

10th  
**UCAAT**

**User Conference on  
Advanced Automated Testing**

# How to Test Digital Twins

Presented by: Maroš Kutschy



**Ness  
Digital  
Engineering**

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# Let me introduce myself

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# Agenda

1. Definition of digital twins
2. History of digital twins
3. Examples of industrial sectors where digital twins are used
4. Real life examples of digital twins
5. Demo pages of digital twins
6. Manual testing of digital twins
7. Automation testing of digital twins + demo
8. Key takeaways
8. Q&A

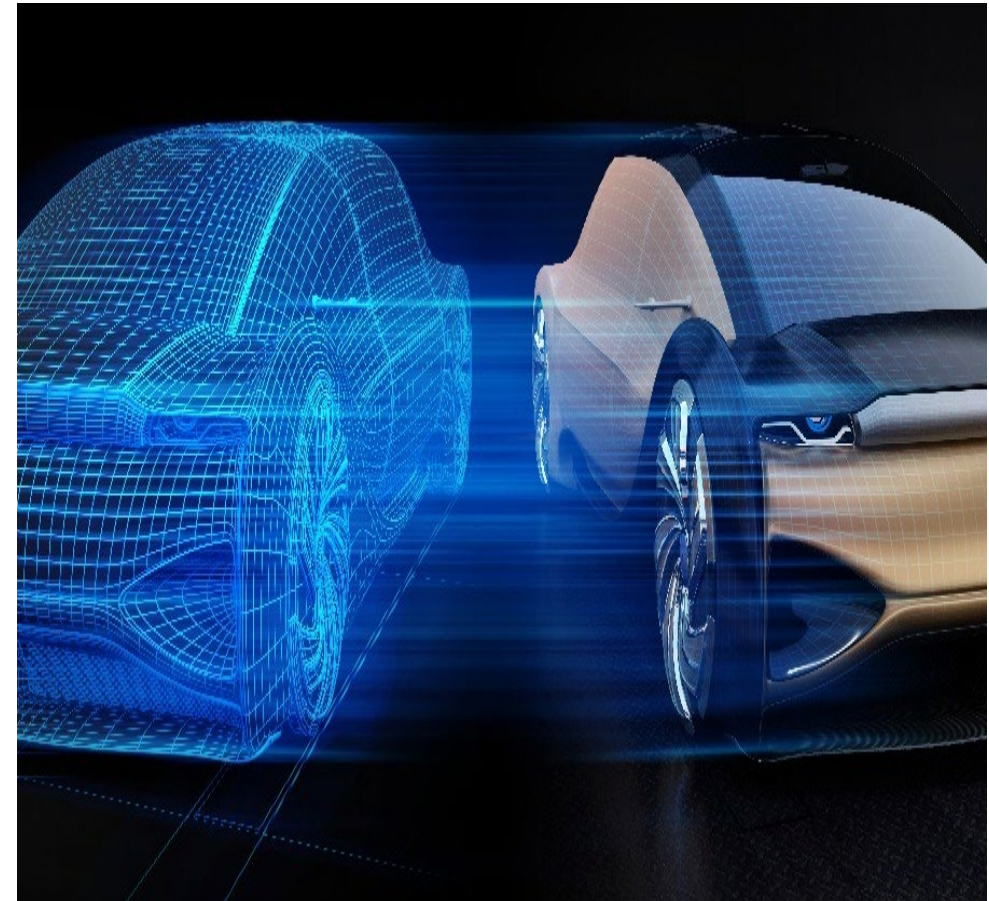
# Definition of digital twins

A digital twin is a **virtual representation** of an entity or system that exists in the physical world,

it is composed of the following three elements:

- a **physical** entity in real space;
- the **digital** twin in software form;
- **data** that links the first two elements together

It is used to **optimize** operations, **improve** quality, **reduce** costs, and **enhance** innovation

