ALTAIR

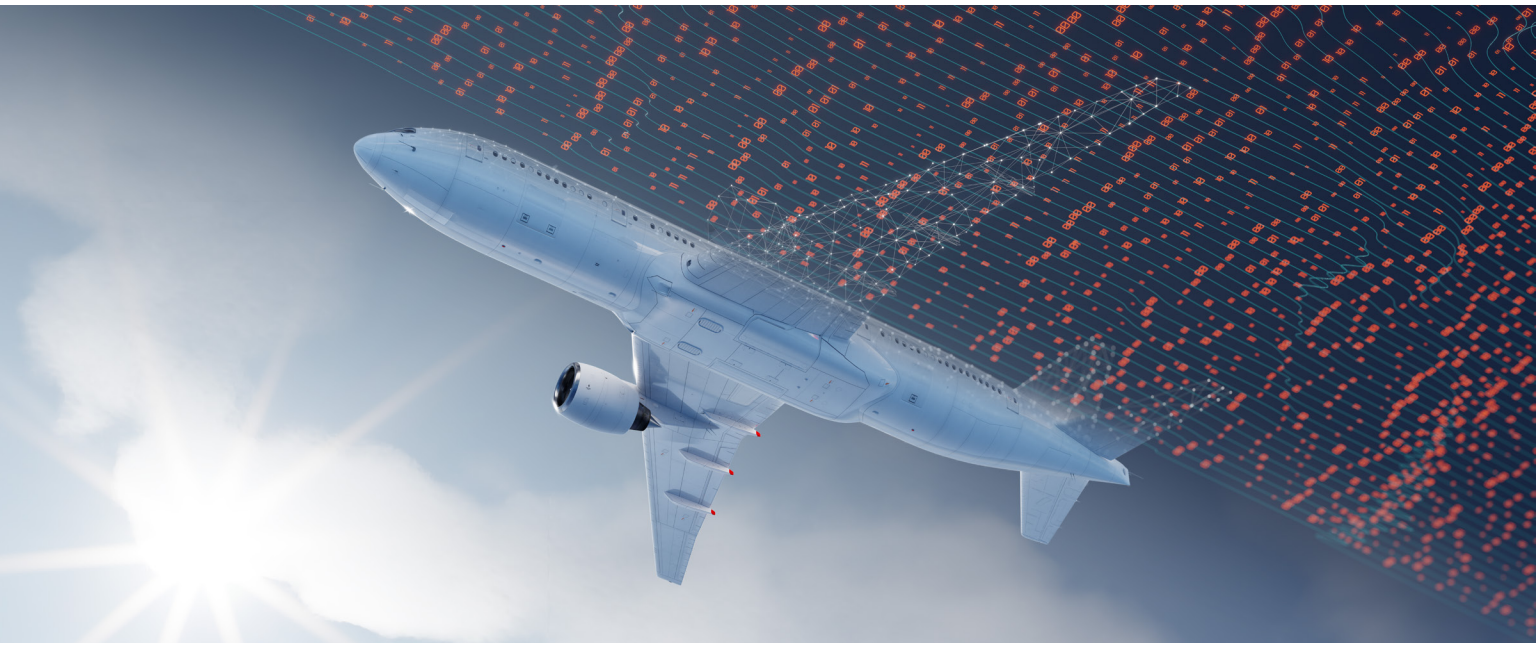
AI FOR ENGINEERING: YOUR ROADMAP TO GETTING STARTED

INTRODUCTION

No longer science fiction, artificial intelligence (AI) is here and already transforming organizations around the world. This eGuide goes beyond the hype and provides you with an essential roadmap for modernizing your engineering processes with AI-powered solutions.

At Altair, we understand AI. This guide will demystify its complexities and equip you with the knowledge and insight you need to champion its adoption within your organization. We'll provide practical steps to navigate the process and empower you to measure success. This guide also explores the future of AI in engineering and showcases how Altair's solutions have been applied in real-world customer projects. Above all, you'll learn how AI unlocks new possibilities in data-driven engineering. Without further ado, let's dive in.

Table of Contents



HOW IS AI EMPOWERING ENGINEERING?

AI is an indispensable technology that's transforming how engineers design, develop, and monitor systems and processes. This section explores the various ways AI is impacting the engineering process throughout the system life cycle from initial design to manufacturing to in-service operation to post-operation reuse and recycling.

