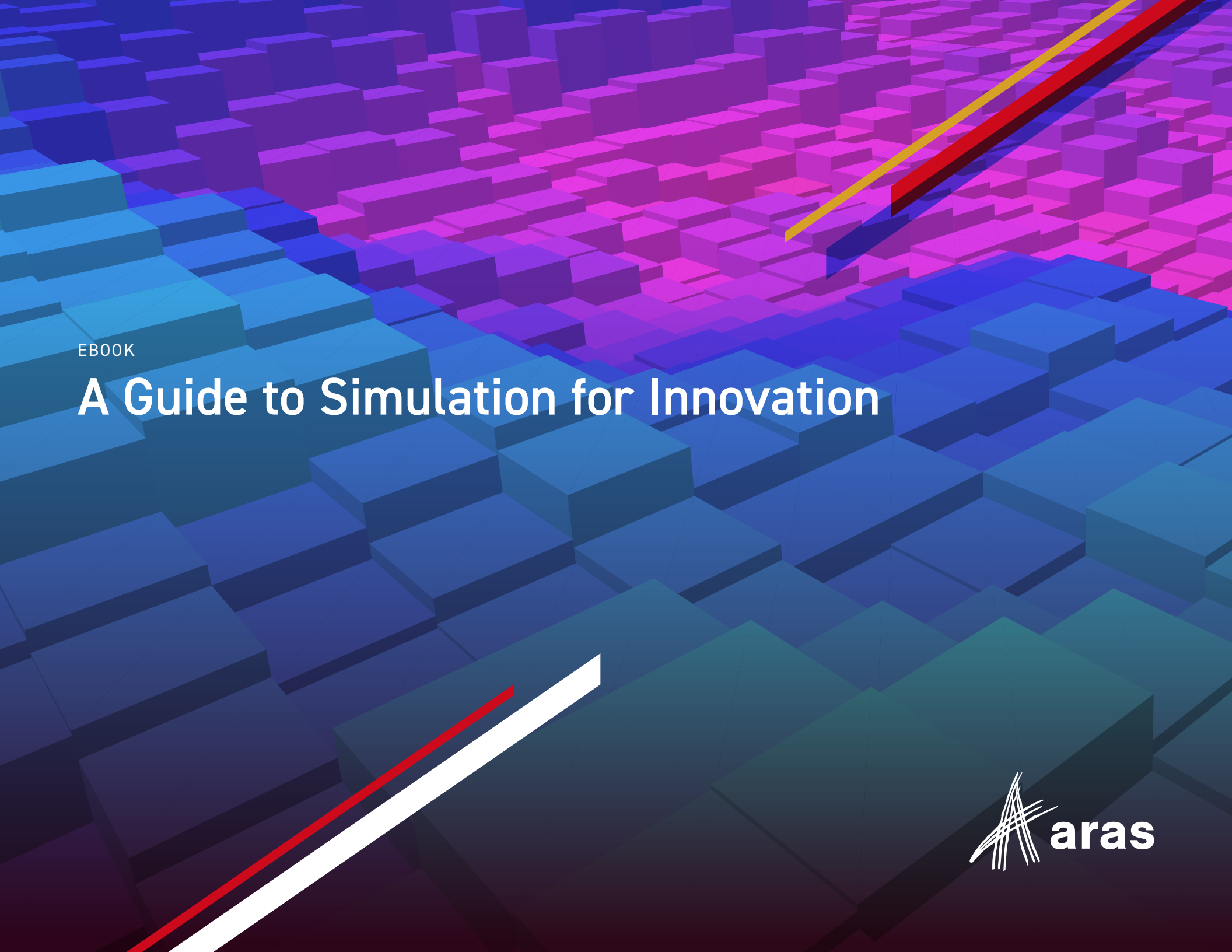

EBOOK
A Guide to Simulation for Innovation
aras

A GUIDE TO SIMULATION FOR INNOVATION

Aras believes that the right technology strategy helps companies achieve competitive advantage today and market-leading innovations tomorrow. See how your simulation strategy and its supporting technologies measure up.