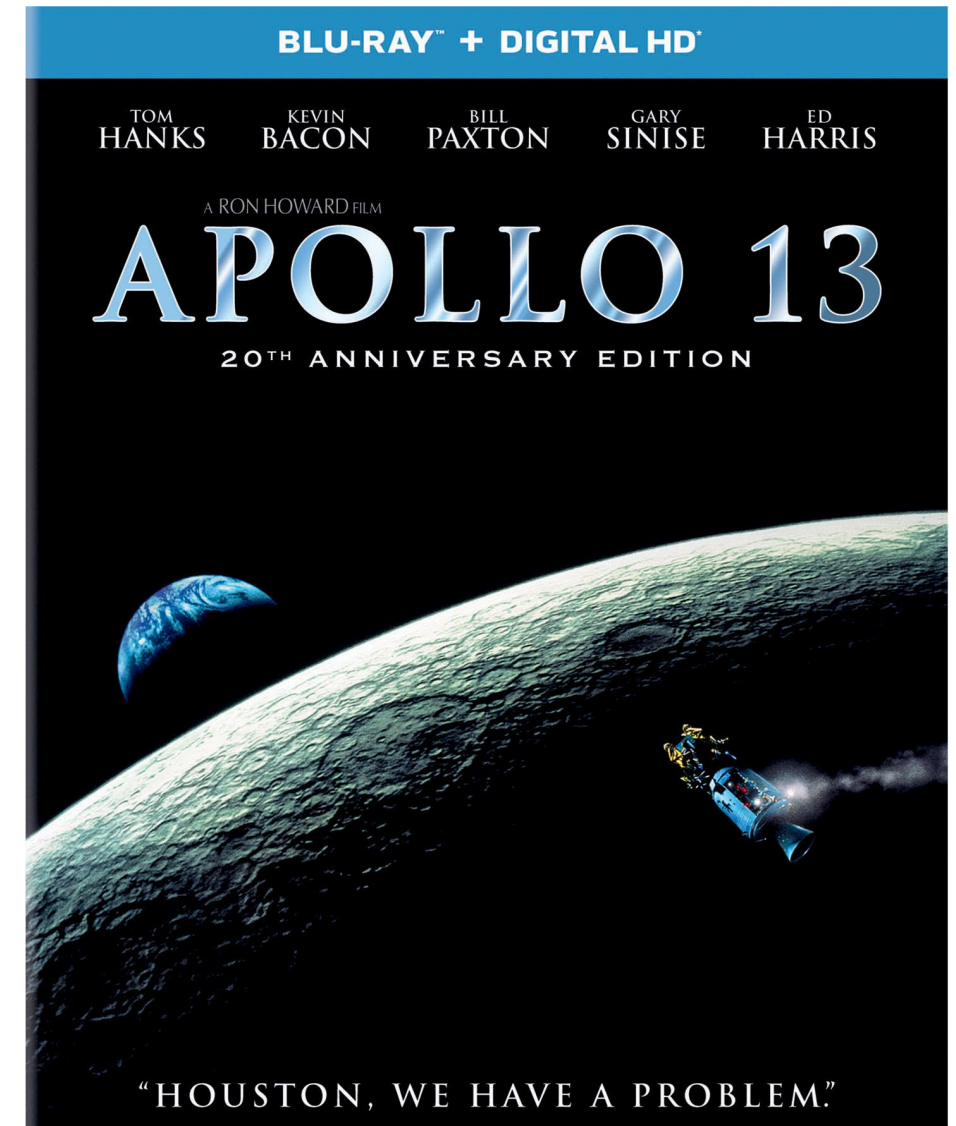


# History of digital twins – Apollo 13 <sup>10th</sup>UCAAT

After the **launch** of Apollo 13 on **April 1970**, no one could have predicted it would become a fight for survival as the oxygen tanks exploded early into the mission.

It became a famous **rescue mission** as the world held its breath, with technical issues needing to be resolved from up to 200,000 miles away.

