Schwegman Lundberg & Woessner | slwip.com

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Building Extraordinary IP Assets

Emerging Tech Webinar Series

Digital Twins: Transforming Decision-Making for the Future

Before We Get Started...

Recording

A link to the recording and slides will be emailed to all registrants.

Questions

Type in the question box and we will answer in real time or during the Q&A.

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Today's Presenters...

Steve Lundberg
Principal & Chief Innovation Officer
Schwegman Lundberg & Woessner

Suneel Arora
Principal
Schwegman Lundberg & Woessner
Former Senior Engineer at Cardiac Pacemakers (Guidant Corp.)

Manjeet Rege, PhD.
Director of Center of Applied Artificial Intelligence, Chair, University of St. Thomas Graduate Programs in Software Engineering, Data Science

Dan Isaacs
CTO of the Digital Twin Consortium, and VP/Technical Director (DTC) of Object Management Group

Steve Komarec
Principal
Schwegman Lundberg & Woessner

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Digital Twins: An Introduction

Digital Twin Market: Poised for Growth

Digital Twin Market demand to hit US$ 50 billion by 2027; Global Market Insights, Inc.

Global Market Insights, Inc

July 14, 2021 · 5 min read

Some of the major digital twin market participants are ABB Group, IBM Corporation, Accenture, Autodesk Inc, Bentley Systems, General Electric Company, Robert Bosch GmbH, Schneider Electric SE, and Siemens AG.

What is a Digital Twin?

"A digital twin is a dynamic virtual representation of a physical object or system, usually across multiple stages of its lifecycle. It uses real-world data, simulation or machine learning models, combined with data analysis, to enable understanding, learning, and reasoning. Digital twins can be used to answer what-if questions and should be able to present the insights in an intuitive way."

- IBM

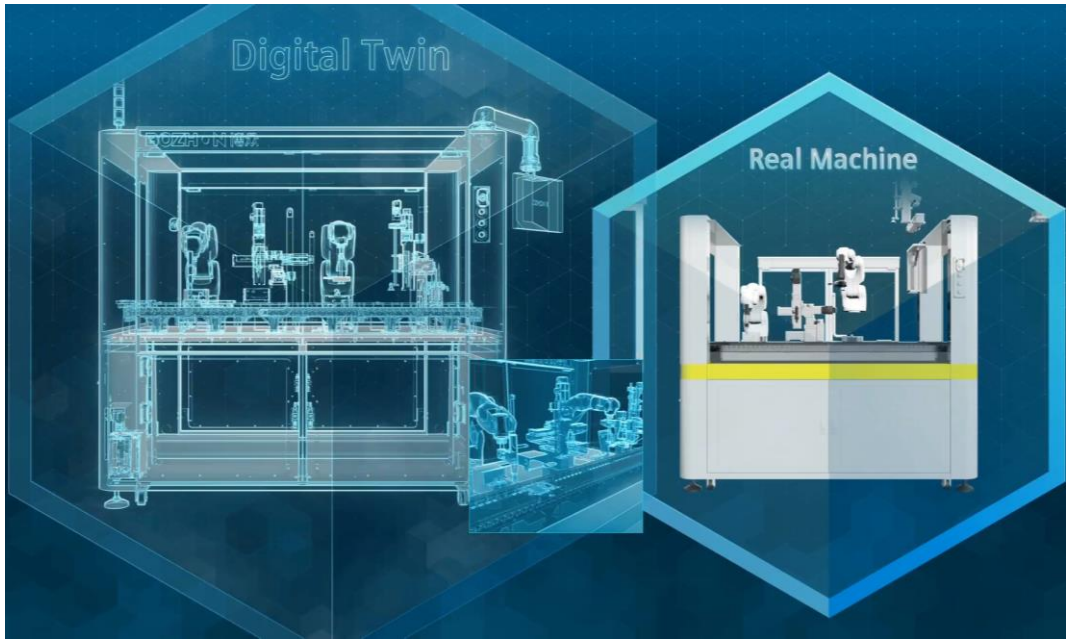
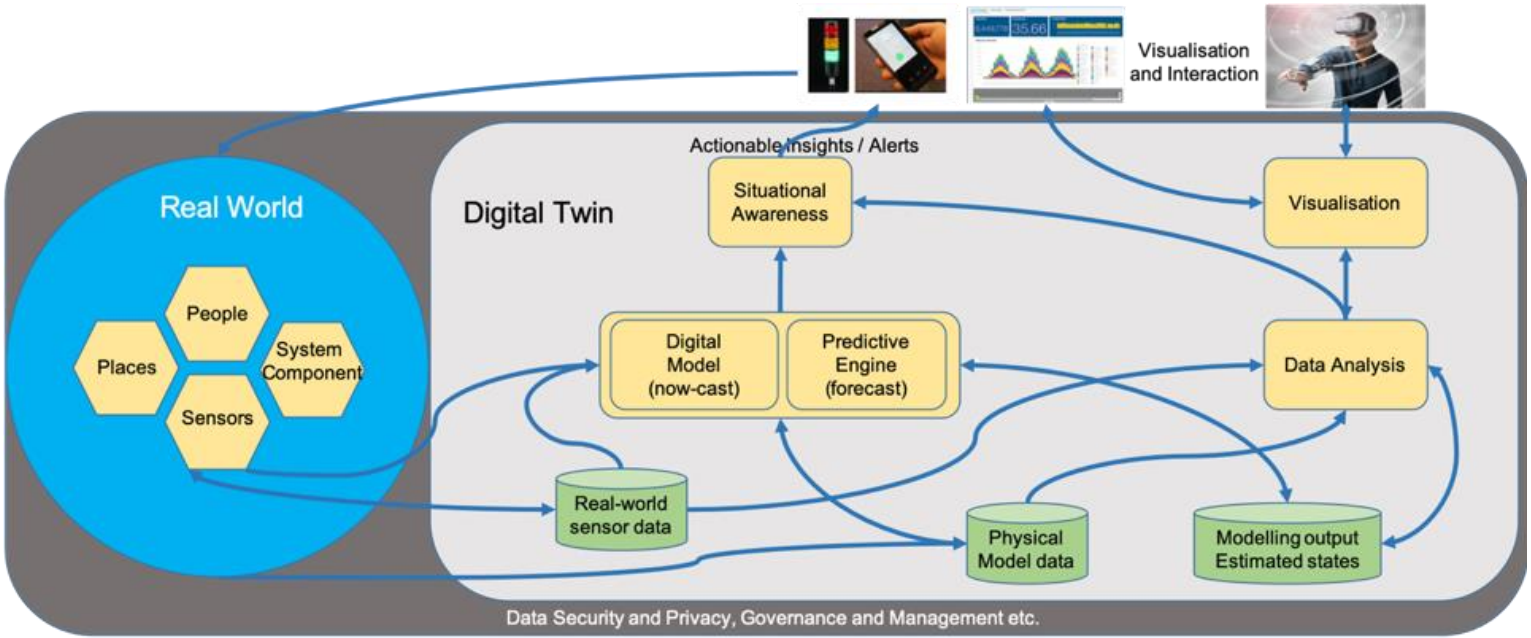


Image Credit: https://www.plm.automation.siemens.com/global/en/webinar/digital-twin-in-manufacturing/68561

High-level component view of a Digital Twin



The digital twin does not stand alone; it must be integrated with the overall enterprise architecture.

Image Credit: https://developer.ibm.com/articles/what-are-digital-twins/

Using digital twins to solve real world problems

Digital twins may be used to address challenges that organizations encounter, including but not limited to:

- Project planning
- Designing products
- Deciding on requirements
- Reliability engineering
- Decision making
- Decommissioning resources
- Training

Advantages and benefits of digital twins

- **Better research & development**
- **Increased efficiency**
- **Product end-of-life**

Image Credit: https://www.konicaminolta.eu/eu-en/rethink-work/tools/digital-twins-%E2%80%93-doubling-the-potential-for-innovation

Digital Twins: When should you use?

Types of projects that benefit from the use of digital models:

- Project planning
- Physically large projects
- Mechanically complex projects
- Power equipment
- Manufacturing projects

Industries that achieve greatest success:

- Engineering, Manufacturing, Construction, etc.

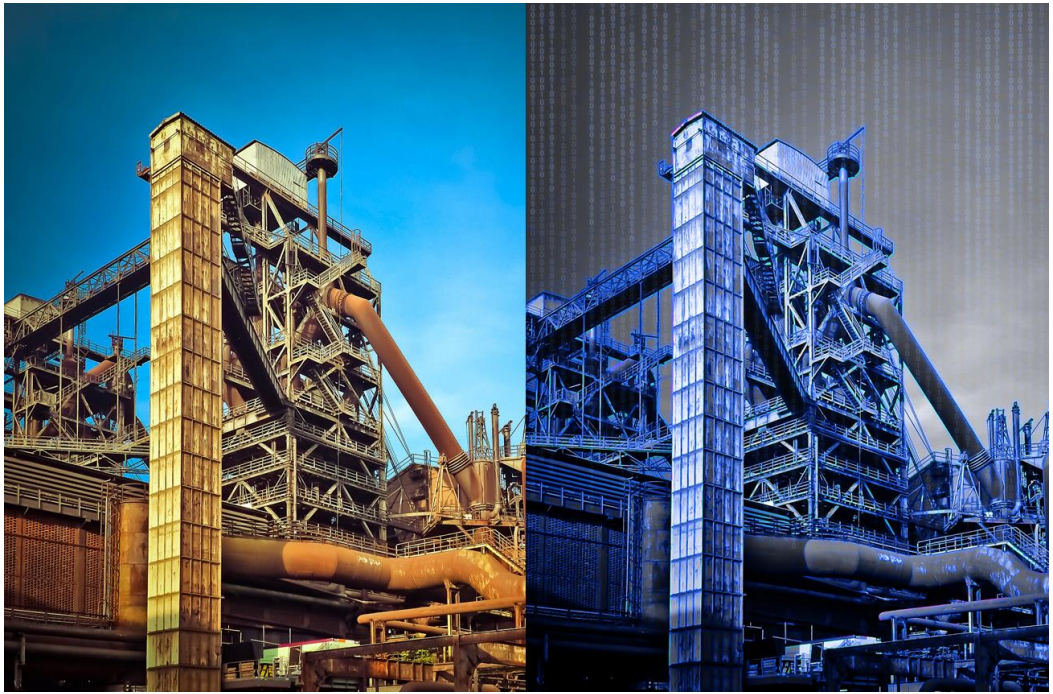
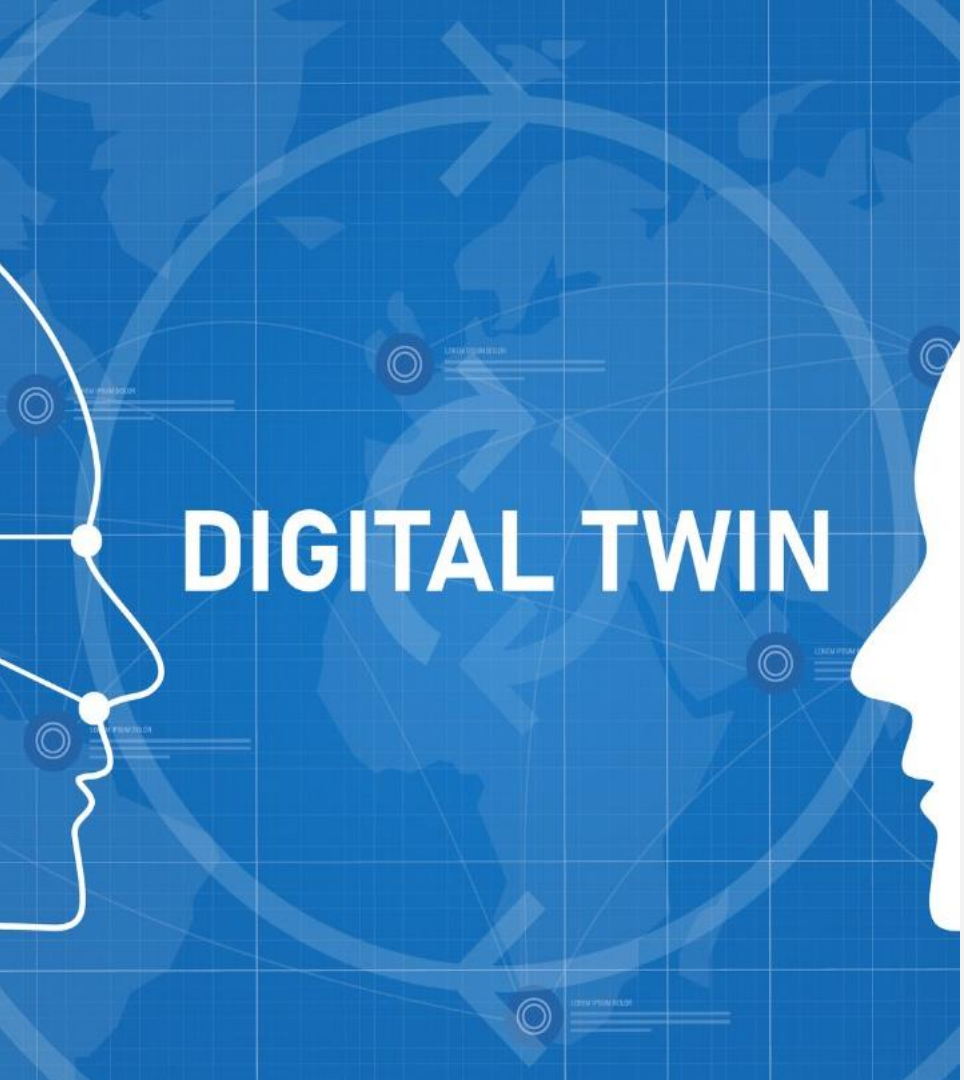


Image Credit: https://viridis.energy/en/blog/role-digital-twins-energy-and-utilities-management



Considerations:

Complexity: How expensive (time and money) would it be to build a digital twin?

