Panel Discussion at The Fifteenth International Conference on Digital Society (ICDS) 2021

July 18-22, 2021 – Nice, France

Digital Twins: A 360° Tour of Life Cycle and Applications on Built Environments

(software development, sensing, industrial use cases, predictive maintenance, social use cases, products, constructions, arts)

Chair: *James Candon*, Managing Director, United Europe, Germany

About United Europe

United Europe
competitive and diverse

- Website: *https://www.united-europe.eu/*
- United Europe is a pro-European organization aiming to ensure peace, liberty and prosperity for future generations.
- It wants Europe to remain ideologically, politically and economically competitive in the world. It believes that Europe will only thrive if it respects the diversity of its peoples and cultures.
- It does not represent any political or economic individual interests.
- Hit has individual members from 19 European countries and over 30 companies.

Initiatives/Projects

• EU SPACE: European Research Horizons

A digital space dedicated to research programmes including *Horizon 2020*, *ERASMUS+*, *INTERREG* and even proposals for Horizon Europe projects

James Candon

A former tech lawyer, joined United Europe beginning November 2020. In the two years prior to joining United Europe he had founded Idemo.club, a start-up geared to bringing young people together across borders and cultures through the medium of amateur sport, starting with Rugby.

The global SARS-COV2 pandemic having forced Idemo into a deep freeze, James is delighted to work with United Europe in bringing people together to celebrate their diversity and drive forward for a more competitive Europe.

Narrative on the table

- Digital Twins – is the concept a new or rebranded innovation?
- Do they allow for trial and error/practice over infinite iterations at little increase in marginal costs?
- What are the challenges in creating a digital twin which is sufficiently realistic to be useful?
  - How can digital twins provide competitive advantage in the market?
  - Can they be scaled to replicate very large systems? What are the obstacles?
  - Can digital twins be useful for conserving knowledge and artifacts for future generations?
  - How do digital twins make practicing and learning safer?

- Particular digital twin models in this panel discussion:
  - How original are they?
  - Can they easily be transferred or reutilised across borders at least within Europe?

Structure of the panel

Chair

- James Candon, Managing Director, United Europe, Germany

Panellists

- Olga Levina, TH Brandenburg, Germany
- Mohamad Kassem, University of Northumbria Newcastle, UK & RINNO Consortium
- Lasse Berntzen, University of South-Eastern Norway, Norway
- Camelia Chivăran, University of Cambridge / University of Campania "Luigi Vanvitelli", UK / Italy
- Jean-Pierre Toumazet, Université Clermont Auvergne, France

DigitalWorld 2021 Experts Panel
Digital Twins; A 360° Tour of Life Cycle and Applications on Built Environments
(software development, sensing, industrial use cases, predictive maintenance, social use cases, products, constructions, arts, etc..)
DigitalWorld 2021

Panellist Position

Digital Twins as design artifacts in the realm of socio-technical systems design

Olga LEVINA, Brandenburg University of Applied Science, Germany, levina@th-brandenburg.de

- Systems analysis as integral part of digital twin design
- Accuracy of representation requires scope, stakeholder and requirements analysis
- Feature selection
- Model design
- Ethical questions are part of the sub-system design

→ Considering the scope and the requirements of the digital twin is an important issue

→ Problem complex : necessity to derive an accurate model with sufficient features embedded in the business process context

→ Solution : Approach digital twin design with similar methods and responsibility as information systems design

→ Digital twin design methods need to consider the business and utilization context as well as principles of human-machine interaction

Panellist Position

Digital Twins in Construction and the Built Environment Project

Mohamad KASSEM, Northumbria University, UK, mohamad.kasssem@northumbria.ac.uk

- 'Digital Twin' Definitions: a new or a rebranded innovation?
- Some conceptualizations of Digital Twin and its Enabling technologies for construction and built environment
- Applications of 'Digital Twins' in Construction and built environment projects
- Open / ongoing challenges for adoption of Digital Twin in Construction and Built Environment

→ No consensus about a definition for 'Digital Twin' but some common characteristics/features can be identified

→ 'Digital twin' is enabled by existing digital technologies (BIM, IoT, Data Analytics / AI, Cloud Computing, VR/AR) used in Construction and Built Environment project

→ 'Digital twins' applications are only emerging in construction and built environment projects and extend over the whole project life cycle of built asset (design, construction, maintenance and operation).

→ Research is only at early stage and several technical and organizational challenges need to be overcome

Panellist Position

Competitive Advantage by Digital Twins

Lasse Berntzen, University of South-Eastern Norway, lasse.berntzen@usn.no

- Definition
- Internet of Things
- Big Data and Analytics
- The Digital Twin as a Model
- Examples
- Work in Progress

→ Recent developments in low-cost IoT make digital twins feasible also for everyday products

→ Digital twins can be a measure to gain competitive advantage

→ But digital twins can also be used for larger systems (examples)

Panellist Position

Museum Accessibility and Digital Twins

Camelia Chivăran, University of Campania "Luigi Vanvitelli"/University of Cambridge, Italy/UK camelia.chivaran@unicampania.it

- Accessibility to Cultural Heritage
- Virtual experience in museums
- Engagement in digital visits

→ Increased use of digital twins in the cultural world

→ Are digital twins contributing to improving accessibility in museums?

→ Are people really engaged in virtual experiences?

Panellist Position

Digital Twins for training inexperienced users in electrical occupational hazards

Jean-Pierre TOUMAZET, Université Clermont Auvergne, France, j-pierre.toumazet@uca.fr

- Electrical hazards Simulation,
- Immersive Virtual Reality
- Interactive Devices
- Problem-Based Learning
- Co-design
- Multi-disciplinary
- Professional gestures, Security

→ Teaching of electrical hazards for future professionals is an important issue

→ Problem complex : necessity to confront students with dangerous situations, but without making them take risks

→ Solution : Digital twins of an electrical cabinet to validate different levels of expertise

→ A tool designed with students for students

Fachhochschule Brandenburg
University of Applied Sciences
Fachbereich Wirtschaft

IARIA

Digital Twins as design artifacts in the realm of socio-technical systems design

Olga LEVINA
Brandenburg University of Applied Science, Germany
levina@th-brandenburg.de

Olga Levina

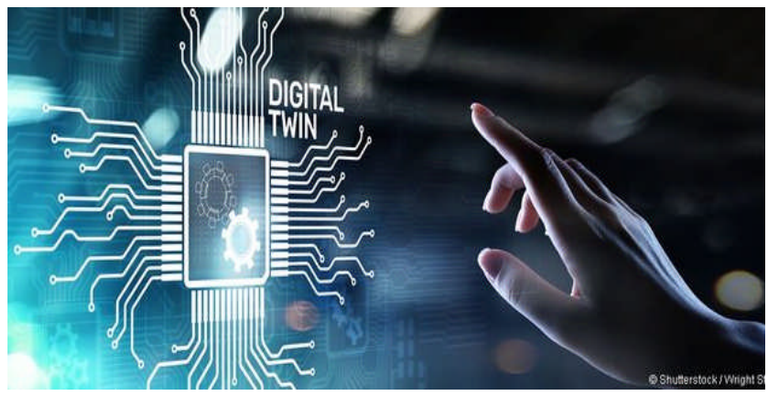
Olga received the diploma degree (Diplom, an equivalent of the Master‘s degree) in industrial engineering and management from Technical University of Berlin, Germany in 2007. She received her PhD in information systems from Technical University of Berlin in 2012. She was a PostDoc researcher and project manager at Technical Unteversity of Berlin until 2015 and at FZI Research Center for Computer Science in Berlin from 2016 until 2020.

Her reserach interests are focused on digital platforms digital transformation, business processes and ethical aspects of digital transformation.