Product and System Design and Development

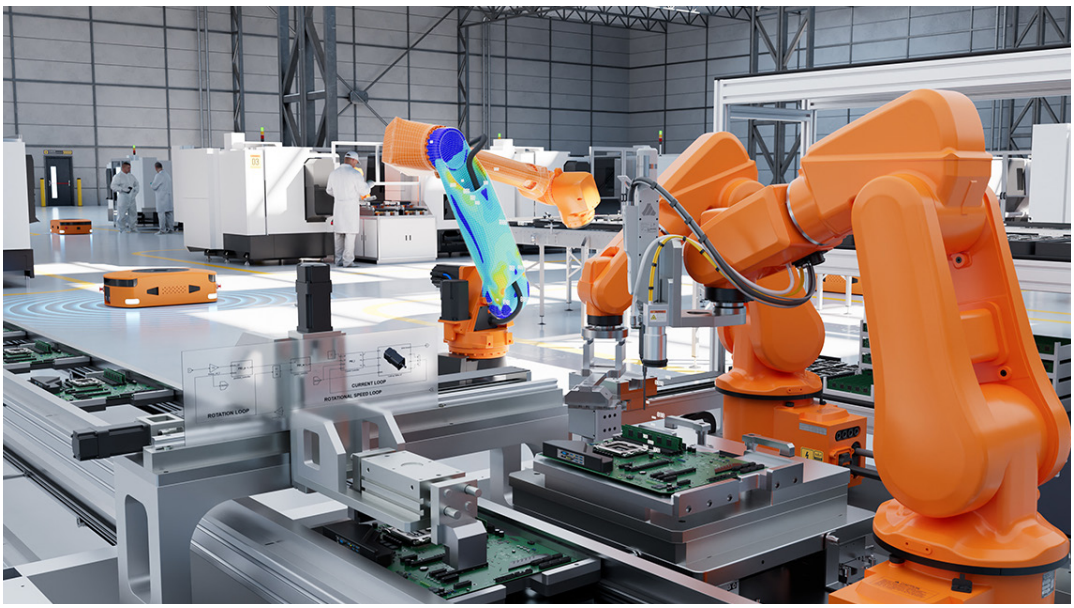
Here's how AI can transform engineering processes throughout the product life cycle:

- **Simulation, Modeling, and Analysis:** Addressing the need to efficiently predict complex system behavior under various conditions without using physical prototypes, organizations can deploy AI-augmented engineering methods that recognize patterns and shapes, quickly simulate models, emulate experts and identify potential system failures or performance issues.
- **Fast Physics Predictions:** Overcoming slow and resource-intensive traditional solver simulations, engineers can use models trained on past simulation data from any source to rapidly predict physics outcomes like stress, deformation, and flow rates up to 1,000x faster or more compared to traditional simulations, facilitating quicker evaluation of numerous design variations without extensive computational costs.
- **Design Optimization:** Meeting optimization requirements for performance, cost, and weight, engineers can use AI to rapidly explore vast design spaces, produce efficient designs, and reduce development time.
- **Generative Design:** To efficiently deliver design innovations, engineers can leverage simulation methods that use machine learning algorithms to explore a multitude of design possibilities based on defined goals and constraints.
- **Design Errors and Correction:** To prevent flawed products and costly downstream corrections, AI tools can detect inconsistencies and errors early in the design cycle by comparing design data with accepted standards, empowering engineers to make timely, informed modifications.
- **Data-Driven Manufacturing:** Tackling challenges in sustainable manufacturing, waste reduction, process-efficiency improvement, and time to market, users of all skill levels can leverage operational data through AI-enabled, self-service data analytics, design, and simulation platforms with low- and no-code workflows.
- **Reduced Order Modeling and System Identification:** Simulating detailed 3D models comes with a hefty computational price tag, but with AI, engineers can transform these high-fidelity models into efficient 1D, ROMs for system-level study in a variety of applications: digital twin deployment, system identification, faster optimization, multidisciplinary analysis, improved real-time simulation accuracy, and more.
- **Collaboration:** Addressing the need for efficient data and knowledge integration across numerous project phases and domain silos, AI platforms can automate repetitive tasks and streamline decision-making by promoting real-time collaboration between all stakeholders including design, development, engineering, testing, manufacturing, and partner alliances.

Strategic Operations

AI offers an array of capabilities that can augment traditional engineering practices across all engineering domains. For large and small organizations alike, AI assists with critical goals like:

- **Energy Efficiency and Sustainability:** By using machine learning capabilities to analyze data from energy systems, engineers can develop energy-saving strategies that optimize energy consumption, reduce waste, and deliver more sustainable product designs.
- **Predictive Maintenance:** To reduce downtime and prevent costly breakdowns, AI-powered predictive maintenance systems can process sensor data from equipment to find patterns indicative of potential failures.
- **Supply Chain Optimization:** To enhance cost-effectiveness in supply chains, AI can analyze supply chain data to optimize inventory levels, improve procurement processes, and predict demand fluctuations, thereby mitigating risks and potential bottlenecks.
- **Quality Control:** Facing challenges to improve product quality and achieve Six Sigma efficiency, organizations are leveraging AI-powered solutions to capture, monitor, and analyze data from digital streaming and embedded sensors in equipment on the factory floor. Deploying AI in this way enables lean manufacturing, continuous process improvement, and end-product flaw reduction.
- **Improved Productivity and Streamlined Processes:** To inform operators with precision and efficiency on engineering tasks during assembly, inspection, and maintenance, organizations can take advantage of AI-augmented automated manufacturing systems to streamline processes.