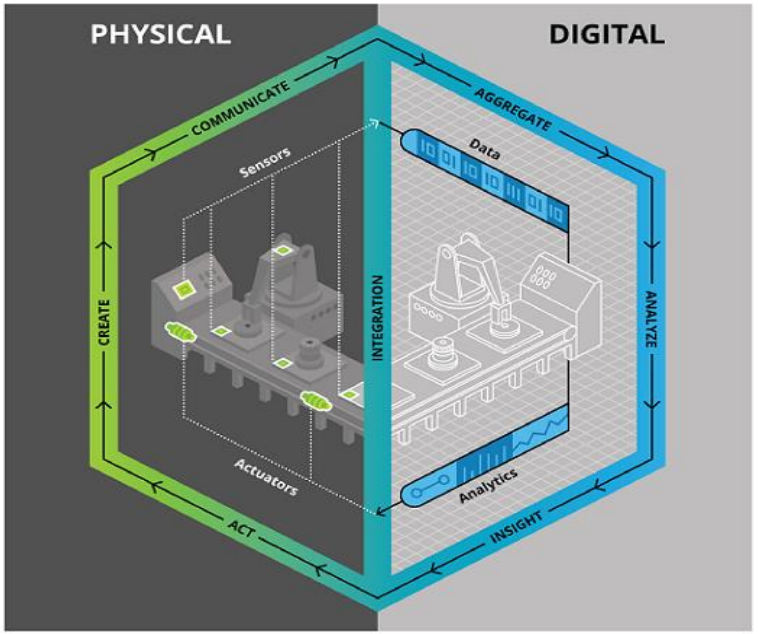
Breadth: How specific or how generic would the digital twin be?

Depth: How accurate and detailed would the results be?

Digital-twin use cases: Manufacturing

- An industrial manufacturer facing numerous quality issues in the field was able to improve the assembly process, reducing rework by 15 to 20 percent.

Figure 1: Manufacturing Process Digital Twin Model



Source: Deloitte University Press

Image Credit: https://deloitte.wsj.com/articles/meet-manufacturings-digital-twin-1502251346

Digital-twin use cases: Automotive

- The digital twin of product comprises the entire car, its software, mechanics, electrics, and physical behavior.
- This allows to simulate and validate each step of the development in order to identify problems and possible failures before producing real parts.

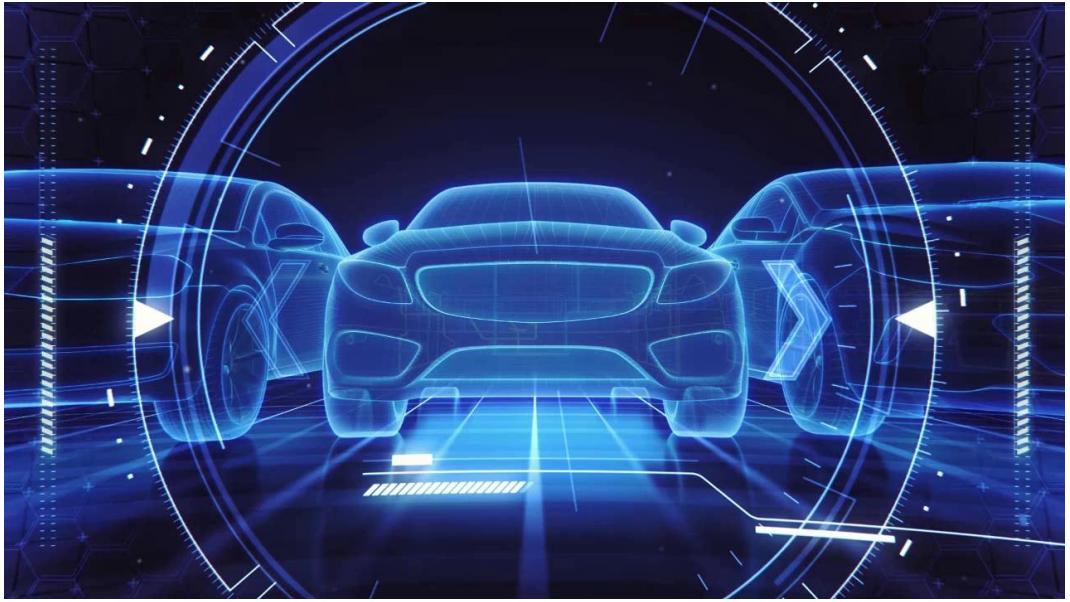


Image Credit: https://new.siemens.com/global/en/markets/automotive-manufacturing/digital-twin-product.html

Digital-twin use cases: Healthcare

- In a world full of wearables, hospitals could be run like smart factories.
- Band-aid sized sensors send health information back to a digital twin used to monitor and predict a patient's well-being.

https://www.digitalnewsasia.com/digital-economy/healthcare-innovation-could-lead-your-digital-twin

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Digital Twins: Evolving & Accelerating Technology & Ecosystem

digital twin™
CONSORTIUM

The Authority in Digital Twin

Dan Isaacs: CTO Digital Twin Consortium
isaacs@digitaltwinconsortium.org

September 2021

Digital Twin Market Growth Forecast

Digital Twin Market Size, Growth Forecast Report 2027 (gminsights.com)

Digital Twin Market Challenges

Limited Interoperability

- There is no standardization, definitions and common language
- Digital twins can be difficult to apply across the product lifecycle
- Often there are multiple digital twins, versions or views that don't interoperate
- Your efficiency could be limited by data silos
- You need to fit digital twin technology within a legacy environment

Market Confusion

- Limited use cases and research available to learn from others
- It's difficult to know where to start to quickly get value
- How do you decide what technologies to use?
- What is your minimally viable digital twin?
- In most cases, your employees haven't done this before.
- Many companies re-brand as "Digital Twin" overnight

High Stakes

- Once you choose a digital twin path you have to stay on it
- The software world does not apply to the digital twin world
- Digital twin projects require heavy investment of both hard and soft costs: money, people, time, equipment
- No defined answers to what to use, when to use it and how to use it
- If you get it right, the payoff is worth the risk

How Can a Consortium Help?

Improve Interoperability

Accelerate the Market

Demonstrate the Value

Our Members


Researchers
Technology Providers
Academia
Government
Digital Twin Users
250+
members
& growing

Founders

Ansys Bentley GE Digital lendlease

AUTODESK. DELL Technologies Microsoft NORTHROP GRUMMAN

Groundbreakers – members since day 1

Air Force Research Laboratory, Animated Insights, Association of Asset Management Professionals, Cybertwin, e-Magic Inc., Gafcon Inc., Healthskouts, Idun Real Estate Solutions AB, imec, IOTA Foundation, IOTIFY, Jitsuin Inc., Lux Modus Ltd., NSW State Government, Padi LLC, Ricardo, Slingshot Simulations, Transforma Insights, University of Melbourne, Willow

Currently 250+ members

Vision and Mission

- **GOAL** - Become ***THE Authority in Digital Twin*** as it relates to:
  - Policy, Security, Trustworthiness, Interoperability and overall development
- **DEFINE** - Ecosystem, standards requirements, architectures, open source code
- **IDENTIFY**- Gaps - enable solutions to address them
- **PUBLISH** - Publish statements and opinions
- **PARTNER** - with Industry, academia & government in a collaborative open environment
- **DRIVE ADOPTION-** use case, interoperability
  - Development of digital twin technology
- **PROPEL** - Innovation of digital twin technology
  - Consistent approaches and open source development.
- **COMMIT** - Accelerating the market and guide outcomes for users

Our Working Groups

3T

- Terminology
- Taxonomy
- Security & Trustworthiness
- Platform stacks

Infrastructure

- Construction
- Smart cities
- Transport
- Real estate

Natural Resources

- Oil & gas
- Mining
- Water
- Solar

Manufacturing

- Mfg equipment
- Product development
- Supply chain

Aerospace & Defense

- Land
- Maritime
- Air
- Cyber
- Space

FinTech

- Value
- Payments
- Ownership
- Information
- Risk
- Access control

Healthcare & Life Sciences

- Healthcare management
- Medical devices
- Patient journey
- Pharmaceuticals

Marketing

- Public relations
- Thought leadership
- Brand awareness
- Market education

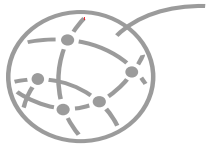
Characteristics and Enabling Technology Examples

- Accessibility
- Trustworthiness
- Security
- Connectivity
- Analytics
- Data

Artificial Intelligence/Machine Learning
Internet of Things (IoT) (IIoT)
5G
HPC
Big Data / Analytics
Augmented/Virtual Reality (xR)
3D Scanning
Advanced Sensor
Multi-Cloud
Edge Computing
Advanced Modeling
. . .


