L&T Technology Services

THE BUSINESS NERVOUS SYSTEM:

engineering intelligence in the enterprise

How

AI and Digital Engineering 2.0
Connect **Design, Products, and Operations**



CONTROL ENGINEERING

A **Control Engineering-LTTS** Joint Production

FOREWORD

For most of its history, engineering has advanced by helping people manage complexities. Each new tool – the drawing board, the mainframe, CAD, simulation, and digital engineering itself – extended the reach of the engineer's mind. But the terms never changed.

Humans learned the tool, bent it to the problem, and carried the weight of judgment alone. Technology was always less flexible than the people using it, so we trained the people.

That premise is now breaking. For the first time, the tool can adapt to us – learning our processes, our data, and our intent faster than we can adapt to it. This is the shift at the heart of this book. When artificial intelligence is woven through every stage of the engineering lifecycle, the result is not a faster version of what came before. It is something new. There is a name for it: Engineering Intelligence.

It is worth being precise, because Engineering Intelligence is easy to misread. It is not generic AI aimed at engineering problems. A model trained on the open internet knows nothing about your materials, your failure modes, your tolerances, or your compliance obligations. Engineering Intelligence is different because it is grounded in engineering context – the knowledge graphs, domain models, and lifecycle data that capture how your products actually behave – and because it works under governance, so that every recommendation can be traced, explained, and trusted. It lives in three places at once: inside engineering, inside the products you create, and inside the operations that build and sustain them. That combination – reasoning power, plus engineering context, plus governance – is what turns a raw model into a dependable engineering asset, and what separates a helpful copilot from a trustworthy collaborator in safety-critical work.

The distinction matters most where the stakes are highest. In the pages that follow, you will hear from leaders helping build this future across automotive and mobility, industrial operations, and the enterprise itself. Their examples differ, but the through-line is constant: value comes not from replacing engineers, but from amplifying them. AI can generate a thousand design options, run millions of data points a second, and surface patterns no human could see across ten dimensions of data. What it cannot do is be curious. It cannot imagine, question its own assumptions, or decide what is worth building. Those remain profoundly human capacities, and they become more valuable, not less, as the routine work is absorbed.

This is why Engineering Intelligence should be understood as a change in the engineer's role, not a threat to it. The work shifts from manual, local, iterative

problem-solving toward strategic orchestration – decomposing problems, directing intelligent systems, setting guardrails, and exercising the judgment to know when an answer is wrong. It also redistributes power. Instead of a handful of centralized projects dictated from the top, thousands of empowered users can solve the problems they understand best. The engineer becomes the conductor of an orchestra of capable instruments, responsible for the music rather than each individual note.

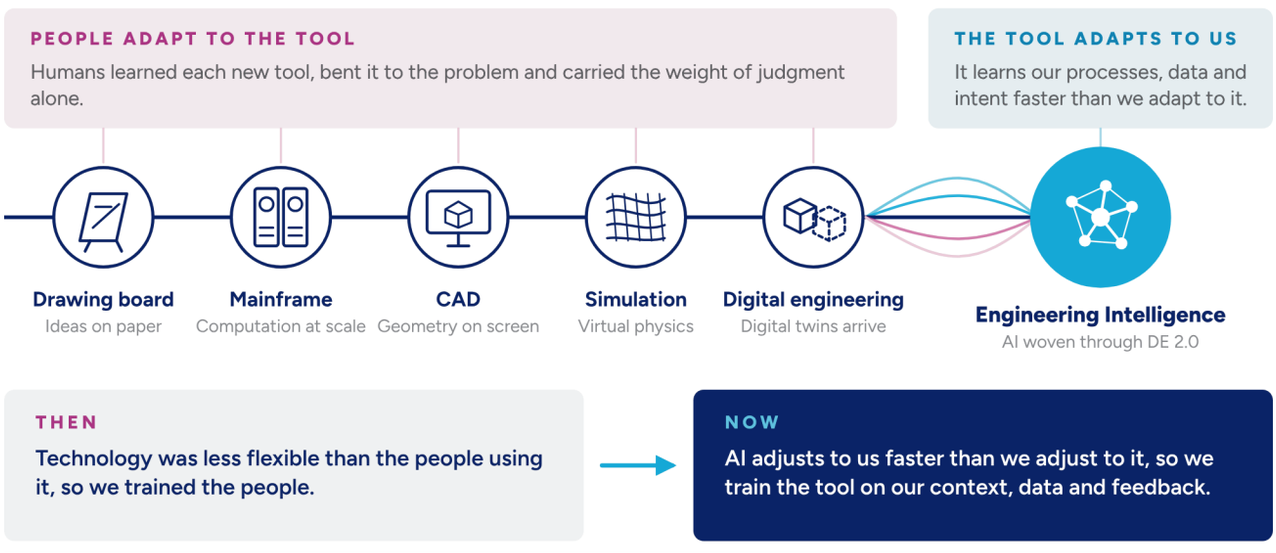
None of this is automatic. Realizing it demands high-quality data, integrated toolchains, new skillsets, and leaders willing to champion change against institutional inertia. This book does not pretend otherwise; it treats the obstacles as seriously as the opportunities. But the direction of travel is no longer in doubt. Organizations that embrace Engineering Intelligence will compress innovation cycles, reduce waste, and design products once thought impractical. Those that wait will find the gap to their competitors widening faster than they can close it.

What you hold is a map of that transition – from Digital Engineering 2.0 as the environment, to Engineering Intelligence as the outcome it was built to produce. Read it not as a forecast of some distant future, but as a practical guide to a change already underway. The engineers and leaders who understand it first will be the ones who shape what comes next.

FIGURE 1

The tool now adapts to us

Every earlier engineering tool extended the engineer's reach, but people had to learn it. Engineering Intelligence is the first tool that learns us.



Source: Foreword; Arijit Sengupta, Founder and CEO, Aible (Chapter 1).

CHAPTER 1:

Defining DE 2.0 in the Enterprise Context

Digital Engineering (DE) 2.0 represents a generational shift and advancement in technology. Its foundations include artificial intelligence (AI), digital twins, the Internet of Things (IoT), data analytics, and other leading-edge tools.

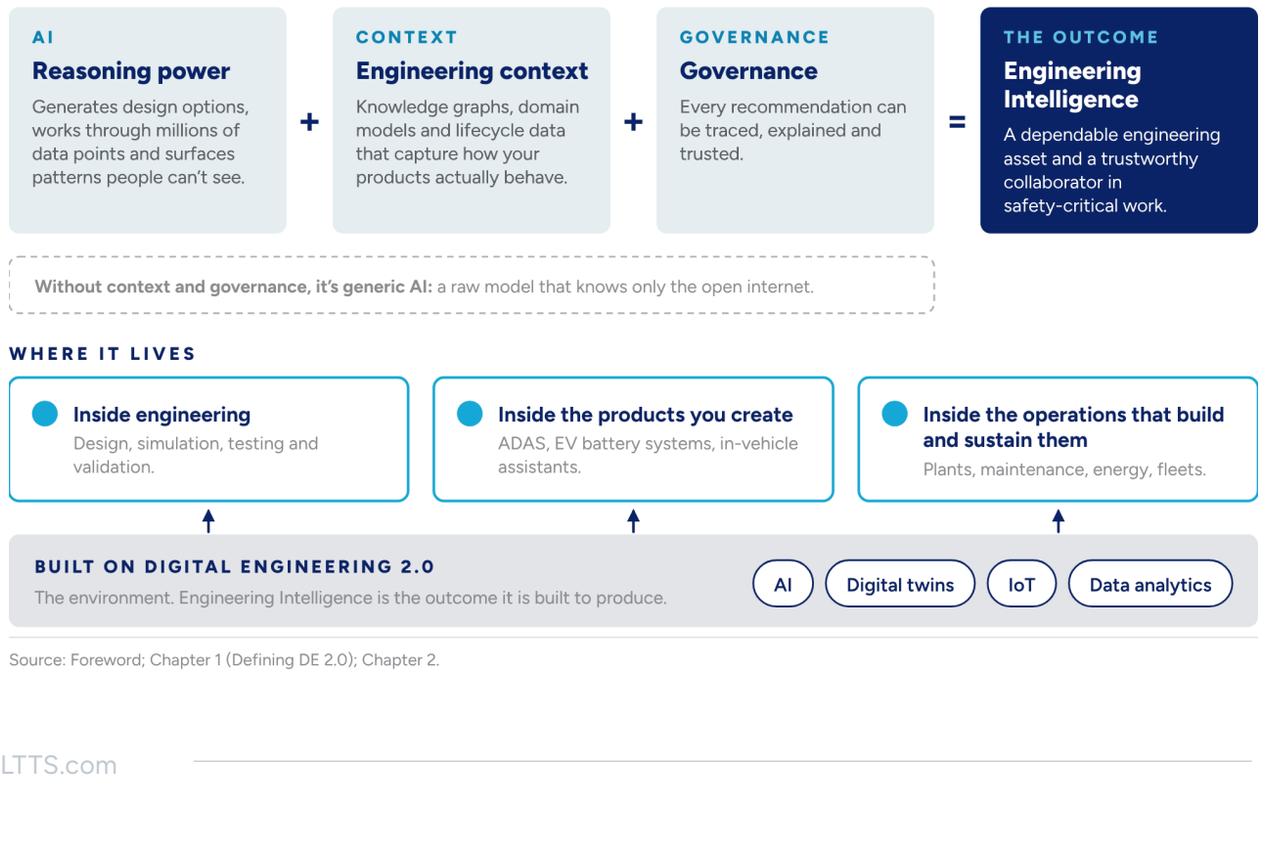
It creates a holistic, data-driven, collaborative, and enterprise-wide environment that supports operational excellence and sustainability, improves productivity, and speeds time-to-market. When successfully adopted, DE2.0 can result in significant competitive advantage.

No longer limited to individual engineering specialties or silos, DE 2.0 supports domain-independent problem-solving skills that allow you to identify and formulate underlying design issues, not just solve limited problems. It leverages AI to coordinate your activities with other designers, even those at

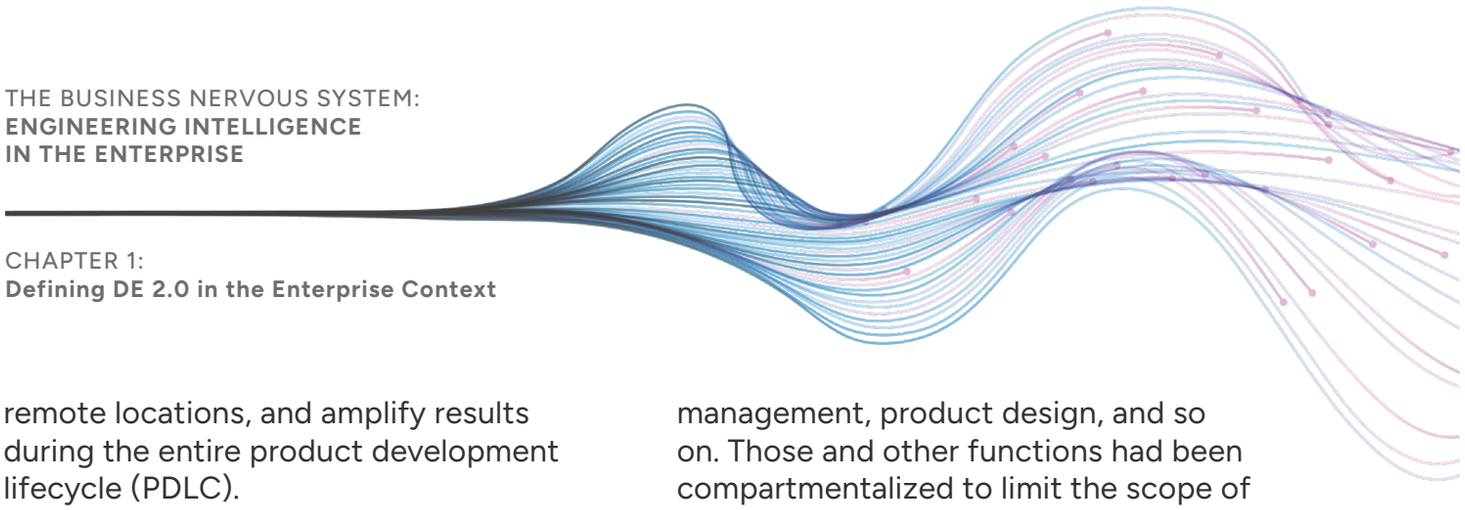
FIGURE 2

What makes it Engineering Intelligence

Three ingredients turn a raw model into a dependable engineering asset.



Source: Foreword; Chapter 1 (Defining DE 2.0); Chapter 2.



remote locations, and amplify results during the entire product development lifecycle (PDLC).

From DE 2.0 to Engineering Intelligence

There is a name for what emerges when AI is woven through every stage of DE 2.0: Engineering Intelligence. It is the practice of embedding intelligence across the entire engineering lifecycle – from product design and development through to operations and optimization – so that lifecycle data, domain expertise, and real-world performance are continuously converted into governed, actionable insight.

Engineering Intelligence is not generic AI pointed at engineering problems, but rather, the intelligence that lives inside three places at once: inside engineering, inside the products you create, and inside the operations that build and sustain them.