TABLE OF CONTENTS

Achieving Today's Advantage...

Scale and Automate Simulation to Expand Virtual Testing 3

MBSE and SPDM: Bringing it All Together 4

Improve Traceability and Efficiency: Expanding the Digital Thread 5

Powering the Digital Twin 6

...and Tomorrow's Potential

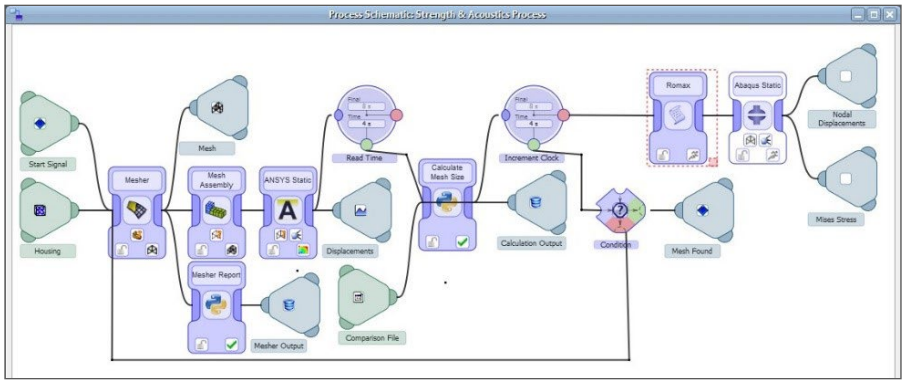
The Path to Design Space Study & Generative Design 3

Systems of Systems Simulation 4

Tomorrow's Digital Thread: AI in the Loop 5

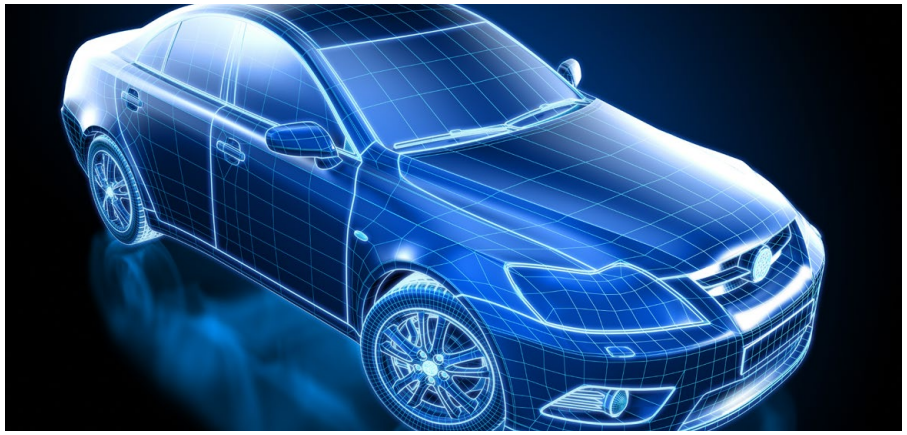
With AI in the Loop 6

Introduction to Aras Simulation Management: Aras Simulation Management offers SPDM technology—simulation process and data management—to scale simulation best practices across the entire product lifecycle. By delivering automated simulation processes to the enterprise via fully connected, intuitive apps, Aras Simulation Management powers accurate and consistent multi-physics, multi-fidelity analyses; returns fast, understandable results; and ensures input data and simulation findings are fully connected to the latest product configuration, completing the Digital Thread of product data to advance tomorrow's strategic initiatives.



With Aras Simulation Management, you can capture, enforce, and scale simulation best practices to more enterprise teams, automatically generating model files and chaining together multiphysics simulation tools.

