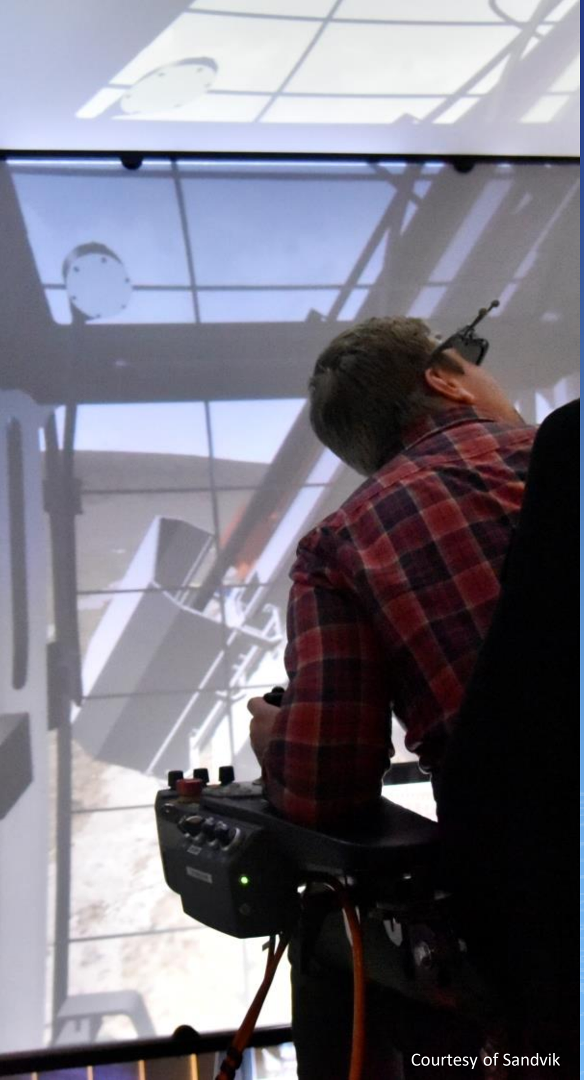
Courtesy of Sandvik

CIMdata eBook

Sponsored by Mevea

# Digital Twins

## Changing the Way We Engineer, Validate, Market, and Operate our Products

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# Key Takeaways

## Highlights

**Takeaway #1**

Increased complexity of cyber-physical products and their IoT-enabled operating environments demands thinking beyond traditional stage-gate oriented engineering approaches. Model-driven systems engineering methods require a holistic and agile approach to applying the latest trends in digitalization. The physics-based **Digital Twin** plays a key role in this business transition.

**Takeaway #2**

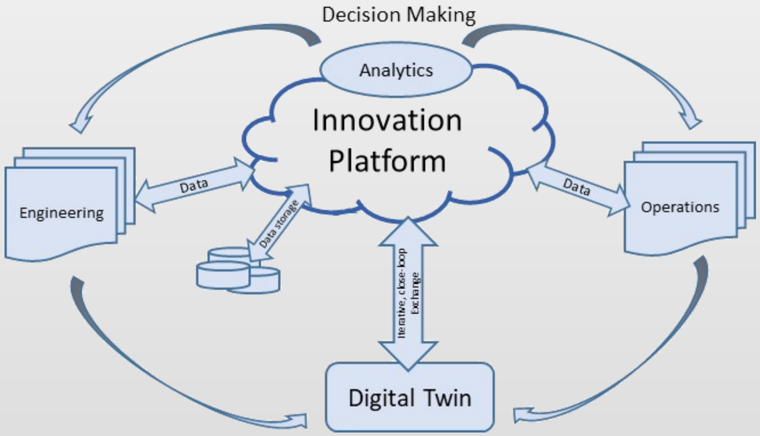
Being competitive in the modern fast-paced business environment means applying the latest principles in organization / process / technology to the business—essentially, going for higher maturity levels than the competition. Market segment leaders are already striving to achieve the highest level of **Sustainable Innovation** for their businesses. As this relates to enabling the Digital Twin strategy, this means enabling a "**Cognitive Digital Twin.**" To achieve those highest levels of maturity companies have to apply a holistic approach.

**Takeaway #3**

Mevea of Finland, with its **end-to-end solution,** is a **thought leader** that is helping leading industrial equipment companies today to realize first mover **benefits** of implementing the Digital Twin approach. Mevea's technical capabilities enable companies to start the journey in achieving **increased competitiveness** for the overall business by rapidly reaching higher levels of digitalization maturity.

**Takeaway #4**

Mevea, as a platform neutral provider of Digital Twin technology and implementation services is in an excellent position to form long-term **partnerships** with leading OEMs and their suppliers, augmenting their current platforms for PLM, ERP, MRO, IIoT, etc.




**Digital Twin: Higher-level Architecture**
CIMdata, SMS_ThinkTank™

# Introduction—Business Challenges



**A global economy**

In today's rapidly changing and digital world, all regions and industries are not only interconnected but, in many cases, also interdependent on each other. In addition, the immense variety of cultures makes it very difficult to define and create common denominators across regions and industries.

**Faster than ever changing and evolving technology**

Globalization and digitalization dramatically increases the pressure on all companies to remain competitive. Companies need to stay on top of the latest technology and business trends to make sure their business model is capable of effectively making use of the current technology and engineering capabilities. At the same time, the latest high-end technology is now available to almost all sizes of business. This enables upcoming businesses in emerging countries as well as start-up companies in well-established economies to compete with the larger, established market leaders across all industries, thus changing the market dynamics.

**The age of data and information**

Data and information in the current business environment are some of the most essential assets. The way engineers use data and turn it into knowledge can be a market differentiator and determine who will be leaders or laggards. This includes how we capture data and knowledge (within a company and from external sources) and make it available for further use.

**Digitalization, visualization, and collaboration**

Virtual realities are becoming more relevant not just in our daily life but also in business. The major challenge is to create a culture and infrastructure that allows closed-loop connections between the physical (real) and the virtual worlds. Many modern engineering processes and applications are requiring such a connection to be real-time (or close to it).

Virtual realities leverage a large amount of virtual simulation at various fidelity levels. In addition, collaboration at all stages of the product lifecycle is a key enabler for increased competitiveness. For that, rapid visualization of simulation results, data, and models in general are paramount. The challenge is to achieve this with the right amount of information between the various stages and domains without sacrificing content.

**The complexity issue**

Digitalization has also led to the rapid growth of electronics and embedded software in almost all products. To stay competitive businesses need to adjust for this increasing complexity. Some industries have already adapted to this great challenge while others still need to find their way.

