximum Weight Savings

A crucial aspect is the ability to consider the optimal geometry and the best use of specialized materials for the overall structure as early as possible in the design phase. At this stage, design flexibility is greatest, offering the highest potential for weight savings. To support this, Airbus Defence and Space developed the multidisciplinary structural optimization system Lagrange, which enables the optimization of lightweight structures based on various design parameters. These include, for instance, cross-sections of individual components or entire groups of components, as well as ply thicknesses and fiber paths of composite materials.

Complex Requirements and Comprehensive Optimization Criteria

In addition to the goal of minimizing the weight of a structural element, a wide range of mechanical and physical requirements must also be considered. The Lagrange optimization system provides a broad set of relevant multidisciplinary analysis and evaluation models. These models allow for the definition of not only mechanical strength and stability criteria, but also various constraints related to natural frequencies, flutter speeds, and other aeroelastic interactions.

Automation, Manufacturing Constraints, and High-Performance Computing

One key method for automating the overall design process is coupled aerodynamic-structural analysis (aeroelasticity). This approach allows aerodynamic loads to be actively incorporated into the optimization process alongside structural sizing. Additionally, Lagrange supports the inclusion of specific manufacturing constraints for composite materials, ensuring that the optimized designs can be manufactured using available methods. This enables the creation of highly realistic design concepts at the very beginning of the development phase – designs that may involve thousands of design variables and hundreds of thousands of constraints.

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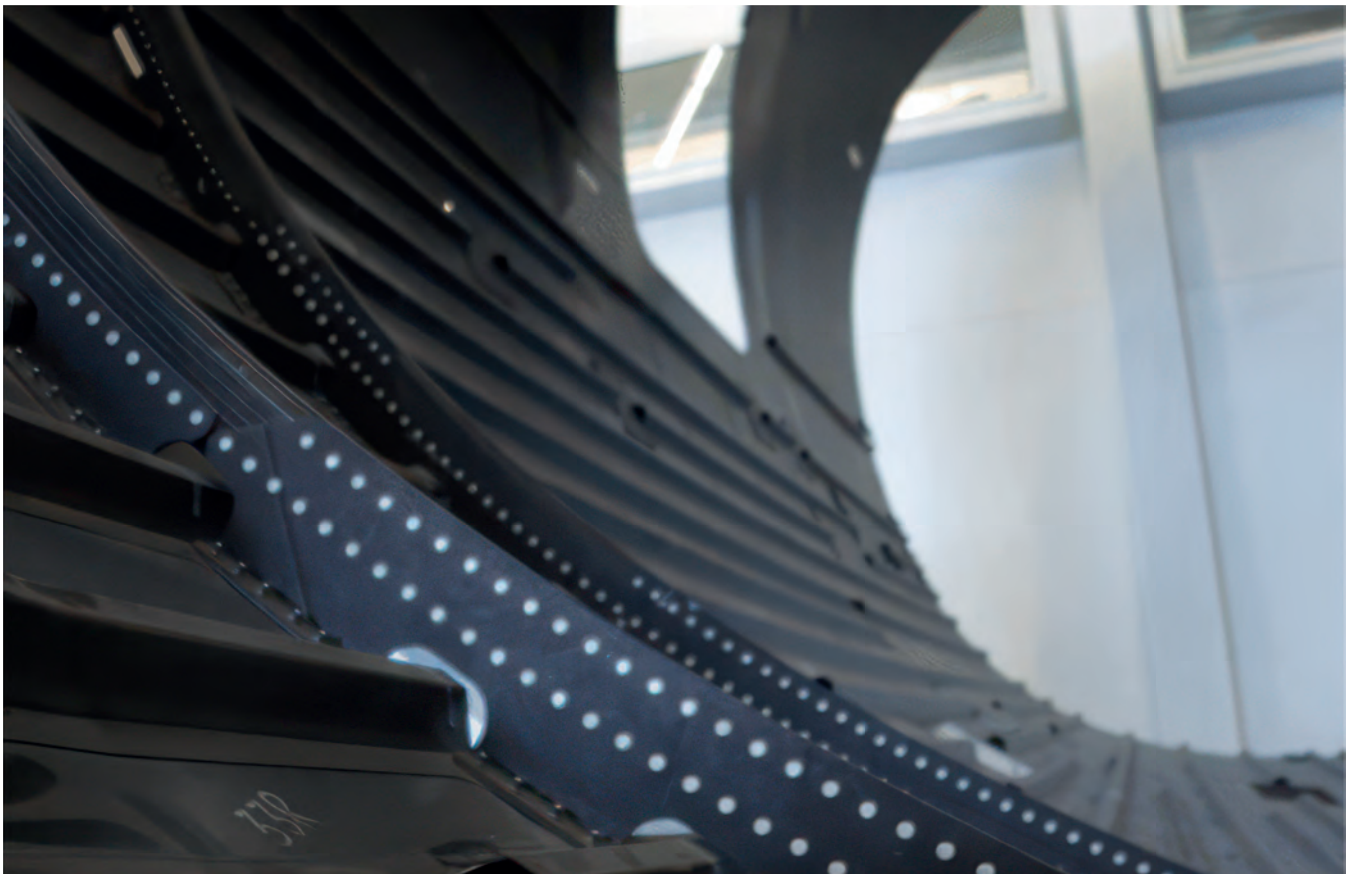