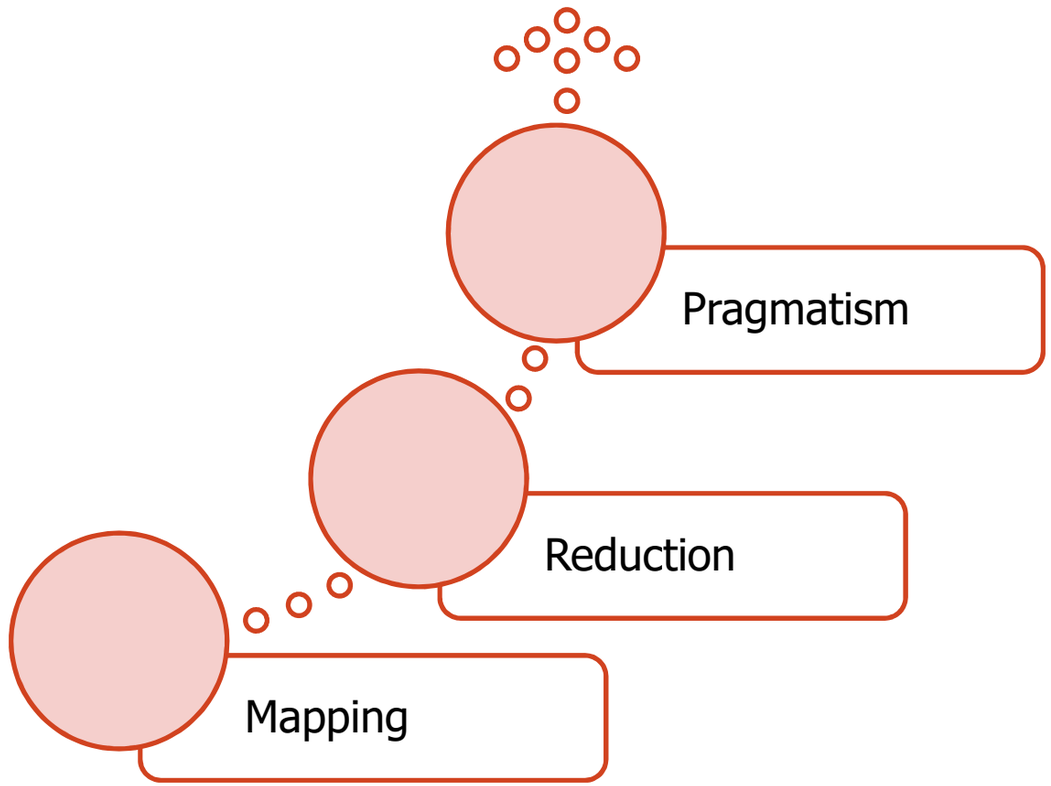
She is currently professor for business process management at the Brandenburg University of Applied Science.

Digtial Twin: Design and Use as a Socio-technical System

Bearingpoint



Digital Twin: Model design



Stachowiak 1973

Digital Twin- *Mapping*: System analysis

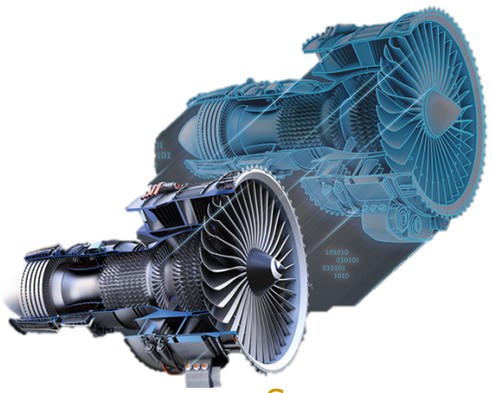
Source

Source

Digital Twin- *Reduction*: Scope and requirements analysis

Stakeholder analysis

Requirements Analysis



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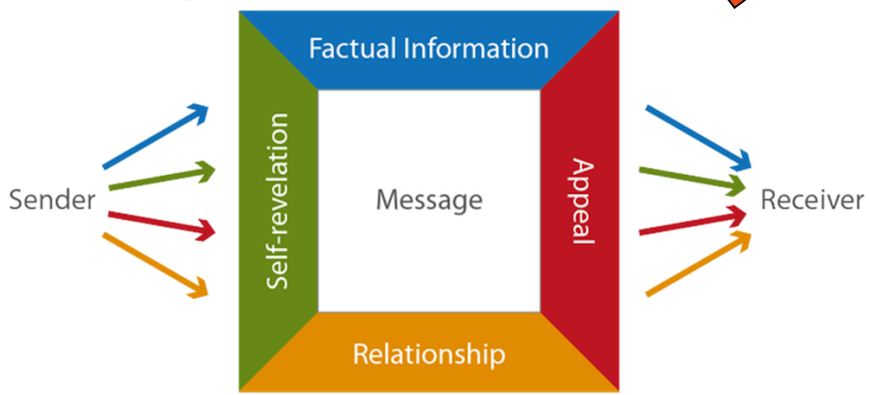

Schulz v. Thun: Communication Model

Digital Twin- *Pragmatism*: Feature selection

Goal and process definition

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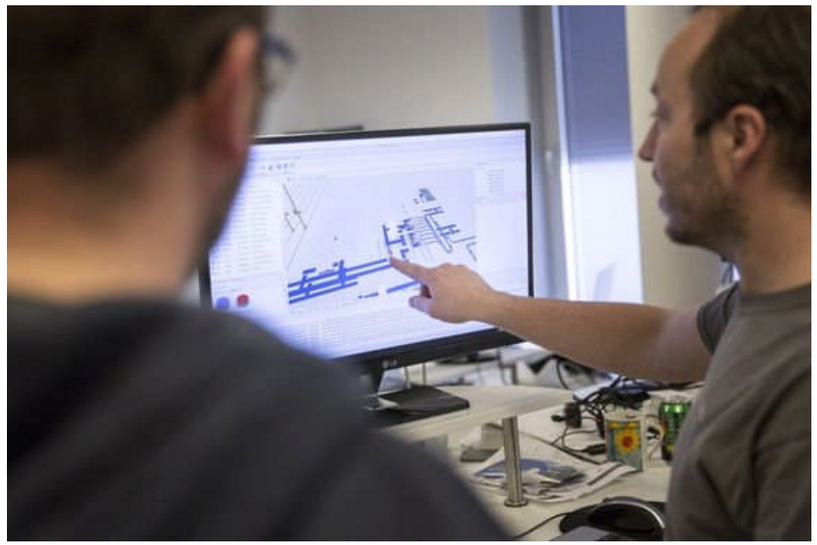


Source

Digital Twin: Challenges- Ethical challenges of digital products by Mason (1986)

Privacy

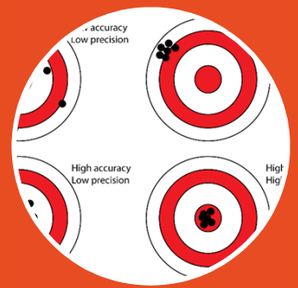
- Data collection
- Feature selection
- Employe's data

Property

- Data ownership
- Mastery over data
- Interaction data

Accessibility

- Human-machine (digital twin)- interaction
- Stakeholder analysis
- How? When and to whom?
- Virtual and physical interactions



Accuracy

- System and Scope definiton
- Feature selection
- Responsibility

‘Digital Twins’ in Construction and the Built Environment: Nuances, Applications and Challenges

https://rinno-h2020.eu/

Live Panel Discussion

Digital Twins; A 360° Tour of Life Cycle and Applications on Built Environments
(https://www.iaria.org/conferences2021/ProgramICDS21.html)

Prof. Mohamad Kassem
Northumbria University, Newcastle, UK
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Northumbria University
NEWCASTLE

Digital World Congress 2021

19/07/2021 @ 5:00 pm (CEST)

Professor Mohamad Kassem
Email: Mohamad.Kassem@northumbria.ac.uk

Professional Experience

- Professor of Digital Construction and Engineering Project Management
- Head of Subject for Construction and Project Management Division
- Lead for the Digital Built Environment research group.
- Chair of the Human Data Interaction (HDI) technical committee at the European Council for Computing in Construction (EC3).

Research and Publication

- Interdisciplinary topics related to digitalisation of construction processes and the digital transformation of the built environment.
- Published more than 110 outputs in international journals and conferences
- Secured and delivered several research and enterprise grants (total value exceeding £5m) funded by British and international funding bodies.
- Consultancy appointments to the European Commission, the Foreign and Commonwealth Office, and a number of governments.

‘Digital Twin’: a new or a rebranded innovation?

- Unconvinced
- Undecided
- Committed

Source:
Douglas, D., Kelly, G., & Kassem, M. (2020). BIM, Digital Twin and Cyber-Physical Systems: crossing and blurring boundaries. *Proceedings of the 2021 European Conference on Computing in Construction, Online Conference*.

‘Digital Twin’ Definitions: a new or a rebranded innovation?