For instance, the integrated circuit industry was able to continuously apply the latest technologies without increasing time-to-market, while the automotive industry managed to drastically reduce time-to-market over the years. The established aerospace industry on the other hand is still struggling with this issue.

Available technology and tools are usually not the biggest issue. More complex technologies are challenging the ability for middle and upper management to understand the emerging needs of the business and adjust to those needs.

> "Digital is the main reason just over half of the companies on the Fortune 500 have disappeared since the year 2000."
>
> *Pierre Nanterme, CEO of Accenture*
>
> *2016 World Economic Forum*

# Introduction—Trends in Engineering

## Some of the Basic Trends

**Increased complexity**

*Product complexity* is not just an increase in the number of assemblies but foremost in the way electronics, software, and embedded systems have become an essential part of today's customer demands. In addition, products now need to connect with one another (i.e., smart connected products). The choice of materials also becomes much more flexible due to new manufacturing technologies, but also must meet sustainability goals.

*Ecosystem complexity* is another level companies must address. Within companies, it's manifested through digitalization efforts covering the entire lifecycle process. Beyond companies, environmental impacts (*sustainability)* dominate more and more. At the same time, companies need to understand that they design and manufacture products and provide services that are increasingly *connected and interactive while meeting individual needs* within our societies.

**Demand for more flexibility and choice**

The time of "one size fits all" is gone. Individuals expect that products and services can be customized to their needs and desires. They want them to be a personal experience.

**Improved product quality and robustness guarantee**

Consumers also expect that their products will be much more reliable than before. New flexibility in materials and manufacturing methods (like additive manufacturing) allow, from a purely mechanical perspective, much better solutions. At the same time, it is expected even more so that a product went through a rigorous design and testing process before launching. Beyond that, service and updates while in operation are also becoming common for most products.

**Digitalization**

To be able to provide the "personal experience," improved quality and robustness are essential. But staying competitive means companies must be able to bring products and services to the market more quickly and respond even faster to changes in the market. To do so requires virtual capabilities at all stages of engineering (from inception through product development to manufacturing to in-service). This requires *data and process management, visualization, and collaboration,* as well as the required *predictive capabilities*.

Having everything in digital form within a company still doesn't mean that it achieved "digitalization." Digitalization essentially means a company is able to capture all relevant data (be it from the real or virtual worlds), create new data and information virtually, process it, make it available for re-use and decision making—focusing on creating a virtual engineering environment.

There are various levels of digitalization maturity within a business which can have an impact on competitiveness and profitability of the enterprise. Leading companies strive to create a virtual environment which allows them to enable **sustainable innovation.**

To be or become a leader in their respective industries companies need to define, deploy and live best practices utilizing virtual engineering that can support the goal of **Innovation Leadership.** Some of the major enablers for that are:

- Systems modeling and simulation
- Digitalization of the enterprise
- IIoT (Industrial Internet of Things) and Industry 4.0
- Big data and IoT (Internet of Things)
- Agile, iterative, and collaborative approaches
- Digital Twins
- Cognitive Engineering

"If you went to bed last night as an industrial company, you're going to wake up this morning as a software and analytics company."

*Jeff Immelt, ret. GE CEO*

# Introduction—Trends in Engineering

## Achieving Sustainable Innovation means "Innovating at the Speed of Thought"

**System modeling and simulation (SMS)**

SMS is the use of interdisciplinary functional, architectural, and behavioral models (with physical, mathematical, and logical representations) in performing *MBSE (Model-Based Systems Engineering)* to specify, conceptualize, design, analyze, verify and validate an organized set of components, subsystems, systems, and processes.

**IIoT and Industry 4.0**

IIoT is a subset of the larger scope of IoT focused on manufacturing. It will revolutionize manufacturing by enabling the acquisition and accessibility of far greater amounts of data, at far greater speeds, and far more efficiently than ever before. A number of innovative companies have started to implement IIoT by leveraging intelligent, connected devices in their factories.[1]

**Big data and IoT**

IoT is a network of intelligent computers, devices, and objects that collect and share huge amounts of data. The collected data is sent to a central cloud-based service where it is aggregated with other data and then shared with end users in a way that meets their unique needs and objectives. IoT will increase automation in homes, schools, stores, and in many industries.[1]

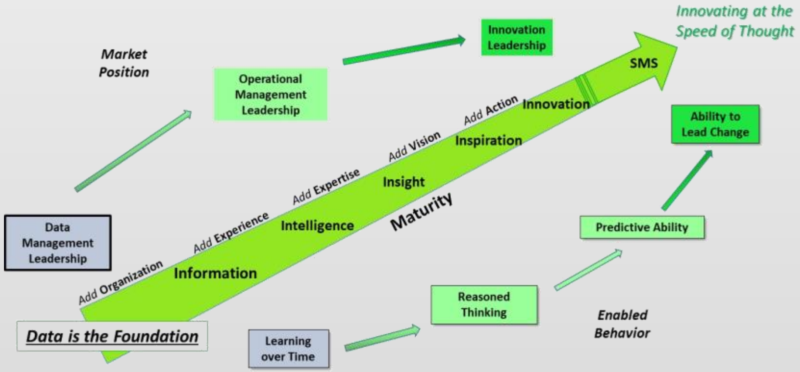
**Iterative and collaborative approaches**

The time for sequential approaches is long gone. To be able to optimize products and processes quickly and effectively while in development and improve and optimize performance while in operation, agile, iterative, *closed-loop* approaches need to be implemented. Only such modern approaches and practices can allow collaboration within teams and between teams and domains, and even across companies. Each stage in a product's lifecycle needs to have agile, iterative, and closed-loop approaches.

**Cognitive engineering**

This is making use of **predictive analytics** in conjunction with simulation models, data, and information gathered utilizing IoT to improve the behavior of a system. This can be applied to products as well as processes while in development or already in operation. Cognitive behavior implies the utilization of **deep learning** (see also machine learning and AI) capabilities.