EuroTrans: Driverless Systems Paving the Way to Industry 4.0

An integrated software system for modeling, simulation, and control of driverless transport systems.

Driverless transport systems are already widely used today in production facilities, logistics centers, and hospitals — for transporting meals, medications, and laundry. In light of current trends such as Industry 4.0 and the Smart Factory, these systems are set to face tremendous opportunities and entirely new challenges in the coming years.

DS Automotion, a Linz-based global leader in driverless transport systems, commissioned RISC Software GmbH over 20 years ago to develop an integrated planning, simulation, and control software for free-navigating driverless transport systems. The primary objective of this new modeling and control software was to significantly reduce implementation and commissioning times for driverless transport solutions in real-world facilities.

Highly Configurable Control Software
The control software for managing the driverless transport systems was designed as a flexibly configurable standard system, equipped with powerful algorithms for task dispatching, collision-free vehicle routing, and the prevention and resolution of deadlock situations. Thanks to generic interfaces, the software can be easily adapted to specific system requirements and integrated with external systems via plant-specific extension modules.

Integrated Simulation Environment
A key concept of the new software system was the development of an integrated simulation environment for driverless transport systems. This environment can automatically generate a highly realistic simulation model of a specific facility based on the track layout design.

The same control software used to manage vehicles in real operations can be used without modification to control the simulated vehicles. This ensures that a current, realistic simulation model is available from the planning phase onward — enabling cost- and time-efficient virtual commissioning and the evaluation of later adjustments or expansions to a system.

Proven in Real-World Applications
The software system, now successfully deployed in a wide range of facilities of varying sizes around the globe, already incorporates many features that are now considered essential for Industry 4.0 solutions.

