



How Digital Twins Are Changing Our World

Guidebook



The Power of Perspective

Executive Summary

Since its genesis by NASA scientists, the birth of digital twin technology has been transforming our world in new, unimaginable ways, and at a rate of change that has accelerated significantly in the last few years. It is revolutionizing healthcare, for example, particularly in trialing new medical procedures and in the fight against cancer; it is remodeling our cities, with estimates suggesting it could save our city planners and architects \$280 billion by 2030. It is propelling engineers to more rapidly devise car and plane prototypes, including Air Force fighter jets.

This guidebook looks at the history of digital twin technology. It examines the drivers that have speeded up its adoption, which include the spread of 5G networks; improvements in 3-D rendering; and the remote work demands of COVID-19. It summarizes its advantages – and its negative consequences – as well as explaining why modeling the sensitivity analysis can be so important. It concludes with an exploration of how digital twinning technology is helping to create a more sustainable working environment.

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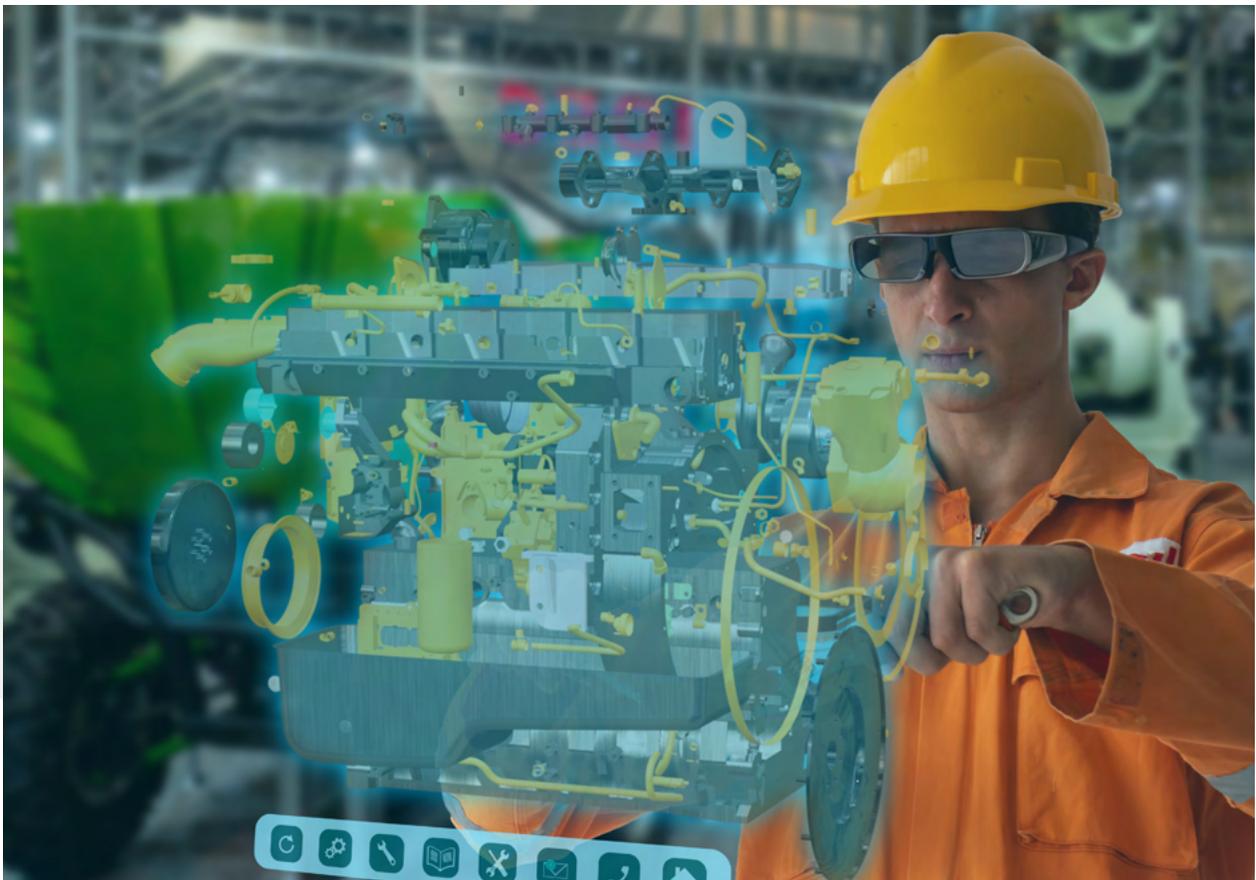
Introduction: The Third Wave of the Internet

Science fiction writers are no longer getting to have all the fun, inventing parallel universes and alternate realities. Clever technologists have muscled in on their playpen with the advent of digital twins – where organizations are building a virtual realm to copy the real world, enabled by mass computing power and machine learning. The birth of digital twins is transforming the worlds of business, supply chains, services and, crucially, the environment.