The level of deployment and utilization of any of the previously mentioned trends and capabilities along with the way we make use of data is defining the competitiveness and eventually the market position of companies (see picture). Companies that have processes in place that allow real-time (or close to real-time) access to data and information are, and will continue to be, the **innovation Leaders across various industries.** This is what we refer to as **"Innovating at the Speed of Thought."**



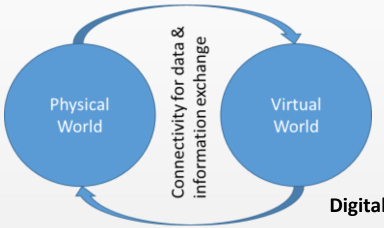

**Innovating at the Speed of Thought**
Courtesy: SMS_ThinkTank

[1] Source: https://inductiveautomation.com/what-is-iiot

# Digital Twin—Definition and Application Streams



Digital Twin[2] refers to a digital surrogate that is a dynamic physics-based description of physical assets, processes and / or systems that can be used for various purposes. The twin accompanies its real-world companion throughout its lifecycle—being changed in tandem with the physical version.



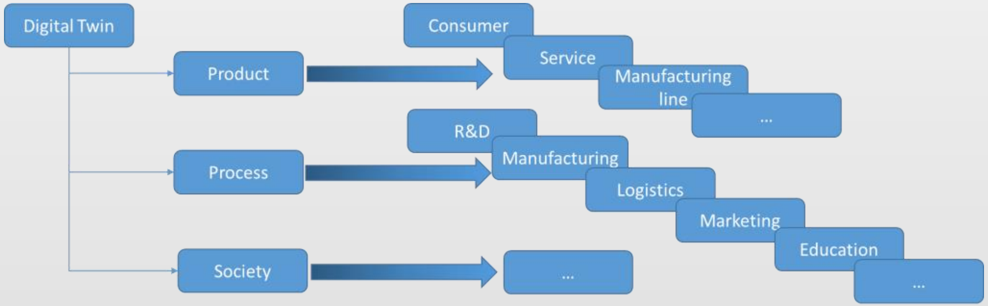

**Digital Twin: Simplified Architecture**

Based on the specifics of the role and purpose within the ecosystem, a Digital Twin can be created for a variety of different areas. We call these the application streams of the Digital Twin within the ecosystem.

The complexity seems almost endless (see picture to the right). The focus here is on the industrial side of the Digital Twin. Since human behaviour and society can be modelled and predicted as well, we mention this possible portion of a Digital Twin for completeness.

Independent of any very specific purpose of a particular Digital Twin, Digital Twins exist to:

- Optimize the design during the verification and validation phase
- Optimize the performance and life of a specific product while in operation
- Optimize operational performance of processes in operation
- Provide real world input for future design improvements (duty cycles, operating loads, stresses and fatigue life, vibration levels, sound levels, etc.)
- …




**Digital Twin: Application Streams**

[2] CIMdata—adapted from https://en.wikipedia.org/wiki/Digital_twin, and https://www.dodmantech.com/ManTechPrograms/Files/AirForce/Cleared_DT_for_Website.pdf

# Digital Twin—Its Position in the Lifecycle

## When does a Digital Twin become the Digital Twin?

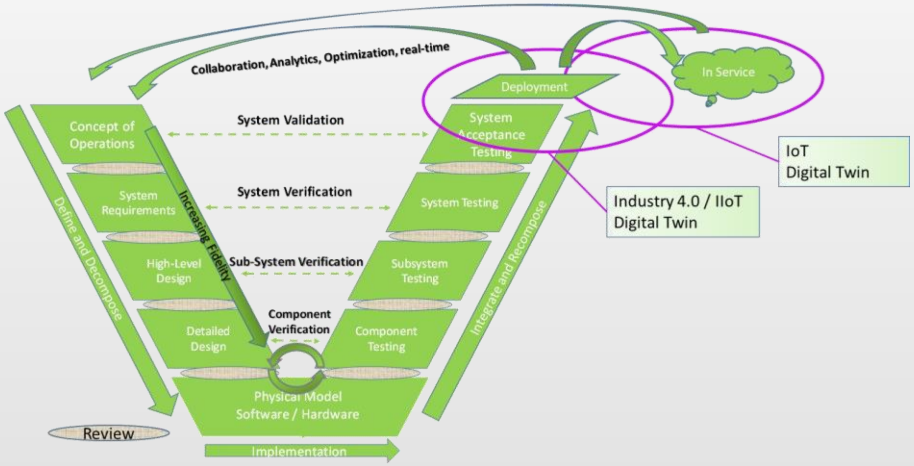
In our modern engineering environments, large amounts of virtual simulation are performed to develop new products and processes. For that, virtual simulation models with varying fidelity levels are typically being generated.

At the point when a product or process is released into the real world and is associated with its "as released" virtual model this virtual model becomes the Digital Twin of the real-world asset.

*A virtual model is typically associated with a product series (for instance: vehicle Series A Model Year 2018) or a general process (for instance: chassis forming operations for vehicle Series A Model Year 2018). The Digital Twin, on the other hand is only associated with one specific vehicle (vehicle XYZ from the Series A Model Year 2018) or specific process (chassis forming process for Series A Model Year 2018 in the plant XYZ).*

To position the Digital Twin, the traditional understanding of the lifecycle of a product or process needs to change from a sequential to an iterative view at every stage based on a closed loop process. At the same time, the traditional understanding of the **Systems Engineering** "V" needs to be expanded as well. We use here a new graphic to explain the model-based systems engineering process in a simpler way.

From the picture it becomes clear that IoT, IIoT, and Industry 4.0 are changing the way we need to think about the traditional sequential and stage gate product development lifecycle approach.



