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Conversations for tomorrow

Quarterly review
N°3 — 2021

Intelligent Industry: The Next Era of Transformation

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DIGITAL TWINS: MIRRORING THE REAL WORLD FOR A BETTER AND SUSTAINABLE PERFORMANCE

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Corinne is Executive Vice President, Chief Presales & Innovation Scaling at Capgemini Engineering. She is leading Centers of Excellence deployment to co-build and leverage Intelligent & Sustainable industry offerings. Corinne joined Altran in 1993 where she led numerous R&D projects in a variety of sectors for many international clients. As a pioneer in the practice of design thinking in the industry, since 2004, she develops new services offerings and catalysis projects of major innovations that put people and planet at the heart of developments, in open innovation dynamics.

Member of Capgemini Engineering Leadership Community, Christophe is global head of Digital Manufacturing for Capgemini Engineering, the global business line combining engineering activities of Altran and Capgemini. Christophe joined Capgemini in 2003 to conclude his engineering degree in Aerospace & Software Engineering at ENAC in Toulouse and Embry-Riddle University in Daytona. He puts people, innovation and transformation at the center of the strategic relationship with group clients to help them create value for the future. Prior to Altran acquisition, he was Vice President leading engineering activities of Capgemini for Toulouse area, the largest location in Europe at that time.

Capgemini's Perspectives

The city-state of Singapore has taken logistics technology to the point where it can seem like looking in a mirror. City authorities can look at a dynamic model in order to plan emergency evacuation routes or decide where to install solar panels; they can guide traffic with the help of real-time inputs; and they can even identify likely outbreaks of dengue fever by measuring the density of people who have been bitten by the disease-carrying mosquitoes. This is all owing to Virtual Singapore, the city's 3D digital twin.[1]

Technologies such as AI, 5G, and cloud have enabled the development of a smarter network that connects products, processes, services, and systems. The digital twin concept has strong potential to accelerate this transformation across multiple industries. The benefits it offers to organizations range from increased efficiency and increased lifecycle environmental impact to greater reliability and cost savings.

> **"City authorities can look at a dynamic model in order to plan emergency evacuation routes or decide where to install solar panels; they can guide traffic with the help of real-time inputs; ... thanks to "Virtual Singapore", the city's 3D digital twin."**

1 GovInsider, "Meet Virtual Singapore, the city's 3D digital twin," January 2018

Modelling the modern environment

A digital twin is a virtual replica of a physical product, system, or process. The digital version can be used to monitor, control, and optimize all aspects of its physical twin – across both internal and external ecosystems and over time.

A digital twin is not just a simulation, a computing model, or a graphical user interface. Key characteristics of a digital twin include:

> **"A digital twin is a virtual replica of a physical product, system, or process."**

- The existence of a physical product, system, or process upon which its digital counterpart is based
- Connectivity and a flow of information between physical and digital entities
- The ability of the virtual entity to store and trace data through a network or system
- Periodic or near real-time synchronization of the states of the physical and virtual twins
- The ability of the virtual twin to simulate the physical entity, its characteristics, and its performance levels
- The ability of the virtual twin to predict the characteristics of its physical counterpart, and prescribe characteristics to make it more efficient
- The ability of the virtual twin to monitor, maintain, and optimize the operations of the physical twin.

This combination of shared characteristics is what makes the development of a digital twin useful across a number of industries.

System-of-systems digital twins

A digital twin, in its simplest form, is the duplicate of a single unit of equipment, such as a robotic arm (unit level). Organizations can also create a connected system of such individual digital twins, thereby augmenting the efficiency gains from the individual units to a broader, systemic level. For instance, digital twins of multiple robotic arms or machines can be combined to create the digital twin of a production line (system level). Taking the idea a step further, digital twins of multiple such production lines can be used to create the digital twin of a factory or even of several factories that are part of a shared supply chain (system-of-systems level). On a higher level yet is the concept of a digital twin on the scale of a city or even a nation, of which "Virtual Singapore" is the most prominent but surely not the last example.

Digital twins for sustainability

Intelligent Industry enables organizations to be economically profitable while being environmentally responsible. While organizations today are focused on reducing carbon emissions in their operations, only when they look at their entire value chain, including their customers and their suppliers, can they make a significant difference. Digital twins can play an important role here as they allow organizations to better utilize their resources, simulate emissions, and optimize the supply and transportation networks.