Aras has a strategic OEM partnership with ANSYS. Aras customers may consider ANSYS Minerva, powered by Aras, for an out-of-the-box commercial Simulation Process and Data Management solution.



SCALE AND AUTOMATE SIMULATION TO EXPAND VIRTUAL TESTING

Accelerate time-to-launch and reduce product development costs: Virtual product testing reduces the cost, time, and engineering resources used downstream in physical testing, and improves certainty in test results to help eliminate late-stage changes and cost overruns.

Enable mass customization: Simulation tests every option and variant—without the need to build them all physically—so companies can meet growing demands for features and options, satisfy regional requirements, and advance ETO (engineer-to-order) strategies.

Manage integrations virtually to improve quality and safety: Integrating systems virtually, well before they can be integrated in physical prototypes, helps engineers to evaluate trade-off decisions and balance competing requirements to avoid quality and safety issues later.

THE PATH TO DESIGN SPACE STUDY & GENERATIVE DESIGN

Aras Simulation Management automates model preparation, and chains together multiple physics-based simulation tools into repeatable processes—enabling design space study and generative design.

Design Space Study: Studying the design space with simulation helps engineers analyze more design possibilities than manual processes alone, so they can eliminate options that won't perform and spend more time refining those that will.

Next-generation design and manufacturing processes: Multiple series of simulations are used during generative design, which relies on topology optimization and genetic algorithms to create organic-looking shapes that can be produced using advanced manufacturing techniques such as additive manufacturing. While these can have significantly lower mass, they require simulation to predict and ensure quality and performance.

MBSE AND SPDM: BRINGING IT ALL TOGETHER

Aras Simulation Management leverages an MBSE (Model-Based Systems Engineering) approach connected seamlessly to the latest configuration of the product's data as it evolves throughout the lifecycle. It leverages simulation from the level of systems models (requirements, functional, and logical) all the way through to 3D CAD models, and every level of fidelity in between to automate simulation processes across mixed fidelity, multi-domain, and multi-physics calculations, on-demand throughout the lifecycle:

Benefits at every lifecycle stage include...

Conceptual Design:

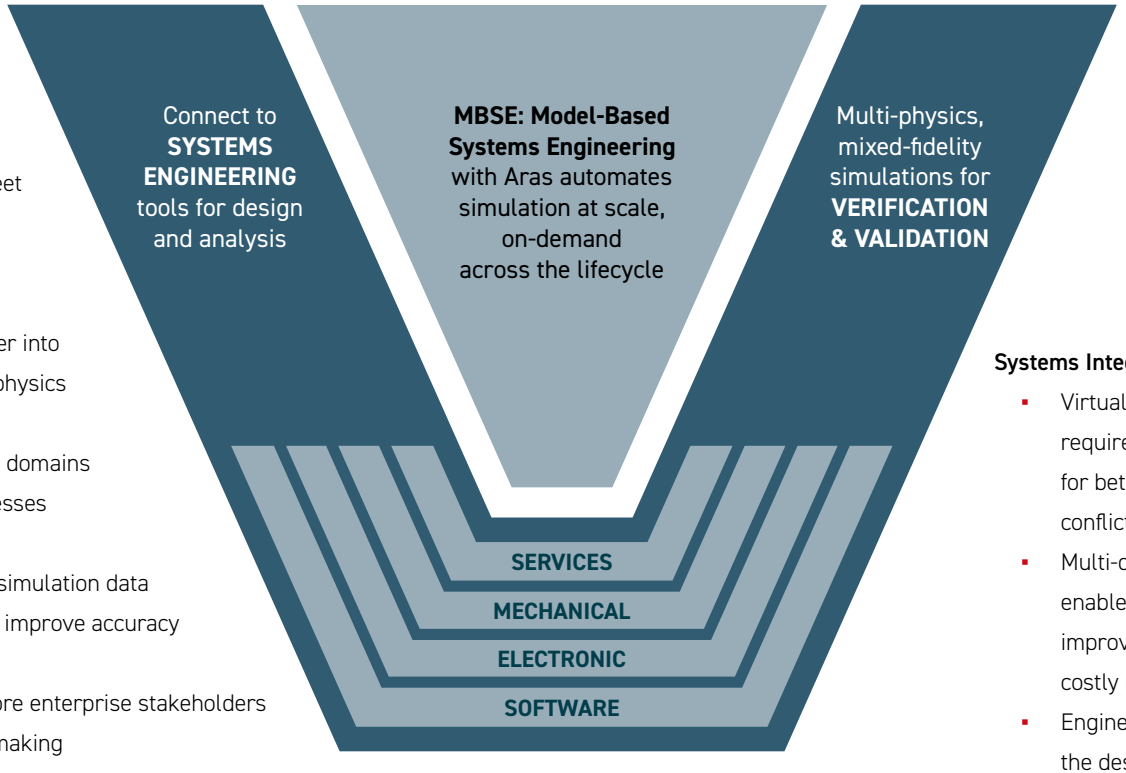
- Ensure requirements traceability through development, manufacture, and service
- Iterate on multiple systems architectures early to best meet system requirements