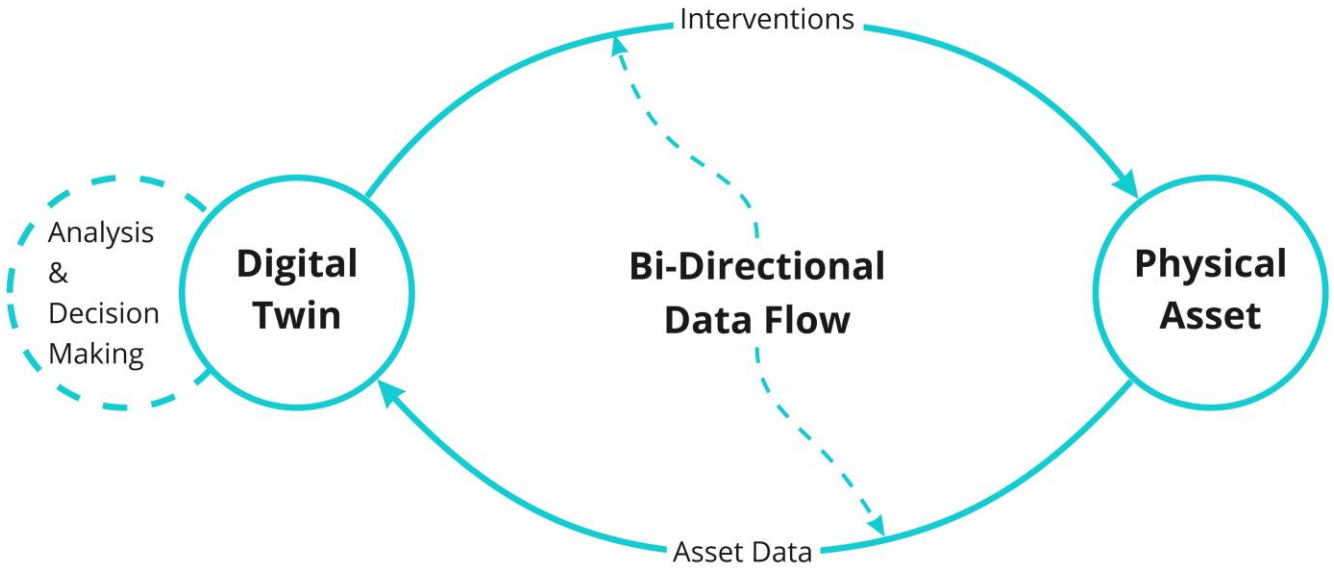
- Digital Twin as Continuation of BIM
- BIM & Digital Twin as two distinct concepts
- BIM & Digital Twin as complementary concepts

Source:
Douglas, D., Kelly, G., & Kassem, M. (2020). BIM, Digital Twin and Cyber-Physical Systems: crossing and blurring boundaries. *Proceedings of the 2021 European Conference on Computing in Construction, Online Conference*.

‘Digital Twin’ Definitions: a new or a rebranded innovation?

- Comprised of three essential elements

- Digital Twin capabilities
  - Simulate
  - Monitor
  - Control
  - Predict
  - Prototype



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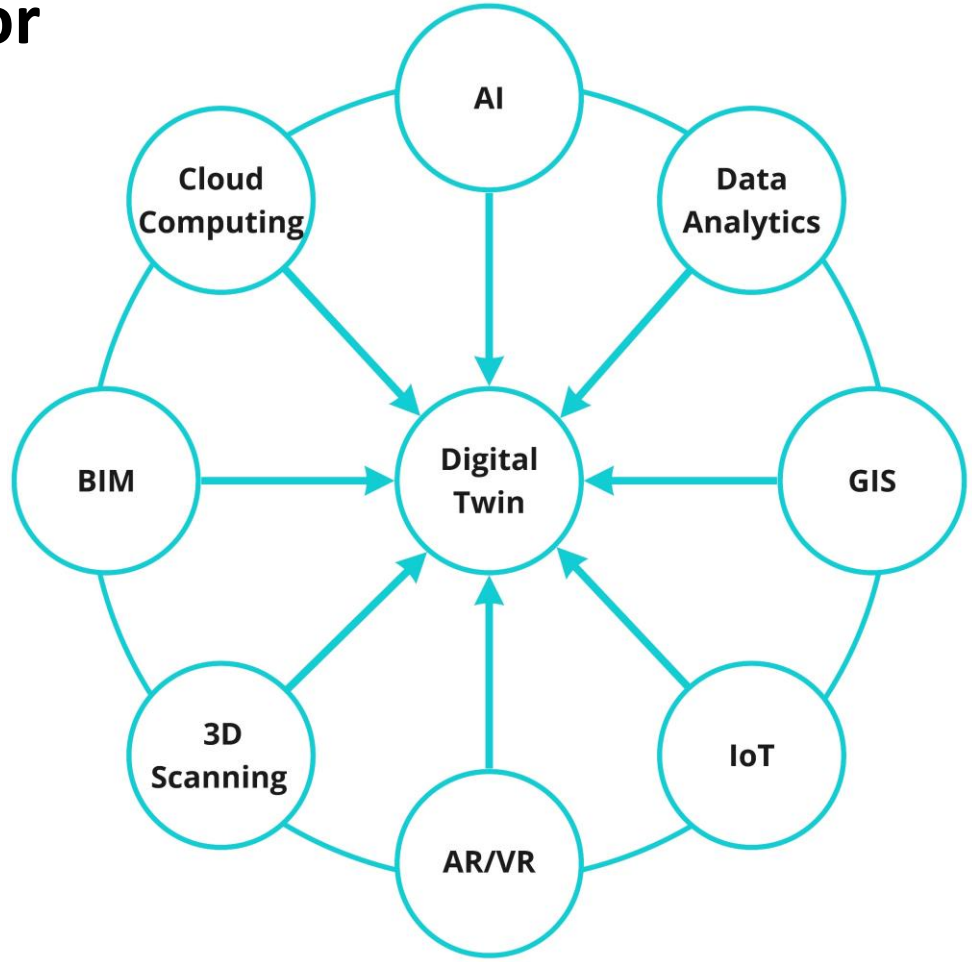
Digital Twin and its Enabling technologies for construction and built environment

- Digital Twin is no one technology
- It is rather a sum of parts connecting disparate systems
- It is an **<u>umbrella concept</u>**



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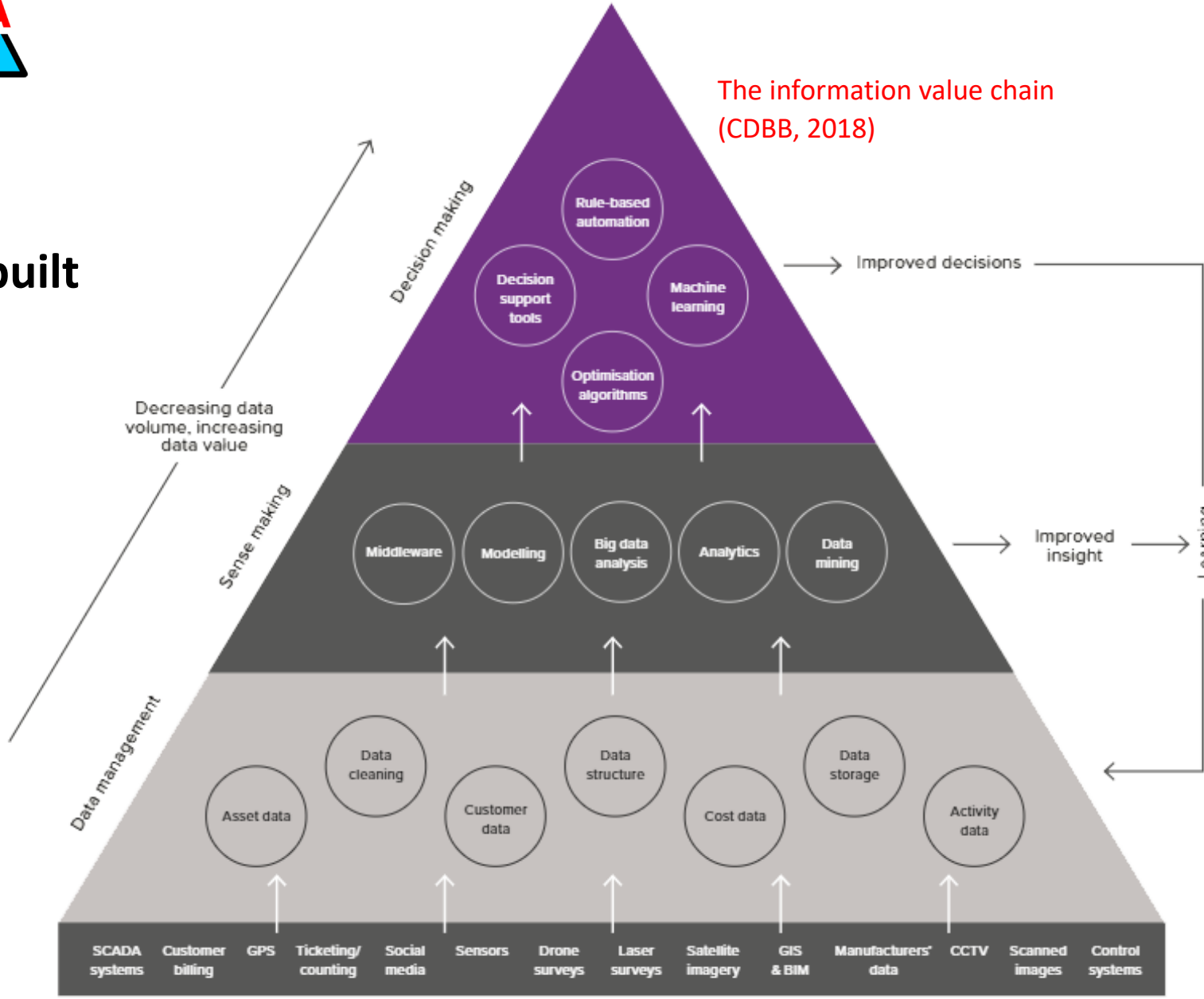
Digital Twin and its Enabling technologies for construction and built environment