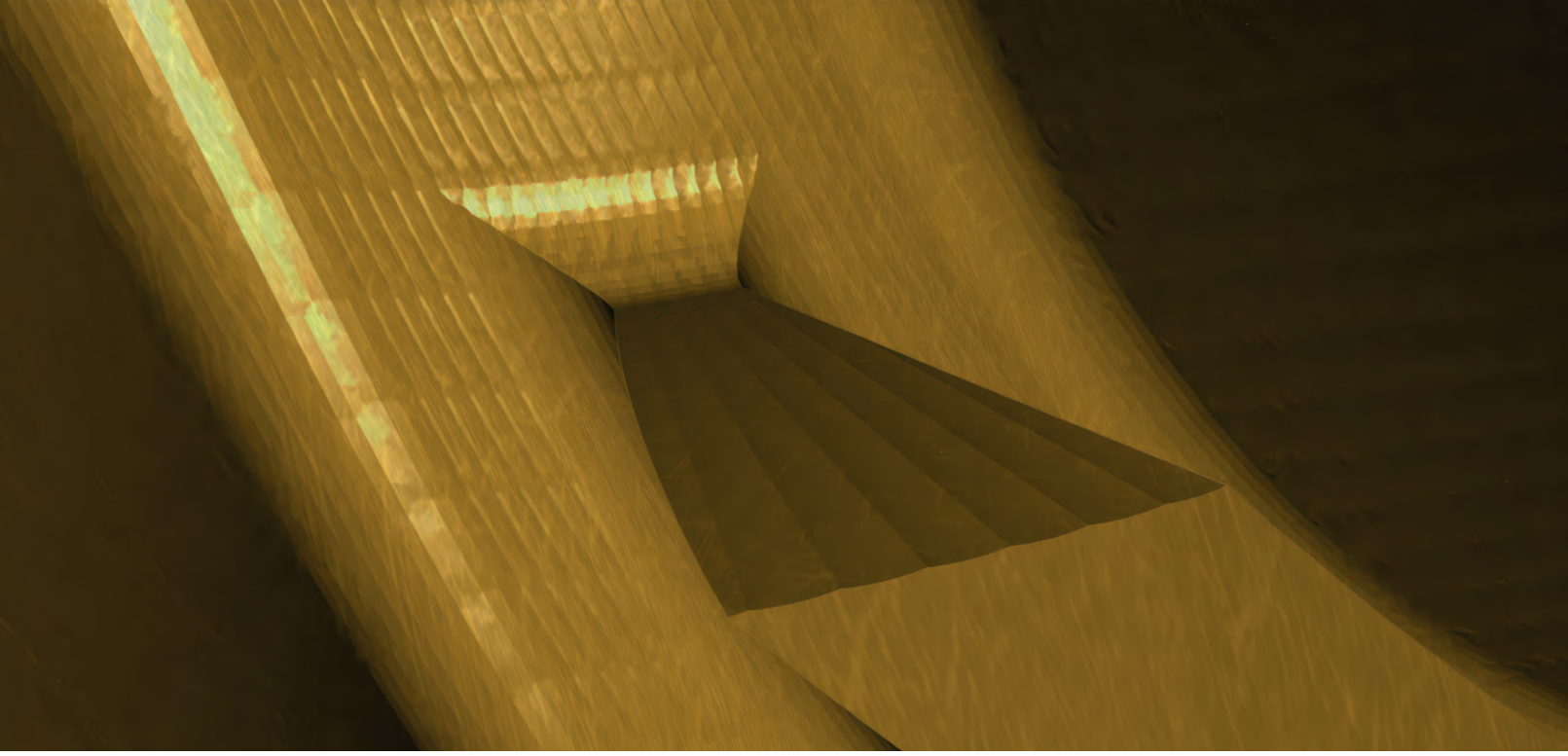
Through a long-term, collaborative partnership with DS Automotion, numerous innovations have been developed within several joint research projects.

Global Coordination, Local Autonomy
The recent advancements in robotics are opening up entirely new possibilities for driverless transport systems:

On one hand, small, agile, highly autonomous robot-like systems are increasingly being used for service and transport tasks involving light loads.

On the other hand, mature, cost-effective sensor solutions and proven, efficient robotics algorithms are being integrated into driverless transport systems.

One of the key challenges ahead is achieving seamless coordination between local and global intelligence to create a cohesive, well-orchestrated overall solution.



Virtual Modeling Library: High-Precision Modeling of Detailed Geometries in Real Time

The Virtual Modeling Library (VML) is a software library that implements new algorithms for the exact geometric modeling of solid bodies in real time. It supports operations based on Constructive Solid Geometry (CSG) as well as bounding volume calculations.