Detailed Design:

- Chain simulation tools together into repeatable, automated multi-physics simulation processes
- Capture best practices across domains and scale as executable processes to enterprise teams
- Ensure connectivity between simulation data and the latest product data to improve accuracy and efficiency
- Provide simulation data to more enterprise stakeholders for timely, accurate decision-making

SYSTEMS OF SYSTEMS SIMULATION

Automating mixed-fidelity, multi-physics, and multi-domain simulations at scale is the key to designing tomorrow's smart products: systems of systems with sensor technology that helps them to recognize and adjust to inputs from their environments, or the broader systems of which they are a part. For example, when designing autonomous vehicles, simulation processes leverage high-level systems models that include systems outside the product under development. They can also use software-in-the-loop simulation to "train" onboard AI in the best responses to the inputs they'll experience. Hundreds of thousands of simulation processes—or more—automated at scale, are essential to this testing process.



Virtual & Physical Test:

Expand the possibilities for virtual and physical testing by leveraging software-in-the loop, which connects software outputs to simulations using CAD and other inputs, to calculate the impact of software/hardware interactions under real-world conditions.

Systems Integration:

- Virtual integrations resolve competing requirements before physical integration, for better tradeoff decisions that eliminate conflicts
- Multi-domain, multi-physics integrations enable earlier tradeoff decisions, improving designs sooner and reducing costly rework and changes later
- Engineers spend more time refining the designs that work, and less time on change, rework, and discarded designs

IMPROVE TRACEABILITY AND EFFICIENCY: EXPANDING THE DIGITAL THREAD

Enforced connections between simulation results and related inputs, including their configurations, improves accuracy by offering context for findings: for correct interpretation, you must know what was simulated.

Simulation in the Digital Thread offers enterprise teams better traceability:

- Improved compliance, with access to all data, including simulation
- Executable, repeatable processes across engineering teams, to ensure consistency and compare "like vs. like" during iteration
- Faster, easier access to accurate, up-to-date performance insights from test and simulation, supporting better, faster decisions

Other benefits of the Digital Thread? Improved operational efficiency:

- Automated simulations mean less time spent searching for the right data, preparing it at the right fidelity, and waiting for multiple teams and tools
- Reduced time spent in non-value-added work, since results are sent faster and in context with requirements, improving decision-making
- Eliminate redesign, rework, and discarded work by eliminating manual data exchange, and parallel design paths, across multiple teams

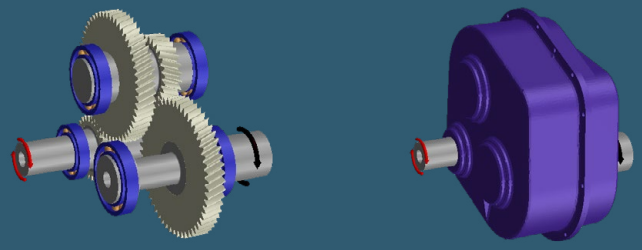
TOMORROW'S DIGITAL THREAD: AI IN THE LOOP

Automated simulation execution connected to the right configuration of a design both empowers today's teams and front-loads tomorrow's strategic initiatives.

