From Structural Health Monitoring to Digital Twin

The better the question. The better the answer.
The better the world works.

EY
Building a better working world

Agenda

1. The EY Team
2. Digital Twins and Enterprise Metaverse
3. Our Journey: from SHM for Bridges to Digital Twins
4. Retrospective and Prospective
5. Q/A

EY Team

Jeff Sharp
Associate Partner

Jeff is an Associate Partner in the Consulting Team, based in Melbourne. He was previously the General Manager for Technology Partnerships & Innovation at Transurban. Jeff is a flexible, committed and strategically-focused team player who enjoys achieving outstanding results. He is a strategic thinker who is able to assimilate information quickly to solve complex problems and assess a broad range of future possibilities. He has strong engineering experience across telecommunications, transport, mining, health and IT sectors, which he combines with a logical approach to problem solving. Jeff has strong experience in Internet of Things, Machine Learning and predictive analytics leveraging Digital Twins.

Chen Cai
Senior Manager

Dr. Chen Cai is a senior manager at EY, based in Sydney. Prior to this, he led the Transport Analytics group at Data61 (CSIRO), and the leader of Data61's business initiatives in transport and logistics. Being a pioneer in adopting AI for transport, Dr. Cai co-founded group in 2013 and led it to grow into one of Australia's leading research units. Dr. Cai is a board director of Intelligent Transport Systems Australia, the peak-body of the nation's ITS industry. Dr. Cai has led his group to earn more than $7 million external revenue to Data61 since 2016, including the award of the NSW Premier's Innovation Initiative.

Benjamin Itzstein
Senior Manager

Benjamin Itzstein is a senior manager at EY, based in Sydney. Prior to this, he led the Transport Platforms team at Data61, which is responsible for building and maintaining the data and services platform and delivering the Transport Analytics Group's advanced research as tools and products. He has worked as a research and senior software engineer within Transport, Machine Learning and Human-Computer Interaction projects at Data61 (previously NICTA) since 2009. He holds a B.E. in Mechatronics with University Medal, and a B.Sc. (Advanced) in Physics and Computer Science, from the University of Sydney.

Khoa Nguyen
Senior Manager

Dr. Khoa Nguyen is a senior manager at EY, based in Sydney. He previously was a senior research scientist and a team leader at Data61. He is driving the research and projects in predictive analytics for asset management, digital twins, Structural Health Monitoring and energy demand forecasting. His research interest is using applied machine learning and data science for problem solving in different application domains. He has been driving several industrial projects investigating machine learning for real-world problems such as damage detection in civil structures, fault detection in robotic arms and energy demand forecasting. He holds a Ph.D. in computer science at the University of Sydney.

Dilusha Weeraddana
Manager

Dr. Dilusha Weeraddana is a manager at EY, who is passionate about yielding insights from complex datasets. She has more than 10 years of experience obtained through both commercial and research pursuits. Strong knowledge and hands-on experience in machine learning techniques and programming languages. Solid skills in mathematics, algorithms and data science. She has experience predicting water pipeline failures, energy demand forecasting and structural health monitoring leveraging machine learning.

Chao Li
Senior Manager

Chao will drive the red flag analysis and use data science techniques to identify indicators to look for in the data. Chao is a senior full-stack engineer and data scientist transitioning to EY from Data61. He has experience in building large scale distributed systems for big data, machine learning and graph analytics. He is also experienced in building visualisation tools for monitoring and data analytics systems.

2 Digital Twins and Enterprise Metaverse

What is a Digital Twin?

