MHP DeepDive

Industrial Metaverse

Kreieren Sie immersive Lösungen
für die Smart Factory!

MHPDEEPDIVE TERMINE

MHP
A PORSCHE COMPANY

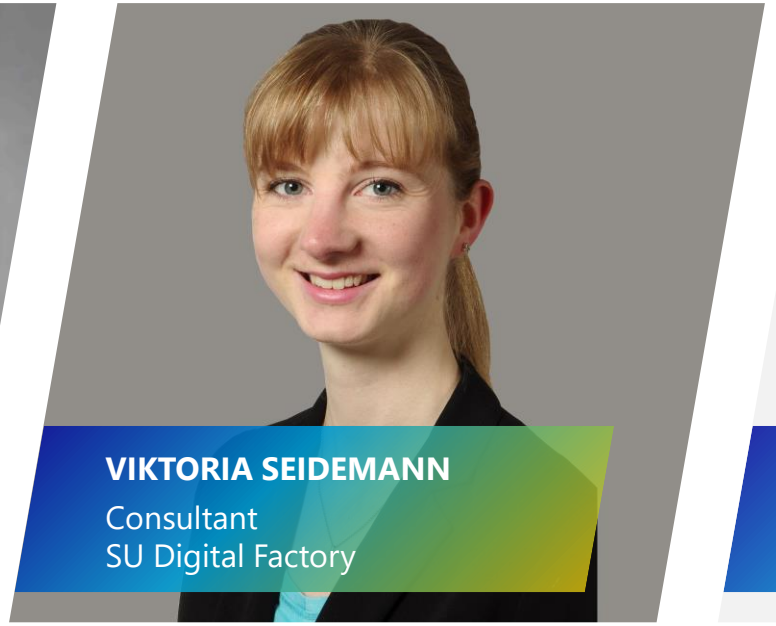
30.06.2023
Sommerhighlight:
MHP Festival

MHPDEEPDIVE
TITEL DES DEEPDIVES

MHP
A PORSCHE COMPANY

DR. DEEPA KASINATHAN
Senior Manager
SU Digital Factory

- Phd in Computational Physics, University of California Davis USA; Post Doc at Max Planck Institute CPfS Dresden
- Shop floor automation, Process orchestration, Smart production, AI-based quality control
- Computer Vision Use Cases & Road Map Digital first strategy via Industrial Metaverse



VIKTORIA SEIDEMANN
Consultant
SU Digital Factory

- Diploma in Business Informatics University of Technology Dresden
- AI-based optical quality inspection and smart manufacturing
- Computer vision use cases, 3D-modelling and robot control via NVIDIA Omniverse

TOM IHME
Consultant
SU Digital Factory

- Diploma in Information Systems University of Technology Dresden
- AI-based optical quality inspection and smart manufacturing
- Computer Vision, Artificial Intelligence

MHP
A PORSCHE COMPANY

AGENDA

1. Industrial Metaverse – What & Why
2. Use Cases
   - Planning
   - Synthetic Data
   - Digital Twin
3. Benefits of Adopting the Industrial Metaverse
4. Conclusion

MHP
A PORSCHE COMPANY

INDUSTRIAL METAVERSE – WHAT & WHY

HISTORY OF METAVERSE

MHP
A PORSCHE COMPANY

1938 — Virtual Reality
French poet Antonin Artaud uses the term in *The Theatre and its Double*

1962 — Sensorama
Simulated motorcycle ride in NYC

1984 — VR headsets
One of the first VR headsets & gloves

1992 — Metaverse
Neal Stephenson coins the term in *Snow Crash*

2003 — Second Life
Shared 3D virtual space for users to interact with others

2006 — Roblox
Massively multiplayer games

2007 — Street View
Google augments Maps Virtual rep. of real world at scale

2012 — Oculus
First low-cost 3D hardware

2016 — Pokémon Go
AR games overlaid on the real world

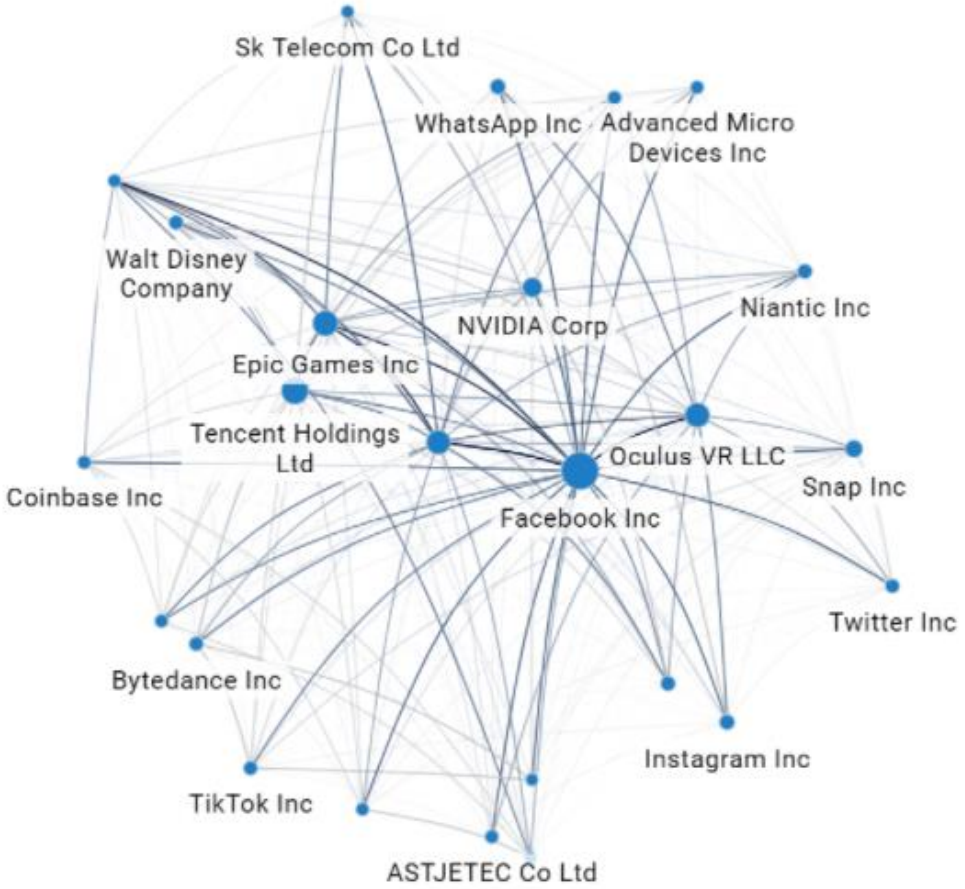
2021 — Meta
Facebook's parent company rebrands itself

2022 — Industrial Metaverse
Nvidia, Siemens, BMW & many more

https://www.techtarget.com/searchcio/feature/Examples-of-the-metaverse-for-business-and-IT-leaders

WHAT IS METAVERSE

- Defining what Metaverse can lead us down a slippery slope ! A pithy definition for this emerging field is still forthcoming
- Linguistics : Words are *deictic* if their semantic meaning is fixed but their denoted meaning varies depending on time and/or place