What Are the Benefits and Challenges of AI for Engineering?

AI is becoming integral to engineering, transforming traditional practices and enabling unprecedented efficiencies. As organizations seek to adopt AI within their engineering processes, it's important to weigh both the benefits and challenges associated with this transformative technology.

Benefits of AI	Challenges of AI
Enhanced Efficiency and Optimized Designs: AI increases process efficiency and accelerates design innovation, enabling smarter decision-making.	**Maturity and Implementation:** As a relatively new technology, AI faces broad maturity and implementation challenges.
Cost Reduction and Innovation: AI reduces operational costs and fosters innovation, enabling advancements in various engineering domains.	**Security and Privacy:** Robust security measures and privacy protocols are essential to safeguard data and maintain trust.
Customization and Collaboration: AI facilitates tailored solutions and promotes collaboration across disciplines, enhancing team dynamics and outcomes.	**Workforce Impact:** While AI augments human capabilities, managing workforce transitions and mitigating bias are critical for effective integration.

By leveraging AI, engineers can overcome challenges, unlock new opportunities, and drive progress in their respective fields.

That said, since AI is relatively new technology at the enterprise level, there are known implementation issues to overcome. Confidence comes with the maturity of any technology – and AI is no different. Companies need a trusted partner like Altair that delivers AI-powered solutions with the infrastructure and security measures that enable customers to leverage AI safely and privately.

Companies using AI will also need to consider the impact of AI on their workforces. Processes will shift, but adopting this extremely powerful technology can only augment and assist the skills and knowledge of an experienced human workforce, not replace them. AI needs a human copilot whose oversight is essential to mitigate bias and improve the quality of AI predictions.

After evaluating its advantages and challenges, companies of all sizes are increasingly implementing AI into their engineering workflows. Thanks to solutions like Altair's that offer low- and no-code AI-embedded workflows, even small companies can easily leverage AI to augment productivity and efficiency within any engineering process.

To Learn More:
Watch On-Demand

According to Forrester's July 2023 Artificial Intelligence Pulse Survey, 72% of global AI decision-makers believed that productivity is one of the greatest benefits of generative AI for their organization; 60% said cost efficiency is also a top benefit. Companies will invest even more aggressively to seize an AI advantage over their competition.

HOW DO YOU SELECT THE RIGHT SOLUTION PROVIDER?

In a market saturated with AI offerings, selecting a provider can be a daunting first step. You need easy access not only to AI-enabled simulation products, but also to AI-augmented model training and deployment and high-performance computing (HPC).

Check List: Key Features for Choosing a Provider

- ☐ **AI Workflows:** Look for simulation products with embedded low-code/no-code AI workflows that enable engineering teams with little or no data analytics experience to quickly leverage AI processes.

- ☐ **Data Access and Management:** Ensure the provider offers no-code data access with visual exploration tools suitable for domain experts and data scientists alike alongside efficient data management systems that connect disparate datasets and enable comprehensive engineering solutions.

- ☐ **Model Training and Validation:** Choose providers who integrate model-training and validation best practices into no-code/low-code solution workflows.

- ☐ **Accessibility and Collaboration:** The provider should offer solutions that are accessible both locally and in the cloud, support non-IT experts with HPC workflows, and promote a collaborative environment for domain experts and data scientists.

- ☐ **Ensure Access to Supplier Expertise:** When selecting an AI provider, confirm that they offer readily available expertise. A good provider like Altair not only speaks the language of engineering and AI but also ensures that their team can clearly explain potential solutions, optimal approaches, and address any concerns related to system integration, reliability, and ROI. This support is crucial for cross-disciplinary teams to effectively leverage AI.

Why Partner with Altair for AI-Powered Engineering?

At Altair, we speak engineering and AI and have the tools to make you successful. We ensure our expertise is available as needed for cross-disciplinary teams. To aid a seamless transition into AI-powered engineering, we will provide you with a clear and concise solution roadmap and tackle any concerns about system integration, reliability, and ROI. Together, we can:

- Enhance CAE workflows with AI to build better products faster.
- Use AI to make reliable physics predictions in a fraction of the time required with traditional simulation methods.
- Turn past simulation data into future insights with geometric deep learning.
- Give a second life to historical data and effortlessly work with CAD, CAE, test, and field data.
- Access reduced order modeling (ROM) methods tuned to retain accuracy with limited data while speeding up computationally expensive simulations for system evaluation.
- Deliver scalable, on-demand HPC for rapid model training across the enterprise.
- Bypass repetitive tasks, emulate experts' decisions, and increase discovery throughout the engineering life cycle.