Essentially, digital twins are the “third wave” of the internet, following the transformative impact of search technologies and, over the last decade, social media. We’re evolving

from a consumer internet to an enterprise internet. The real world, including the world of business as well as the social world, is no longer offline. It’s being put online.

We are fast entering the era of “hyper-data”. According to research group [IDC](#), the number of connected devices is forecast to grow to 42 billion by 2025. In industries such as construction – which has always struggled with its productivity record, i.e., with costly project over-runs – engineering, manufacturing and automotive digital twins are being used for real-time monitoring, remote control of systems, scenario-testing and strategic planning.



What Is a Digital Twin?

A digital twin links the digital and physical worlds. It's essentially the computerized version of something or someone, allowing data to flow between the real object (or person) and the twin, to test performance under various simulated conditions, stressors and so on. The digital twin enables organizations to make adjustments in real time to the physical object based on changes to the digital version, and vice versa. It's an ingenious way to unlock innovation by safe, low-cost trial and error.

According to [GE](#), digital twins are already producing cost reductions of up to 30%, planning time reductions of up to 20%, and reductions in new build and internal process costs of up to 7%. Utilities are also achieving field inspection and back-office productivity improvements by as much as 8%, as well as improved network asset analysis and data accuracy.

[Gartner](#) says 50% of large industrial companies are already relying on digital twins, as they can expect a 10% gain in effectiveness by deploying digital twin technology. The analysts explain that “digital twins are critical as digital business systems are increasingly reliant on continuous integration of human and machine intelligence. A digital twin

reflecting a real-world environment with real people and machines working together allows users to model different scenarios, choose one and then make it real in the physical world.”

The acceleration of digital twin technology inevitably brings concerns. Several questions still need to be properly addressed around areas such as security, privacy, surveillance and ethics. The possibilities inherent in digital twins, for now, however, outweigh any possible negative consequences. Leading analysts say we’re still at the dawn of this technology, but already the tentacles of digital twin technology are affecting visible changes in every walk of life.

History of Digital Twin Technology

Digital twin technology originated back in the 1960s when NASA created physical replicas of spaceships and connected them to simulators. It was for safety reasons. If a crisis happened on a spacecraft hundreds of thousands of miles away, a team could workshop solutions on the ground. It was a huge leap forward.

The concepts around digital twin technology became more formalized in 1991 with the publication of David Gelernter's *Mirror Worlds*. Dr. Michael Grieves, who was on the faculty at the University of Michigan, is credited with first applying the concept of digital twins to manufacturing in 2002, when he formally announced the digital twin software concept. In 2010, NASA's John Vickers coined the term "digital twin".

However, the core idea of using a digital twin as a means of studying a physical object can actually be witnessed much earlier. In fact, it can be rightfully said that NASA pioneered the use of digital twin technology during its space exploration missions of the 1960s, when each voyaging spacecraft was exactly replicated in an earthbound version that was used for study and simulation purposes by NASA personnel serving on flight crews.

There has been a quantum leap in the application of digital twin technology over the last few years, owing to the confluence of several factors, including the increased computing power of cloud-based systems; the spread of 5G networks; improvements in 3-D rendering; and the remote work demands of COVID-19.



CHAPTER 1

Advantages of Digital Twins

Digital twins are especially useful in industries that involve costly or scarce physical objects. In healthcare, for example, digital twins are being used in medicine to replicate and study internal organs by feeding video, images, blueprints or other data into advanced 3-D mapping software. Digital twin technology is being trialed for planning surgical procedures and exploring the heart risks of various drugs. Digital twins are poised to transform how cancer and other complex diseases are being treated and managed. “Cancer patient digital twins”, for instance, can precisely track a patient’s physical state and adjust treatment accordingly.

Digital twins are beginning to revolutionize our cities, making urban planning more efficient. Digital twins already enable planners to

run simulations of new policies or infrastructure projects in the virtual world, allowing them to preview their potential impacts before making a decision in the real one. They allow architects to envisage and then build skyscrapers and city blocks with clarity and precision. Done correctly, according to one estimate quoted by [Bloomberg](#), digital twins could save cities an estimated \$280 billion by 2030.