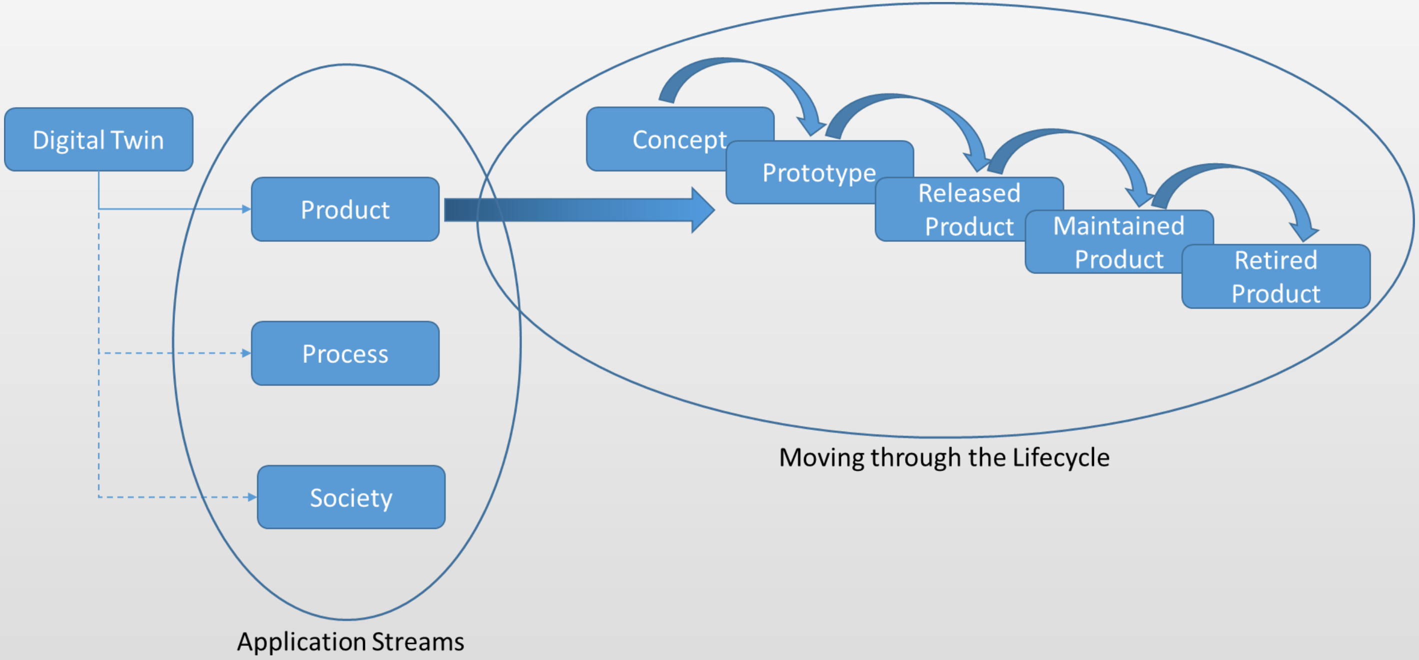

**The Digital Twin's Position in the Lifecycle**
Courtesy: SMS_ThinkTank

# Digital Twin—Its Position in the Lifecycle



It is not just important to know at what point the Digital Twin starts to exist. Like every other model of the product and its processes, the Digital Twin is moving with the physical model through the lifecycle and helping improve the actual product even before it's ready for production and eventually released into service.

For example, while the Digital Twin of a prototype is specific for that physical prototype, it will be associated with many "released into service products" when moving further along the lifecycle.



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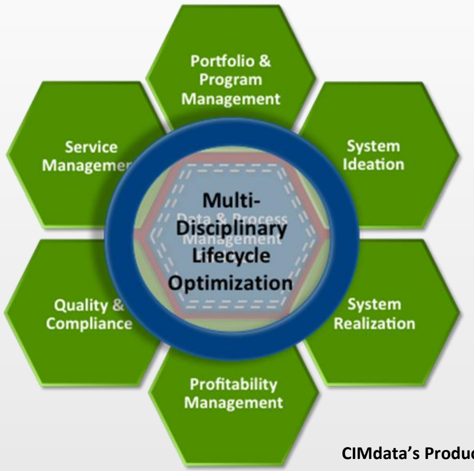
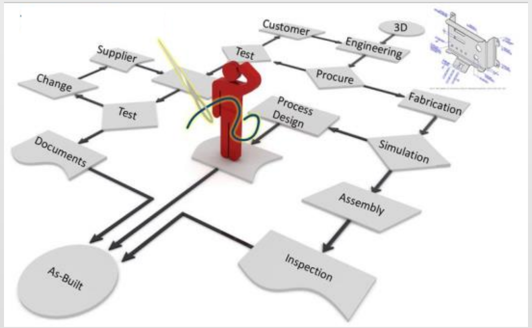
# Digital Twin, Platforms, and the Digital Thread

The Digital Twin lives and grows based on more and better operations data. That data can come from the physical product or process operating in the real world as well as from the virtual world. Per the previous discussion around the graphic "Innovating at the Speed of Thought" it shows the importance for a proper data backbone. In today's enterprise application environments, the **Product Innovation Platform** not only takes on the role of such a backbone but, at the same time connects all users and their information in a single environment to cultivate continuous creativity, yielding improvements in products and processes, plus inspiring new and better innovations throughout full lifecycles and across generations of products.

A Product Innovation Platform spans the enterprise, to support all users across all functions and disciplines. The platform provides a comprehensive set of heterogeneous process-enabling capabilities including platform-native applications which can be packaged and configured to establish and support standardized **end-to-end business processes** and related data access.




**CIMdata's Product Innovation Platform**




**The Digital Thread[3]**

Such platforms are the prerequisites to enable the **Digital Thread.** The digital thread is the foundational requirement to enable the Digital Twin. The Digital Twin needs to have access to the entire history and the current state of a product (or process) to help improve future designs (or processes) or optimize the performance of such while in operation.

This discussion highlights again the importance of an **iterative, agile, and closed-loop end-to-end approach.** These are essential elements for any modern systems engineering approach, especially since the Digital Twin plays a vital role in system modeling and simulation.

[3]http://www.manufacturing-operations-management.com/manufacturing/2016/04/what-is-the-digital-thread-and-digital-twin-definition.html

# Digital Twin, Platforms, and the Digital Thread

Typically, there are several platforms involved to realize all the benefits of having a Digital Twin available. The underlying Product Innovation Platform needs to be able to bring the threads of all those platforms together to ensure that data and information is consistent and not duplicated. **Emerging standards** for vendor-neutral collaboration, model exchange, and co-simulation are vital to any business to ensure an agile and efficient approach for enabling the required Digital Thread/Digital Twin infrastructure. Depending on the application stream for the Digital Twin, different platforms will be called upon to provide data, for instance: MES, ERP, and IIoT for manufacturing.