At Altair, we democratize AI with our comprehensive low-code/no-code embedded AI-powered engineering solutions with accessible HPC and data management that fosters data and information exchange between domain experts, engineers, data scientists, and any project stakeholders in a collaborative, unified environment.

> "Altair makes the right moves at the right time. At first, people questioned why a CAE company was acquiring data analytics technology—now, it's crystal clear. The way they have combined the technology together is great."
>
> Martin Ortega, PhD, Senior Engineer, Mabe

HOW DO I CHOOSE THE RIGHT PROJECTS?

Insights on Project Selection Across Industries

The approach to choosing the right projects for AI integration is the same across industries. The goal is to identify projects that can add the most value. Successful AI implementation requires buy-in across the entire company. It involves feeding AI systems with data from all teams, essentially creating a digital twin of your organization.

Balancing Scale: Starting Small vs. Thinking Big

Begin with Simplicity: Initially, consider simple machine learning applications that streamline menial tasks, saving time and effort.

Aim for Impact: Don't hesitate to tackle significant challenges. AI excels in exploring vast parameter spaces that are beyond human capacity, addressing complex questions that can transform operations.

Expand Horizons Beyond Traditional Engineering

While the focus is on AI-powered engineering, it's crucial to consider the entire design chain:

- **From Start to Finish:** Look at the process from the initial stages of material orders and dealings with suppliers to post-production and beyond.
- **Comprehensive Integration:** Utilize AI to oversee and optimize the entire design chain for enhanced efficiency and innovation.

Real-World Implementation Insights with Altair

- **Connecting Data:** With Altair, companies can connect disparate datasets, identify a broader scope of problems quickly, and gain deeper insights for comprehensive discovery at the system and sub-system levels throughout the system life cycle.
- **Operational Value:** Once concepts become operational, Altair's solutions continue to deliver value by addressing manufacturer warranty issues and defects in production through insights derived from diverse data sources.

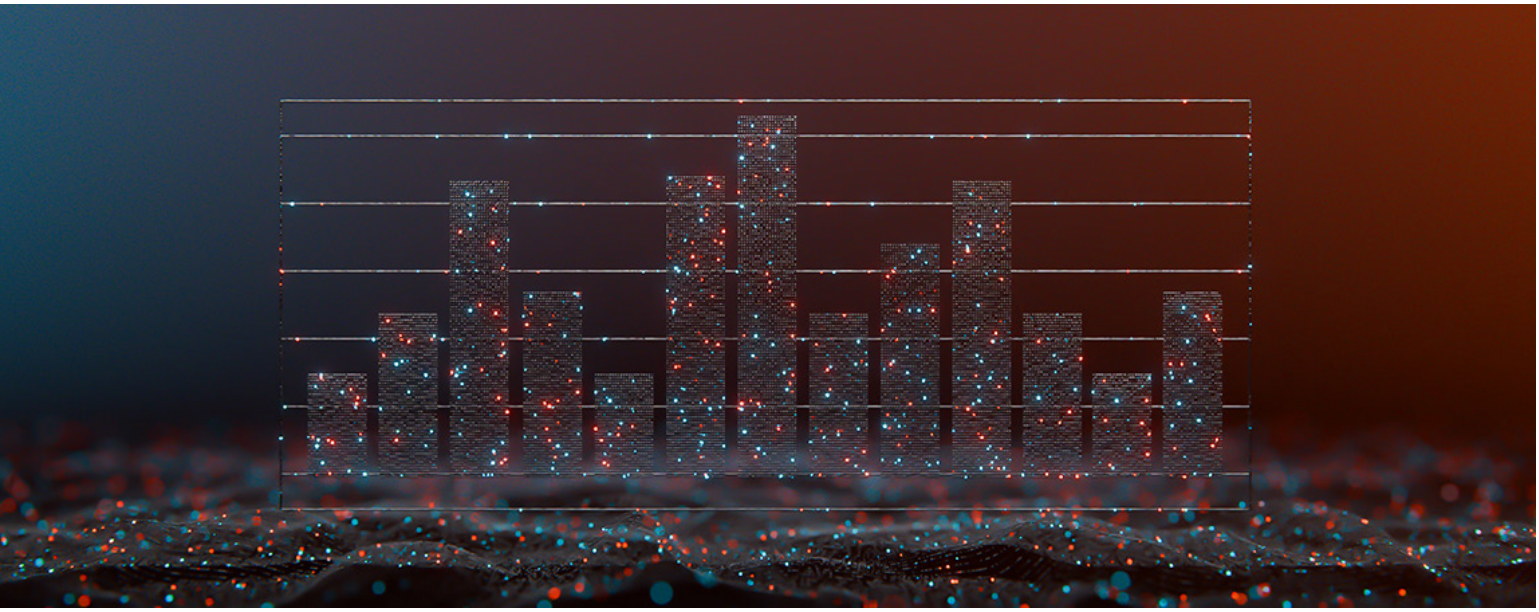
HOW TO COLLECT A MEANINGFUL DATA SAMPLE FROM A SEA OF DATA?