Machine learning and artificial intelligence require both accurate data to analyze and a complete understanding of its context. Machine learning requires huge amounts of *accurate* training data. For product design, the major source of this data is fully-automated simulation that captures the associated context at a scale not possible through manual methods. Managing this Big Simulation Data, including the associated context metadata is vital for robust AI algorithms.

A configuration-aware Digital Thread—which maintains associations between related data across the product's evolution through development, delivery, and out into the field—ensures that the training data for AI algorithms is accurate. When simulation is not maintained in the digital thread, its context within a configuration-managed understanding of the product is also lost: which simulation processes were run, in which tools, with what settings, on which parts and subsystems, and with what results—all are lost both to human and to machine understanding without the means to repeat, connect to, and learn from results, on a small or large scale.

Connecting simulation data and results to the Digital Thread—a complete digital record of product information—lets engineering teams immediately access accurate simulation insights for timely decision-making. Plus, automated, configuration-aware simulation processes provide vital inputs for machine learning.



Templates enforce simulation best practices and repeatability. They work across different members of a product family throughout design changes, to help engineers compare "like with like".

Image created by Aras using software from Romax Technology.

POWERING THE DIGITAL TWIN:

The Digital Twin is a robust digital record of the fielded configuration of a product. Accessed and sometimes even controlled using software, the Digital Twin may include as-designed, as-delivered, and as-maintained product information—often informed by sensor data from connected devices.

WITH AI IN THE LOOP:

By connecting the digital twin with simulation processes, best practices, and tools, AI in the loop can automatically run new simulations leveraging inputs from the fielded configuration of the product to improve maintenance, operations, and next generation products.

Applications of Digital Twin Simulation include:

Predictive maintenance: Simulating the product and future potential maintenance scenarios helps to optimize cost and uptime to only provide maintenance when needed.

With machine learning leveraging field data and simulation at scale, AI can identify patterns pointing to maintenance needs, and predict or even prescribe optimal maintenance intervals.

Root cause analysis and closed-loop quality: Simulating the fielded product under real-world conditions helps to pinpoint and even visualize the root cause of issues, enabling better future designs.

With AI, pattern identification can find potential root causes, simulate their effects using automated processes, return results at a scale not otherwise possible, and flag potential flaws in new or upgraded designs.

What-if scenarios: Simulating the effects of new upgrades, new maintenance or repair procedures, and even new operating conditions, without the risks associated with testing them in the field on the physical product.

With AI in the loop, more what-if scenarios can be tested on a much broader scale, evaluating a breadth of possibilities that a manual process could not.

Improved designs: During next-generation design, using known operating conditions as simulation inputs—that is, actual data gathered in the field by sensors—can continuously drive design improvements in current or next-generation products, ensuring they'll work under usage scenarios not envisioned by the design teams.

With AI analyzing vast quantities of data from real-world conditions, product performance, and customer inputs, pattern-finding can inform ideation, set next-generation product requirements, and recommend new designs humans alone can't uncover.

Smart Manufacturing: Factory Digital Twins

Simulate manufacturing equipment, processes, materials, and outputs for "smart factory" applications to:

- better predict and control outcomes
- try different scenarios
- optimize and balance competing needs

Additive Manufacturing:

Simulating different combinations of material properties and device settings for additive manufacturing processes helps to ensure a part will meet its quality requirements in advance of the costly, time-consuming build process, helping reduce waste.