Digital twins find applications across industries

ENERGY AND UTILITIES

Renewable energy: Digital twins of wind farms or steam/gas turbines enable predictive maintenance based on data covering both general environment and current conditions

AUTOMOTIVE

Digital twins map extensive vehicle data, such as engine performance, as well as data from users' driver profiles

AVIATION

Digital twins of engines contain status data, monitoring vibration and pressure levels to predict required maintenance downtime

MANUFACTURING

Digital twins of production lines include data on the status of all machinery and information about every product

LOGISTICS

Digital twins contain material-flow data to optimize utilization of relevant processes and enable connected fleet management

BUILDING TECHNOLOGIES

Digital twins of dedicated building technologies enable a smart-home application based on smart connected products

HEALTHCARE

Digital twins include health data of patients based on continuous tracking of vital signs through mobile healthcare devices

COMMUNICATION

Digital twins of network and infrastructure enable intelligent network management based on historical data

Source: Capgemini.

Benefits range from process efficiencies and higher productivity to moving to a sustainable and circular economy

Aerospace: Airbus aims to cut its production lifecycle by 50% and is betting on digital twins to help it to achieve this ambitious goal. *"For each new product, we are actually building four digital twins. We not only create a twin for that product; we also create one each for the related production equipment, production process, and service process. We simulate all these aspects before we actually start to build the product or the factory to manufacture it. This helps us significantly reduce our engineering lifecycle and cost in production,"* says Peter Weckesser, former digital transformation officer at the Defense and Space arm of Airbus.[2]

Consumer products: Philip Morris International, PMI, has created a digital twin of its global manufacturing footprint. This allows the company to assess the impact of changes in product portfolio, market regulations, and even business disruption. The company has consequently reduced the use of spreadsheet simulations by 90% and was able to decrease the time required for scenario evaluation from weeks to hours.[3]

> **BMW recently announced the design of a digital factory twin that can be used to simulate the operations of 31 separate factories.**

Automotive: BMW recently announced the design of a digital factory twin that can be used to simulate the operations of 31 separate factories. All elements – associates, robots, buildings, and assembly parts – can be simulated in this model, which is expected to produce planning processes that are 30% more efficient.[4]

Healthcare: Even more interesting applications of digital twins are being made in the healthcare sector. Dassault Systèmes' Living Heart Project – a collaboration between industries, clinicians, and researchers, with members across 130 organizations in 24 countries – has developed the first 3D simulation of

2 I-CIO, "Airbus highlights critical success factors for digital transformation," September 2019.

3 PR Newswire, "River Logic Partners with Philip Morris International to Create Digital Twin of the Company's Global Manufacturing Network," September 2020.

4 FierceElectronics, "BMW features digital factory twin at Nvidia GTC21," April 2021.

a living heart, allowing the development of testing paradigms for virtual insertion, placement, and performance monitoring of pacemakers and other cardiovascular devices.[5] Today, there is ongoing research into the use of digital twins for the planning of surgical procedures; optimizing drug dosage for patients; and even improving drug safety in the design and testing phases.[6]

Manufacturing: Kaeser, a German air-compressor manufacturer, implemented a digital twin system for its air stations. This provides operational data such as the air-consumption rate, which can then be monitored by its employees. This, in turn, allows the company to implement "servitization" – charging consumers on the basis of usage, rather than for the machine units themselves.[7]

Sustainability: Through simulations and scenario analysis, predictive modelling and operational efficiency, digital twins allow organizations to optimize their resource utilizations. For instance, Unilever is making use of digital twins at a facility in Brazil to make production more efficient. The company used a digital twin to set manufacturing parameters; for example, the temperature at which soap is pushed out before being cut into bars. The project resulted in a savings of USD2.8 million by reducing energy usage and improving productivity by 1% to 3%.[8] Further, digital twins also enable infrastructure owners/operators in making the buildings more sustainable.

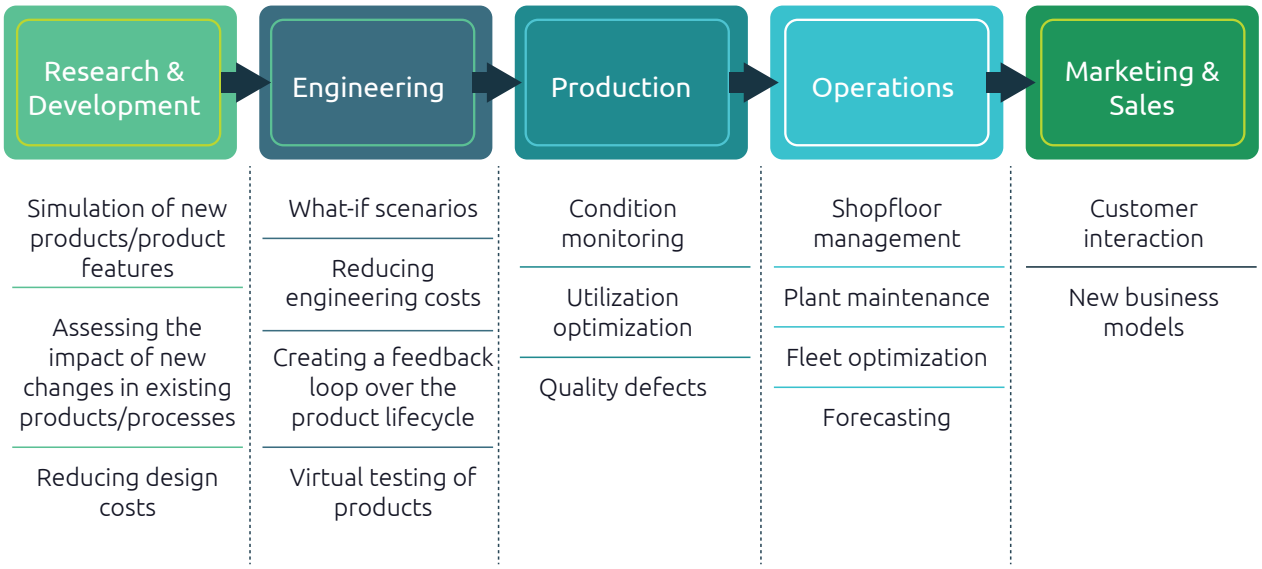
"Digital twins allow organizations to optimize their resource utilizations."