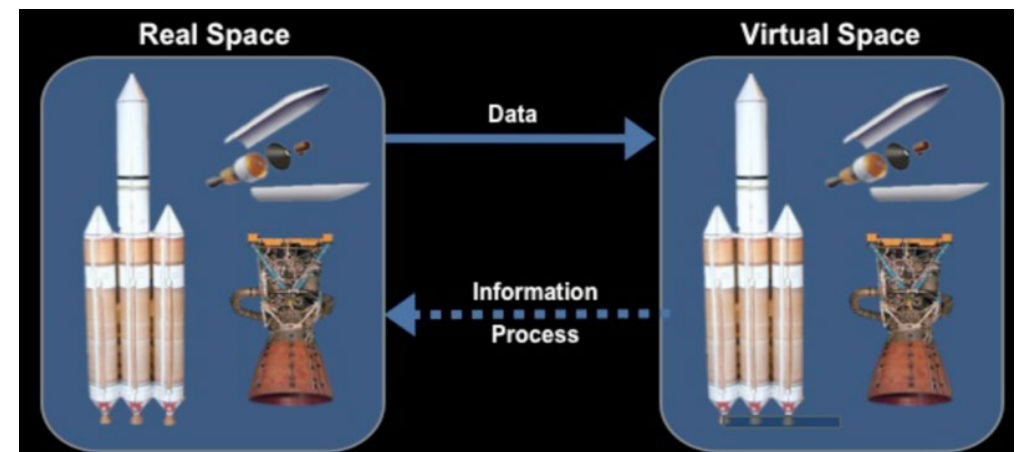
A **key** to the rescue mission, however, was that NASA had a **digital twin model** of Apollo 13 on earth which allowed engineers to test possible solutions from ground level.



# History of digital twins – Michael Grieves <sup>10th</sup>UCAAT

The digital twin **concept** gained recognition in **2002** after Challenge Advisory has hosted a **presentation** for **Michael Grieves** in the University of Michigan on technology

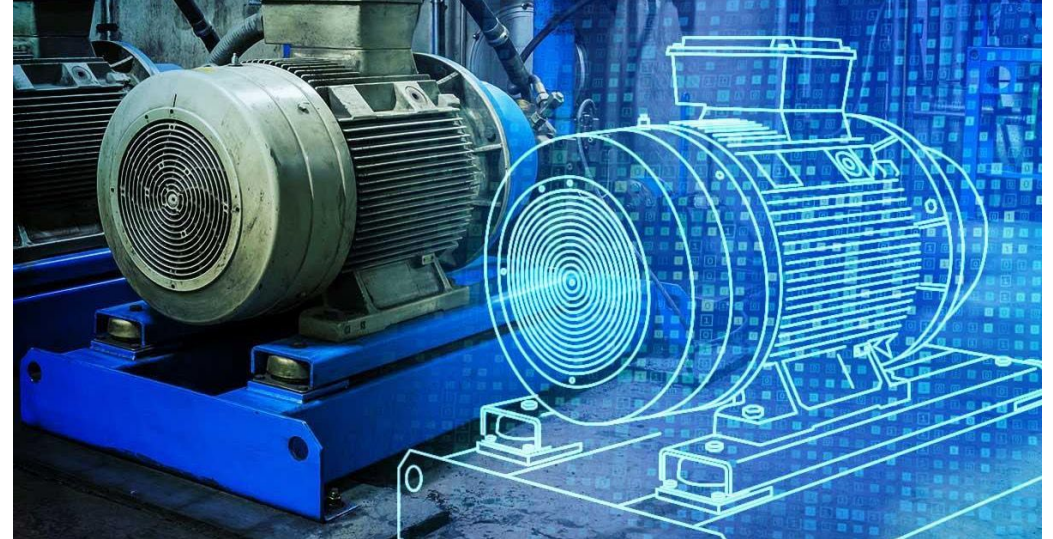
The presentation involved the development of a **product lifecycle management** center. It contained all the elements familiar with the digital twin including; **real** space, **virtual** space and the spreading of **data** and information flow between real and virtual space.