Survey the Data Landscape

Organizations generate massive amounts of data every minute. Engineering companies around the world, of all sizes and activities, appreciate the benefits of transitioning into simulation-driven design. Within the virtual design world, enormous numbers of simulation runs are made throughout any project.

Routinely Collect Data

- **Identify Data Sources:** Regardless of the data's initial perceived value, start collecting it routinely. This could be as diverse as a thermocouple measuring the temperature of a plastics-processing machine, metal spring-back test result, or even the number of spare parts ordered by repair technicians.
- **Embrace All Data:** Don't overlook the potential of any data source. Every piece of information, whether it seems immediately useful or not, can contribute valuable insights.



Leverage Historical Data

- **Recognize Value in All Forms:** Historical data holds immense value, no matter if it's in numerical formats like past simulation data, meshless models, or original CAD files, or qualitative formats like written reports and spreadsheets.
- **Storage and Access:** Ensure that data is stored in accessible formats, whether on local or cloud-based based platforms, making it easier to retrieve and analyze when needed.
- **Don't Dismiss Outdated or Unsuccessful Data:** Historical data, even from outdated or unsuccessful projects, is a treasure trove of insight. Such data can inform future strategies and AI models, helping avoid past mistakes.

Feed AI with Diverse Data

The diversity and volume of data collected can fuel AI systems, enabling them to uncover insights and opportunities that were previously unthought of. By feeding AI with a broad spectrum of data, organizations can explore new possibilities and drive innovation.

Our Customers Say it Best:
Learn More

"For us visualization of data is the perfect tool to convince people to become a data-driven decision maker for everyone—manufacturing operators, process engineers, plant managers … We knew we were winning when one of our operators said, 'If I don't have the data available, I'm working blind!"

Carlos Lopes, Director of Advanced Engineering, Americas, Maxion Wheels

WHAT MAKES ALTAIR THE TOP AI PARTNER?

In the competitive landscape of engineering solutions, Altair provides unparalleled value through its innovative, comprehensive solutions that competitors can't match.

Comprehensive Data Handling

- **Data Type Versatility:** Supports CAD, CAE, meshes, spreadsheets, simulations, and test data.
- **Cross-Domain Integration:** Seamlessly integrates data from simulation, manufacturing, materials, and supply chain sectors.

Streamlined Physics Predictions

Altair simplifies physics predictions with a three-step process:

1. **Feed the Data:** Customers supply the AI model with relevant data that represents the physical phenomena they want to investigate.
2. **Train the AI:** AI models learn from the underlying physical relationships within the data.
3. **Predict Insights:** Customers can use AI to make rapid predictions about future physical behavior based on new input or usage data with fast application across simulation types like CFD and structural analyses.

Expansive Problem-Solving Capabilities

Unique within the market, Altair converges multiple technologies to address complex challenges:

- **Technology Convergence:** Altair's platforms and solutions uniquely converge AI, machine learning, design and simulation, data analytics, and HPC capabilities.
- **Early Intervention:** AI-powered engineering solutions help solve complex physics and multiphysics problems early in the design cycle, saving crucial time and preventing costly downstream errors.

User-Friendly Technology

Altair is leading the industry from the front by blending state-of-the-art technology with a modern, user-centric experience. Our commitment to pioneering accessible, top-tier tools is revolutionizing how professionals interact with advanced engineering solutions, ensuring we remain at the forefront of innovation and usability.

- **Simplified Data Management:** Streamlines data management and integrates seamlessly into existing systems without the need for additional plugins.
- **Open and Programmable Architecture:** Offers user-defined workflows through Python APIs and ensures interoperability with all data types. Flexible, units-based licensing allows companies to tailor solutions to their unique needs.

DO I NEED A DATA SCIENTIST?

Understanding Data Scientists' Role in AI

The need for a data scientist depends on your company's size and scope. Large organizations often benefit from data scientists to manage complex data ecosystems and refine AI models. For smaller businesses, however, investing in a full-time data scientist might prove difficult at the early stages of AI adoption.

Equip Your Team with the Right Tools

AI success often stems from choosing the right tools. Modern AI platforms offer no-code/low-code self-service options that simplify AI model building and training, a trend exemplified by Altair's innovative solutions. These tools empower engineers to undertake data tasks traditionally performed by data scientists, reducing the need for specialized roles. Altair's intuitive workflows are suitable for non-specialists, but are also powerful enough for sophisticated tasks, ensuring you can enhance your AI capabilities without the need to hire full-time data experts to perform them.

Access Expertise When Needed

You might not need a full-time data scientist, but occasional expert assistance can bridge gaps in complex projects. Altair's consulting services can provide that expert guidance, helping you manage costs while easily upscaling your workforce's engineering expertise.

WHAT CHALLENGES MIGHT DERAIL YOUR PROJECTS?