Digital twins could have huge implications for training workers, for formulating complicated technical plans without having to waste physical resources, even for improving infrastructure and combatting climate change. This is where the real battleground will be. Digital twins have propelled engineers to more rapidly devise car and plane prototypes, [including Air Force fighter jets](#).



Benefits of Digital Twins

Better R&D

Using digital twins enables more effective research and design (R&D) of products, with a wealth of data created about likely performance outcomes. That information can lead to insights that help organizations make product refinements before starting production.

Increased reliability and availability

Monitors, simulates and controls an asset, process or network as an effective strategy to improve system performance.

Lower maintenance costs

Predicts issues before breakdowns occur, facilitates ordering of parts, scheduling repairs at times that don't impact production goals.

Improves supply chain efficiency

Ensures product quality with insights into performance of assets and processes in real-time, minimizing impact on supply chains.

Reduced risk

Protects the health and safety of staff, the environment, and business objectives, by reducing asset- and process-related incidents and avoiding unplanned downtime.



CHAPTER 2

Sensitivity Analysis

Digital twin technology is starting to drive business decisions without disrupting any of your base data. Just putting your numbers into a spreadsheet is easy, but if you do that you have that Excel guru who owns the spreadsheet; not everyone can access it. If you've got a digital twin, on a cloud-based sharing platform, it's easy for multiple people to add and manipulate data.

What is really exciting is if, say, you've calculated the cost of shipping Land Rover cars. What if that changes? What if the cost goes up by 20%? What's our cost sensitivity? You can start to model the sensitivity analysis on key factors.

The amount of data in a business is too big to be easily programmed. With digital twins, we can visualize

that for users in an easily comprehensible way. They can start to understand what's material and what's not – lines of production, overproduction. What would happen if the global price of steel or aluminum went up, and how much would that matter?

The shipping of that material to the factory is the most important part because a company might get it from a mine in South Africa, and whether they're shipping it to the UK or Slovenia is probably quite similar. It's not material to them, but the cost of labor in those two locations could be material. Digital twin technology helps to highlight what is important to your decision-making. You can start to pull on those levers. You can focus attention on the stuff that really matters.



The market is speaking

According to the research firm Research and Markets, the digital twin market generated sales of more than \$3 billion in 2020.



CHAPTER 3

Sustainability: How Digital Twins Are Helping Towards a Greener Future

Sustainability is making something that is long-lasting and will continue to run. Is your business model sustainable? If you get a bunch of consultants who come in and go, “This is what you should do to make your organization greener”, and then they leave again, your business after a period will return to type. The intervention isn’t sustained. Change isn’t permanent. If we are digital twinning, is the change to the business going to be sustainable? Will it stick? What do we have to do to make that new model continue to work?

What is a true green measure and what is not? In digital twinning, what’s the cost of converting all of our delivery trucks – if, say, you’re a global fast-food brand – to run on used cooking oil? This is something that McDonald’s have done. McDonald’s are recycling their cooking oil – collecting the oil, cleaning it, filtering it, processing it,

adding chemicals, converting it to road fuel – and running their trucks on it. They’ve done the modeling by digital twinning and discovered that it is not only a good public image thing to do, but it also gets rid of a load of its waste. There’s a maintenance impact on the trucks, but that’s an acceptable trade-off.

What’s the cost? What’s the impact on their business model of doing this? McDonald’s can take all these other green factors and go, “What’s valuable to us – value by means of public perception, environmental impact, dollars?” They can do a cost-benefit analysis and determine: “Let’s do ‘that’, but not ‘this’.” If you’ve got enough business factors in your digital twin, you can start to see how changes will impact on your business. Your green sustainable one is just an additional data set within a set of digital twin models for your range of business objectives, but a very valuable one.