# Examples of industrial sectors where digital twins are used

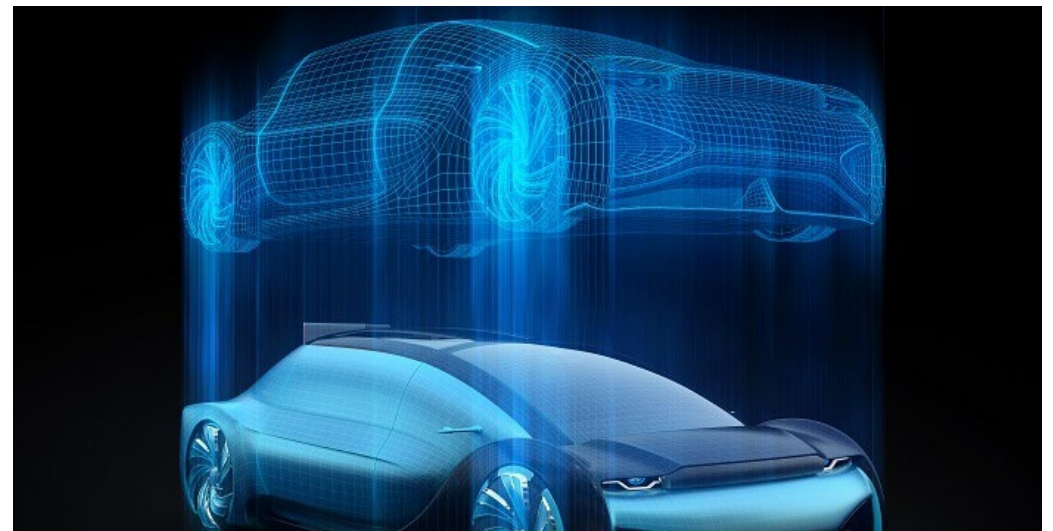
## 1. Manufacturing

- **Factory** design and **layout**
- **Robotics** simulation
- **Monitoring**, guided **maintenance** and **repair**



## 2. Automotive

- 3D car **design** and product **development**
- **Autonomous** driving simulation
- Human-machine **interfaces**



# Industrial sectors where digital twins are used <sup>10th</sup>UCAAT

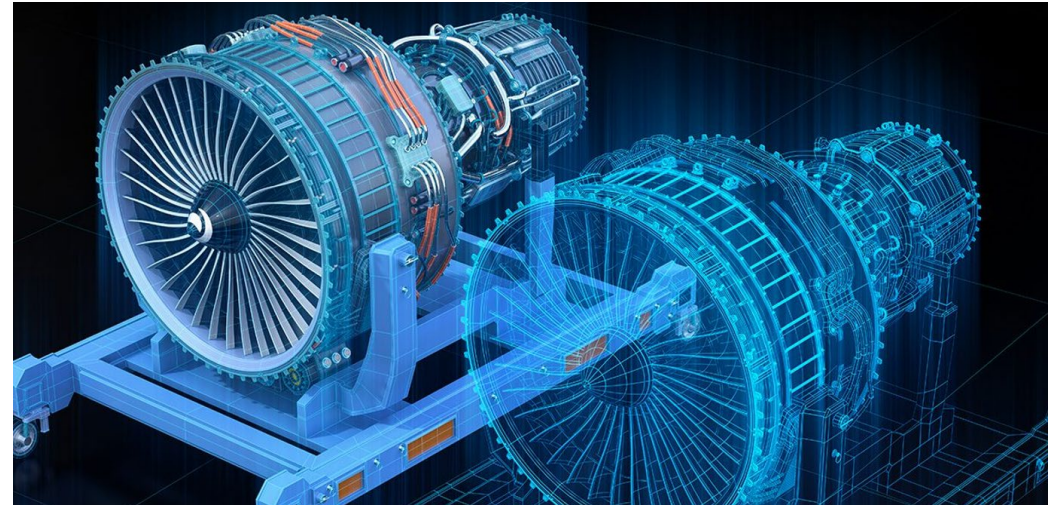
## 3. Health Care

- **optimize** facility **operations**
- improve **hospital designs**
- build a visual and digital **twin** of a **patient's heart** to be used for **further study**



## 4. Aerospace

- product development and **prototyping**
- **simulation** and **training**





# Real life examples of digital twins – Virtual Singapore

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# Virtual Singapore



The Virtual Singapore platform is a **digital twin** of the **city-state** of Singapore.

It **enables** users from different sectors to develop sophisticated tools and applications for **test-bedding concepts** and services.

It also helps in **planning and decision-making**, and research on technologies that could solve complex and emerging challenges in the country

# Virtual Singapore

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The screenshot shows the Virtual Singapore website interface. At the top left, there is a logo for the National Research Foundation and a navigation menu with 'Uses of Virtual Singapore' and 'Virtual Singapore'. A search bar is located at the top center. The main content area features a large 3D rendering of a city skyline with several skyscrapers, including one with the OCBC Bank logo. A text box on the left side of the page is titled 'Light and Temperature' and contains the following text: 'Shadow-Sunlight Simulation' and 'Virtual Singapore calculates percentage of light and shadow per building based on the position of the sun.' Below this text box is a small inset image showing a street scene with people walking and sitting on a bench. The background of the website is a blue sky with a few clouds.