Incorporating AI within projects brings unique challenges due to the complexity and sheer volume of data involved. By understanding and tackling these challenges head-on, organizations can leverage AI more effectively, driving innovation and efficiency.

Efficient Data Management

Challenge: Managing vast amounts of diverse data formats.
Solution: Develop a centralized data management system that ensures all stakeholders have easy, informed access. Altair's tools offer seamless integration and user-friendly interfaces that simplify data complexities across the board.

Upskilling and Collaboration

Challenge: Shortage of in-house expertise in data handling and AI model development.
Solution: Invest in training programs and seek assistance from an AI technology leader like Altair, whose expert consulting services can bridge knowledge gaps, empowering your engineers to effectively leverage AI tools.

Structuring Data and Defining Metrics

Challenge: Creating a suitable data structure, defining key performance indicators (KPIs), and setting up a pipeline.
Solution: Prioritize setting up clear data pipelines and KPIs with the help of advanced analytics platforms. Altair's solutions can facilitate these processes, enhancing data usability and ensuring metrics and KPIs align with business goals.

Strategic Model Selection

Challenge: Creating the perfect model that will give the most accurate answers may not be the right approach, since it can be expensive.
Solution: For a timely solution, focus on matching the model to the use case. For example, deploying a ROM when you need to quickly understand some aspect of a system's behavior can provide you with answers without sacrificing the accuracy you want to achieve at a given point in the design evaluation.

HOW DO I MEASURE SUCCESS?

Manage, Trust, and Validate Your Models

We've mentioned the importance of collecting data, mining historical data, and sharing data securely across organizations. It's equally important to manage this data so enterprises can leverage it through AI to achieve maximum simulation efficiency, gain insights earlier in the design cycle, and develop innovative new designs.

Reliable data evaluation drives successful data management. With use cases as diverse as predicting physics or classifying shapes, organizations must be able to trust their data-driven models. Altair's solutions provide tools to maintain both dataset integrity and the predictive accuracy of models that learn from those datasets, empowering organizations to confidently unleash the power of data.

Taking this further, the datasets that feed into AI – and the datasets that AI generates into new data – can be understood and evaluated for example by smart devices providing in-service performance, durability, sustainability, and repairability streams that feed into and improve the next-gen designs.

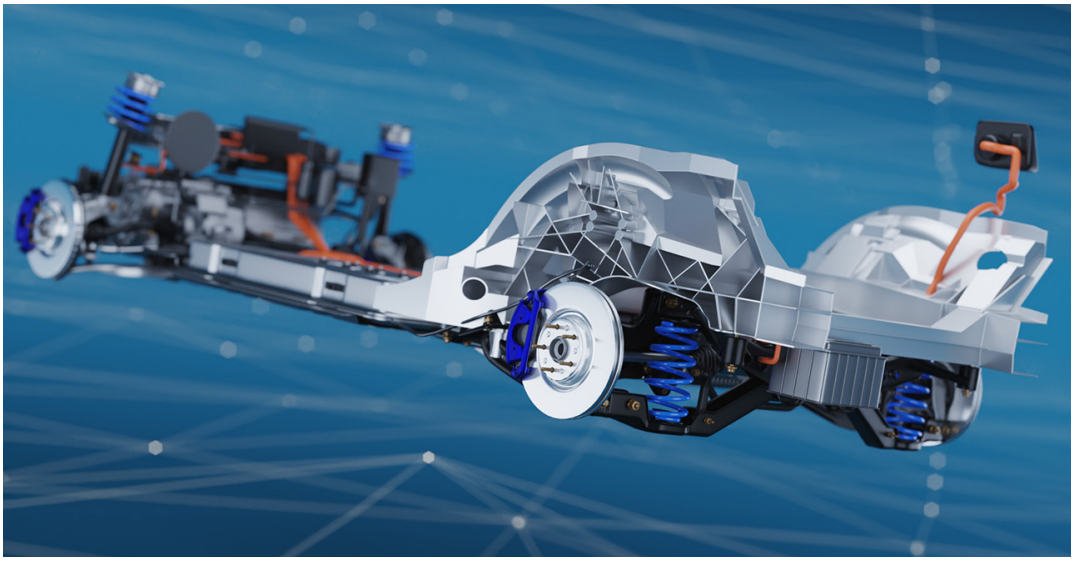
Collaborate and Hit Your Targets Faster

By fostering cross-disciplinary collaboration, engineers working on a common AI-enabled platform for data analysis, modeling, and simulation drives innovation by integrating diverse perspectives into engineering projects.

Learn More at:
Creating Tomorrow: Innovating with AI-powered Engineering

The Right Technology Can Upskill Your Workforce

Maintaining a skilled workforce is essential in any organization, especially when faced with new disruptive technologies. In our ever more digitalized world, combining engineering teams' expertise with Altair's data science techniques is helping companies upskill in-house, equipping themselves for the future.