AI/ML

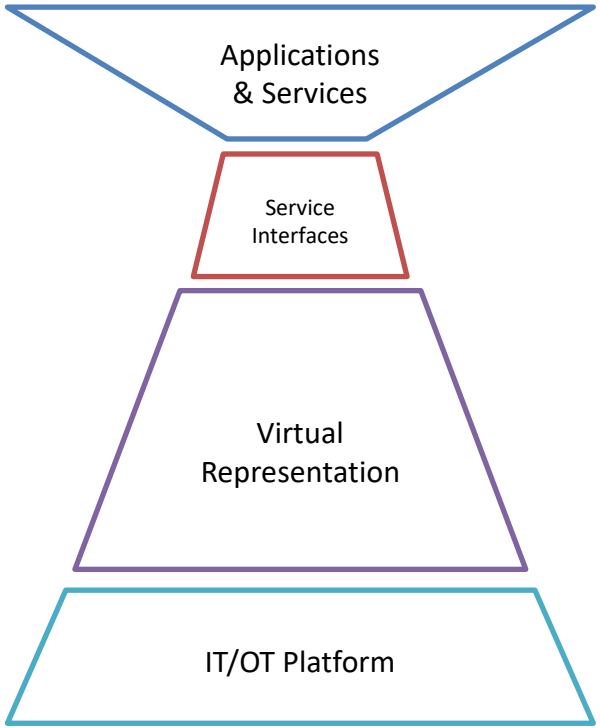

AR/VR


IoT


HPC

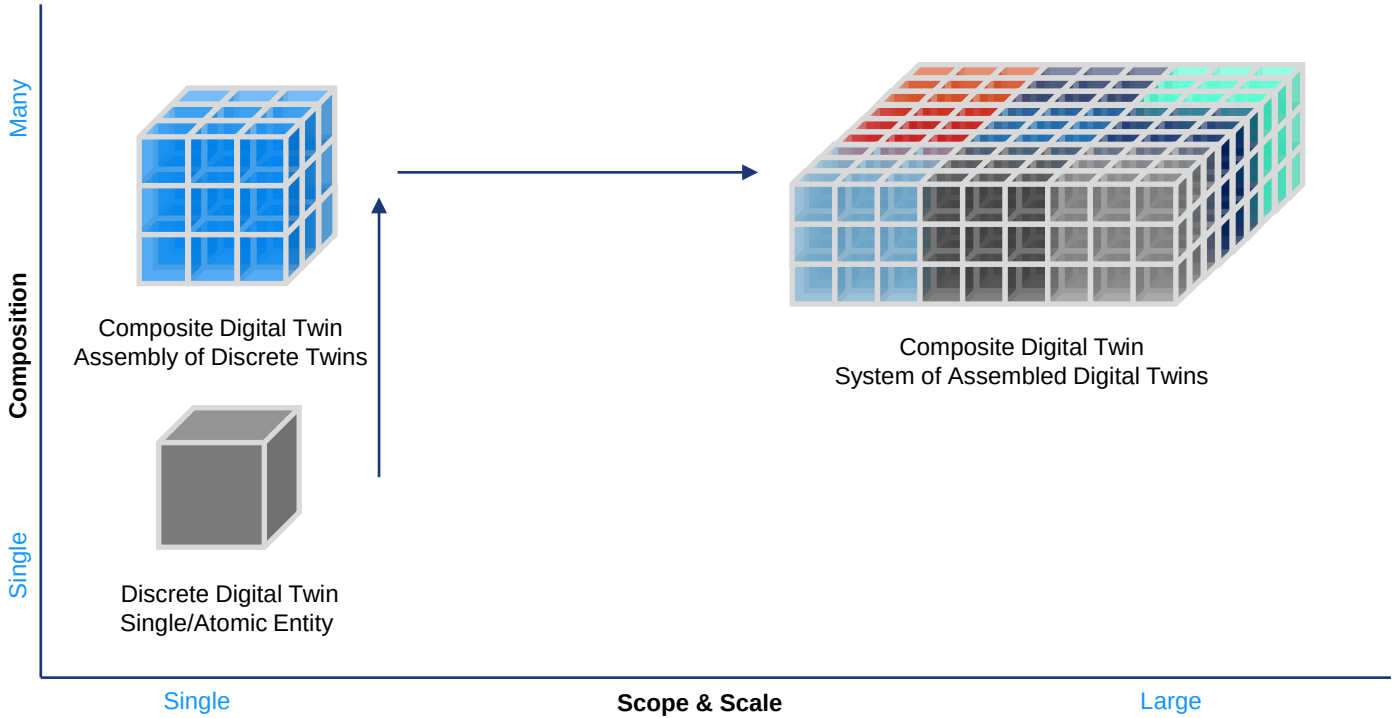

Multi-Cloud

Digital Twin Reference Architecture

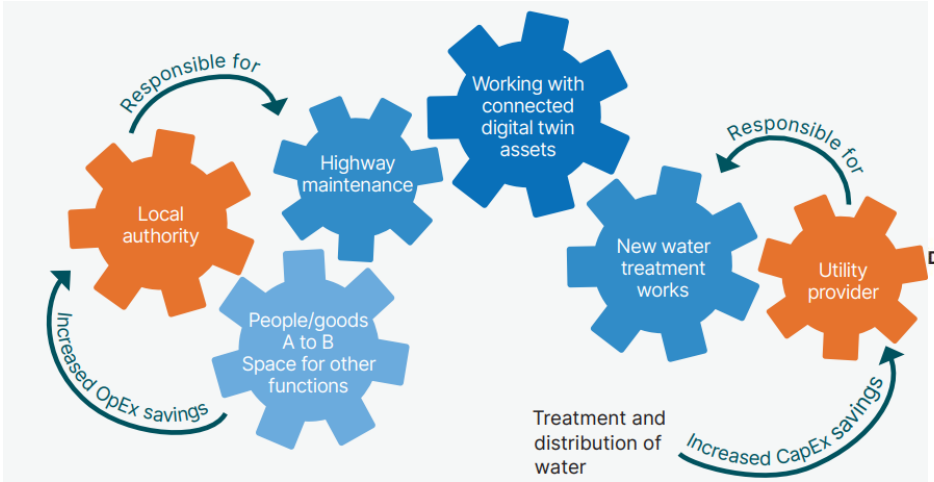


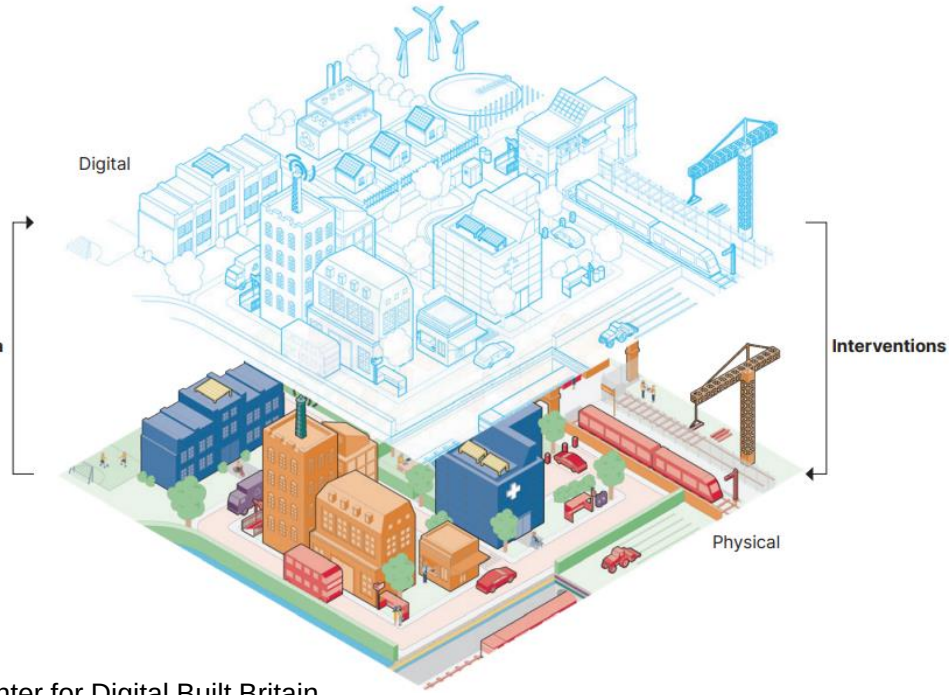
- Run on IT/OT Platforms
- The **Virtual Representation** is the core
- Have Service Interfaces for integration & interoperability
  - Includes elements of synchronisation
- Applications & Services to realise the **value** to all & different stakeholders

Scope and Scale of Digital Twin



Connected Systems and the Digital Twin of Britain



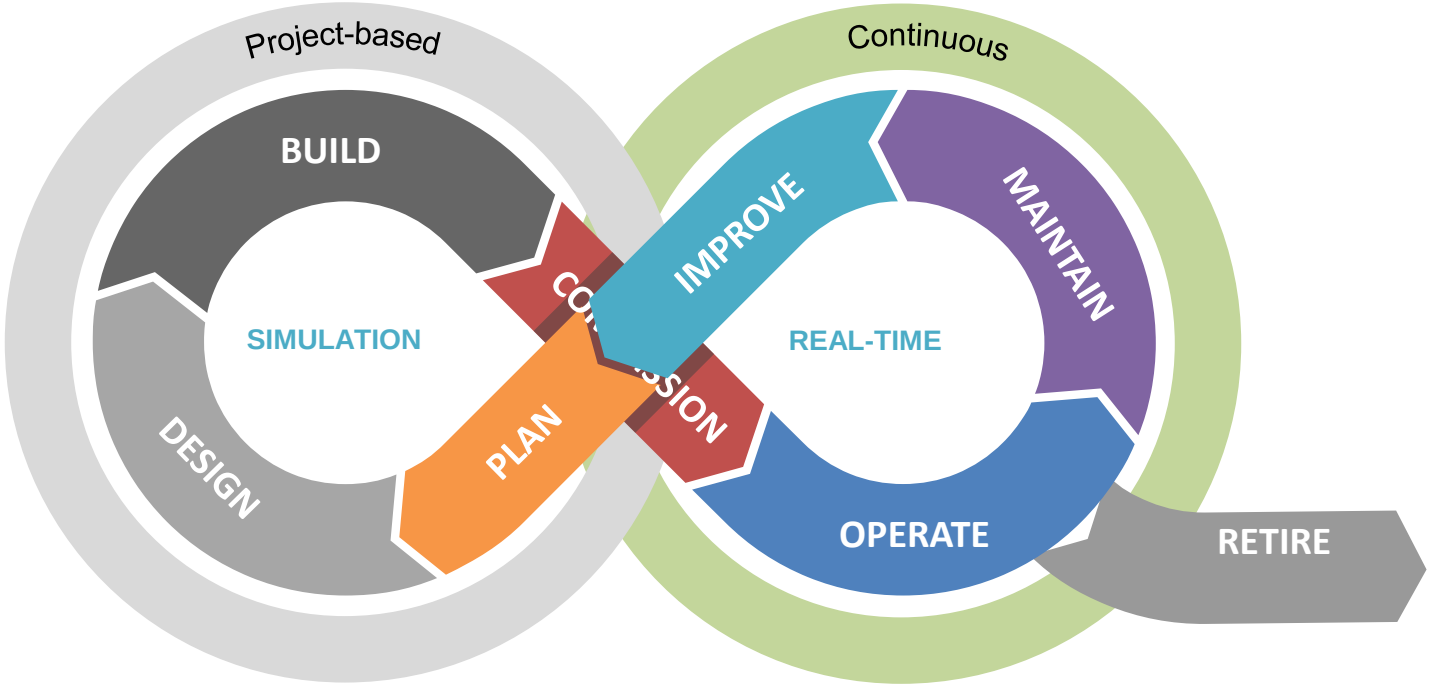


National Digital Twin for Britain – Center for Digital Built Britain

Simplified View of Digital Twin

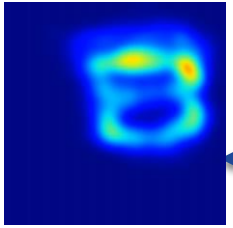
- The digital twin is composed of three components, i.e. physical entities in the real world, their virtual models and the connected data/view that tie the two worlds.

Digital Twin in Asset Lifecycle Loop

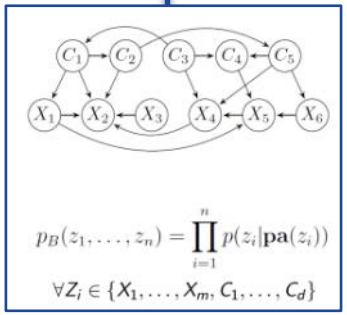


What are the use cases and associated benefits in my industry?

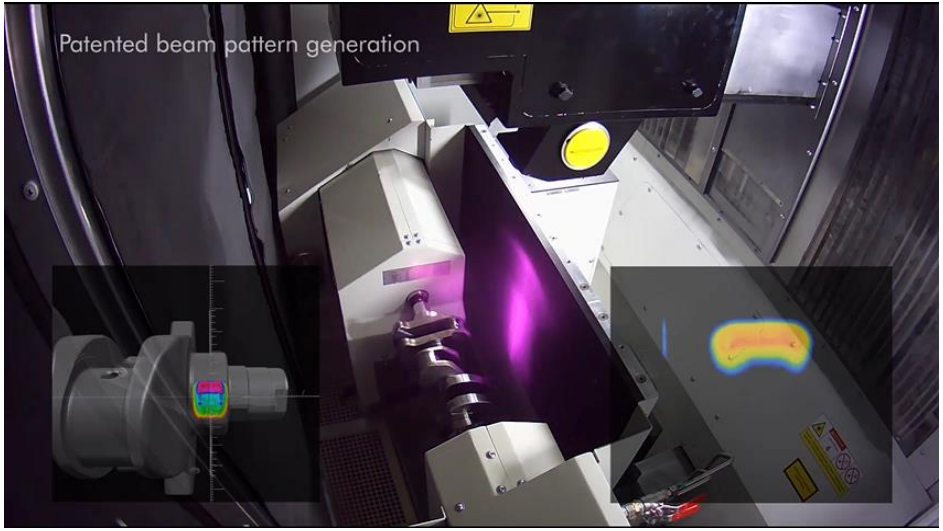
Quality Control

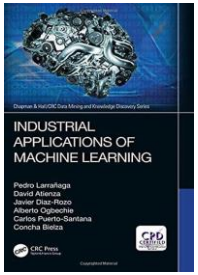


Machine Learning application: Kernel Density Estimation (KDE)



- Ability to detect product quality issues
  - Understanding the process variables
  - Understanding hardware and software interaction with process performance



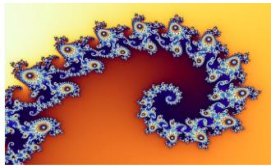


High speed thermography analysis. Process Max fault detection: 3s

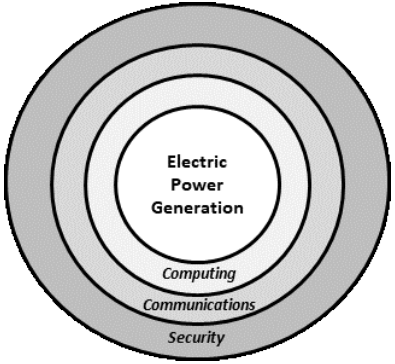
aingura IIoT


Using a Digital Twin for the
Integrated Utility
Infrastructure
Agile Fractal Grid

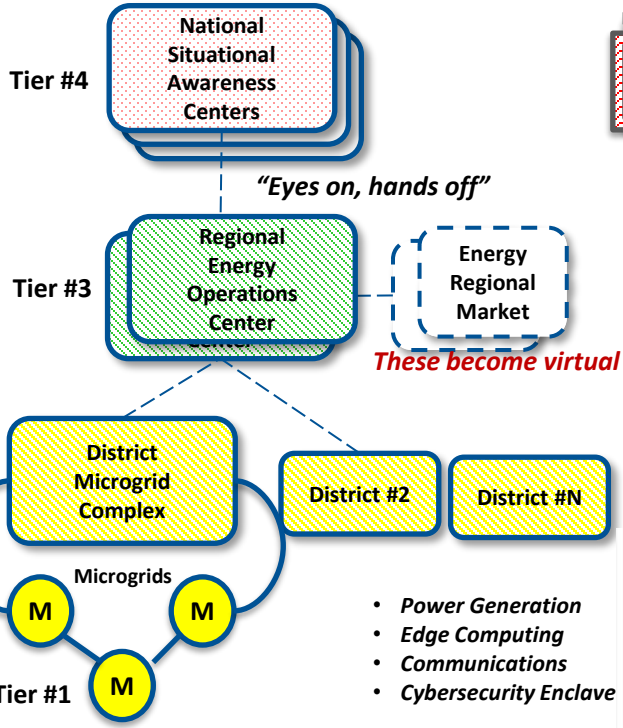
Empowerment at the Edge with Shared Intelligence



Mandelbrot Patterns

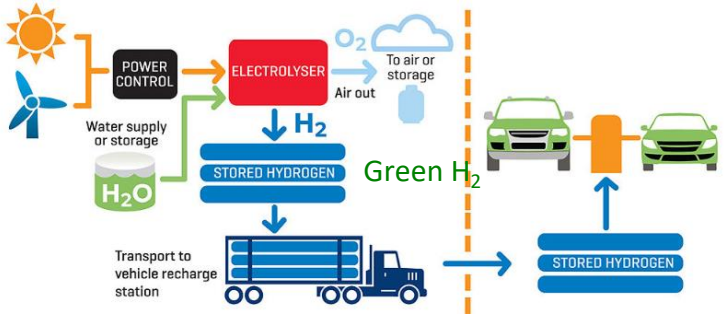


Agile Fractal Grid



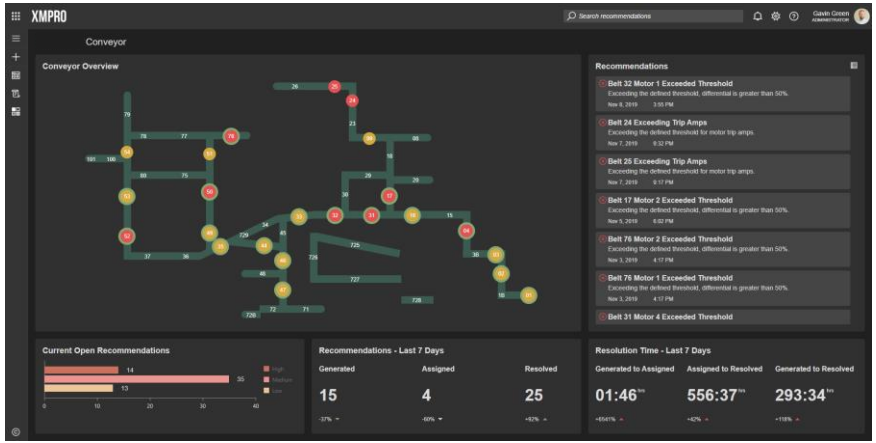
There are 10 ISO Markets in the country.