# Virtual Singapore

The screenshot shows the Virtual Singapore application interface. At the top left, there is a logo for the National Research Foundation and the text "Uses of Virtual Singapore". Below this, the text "Virtual Singapore" is displayed. The main area is a 3D city model with numerous blue bus icons scattered throughout. A red line traces a path through the city, starting from a yellow 'X' on a road and ending at a building. In the bottom left, there is an inset image of a hand holding a smartphone displaying a notification: "Meeting at the restaurant at 12:00". In the bottom right, there is another inset image showing a car's perspective from a driverless vehicle, with a play button icon in the top left corner of the inset.

**Virtual Singapore**

Search

John

NATIONAL RESEARCH FOUNDATION  
Uses of Virtual Singapore

Virtual Singapore

Meeting at the restaurant at 12:00

**Sustainable Transportation**

The autonomous vehicles use 3D models and polygons as well as the street furniture in Virtual Singapore for driverless navigation on the roads. Residents can also check the

# Virtual Singapore

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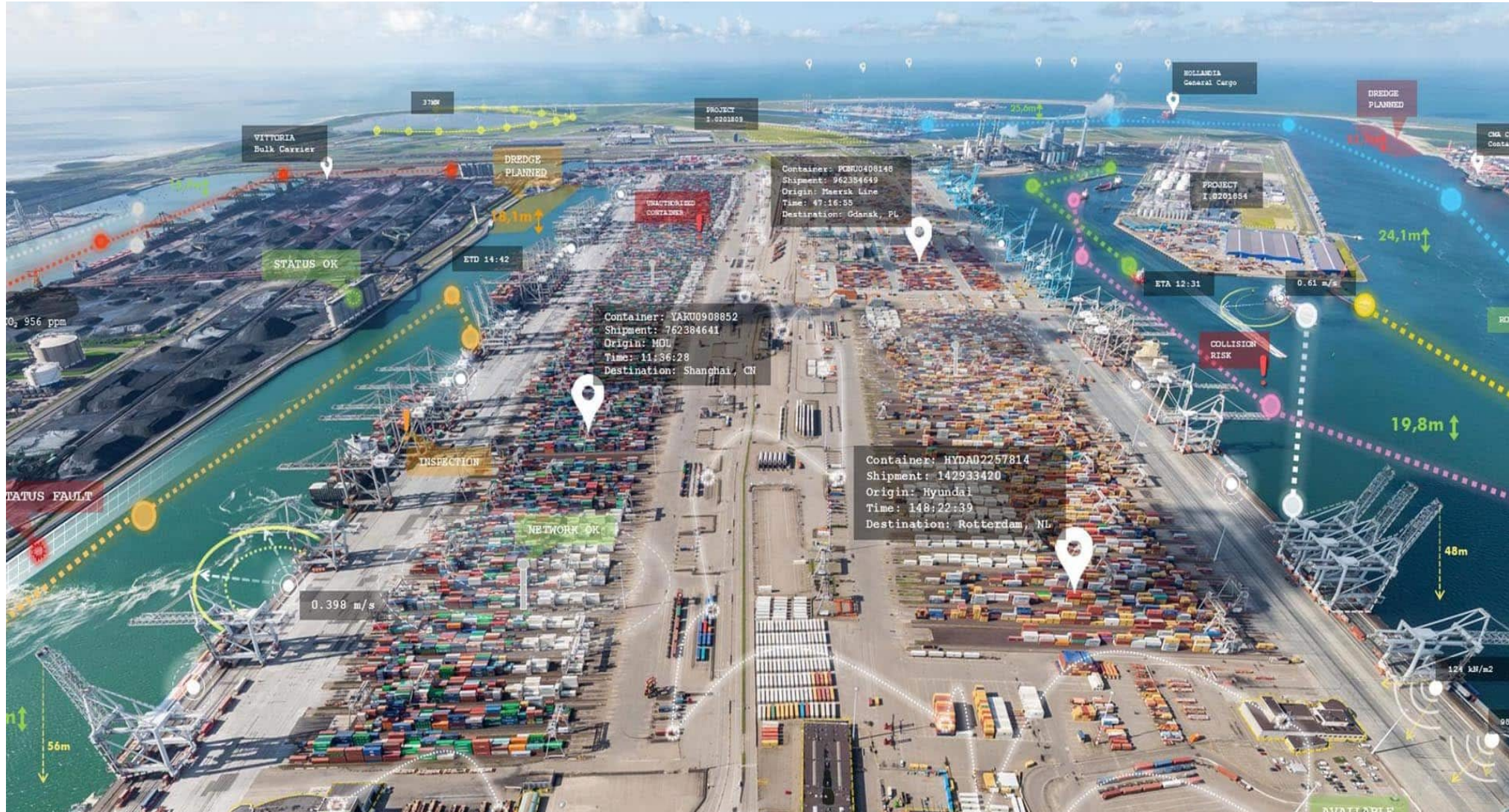
Virtual  
Singapore