Definition

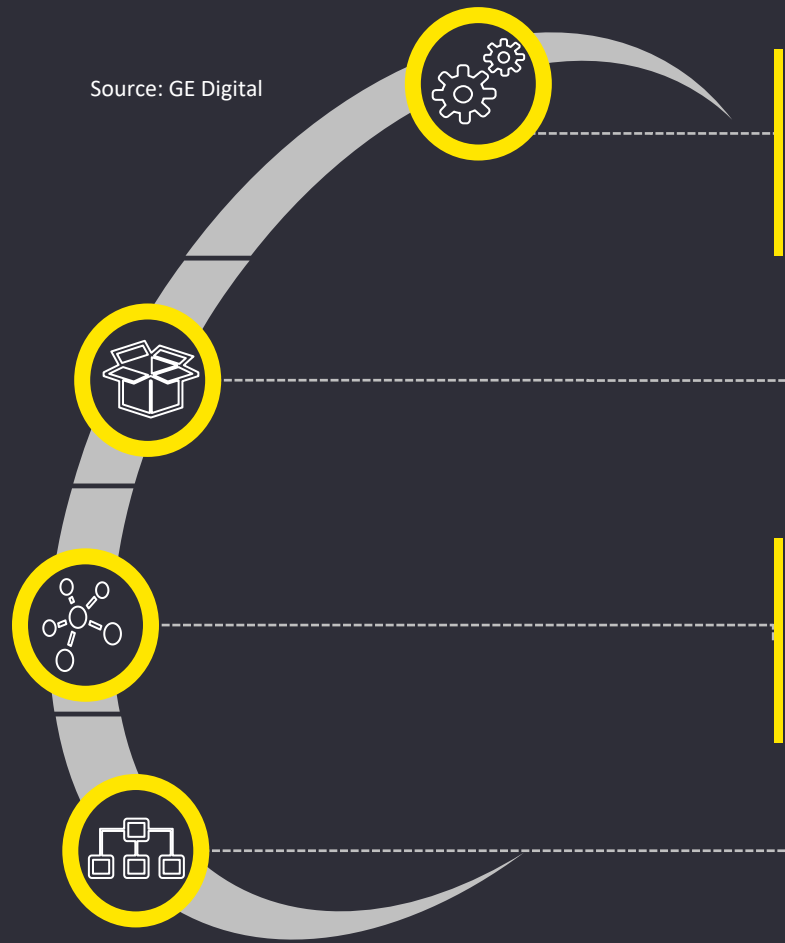
A digital twin is a virtual model or digital replica of processes, products, production assets or services that contains sensor-enabled and IoT-connected machines and devices, combined with machine learning (ML) and advanced analytics to view the operational state in real-time through a 2D- or 3D-visualization platform.

Digital twins are increasingly being used in many industries, including automotive, aerospace, manufacturing, health care, and power and utilities.

Leveraging these technologies, companies can create a virtual model of the physical end-to-end supply chain. The data from various sources and systems across a supply chain network — from IoT sensors and signals from GPS devices, for example — are connected to create a virtual replica containing the same supply entities, parameters and financial targets.

Digital Scope and Benefits

Source: GE Digital



Component level

- Highlight most crucial and essential component in manufacturing process
- Examples: rotor, blade

Asset/product level

- Design, monitoring, predictive maintenance of product and analysis of product life cycle
- Examples: turbine, motors

System level

- Improvising entire production line with the whole fleet of products in the system
- Examples: combined-cycle plant, crude unit

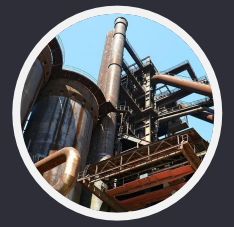
Process level

- Connecting multiple organizations across the supply chain, across the production environment
- Examples: manufacturing process

Benefits/ Value Levers

- Real time performance monitoring
- Reduce Non Value Add Time
- Improved Yield
- Increased OEE
- Predictive Maintenance
- Quality Optimization

Types of Data and Applications

Built environment	Transport network	Asset	Product lifecycle	Business process	Physical process
					

Level of fidelity

Generic data modelling — Domain modelling, Semantics — Simulation, What if?

Frequency of data: Synthetic → Infrequent → Real-time

Data analysis platform	Design testing, Exploratory models	Training Design optimisation
Longitudinal dashboard	Planning insights & forecasts, Lifecycle management	Planning scenario testing
Live dashboard “Digital shadow”	Operational decision support Implement & monitor changes AR/VR field operations	Operational scenario testing Recommendations

Towards Enterprise Metaverse

Smart Sensors

Track locations, conditions, performance, energy, environment using IoT devices

Advance Planning and Scheduling

Segmentation and Synchronization of Supply Chain shift focus to exception handling only.

Artificial Intelligence

Learning and intelligence captured so that a machine can simulate it.

Digital Op Ex

Digital Standard Work Processes, IWS, Digital Op Ex Coach,

Drones, UAVs and Robotics

Inspect high risk areas for inventory, condition. Move material without humans.

Machine Learning

Learn skills and facts from experience to build prediction models and improve decisions

Blockchain

Distributed ledger for managing data throughout supply chain for traceability, inventory control, or even track taxes

Smart Maintenance

Collect data from machine sensors, Use Predictive Analysis to predict failures. Schedule maintenance in advance of failure

Augmented and Virtual Reality

Project useful information in user's field of vision for assembly guidance or virtual design modelling.

Smart Material Handling

Smart Kanban process with automated inbound and outbound material handling.