Word association network

Consumer Metaverse

- Facebook
- Epic Games Inc
- Niantic Inc
- Oculus VR LLC

Enterprise Metaverse

- Coinbase Inc

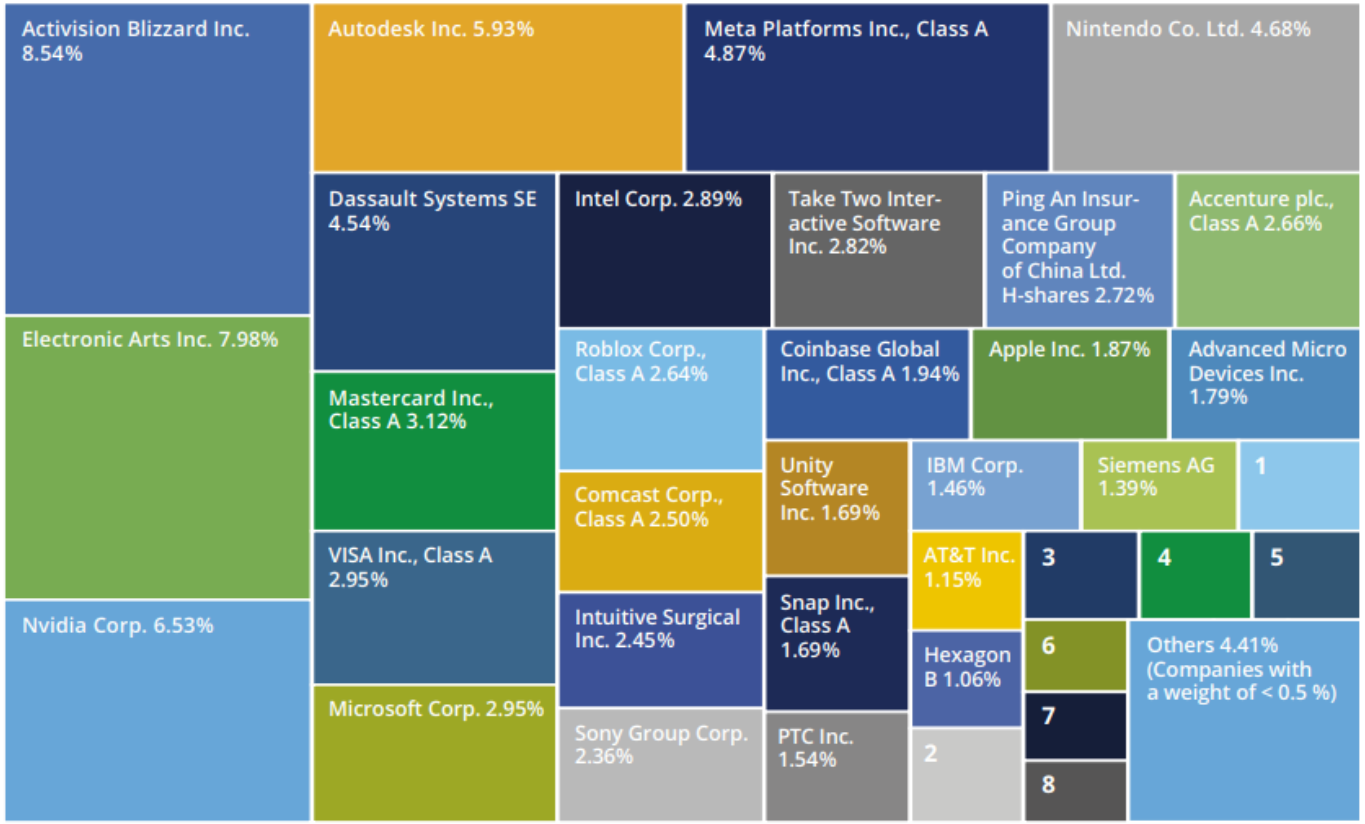
Industrial Metaverse

- Nvidia Corp
- Advanced Micro Devices Inc

ResoluteAI's network graph showing companies mentioned in the news in relation to the term "metaverse." Nov 2021

WHAT IS METAVERSE

- Patent data of companies exposed to technologies associated with the ongoing adoption of Metaverse



1 Bentley Systems Inc., Class B 1.17% **2** Amazon.com Inc. 1.03% **3** Qualcomm Inc. 0.84% **4** Alphabet Inc., Class C 0.81%
5 Samsung Electronics Co. Ltd. 0.80% **6** Alphabet Inc., Class A 0.79% **7** Nike Inc. Class B 0.78% **8** Stryker Corp. 0.66%

Patent association network

Consumer Metaverse

- Activision Blizzard Inc.
- Meta Platforms Inc.
- Roblox Corp.
- Nintendo Co.

Enterprise Metaverse

- Mastercard Inc.
- VISA Inc.
- Coinbase Global Inc.

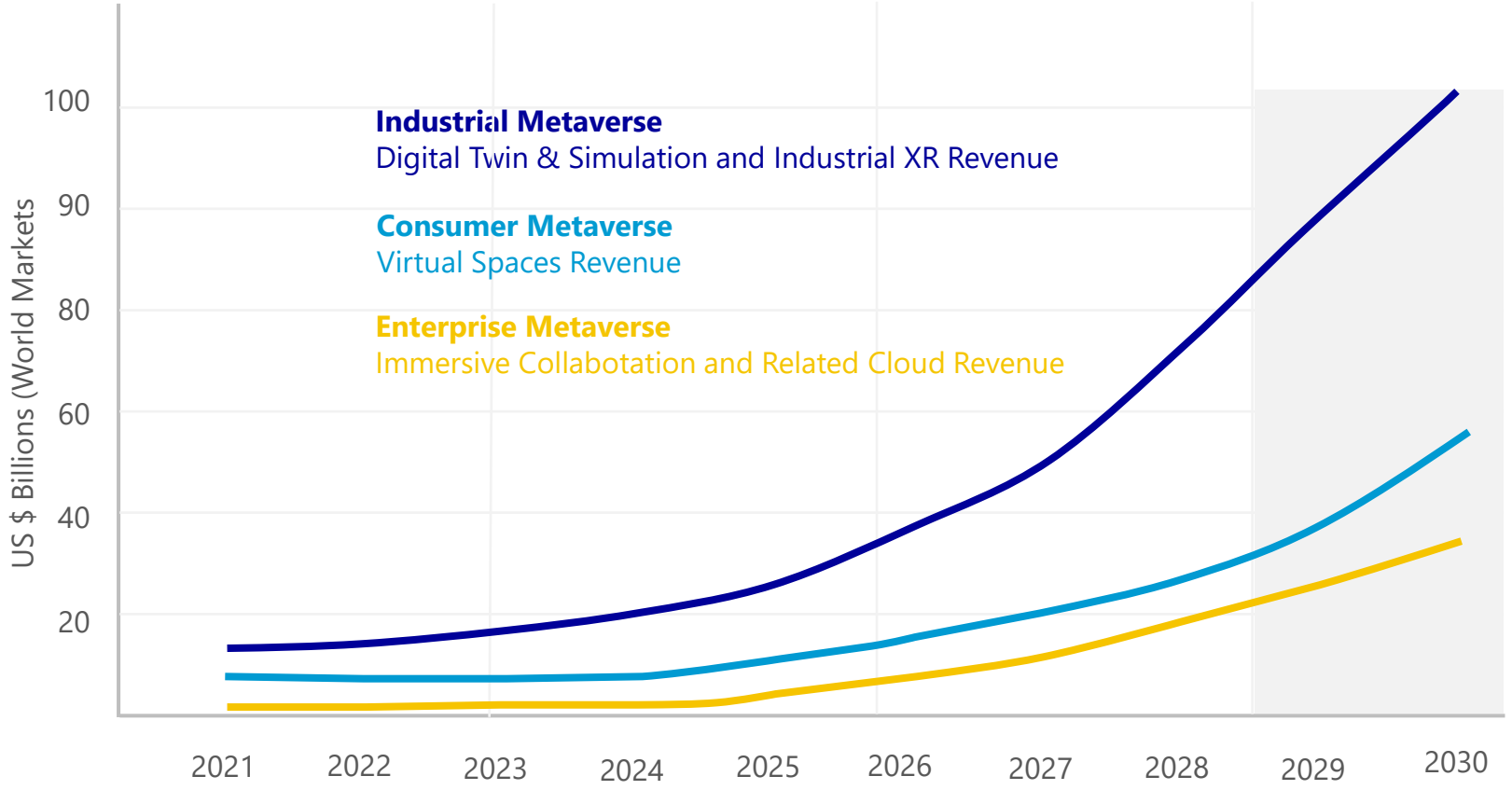
Industrial Metaverse

- Nvidia Corp.
- Autodesk Inc
- Advanced Micro Devices Inc.
- Siemens AG

Source: https://web.qontigo.com/hubfs/Whitepapers/2023%20Whitepapers/Qontigo_WP_202301_Thefutureoflife_theMetaverse_andeverything.pdf