- Solar
- Wind
- Hydro

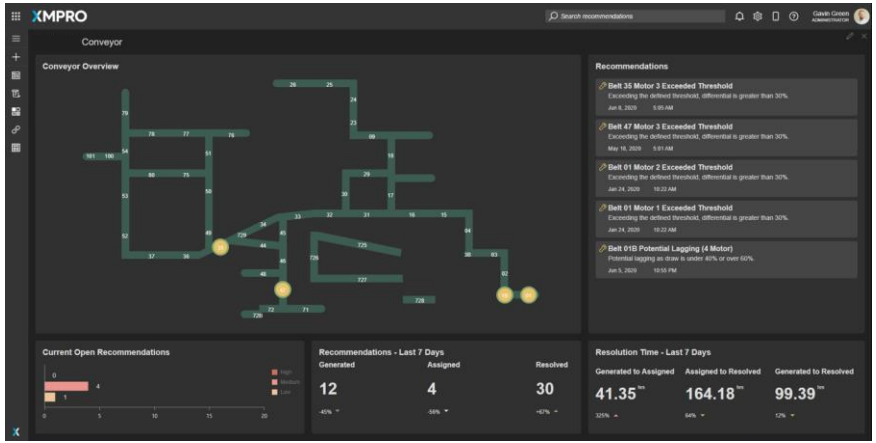


Digital Twin and Mining Operations

Impact – Underground Long Conveyor Twin



November 2019



June 2020

October 2019 to January 2020:
In total, 31 downtime events or ~184hrs of preventable borer downtime was identified, worth potentially **~44k product tonnes**

$4m PdM - Underground Long Conveyor

Challenge

Reduce long conveyor (underground) downtime by 30%

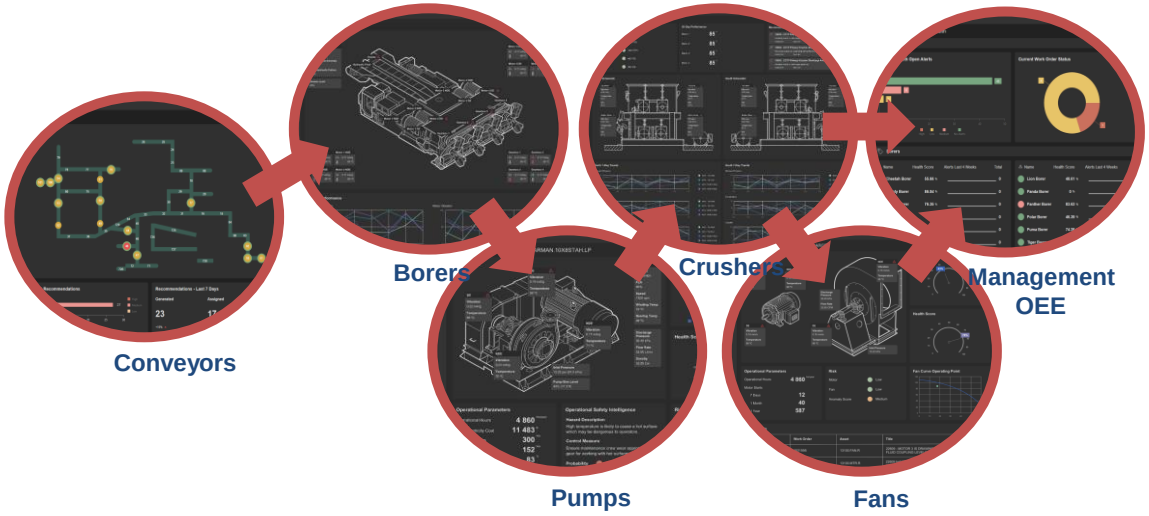
Solution

XMPro monitor 52 (80+km) conveyors and predict fluid coupling and lagging failures

Benefits

~184hrs of preventable borer downtime identified worth ~44k product tonnes

CUSTOMER STORY - Mining



Measures of Success

Time to value - 30 days to deploy initial release

- Integration with OSIsoft Historian and Oracle EAM
- Complex Engineering models
- predictive analytics executed at 2 sec intervals
- 30% reduction in conveyor downtime due to fluid coupling failures add $+4m in revenue

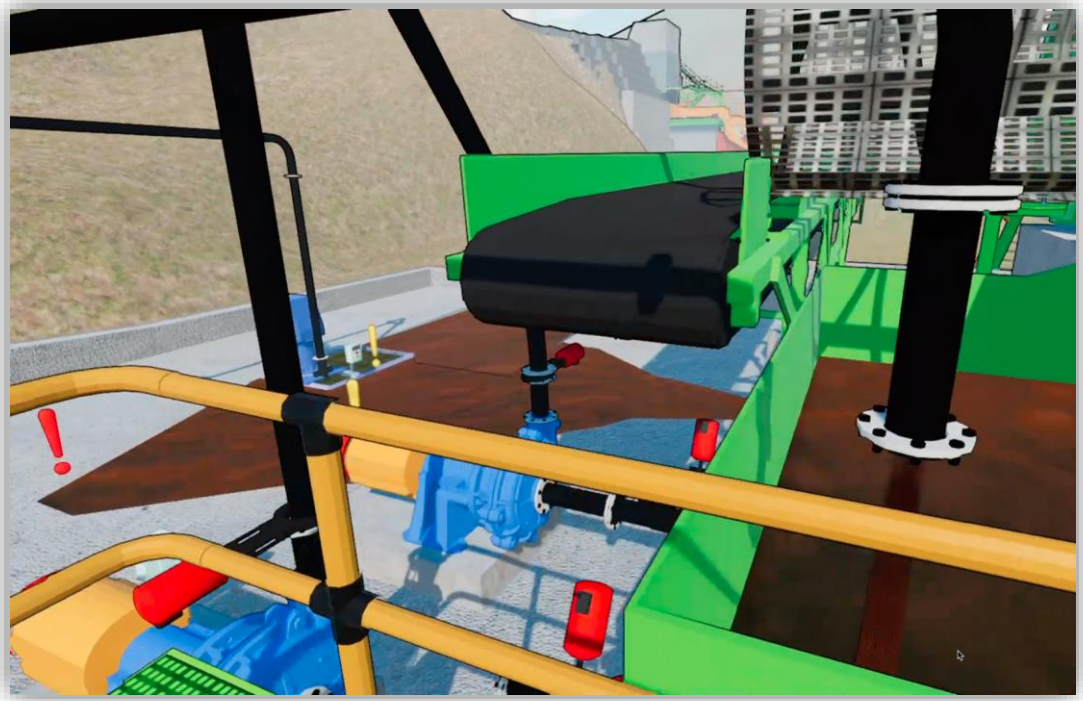
Always On, Situational Awareness

- 52 long conveyors in series
- Monitored and analyzed every 2 seconds
- Real-time dashboards with notifications
- Drill-down for decision-support and automation

Expert Knowledge Capture

- XMPro Recommendations capture expert knowledge on maintenance best practices
- Replaced ad-hoc BI style Excel (.xls) analysis with continuous analysis and notifications for reliability engineers to prescribe appropriate actions
- Recommended actions incorporated into predictive/prescriptive maintenance processes

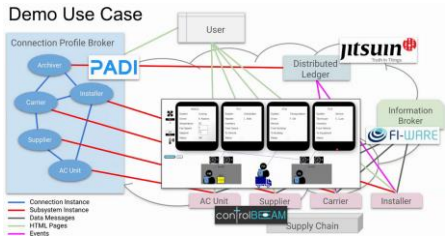
Use Case Example in Mining

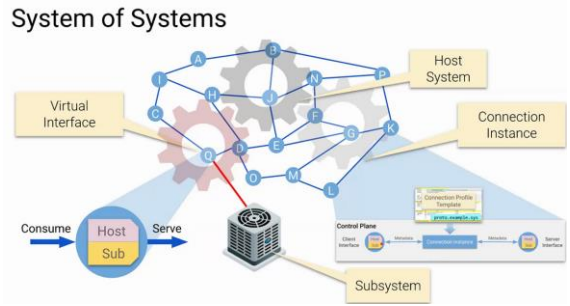


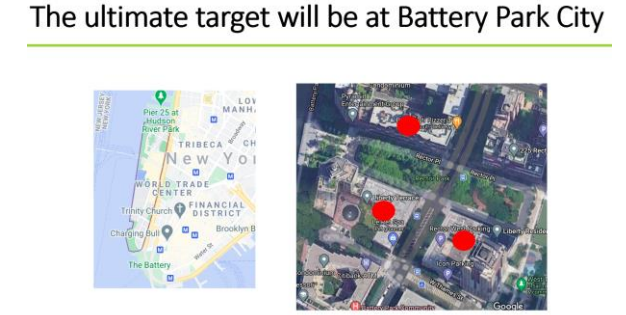
- Real-time process optimization in gold processing plant
- Real-time predictive and condition-based maintenance
- Real-time safety monitoring and hazard assessment

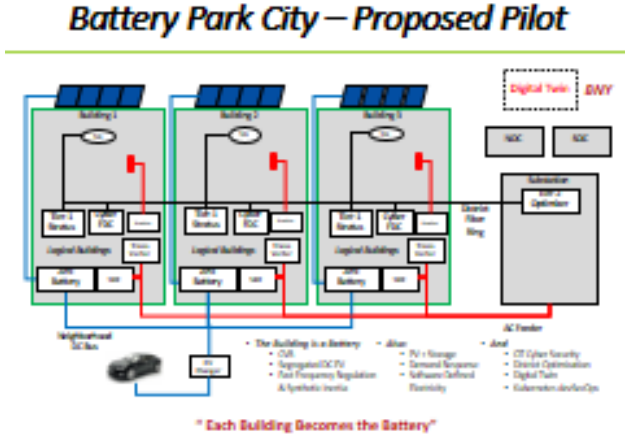
… combined in single twin

Member Collaboration Showcase Projects









Learn More and Get Involved!

Influence → Innovate

Participation in Digital Twin Consortium working groups

Eligibility to co-chair , start working groups

Influence the way the industry uses Digital Twins

Collaborate → Develop

Industry Peers

Access to Materials and Use case presentations

Become part of the consortium speaker Bureau

Implement → Lead

Drive Adoption through Awareness, Innovation and Best Practices

Highlight and showcase thought leadership through proof of value

digitaltwinconsortium.org

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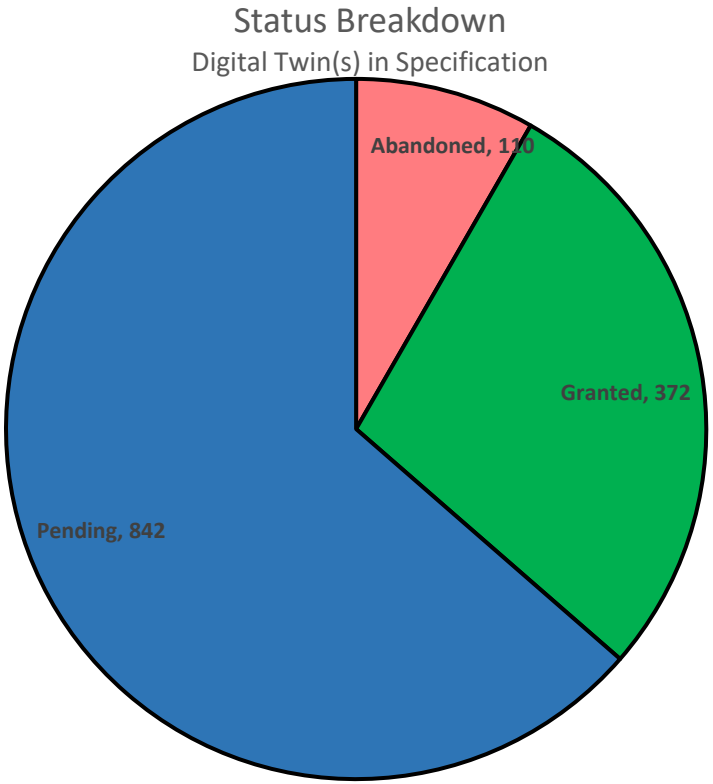
Digital Twins: US Patent Filing Analytics