Corinne Jouanny
Chief Presales & Innovation Scaling Officer, Capgemini Engineering

5 Dassault Systèmes, "THE LIVING HEART PROJECT," accessed September 15, 2021.
6 VentureBeat, "21 ways medical digital twins will transform healthcare," July 2021.
7 Plant Services, "Developing a new business model by selling supply," April 2019.
8 The Wall Street Journal, "Unilever Uses Virtual Factories to Tune Up Its Supply Chain," July 2019.

Capgemini's Perspectives

For industries, the benefits from the use of digital twins span the lifecycle of a product. A few of these benefits are shown below:



Source: Capgemini.

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Navigating the digital twin waters

Connectivity and data management are key to successful implementation of a digital twin

To drive successful pilots or proofs of concept (POC), certain enablers are essential: [9]

- *Connectivity:* To allow transfer of sensor data into the virtual counterparts
- *Data management*: In order to analyze the raw data and convert it into actionable insights
- *Simulation capabilities:* Including artificial intelligence and machine learning, to build the virtual view of operations
- *A human-machine interface:* To augment employees take the necessary actions
- *Digital continuity:* Across the processes and assets to prevent information silos and to strengthen collaboration. While this is a critical enabler for digital twin implementations, "system-of-systems digital twins" can further drive digital continuity across the value chain of an organization.

While the digital twin model has applications across the value chain, *companies should not descend into "pilot purgatory."* This can be avoided by concentrating on a limited number of use cases (for example, an asset or simple-process twin) that have the highest potential value and seeing these use cases through to completion. Once these proofs of concept are completed, learnings from these projects can be implemented in other pilot projects.

9 Capgemini Engineering, "Digital Twins – Translate data into business outcome," October 2021.

Proper governance and increased collaboration are crucial

A successful digital-twin implementation in one part of the company will inspire more such projects in other functions. However, this is when companies need to take additional steps:

- To extract more value, companies should not simply build individual digital twins, but also plan to develop a *system of digital twins* that can combine information as well as resources, amplifying benefits and economies of scale. Setting and following common standards across data management and communication will enable easy integration of multiple digital twins.

- A *governance* program for digital twins, with defined roles for each team (global vs local; business vs IT, ecosystem of partners and suppliers, etc.) will facilitate management. A crucial subsection of this is data and security governance. There should be clearly defined guidelines as to what data digital twins have access to, who can access the data, and how the data is being utilized across the company.

- For complex twins, a successful implementation would require not only intra-organizational collaboration, but also strong ties with their *ecosystem* partners, both upstream and downstream.

Consortiums can play an important role in influencing the development of digital twins. Problems faced by early adopters in communication, particularly when dealing with a system of systems, can be addressed through the adoption of standard formats. Digital Twin Consortium, for instance, counts companies such as Microsoft, GE Digital, and Northrop Grumman among its founders, and is working on creating cross-industry reference architectures and definitions, refining digital-twin best practices, and providing a resource hub for digital-twin producers and consumers.[10]

10 Digital Twin Consortium website, accessed on September 15, 2021.

As the idea of digital twins becomes established, it is clear that their use can extend to just about anything, from water mains to production lines. While digital twins were originally developed predominantly for hardware, we can now just as easily have digital twins for the information-processing domains of finance and accounting, human resources, and supply-chain management. This opens the door to digital twins of entire organizations and promises exponential benefits – including greater visibility of business operations, more advanced monitoring, and prediction of business-impacting events,[11] to name but a few. The possibilities for business twins are truly endless – and, to date, we have just scratched the surface.

11 Capgemini, "Digital Twins for Business Operations" by Lee Beardmore, https://www.capgemini.com/in-en/business-services-thought-leadership/digital-twins-for-business-operations/

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