WORLD MARKET TRENDS IN METAVERSE

MHP
A PORSCHE COMPANY



- Growth in "Industrial Metaverse" - Convergence of key enabling technologies
  - Content
  - Connectivity
  - Compute
  - Intelligence

Based on: ABI Research and Venture Beat article Dec 2022

WHY INDUSTRIAL METAVERSE

MHP
A PORSCHE COMPANY

Smart Factory – a connected ecosystem of Data, Machinery, Employees, Products, Customers & Services

Data	Machines/Processes	Employees	Products	Customer & Service
▪ Secure data and insights from assets and processes ▪ Dynamic bi-directional exchange of data between shopfloor and the digital twin	▪ Virtual design & commissioning ▪ Predictive maintainence ▪ Sustainable processes ▪ Cost efficient	▪ Collaborative space for geographically scattered domain experts ▪ Train employees in immersive virtual facilities that is consistent with reality	▪ AI and ML to design and optimize products ▪ In-line or End-of-line AI based quality control inspections	▪ Immersive channel for customers to view & experience products remotely

"Try before build" option for the manufacturing industry

INDUSTRIAL METAVERSE - EARLY ADOPTERS

MHP
A PORSCHE COMPANY

BMW Group at NVIDIA GTC: Virtu

press.bmwgroup.com/global/article/detail/T0411467EN/bmw-group-at

BMW GROUP ROLLS-ROYCE

Corporate Brands Technology People Heritage Motor Show

Enter search terms...

Article | Photo | TV Footage | Video | Audio

PRESSCLUB GLOBAL · ARTICLE.

BMW Group at NVIDIA GTC: Virtual Production Unde Debrecen

21.03.2023 PRESS RELEASE TOP

+++ "Revolution in factory planning": NVIDIA Omniverse enables virtual pro years before actual series production is launched +++ New dimension of BM planning processes save time and costs +++ Global rollout of virtual plannir Production Milan Nedeljković and NVIDIA CEO and founder Jensen Huang d

#Technology · #Corporate · #BMW Group Facilities · #Production Plants · #Production, Recycling · #Internet,

Siemens and NVIDIA Partner to E

press.siemens.com/global/en/pressrelease/siemens-and-nvidia-partner...

SIEMENS

Company › Press

Press Release 29 June 2022 Siemens AG Munich

Siemens and NVIDIA to enable industrial metaverse

- Partnership to transform the manufacturing industry with immersive experiences across the lifecycle from design through operation
- Companies will connect NVIDIA Omniverse and Siemens Xcelerator platforms to enable full-fidelity digital twins and connect software-defined AI systems from edge to cloud

Siemens, a leader in industrial automation and software, infrastructure, building technology and transportation and NVIDIA, a pioneer in accelerated graphics and artificial intelligence (AI), today announced an expansion of their partnership to enable the industrial metaverse and increase use of AI-driven digital twin technology that will help bring industrial automation to a new level.

Roland Busch (r.), CEO of Siemens AG and Jensen Huang, founder and CEO of Nvidia at the launch event of the Siemens Xcelerator on June 29, 2022 in Munich.

As a first step in this collaboration, the companies plan to connect Siemens Xcelerator, the open digital business platform and NVIDIA Omniverse™, a platform for 3D-design and collaboration. This will enable an industrial metaverse with physics-based digital models from Siemens and real-time AI fr NVIDIA in which companies make decisions faster and with increased confidence.

The addition of Omniverse to the open Siemens Xcelerator partner ecosystem will accelerate the use of digital twins that can deliver productivity and process improvements across the

Bentley Announces Infrastructure

lidarnews.com/press-releases/bentley-announces-infrastructure-projec...

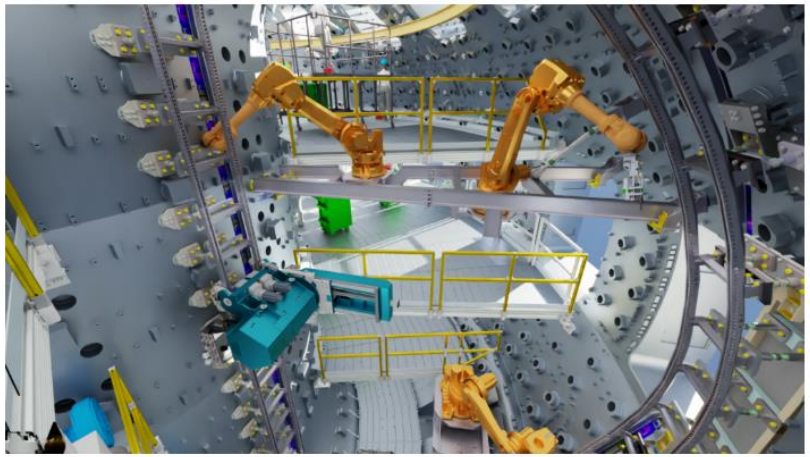
BENTLEY ANNOUNCES INFRASTRUCTURE PROJECTS ..

March 22, 2023 | Leave a comment

Bentley Systems Announces Infrastructure Projects Achieve Measurable Results with LumenRT for NVIDIA Omniverse, Powered by iTwin

Creation of Immersive 3D/4D Experiences Enhances Visualization and Simulation of Infrastructure Digital Twins for Improvements in Communication and Collaboration

EXTON, Pa. – March 21, 2023 – Bentley Systems, Incorporated (Nasdaq: BSY), the *infrastructure engineering software* company, today announced how infrastructure organizations across industries and around the globe are leveraging the power of LumenRT for NVIDIA Omniverse, powered by iTwin, a solution enabling infrastructure organizations to create compelling visualizations and project deliverables with unprecedented speed and quality, make better-informed decisions, and win more projects.