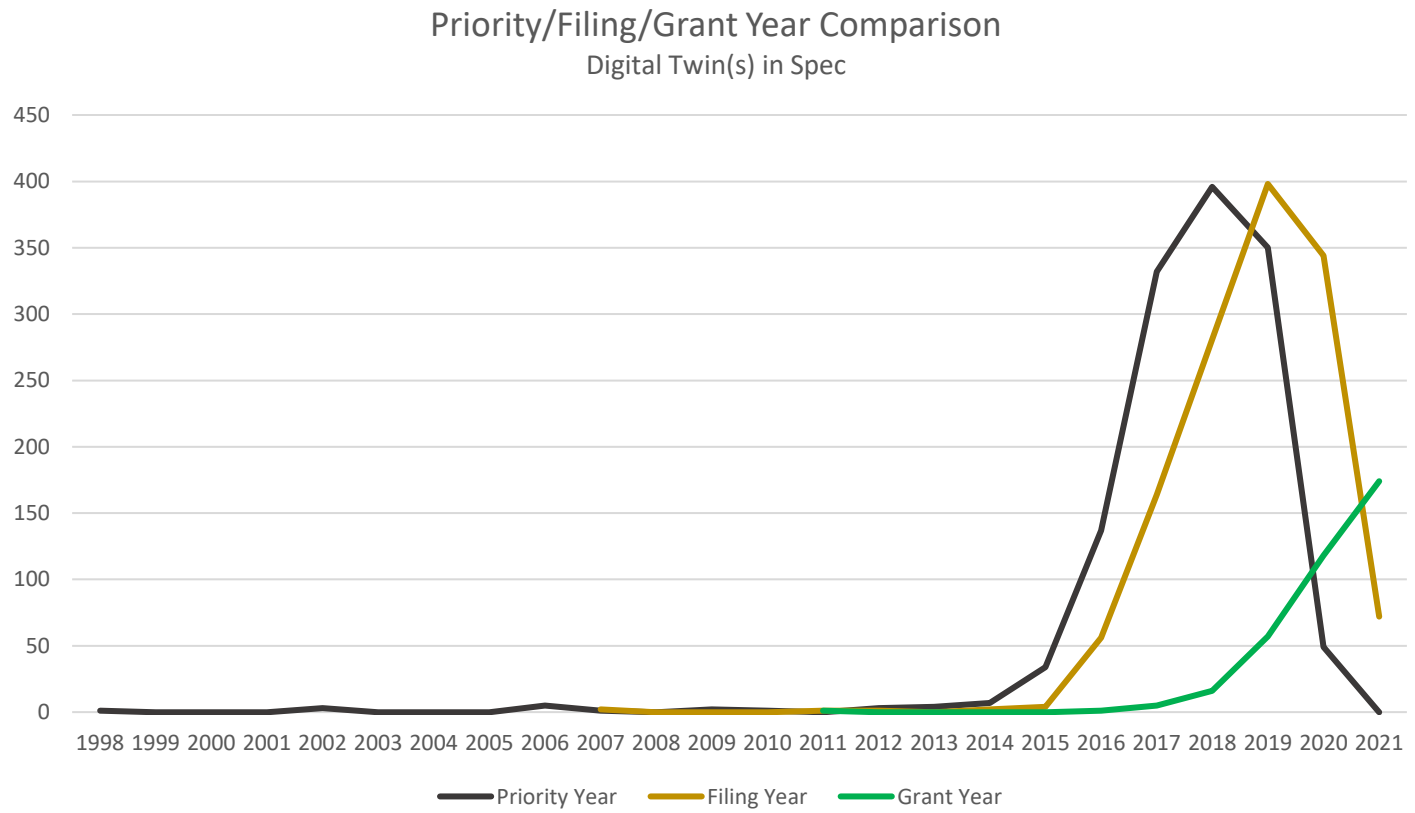
Digital Twin(s) in Specification

Pending: 842
Abandoned: 110
Granted : 372
Total: 1,324

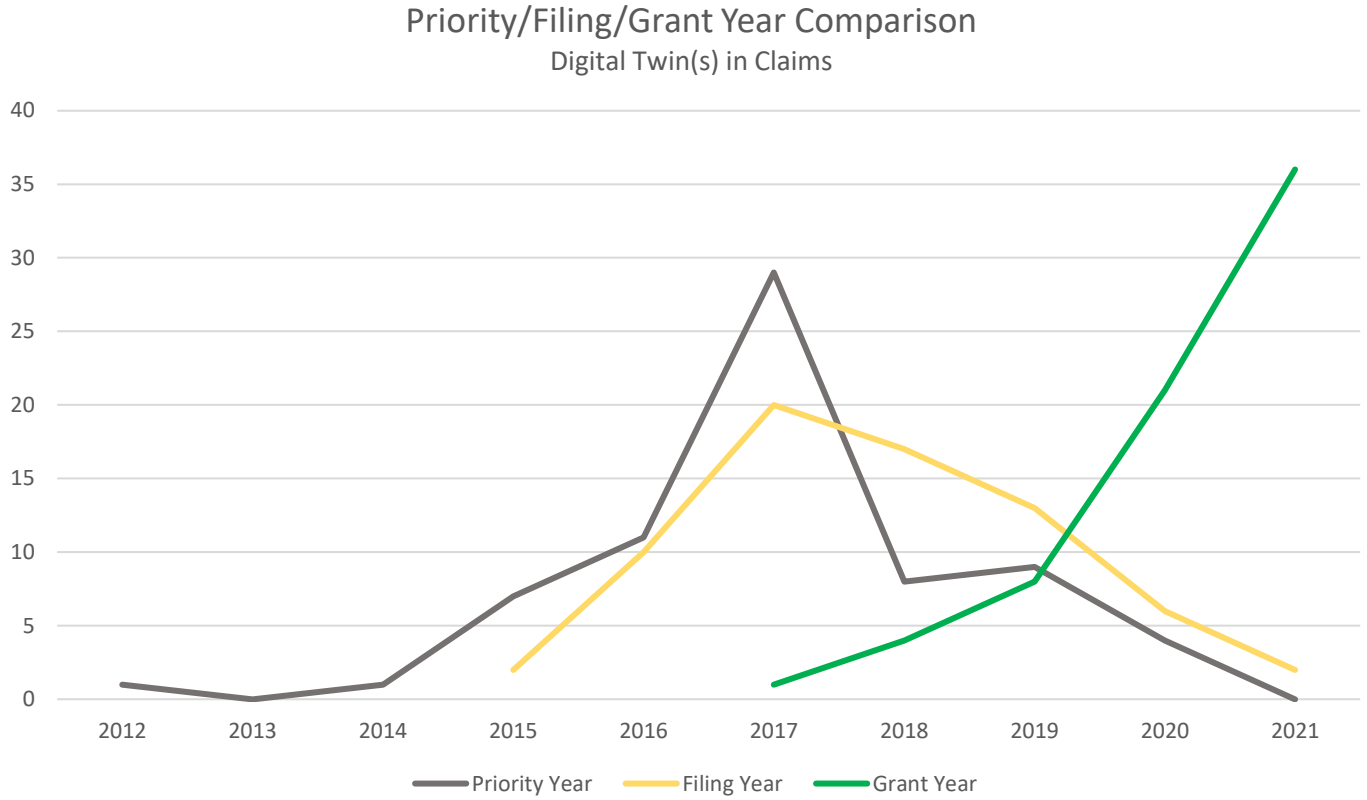
Compare:
Granted Patents with “Digital Twin(s)” in a) Any claim: ~67 or b) Independent Claim: 48



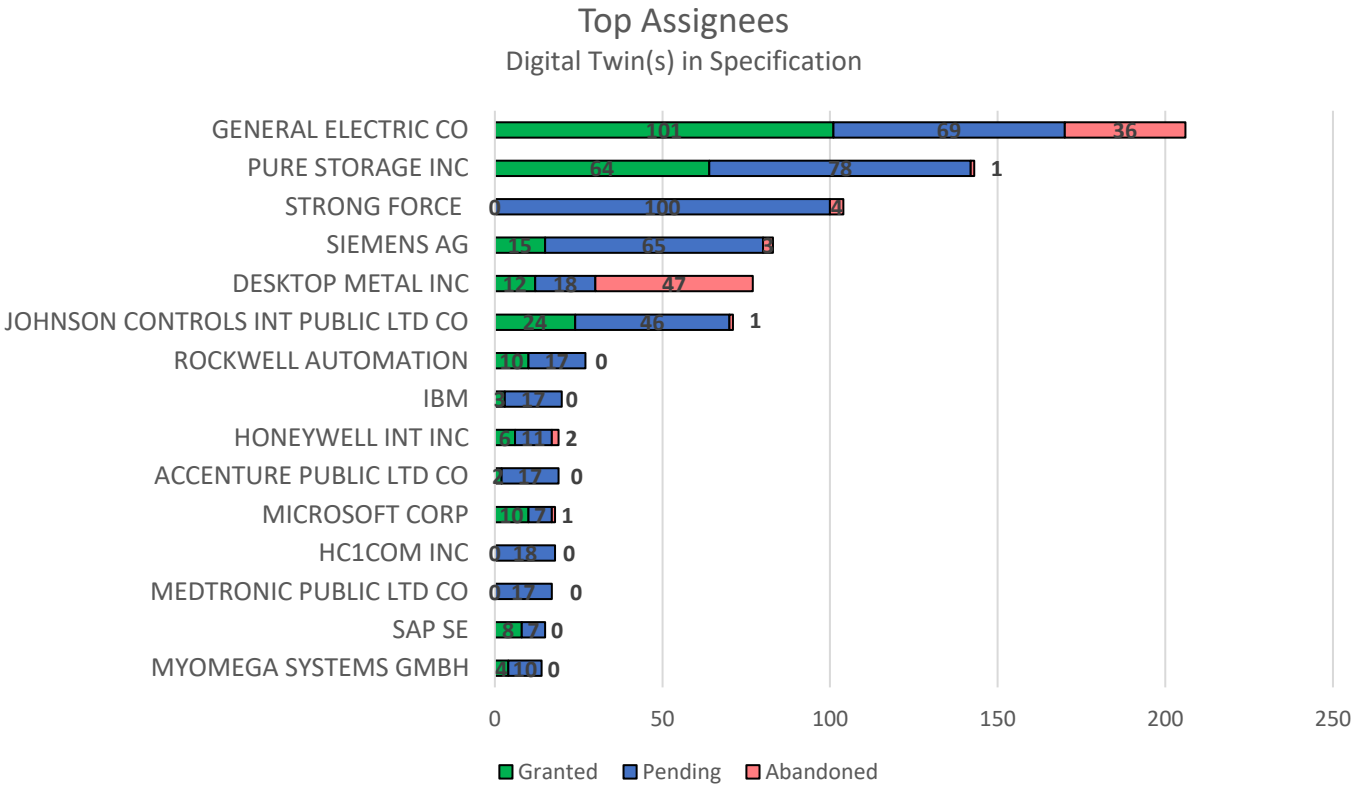
Digital Twin(s) Over Time – Specification of All Filings



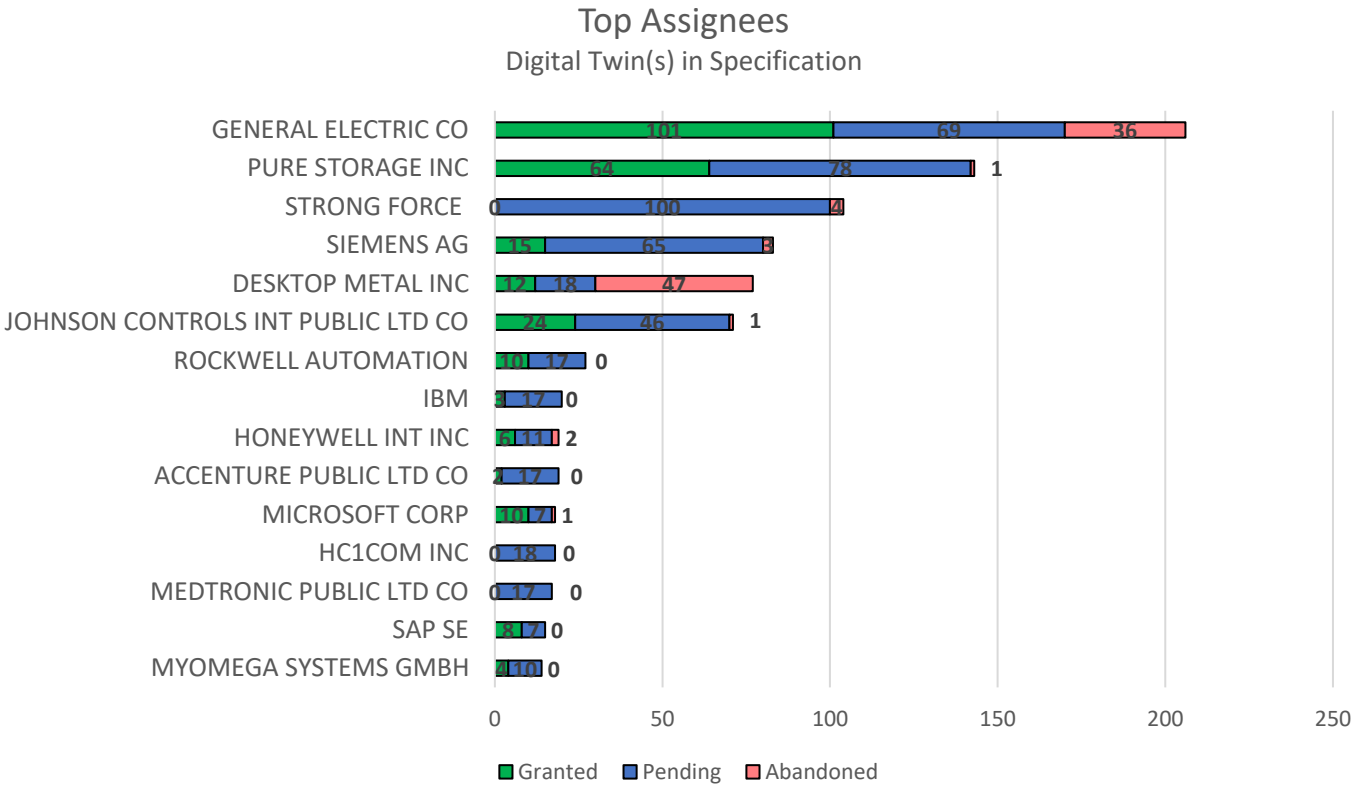
Digital Twin(s) Over Time – Claims of Granted Patents