VML offers excellent scalability with respect to the number of operations performed during modeling. Even executing more than 100,000 such operations has only minimal impact on memory and runtime efficiency.

This makes the library ideally suited for industrial applications that require a combination of geometric precision, real-time performance, and scalability — for example, in the simulation of material removal in machining processes involving a large number of processing steps.

In addition to modeling, VML includes algorithms for interactive visualization, collision detection between any geometry and the current geometry, and surface verification between the current geometry and a reference CAD model. These algorithms also meet the combined requirements for precision, speed, and scalability.

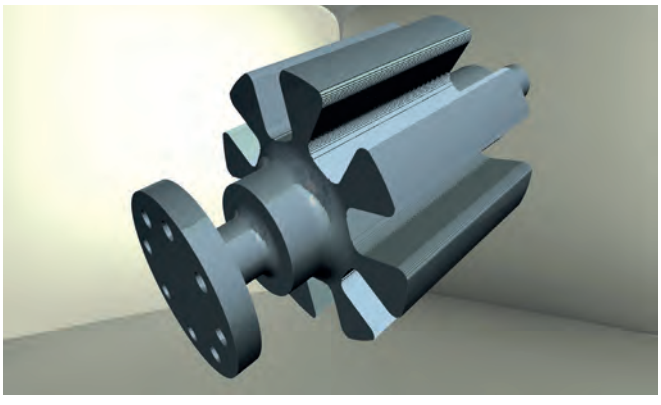
To ensure real-time capability, VML implements massively parallel algorithms that leverage the power of modern hardware architectures such as multi-core CPUs and graphics processing units (GPUs).

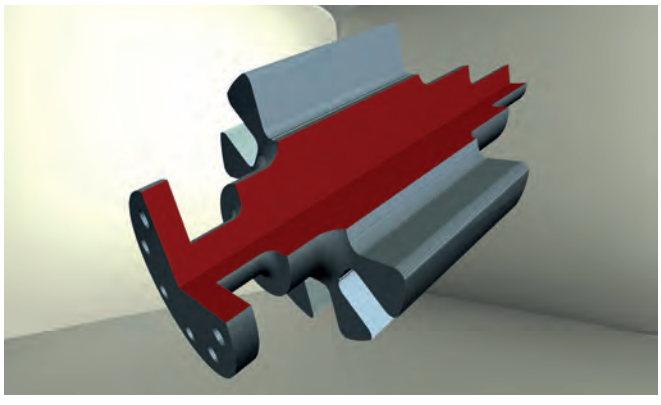
Beyond the features already mentioned, VML also supports surface export of the current geometry, the definition of arbitrary section views, and easy integration into other software systems.