The International Thermonuclear Reactor. *Image courtesy of Brigantium Engineering.*

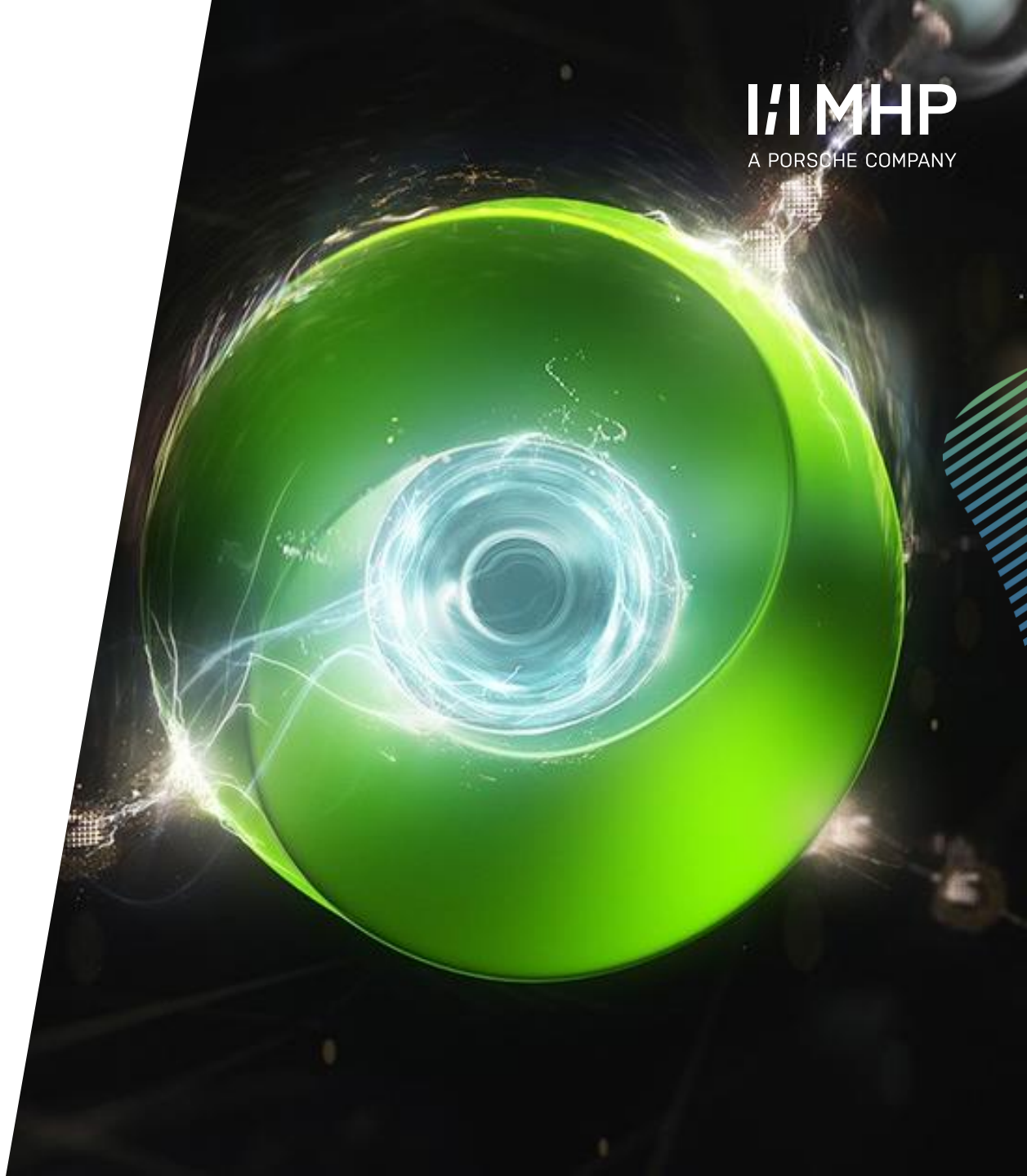
LumenRT for NVIDIA Omniverse is the first engineering software application in the market built on Omniverse, a platform for creating and operating industrial metaverse applications. The

MHP
A PORSCHE COMPANY

CONCRETE USE CASES

NVIDIA OMNIVERSE

- Platform for 3D design and collaboration
- Collection of various apps for rendering, animation, and simulation
- Based on Pixar's Universal Scene Description (USD) and NVIDIA's PhysX engine
- Highly customizable by implementing own apps and extensions
- Provides many connectors to third-party software

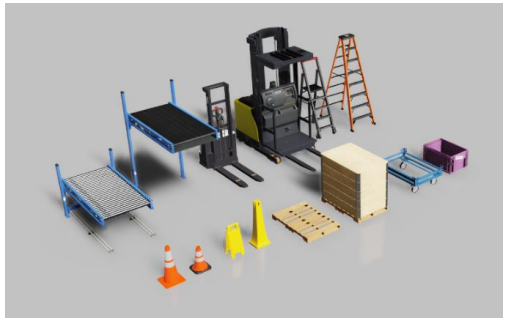


MHP
A PORSCHE COMPANY

USE CASE – PLANNING

WORKFLOW

MHP
A PORSCHE COMPANY



3D Models

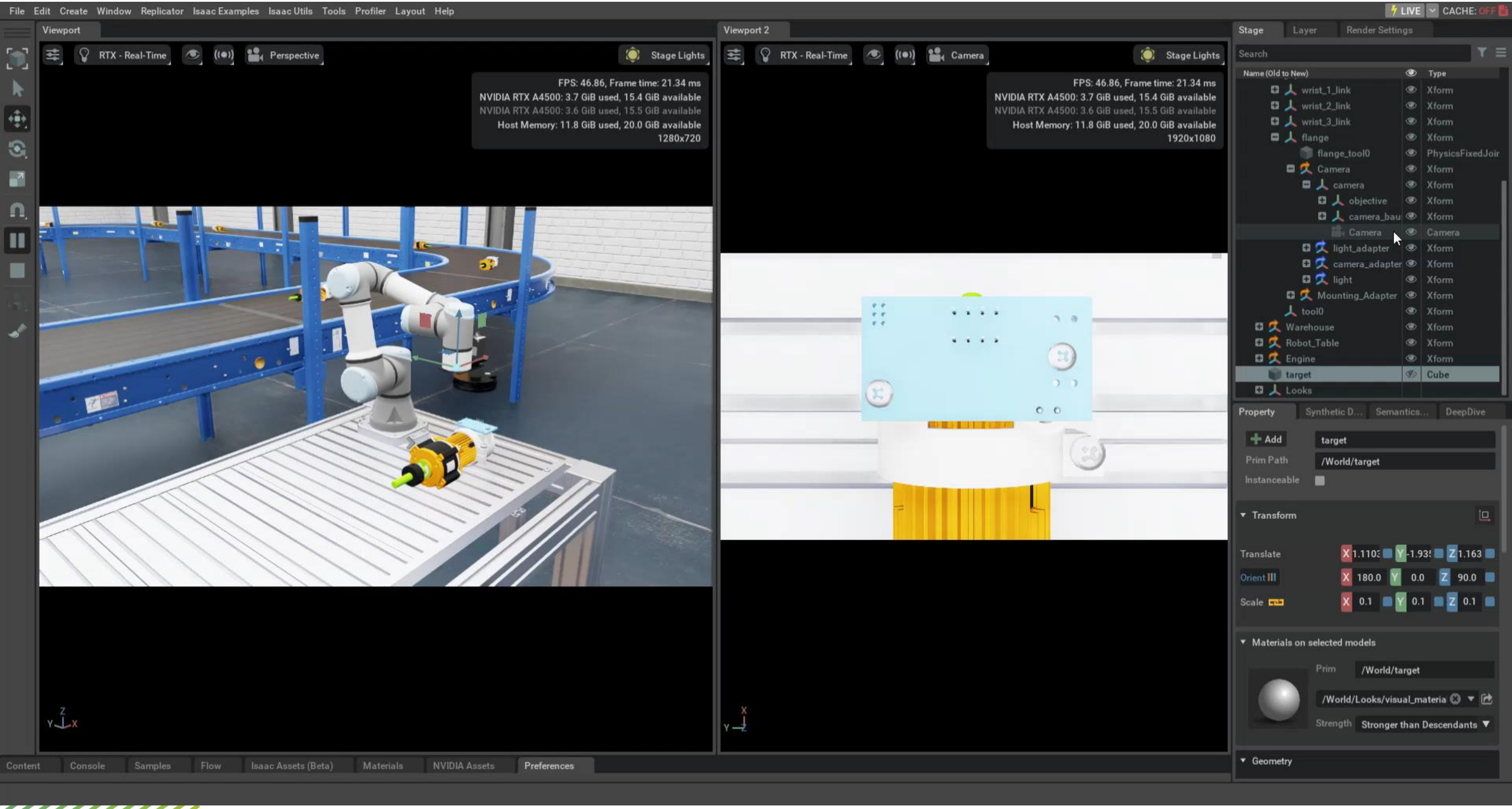
- Import 3D models or point clouds
- Support of various file formats (e.g. OBJ, FBX, glTF, USD)