Where DE 2.0 supplies the holistic, data-driven environment, Engineering Intelligence is the outcome that environment is built to produce. Throughout this book, when we describe the combination of AI plus DE 2.0, we are describing the road to Engineering Intelligence.

The rise of the business nervous system

Arijit Sengupta, Founder and CEO at Aible, calls DE 2.0 the "business nervous system" that connects various business activities like finance, inventory management, product design, and so on. Those and other functions had been compartmentalized to limit the scope of activities and enable humans to handle specific tasks.

In DE 2.0, Arijit sees agentic AI being used to coordinate across the various silos. That provides a more holistic view of the enterprise and more flexibility. The enterprise can become self-balancing and self-adjusting to accommodate dynamic market conditions like changes in tariffs and other international trade challenges, or the emergence of disruptive technologies.

The use of AI in DE 2.0 brings powerful benefits to operations. Humans cannot effectively deal with the complexity of information and simultaneously consider the impact of dynamic market changes on all the different operational silos. As a result, it takes a significant amount of time to reoptimize enterprise performance.

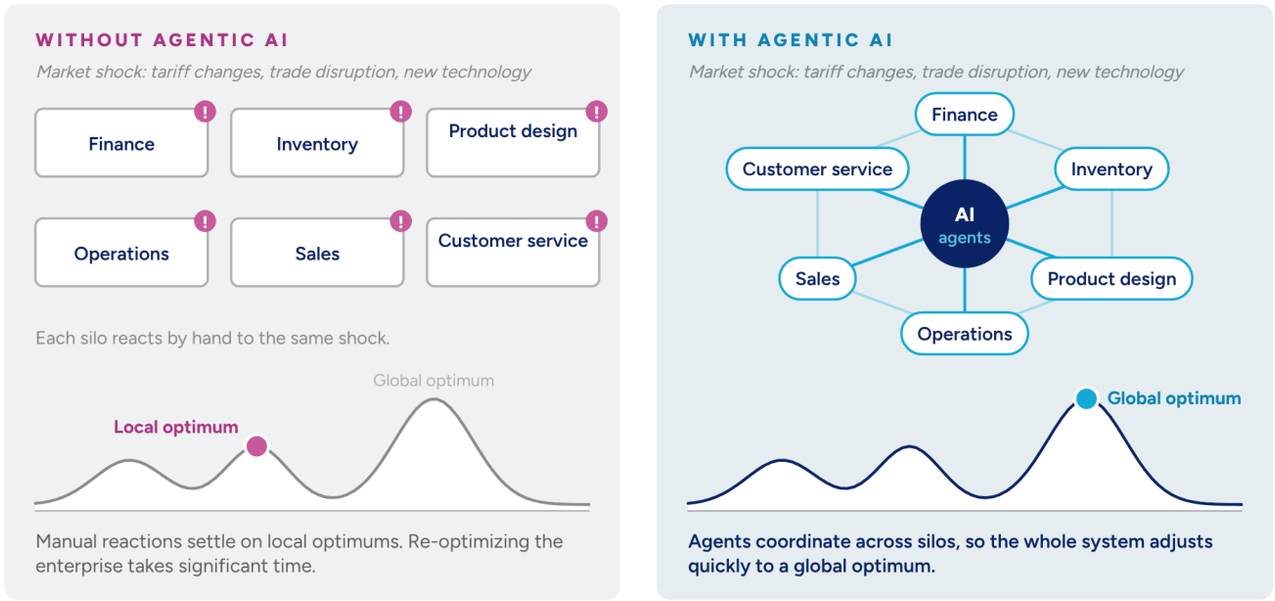
Toward global optimum

Arijit observes, "One of the interesting things about AI is you can start using agents to coordinate across different silos and have a much more holistic view of a process. Without agentic AI, all the reactions to changes are completely manual and thus they are always producing local optimums. Adding AI agents enables the entire system to quickly adjust to a global optimum enhancing the overall performance of the enterprise."

FIGURE 3

The business nervous system

Functions were split into silos so people could manage them. Agentic AI coordinates across them, so the enterprise can rebalance as a whole when markets shift.



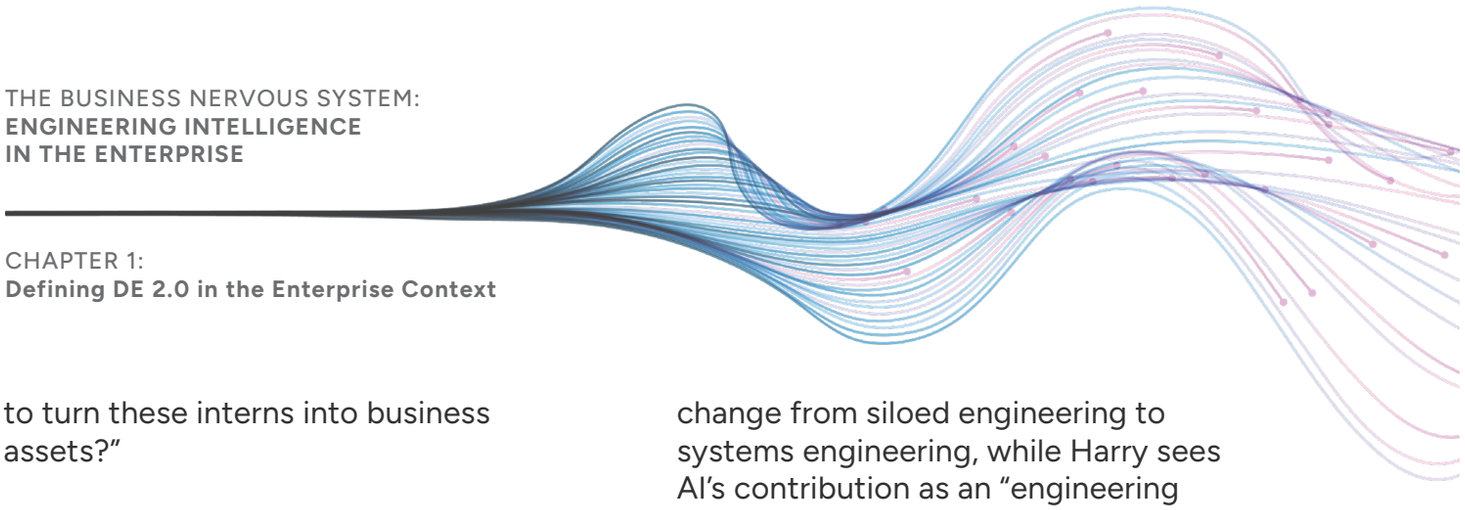
Source: Arijit Sengupta, Founder and CEO, Aible (Chapter 1). Landscape is illustrative.

An "aha" moment for Arijit occurred when he realized how the emergence of DE 2.0 was inherently different from every other technology revolution in the modern age.

Previously, it was the human who was the change agent. Up to now, every new technology was less flexible than the human mind. Humans would learn how to use the new technology to create greater value. Everything was human first. That is why the training of humans was the most important aspect of any new technology adoption.

Arijit observes: "AI is the first technology that can adjust to us faster and better than we can adjust to it. The key is to set everything up to give AI a feedback cycle because AI is dumb. Let us be very blunt: When AI comes out of the box, it only knows what is in the open Internet.

"That means AI knows nothing about unique business processes, unique business strategies, or unique data structures. It just knows nothing. When they come out of the box, I call these raw AI agents 'interns.' A key question is how do we transfer the enterprise-specific context, and domain knowledge needed



to turn these interns into business assets?"

Arijit believes that most organizations do not do effective post-training because they have turned it into a complex data-science-driven process that takes months to do. But the technology is moving faster.

"In a business setting, users are constantly providing feedback that can support continuous updating and training, enabling the AI to adjust to user needs in near real time. That's a fundamental requirement for maximizing the benefit of AI in a business context, including the identification of new revenue opportunities," Arijit concludes.

The applications for DE 2.0 extend beyond general business processes into software and hardware engineering, product development, and operations across every area including automotive, mobility, industrial, and general manufacturing.

Automotive and mobility

Stefan Juraschek, Strategic Advisor with Acsia Technologies, and Harry Kroeger, Board Member and President Automotive at SiMa.ai, agree that DE 2.0 will be a significant factor for improving software development in automotive and mobility applications but see the opportunities from slightly different perspectives.

Both state that it is AI driving the changes. Stefan focuses on the change from siloed engineering to systems engineering, while Harry sees AI's contribution as an "engineering superpower" that enables one person to do what it previously took 10 people to accomplish.

Harry comments, "It is going to be the same in many kinds of engineering because AI will be the great amplifier for capabilities, and it is exciting to be in this age where development will accelerate dramatically because you can do so much more in a given time."

For example, he sees it as being central to the development of increasingly complex software-defined vehicles, where it will reduce the time needed for writing the many loops. "With AI and DE 2.0, an engineer can create code snippets with just a click. They work beautifully and speed up the development of complex software solutions," Harry concludes.

Stefan agrees that support of faster software-development cycles will be a key benefit of AI in DE 2.0, adding that design, simulation and testing will also benefit. He observes, "The amount of software in an automobile is increasing very rapidly, with a doubling of the lines of code every three years. Demands for better software quality are also increasing. We cannot continue doing things the way they were done a few years ago and expect to keep up with the challenges. DE 2.0 plus AI provides the needed tools."

More than speed

With DE 2.0, the process can take a different approach. The AI-supported development tools in DE 2.0 mean you can handle much larger quantities of data compared with five years ago. Using the new AI tools enables everyone to benefit from the data and experience from past development efforts. That results in quicker development times and faster testing producing higher quality software.

Transitioning to a wider view, Stefan continues: "In the past, you had separate technologies like mechanics, software, automation, and manufacturing, each with different centers of gravity and different development speeds. Each technology had experienced engineers that knew everything from past designs and could use that knowledge when developing specifications for the next project."

Today, using AI tools and DE 2.0 you can take several specifications from the various engineering silos and quickly develop a set of unified specifications that can speed the engineering phase of product development. It can remove some steps from the prototyping phase and enable prototypes to be implemented in a digital form, like a digital twin.

Prototype testing can be accelerated. Using an AI toolset, you can deeply analyze a dynamic log and trace (DLT) result from an electronic control unit (ECU) in half an hour instead of taking an entire day. That speeds debugging, performance monitoring, and diagnostics during development.

The use of AI tools can provide a link to the production facility. Without DE 2.0, manufacturing engineering cannot achieve the development speed of product engineering.

For example, without DE 2.0 and the tenets of Engineering Intelligence, it is usually necessary to analyze the operation of individual machines. With virtual prototypes and AI tools, you can quickly analyze the operation and interactions of multiple machines using simulations. That speeds time to market.

DE 2.0 also broadens the concept of collaboration to include more engineering and development disciplines with AI-supported simulations. Stefan observes, "DE 2.0 and AI can strongly support a 'first-time right' outcome for engineering and development activities. That results in higher quality product designs that move quickly from software, to hardware, including manufacturing processes."

Not just more digital

Harry and Stefan both had moments when they realized that with DE 2.0, they were doing something different, not just doing more digital.

For Harry, "It was before Chat GPT came out. When the first powerful Convolutional Neural Networks (CNNs) hit the stage and you could see how well they are doing classification on images.

Then it began dawning that something really powerful was coming our way. And I definitely think everybody had the realization when the first transformer AIs hit the stage that DE 2.0 and AI had this mind-blowing potential."

Stefan agrees that the potential of DE 2.0 and AI was apparent early on. He observed, "At the very beginning of battery electric vehicles (EVs), we did not understand how the batteries behave over the vehicle lifetime. We understood how to deal with combustion engines, gear boxes and electronics, but the battery was challenging and it was, and still is, the most expensive part."

In addition to system integration, considerations like warranty costs are important. DE 2.0 enables engineering teams to get a wide range of information from the field to use in the development process, improving long-term performance and minimizing warranty expenses, especially for EV batteries.

Stefan observes, "The use of DE 2.0 and AI to optimize battery performance in EVs was the beginning of digital twins, but at first, we didn't use that name."

The ability to have continuous monitoring of battery performance and analyze that information quickly using AI so it could contribute to the next development cycle was key, according to Stefan. Compared with the experience in automotive and mobility, the journey from digitization to DE 2.0 was somewhat different for industrial applications.