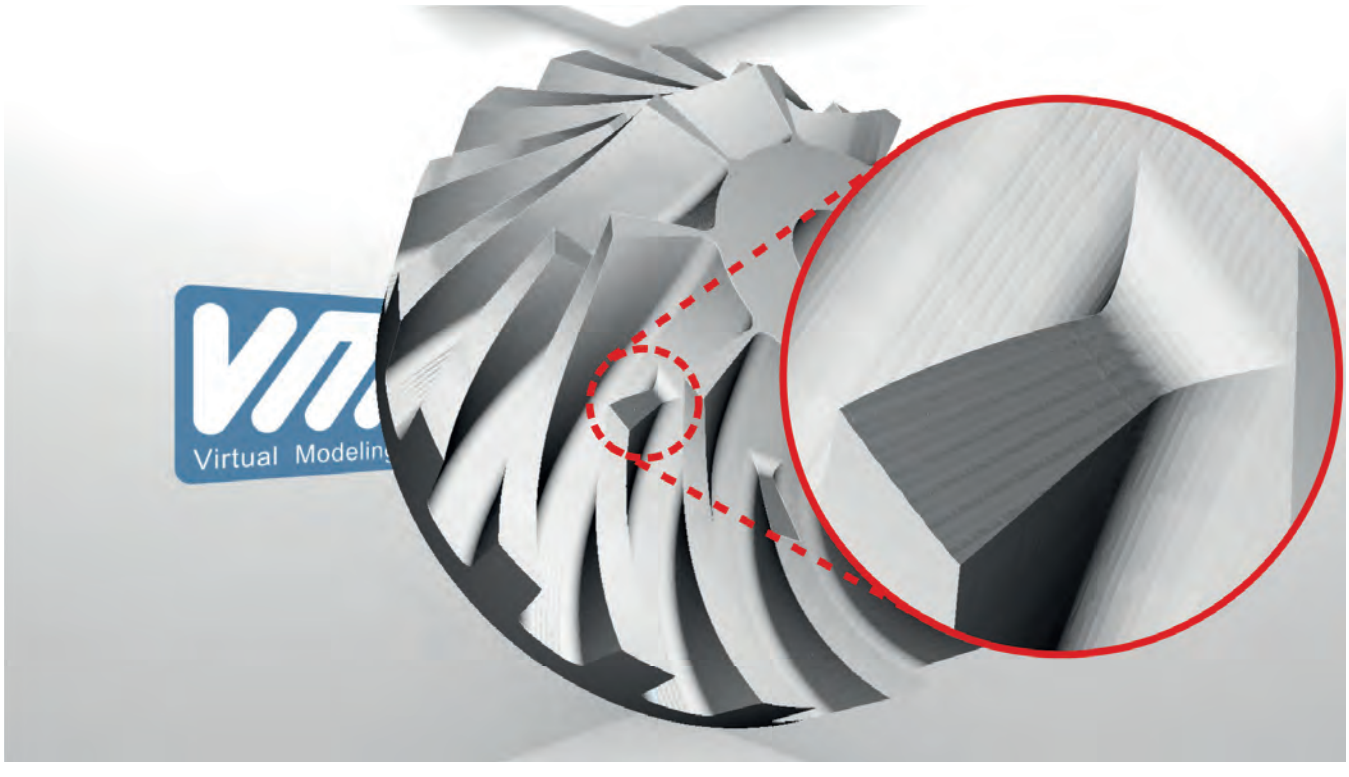
Features of VML:

- Solid Modeling
- Bounding Volume Calculation
- High Number of Operations
- Collision Detection
- Surface Export
- Interactive Visualization
- High Precision
- Arbitrary Section Views
- Surface Verification
- Easy Integration

The development of key components of the methods implemented in VML was funded under the Regional Competitiveness Upper Austria 2007–2013 program, supported by the European Regional Development Fund and the State of Upper Austria.







Rumplmayr: Donausäge Rumplmayr Relies on RISC IBEX Optimization Software

Donausäge Rumplmayr focuses on sustainable wood processing and energy self-sufficiency. At its sites in Altmünster and Enns, roundwood from Austria, Bavaria, and Bohemia is fully processed into sawn timber, planed wood, wood chips, and pellets. An in-house bark power plant covers the company's entire energy needs.

To further enhance efficiency and precision in production, mathematical models of the optimization processes were developed in close collaboration with RISC Software GmbH. These models are solved efficiently to global optima using RISC's proprietary optimization library, RISC IBEX. This mathematical modeling enables optimal planning and execution of all process steps — from selecting the roundwood, to the saw line and drying chambers, all the way to loading for shipment. Special emphasis is placed on designing the ideal weekly cutting schedule and determining the optimal dimensions — both in length and quality — for each order.

With the use of these optimization applications, Donausäge Rumplmayr can:

- **Use resources efficiently**: Maximize high-quality sawn timber output while minimizing roundwood consumption.
- **Design processes with precision**: Take into account varying capacities throughout the entire production chain.
- **Respond flexibly to market demands**: Quickly adapt to current sales decisions and derive inventory developments at the log yard.