- How these are deployed and combined
- Purpose driven
- Enabling the capabilities of the Digital Twin

The information value chain (CDBB, 2018)



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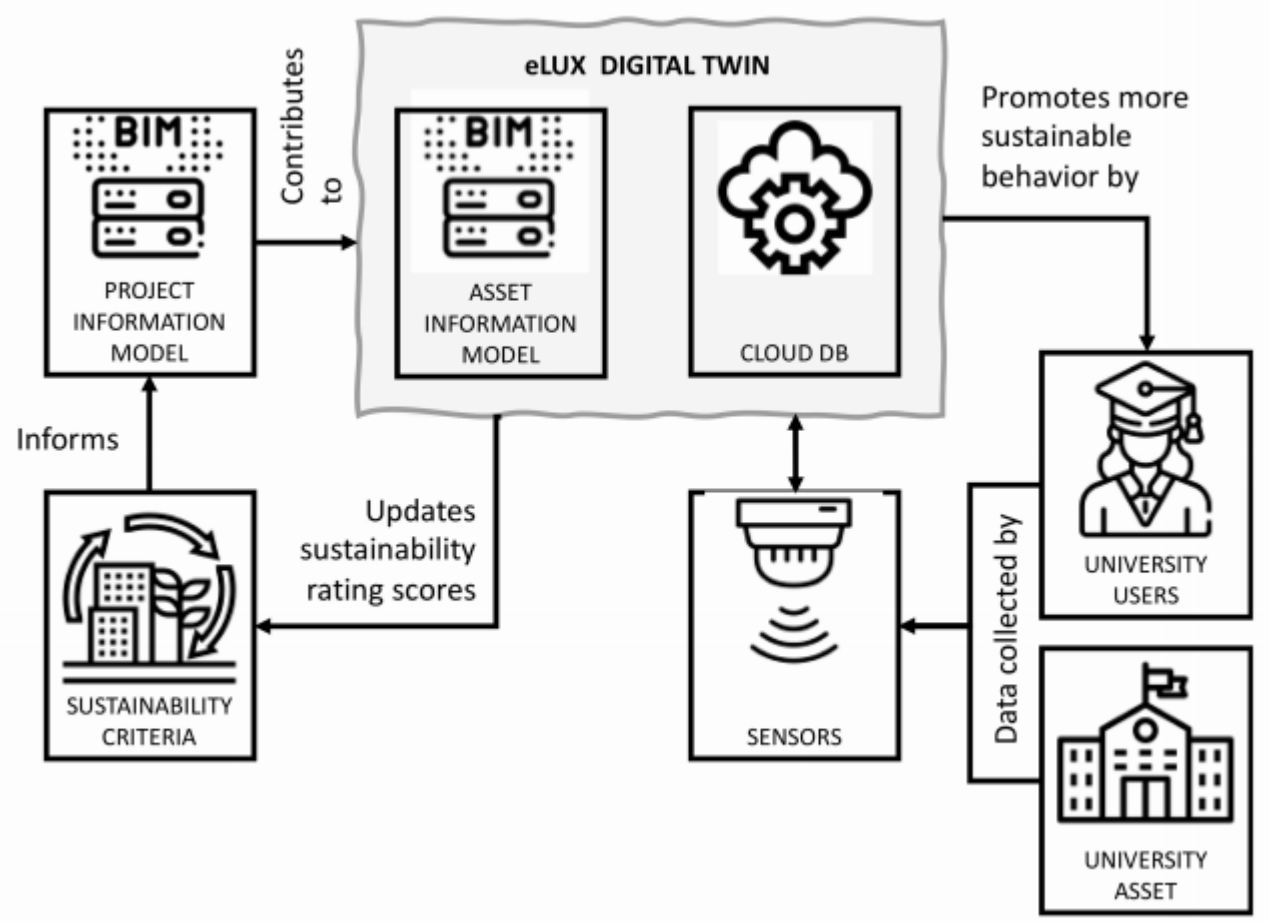
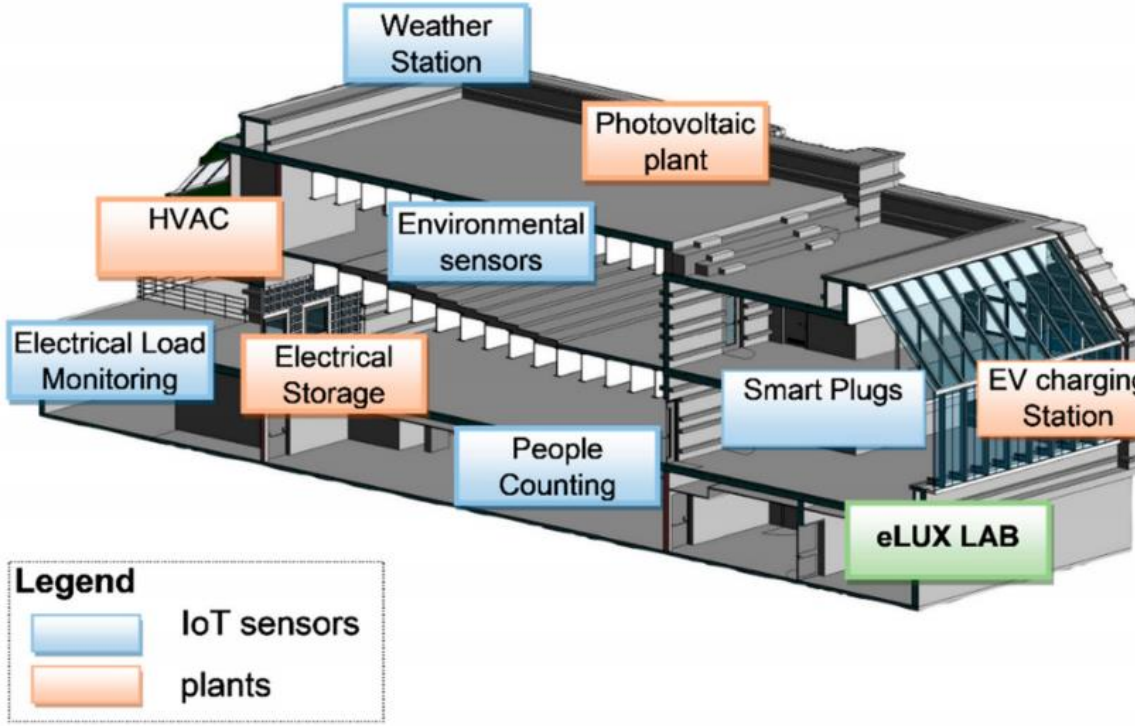
Applications of ‘Digital Twins’ in Construction and built environment projects

- Numerous possibilities for DT application in built environment. The focus of development is in **operation and maintenance of built assets** at different scales (building, district, cities).
- Lack of applications that develop understanding across lifecycle phases (e.g. linking insights from understanding operation of assets into the design of new assets)