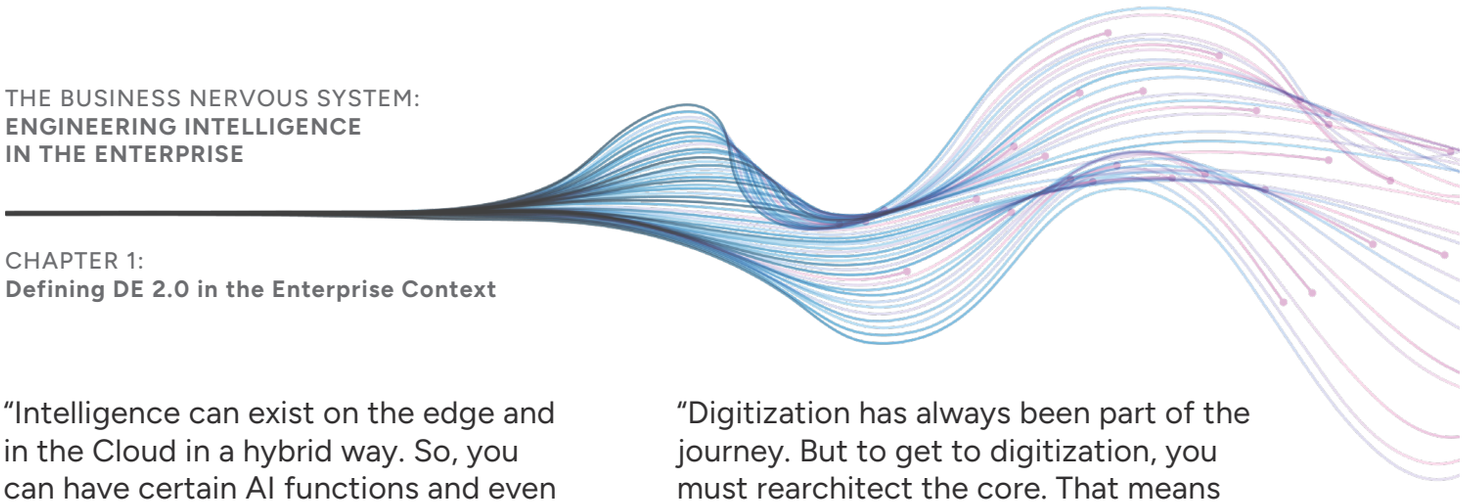
DE2.0 in industrial applications

Prateek Kathpal, President of SymphonyAI, began discussing industrial applications for DE 2.0 with the observation: "I think DE 2.0 in industrial applications is different in several ways. First, the last decade has been more about digitization: It has been moving from paper to screens to collect data and create point-based solutions."

"But now, DE 2.0 is focused on AI as the new execution engine. So, instead of dashboards waiting for human inputs, we have industrial AI agents that can interpret the signals in context and autonomously execute workflows," concluded Prateek.

The second impact of DE 2.0 is unification of the data, a key input to the AI. It also acts as both logical and domain knowledge into the semantic layer. So, the industrial knowledge graph that maps relationships between operational entities like equipment, processes, sensors, and materials, feeds LLMs and digital twins that operate as living models of the plant. They provide you with feedback as part of the AI instead of having information in spreadsheets or siloed apps, as used to be the case.

Prateek sees the third impact of DE 2.0 as the opportunity to leverage edge AI:



"Intelligence can exist on the edge and in the Cloud in a hybrid way. So, you can have certain AI functions and even physics elements defined near the edge. And have large-scale operations and the data lake in the Cloud."

It is not just digitizing but also about rearchitecting the core. Prateek observes, "Digitization has always been part of the journey. But to get to digitization, you must rearchitect the core. That means adding data, increasing data density, and the variability of the data. Ensuring all those changes play together to arrive at the AI use cases you want can require further rearchitecting the intelligence of the core."

Conclusion

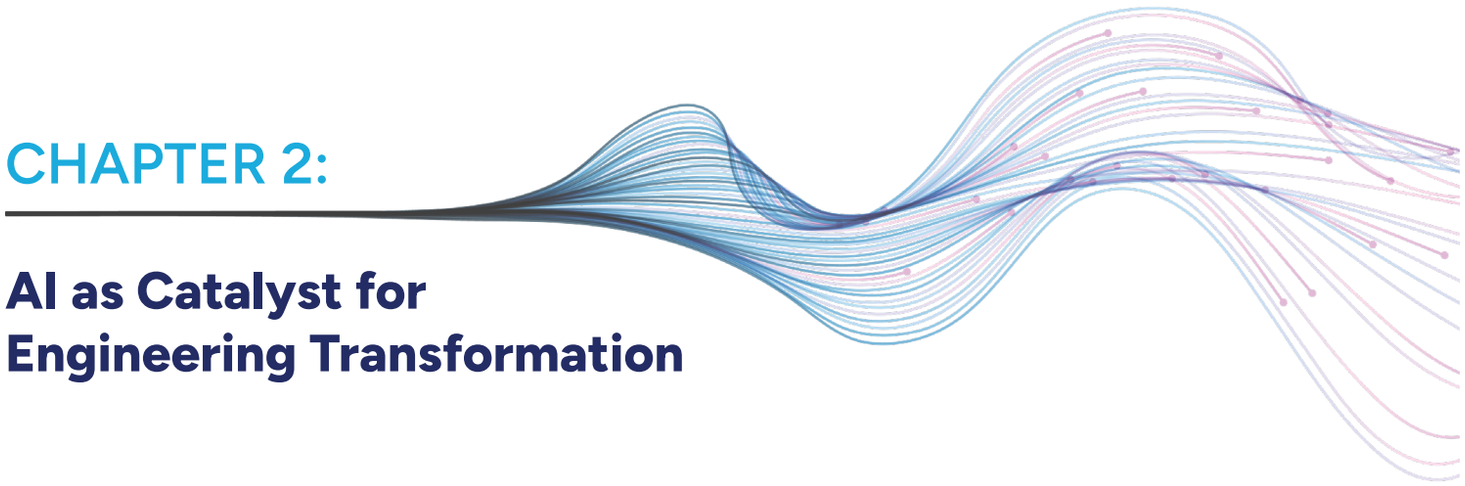
DE 2.0 and Engineering intelligence represent a paradigm change for your design activities. It leverages AI, digital twins and other technologies to enable increased speed, flexibility, breadth and depth of analysis. It can be based on the cloud or implemented with a hybrid of cloud and edge computing depending on the application requirements.

In addition to breaking down barriers between functional silos, the transformation can link and enhance enterprise-wide operations like finance, product development, sales, customer service, and so on. For engineering and product development, it facilitates and integrates the entire range of functions from initial specification development to prototyping, testing, and manufacturing.

Adding AI to DE 2.0 automates routine design and simulation tasks and provides you with data-driven AI tools to rapidly explore complex alternative approaches and arrive at optimized solutions. That will shift your role as a designer from implementation of locally focused manual processes to strategic orchestration.

Organizations that deploy DE 2.0 plus AI can expect to enjoy increased competitive advantage and unlock new cost saving and revenue generating opportunities. The following four chapters explore various aspects of the challenges and benefits for you as AI becomes increasingly embedded in DE 2.0.

CHAPTER 2:



AI as Catalyst for Engineering Transformation

AI is an active agent for transformation in digital engineering (DE) 2.0. It shifts engineering processes from passive modeling to proactive, expansive, and collaborative initiatives.

AI today can identify engineering bottlenecks before they become roadblocks. That accelerates the design process and boosts the importance of humans-in-the-loop by enabling them to focus on complex multi-dimensional design challenges and arrive at creative solutions in a system-wide context.

This will dramatically change industries through a combination of personalization, automation, and predictive insights – not only optimizing operations but also enhancing user experiences.

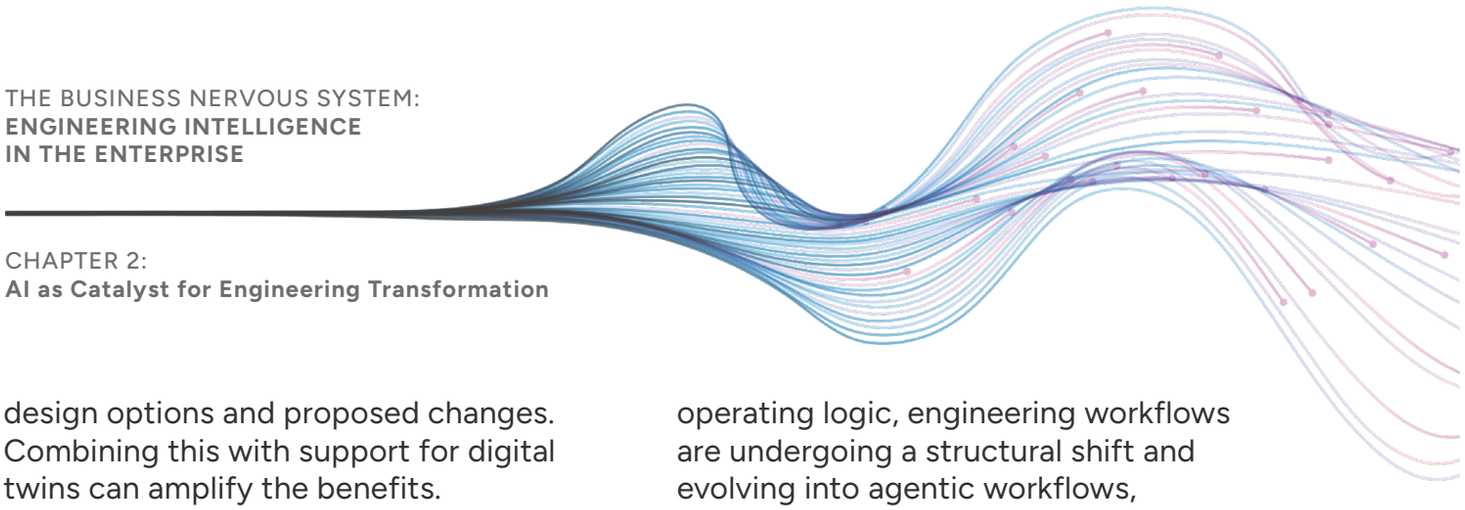
AI plus DE 2.0 will transform design processes by automating repetitive tasks using generative design tools and rapidly presenting numerous design options. It will enable real-time simulations and virtual testing to speed validation of selected designs and support designing for manufacturability. Once the design has entered production, AI plus DE 2.0 will support predictive maintenance for enhanced productivity and improve sustainability throughout the product lifecycle.

Generative AI is not an "all or nothing" choice. You can use an AI copilot, a generative AI-powered digital assistant that can automate routine tasks like summarizing documents, basic coding, and drafting emails. A copilot works alongside you to boost productivity and frees your time for more creative activities where AI is not suited to contribute.

As an engineer, you will be able (and expected) to focus on creativity and strategic thinking that will support quicker development of more innovative products. While AI can automate tedious functions, it can also require development of new skills, for example in machine learning, data interpretation, and coding. AI has no imagination and needs human guidance.

AI also needs significant oversight; it can generate thousands of design possibilities taking into consideration factors like materials, cost, and manufacturing process constraints. This means that you need to be adept at sorting through a wide array of design details and options to effectively manage an AI-centered design process.

AI's ability to implement complex simulations can provide you with additional feedback on selected



design options and proposed changes. Combining this with support for digital twins can amplify the benefits.

The ability to quickly analyze the complex datasets that comprise digital twins can improve decision making by simulating detailed scenarios in a virtual environment. That can lead to earlier identification of potential design flaws and reducing risks. The use of generative AI, also enables natural language interactions for you to ask detailed questions about digital twin performance and possible changes.

The ability to directly communicate with AI can also make it a creative partner. Your approach to design can evolve to take advantage of the strengths of AI. You can ask about specific alternatives and get detailed analysis. The process will evolve from using generative AI to the use of more proactive agentic AI.

Sometimes even asking "obvious" questions can elicit unexpected responses due to AI's ability to deeply analyze huge datasets beyond the reach of human reasoning. That can be helpful to overcome creative blocks and push the limits of creative designing. To realize and maximize the potential of AI plus DE 2.0 requires a different approach and a structural shift.

Beyond an operating logic

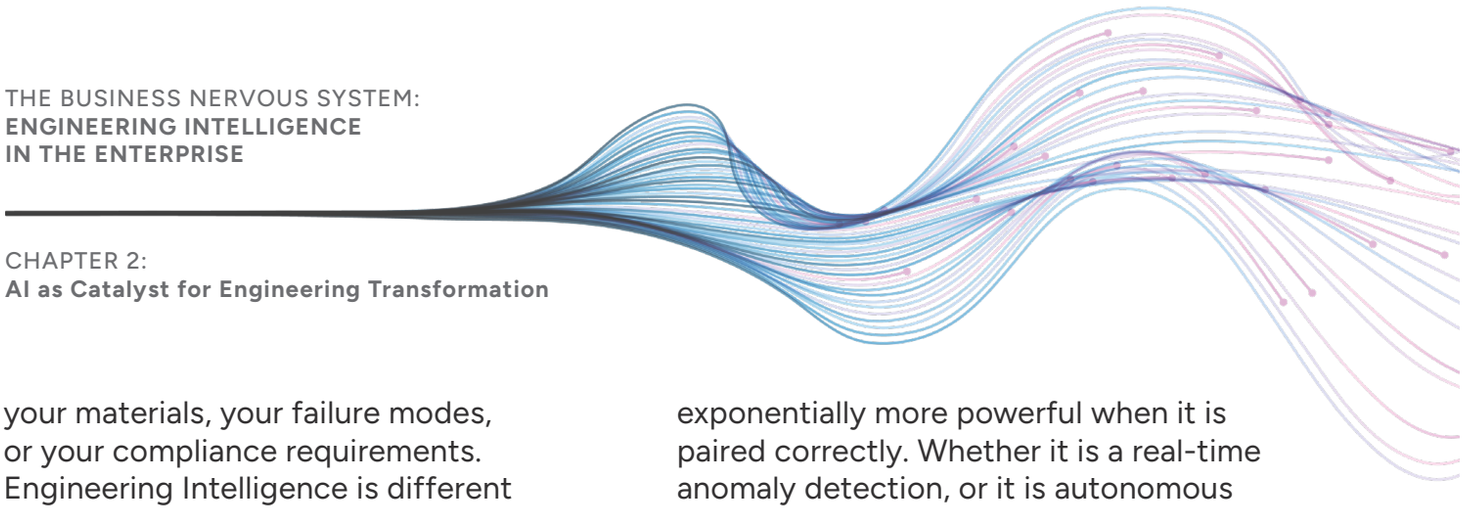
As the use of AI changes in DE 2.0, from being just a tool to being an operating logic, engineering workflows are undergoing a structural shift and evolving into agentic workflows, according to Prateek Kathpal, President of SymphonyAI.