## Emergency Services

Gas leaks can be simulated in Virtual Singapore to identify the affected areas to the first responders and prepare escape routes for the residents.

# Real life examples of digital twins – the Digital Port of Rotterdam



# Digital Port of Rotterdam

**Important step** in the process of enabling **autonomous shipping** within the port of Rotterdam by the year 2030 is the development of the port's **digital twin**.



# Digital Port of Rotterdam

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This digital version incorporates **all manner of data** about the port area, including all **infrastructure objects**, **shipping movements**, **weather conditions** and **hydrological readings**.

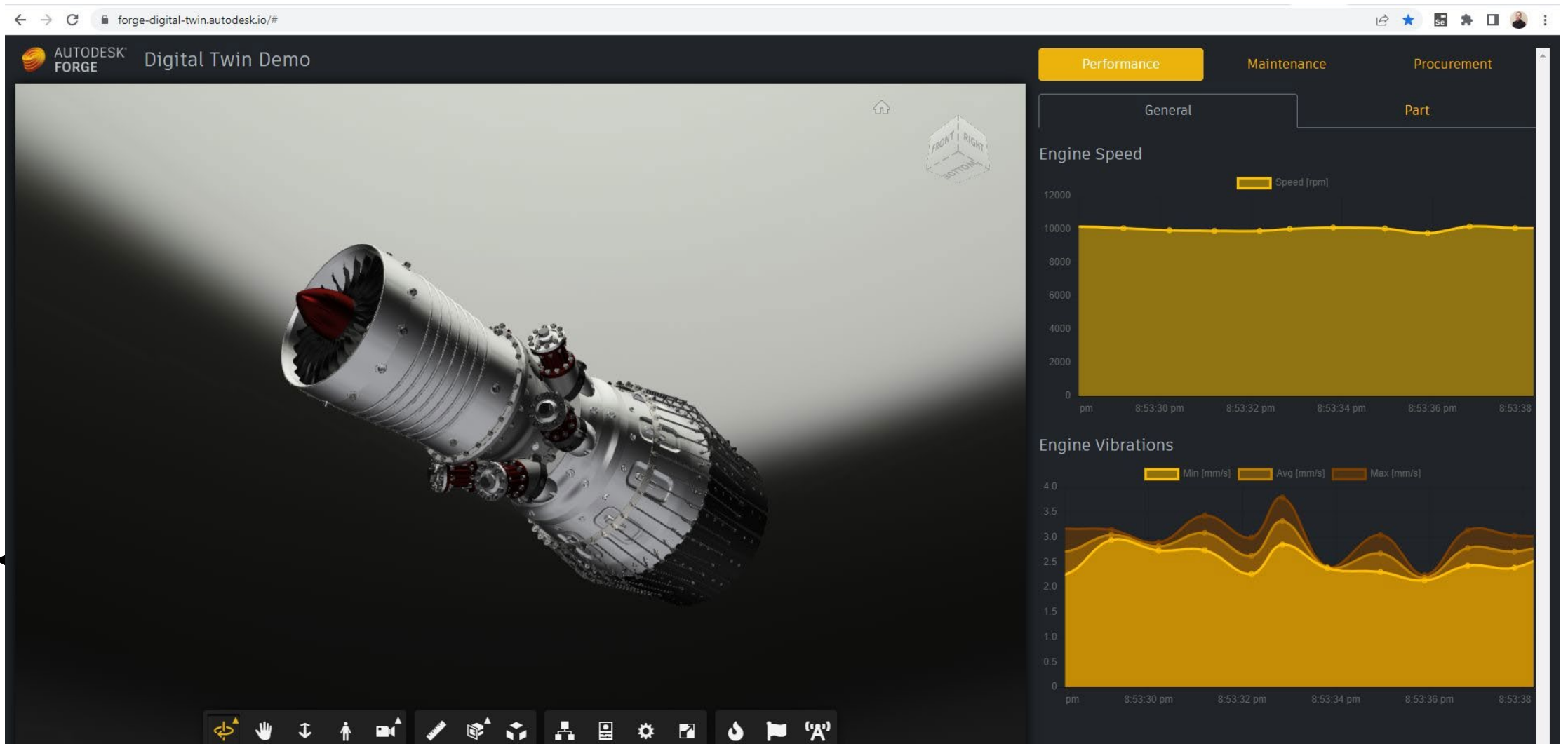
The platform is intended to help the port **reduce waiting times** and **optimize** mooring, loading and departure windows.