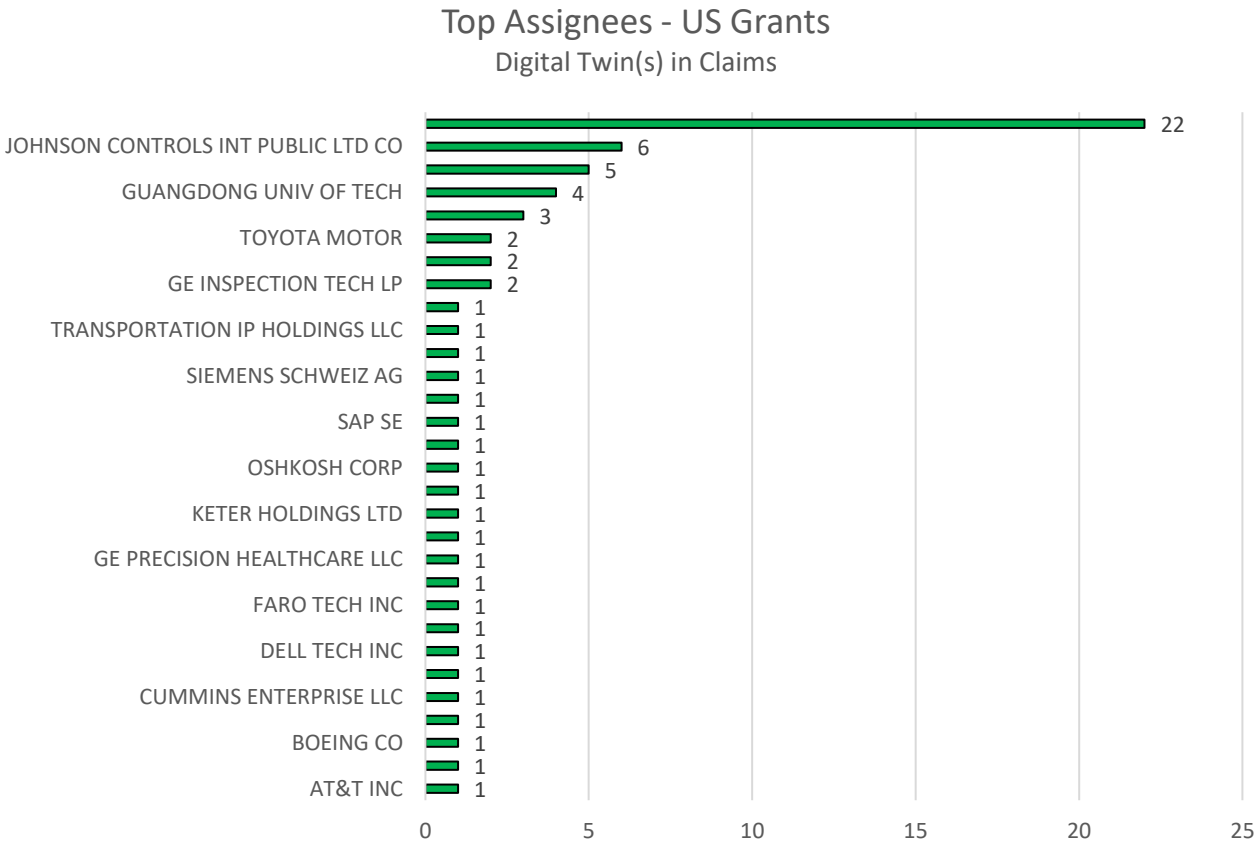
Digital Twin(s) in Specification – Top Assignees of All Filings



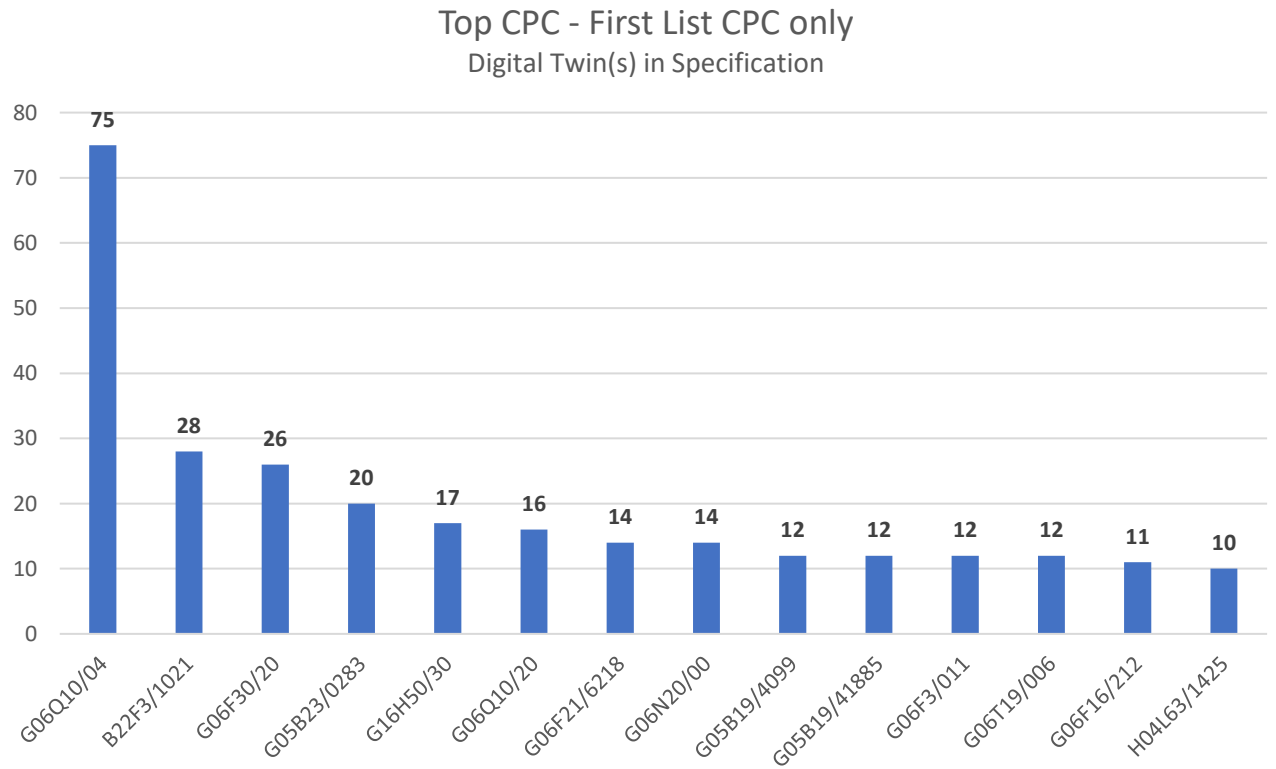
Digital Twin(s) in Specification – Top Assignees of All Filings



Digital Twin(s) in Claims – Top Assignees of Patent Grants



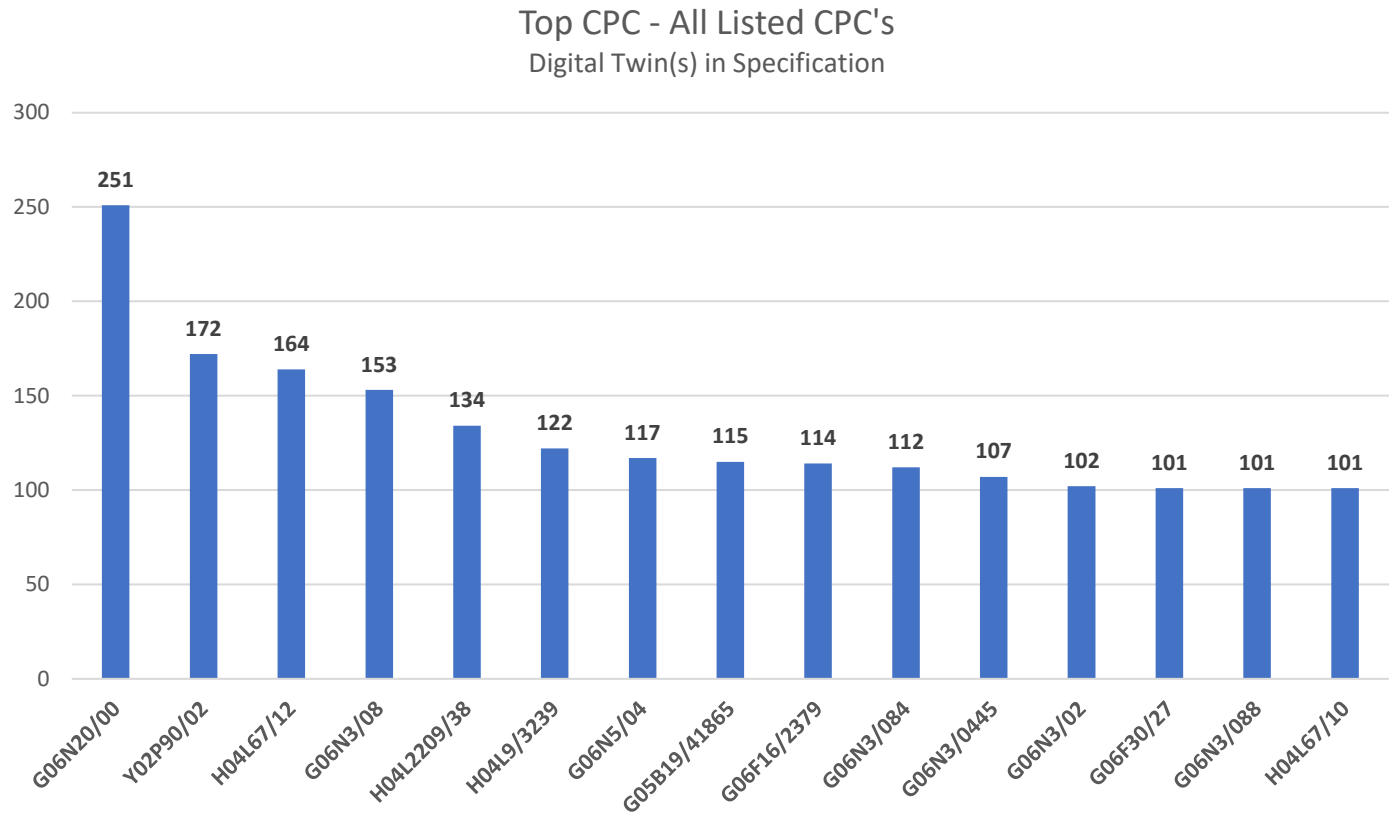
Digital Twin(s) in Specification – Top CPC – First CPC Only



Digital Twin(s) in Specification – Top CPC – First CPC Only

CPC Class	Class Title	Hits
G06Q10/04	DATA PROCESSING SYSTEMS OR METHODS, SPECIALLY ADAPTED FOR ADMINISTRATIVE, COMMERCIAL, FINANCIAL, MANAGERIAL, SUPERVISORY OR FORECASTING PURPOSES; SYSTEMS OR METHODS SPECIALLY ADAPTED FOR ADMINISTRATIVE, COMMERCIAL, FINANCIAL, MANAGERIAL, SUPERVISORY OR FORECASTING PURPOSES, NOT OTHERWISE PROVIDED FOR > Administration; Management > Forecasting or optimisation, e.g. linear programming, travelling salesman problem" or "cutting stock problem" "	75
B22F3/1021	WORKING METALLIC POWDER; MANUFACTURE OF ARTICLES FROM METALLIC POWDER; MAKING METALLIC POWDER > Multiple heating or additional steps > Removal of binder or filler	28
G06F30/20	ELECTRIC DIGITAL DATA PROCESSING > Computer-aided design [CAD] > Design optimisation, verification or simulation	26
G05B23/0283	CONTROL OR REGULATING SYSTEMS IN GENERAL; FUNCTIONAL ELEMENTS OF SUCH SYSTEMS; MONITORING OR TESTING ARRANGEMENTS FOR SUCH SYSTEMS OR ELEMENTS > characterized by the response to fault detection > Predictive maintenance, e.g. involving the monitoring of a system and, based on the monitoring results, taking decisions on the maintenance schedule of the monitored system; Estimating remaining useful life [RUL]	20
G16H50/30	HEALTHCARE INFORMATICS, i.e. INFORMATION AND COMMUNICATION TECHNOLOGY [ICT] SPECIALLY ADAPTED FOR THE HANDLING OR PROCESSING OF MEDICAL OR HEALTHCARE DATA > ICT specially adapted for medical diagnosis, medical simulation or medical data mining; ICT specially adapted for detecting, monitoring or modelling epidemics or pandemics > for calculating health indices; for individual health risk assessment	17
G06Q10/20	DATA PROCESSING SYSTEMS OR METHODS, SPECIALLY ADAPTED FOR ADMINISTRATIVE, COMMERCIAL, FINANCIAL, MANAGERIAL, SUPERVISORY OR FORECASTING PURPOSES; SYSTEMS OR METHODS SPECIALLY ADAPTED FOR ADMINISTRATIVE, COMMERCIAL, FINANCIAL, MANAGERIAL, SUPERVISORY OR FORECASTING PURPOSES, NOT OTHERWISE PROVIDED FOR > Administration; Management > Product repair or maintenance administration	16
G06F21/6218	ELECTRIC DIGITAL DATA PROCESSING > Protecting access to data via a platform, e.g. using keys or access control rules > to a system of files or objects, e.g. local or distributed file system or database	14
G06N20/00	COMPUTER SYSTEMS BASED ON SPECIFIC COMPUTATIONAL MODELS > Machine learning	14
G05B19/4099	CONTROL OR REGULATING SYSTEMS IN GENERAL; FUNCTIONAL ELEMENTS OF SUCH SYSTEMS; MONITORING OR TESTING ARRANGEMENTS FOR SUCH SYSTEMS OR ELEMENTS > characterised by using design data to control NC machines, e.g. CAD/CAM > Surface or curve machining, making 3D objects, e.g. desktop manufacturing	12
G05B19/41885	CONTROL OR REGULATING SYSTEMS IN GENERAL; FUNCTIONAL ELEMENTS OF SUCH SYSTEMS; MONITORING OR TESTING ARRANGEMENTS FOR SUCH SYSTEMS OR ELEMENTS > Total factory control, i.e. centrally controlling a plurality of machines, e.g. direct or distributed numerical control [DNC], flexible manufacturing systems [FMS], integrated manufacturing systems [IMS], computer integrated manufacturing [CIM] > characterised by modeling, simulation of the manufacturing system	12
G06F3/011	ELECTRIC DIGITAL DATA PROCESSING > Input arrangements or combined input and output arrangements for interaction between user and computer > Arrangements for interaction with the human body, e.g. for user immersion in virtual reality	12
G06T19/006	IMAGE DATA PROCESSING OR GENERATION, IN GENERAL > Manipulating 3D models or images for computer graphics > Mixed reality	12
G06F16/212	ELECTRIC DIGITAL DATA PROCESSING > Schema design and management > with details for data modelling support	11
H04L63/1425	TRANSMISSION OF DIGITAL INFORMATION, e.g. TELEGRAPHIC COMMUNICATION > by monitoring network traffic > Traffic logging, e.g. anomaly detection	10