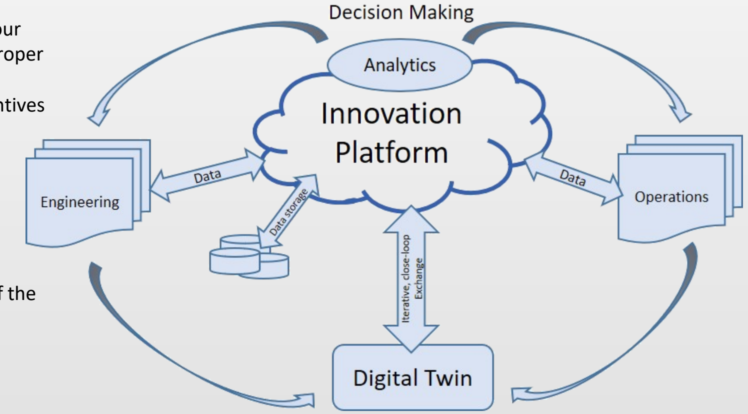
What all of them have in common is the need for **predictive analytics**. Here are four elements important to achieving advanced analytical capabilities, thus enabling proper use of the Digital Twin:[4]

- Intent: Resolving to be data driven—creating structures, processes, and incentives to support analytical decision making
- People: Mix of data science, business acumen, and technical expertise
- Data: Quality, consistent data stored in a manner that is easy to access
- Tools: State-of-the-art tools like unstructured databases, scale out compute clusters, and heuristic instrumentation

Those four elements not only strongly tie back to the product innovation platform approach described earlier but highlight the need as well for a proper balancing of the three major categories in order:

- Organization / Culture / People
- Processes
- Technology

Those are foundational categories for next generation **systems engineering of complex cyber-physical systems** where a **model-based** approach plays a vital role.




**Digital Twin: Higher-level Architecture**
CIMdata, SMS_ThinkTank

[4] Source: Bain Research, "Bain Brief—The Value of Big Data"

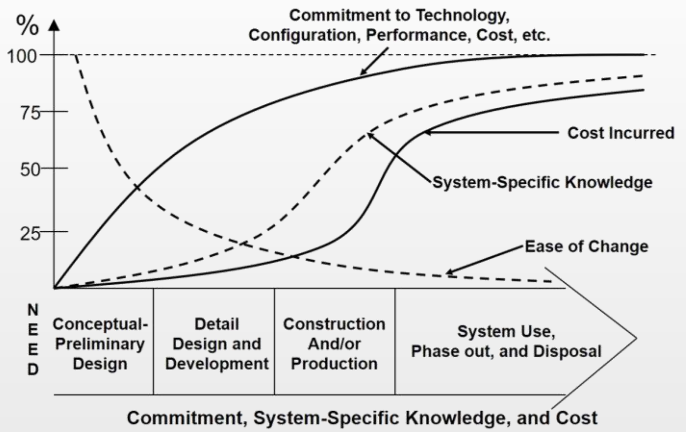
# Digital Twin—Benefits



A major part of any process that includes releasing products, processes, or services into operation is to understand when it is the best, easiest to change, or easiest to adjust. Since the Digital Twin in general is part of the overall systems engineering approach one can get a general understanding of when it is best to employ virtual techniques looking at the "Time-phase Sensitivity of Systems Engineering to total System Lifecycle Costs."

As system design and development progresses, the flexibility to implement system design changes is reduced and the cost impact of introducing changes is increased. Systems engineering has its greatest opportunity to influence design decisions earlier in systems design and development when the system design is still in evolution.

Typically, 80% of main engineering decisions are taken in the first 10% of the project lifecycle. By employing systems engineering within projects, companies have realized schedule reductions of more than 20% and cost savings exceeding 20%.[5]




**Time-Phased Sensitivity of Systems Engineering to Total System Lifecycle Cost[5]**

The Digital Twin plays a key role in realizing those costs benefits early as well as throughout the lifecycle. The following business benefits can be realized when utilizing Digital Twins:

- Assessment of a system's current and future capabilities throughout the entire lifecycle.
- Early discovery of systems performance through upfront simulation of operation and intended use. This includes making use of data and information of previously deployed related products and processes utilizing the analytics engine.
- Optimization of products, processes, and entire systems while in operation in real time (or close to it). This includes the enablement of autonomous or semi-autonomous behavior of systems (like machinery) using underlying foundational elements like analytics engine, innovation platform, and cloud enabled systems.
- Diagnose and troubleshoot:
  - Anticipate breakdowns
  - Determine optimal point for maintenance
- Training and education in a Virtual Reality (VR) environment to help future operators of machinery, production lines, or consumer products to become familiar with the product and its specific operations.
- Upfront optimization of placement of machinery and how it fits into the overall logistics of the entire system the machine will be integrated into.

[5] Building A Business Case for Systems Engineering: the 2012 SE Effectiveness Study © 2012 Carnegie Mellon University, 22-Oct-2012, Joseph P. Elm, Software Engineering, Alan R, Brown, Boeing Company

# Digital Twin—Hype and Maturity

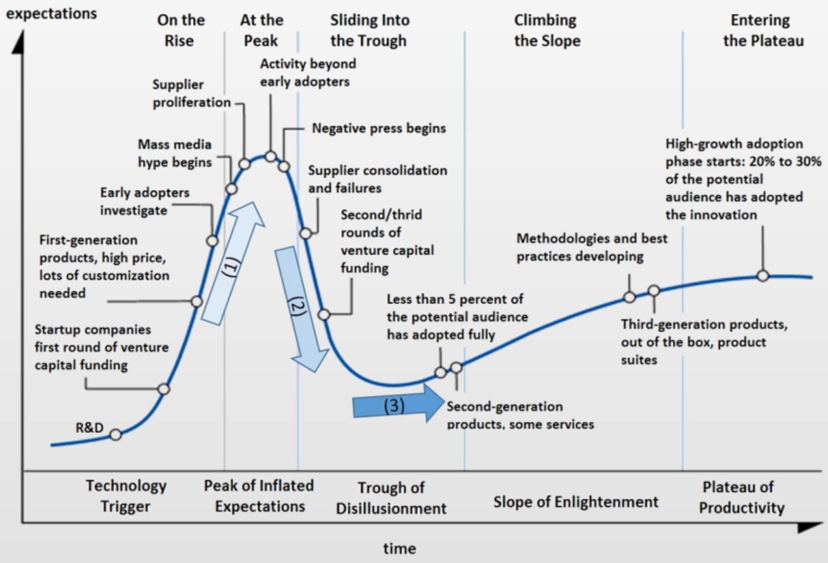
Even though the Digital Twin as an idea and practice has been around for a while (see Dr. Grieves and NASA references later in this eBook) there is still quite a bit of hype associated with it. Just because people are talking about the Digital Twin doesn't mean they have the proper understanding of what is involved to properly and fully implement such a concept.

In addition, there isn't just one spot we can put the Digital Twin on the **Hype-Curve**. As we outlined before, we must differentiate the maturity for the various application streams, which will vary by industry and even by company within various industry segments (e.g., automotive, aerospace, high tech, medical equipment, heavy machinery).