In DE 2.0 an agentic workflow is an AI-driven process where autonomous agents, powered by large language models (LLMs), independently plan, reason, use tools, and execute complex, multi-step design tasks with minimal human intervention. Unlike conventional automation, agentic workflows can adapt to new information, iterate results, and act to achieve goals.

"Engineers do not need to originate every analysis. They can validate the recommendations," states Prateek. If a serious, recurring, or high-risk issue is identified during the design process, agentic AI can implement a root cause analysis (RCA), to find the underlying cause rather than just fixing the symptoms.

"Instead of having the tribal knowledge in the brains of the engineers, you can now have encoded knowledge graphs, performance graphs, and domain models, where every insight is preserved and is immediately accessible by the agentic AI," Prateek continues.

This is the distinction at the heart of Engineering Intelligence. Generic AI, trained on the open internet, knows nothing about your specific processes,



your materials, your failure modes, or your compliance requirements. Engineering Intelligence is different because it is grounded in engineering context – the knowledge graphs, domain models, and lifecycle data that encode how your products actually behave. It couples the reasoning power of AI with verified engineering knowledge, and it does so under governance, so that every recommendation can be traced, explained, and trusted.

That combination – AI, plus engineering context, plus governance – is what turns a raw model into an engineering asset. It is also what separates a helpful copilot from a dependable collaborator in safety-critical work, where an unexplained answer is worse than no answer at all.

To handle large quantities of data and large AI models, cloud-based tools will be a key aspect of DE 2.0 plus AI. That will require new approaches.

AI is expected to be the central element for improving the performance of industrial operations, transportation, and overall sustainability. Three important pairings of AI will be: AI and IoT, where the IoT provides the data, the AI provides the interpretation; AI and cloud virtualization for scalable analytics; and AI and enterprise IT for decision automation.

Exponentially increasing AI power

"I think for all those areas, the AI becomes exponentially more powerful when it is paired correctly. Whether it is a real-time anomaly detection, or it is autonomous edge agents performing and reacting on certain things, or it's closed loop systems, they will form these self-optimizing pairs," Prateek continues.

Performance optimization will rely on enterprise-wide collaboration, including knowledge graphs across the whole organization not just at the local level. It will include digital twins and unified data fabrics across the enterprise. The AI will run millions of data points per second to deliver continuous optimization.

Prateek sees the pairing of AI plus enterprise IT playing a big role. "This is where an 'always on' enterprise, which is what we have been trying to get to, can become a reality because now you can generate the decisions, and then push the actions into the enterprise systems," he observes.

"The impact, let us say in the industrial manufacturing and energy sectors, could be based on predictive reliability, performance optimization and scheduling, and safety compliance which all get improved."

"When the downtime is happening in the energy sector, for example, you could now process billions of data points and decide what caused the situation, what the upstream and downstream factors are, and feed that analysis into mobility and transportation networks," he adds.

Digging deeper into mobility and transportation, Prateek sees this as another opportunity where autonomous agents will replace the traditional engineering workflows. Fleet behavior, for example, including routing, energy usage, even vehicle health, will be more optimized using AI.

There will be a significant payoff related to sustainability. "When it comes to sustainability, energy generation as well as transmission in electric utilities can be optimized using autonomous AI agents to predict consumption and emissions," Prateek concludes.

Big projects can deliver large results. But some circumstances can benefit from hundreds or thousands of small, locally developed, projects that use agentic AI to address specific user and enterprise needs.

Democratizing the development

"The fundamental problem with AI and data science continues to be the data scientist mindset that seeks to control the integration of AI into DE 2.0," continues Arijit Sengupta, Founder and CEO at Aible.

The business paradox arises because the data science approach takes a high-level view of the enterprise including the business strategies, data constraints, process goals, and so on, and adjusts the AI accordingly with the goal to achieve massive economic impact by developing a handfull of focused projects.

"There are companies out there who say enterprises only need five possible generative AI projects. Fortune 500 size companies are saying that because they have the mindset of a bow and arrow, and can only get five shots on target. Which shots do we take?" Arijit observes.

A potential approach here is to shift to generative AI that makes automated adjustments, where the AI is constantly learning from the business users and evolving. "You can turn the approach into a machine gun instead of a bow and arrow. So, you are not trying to see how I can get five shots on target, you are saying I am going to take a thousand shots."

"We have shown that this is possible. For example, in the state of Nebraska, we did a hackathon where 36 people built 222 agent prototypes in 90 minutes. Taking this approach, you should be able to get impact from AI if you focus on your business outcomes, your business goals," according to Arijit.

"A business has enough users and all of them will apply this technology and find ways of creating value that no centralized team would have ever thought of. An end user can come up with an agentic AI use case that does not appear to make sense to an outsider. But the users have intimate knowledge of their domains and identify value that's hidden to an outsider," Arijit continues.

FIGURE 4

Five shots, or five thousand

Centralized AI programs pick a handful of big bets. Democratized development lets the people closest to each problem build their own agents.

CENTRALIZED, DATA-SCIENCE-LED

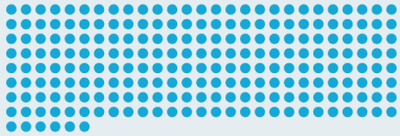


5 projects

the number some say an enterprise needs

- Big bets chosen top-down by a central team
- Post-training becomes a months-long data-science process
- The question is "which five shots do we take?"

DEMOCRATIZED, USER-LED



36 people
222 agent prototypes
90 minutes

Each dot is one of the agent prototypes built at a single hackathon in Nebraska.

- Business users build for problems they understand best
- AI keeps learning from their feedback in near real time
- Value appears that no central team would have thought of

THE BALANCE TO STRIKE

Governance and empowerment at scale. Without both, you could be stuck doing 5 projects when you should be doing 5,000.

Source: Arijit Sengupta, Founder and CEO, Aible (Chapters 2 and 4).

Continuous improvement and humility

The development process can become continuous, constantly adjusting, constantly learning and constantly evolving from experience and adjusting to changing conditions. "That's a fundamental shift enabled by AI," Arijit states.

For example, in a retail operation, it is possible for AI to look at every item or stock keeping unit (SKU), every store, every warehouse, every supplier and look for changes. It can be used to look for factors causing the changes like weather patterns, tariffs, changes in consumer behaviors and spending patterns, everything you can think of. No manual process could ever do that because this involves tens of millions of variable combinations across billions of rows of data.

Arijit observes, "CVS Health has publicly talked about one such use case where 10 million variable combinations were considered across 4.8 billion rows of data. It is humanly impossible to do it manually."

"You need to allow the AI to do the analysis, but it also requires humility. The AI should be programmed with the humility to tell the human – 'Hey, this is what happened and this is why I took this action. Is it OK?' The human can subsequently adjust the results, but the AI can't wait for the human. If it does, you are stuck in a slow process that cannot react in real time to realize maximum

benefits," Arijit concludes.

Balancing speed and governance will be a key challenge when adding AI to DE 2.0. For example, in automotive designs, it is often necessary to balance the tradeoffs between safety, efficiency, and comfort. That will require effective governance to ensure an optimal outcome without sacrificing the benefits possible when adding AI.

Safety, efficiency, and comfort

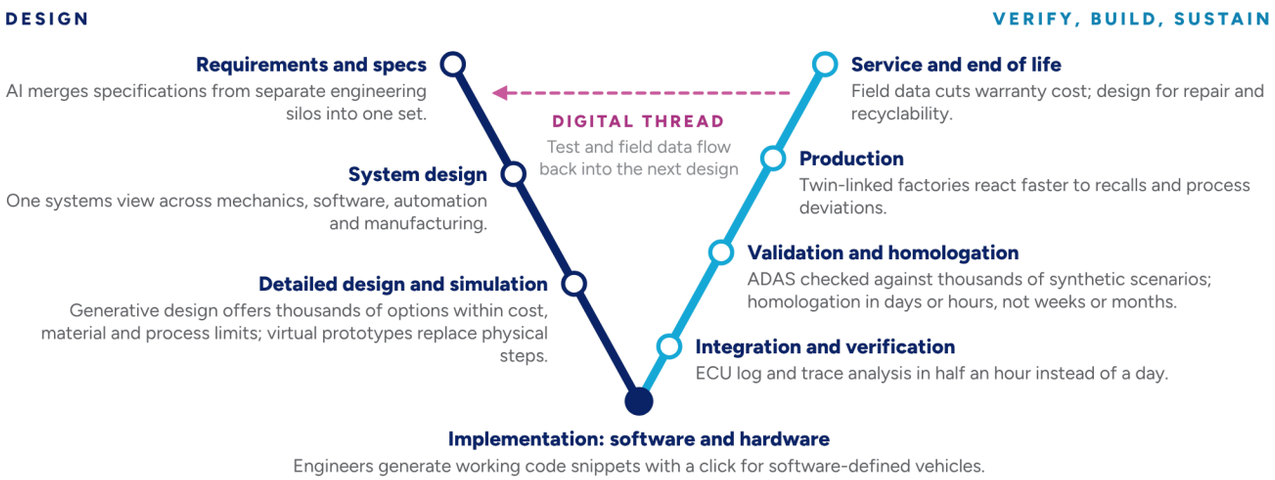
Safety, efficiency, and comfort are three of the areas where automotive and mobility system designs will benefit from combining DE 2.0 with AI. For example, AI is being used to generate high-fidelity synthetic data that enables virtual testing of advanced driver assistance systems (ADAS) in a variety of weather conditions, lighting situations and unexpected or rare operational scenarios. That will allow engineers to digitally validate ADAS algorithms against thousands of scenarios rapidly before building prototypes.

Harry Kroeger, Board Member and President Automotive at SiMa.ai, believes that next-generation ADAS supported by AI will act as a guardian angel that alerts drivers before they make mistakes. "That will save lives and will be a big step. Heavier adoption of ADAS technology could drive down the number of people getting hurt by 90%. Nobody would drive a car without a seatbelt anymore, or an airbag. Advanced ADAS technology will be more important than the airbag and seatbelt combined."

FIGURE 5

AI across the systems-engineering V

Where Digital Engineering 2.0 plus AI changes the work, from first specification to end of life.



Source: Stefan Juraschek (Acsia Technologies) and Harald Kroeger (SiMa.ai); Chapters 1, 2 and 5.

In addition to speeding and improving the design of ADAS, DE 2.0 plus AI will more efficiently handle safety homologations. "Many tests are required to homologate a vehicle. It can take weeks, or months. Then the test results must be confirmed, taking more time. Using DE 2.0 and a big database supported by AI can reduce the time to days, or hours, and produce better results," Stefan Juraschek, Strategic Advisor with Acsia Technologies, observes.

Stefan continues, "Optimization of electric vehicle operation very much relies on system optimization. It is not useful to only optimize, let us say, 11 parameters related to the efficiency of the electric motor. You also must consider battery pack design and size, battery material selection, operating environment, and more. The variety of requirements is very wide and can vary for different platforms. Arriving at cost-effective and technically optimal solutions in this complex environment requires the use of DE 2.0 plus AI."

The increasing capability and complexity of the In-Vehicle Infotainment (IVI) systems is another area that will benefit from using AI. Convenience and comfort are increasing, but what started out as a simple touch interface now has multiple levels and menus that are not standardized between auto makers or even between models from one year to the next. That can lead to driver distractions and reduced safety.

The use of small language models (SLMs) can offer a solution. Compared with large language models like ChatGPT that have hundreds of billions or trillions of parameters, SLMs can have fewer than 5 billion parameters and run efficiently on edge processors using as little as 10 W of power.

Harry predicts that, "instead of navigating a maze of menus, you will have a conversation with the car. You might say 'my back is sore' and the car would ask if you want the seat heater turned on. The operator is going to be able to talk to the machine and say I want to do this and that, and the machine will respond in an intelligent way. So, you're going to work with those machines in a completely different way. That will enhance safety as well as comfort."

DE 2.0 plus AI will not only provide you with an effective tool for improving system design and integration, but will also boost the efficiency of your design efforts throughout the systems engineering "V" model from initial R&D, to manufacturing, service, and end-of-life decommissioning and recycling.

AI as a force multiplier

In addition to changing how cars and other products are designed and used, engineering workflows will be modified to maximize the benefits from merging with DE 2.0 plus AI. Effectively integrated into the engineering process, AI can now act as a force multiplier

enabling you to move away from manual, iterative processes to managing intelligent systems, focusing more on innovation rather than routine analysis.

Harry comments, "Of course, you will still need to know the basics like the physics of car stability. That does not go away. But you will be able to get to a good solution much faster. With AI, you will be able to get to a very good setting of all parameters in your physical system without doing two weeks of testing on the road. You will do a couple of test rides to optimize the system parameters, and it will feel like you have been optimizing this function for months instead of just for a day."