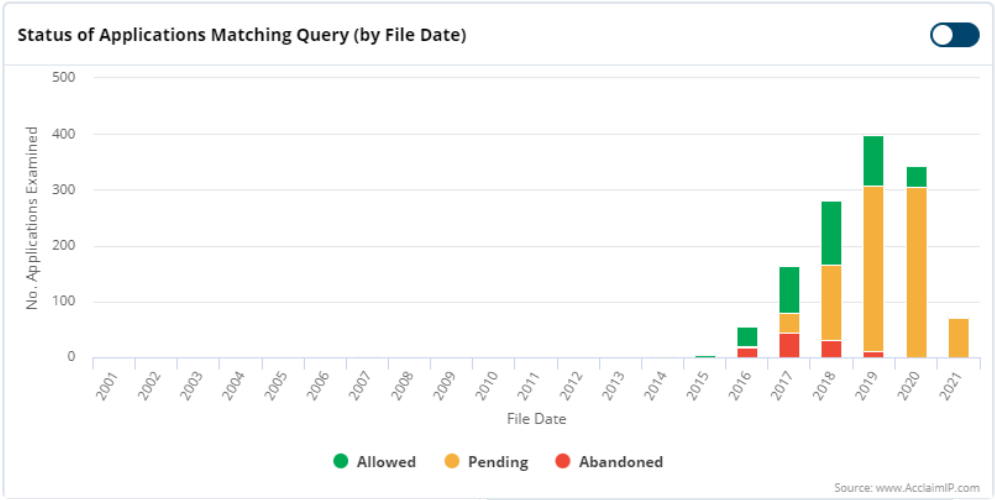
Digital Twin(s) in Specification – Top CPC – All CPC's

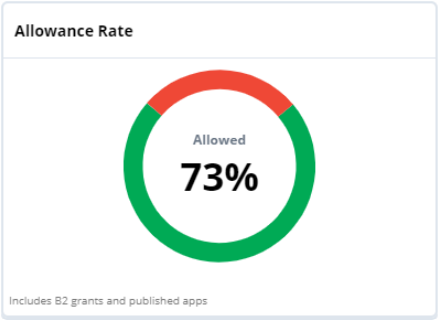


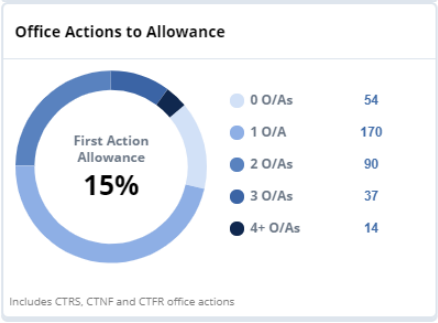
Digital Twin(s) in Specification – Top CPC – All CPC's

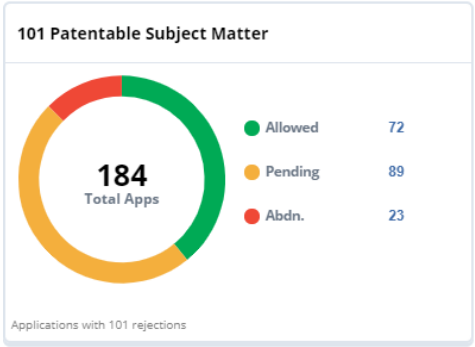
CPC Class	Class Title	Matters
G06N20/00	COMPUTER SYSTEMS BASED ON SPECIFIC COMPUTATIONAL MODELS > Machine learning	251
Y02P90/02	CLIMATE CHANGE MITIGATION TECHNOLOGIES IN THE PRODUCTION OR PROCESSING OF GOODS > Enabling technologies with a potential contribution to greenhouse gas [GHG] emissions mitigation > Total factory control, e.g. smart factories, flexible manufacturing systems [FMS] or integrated manufacturing systems [IMS]	172
H04L67/12	TRANSMISSION OF DIGITAL INFORMATION, e.g. TELEGRAPHIC COMMUNICATION > Network-specific arrangements or communication protocols supporting networked applications > adapted for proprietary or special purpose networking environments, e.g. medical networks, sensor networks, networks in a car or remote metering networks	164
G06N3/08	COMPUTER SYSTEMS BASED ON SPECIFIC COMPUTATIONAL MODELS > using neural network models > Learning methods	153
H04L2209/38	TRANSMISSION OF DIGITAL INFORMATION, e.g. TELEGRAPHIC COMMUNICATION > Additional information or applications relating to cryptographic mechanisms or cryptographic arrangements for secret or secure communication H04L9/00 > Chaining, e.g. hash chain or certificate chain	134
H04L9/3239	TRANSMISSION OF DIGITAL INFORMATION, e.g. TELEGRAPHIC COMMUNICATION > using cryptographic hash functions > involving non-keyed hash functions, e.g. modification detection codes [MDCs], MD5, SHA or RIPEMD	122
G06N5/04	COMPUTER SYSTEMS BASED ON SPECIFIC COMPUTATIONAL MODELS > Computer systems using knowledge-based models > Inference methods or devices	117
G05B19/41865	CONTROL OR REGULATING SYSTEMS IN GENERAL; FUNCTIONAL ELEMENTS OF SUCH SYSTEMS; MONITORING OR TESTING ARRANGEMENTS FOR SUCH SYSTEMS OR ELEMENTS > Total factory control, i.e. centrally controlling a plurality of machines, e.g. direct or distributed numerical control [DNC], flexible manufacturing systems [FMS], integrated manufacturing systems [IMS], computer integrated manufacturing [CIM] > characterised by job scheduling, process planning, material flow	115
G06F16/2379	ELECTRIC DIGITAL DATA PROCESSING > Updating > Updates performed during online database operations; commit processing	114
G06N3/084	COMPUTER SYSTEMS BASED ON SPECIFIC COMPUTATIONAL MODELS > Learning methods > Back-propagation	112
G06N3/0445	COMPUTER SYSTEMS BASED ON SPECIFIC COMPUTATIONAL MODELS > Architectures, e.g. interconnection topology > Feedback networks, e.g. hopfield nets, associative networks	107
G06N3/02	COMPUTER SYSTEMS BASED ON SPECIFIC COMPUTATIONAL MODELS > Computer systems based on biological models > using neural network models	102

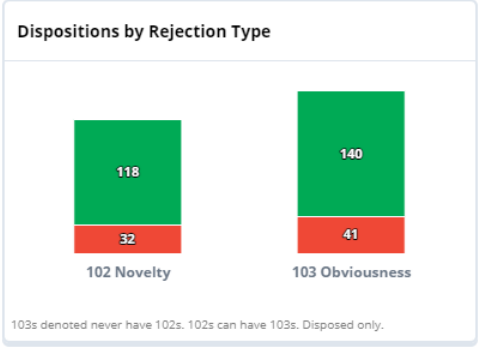
Digital Twin(s) in Specification – Prosecution Analytics





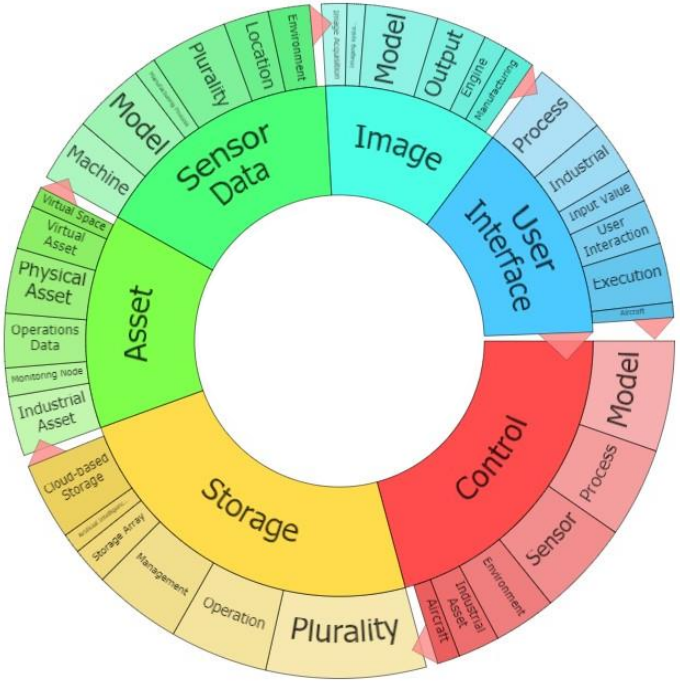






Digital Twin(s) in Specification – Concept Landscape

All Assignees



Use Case – Manufacturing: Part Assembly Verification

(19) **United States**
(12) **Patent Application Publication**
Rakshit
(10) **Pub. No.: US 2021/0149380 A1**
(43) **Pub. Date: May 20, 2021**

(54) **PROGRESSIVE GUIDANCE OF DIGITAL TWIN MODEL ASSEMBLY**

(71) Applicant: **International Business Machines Corporation**, Armonk, NY (US)

(72) Inventor: **Sarbajit K. Rakshit**, Kolkata (IN)

(21) Appl. No.: **16/687,900**

(22) Filed: **Nov. 19, 2019**

Publication Classification

(51) **Int. Cl.**
G05B 19/418 (2006.01)
G06F 3/01 (2006.01)

(52) **U.S. Cl.**
CPC ***G05B 19/41875*** (2013.01); ***G06F 3/016*** (2013.01); *H04L 67/10* (2013.01); *G05B 2219/40111* (2013.01); *G05B 2219/32368* (2013.01); ***G06F 3/011*** (2013.01)

(57) **ABSTRACT**

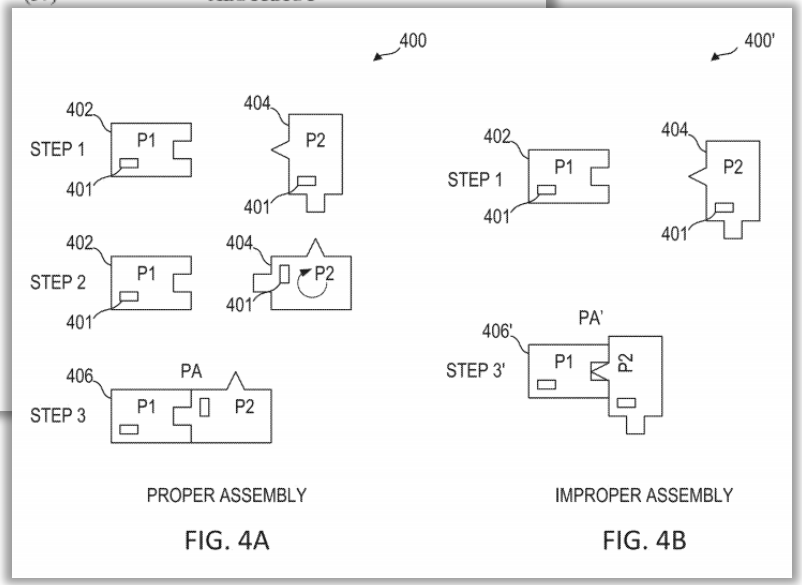


FIG. 4A FIG. 4B

Use Case – Manufacturing: No Office Action Required

1. A computer implemented method, comprising:

receiving digital twin instance part assembly information (IPAD) from a sensor scan of a physical part assembly produced by assembling a first physical part with a second physical part;

receiving digital twin framework part assembly data (FPAD) representing a correctly assembled physical part assembly and that corresponds to the physical part assembly;

receiving context data associated with a context within which the physical part assembly is produced;

comparing the FPAD with the IPAD, utilizing the context data, to determine whether a deviation of the IPAD from the FPAD exceeds a threshold; and

responsive to the deviation exceeding a threshold, providing corrective information to a device of an assembler for re-assembling the first physical part to the second physical part to produce a reassembled physical part assembly based on the corrective information.