The majority of industry is still at the first up-slope (1), especially for those with product focused Digital Twins in the field utilizing IoT functionality. Only a few early adoption leaders have gone beyond the "Peak of Inflated Expectations." They are typically focused on the machinery and equipment industries utilizing IIoT functionality as well as certain aspects of social media utilizing artificial intelligence (AI) capabilities (2). Those companies realize the complexity of the required architecture much better than all the other companies. Good examples of these early adopters are companies leading in developing autonomous or semi-autonomous driving technology as well as electrical vehicle systems.

Still, to make the turning point through the "Trough of Disillusionment" (3) another important understanding needs to take hold. Areas where we see elements around this turning point are the thought leaders utilizing IIoT and focusing on Industry 4.0, as well as application of social media using the latest AI capabilities.

Here we are not just talking about the level of Digital Twin maturity from a technology perspective but from an organizational and process point of view: *Is the business or organization ready for the Digital Twin?*




Digital Twin on the Gartner Hype-Curve

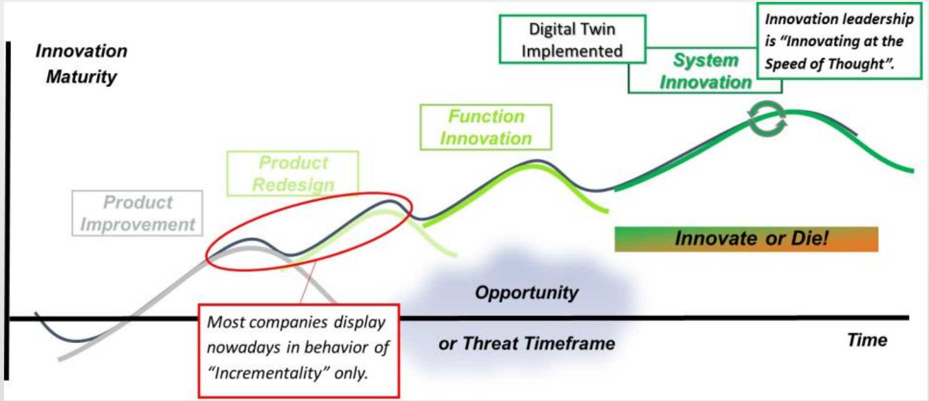
# Digital Twin—Hype and Maturity

Leaders in their industry typically have the highest level of maturity as a whole organization, not just for a specific engineering area or functional discipline. This can be characterized through the level of **Innovation Maturity**. Achieving the highest level of innovation maturity, "System Innovation" is defined by the way a company uses the information that is available (see "Innovating at the Speed of Thought"). Predictive and analytic capabilities play a central role in enabling the movement toward this top level of maturity.

Today, companies understand that they must go beyond the typical S-curve to stay competitive. This moves into the level of "Product Redesign." This is where most companies operate today. It also can be described as an "incrementality behavior."

Each S-curve typically has its own lifecycle, traditionally defining where a product once put into service is doomed to "die" or to be "retired." Such an approach is no longer competitive in the vast majority of industries. With the new understanding of the global competitive environment and the possible use of the enabling and available technology, companies with the highest level of maturity see the launch of a product into service as a potential for new business and profits that did not previously exist.

With the enablement of Product Innovation Platform, IIoT, and IoT the Digital Twin can become reality and companies that are beginning to achieve the desired level of System Innovation.




**Innovating Maturity Levels**
Courtesy: SMS_ThinkTank


**Higher Levels of Innovation Maturity Require a New Understanding of the Lifecycle**
Courtesy: SMS_ThinkTank

# Digital Twin—Hype and Maturity

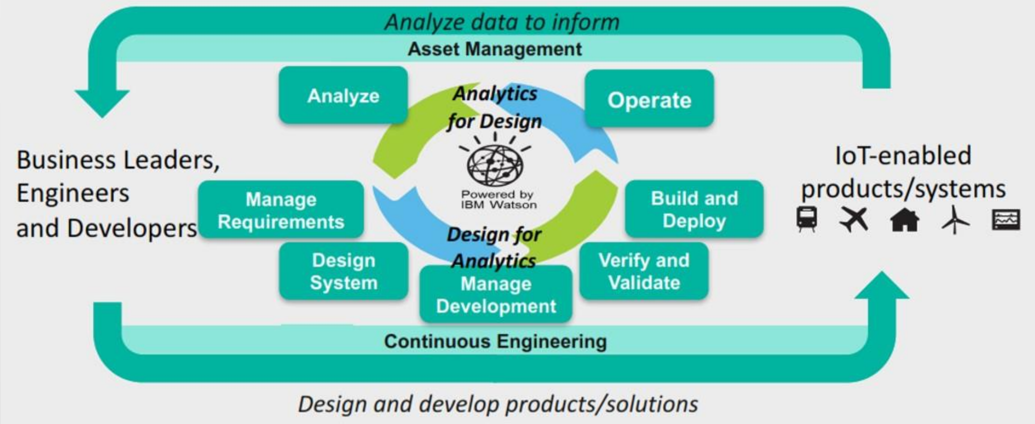
As discussed, the Digital Twin itself has various levels of maturity. To better understand this, it makes sense to mention the three major human tools that support the Digital Twin capability:[6]

- Conceptualization
- Comparison
- Collaboration

Those lay the foundation for the next generation of problem solving and achieving a higher level of innovation maturity.

At the beginning of this eBook we talked about a major trend in engineering being **Cognitive Engineering**. In line with this, we see as the top-level maturity for the Digital Twin the "**Cognitive Digital Twin.**" With the understanding of the word "cognitive" in conjunction with the top innovation maturity we can highlight major behaviors:[7]

- Learn faster
- Adapt faster
- Innovate faster.




**Cognitive Digital Twin[7]**

[6] Source: Dr. Grieves "Digital Twin: Manufacturing Excellence through Virtual Factory Replication", White Paper, 2014

[7] Source: IBM Watson IoT Connected_Products_Presentation_July 2017

# Digital Twin—The Path Forward

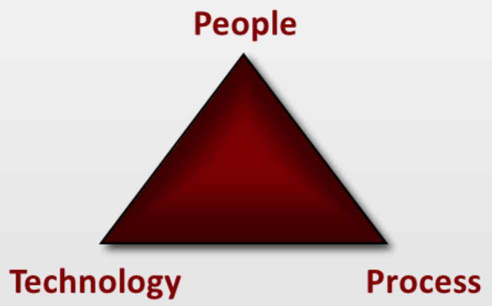
Looking at what lies ahead of us, we see from a technology perspective the following:

- Create an efficient infrastructure that supports real-time (or close to it) Digital Twin behavior
- Make full use of augmented reality—visually overlay the virtual with the real world while highlighting significant differences to support decision making processes with the human-in-the-loop
- Disconnect from the physical location by entering the virtual realm when looking into innovative ideas—probabilistic possibilities

But, it will not be possible to become an innovation leader if we don't change the way we approach deployment and introduction of innovative ideas. Key to this are the three categories of implementation maturity mentioned previously:

- Organization / People / Culture
- Processes
- Technology / Tools

Companies and societies need to get away from putting technology first and looking at the people as an afterthought. We need to reverse the order and start with the **People / Organization** followed by the **Processes**. The **Technology/Tools** will follow automatically based on the business objectives and process requirements as defined by the first two categories. An organization which is not ready will not be able to deliver even if they have all the required technologies and tools available to them.