INSIGHTS ON AI IN ENGINEERING: AN INTERVIEW WITH ALTAIR'S DR. FATMA KOCER

Please introduce yourself and your role.
I'm Fatma Kocer, VP of engineering data science at Altair. I'm part of Altair's analytics and IoT development team and I also lead the engineering data science team. We are a group of CAE experts who also have data science experience and education. We are looking into the use of data science in the CAE domain—this can be speeding up model builds, making fast physics predictions, generating new designs, and finding optimal designs. Engineering teams' expertise with Altair's data science techniques are helping companies upskill in-house, equipping themselves for the future.

In a few words, what is Altair's vision and direction concerning AI in engineering?
Altair's vision is to leverage computational science to drive innovative, intelligent decisions for a safer, more connected, and more sustainable future. That means as we move from the third paradigm of engineering – which relies on computational physics-based models – to the fourth paradigm, where we will rely on or use both the power of data and our understanding of the physics. In a nutshell, Altair is fast forwarding that transition, so that everyone can leverage the power of data along with the physics.

When looking into using more modern techniques of AI in engineering, leveraging traditional methods of data science and engineering through design of experiments or optimization, we found three categories of use cases: improving efficiency, augmenting toolkits, and emulating experts.

To do this, we started developing both embedded and enabling technologies. Embedded technologies are for use cases where we know our customers have pain points. We can do the research and identify techniques to solve them, then embed the technology into our products so customers do not have to be data scientists to do it themselves. For situations where we don't have an embedded technology, then we have Altair® RapidMiner®, our data science and AI platform, for users to build their own AI solutions.

> Altair is ahead of the rest in terms of both the technologies and productization. As a trailblazer in AI-powered engineering, our customers are already exploiting our unparalleled technologies and expertise to democratize AI for everyone across their product life cycle.
>
> Dr. Fatma Kocer, VP of engineering data science Altair

How do you feel AI has been received so far by engineering industries or companies?
I think that engineering industries, at least CAE, the one that I focus on, were a bit envious of other industries that were truly benefiting from their data. Engineering also generates a lot of data, but we weren't quite making the best of it compared with other sectors. This is partly due to challenges, such as working with 3D geometries, or data from time-consuming expert-driven simulations.

While I don't think the engineers were worried about "the robots taking over," there were some concerns AI was going to take their jobs or security-related issues.

People soon realized that domain expertise is always very valuable, expensive to buy or replace, which means AI will only be improving engineers' productivity, creativity, and innovative insights. Once that was established, I think engineers started to think about what are the value-added tasks that data science should replace to become an AI-driven solution. This is pretty much where we came in, and were able to show how to embrace AI, rather than fear it.

As to security, data sharing of models is not something that happens in the CAE world, rightfully so because we're talking of customer proprietary products. We showed with our solutions there's no data exchange and no model exchange. All these stay in the ring-fenced virtual environments set up by our customers who can control access to, say, only people who train models.

How is Altair making it easy for their customers to get started?
To start with, by making AI tools work in our products that our customers are already familiar with. With that our solutions are easy to use, with ease of access through embedded forms, and through our licensing. We identify true value-added use cases, not some hyped up use cases. In addition to improving users' productivity, we also augment with embedded tools like Altair shapeAI, and augment their tools kit with tools like Altair® physicsAI™. Not forgetting, we have the Altair RapidMiner platform for customers; whether they are data scientists, engineers, end-operators, or analysts, they can build their own AI solutions, a totally unique feature in the industry.

We are engineers ourselves, so we have the domain expertise when we are working through our solutions and productizing them.