Use Case – Automotive: Predictive Maintenance Reports

(19) **United States**
(12) **Patent Application Publication**
Shiraishi et al.
(10) **Pub. No.: US 2019/0287079 A1**
(43) **Pub. Date: Sep. 19, 2019**

(54) **SENSOR-BASED DIGITAL TWIN SYSTEM FOR VEHICULAR ANALYSIS**

(71) Applicant: **TOYOTA JIDOSHA KABUSHIKI KAISHA**, Toyota-shi (JP)

(72) Inventors: **Shinichi Shiraishi**, Mountain View, CA (US); **Yu Zhao**, Mountain View, CA (US)

(21) Appl. No.: **15/925,070**

(22) Filed: **Mar. 19, 2018**

Publication Classification

(51) **Int. Cl.**
G06Q 10/00 (2006.01)
G07C 5/00 (2006.01)
G07C 5/08 (2006.01)
G06Q 30/06 (2006.01)

(52) **U.S. Cl.**
CPC ***G06Q 10/20*** (2013.01); ***G07C 5/008*** (2013.01); ***G06Q 30/0623*** (2013.01); ***G06Q 30/0643*** (2013.01); ***G07C 5/0841*** (2013.01)

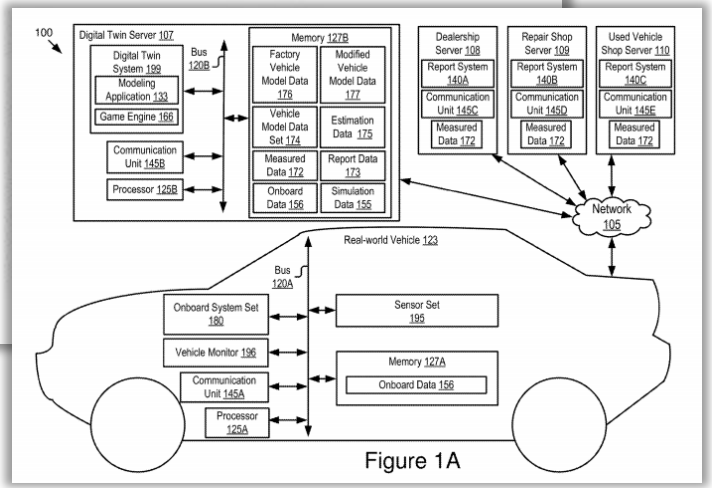


Figure 1A

Use Case – Automotive: 3rd Office Action Received

1. (Previously Presented) A method comprising:

generating a digital twin of a vehicle;

receiving digital data recorded by a sensor and describing the vehicle as it exists in a real-world;

generating a simulation that includes, based on the digital data, a virtual version of the vehicle that is correspondingly altered from when the vehicle was manufactured, wherein the simulation causes static objects and dynamic objects to behave as real-world objects in relation to the virtual version of the vehicle;

updating the digital twin of the vehicle based on the simulation so that the digital twin is consistent with a condition of the vehicle as it exists in the real-world; and

generating an electronic report describing the vehicle based on the simulation and the updated digital twin, wherein the electronic report includes a prediction that a particular part of the vehicle will need to be replaced or how the vehicle will perform if purchased.

Use Case – Healthcare: Health Tracker Device Treatment Plan

(12) **United States Patent**
T et al.

(10) **Patent No.: US 10,957,451 B2**
(45) **Date of Patent: Mar. 23, 2021**

(54) **PATIENT HEALTHCARE INTERACTION DEVICE AND METHODS FOR IMPLEMENTING THE SAME**

(71) Applicant: **GENERAL ELECTRIC COMPANY**, Schenectady, NY (US)

(72) Inventors: **Satyanarayana T**, Bangalore (IN); **Abraham Gogulamudi**, Bangalore (IN)

(73) Assignee: **GENERAL ELECTRIC COMPANY**, Schenectady, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 393 days.

(21) Appl. No.: **15/910,686**

(22) Filed: **Mar. 2, 2018**

(58) **Field of Classification Search**
CPC G16H 40/20
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Michael Tomaszewski

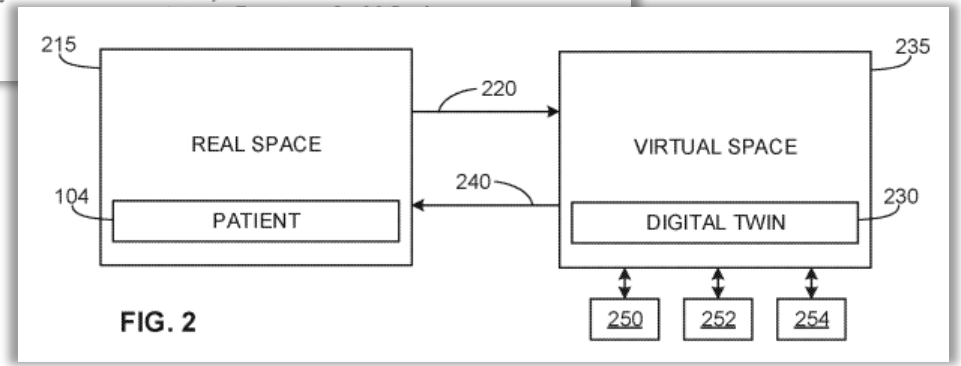
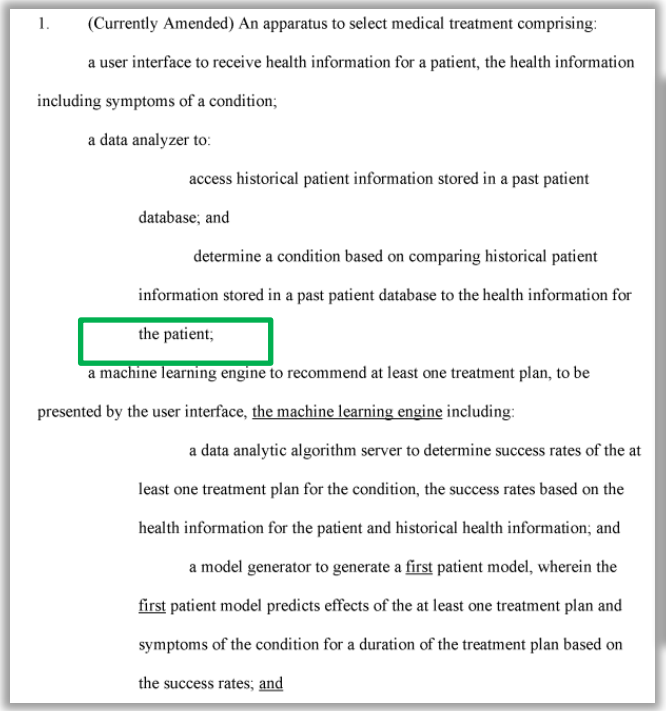


FIG. 2

Use Case – Manufacturing: Allowed After 1st Office Action



1. (Currently Amended) An apparatus to select medical treatment comprising:

a user interface to receive health information for a patient, the health information including symptoms of a condition;

a data analyzer to:

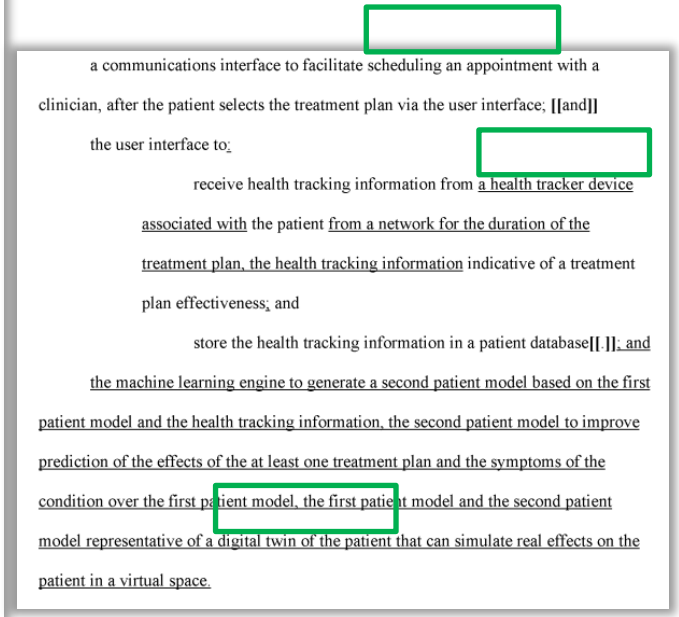
access historical patient information stored in a past patient database; and

determine a condition based on comparing historical patient information stored in a past patient database to the health information for the patient;

a machine learning engine to recommend at least one treatment plan, to be presented by the user interface, the machine learning engine including:

a data analytic algorithm server to determine success rates of the at least one treatment plan for the condition, the success rates based on the health information for the patient and historical health information; and

a model generator to generate a first patient model, wherein the first patient model predicts effects of the at least one treatment plan and symptoms of the condition for a duration of the treatment plan based on the success rates; and



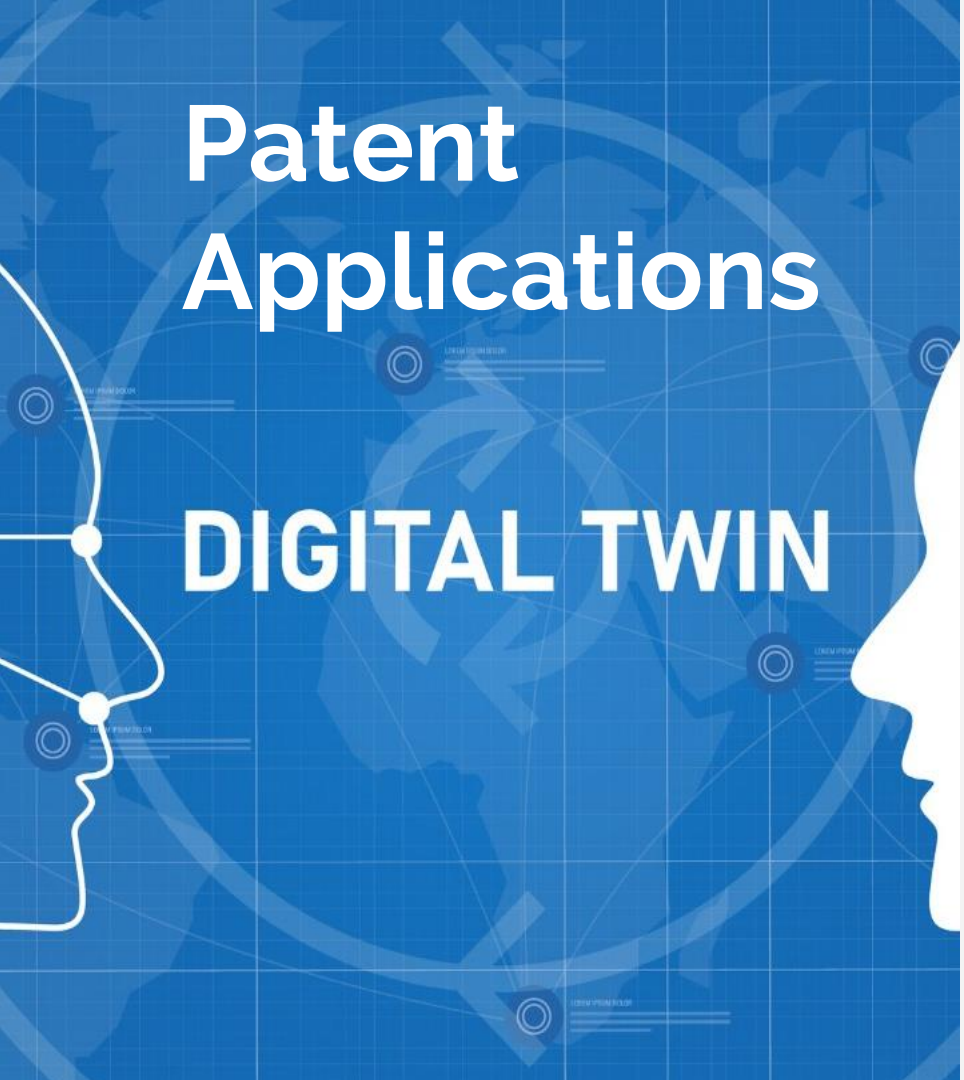
a communications interface to facilitate scheduling an appointment with a clinician, after the patient selects the treatment plan via the user interface; **[[**and**]]**

the user interface to:

receive health tracking information from a health tracker device associated with the patient from a network for the duration of the treatment plan, the health tracking information indicative of a treatment plan effectiveness; and

store the health tracking information in a patient database**[[**.**]]**; and

the machine learning engine to generate a second patient model based on the first patient model and the health tracking information, the second patient model to improve prediction of the effects of the at least one treatment plan and the symptoms of the condition over the first patient model, the first patient model and the second patient model representative of a digital twin of the patient that can simulate real effects on the patient in a virtual space.



Drafting & Enforcement Things to Consider:

- Patentable Subject Matter Rejections
  - Include Computer Hardware
  - Include Real-World Result
- Infringement Detection
  - Level of investigation needed?
- Infringement Assertion
  - Who would infringe the claim?
  - Divided infringement
- “Standard Essential” Issues

Thank you for your interest.

Questions?

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