Recent expansions of the optimization application now ensure optimal truck loading for shipments and ideal utilization of the drying chambers. These enhancements aim to integrate additional process steps into the decision-making for optimal cutting volumes — not just from a capacity perspective, but as active components in the overall optimization strategy.

Additional digitalization projects are already in the planning stage to continue the successful partnership between Donausäge Rumplmayr and RISC Software GmbH and to ensure the efficient use of the valuable raw material wood.

> **With RISC Software GmbH, we've found a partner for complex optimization tasks that enables us to approach projects with creativity while also ensuring practical implementation and successful completion.**

Severin Rumplmayr, Managing Director Donausäge Rumplmayr

NextBase: Intelligent Adaptation of Production and Intralogistics Systems

In the project NextBase, RISC Software GmbH and ABF GmbH integrated innovative data-driven methods from prescriptive analytics and machine learning into industrial automation processes.

Challenges in Integrating New Production Processes
ABF GmbH controls complex production and intralogistics systems with its OneBase system platform. Introducing new products, equipment, or operational changes often requires software modifications whose effects on the overall system are difficult to predict. Existing simulation functions for testing such changes are resource-intensive, especially since many systems operate continuously.

Using Prescriptive Analytics and Machine Learning for Process Optimization
By applying modern methods from prescriptive analytics and machine learning, the NextBase project aims to improve and simplify these change processes. Automated adjustments are intended to reduce manual interventions in logic and rule sets. Methods from machine learning, simulation, and optimization are used. Decision models are trained using historical data, enabling them to adapt to new and changing situations. Optimization algorithms help maximize the efficient use of available resources, while simulation models serve as training environments.

Early Successes in AI for Production and Intralogistics
Within the three-year NextBase research project, early successes have already been achieved in applying artificial intelligence and machine learning to intralogistics.

Two use cases have been presented:

- **Maximizing transport throughput**: Improved collaboration between multiple transport vehicles within a shared workspace using AI algorithms that dynamically optimize transport movements.
- **Intelligent avoidance of relocations**: Machine learning is used to factor in forecasts when reserving storage capacity, reducing unnecessary relocations and improving warehouse efficiency.

These approaches demonstrate the potential of AI in intralogistics and lay the foundation for further applications in production workflow and equipment control.

FFG
Promoting Innovation.

Success Through Algorithms: Tailored Optimization Solutions for Production and Logistics

Optimal resource utilization is one of the most critical factors for competitiveness. Despite its immense economic relevance, practical out-of-the-box software solutions for planning are scarce and often fall short when it comes to handling complex requirements.

Custom Planning Software

High product variety and increasing complexity — hallmarks of modern manufacturing structures — along with rapid technological progress driven by Industry 4.0, lead to evolving and complex demands, particularly in the planning and control of production processes. Priorities often include the sustainable improvement of manufacturing workflows, continuous reduction of energy and resource consumption, and greater on-time delivery performance. These goals can be achieved through efficient planning and intelligent control.

RISC Software GmbH creates significant added value through its customized software solutions. By combining and advancing methods from mathematics and computer science, and working closely with domain experts, the company focuses on:

- Modeling complex planning problems while accounting for available resources
- Developing automated, multi-level, and intelligent planning systems to make production processes significantly more efficient, flexible, and cost-effective
- Applying both mathematical and heuristic methods as well as approaches from artificial intelligence to successfully meet optimization requirements

Cross-Industry Applications

Sustainable solutions have already been developed in collaborative projects with clients across various industries. An automated, integrated lot-sizing and sequencing system enables optimal use of production capacity, increased throughput, and improved flexibility and delivery reliability.