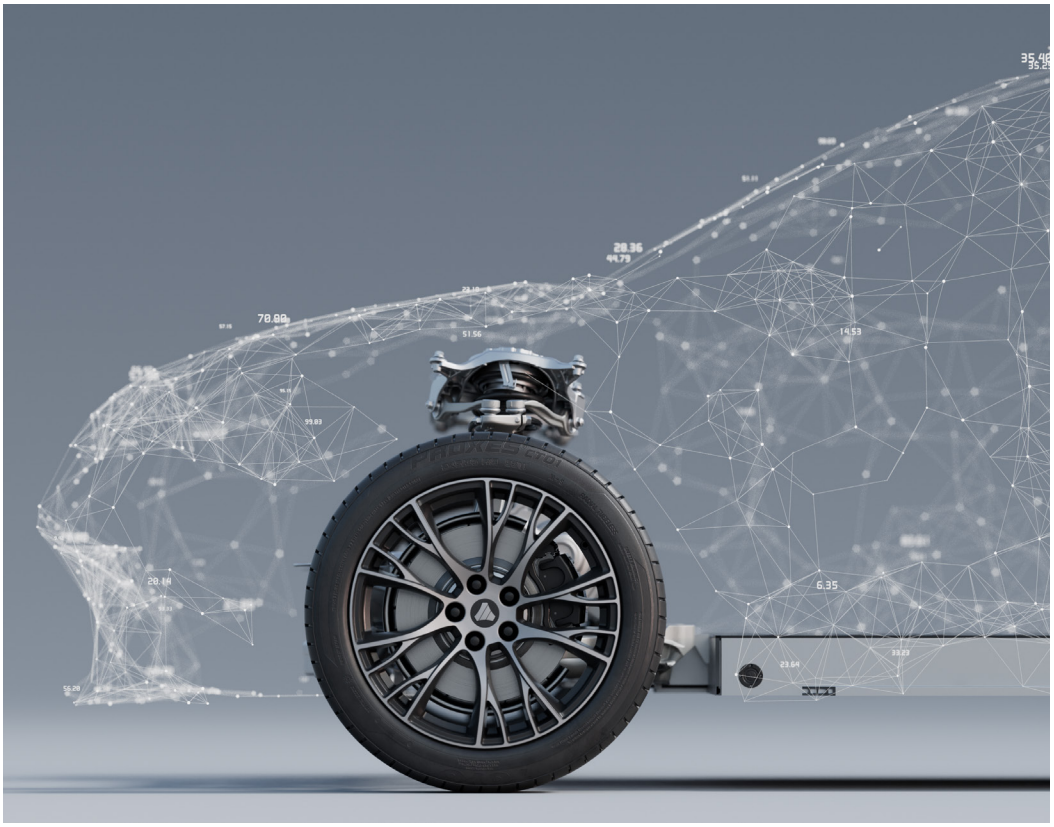
Technologies like physicsAI are also available in our cloud innovation gateway—Altair One™. With Altair One, you can access your enterprise data, which makes your learning richer, and you have direct access to HPC, which means that you can train your models with your enterprise's GPU resources, which can be expensive to buy.

Why do organizations look to Altair for AI solutions?

For all types of engineering and regardless of the size of your business, we have such a wide variety of tools available on one platform. And we offer access to these tools with our unique Altair Units licensing model that effectively lets you "pay for what you use." We also offer worldwide knowhow and expertise across our engineering teams to provide any needed support.

Altair is ahead of the rest both in terms of our technologies and how we make these technologies so easily accessible through our refined product workflows. As a trailblazer in AI-powered engineering, our customers are already exploiting our unparalleled technologies and expertise to democratize AI for everyone across their product life cycle.

We're talking about Altair offering a data science product, Altair® HyperStudy®, for more than 25 years. Then, about six years ago we started looking into using more modern techniques, and via some strategic acquisitions with companies having expertise for 20+ years in their domain, so overall I'd say we're looking at a collective development for more than 25 years for each domain. Over the last five years, Altair has truly converged this wealth of expertise to empower industries worldwide to revolutionize simulation-driven innovation by exploding the boundaries of design, development, analysis, and operational efficiency.



ADDITIONAL INFORMATION ON AI-POWERED ENGINEERING

Discover more about the transformative engineering and design advancements emerging from the convergence of simulation, AI, and HPC. Gain in-depth perspectives from experts in the automotive, aerospace, heavy machinery, and electronic system design industries, and hear how they're optimizing design processes, accelerating development cycles, and leveraging AI to achieve breakthrough results and out-innovate the competition.

For a deeper understanding of generative AI, check out A Human's Guide to Generative AI.

Charting the Future of Aerospace & Defense: A Conversation with Industry Experts
Jason Napolitano | SVP, Americas, Altair
Gio Greco | Astra Chief Engineer & SVP Mission Assurance

Structural Modelling – A Foundation of the Intelligent Engine
Carsten Buchholz | Project Engineer - Hybrid Electric Flight Demonstrator, Rolls Royce

Accelerate CAE and CFD with Hassle-Free High-Performance Computing (HPC)
Rick Watkins | Sr. Director, Cloud Computing, Altair

Why Architecture Matters in Automotive Engineering and Simulation
Rick Knoechel | Global Strategy Lead, Automotive and Discrete Manufacturing, AMD

Combining AI and Simulation for OSD Manufacturing Process Optimization
Stefan Pantaleev | Lead Engineer, Simulation & Design Support - GTT, Altair

The Value of Achieving a Fully Integrated Engineering Solution for Electronic System Design
Rebecca Fifelski | Automotive Electronics Engineering Executive

Altair physicsAI for Fast CAE Predictions Using Deep Learning
Dr. Charles Mortished | Lead Engineering Data Scientist, Altair

Learn More at altair.com/ai-powered-engineering

Altair is a global leader in computational intelligence that provides software and cloud solutions in simulation, high-performance computing (HPC), data analytics and AI. Altair enables organizations across all industries to compete more effectively and drive smarter decisions in an increasingly connected world – all while creating a greener, more sustainable future.

To learn more, please visit www.altair.com