Digital Worker/ AR

Worker gets all relevant information overlaid into animated work instructions and comments

Digital Twins

Virtual models simulate processes to improve performance

Big Data & Analytics

Large volume data that cannot be managed by traditional relational techniques

Intelligent Process Optimization

Model complex production processes with advanced analytics

Smart Equipment

Make low-cost changes that reap large savings through analysis of performance data

30 November 2022

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From SHM for Bridges to Digital Twins


4
Retrospective & Prospective

Where We are Leading

E2E SHM Design

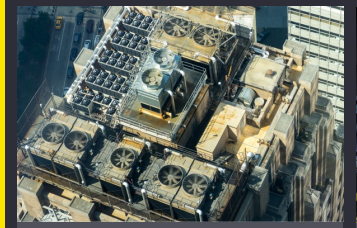
- Sensors and sensing networks
- Data Acquisition
- Edge Computing
- Communications
- Data Platform
- AI/ ML
- Digital Systems/Simulation
- UI/API

Proven Use Cases

Bridge SHM




General Predictive Asset Management



- Industry HVAC

- Robotics

Digital Twinning

- Digital Shadows
- Digital Models
- Advanced analytics, AI, machine learning
- Semantics

Impact

- SHM concept proven in various industry verticals
- Demonstrated business use cases
- Increased technology readiness
- Raised public awareness of SHM
- Contributions towards technology standardization and development guidelines
- Promotion of best practice
- Fostering the growth of SHM ecosystem

Where We are Lacking

Cost and Serviceability

- Low-cost, low energy consumption sensors
- Redundancy, fault tolerance , and longevity
- Scalability and data management
- Serviceability
- Cyber security

Business Workflow Integration

- E2E business process digitization
- From a failure point to the impact of the whole business process
- Work assignment and tracking
- Procurement and onboarding
- Simulating impact of the onboarding for change management
- Proactive inventory and shop floor management

Benefits Realization

Strategic

- Completion of the digital transformation for the underlying E2E business process
- Alignment of business strategy and culture
- Business resilience to disruptions

Operational

- Improvement in asset performance KPIs
- Reduced OPEX
- Improved performance of CAPEX

The Way Forward

Digital Twin of a System

Use cases

SHM

Predictive asset management

Challenge

Cost

Sensors and network design

Scalability, serviceability

Outcome

Permanent adoption

Workflow integration

Performance gains

- Digital twin of a bridge with a SHM, a digital model, and a simulator.

Digital Twin of a Process

Use cases

Supply chain management

Production line management

Challenge

Alignment of business strategy and culture

Change management

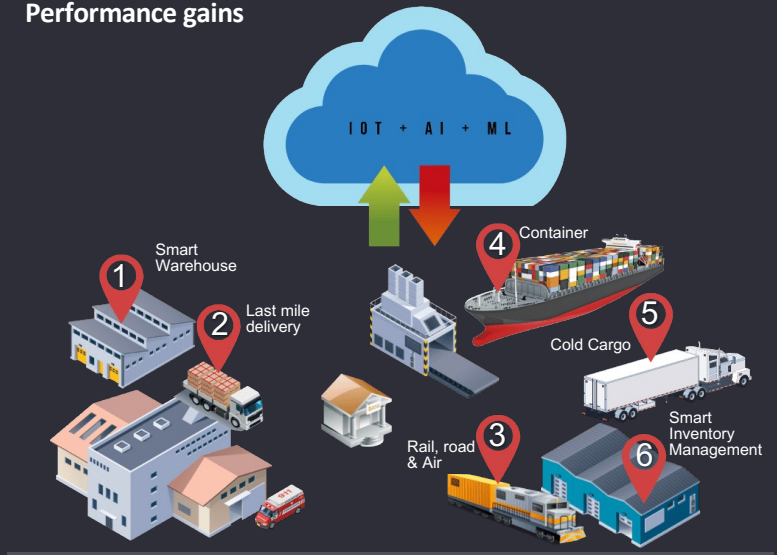
Stakeholder engagement

Outcome

Business transformation

Workforce transformation

Performance gains



- Digital twin of an E2E supply chain, with connected digital twin instances for each of the systems in the process.

Enterprise Metaverse

Use cases

Design, engineering, scenario planning

Sales, marketing, customer experience

Challenge

Technology readiness

Organizational readiness

Customer readiness

Outcome

Market transformation

Consumer culture shift

- A digital and immersive environment that replicates and connects all aspect of an organization.

EY | Assurance | Tax | Transactions | Consulting

About EY
EY is a global leader in assurance, tax, transaction and consulting services. The insights and quality services we deliver help build trust and confidence in the capital markets and in economies the world over. We develop outstanding leaders who team to deliver on our promises to all of our stakeholders. In so doing, we play a critical role in building a better working world for our people, for our clients and for our communities.

HR changes, for example implementation in HR systems and people mapping, are subject to regional implementation particularities.

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