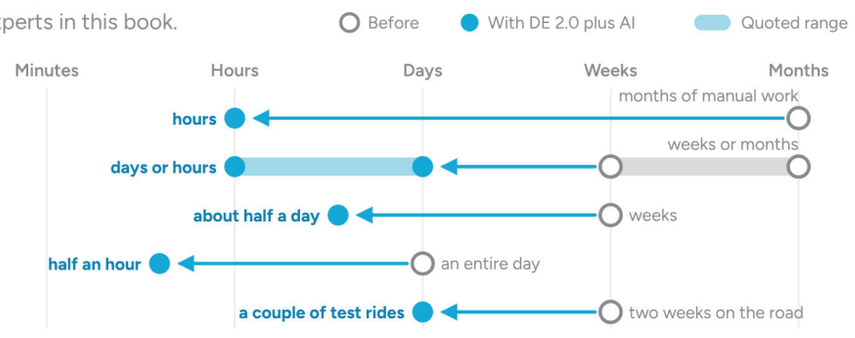
Stefan agrees and observes that with AI-driven digital twins you will be able to combine real-time operational data with unstructured data from diverse sources supporting the right side of the systems engineering "V" model that includes system integration, verification, validation, production, maintenance, traceability, and so on.

"It is validation and manufacturing in terms of quality and big data, to support vehicle digital twins. That will enable much faster reaction times, for example in the case of a recall, or if there is an identified deviation in the manufacturing process. In these cases, digital twins with a centralized database in the cloud will support field operation at dealers and improve maintenance in addition to enabling better designs," concludes Stefan.

FIGURE 6

Compressing engineering time

Before-and-after examples cited by the experts in this book.



Expert estimates quoted in this book; positions on the time scale are indicative.

Conclusion

When the combination of AI plus DE 2.0 goes beyond simply being an operating logic, it will result in a structural change in the design process. The process will evolve from a rigid, sequential activity into a compressed, non-linear, and AI-enabled workflow.

In addition to managing how AI performs, you will be expected to focus on high-level creative problem solving and critical decision making.

AI's ability to combine and analyze huge amounts of real-time and historic data from enterprise IT will further increase its power to contribute. Using both generative and agentic AI will enable users at all levels in an enterprise to leverage their unique knowledge and needs, leading to a democratization of development where hundreds of local projects are supported instead of a handful of large, centralized initiatives.

Deriving maximum benefit from AI as a force multiplier, will therefore require embedding humility into the AI tools. In addition to providing rapid and detailed results, the AI should automatically explain why it made specific choices and decisions. That is needed so you can understand the underlying logic of AI results and make any needed adjustments.

The combination of AI plus DE 2.0 will boost the importance of engineers and enable you to quickly arrive at tested solutions in a system-wide context. That will free you to guide the process toward more creative outcomes and superior products.

CHAPTER 3:

Integration with Emerging Technologies



The full benefits of AI cannot be realized by just using it as a standalone technology. Combined with DE 2.0, AI can enhance design engineering work through synergy with technologies like the Internet of Things (IoT), 5G telephony, and augmented reality and virtual reality (AR/VR) by creating more intelligent, data-driven, and immersive processes.

The IoT has been successful but has not lived up to its full potential. The addition of AI to DE 2.0 will amplify the current success of the IoT. For its primary mission of monitoring performance and environmental parameters, the IoT is a powerful tool.

The IoT produces massive amounts of data, only a small fraction of which is needed for its primary mission. AI can change that, efficiently analyzing the data tsunami created by millions of IoT sensors embedded in products and manufacturing equipment. That analysis makes the data accessible for you to use in product design and system optimization and can unlock new possibilities.

Real-time operations are another important consideration. With all that data available, you need high-speed, low latency connectivity. That's where 5G comes in enabling near-instantaneous transfers of massive datasets for AI to analyze in support of DE 2.0.

Analyzing and transferring massive datasets is a necessary, but not sufficient condition for maximizing the benefits of combining AI and DE 2.0. The results of the AI analysis must be communicated to you in a meaningful and readily digestible format. That's where AR/VR enters the scene and provides an immersive perspective.

AR overlays information from the AI analysis onto images of the physical world. AI can also be used to enhance the raw results for even better visualizations. It can improve collaboration across the enterprise by giving geographically diverse groups access to the same detailed information in the same format. It can be a bridge between CAD models and physical devices, enabling you to identify and correct design flaws earlier in the development process.

VR can take that one step further by creating immersive, simulated environments for testing and design reviews. The addition of both generative AI and agentic AI can bring different benefits to your VR supported design activities.

Generative AI can be used to create unique, real-time, and adaptive content, allowing the virtual world to be customized to your specific needs. Entire environments can be created and changed on-the-fly for visualizing and comparing various design approaches.

Agentic AI can go a step further and be your proactive assistant. It can perceive its surroundings, set goals, and independently manage tasks, such as presenting design alternatives for your consideration based on performance data combined with design specifications and goals.

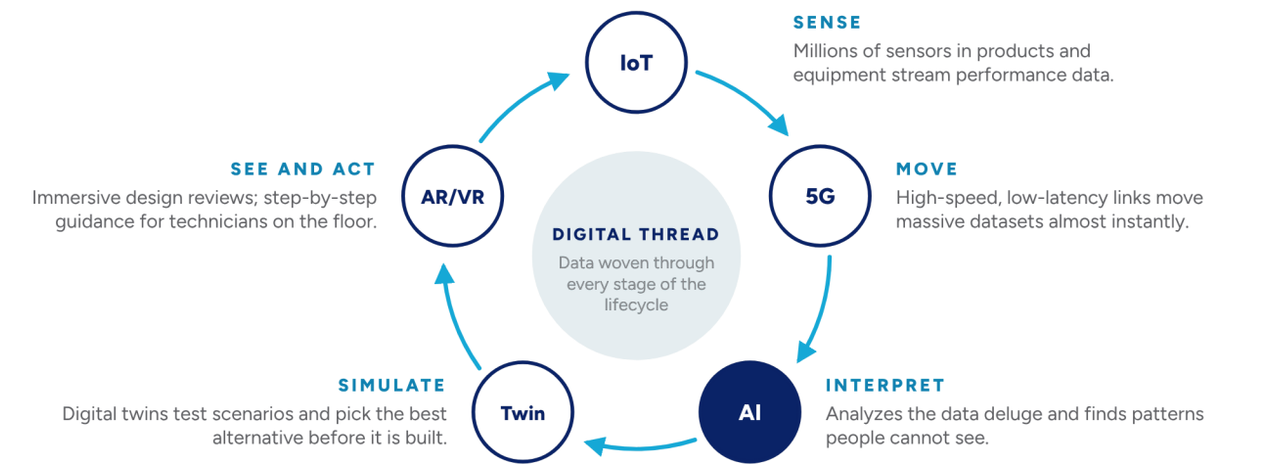
Which is the best alternative? You can use VR to produce a high-fidelity digital twin that can be tested and once finalized, transferred directly into production. IoT sensors in the factory will be used to compare equipment performance and product quality, enabling fine tuning and control of the production process to maximize quality and minimize waste.

Should a production anomaly occur, 5G can be used to send data directly to the factory floor and AR used to provide step-by-step immersive instructions to a maintenance technician for fixing the problem in real time. That same data will be incorporated into the digital twin to improve your future designs.

FIGURE 7

One loop, five technologies

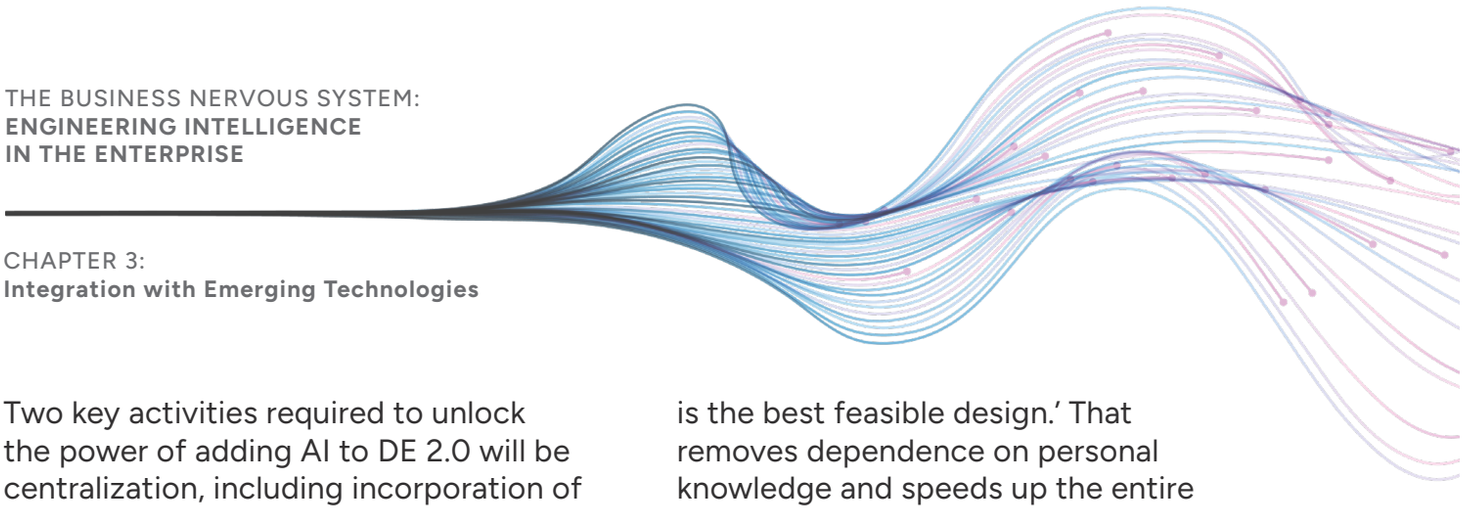
AI ties IoT, 5G, digital twins and AR/VR into one closed loop between the factory floor and the design team.



EXAMPLE: A PRODUCTION ANOMALY

1. Sensors in the plant flag the anomaly
2. 5G sends the data straight to the factory floor
3. AR walks a technician through the fix in real time
4. The same data updates the twin to improve future designs

Source: Chapter 3 (Integration with Emerging Technologies).



Two key activities required to unlock the power of adding AI to DE 2.0 will be centralization, including incorporation of continuous flow of IoT data into digital twins to inform your future designs, and decentralization, like sending data to the factory floor or to individual users in an enterprise to improve operations.

Data currently spread across numerous operational silos will need to be compiled into a centralized database, and some applications that are currently centralized will need to be decentralized. It starts by organizing the existing deluge of data from the IoT.

The data deluge

Development of the IoT was an important beginning. Combined with various wired and wireless broadband connectivity technologies, IoT is producing a deluge of data. "Companies invested into sensors and got all kinds of data. There was more data than people could use, so you had piles of data that were accumulating," observes Harry Kroeger, Board Member and President Automotive at SiMa.ai.

He continues, "It is like a 10-dimensional space and people cannot see patterns in that data. So, AI is really the missing piece in the puzzle to make that data useful. AI without data is worthless, but AI with data can generate a lot of benefits."

"Combining AI tools plus the available data from the past, you can quickly get an answer to the question 'What is the best feasible design.' That removes dependence on personal knowledge and speeds up the entire development process," agrees Stefan Juraschek, Strategic Advisor with Acsia Technologies.

He adds, "It is also dependent on the quality of the data and the capability of the AI tools. Good data combined with the right AI tools can tremendously speed up the design process. Depending on the design complexity, the first design phase can be reduced from weeks down to half a day, or something like that."

Digital twins and leaps in productivity

The ability of AI plus DE 2.0 to collect large quantities of data and identify multi-dimensional interrelationships will also be an important factor in the growing impact of digital twins and will deliver the next leap in productivity across several areas including design engineering, maintenance, and manufacturing.

"The idea of a digital twin is part and parcel of this end-to-end process," states Arijit Sengupta, Founder and CEO at Aible. "It's not an end. It's just a step in the process."

"What you really do not want to do as a human is sit there and look at the digital twin. Digital twins are going to be important because you can quickly simulate many scenarios and as different

possibilities appear, you can react very fast. And that speeds and improves the entire process," Arijit continues.

"Digital twins can also improve factory support and service by translating the predictive model and the optimization model into business KPIs and resource requirements. You might find that you can reduce downtime by 20%, but that might require you to increase staffing by 5%. Are you willing to dedicate 5% more resources to staffing? That conversation cannot happen without a digital twin," he points out.

"Digital twins can also be used to minimize energy consumption and improve reliability. In Europe, and especially in Germany, we are suffering from high energy costs. With a digital twin of the production line, you can shape the energy consumption over the day or over the week. You might shift and do high energy consumption operations during periods when energy costs are lower and energy availability is better," adds Stefan.

AI umbrella or convergence?

The addition of AI to DE 2.0 can be thought of as a convergence of technologies rather than merely an umbrella concept. The development needs to be a blending of AI with the entire ecosystem including data analytics, digital twins, software engineering, and so on, to create a unified, intelligent and agentic workflow at the local level as well as throughout the entire organization.