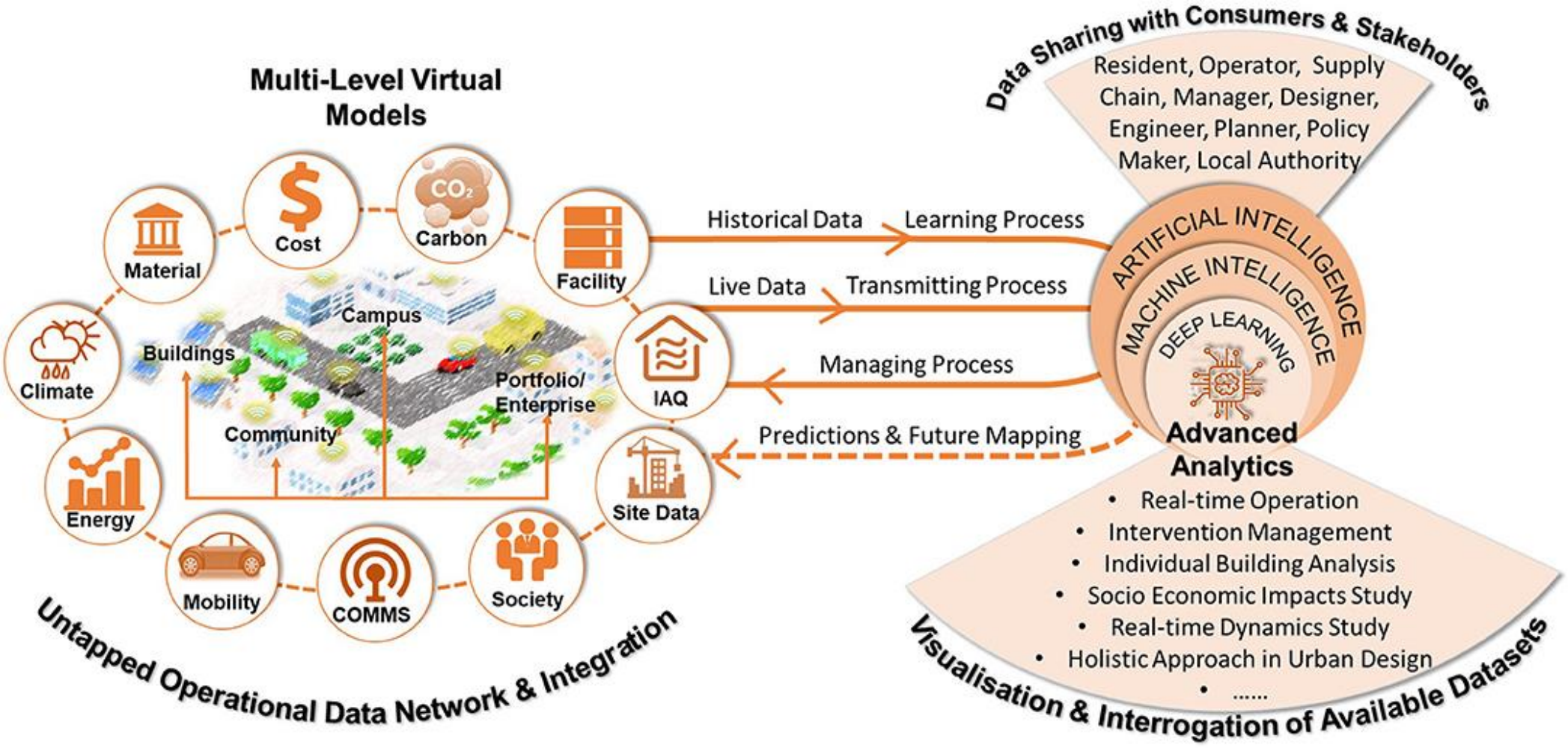
Applications of ‘Digital Twins’ in Construction and built environment projects





Source: Tagliabue, L.C.; Cecconi, F.R.; Maltese, S.; Rinaldi, S.; Ciribini, A.L.C.; Flammini, A. Leveraging Digital Twin for Sustainability Assessment of an Educational Building. *Sustainability* **2021**, *13*, 480. https://doi.org/10.3390/su13020480

Applications of ‘Digital Twins’ in Construction and built environment projects



Source: Xingxing, Z. et al. (2021). Digital Twin for Accelerating Sustainability in Positive Energy District: A Review of Simulation Tools and Applications, Frontiers in Sustainable Cities, https://www.frontiersin.org/article/10.3389/frsc.2021.663269

Open challenges

- Digital Twin for construction and the built environment is still in its infancy.
- **Understanding the relationship between DT and other prevalent concepts:** lack of clarity around the concept and the tendency to opportunistically label research outputs and industry products as ‘digital twin’ are creating confusion.
- **Inadequate maturity** of the sector in recognising what data brings value from the wealth of IoT-streamed data
- **Data Analysis and Semantic Interoperability:** lack of semantic models to standardize concept descriptions and data representations for interoperable interactions.
- **Economic analysis and business models**: Feasibility studies and benefits evaluation models are lacking for most use cases / applications. Custom-made and all-encompassing nature of DT as a technology adds to this challenge.
- **Data Security and Management**: confidentiality, integrity, and availability of data in the cloud.

Thank You

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Position Statement

Competitive Advantage by Digital Twins

Lasse Berntzen

University of South-Eastern Norway

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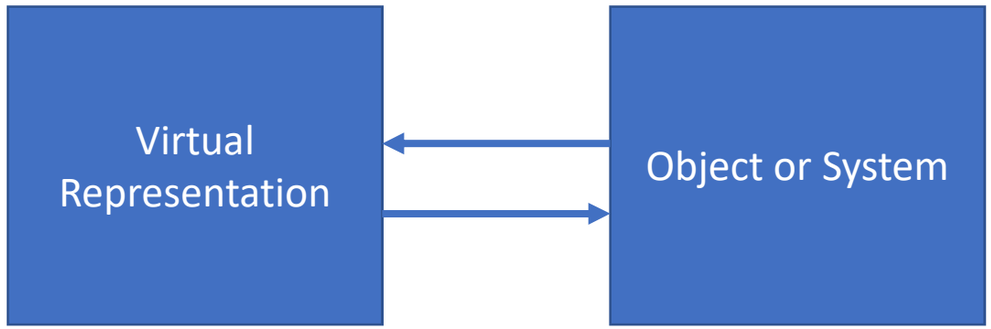
About me

- Professor, Information Systems, University of South-Eastern Norway
- Research on:
  - Smart Cities
  - Smart Grids
  - Autonomous Systems
- Teaching
  - Internet of Things
  - Business Analytics

University of South-Eastern Norway

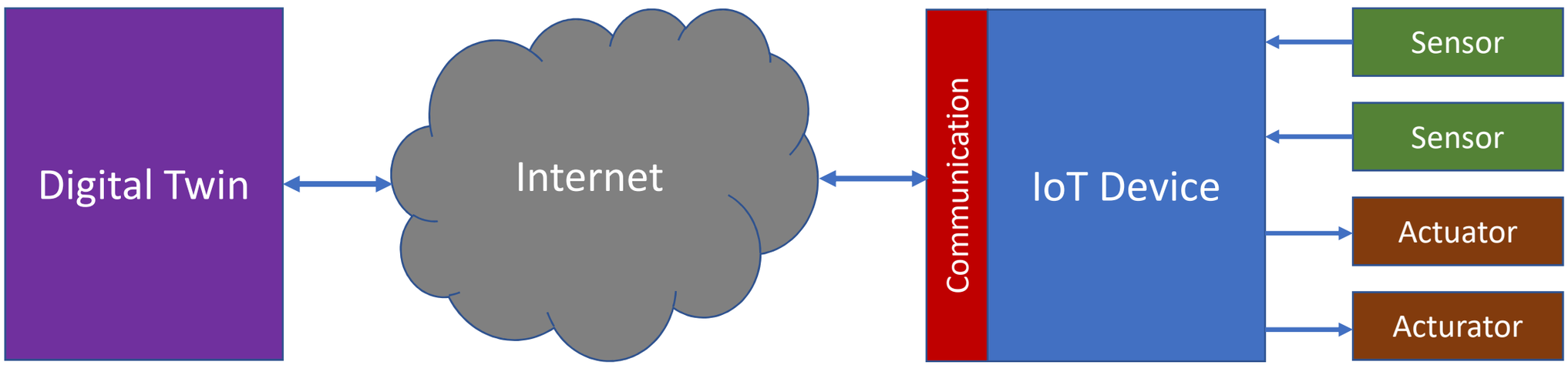
Digital Twin

"A digital twin is a virtual representation of an object or system that spans its lifecycle, is updated from real-time data, and uses simulation, machine learning and reasoning to help decision-making."



https://www.ibm.com/blogs/internet-of-things/iot-cheat-sheet-digital-twin/

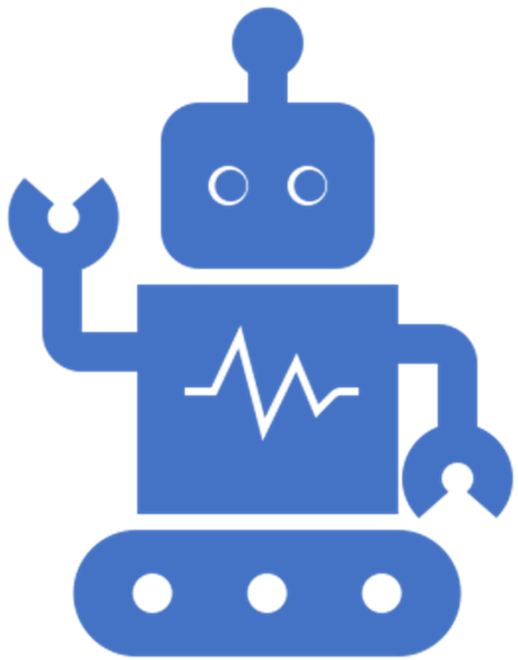
Internet of Things



Internet of Things (IoT) devices interacts with the physical environment through sensors and actuators. The IoT device includes communication technology to communicate with services through the Internet. A digital twin may be one such service.