Generate Scene

- Assemble the scene with the imported assets (e.g. robots, cameras, conveyor belts, products)
- Build entire production lines, shopfloors, and production halls virtually

Plan Equipment

- Configure equipment (e.g. camera, lenses, robots)
- Test and simulate processes


File Edit Create Window Replicator Isaac Examples Isaac Utils Tools Profiler Layout Help
LIVE
CACHE: OFF
Viewport
RTX - Real-Time
Perspective
Stage Lights
FPS: 46.86, Frame time: 21.34 ms
NVIDIA RTX A4500: 3.7 GiB used, 15.4 GiB available
NVIDIA RTX A4500: 3.6 GiB used, 15.5 GiB available
Host Memory: 11.8 GiB used, 20.0 GiB available
1280x720
Viewport 2
RTX - Real-Time
Camera
Stage Lights
FPS: 46.86, Frame time: 21.34 ms
NVIDIA RTX A4500: 3.7 GiB used, 15.4 GiB available
NVIDIA RTX A4500: 3.6 GiB used, 15.5 GiB available
Host Memory: 11.8 GiB used, 20.0 GiB available
1920x1080
Stage
Layer
Render Settings
Search
Name (Old to New)
Type
wrist_1_link Xform
wrist_2_link Xform
wrist_3_link Xform
flange Xform
flange_tool0 PhysicsFixedJoir
Camera Xform
camera Xform
objective Xform
camera_bau Xform
Camera Camera
light_adapter Xform
camera_adapter Xform
light Xform
Mounting_Adapter Xform
tool0 Xform
Warehouse Xform
Robot_Table Xform
Engine Xform
target Cube
Looks
Property
Synthetic D...
Semantics...
DeepDive
Add
target
Prim Path
/World/target
Instanceable
Transform
Translate
Orient
Scale
Materials on selected models
Prim
/World/target
/World/Looks/visual_materia
Strength
Stronger than Descendants
Geometry
Content
Console
Samples
Flow
Isaac Assets (Beta)
Materials
NVIDIA Assets
Preferences

BENEFITS

- Planning, testing, and simulating entire production lines, shopfloors, or production halls

- Elevated efficiency:
  - Optimize processes in the planning phase through realistic simulations

- Cost reduction:
  - Detect planning errors early in the process before realizing the project
  - Minimize downtime by optimizing exsisting processes virtually without interuptions in the real production

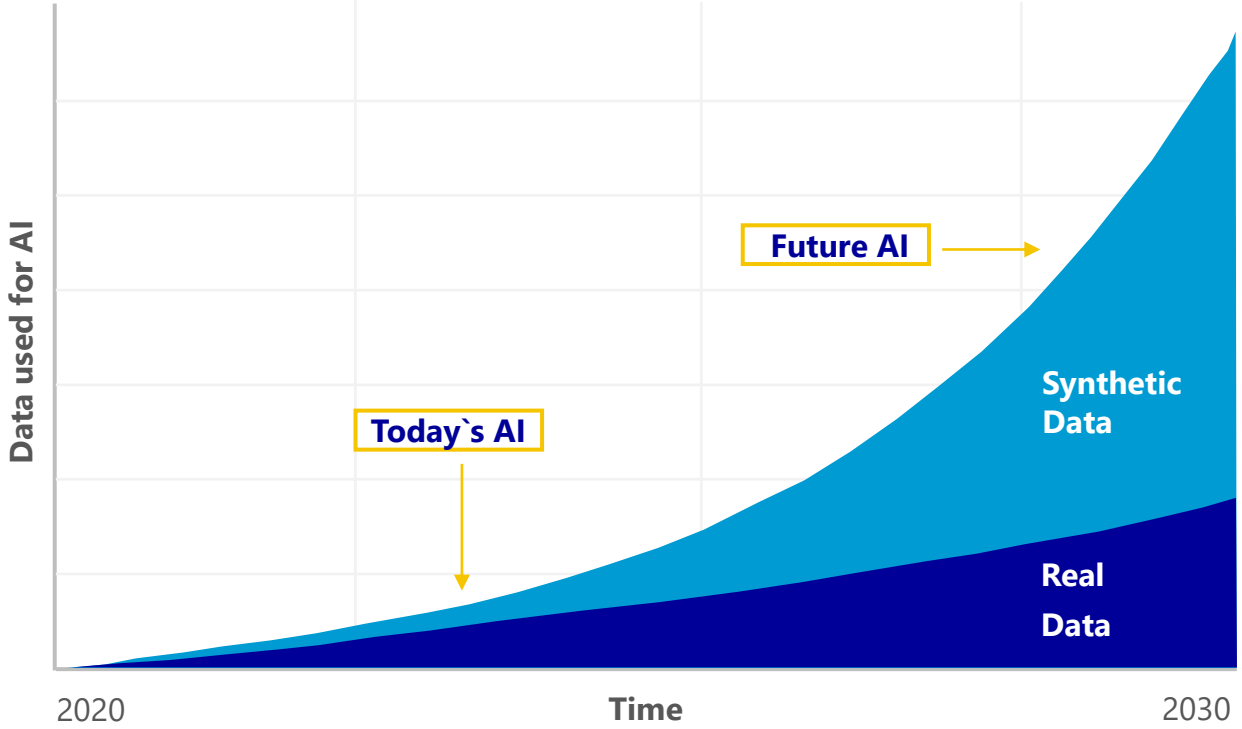
MHP
A PORSCHE COMPANY

USE CASE – SYNTHETIC DATA

SYNTHETIC DATA VS. REAL DATA

MHP
A PORSCHE COMPANY

Use of synthetic data vs. real data
By 2030, synthetic data will completely overshadow real data in AI models

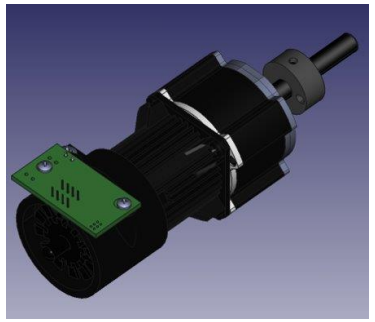


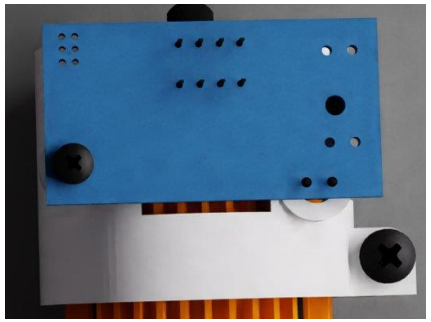
- Real Data:
  - Obtained from direct measurements
  - Constrained by cost, logistics, and privacy reasons
- Synthetic Data:
  - Artificially generated data
  - Generated from simple rules, statistic modelling, simulation, and other techniques

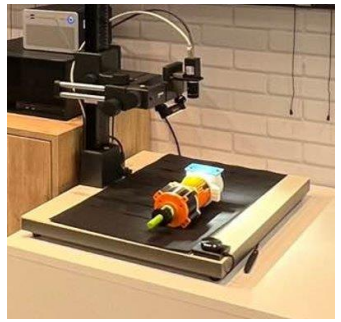
Source: Gartner, "Maverick Research: Forget About Your Real Data – Synthetic Data Is the Future of AI," Leinar Ramos, Jitendra Subramanyam, 24 June 2021.