On-Demand Simulation Throughout the Product's Lifecycle: Downstream of conceptual and detailed design and validation, automated simulation best practices, connected with the each instance of a product in the field, offer a number of benefits.

Simulation at Scale—Rewriting the Requirements Realizing the benefits of current and next-generation applications for simulation requires automated, multi-physics, and multi-fidelity processes. Scaled across the enterprise with Aras Simulation Management, these promise to improve performance and accelerate efficiencies. But they can also front-load tomorrow's strategic initiatives. Aras Simulation Management offers a unique, enterprise-class solution to scale the use of simulation to more teams and processes throughout the product's lifecycle. It meets the needs of today's engineering and simulation teams, complex products, and quickly evolving business strategies to scale the benefits of simulation to the enterprise today—and tomorrow.

New requirements for simulation...	**Met by Aras Simulation Management:** Centralized access, multi-tool automation, and data management using a unified data model across all simulations
Connect engineering teams with simulation knowledge: Capture, scale, and enforce simulation best practices across more teams throughout the product's lifecycle.	▪ **Simulation leads** build best practice templates: reusable, automated processes for simulation knowledge-capture and reuse. ▪ **Engineering teams** run simulation processes using simple, intuitive apps—with user interfaces that any engineer can navigate—and access easy-to-understand simulation results for timely decision-making. ▪ **Digital Thread connectivity** enforces use of the right input data every time to eliminate errors and parallel design paths, and provides context for findings—saving time and resources for higher-value projects while reducing errors.
Improve the development of complex products: Integrate multi-physics, multi-domain, and multi-fidelity approaches using executable simulation processes that enforce best practices.	▪ **Leverage multi-domain data** from across engineering disciplines to enable digital systems integration and evaluate interactions: providing for the reliable virtual testing of complex systems in complex operating conditions. ▪ **Chain together multi-physics simulation tools** in automated simulation processes, for use and reuse at scale, to ensure all requirements are met, improve tradeoff decisions, reduce errors, and ensure consistency and repeatability. ▪ **Enable multi-fidelity simulations** within automated processes; generate accurate, connected mixed-fidelity models with minimal manual effort, balancing computational expense with higher simulation accuracy only where required.
Meet the needs of evolving business processes: Ensure repeatability to meet high standards for quality, safety, and performance across changing teams and processes, and accounting for differences across global geographies.	▪ **Connect to changes, options, and variants** so design iterations and product lines can be compared, "like vs. like," at each critical stage; managing simulation data and results alongside configurations and requirements they apply to. ▪ **Scale existing (and new) simulation tools** throughout the product's lifecycle, guided by your unique processes, to develop virtual test, virtual systems integration, and design space study strategies. ▪ **Simulation in the Digital Thread to support tomorrow's technologies:** simulation-enabled Digital Twin, powerful smart manufacturing and generative design applications, and the hundreds of thousands of automated, configuration-aware simulation processes necessary for machine learning to train AI algorithms to understand big data streams.

CONCLUSION

Aras Simulation Management connects simulation data, processes, and results with the right version of product data in a traceable Digital Thread, supporting robust, effective simulation automation at scale throughout the enterprise.

Aras is the leading provider of an open, digital end-to-end product lifecycle platform that enables the world's leading complex manufacturers to digitally transform and gain a competitive edge. Headquartered in Andover, MA with major offices throughout the world, Aras' 500 employees support over 350 global multinational customers and over 250,000 users. Aras is the fastest growing PLM company worldwide. Aras' open, flexible, scalable and upgradeable PLM platform and applications connect users in all disciplines and functions to critical product data and processes across the lifecycle and throughout the extended supply chain. The Aras Innovator platform is freely downloadable. All applications are available at a single subscription rate, which includes all upgrades performed by Aras. Aras customers include Airbus, BAE Systems, GE, GM, Hitachi, Honda, Kawasaki Heavy Industries, and Microsoft.

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