Internet of Things

- Recent developments in low-cost Internet of Things provides new opportunities for product and service developments:
  - Real-time data collection
  - Remote control of functions
  - Automatic software updates



Big Data and Analytics

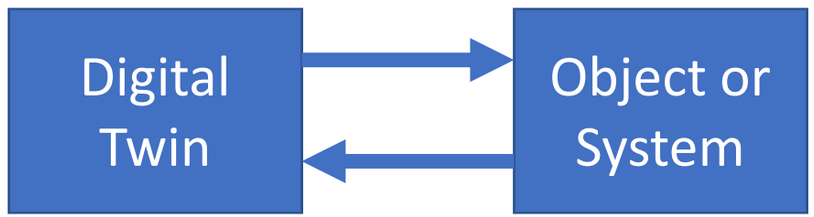
Data from the IoT devices can be stored and analyzed.

Collected data can be used for:

- Understanding performance
- Product or service improvements
- Product or service adjustements
- Troubleshooting
- Predictive maintenance.

Big Data and Analytics

- What happened?
- What is happening?
- What will happen?



Service Business Model – IoT supports predictive maintenance

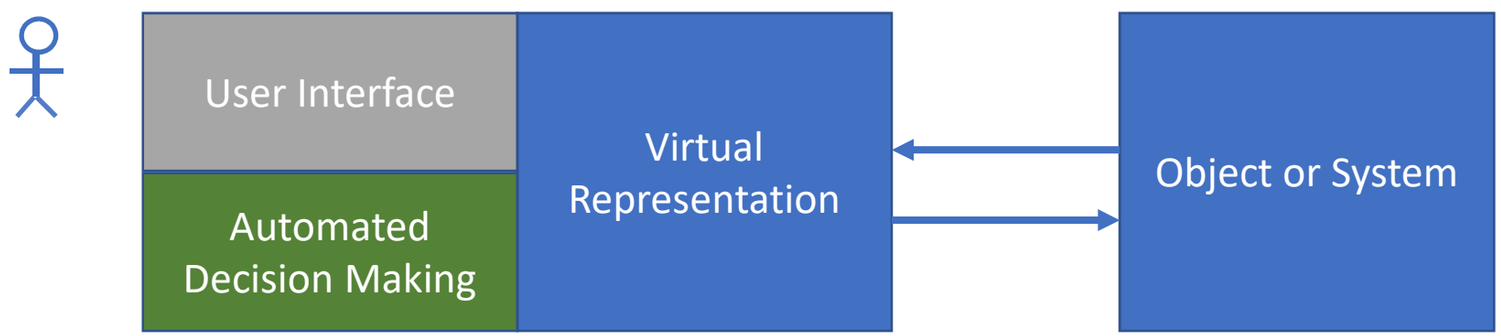
Past
Descriptive
Diagnostic

Present
Rules engine
Real-time analysis

Future
Predictive
Prescriptive

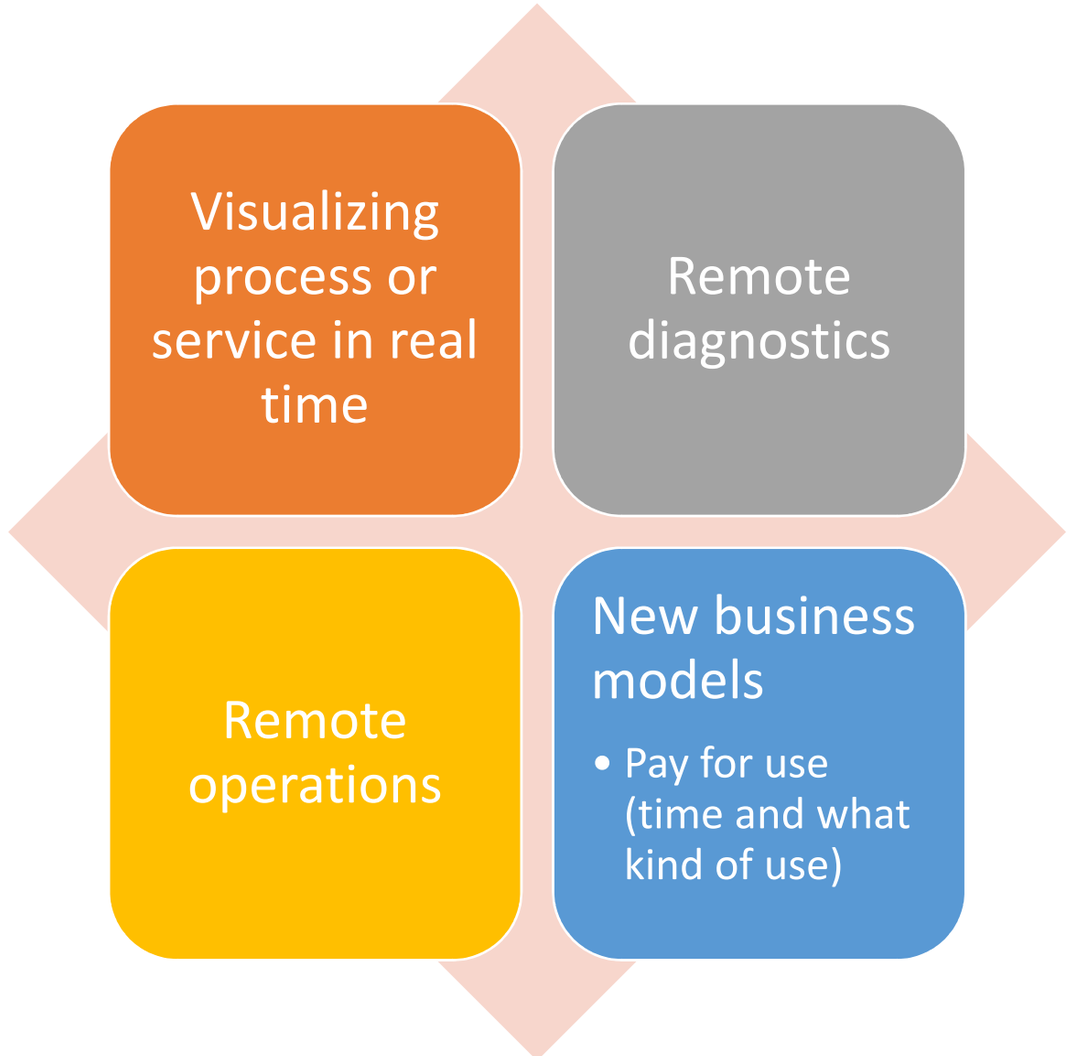
The Digital Twin as a Model

- The Digital Twin is a virtual representation (model) of the physical object or system.
- The user can interact with the Digital Twin through controls and visualizations
- The Digital Twin can also be manipulated through automated decision making



Applications of Digital Twins

Enhancing products and services to gain competitive advantage



Two Examples of Value Creation

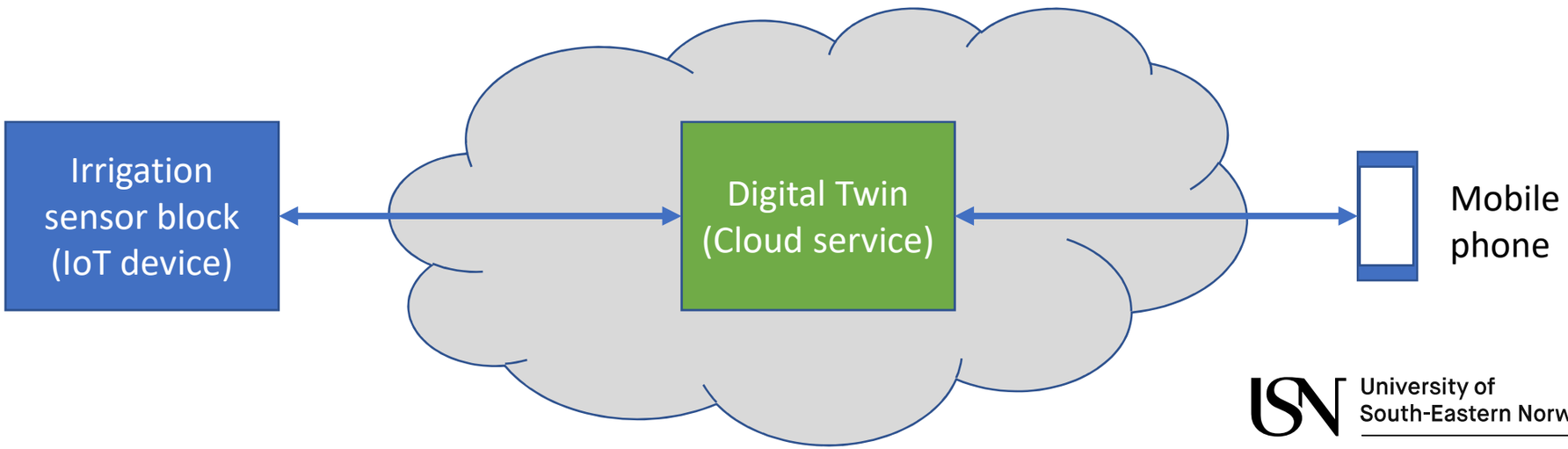
- Irrigation sensor digital twin
- Ship control system digital twin

