



Digital Twins

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A decorative graphic on the left side of the slide. It features a dark blue vertical bar on the far left. A black arrow points to the right from the top of this bar. Several thin, curved lines in shades of blue and grey sweep upwards and to the right from the bottom left area, creating a sense of motion and flow.

What are Digital Twins?

- ▶ Computer-based versions of anything that physically exists.
- ▶ Cloud based virtual image of your asset maintained throughout the lifecycle and easily accessible at any time.
- ▶ Virtual copy of something real, modelled to behave realistically.
- ▶ One platform brings all the experts together providing powerful analysis, insight and diagnostics.



A dark grey arrow points to the right from the left edge of the slide. Below it, several thin, curved lines in shades of blue and grey sweep across the left side of the slide.

Concept - Digital Informational Construct

Vision - Create, Test, Build

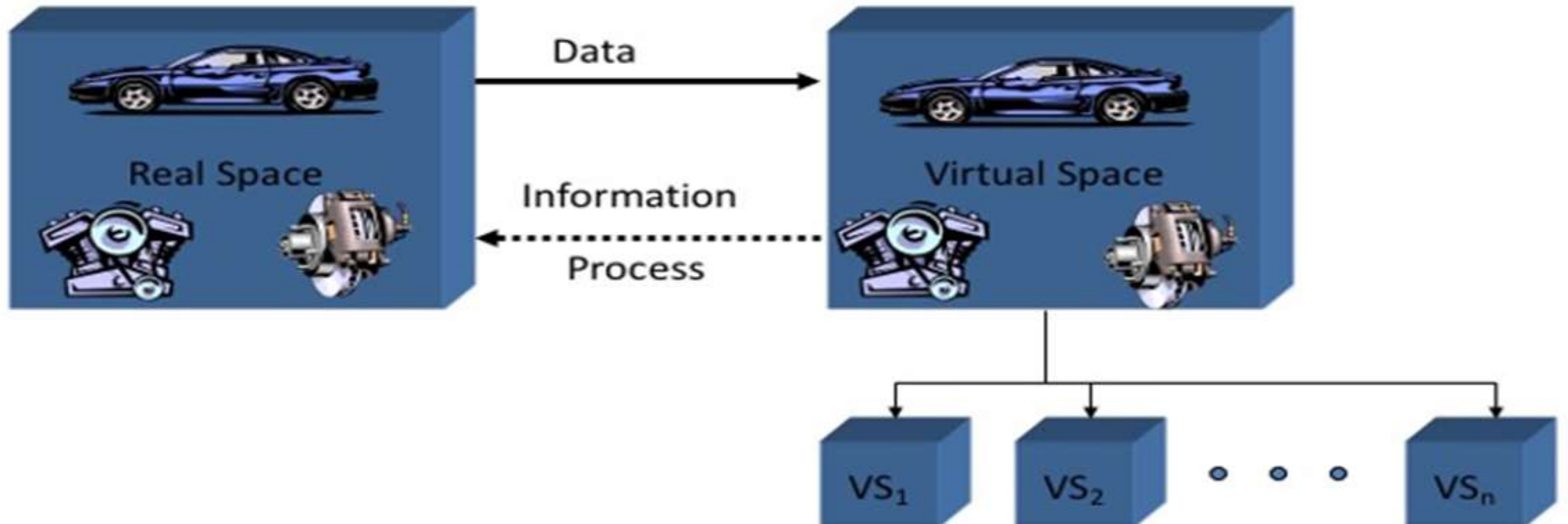


Origin of Digital Twin

- ▶ University of Michigan presentation originated by Dr. Grieves, called it “Conceptual Ideal for PLM”.
- ▶ Elements of the Digital Twin
- ▶ There was a mirroring or twinning of systems between what existed in real space to what existed in virtual space and vice versa.
- ▶ The Digital Twin has been adopted as a conceptual basis in the astronautics and aerospace area in recent years by NASA.

Information Mirroring Model

Conceptual Ideal for PLM





Difference between CAD and Digital Twins!