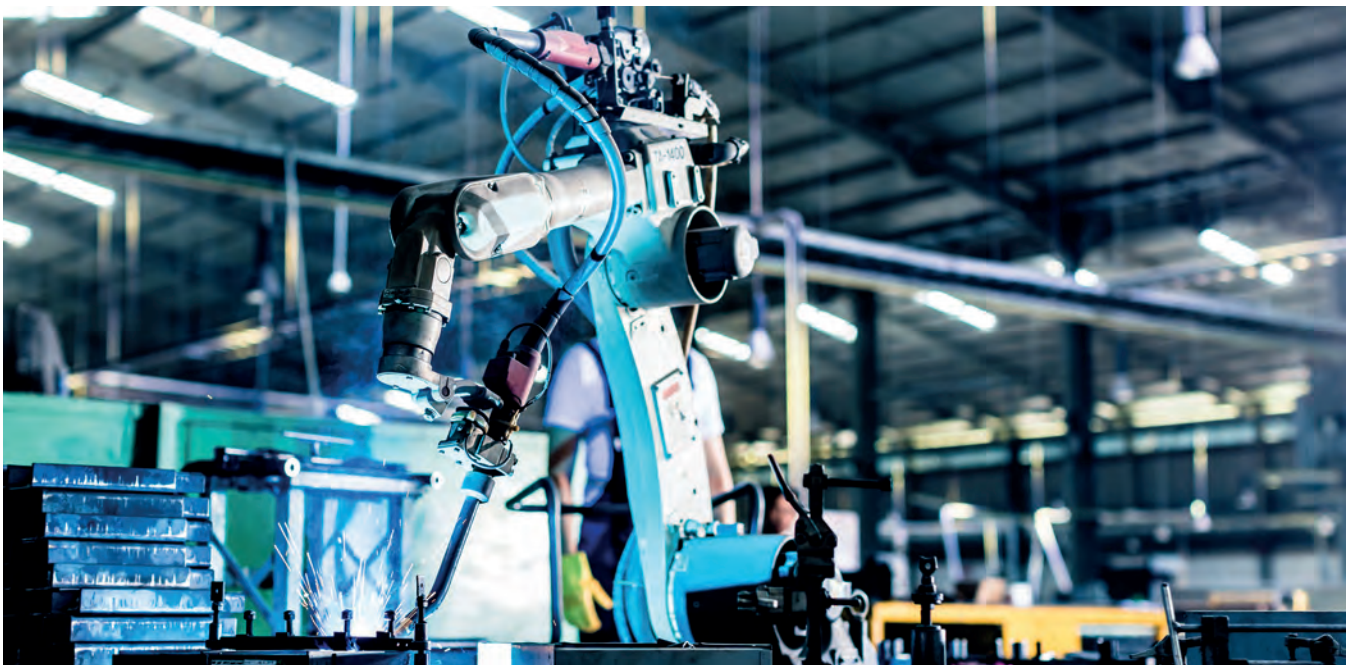
In this context, RISC Software GmbH and Industrie Informatik GmbH developed an intelligent optimization module for solving large-scale detailed planning problems with dynamic constraints. Another project focused on a custom solution for optimizing the inflow and outflow of freight cars and detailed planning of loading and unloading processes.

Dynamic route planning — such as efficiently supplying assembly lines via dynamic tugger trains or adapting delivery routes to inventory levels — has also resulted in significant efficiency gains.

With the help of tailored optimization applications, Donausäge Rumplmayr is able to utilize resources more efficiently and design production processes with precision.

Other focus areas include optimization tasks directly on the production machine, where optimal decisions must be made in near real-time. For example, a real-time algorithm was developed for FILL Gesellschaft m.b.H. to optimize glue-laminated timber and automate layer formation at the production line. Similarly, for Sprecher Automation GmbH, an automated board optimization system was created to maximize cutting yield on an automated saw line.

For these and similar projects, RISC's in-house optimization library IBEX is used alongside a wide range of solution approaches, algorithms, and tools, and, if needed, the latest in advanced mathematical software. With software solutions tailored to specific needs, RISC Software GmbH enables clients to respond quickly and efficiently to current market conditions — and to turn them into new opportunities.



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