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# Mevea's "End-to-End Solution"



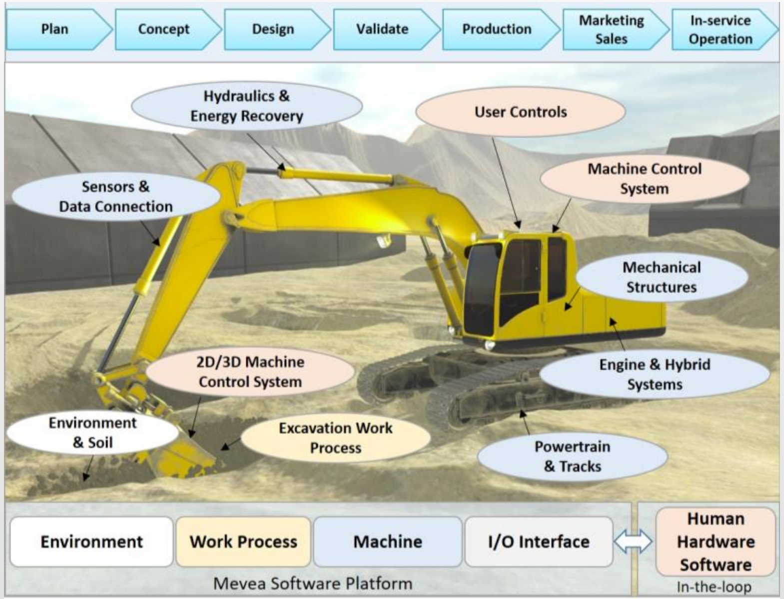
Mevea is delivering a compelling **end-to-end solution** (with focus on the machinery and equipment industries) in the form of Digital Twin enabling technology and associated methodology that link the real and the virtual worlds together. Their multi-physics solution spans the entire lifecycle utilizing technologies, including:

- Multi-Body Simulation (MBS)
- Hardware-in-the-Loop (HiL)
- Software-in-the-Loop (SiL)
- Human-in-the-Loop (HuiL)

With its real-time simulation capabilities, Mevea has a foundation in place that interacts directly between the digital model and the real-world asset.

Mevea currently focuses on helping their customers in areas of:

- Find and test new solutions in product development faster than before and without any physical prototypes.
- Training on machine operation by bringing the virtual model and the physical simulator together to teach before equipment is being put into operation.
- Simulating the specific customer operating environment to identify optimal placement and operation of machinery.
- Identify new business opportunities for their products.
- Monitoring the asset during operation and compare its actual performance with the performance characteristics of the Digital Twin. This will allow:
  - Optimization of the actual performance of the physical asset utilizing virtual simulation feedback of the Digital Twin based in the specifics of the operational environment.
  - Improve future product releases for similar applications.




**End-to-End Solution**
Courtesy of Mevea



CIMdata®

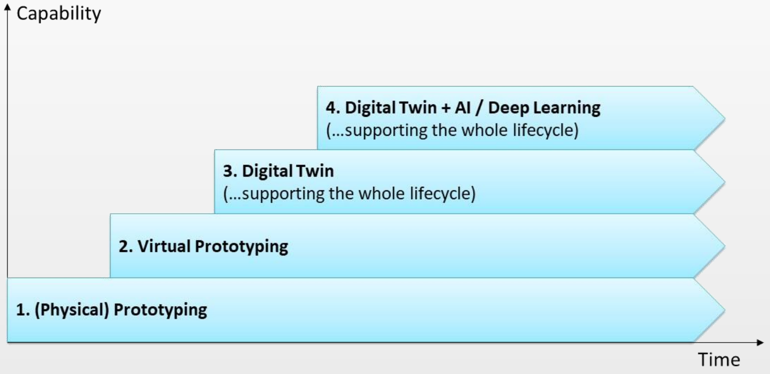
# Mevea's "End-to-End Solution"



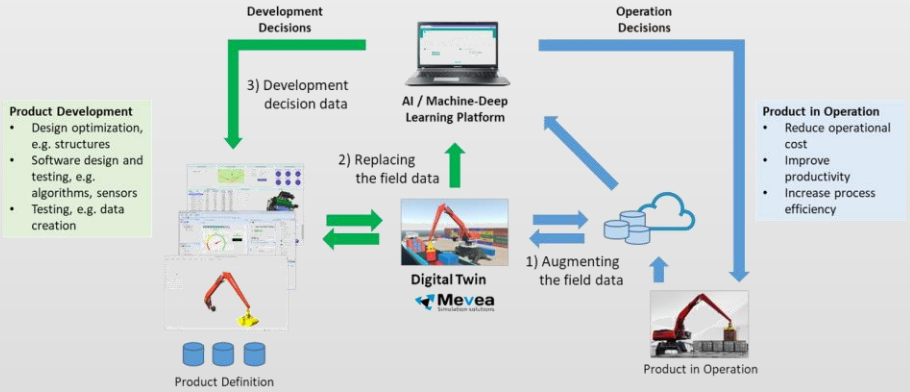
## Mevea has a clear understanding of the role of the Digital Twin and how to execute the solution

Mevea's focus is on providing its customers with Digital Twin capabilities that span the entire product lifecycle. Mevea delivers high maturity Digital Twin capabilities that not only integrate to predictive analytics and deep learning functionality but also provide real-time simulation capabilities for the optimal support of deployed assets. This in turn, requires a complete digital thread capability throughout the entire business and lifecycle which they also support.

Mevea's business philosophy understands that this can happen only over a long period of time and in close partnership with its industry customers.