- USN students have been involved in both projects/developments through work on their bachelor projects

University of South-Eastern Norway

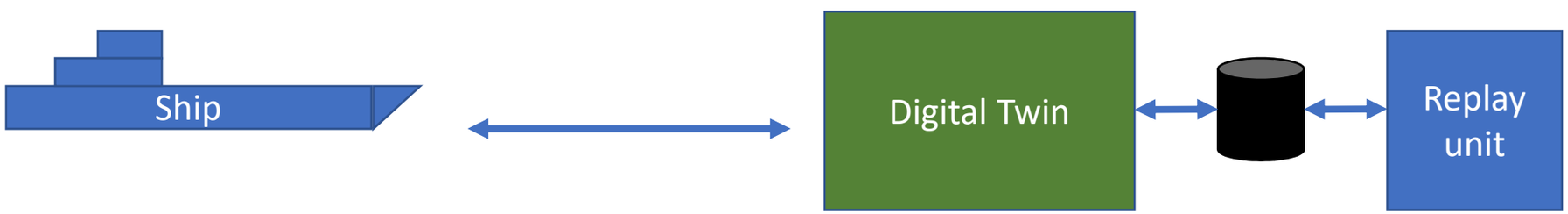
How to Create Value (Example)

- A digital twin for an autonomous irrigation unit for use in agriculture. Provides the farmer with updated information on geolocation, performance and possible malfunction through a cloud service accessed through a mobile app.
- Irrigation unit saves water and prevents damage by flooding.



How to Create Value (Example)

- A “black box” collects sensor information from the control system onboard commercial ships.
- Students made a system to replay and visualize what happens prior to accidents.



Current idea for a project – Telemark Canal

- The Telemark Canal was completed in 1898
- 500 men / 5 years
- Length: 105 km.
- 18 lock chambers
- Height difference: 72 meters
- Aim: Deploy sensor platforms in all lock chambers
- Demonstration case for digital twin / Internet of Things

Conclusion

Recent developments in low-cost IoT make digital twins feasible also for everyday products

Big Data and Analytics brings new opportunities

Opportunities for companies to gain competitive advantage

Possible student projects

Telemark Canal would be an interesting showcase

Museum Accessibility and Digital Twins

SMARTACCESSIBILITY2021
Digital World Experts Panel - «Digital Twins»
18-22 July 2021, Nice, France

Camelia Chivăran
University of Campania «Luigi Vanvitelli», Italy/ University of Cambridge, UK

Camelia Chivăran

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Professional Experience

PhD student in «Environment, Design and Innovation», Department of Engineering, University of Campania «Luigi Vanvitelli», Italy (November 2018 - present day)
PhD student - collaborator, Inclusive Design Group, Department of Engineering, University of Cambridge, UK (march 2021 - present day)

Professional qualification as Architect (October 2019)

Faculty of Architecture, Technical University «Gh. Asachi», Iasi, Romania (October 2009 - July 2015)

Publications

Capece, S., & **Chivăran, C.** (2021). *Culture through Time: Models for Interactive Fruition.* LDE HERITAGE CONFERENCE on Heritage and the Sustainable Development Goals: PROCEEDINGS 26th - 28th November 2019 - Delft. TU Delft Open. ISBN 978-94-6366-356-4.

Chivăran, C. (2021). *Knowing the Invisible Dimension of Water through Augmented Interactions and Perceptions*. In SMC Sustainable Mediterranean Construction Land Culture Research and Technology, Focus on SDG 2030 Health Clean Water Resources, N°13, pp. 88-93. Naples: Luciano Editore. PRINTED EDITION ISSN: 2385-1546/ONLINE EDITION ISSN: 2420-8213.

Capece, S., & **Chivăran, C.** (2020). *The Sensorial Dimension of the Contemporary Museum between Design and Emerging Technologies*. HERITECH 2020. IOP Conf. Ser.: Materials Science and Engineering, 949, 012067. doi:10.1088/1757-899X/949/1/012067.

Capece, S., **Chivăran, C.**, Giugliano, G., Laudante, E., Scognamiglio, C., Buono, M. (2020). *WID. Wearable and Interactive Devices for Augmented Fruition*. In SID |100 anni dal Bauhaus. Le prospettive della ricerca di design, pp. 170-177. ISBN 9788-89-43380-2-7.

Position statement

- The use of DIGITAL TWINS in the case of MUSEUMS has the potential to provide increased ACCESSIBILITY to a wider audience.

- Is this accessibility real?

Image source: https://www.quotemaster.org/

- Are people fully engaging with Digital Twins in the case of museums?

Image source: https://cherwell.org/

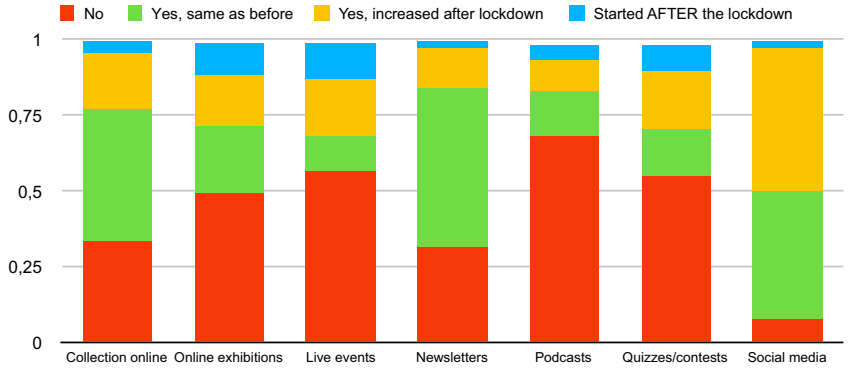
Current context

Museums, museum professionals and COVID-19: survey results

ICOM international council of museums

Changes in digital services

	Collection online	Online exhibitions	Live events	Newsletters	Podcasts	Quizzes contests	Social media
No	33,31%	49,46%	56,47%	31,66%	68,26%	55,15%	7,67%
Yes, same as before	43,86%	22,18%	11,54%	52,18%	14,67%	15,33%	42,21%
Yes, increased after lockdown	**17,97%**	**16,16%**	**18,80%**	**13,36%**	**10,39%**	**19,21%**	**47,49%**
Started AFTER the lockdown	4,04%	**10,88%**	**12,28%**	1,90%	5,11%	8,57%	1,98%



Source: https://icom.museum/en/covid-19/surveys-and-data/survey-museums-and-museum-professionals/

DIGITAL activities in MUSEUMS around the world INCREASED or began after the lockdowns caused by the recent pandemics with the purpose of enabling remote access to museum collections

Examples

- Smithsonian American Art Museum
  «Beyond the Walls»

Source: https://store.steampowered.com/app/1087320/Smithsonian_American_Art_Museum_Beyond_The_Walls/

- digital reproduction of the galleries of the Smithsonian American Art Museum
- Virtual Reality experience with the support of VR headsets (HTC Vive or Oculus Rift) and a headheld controller
- augmented visual and audio information provided for selected artworks to foster interaction and learning

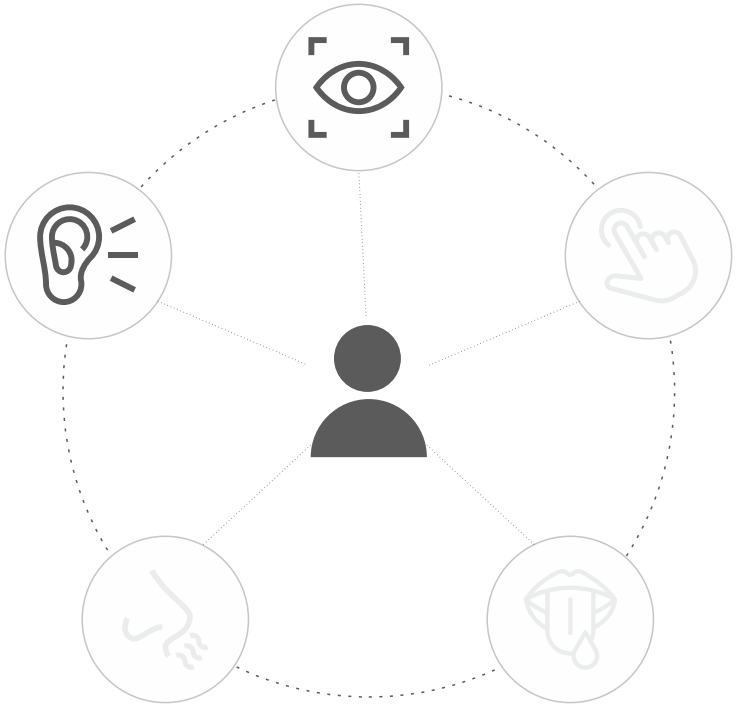
Examples

- Musée du Louvre
  «Mona Lisa: Beyond the Glass»

Source: https://www.viveport.com/18d91af1-9fa5-4ec2-959b-4f8161064796

- Digital Twin of Leonardo da Vinci's «Mona Lisa»
- VR experience both in place and from home
- augmented information on the artwork through visual and audio narrations providing hidden details of the painting, information on the painting process and on the character of Mona Lisa
- VIVEPORT, other VR platforms, mobile VR

What is not working?