WORKFLOW

MHP
A PORSCHE COMPANY







3D Model

- Import 3D models
- Support of various file formats (e.g. OBJ, FBX, glTF, USD)
- Rendering with NVIDIA Omniverse

Synthetic Data Generation

- Generation of variable datasets with domain randomization
- Simulation of defects possible
- Automatic labelling of images (e.g. bounding boxes, segmentations, depth information)
- Automation of the generation process based on Python scripts

Training of AI Models

- Training of AI models based on the synthetic datasets
- Application of trained AI models in real-world scenarios
- Faster deployment due to early training

DOMAIN RANDOMIZATION

MHP
A PORSCHE COMPANY

- Generation of random environment settings allows variable datasets
- Defining environment parameters which can vary during the generation process
- Defining value ranges for variable parameters
- During the generation process, random values will be assigned to the variable parameters

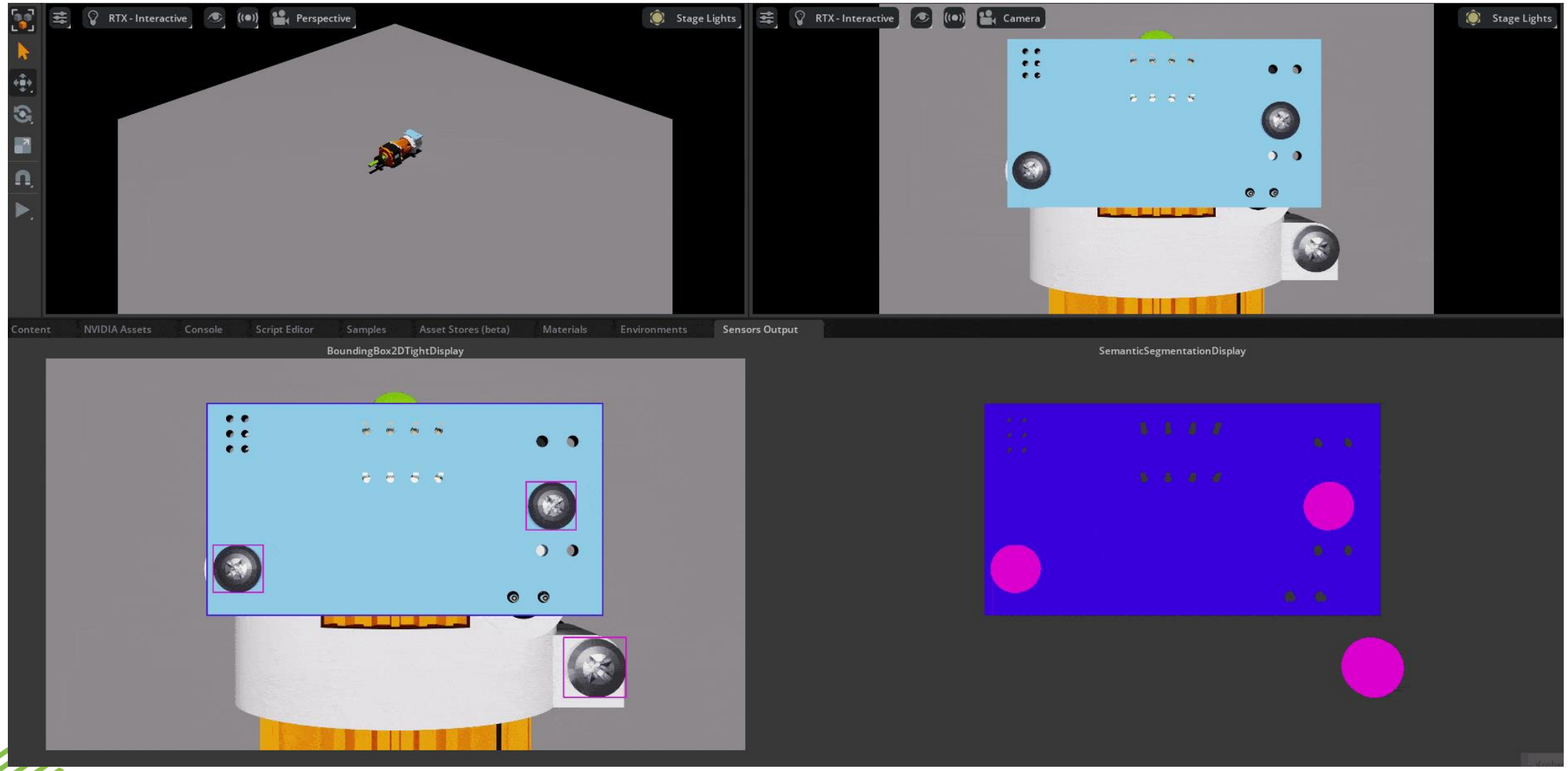
Example Script:

Generate Synthetic Images with Domain Randomization

```python
import omni.replicator.core as rep

path_to_engine = "omniverse://localhost/Projects/0001_HMI_Messe/Engine/engine.usd"

def create_engine(path):
    engine = rep.create.from_usd(path)
    rep.modify.pose(
        position=(0, 0, 16.4),
        rotation=(180, 0, 180),
        input_prims=[engine]
    )
    return engine

def change_engine_position(engine):
    rep.modify.pose(
        position=rep.distribution.uniform((-5, -5, 16.4), (5, 5, 16.4)),
        rotation=rep.distribution.uniform((180, 0, 170), (180, 0, 190)),
        input_prims=[engine]
    )
    return engine

def create_light(type):
    light = rep.create.light(
        position=(0, 0, 70),
        rotation=(0, 0, 0),
        scale=100,
        light_type=type,
        intensity=1000
    )
    return light

def change_light_position(light):
    rep.modify.pose(
        rotation=rep.distribution.uniform((-45, 0, -180), (45, 0, 180)),
        input_prims=[light]
    )
    return light

def create_camera():
    camera = rep.create.camera(
        position=(-41, 0, 100),
        rotation=(0, -90, 0)
    )
    return camera

def create_ground_plane():
    plane = rep.create.plane(
        position=(0, 0, 0),
        rotation=(0, 0, 0),
        scale=(10, 10, 1)
    )
    return plane

rep.randomizer.register(change_engine_position)
rep.randomizer.register(change_light_position)

with rep.new_layer():
    plane = create_ground_plane()
    engine = create_engine(path_to_engine)
    light = create_light("distant")

    camera = create_camera()
    render_product = rep.create.render_product(camera, resolution=(1024, 1024))

    with rep.trigger.on_frame(num_frames=10):
        rep.randomizer.change_engine_position(engine)
        rep.randomizer.change_light_position(light)

    writer = rep.WriterRegistry.get("BasicWriter")
    writer.initialize(
        output_dir="C:/Users/AI_Workstation/Desktop/Output",
        rgb=True,
        bounding_box_2d_tight=True,
        semantic_segmentation=True
    )

    writer.attach([render_product])
```