Formal Definition and its Types

- ▶ Digital Twin is a set of virtual information constructs that fully describes a potential or actual physical manufactured product from the micro atomic level to the macro geometrical level. At its optimum, any information that could be obtained from inspecting a physical manufactured product can be obtained from its Digital Twin.
- ▶ Digital Twins are of two types:
 - Digital Twin Prototype (DTP)
 - Digital Twin Instance (DTI)
- ▶ DT's are operated on in a Digital Twin Environment (DTE).

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TYPES

- ▶ Digital Twin Prototype (DTP)
- ▶ Digital Twin Instance (DTI)
- ▶ Digital Twin Aggregate (DTA)



Purpose

- ▶ Digital Twin Environment (DTE)- this is an integrated, multi-domain physics application space for operating on Digital Twins for a variety of purposes
- ▶ Predictive
- ▶ Interrogative



Working Of Digital Twins

Digital Twin – The Mind of a Machine

SEE



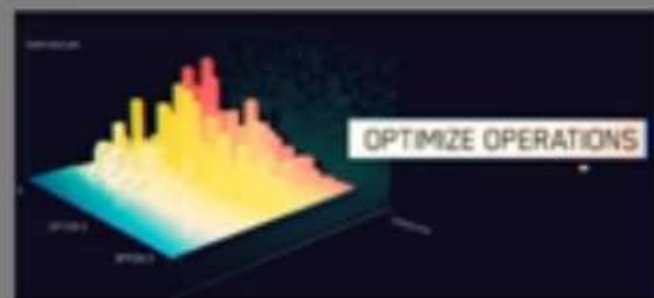
updating, learning



THINK



reasoning, optimizing



DO



informing, acting using
edge controls





Digital Twin Fulfillment Requirements

Unified Repository



Digital Twin Model Use Cases

The 3 C's

Examples

- Efficiency-A wind farm
- Safety Risks-An aircraft engine
- Maintenance-A race car engine
- Assembly- A digital twin of an air conditioning unit
- Smart City- includes underground structures such as water systems
- Testing-A digital twin of a smart phone
- Design- 3D printer
- Healthcare-
- Robotics
- Performance Tuning- a spacecraft is tuned from Earth
- Customer Experience- modeling fashions on a visual twin of a customer
- Any Physical entity
- Software
- GE
- Black & Decker
- PLM : the main reason for its inception.





Product Lifecycle Management

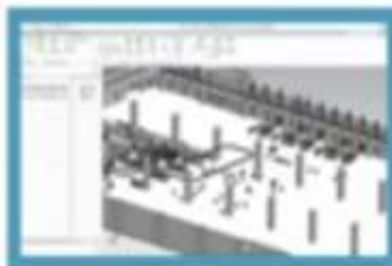
- ▶ Challenging conventions through Digital Twins Concept and transform manufacturing.
- ▶ 6 step process being introduced to this concept.



Product
design



Process
planning



Layout



Process
validation



Throughput
optimization



Manufacturing
execution

- Digitalized the process
- Connected the steps in-between



Disadvantages

- ▶ Dependent on internet connectivity
- ▶ Security is at stake.
- ▶ Digital Twins concept is based on 3D CAD models and not on 2D drawings.
- ▶ 39% of design work produces 2D drawings, 27% 3D models and 34% both 2D drawings and 3D models. 2D drawings automatically generated from 3D CAD models are important as there is more software development on 2D drawing capability.
- ▶ A digital twin will be required across entire supply chains.
- ▶ The challenges here involve globalization and new manufacturing techniques. Managing all these design data for digital twin amongst partners and suppliers as the physical product evolves will be a challenge.



Scope

- Scalability
- DMDII
- Humanoid
- Completely 3D approach
- Interfaces and Maps



References



- ▶ <https://www.youtube.com/watch?v=xcS9tlc6ZYE>
- ▶ Digital Twin: Mitigating Unpredictable, Undesirable Emergent Behavior in Complex Systems (Excerpt) Dr. Michael Grieves and John Vickers
- ▶ <https://youtu.be/gK5sHDfBMP4>