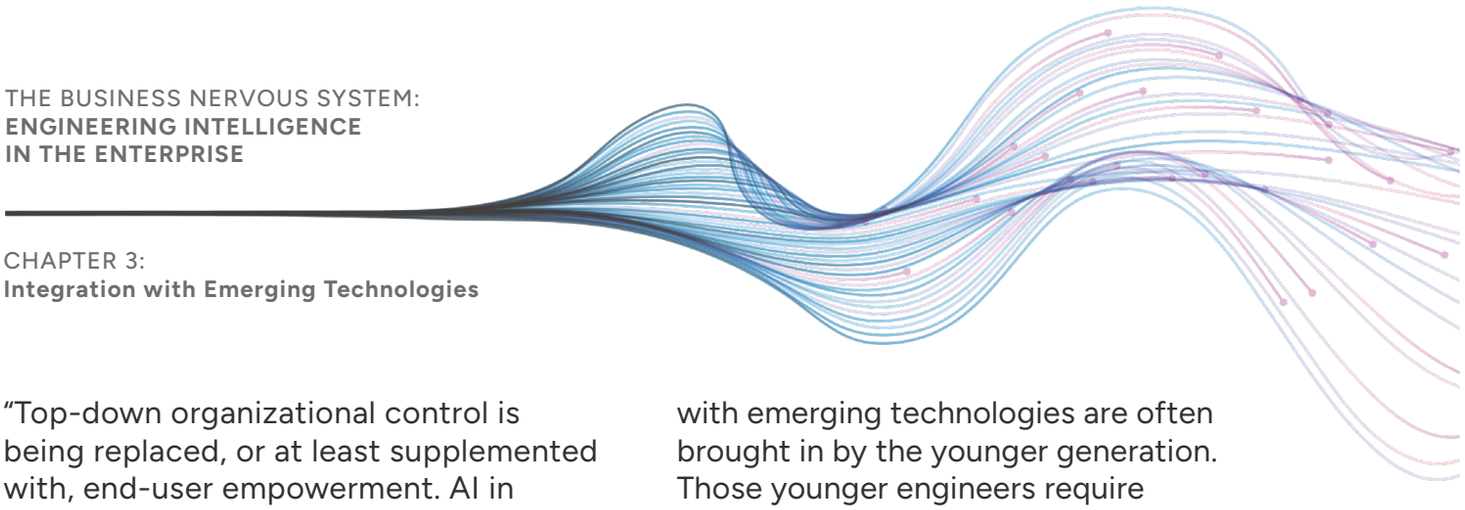
To realize the maximum benefit, AI must be woven through every stage of the product development lifecycle. "Convergence signifies a shift where AI is not just another tool applied on top of digital engineering to enable autonomous operations at the user level. The future is about SLMs focused on use cases within the enterprise and solving those specific user problems," Prateek states.

"From my perspective, these users have no idea how amazing a structure they are building while focusing on very specific uses. Each user is working on a very focused problem. If we empower the end user, they will find ways of combining the technology that we could have never planned for ourselves. That's a powerful result", adds Arijit Sengupta, Founder and CEO at Aible.

Cathedrals vs. decentralization

High-speed 5G connectivity with the cloud makes massive amounts of data available throughout an organization. That is an important factor supporting the proliferation of decentralized activities and empowering local users to become agents of change.

When considering the benefits of integrating AI plus DE 2.0 with emerging technologies, Arijit uses the analogy of a decentralized and self-organizing system where local user activity, control, and optimization supplements and enhances "cathedrals" of centralized organizational control.



"Top-down organizational control is being replaced, or at least supplemented with, end-user empowerment. AI in the cloud is combined with AI at the edge and on your desktop. To get the maximum impact, it's necessary to appropriately combine optimization algorithms, predictive algorithms, and generative AI algorithms. If the use case is appropriate and needs post training, local SLMs can be a better approach compared to LLMs in the cloud," Arijit states.

"Development of composable systems where software, or business components are modular, independent, and interchangeable, allows components to be assembled and reassembled to meet specific needs. That can help individual users to achieve something, the right composition of tools and technologies is available to them without any effort. We call this no expertise required, not just a low code solution, it's no code," adds Arijit.

"Even no code development requires knowledge of data pipelines. The user can focus on the goal of optimizing a specific process. The right tool is an optimization LLM that can analyze data and automate complex workflows, increasing efficiency, no AI expertise is required," Arijit concludes.

"Of course, seasoned engineers can learn new things, but if you look back, big changes like integrating AI and DE 2.0 with emerging technologies are often brought in by the younger generation. Those younger engineers require sponsors to empower them to push this forward, generating the avalanche of positive success stories needed to drive change," Harry counsels.

Integration of AI with DE 2.0 is not a "once-and-done" activity. To realize maximum success, it needs to be a process designed to drive continuous improvement.

More integration challenges

The integration challenges will not end soon. Over a 5 to 10 year horizon, the impact of adding AI to DE 2.0 is expected to continue growing. And the challenges will shift from basic integration to sustaining increasingly complex data pipelines, managing multi-dimensional system dependencies, and ensuring ethical and secure AI operation.

It will require development of semantic industrial knowledge graphs where a structured network connects data from heterogeneous sources, like sensors, programmable logic controllers (PLCs), and legacy databases, into a unified, machine-interpretable format.

When fully implemented, it will use semantic models to define relationships between physical assets and processes, enabling AI-driven design, diagnostics, automated reasoning, and data integration.

Prateek observes that, "You will have systems running on the edge and scaling in the Cloud as hybrid layers with a semantic industrial knowledge graph that sits across the IoT. That will move us from a cloud-based approach that is much more reactive to localized SLMs that are predictive and prescriptive driving more autonomous solutions."

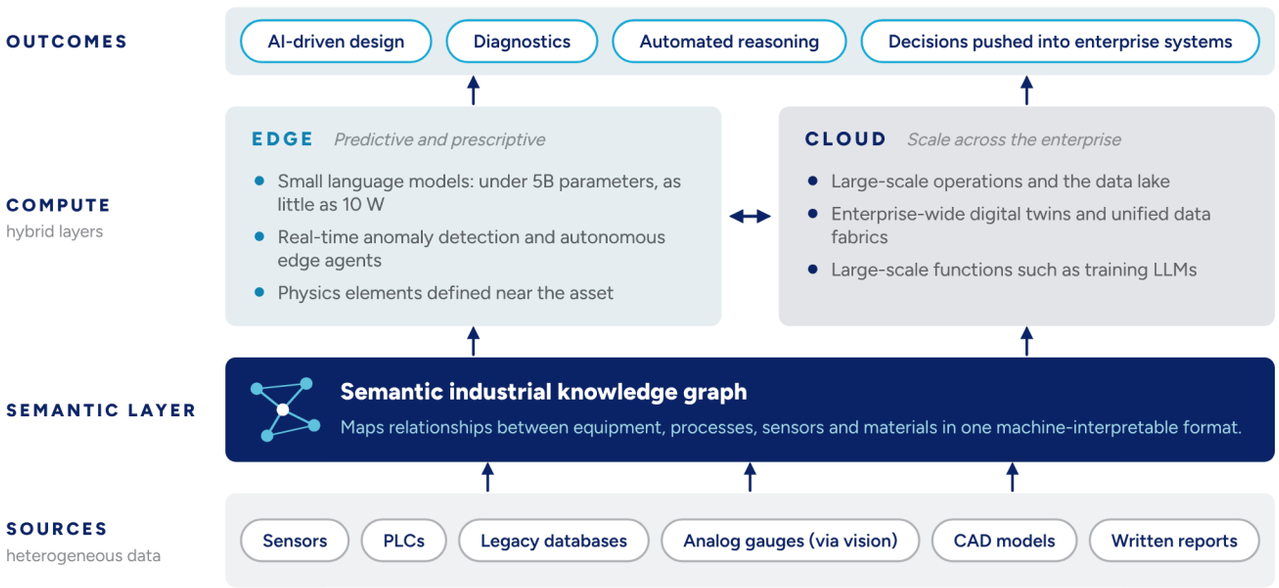
"It will take time to completely overcome cultural resistance to automated workflows. In the longer run, success requires transitioning from using AI as a standalone tool to embedding it within cohesive, trustworthy, and validated digital engineering ecosystems," Harry asserts.

He adds, "In the longer term, we are going to have a lot more local computing power. That is the bigger point. I believe what is happening right now is madness in the long run. Building centralized super expensive data centers is not sustainable. It is a must to have more balance and more of AI back on the edge and use the cloud for large-scale functions like training LLMs."

FIGURE 8

Edge, cloud and the knowledge graph between them

The reference architecture the experts describe for industrial AI at scale.



Source: Prateek Kathpal (SymphonyAI) and Harald Kroeger (SiMa.ai); Chapters 1–4.

Conclusion

Deriving maximum benefit from AI requires integrating it into DE 2.0, leveraging a "digital-first" mindset where generative and agentic AI are your design and development tools of first resort.

AI will analyze the deluge of data coming continuously from the IoT over 5G networks enabling dynamic digital twins and digital threads woven through every stage of the lifecycle. Enterprise-wide integration of AI will be supported by the proliferation of broadband connectivity options and the increasing use of sensor fusion.

The use of digital twins will be enhanced by integrating emerging technologies. 5G enables real-time data flow from IoT sensors and legacy databases. AR/VR interfaces provide immersive platforms for visualizing and interacting with digital twins. That will result in a leap in productivity and increasingly optimized processes like predictive maintenance, real-time quality control, and faster prototyping.

To enjoy maximum results, you will need to blend AI into all of your activities, not just overlay it on top of existing systems, to create a unified, intelligent and agentic workflow at the local level as well as throughout the entire organization.

That blending, combined with ubiquitous high-speed 5G connectivity will empower you and other local users to drive change at a local level, instead of being recipients of directives from higher management. That will result in a snowballing of success stories through the organization and drive ever wider adoption of AI plus DE 2.0.

You will face ongoing challenges related to technical and organizational adoption hurdles, AI ethical concerns, and skill gaps. It will take time to fully integrate these new tools with emerging technologies and realize the benefits of adding AI to DE 2.0. The reward will be a new era of AI supporting sustainable innovations.

CHAPTER 4:

Strategic Opportunities and Scaling Challenges

Scaling the use of AI in DE 2.0 means overcoming significant challenges to realize the massive strategic opportunities. It means more innovation, not more of the same.

DE 2.0 creates a fully integrated, intelligent, and immersive ecosystem. Scaling will enable the integration of massive quantities of data and support the implementation of comprehensive simulation technologies.

Combining AI with DE 2.0 will enable you to create a detailed digital thread that supports the right side of the product lifecycle V-curve including verification, validation, integration, and sustainability, by shifting from document-based, reactive testing to continuous, simulation-driven, and virtual testing.

These advancements allow organizations to shift from form-driven, serial processes to a concurrent, collaborative, and agile digital environment that reduces rework and significantly lowers costs.

Challenges and barriers

As experienced by Prateek Kathpal, President of SymphonyAI, scaling has always been a challenge, with or without AI. That can be especially true in legacy heavy industries.

"When you are bringing AI in, it is more than scaling challenges. It is real barriers that are about structural factors like data quality and data fragmentation that exist today and must be fixed to get to the support needed by AI," Prateek states.

Organizations seeking to scale DE 2.0 face critical data-driven challenges. While successful DE 2.0 deployments can revolutionize design and manufacturing, many projects fail due to poor quality data and ineffective data management. Specific factors can vary from project to project but include managing the huge volume and variety of information, ensuring data quality, and overcoming legacy, siloed architectures.

"Most organizations do not understand the fragmentation of data across the operational technology (OT) and information technology (IT) systems. It is not about collecting data, but about contextualizing the data and creating a unified structure," Prateek continues.

Data models need to reach across the organization, even bringing in data from legacy systems. The integration of real-time data from legacy systems can be especially challenging. Many industrial plants include processes with

analog sensors and gauges. They were not designed for real-time control and automation.

Analog to digital

"Interoperability is a key consideration in industrial operations and may require camera-based vision to convert analog gauges into digital information," Prateek observes.

Legacy operations where camera-based vision is needed are often the ones where the talent gap is the widest. He continues, "I feel right now, there are a lot of data scientists. The gap is in the understanding of what processes are being used in a specific industry and the translating the impacts of operational problems into agentic workflows. That is a huge gap."

In addition to issues with the available workforce and data quantity and quality, institutional momentum and misunderstanding can slow down and limit the adoption of AI and DE 2.0.

Momentum and misunderstanding

Arijit observes, "For four years now we have been running a contest where we take high school kids, give them 60 to 90 minutes of training and put them up against expert data scientists to develop AIs. In all four years, the high school kids have beaten the experts. We held these contests because most business users believe they are reactive recipients of AI wisdom. They are not in control."

"As long as you believe that you are going to be in that helpless state where AI will be done to you. The more you go out there and you show the business users that they can change their own lives, they can use AI as an accelerator for what they're trying to achieve," Arijit continues.

Harry also sees institutional momentum holding back expanded use of DE 2.0, "Like any transformation, it takes time to get everybody on board. That is really what is happening right now. So, you have always this notion of, oh we always did it like that, why should we change that? You must have the right mixture of adventurers going out and trying new stuff while others are staying on the old course which is stable," Harry observes.

Referring to the mix of staying on the old course versus trying new options, Arijit comments: "You cannot manage every use case. Balancing governance and empowerment at scale is important. When you have those two things in balance, you get value. Otherwise, you could be stuck doing 5 projects when you should be doing 5,000."