# Demo pages of digital twins - engine

<https://forge-digital-twin.autodesk.io/#>



# Demo pages of Digital Twins - engine

<https://forge-digital-twin.autodesk.io/#>

**AUTODESK FORGE** Digital Twin Demo

Performance Maintenance Procurement

Revisions Issues Statistics Docs

### Revision History

| Date      | Part # | Reviewed By     | Result |
|-----------|--------|-----------------|--------|
| 1/16/2020 | 1469   | Sherbaum Valery | Good   |
| 1/18/2020 | 1375   | Wilbert Awdry   | Bad    |
| 1/18/2020 | 1375   | Klaus Hünecke   | Good   |
| 1/23/2020 | 1375   | John Golley     | Good   |
| 1/27/2020 | 5      | Wilbert Awdry   | Good   |

2 23 24 25 26 27 28 29 30 31 32 33

### New Revision

Part # 1124

Status Good

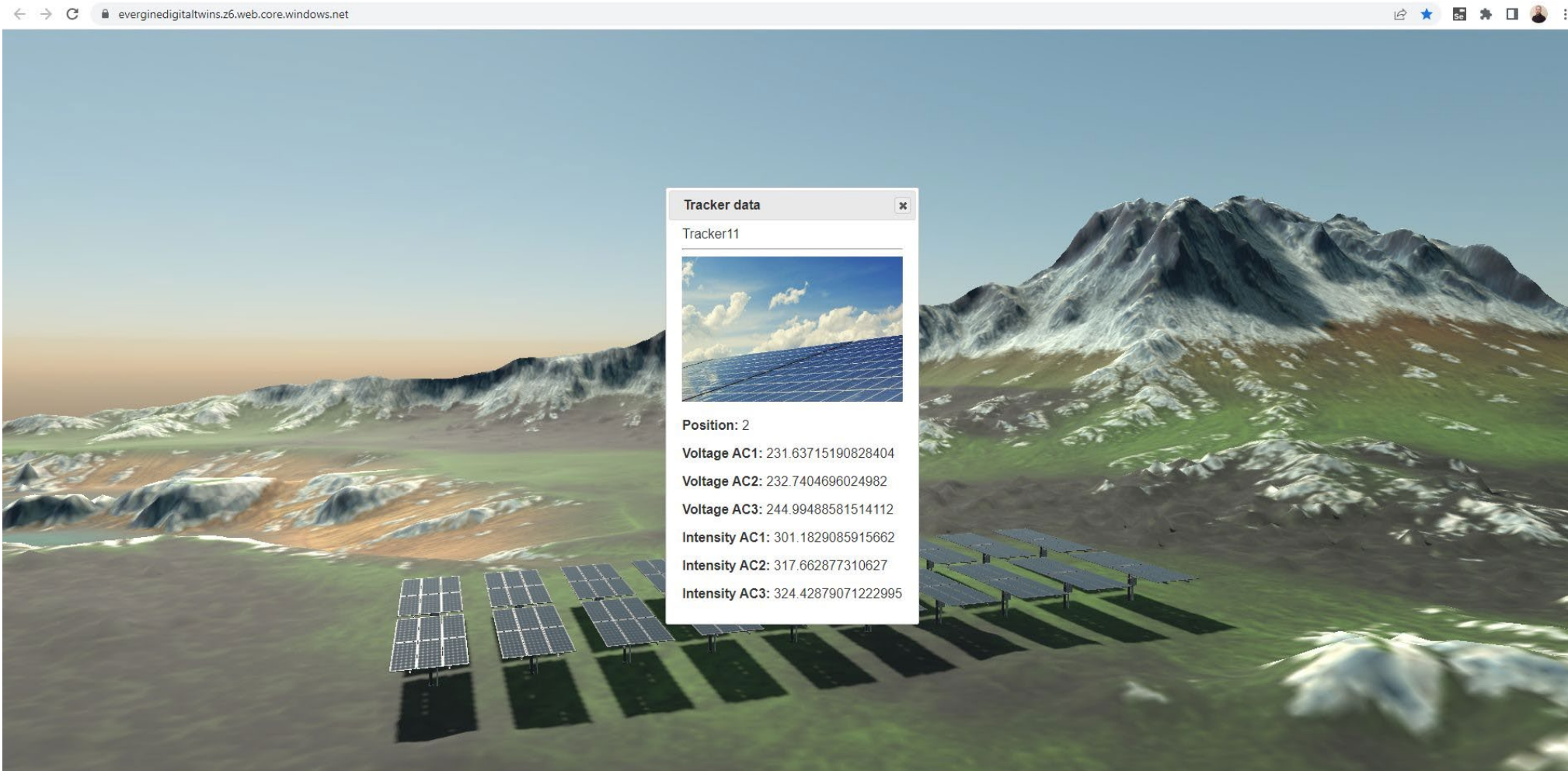
Author Sherbaum Valery

Recommended Repair

Submit

# Demo pages of digital twins – solar energy field

<https://everginedigitaltwins.z6.web.core.windows.net/> <sup>10th</sup>UCAAT



# Manual testing of digital twins <sup>10th</sup>UCAAT

## 1. Validation of data

if the data is **inaccurate** or **incomplete**, it can lead to errors or inaccuracies in the virtual model and in the testing results.

## 2. Verification of the model

process of checking that your digital twin model is **built** according to the **specifications** and **requirements** that you defined. It involves testing the logic, functionality, and structure of your models, and identifying and correcting any errors or bugs

## 3. Validation of the model

checking that your digital twin model is **consistent** with the **reality** that they represent. It involves comparing the outputs and behaviors of your models with the reality, and measuring and improving their accuracy and fidelity