**HIGH
EMISSIONS**



**LOW
EMISSIONS**

Moving to a More Sustainable Economy

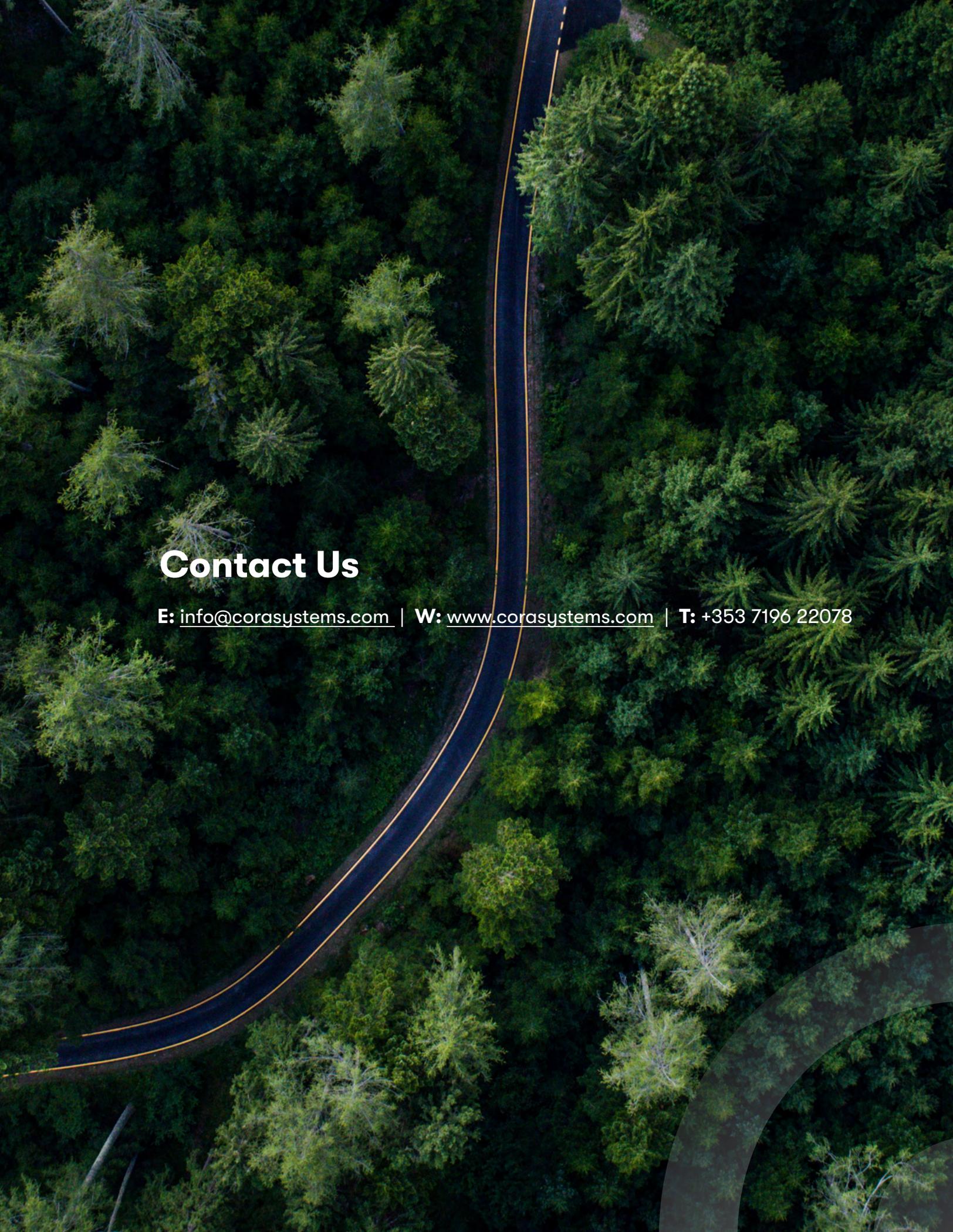
According to research by the United Nations in collaboration with Accenture, 99% of CEOs from organizations with more than €1 billion in annual revenue believe that sustainability will be important for the future success of their business. The move to a greener economy in the manufacturing industry is a key driver for organizations who are increasingly building their brands and identities on more sustainable foundations. It is non-negotiable: finding a way to stay competitive while reducing emissions to meet climate change targets.



Author Bio

Karl Reilly is Head of Design and Innovation at Cora Systems. Karl leads the R&D team through the development of new SPM software, developing the functionality of program & portfolio management capabilities – introducing AI and machine learning functionality – to our products and introducing a greater focus on the user experience.

He brings over 30 years of PPM experience from the public and private sectors, delivering change and business transformation programs. Prior to joining Cora, Karl worked with PwC as their Global Lead for PPM Methods & Tools.

An aerial photograph of a winding asphalt road with yellow lane markings, curving through a dense, lush green forest of tall evergreen trees. The road starts from the top center and curves downwards and to the left, then back towards the center. The forest is thick and vibrant green, filling the rest of the frame.

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