Prateek observes that the transition is not a once-and-done activity, but rather, an ongoing one: "As innovation keeps on, designs need to be more on the intent of the application instead of on solution specifications. That will be important whether you are using an agentic AI approach today, or an autonomous AI approach in the future." He adds that it

is not just about augmenting DE with the inclusion of AI. The continuing evolution of AI also needs to be accounted for as we build tactical and strategic initiatives to maintain long-term momentum.

Leadership support

Challenges for scaling the use of DE 2.0 span technical, organizational, and data-related domains. To overcome those challenges, business leadership needs to prioritize clear strategic alignment, comprehensive change management, and continued workforce development. Success here requires moving beyond technology adoption to foster a culture of adaptability, provide continuous training, and implement metrics that measure actual value rather than just activity.

"It needs to be somebody really knowledgeable, not just an existing leader pretending to be knowledgeable. The advocate must also empower others and push the adoption of DE 2.0 forward, generate positive success stories, and create an avalanche of progress," according to Harry.

Prateek adds, "AI is moving fast. About every three months, there is a new LLM or a significant improvement. That makes it very difficult to define a long-term strategic roadmap. Instead, we need to design systems and machines as adaptive learning entities."

Speed is essential

When quickly and efficiently deployed, DE 2.0 helps organizations gain and maintain competitive advantage, shorten innovation cycles, and capitalize on evolving market opportunities and technological shifts.

Speed is essential and the fastest way to move AI from pilot and development applications to larger scale production agents is by minimizing the differentiation between the two types of deployments, according to Arijit.

"Today, you can build an agent on an NVIDIA device designed for a single user running language models on their desktop. The moment they are happy with the new AI agent, they can press a button and move that into cloud," Arijit observes. The difference between a pilot and a production agent is simply the scale of compute being used.

That is not what happens, however, in many instances. First a pilot agent is developed simply to prove that the goals can be achieved. Then the agent is rebuilt for production. However, the underlying technology is rapidly evolving and advancing.

"That kind of old school IT management approach will not work because by the time you have finished your project and gone through a governance process, and then taking it to production, the underlying tech has changed, the

business problems have changed, and it's no longer an optimal solution," Arijit argues.

Bringing it together

As reviewed by our panel of experts, you can face significant challenges when scaling DE 2.0 plus AI. The challenges vary by the needs of individual companies and the demands of specific industries.

It requires a change in mindset that can be difficult to proliferate across the organization. The issues can be daunting. But the returns are great.

Legacy systems are often designed to operate with imperfect or limited data. AI models do not work well with fragmented and unstructured engineering data. AI needs high-quality, structured, and labeled data.

Getting the most from AI and DE 2.0 requires integrating data from diverse sources like sensor readings, CAD models, written reports, and so on. Effective integration of heterogeneous data into a unified AI workflow can be a significant challenge.

FIGURE 9

What stands between pilots and scale

The barriers the panel names, and what leadership has to do about them.

Data

- Fragmented across OT and IT systems
- Unstructured or poor-quality engineering data
- Rare failure modes leave too few examples
- Analog sensors and gauges built before real-time control

Technology

- High compute cost to train and deploy models
- Legacy systems need heavy modification for AI
- Low-latency demands for twins and the edge
- Moving data across domains risks control and quality

Trust

- Black-box answers in safety-critical designs
- Bias in training data amplified in results
- Domain shift as operating conditions change
- Hallucinations that are hard to spot early, even for experts

People and governance

- Few engineers combine AI skills with domain depth
- Fear of "training their replacement"
- Institutional inertia: "we always did it like that"
- Privacy rules and data sovereignty across borders

WHAT LEADERS MUST DO

- Align AI with clear business goals
- Measure value, not activity
- Drive real change management
- Put knowledgeable advocates in front
- Keep developing the workforce
- Design systems that keep learning

Source: Prateek Kathpal, Harald Kroeger and Arijit Sengupta (Chapter 4).

Even with large quantities of high-quality data, data scarcity can remain a problem. Rare failure modes may not be common, but they must be handled. In legacy approaches, the tribal knowledge of the engineering community can often handle those cases. If not addressed, they can present a roadblock to progress.

Technical and non-technical roadblocks

Technical roadblocks also exist related to high computational costs to implement AI solutions. Those computational costs include effective training and deploying large models, integration of legacy systems with AI tools and the requirement to implement AI with low latency, especially with digital twins and edge operational cases.

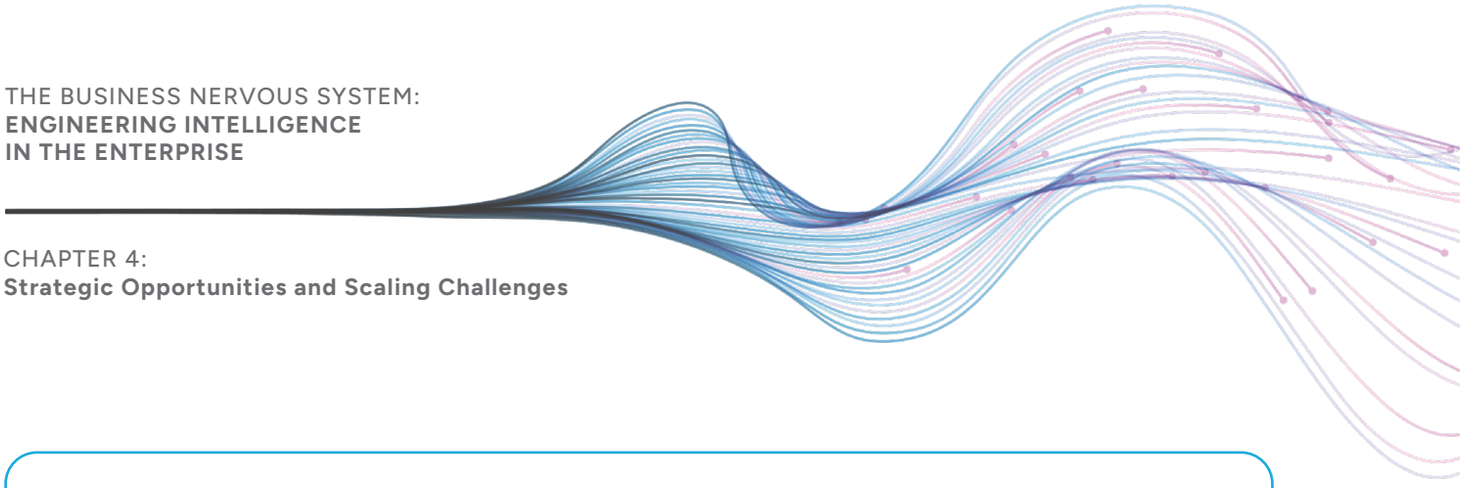
Many existing systems are not compatible with AI and require extensive modification. Moving data across computing domains is not always an option and can result in unacceptable loss of control and quality and cause delays.

Complex AI models often lack transparency. Engineers inherently desire to know how things work, and that's not always possible with AI. This so-called "black box problem" can breed lack of trust, especially in high-risk safety-critical designs. AI implementations can amplify existing biases in training data, leading to skewed, unfair, or even unsafe results.

Lack of trust can be further exacerbated by the inability of AI models to perform well as environmental conditions change. This 'domain shift' can be difficult to detect and more difficult to fix. Outright errors, or hallucinations, from AI tools can lead to incorrect designs and can be challenging even for experts to detect at early stages of a design.

In addition to the daunting technical hurdles to overcome, there are equally challenging non-technical factors that can derail or limit the benefits of adding AI to DE 2.0. Limited availability of engineers skilled in both AI/ML and with domain-specific engineering expertise is often a serious concern. Worse, available engineers may be resistant to "training their replacement" and fear job displacement because of the introduction of AI.

AI initiatives must be aligned with business goals and requirements. For example, as AI systems handle more sensitive business and engineering data, they must comply with stringent privacy regulations. Data sovereignty can be a serious concern for global development teams that must satisfy the potentially conflicting requirements of local data governance laws.



Conclusion

Organizations that successfully overcome the challenges and adopt AI-driven DE 2.0 can achieve a competitive edge based on faster development times and lower costs. You will see the results in accelerated design and product development. Enhanced operational efficiency and productivity will result from the increased automation and "first-time right" results from using advanced AI tools.

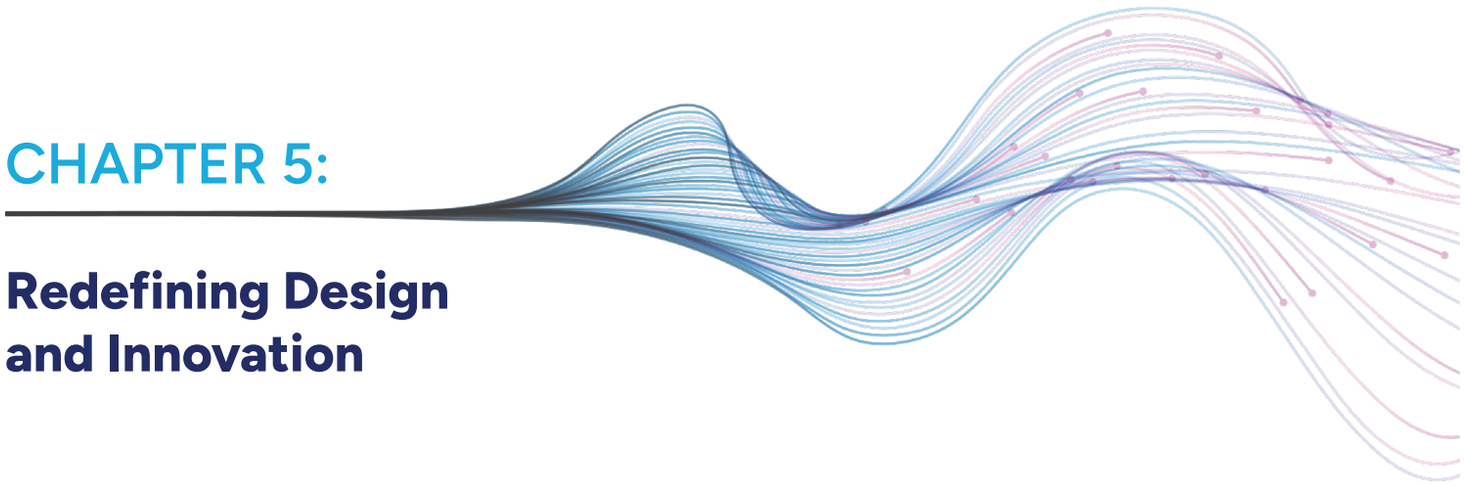
Predictive analysis will improve system and machine maintenance and reduce waste, lowering lifecycle costs and enhancing sustainability. Multidimensional and adaptive optimization will give you actionable insights for better-informed decision throughout the product lifecycle.

At an organizational level there are significant challenges in scaling the combination of DE 2.0 plus AI due to high-quality data requirements, technical expertise gaps, and legacy system compatibility issues. When successful the merger of AI into DE 2.0 will enable you to accelerate design, optimize simulation, and automate complex workflows.

All these rewards will be accompanied by higher quality outcomes and reduced risks.

CHAPTER 5:

Redefining Design and Innovation



Combining AI and DE 2.0 is not just about improving design and innovation, but rather, about redefining and reinventing the entire process. AI is not a simple additive to DE 2.0 – it is a multiplier, and will deliver massive results and improvements that are otherwise unattainable.

Traditional digital engineering (DE 1.0) introduced the concept of digital twins. That was a significant advance. DE 2.0 plus AI will transform digital twins into proactive models and move product design from a passive, human-driven modeling process into an active, AI-powered, and self-improving activity.

One of the key impacts will be to redefine the role of engineering. As an engineer, your activities will morph from routine design, coding and documentation within a specific engineering silo, into considerations of high-level system design and architecture across silos including critical analysis of the activities of your AI assistants.

The need for physical prototypes will be significantly reduced. Testing will become more virtual and the entire process will accelerate. That will enable you to explore, innovate and choose options from an expanded AI-generated design space.