GENERATION OF SYNTHETIC IMAGES

MHP
A PORSCHE COMPANY



BENEFITS

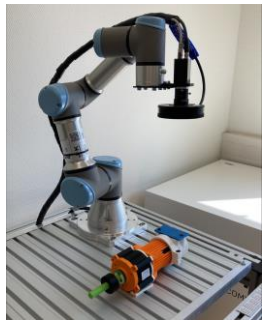
- Seamless high automated AI Pipeline:
  - Accelerate AI model training by augmenting real data
  - Automatic domain randomization
  - Automatic assignment of labels – Easy and correct labelling
- Cost and time efficient:
  - Synthetic data is way cheaper to generate
- Faster creation of first results:
  - Fast track proof-of-concept to understand their viability
  - Accelerating R&D to get to market quicker
- Superior result quality and security:
  - No more biased datasets - Ethical and Fair AI
  - Exploring rare data – Synthetic data to simulate dangerous / rare / unusual fraud scenarios

MHP
A PORSCHE COMPANY

USE CASE – DIGITAL TWIN

WORKFLOW

MHP
A PORSCHE COMPANY



Robot Behaviour

- Safely define robot behaviour in virtual environment
- Test learned behaviour in safe environment

Transfer to Real World

- Connect to physical pendant
- Transfer learned behaviour from virtual to real robot

Digital Twin

- Establish real-time connection between virtual and physical robot
- Read current state from real robot
- Adapt current robot behaviour after virtual optimization

File Edit Create Window Replicator Isaac Examples Isaac Utils Tools Profiler Layout Help

LIVE CACHE: OFF

Viewport

RTX - Real-Time Perspective Stage Lights

FPS: 41.85, Frame time: 23.89 ms
NVIDIA RTX A4500: 3.8 GiB used, 15.2 GiB available
NVIDIA RTX A4500: 3.8 GiB used, 15.3 GiB available
Host Memory: 13.1 GiB used, 18.8 GiB available
1280x720

Viewport 2

RTX - Real-Time Camera Stage Lights

FPS: 41.85, Frame time: 23.89 ms
NVIDIA RTX A4500: 3.8 GiB used, 15.2 GiB available
NVIDIA RTX A4500: 3.8 GiB used, 15.3 GiB available
Host Memory: 13.1 GiB used, 18.8 GiB available
1920x1080

Stage Layer Render Settings

Search

Name (Old to New)	Type
physicsScene	PhysicsScene
World	
UR3e	Xform
Warehouse	Xform
Robot_Table	Xform
Engine	Xform
target	Cube
Looks	
PaintTool	Xform

Property Synthetic Data... Semantics Sche... DeepDive

Add target

Prim Path /World/target

Instanceable

Transform

Translate X 1.07559 Y -1.9586 Z 1.17363

Orient X -180.0 Y 0.0 Z 90.0

Scale X 0.1 Y 0.1 Z 0.1

Materials on selected models

Prim /World/target

/World/Looks/visual_material

Strength Stronger than Descendants

Geometry

Mesh

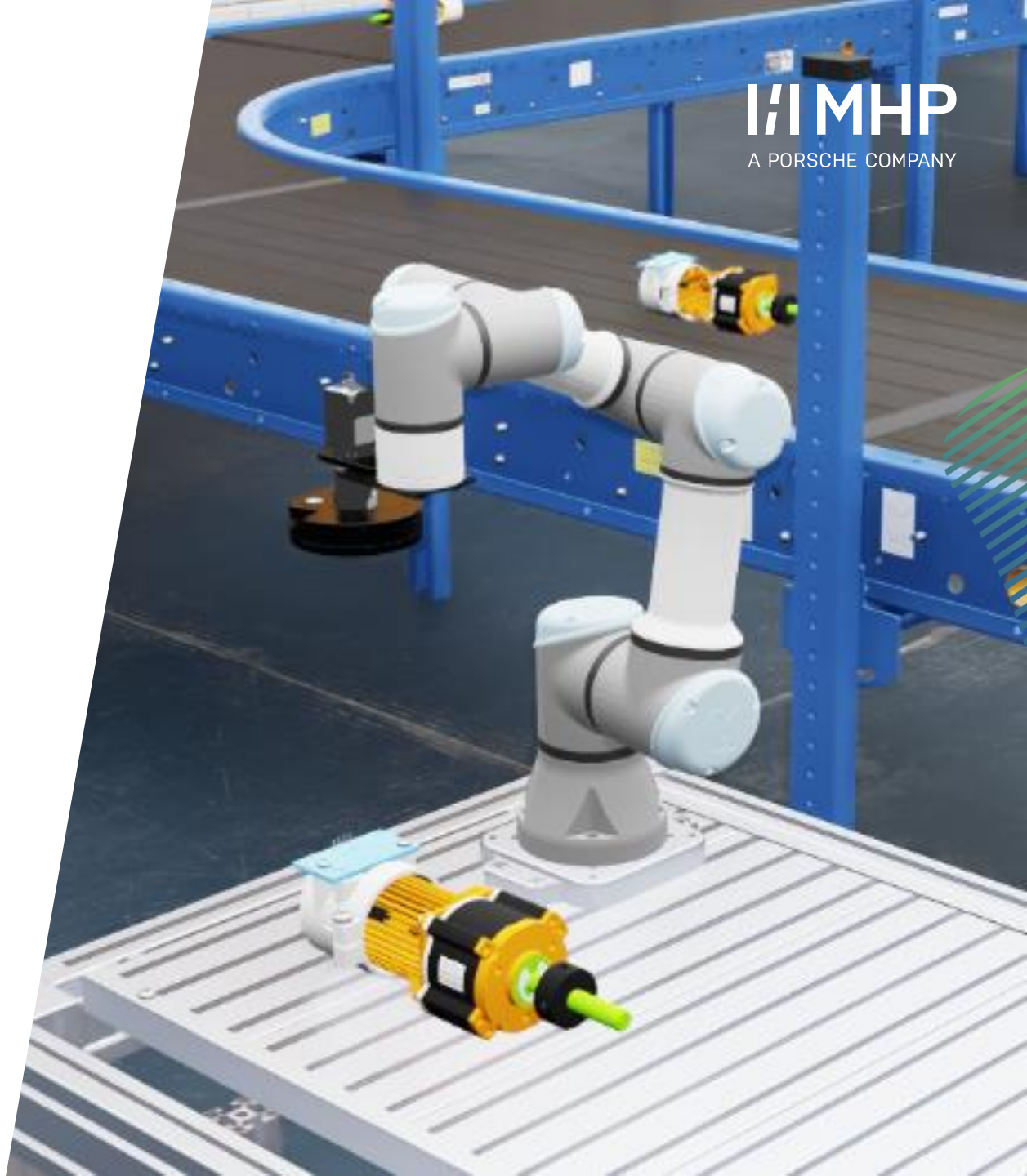
Content Console Samples Flow Isaac Assets (Beta) Materials NVIDIA Assets Preferences

BENEFITS

- Cost reduction:
  - Monitor, track, and control the systems before they are put in place
  - Adapt and optimize existing processes without interrupting the running production

- Predictive maintenance:
  - Predicting current and future state of a physical asset by analyzing its virtual counterpart
  - Combine many digital twins to simulate whole systems

- Robotics:
  - Train and test robot behaviour safely in virtual environments
  - Operate different robots without coding



MHP
A PORSCHE COMPANY

BENEFITS OF ADOPTING IM

COLLABORATION

By virtually mapping the entire production process and linking all components of the value creation process, engineers and designers can develop products and concepts in realistic environments. When problems arise on the shop floor, experts can search for solutions remotely or connect with employees on-site via AR devices.