# Manual testing of digital twins <sup>10th</sup>UCAAT

## 4. Sensitivity analysis

assessing how the **outputs** of your model **vary** with different values or ranges of the inputs or parameters. It helps you to identify the most influential factors that affect your results, and to optimize your models for different scenarios or objectives

## 5. Uncertainty analysis

estimating the level of **confidence** or **error** that you have in your outputs, given the **uncertainty** or **variability** in the **inputs, parameters,** or **assumptions**. It helps you to quantify and communicate the **reliability** and **robustness** of your models, and to account for any gaps or limitations in your data or knowledge

# Manual testing of digital twins



## 6. Testing integration with existing systems

This can include testing related to **data transfer, communication, and compatibility**

## 7. Validation of Standards and regulations

ensure that the virtual model meets the standards and regulations **for the industry**. This can include issues related to **data privacy, security, and compliance**.

# Automation testing of digital twins <sup>10th</sup>UCAAT



Visual Studio Code



ROBOT  
FRAME  
WORK/



Selenium



Playwright



applitools

AI powered Visual Testing & Monitoring

# Automation testing of digital twins <sup>10th</sup>UCAAT

## Demo

[https://github.com/maroskutschy/Digital\\_Twin\\_Demo.git](https://github.com/maroskutschy/Digital_Twin_Demo.git)



# Key takeaways

- **Digital twins** are very **interesting** topic
- **Testing** of digital twins is **important**
- **Automation** testing of digital twins **can be done**
- **Study** digital twins now and be prepared for the **future**

# Q&A

# Thanks for your attention

Contact me:  
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