**Evolution of Machine Design & Testing**
Courtesy of Mevea




**Delivering the Digital Twin—"Digital Twin & AI / Machine-Deep Learning"**
Courtesy of Mevea

# Use Case—Sandvik Mining & Construction

## Digital Twin enables Virtual Validation in the early phases of product development

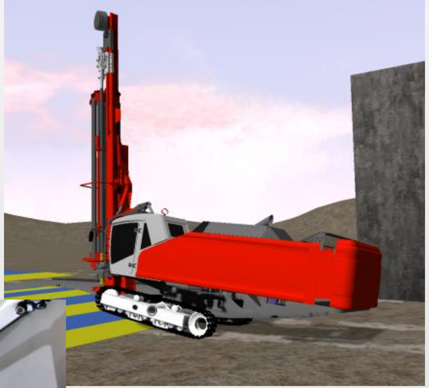
With Sandvik's focus on equipment, tools, services, and technical solutions for the mining and rock excavation industry, it is important to understand that ~80% of the costs and features are committed and decided in the conceptual phase. Sandvik decided to utilize virtual simulation capabilities in those early stages of product development, thus making use of Mevea's Digital Twin capability. This allowed Sandvik's drilling machine equipment development to connect the physical simulator with the virtual simulation model. This helped Sandvik realize cost and time savings, as well as identify new business opportunities.

By using an iterative design approach in conjunction with the specifics of the future customer's operating environment allowed Sandvik to improve their product quality upfront and apply customer specifics for each application. Some features used include:

- Software-in-the-loop (SiL)
- Real-time simulation
- Human-in-the-loop (HuiL): which allows customization of their products as well as customer validation
- Augmented Reality (AR)

Feedback from released products to development will enhance Sandvik's virtual modeling and simulation capabilities further in the future.

**Sandvik's Goal** is to utilize Digital Twin capabilities throughout their product line in the future.



**Drilling Equipment—Virtual Simulation Model**
Courtesy of Sandvik

"With Mevea's Digital Twin End-to-End capability it is possible to develop production-ready solutions at an early stage without any physical prototype."

*Mr. Arto Vento, Engineering Manager, FEA and Simulation*

**Human-in-the-Loop "Driving the Digital Twin"**
Courtesy of Sandvik

https://www.rocktechnology.sandvik/

# Use Case—Normet

## The Digital Twin approach helps Normet reach new innovation maturity levels

Normet is a fast growing and innovative technology company with a passion for trying to continuously improve its partners' processes to increase safety, productivity, and profitability utilizing its wealth of expertise and experience in specialised underground mining and tunnelling processes. Normet's focus on utilizing the Digital Twin approach to realize these benefits is driven by challenges such as:

- Product complexity fuelled by increased automation and customization.
- Rapid development cycle: from idea to working concept, solution tailoring, and optimization of the automation and mechatronic systems prior to manufacturing.
- Prototyping advanced automation in autonomous and semi-autonomous machine operations.
- Operator training of new solutions.

Utilizing Mevea's Digital Twin approach Normet was able to effectively achieve the following benefits:

- Significantly decreased the development lead time of automation development projects.
- Enabled the development of solutions previously thought too complex and demanding.
- Identified areas of potential failure faster and cost effectively.
- Improved operator training capabilities.

> The utilization of Digital Twins is typically a focus of the product development areas. But Normet sees the potential of Digital Twins being applied across the entire organization spanning the entire lifecycle, such as for predictive maintenance, machine learning, adaptive process control, pre-simulated operations planning, etc.

**Digital Twin in Action**
Courtesy of Normet

> "What we have learned is that through the utilization of Digital Twins, we can significantly speed up development and test new ideas that were previously prohibited by high cost of prototyping. Additional benefits are that the Digital Twins can be used beyond the product development phase for various activities ranging from training to adaptive process control and operations planning."
>
> *Mr. Samu Kukkonen, Technology Director*

**Concrete Spraying Machine in Action**
Courtesy of Normet

https://www.normet.com/

# Use Case—Mantsinen

## Moving their Digital Twin capabilities to new maturity levels

Mantsinen, with its focus on hydraulic material handlers for harbors and logistics services is another good example of an early adopter of Mevea's Digital Twin approach. The main challenges Mantsinen was experiencing made the idea of the Digital Twin a very good fit:

- Product development: product complexity and intelligence, software testing (SiL).
- Customer applications: each project is unique, which requires individual approaches to each customer project based on product performance and operating requirements.
- Product in operation: It's being used for operator training (HuiL) and to improve Mantsinen's customer service utilizing feedback from operational data.

Mantsinen has so far achieved the following benefits:

- Crane control system change and implementation was done completely utilizing the Digital Twin approach. This included the pre-release testing of the software using the Digital Twin model.
- Providing customers the utilities for operator profiling and training.

The future plan is to add advanced analytics capabilities to make better use of the operational data not just for future projects but also for in-service applications.

Mantsinen sees Mevea's Digital Twin capability as a versatile solution utilizing it by various functions from R&D to training for a wide spectrum of applications.

**Digital Twin of 200 Material Handler**
Courtesy of Mantsinen

"Using Mevea's Digital Twin capability has proven its value during the product lifecycle at Mantsinen. We are looking now at possibilities to use it in connection with advanced analytics together with a remote data collection system in order to better understand operational data."

*Mr. Jussi Lappi, Customer Support Director*

**200 Material Handler**
Courtesy of Mantsinen

http://www.mantsinen.com/en/

# Conclusions

## Digital Twin technology is maturing and finding its way into specific industrial applications where there is clear business case and ROI

CIMdata believes that Digital Twin technology and business processes are in many ways still at the very early adoption stages. While the technologies required for enabling the Digital Twin approach are evolving rapidly, the required holistic understanding of a functional Digital Twin approach is only now being introduced. Such understanding includes the knowledge of the various application streams for the Digital Twin as well as how the Digital Twin itself fits effectively into the overall product and process lifecycle.

Many solution providers are still developing appropriate offerings to effectively enable the ultimate Digital Twin use cases. CIMdata believes that Mevea with its end-to-end Digital Twin solution approach is already delivering tangible business value to its customers. For its customers, as shown in the use cases highlighted herein, the Digital Twin plays a central role in achieving not only competitiveness but improving products and processes for their end customers as well. By increasing step-by-step the implementation maturity of their specific Digital Twin realization, Mevea's customers will eventually reach higher maturity levels as businesses and thus, achieve levels of sustainable product and process innovation.

Mevea Simulation solutions

Mevea is a Finnish high tech company and one of the leading real-time simulation and simulator technology providers.

https://mevea.com

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