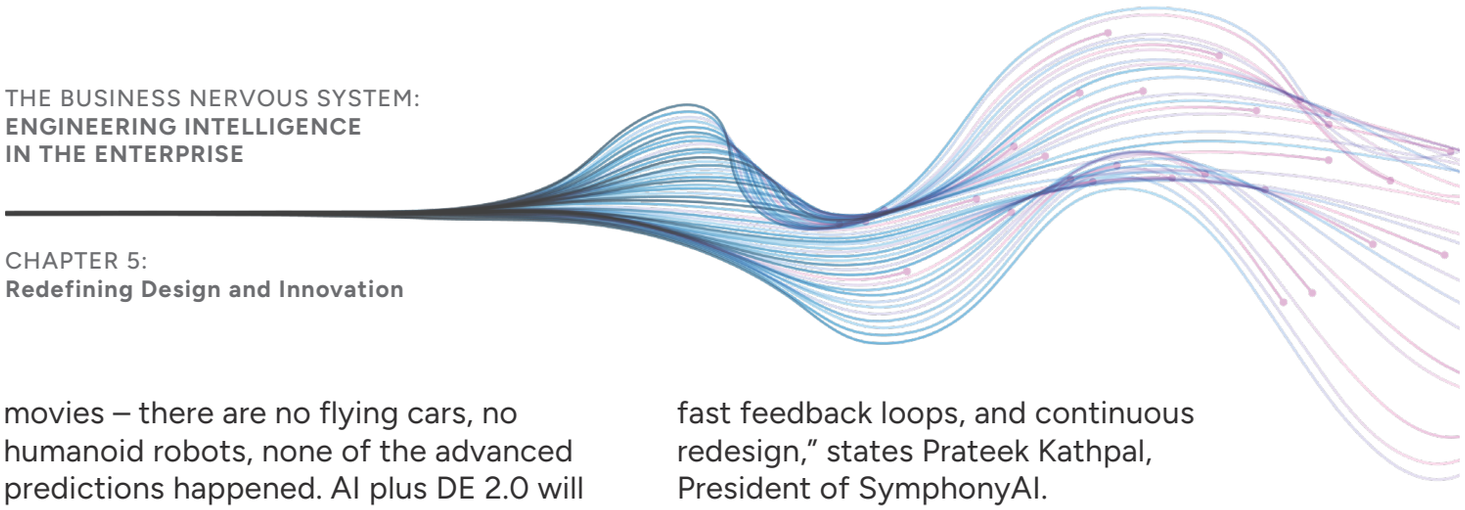
Part of that process will include the use of explainable AI (XAI). XAI consists of AI systems that can explain their decisions and actions in a way that is understandable to their human masters. AI tools will also be increasingly democratized.

Instead of being handed AI tools developed by a central authority, as a user, you'll be directly involved in the development of AI tools for your specific activities. As AI becomes more accessible and more responsive to your specific needs, it will become an innovation superpower. That will have far-reaching impacts that will require new skillsets.

Innovation superpowers

Full integration of AI into DE 2.0 has been called an innovation superpower by Harry Kroeger, Board Member and President Automotive at SiMa.ai: "I believe that AI added to DE 2.0 will be our superpower for design and innovation. We will be able to take much bigger steps and much faster steps in technology and product development.

"Today, we are working toward incremental advancements, like 2% steps in improving efficiency. Technology advancements in past decades have been slower than predicted by science fiction



movies – there are no flying cars, no humanoid robots, none of the advanced predictions happened. AI plus DE 2.0 will accelerate innovation. It will super speed our ability to advance from a cool idea to an actual product," Harry concludes.

Redefining innovation is also how Arijit Sengupta, Founder and CEO at Aible, sees the impact of adding AI to DE 2.0. "AI is fantastic at dynamic global optimizations. You can use AI hallucinations to generate different ideas going in different directions, but I would still put human curiosity and the ability to imagine and come up with ideas ahead of AI's ability to optimize those solutions."

Arijit sees people being able to use AI's ability to identify global dynamic optima as a key for improving human society at scale. "We have a lot of waste. We have a massive amount of waste in our retail processes. We have a massive amount of waste in our energy production, our agricultural and food storage."

"With AI added to DE 2.0, we can move to a reactive dynamic optimizing of processes. As we move to that, the overall society will be more resource efficient. We will be able to achieve a lot more with a lot less," Arijit concludes.

The improvements in design, development, and resource utilization realized using DE 2.0 will be inherently nonlinear. "You need to be comfortable with iterative innovation including fast feedback loops, and continuous redesign," states Prateek Kathpal, President of SymphonyAI.

Prateek further observes that "Organizational goals need to be customized for the engineering heads, the plant heads, and operational heads, to ensure that the priorities are set for reliability, safety, and accountability through human-centric loops for achieving the necessary levels of performance in a fast-paced environment that integrates AI."

DE 2.0 plus AI will lead to faster and larger steps in technology development, to dynamic global optimization on society-wide levels, and to nonlinear iterative innovation on scales not previously possible. That will require changes to leadership approaches and need new skillsets to ensure success.

Strong leadership and new skillsets needed

A new leadership focus will be a key to realizing the future promise of using AI plus DE 2.0. As an analogy, AI may have great technical techniques and be able to play all of instruments in the orchestra of product development and innovation.

But human imagination and engineering skillsets are needed to be the conductors that bring all the instruments together in a meaningful way to interpret the music and produce beautiful results. That orchestration and coordination of AI-

centric DE 2.0 take proactive leadership and specific skillsets.

Curiosity and flexibility will be the most important traits for leaders. "Leaders must understand that AI cannot be curious. It can hallucinate. It cannot be curious. Human leaders must bring curiosity to the table," according to Arijit.

Instead of dealing with multiple engineering silos and optimizing the results, leaders must have more than engineering skills. They need to think and act more comprehensively, beyond traditional engineering.

"Engineers will still need to understand the basics of physics, mathematics and all engineering tools. They will also need training to use AI tools. At the end of the day, you need both. You need deep engineering understanding to recognize any deviations from expected results, and you need to be able to apply a certain amount of judgment based on how the AI tool is performing and recognize any potentially incorrect answers," adds Stefan Juraschek, Strategic Advisor with Acsia Technologies.

Engineering skills will continue to be important, but alone they are not enough. AI can handle many engineering tasks. Successfully integrating AI and DE 2.0 will require a more holistic leadership approach.

"The biggest skill set that will be needed by leaders is the ability to understand beyond just the use case," stated Prateek. "Leaders will need to understand the cross-dimensional aspects of product lifetimes in a comprehensive way including the physical, human, and cyber domains."

"Instead of being impacted by AI, it will be about directing AI as part of the overall process," Prateek continues.

Leaders will need to understand how to decompose problems and convert them into tasks suitable for AI agents. A key aspect of that process will be understanding AI traits and understanding how to design and implement optimized and effective AI guardrails.

"Humans will continue to be the key element in the future of DE 2.0 plus AI. Whether you're developing, building, or implementing the solutions, humans will still play the defining role. The role of humans will not go away, it will evolve," concludes Prateek.

Failure to adapt is not an option

Harry sees the coming together of AI and DE 2.0 as a pivotal change. It is not an opportunity to get a little bit better and improve on past performance.

"Resistance to change will not be a successful option. This is not a passing fashion, and it is not something that you can decide not to like and wait for it to pass. Companies with leaders that

don't embrace this with full force will quickly run into a real hard problem with competitors that are moving fast to adopt this new approach. It will require leaders that understand the new technology and can promote it to position their company for success," Harry concludes.

Just the beginning

Combining AI with DE 2.0 is not the end of the road, but rather, just the beginning of a journey to bigger and continuous innovation. It is also not an option but will be a key for future success. The result will be to shift AI from a productivity booster to the central engine of rapid innovation.

In the near-term it is important for organizations to transition from isolated pilot projects to fully integrated initiatives. That will demand a fundamental shift in thinking from reactive human-centered processes to proactive AI-augmented processes and will be challenging for many organizations but can enhance every aspect of the product development lifecycle.

For example, the use of digital twins will expand. Today's digital twins are powerful tools for model-based systems engineering (MBSE). The digital twins enabled by AI plus DE 2.0 will be transformed into dynamic, proactive system models, think MBSE 2.0, that predict failures, recommend optimizations, and analyze performance in real-time, moving from reactive maintenance to proactive reliability.

Reduced order models (ROMs) will efficiently use available computing resources and enable AI to rapidly provide you with high-fidelity validation of designs, or early fault detection, and will support the use of MBSE 2.0. The growing utility of MBSE will, therefore, will be visible across accelerating development time and minimizing the need for physical prototypes, even for areas like compliance testing.

The corresponding digital threads will also become more adaptive and comprehensive. Using AI will enable them to automatically adjust to new performance requirements and reduce, or eliminate, the need for physical modeling and prototypes.

The shift will also unlock legacy databases. Agentic AI can capture information in unstructured historical data like reports or PDFs, adding historic knowledge into the design process. The new AI assistant will complete months of formerly manual work in hours, allowing you to focus on higher-value tasks.

With the powerful support of AI plus DE 2.0, there will be freedom to optimize what might have previously been second-order considerations like manufacturability, repairability, recyclability, sustainability, and other factors needed to effectively support a circular economy.

The payoff

The ultimate payoff of AI plus DE 2.0 will be enhanced engineering productivity, higher-order creativity, and strategic problem solving. AI will be a collaborator as well as a tool to quickly handle complex and repetitive tasks and data analysis. For example, generative design tools will take engineering constraints into consideration when quickly producing thousands of design options. Engineers will be able to explore a wider array of alternatives, further enhancing the power of human creativity.

AI is great at analyzing massive datasets but is unable to 'think outside of the box.' That's where the collaboration of AI plus human engineers will excel.

AI can be a deeply capable advisor to the human imagination, freeing you to consider options that otherwise would be ignored due to time or budget constraints. There's lots of work to do to reap these massive benefits. It will demand new engineering structures, new skillsets and new leadership approaches.

The combination of AI plus DE 2.0 and human engineers will open opportunities for taking faster and larger steps in the development processes and at the same time factoring in sustainable design and development for a circular economy, with Engineering Intelligence embedded at its core.

FIGURE 10

From instrument to conductor

How the engineer's work changes, and what stays human.

FROM	TO
Originating every analysis	**Validating what AI recommends**
Routine design, code and documents in one silo	**System design and architecture across silos**
Manual, local, iterative problem-solving	**Orchestration: decompose, direct, set guardrails**
Physical prototypes and weeks of road tests	**Virtual testing across an AI-generated design space**
Tribal knowledge in engineers' heads	**Knowledge graphs every agent can draw on**
A handful of projects dictated from the top	**Thousands of empowered users solving local problems**

WHAT STAYS HUMAN, AND GROWS IN VALUE

Curiosity | Imagination | Questioning assumptions | Deciding what is worth building | Knowing when an answer is wrong

AI can play every instrument. Engineers still need the physics, the math and the judgment to conduct.

Source: Foreword; Prateek Kathpal, Arijit Sengupta, Stefan Juraschek; Chapters 2 and 5.

Stefan Juraschek

Advisory Board - Acsia, Dukosi, Ex - BMW Vice President - R&D Electric/Electronic Dept



Stefan Juraschek is a distinguished expert in the automotive industry, with a career spanning over three decades, primarily at BMW Group. Renowned for his contributions to electric mobility and powertrain development, Stefan has held pivotal roles, including Vice President of Development for Electric Powertrain and other high-impact R&D leadership positions. His work at BMW has been instrumental in advancing the company's electric and electronic systems, showcasing his deep expertise in innovative automotive technologies. Last 4 years, Stefan joined Dukosi Ltd. and Acsia Technologies as a Strategic Advisor, where he continues to leverage his extensive knowledge in electric mobility and automotive software to drive innovation and strategic growth. Stefan's academic foundation was laid at Technische Hochschule Darmstadt, and he is currently based in the Munich Metropolitan Region.

Prateek Kathpal

President, SymphonyAI



With over 20 years of technology leadership and extensive experience in the enterprise, telecom, and automotive industries, Prateek brings a unique background in machine learning and AI, product strategy, operations, product technology, engineering, and sales to SymphonyAI.

Prateek has extensive experience with highly engineered systems and expertise in B2B and consumer technology, deep learning, cloud virtualization, enterprise software, mobile applications, and information life cycle management.

Before joining SymphonyAI, Prateek served as EVP and CTO at Cerence, where he was responsible for Cerence's technology vision, R&D, and professional services, and rolling out Cerence technology and solutions to more than 65 automotive customers across the world and more than 450 million cars on the road. Before Cerence, Prateek served as general manager of AI and IoT products at View, responsible for leading product strategy, defining and driving product roadmap, and supporting M&A activity to accelerate growth. Before View, he served as VP of product and solution management at Polycom, chief strategy officer at HighQ, and VP of product strategy at Accusoft, which acquired Adeptol, a company Prateek founded. Prateek previously worked for several companies, including EMC, Sapient, Cognizant, and NEC.

Prateek holds an MBA and a Bachelor's of engineering degree in instrumentation and process control.

Harald Kroeger

Board Member and President Automotive, SiMa.ai



Harald Kroeger is a member of the board, head of sales, and president of automotive for SiMa.ai since Jan 2023.

Harald was a member of the board of Tesla and Rivian.

Mr. Kroeger served as a member of the board of management for Bosch until Dec 2021, being responsible for all of automotive besides powertrain.

Before that, he was 21 years with Mercedes-Benz, where in his career he was -amongst others- head of purchasing for electrics/electronics, head of quality, and head of development for electrics and electronics of Mercedes-Benz cars.

Mr. Kroeger holds an M.S. in Electrical Engineering from Stanford University, and he holds a Diplom-Engineer in Control Engineering and a Bachelor in Economics, both from the University of Hannover.

Arijit Sengupta

Founder and CEO at Aible



Arijit Sengupta is the Founder and CEO of Aible, the leading autonomous agent solution for business users at enterprise scale. Aible is trusted by Fortune 500 enterprises across retail, healthcare, insurance, transportation, etc. and partners with NVIDIA, Dell, Cisco, HPE, Nebius and others. Previously Arijit founded BeyondCore (acquired by Salesforce.com to become Einstein Discovery). He co-created the Harvard Business School's first MBA AI course and authored AI Is a Waste of Money, based on 1,000+ AI projects he led. He holds an MBA from Harvard and studied AI at Stanford before it was popular.

L&T Technology Services | CONTROL ENGINEERING



L&T Technology Services

engineering intelligence

ENGINEERING **THE CHANGE**