Remote Collaboration

Factory Planning

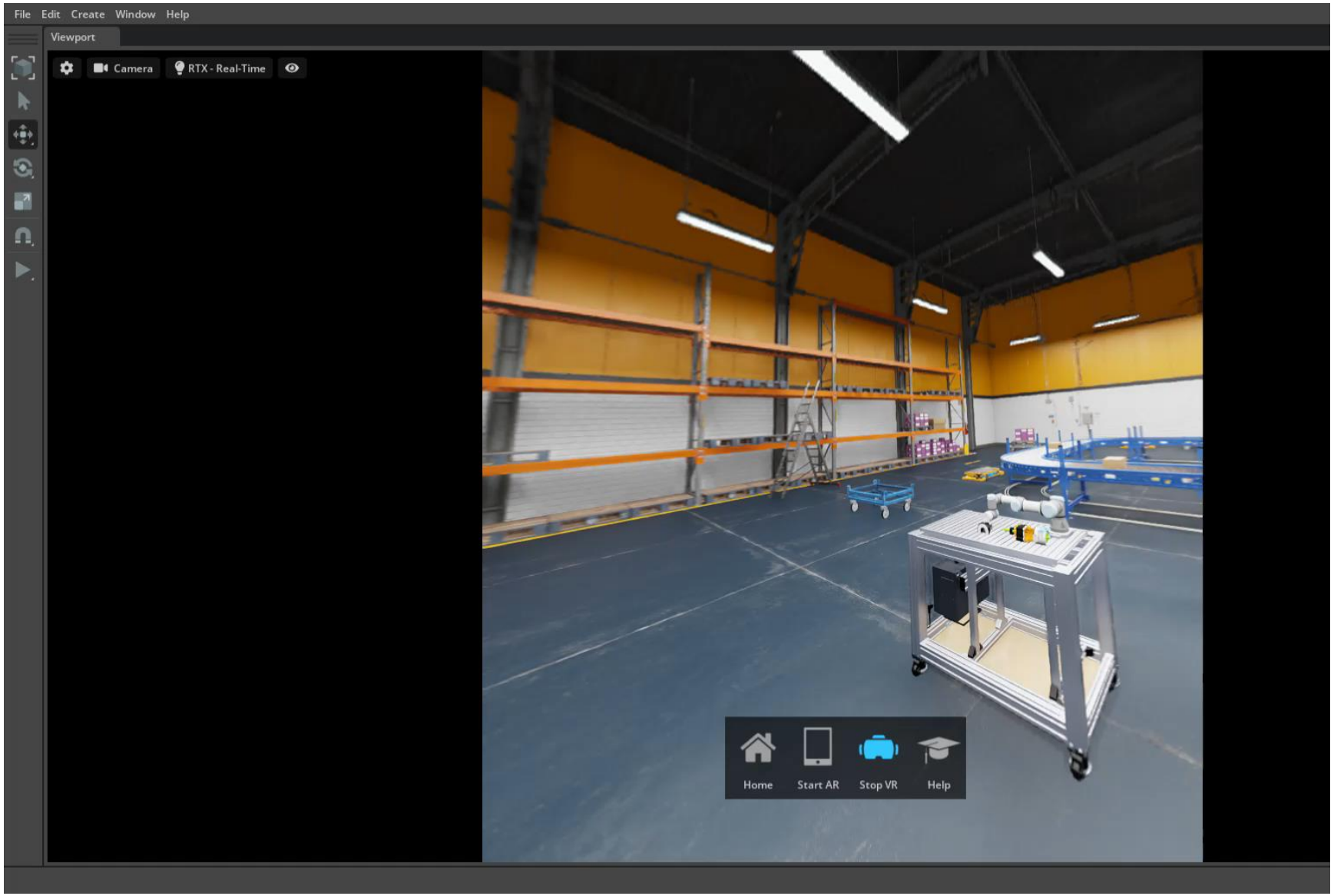
Product Design

Expert Feedback

https://news.microsoft.com/source/features/innovation/hololens-2-industrial-metaverse/

TRAINING – VR EXPERIENCE

MHP
A PORSCHE COMPANY



TRAINING AND EDUCATION

Traditional tranings can be slow, inefficient and expensive. With the help of the Industrial Metaverse workers can be placed in a real-world scenario remotely. This offers an improved learning experience and feels like playing video games.

Remote Training

Immersive Learning Experience

AR/VR Devices

Immediate Feedback

https://news.microsoft.com/source/features/innovation/hololens-2/

SUSTAINABILITY

Sustainability is one of the most important topics in our time. The industrial sector is one of the main drivers of carbon dioxide and waste. With the help of the Industrial Metaverse the production gets more efficient and saves resources.

Efficient Processes

Less Waste

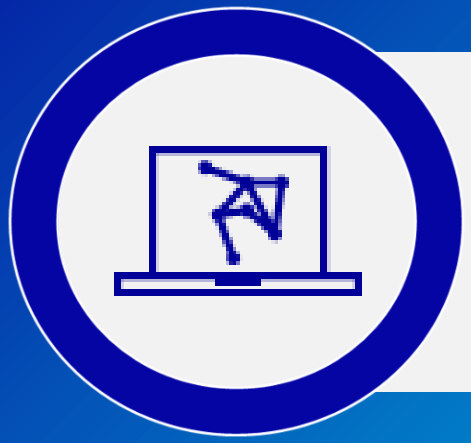
Test before Build

MHP
A PORSCHE COMPANY

CONCLUSION

ENABLER

MHP
A PORSCHE COMPANY



Digital Twins

Today digital twins already exists as a digital representation of a physical object which integrates data (sensors etc.).

Extended Reality

AR/VR devices enable interaction in the industrial metaverse and thus provide the basis for immersive experiences.

Computing Power

It needs modern hardware to process high amounts of data in different formats. Also cloud computing is important.

Interoperability

Connect and communicate through different software, products, machines etc. Via standardized data formats.

USE CASES

MHP
A PORSCHE COMPANY

Factory Planing

Generate a 3-dimensional representation of your future production line – plan the positioning of all assets and the whole equipment to simulate and optimize the production process

Overcome Sim2Reality Gap

Generate synthetic data to create robust AI models (e. g. visual quality inspection) even before the production line ist set up - overcome the lack of data also for small batch sizes

Modify Robot Behaviour

Define or modify the robot behaviour in your virtual environment and transfer it to the real application without stopping the process

Faster ramp-up process

Define your whole process in the virtual representation of your production line and get a complete and running solution at the start of production

LET'S GET CONNECTED

MHP
A PORSCHE COMPANY

DR. DEEPA KASINATHAN
Senior Manager

Mobil: +49 (0)152 21703959

E-Mail: deepa.kasinathan@mhp.com

VIKTORIA SEIDEMANN
Consultant

Mobil: +49 (0)152 33145103

E-Mail: viktoria.seidemann@mhp.com

TOM IHME
Consultant

Mobil: +49 (0)152 33148653

E-Mail: tom.ihme@mhp.com

MHPDEEPDIVE TERMINE

MHP
A PORSCHE COMPANY

30.06.2023
Sommerhighlight:
MHP Festival

MHPDEEPDIVE VERPASST?

Kein Problem!

Alle vergangenen **MHP**DeepDives finden Sie hier:

www.youtube.de/MHPProzesslieferant

MHP
A PORSCHE COMPANY

www.mhp.com/de/unternehmen/events