- digital divide hardly considered, therefore limited accessibility
- limited sensory engagement, therefore limited accessibility
- copyright / protection of the works?
- not all virtual reproductions are reliable
- «originals are always better»

What can be done?

- increase digital access through simplified functionalities and explanatory information provided through multiple ways of representation and multiple sensory channels
- increase multisensory engagement, therefore accessibility for all
- provide layered information from which the user has the opportunity to choose
- foster real visit by raising curiosity

Thank you!

Acknowledgments:
This presentation is part of the research conducted in collaboration with
the Design group of the Department of Engineering, University of Campania «Luigi Vanvitelli», Italy
and the Inclusive Design Group of the Department of Engineering, University of Cambridge, UK

Digital Twins for Training Inexperienced Users in Electrical Occupational Hazards

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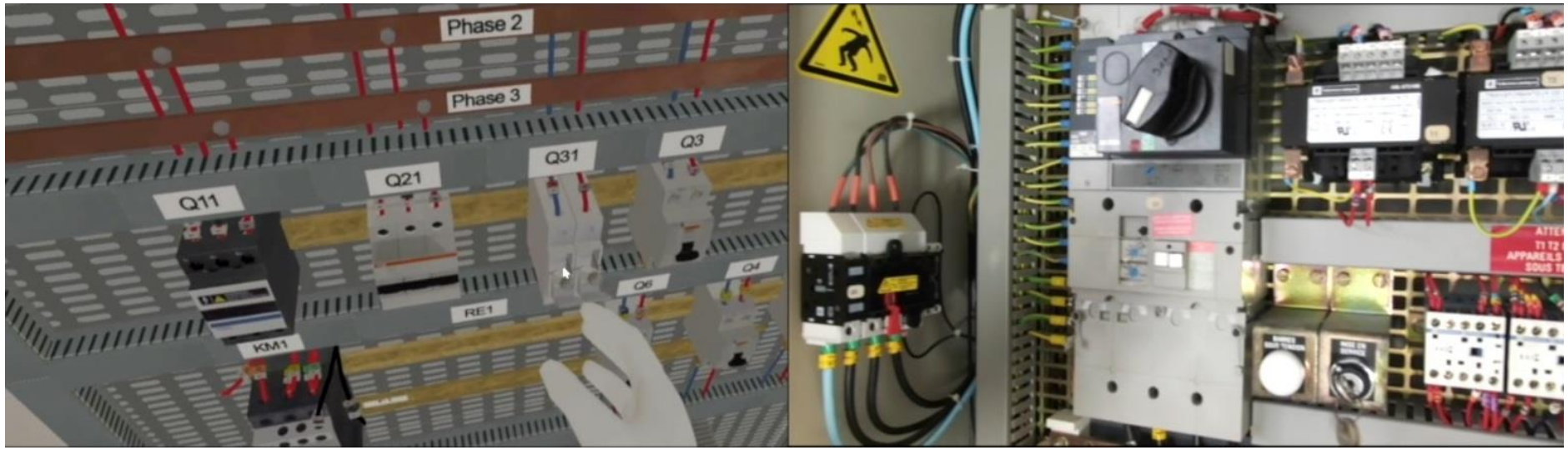


DigitalWorld 2021 Experts Panel
Digital Twins; A 360° Tour of Life Cycle and Applications on Built Environments

DigitalWorld 2021

Education

Experience

Field of expertise

VirtuElec Project

IUT CLERMONT AUVERGNE

Jean-Pierre TOUMAZET

Education

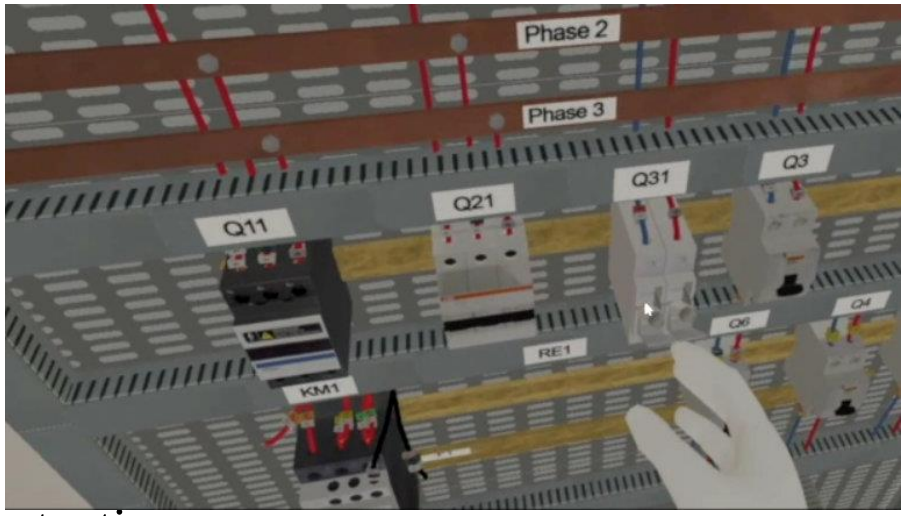
Electrical Engineering engineer,
Polytech Engineering School, France, 1995
Postgraduate Degree in Electronics & Systems,
Blaise Pascal University, France, 1995
Ph.D., Blaise Pascal University, France, 1998,
obtained with first class honours of the University

Current Academic Position

j-pierre.toumazet@uca.fr

Associate Professor in electrical engineering and electrical energy management,
University Institute of Technology - Clermont - Auvergne University - France

Teaching topics



Prevention of electrical risks
Electrical engineering
Production and management of electrical energy

Research themes

Initial theme: applied research in the field of electrical protection
After my thematic reconversion: 3D modeling and characterization applied to physical geography

Industry-related experience

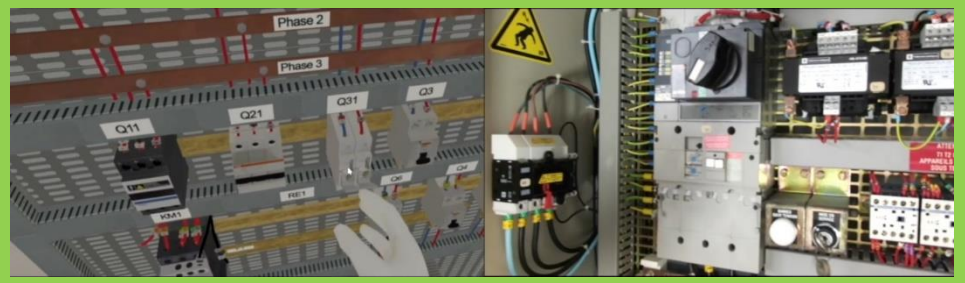
Technical activity (automotive, aeronautics, space)
Supervision of apprentice engineers
(automation, manufacturing, electrical production)
Research activity in the field of electrical protections
(partnership with Shneider Electric)
Expert member of the Habilec 8 panel (including both industrial and academic members): design of training tools for electrical risks
Co-development of training tools

Teaching topics

Research themes

Industry-related experience

VirtuElec Project



Need for digital twins in electrical risk training

⇨ Good knowledge of electrical hazards essential for students in electrical engineering.

⇨ Development of apprenticeship training : learners increasingly confronted in their training course with potential danger in an industrial environment.

⇨ Training equipments exist but generally not realistic enough, or if they are realist (presence of real risks) : situation stressful for the student and for the trainer

⇨ VirtuElec project : co-development of a digital twin of an industrial electrical cabinet

⇨ Different expertise levels simulated : virtual environment with different scenarios of electrical risks

⇨ A mission is given and the right decisions must be taken (choice of intervention and protection equipment, behavior, professional gestures).

Originality of the project : A real partnership with a company, really involving students co-developing the tool in terms of ergonomics and functionality: An educational tool developed by students for students.

Methodology

Thank you for your attention

.

More informations on the VirtuElec Project :

https://cap2025.fr/formation/learnin-auvergne/actualites-et-evenements/matinee-de-la-pedagogie-et-des-realites-immersives

https://cap2025.fr/formation/learnin-auvergne/thematiques-des-projets/virtuelec-la-realite-virtuelle-au-service-de-lautoformation-aux-risques-electriques

CAP 20-25 I-SITE Clermont
Clermont Auvergne Project

Innover, c'est dans notre nature
Innovation. It's in our nature