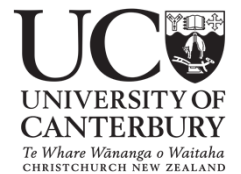# Theme 2
Digital Engineering

Industry Day

Areas Previously Addressed

- Benefits of digitalization for NZ
  - *10 Recommendations for NZ*

- Location standards for utilities in NZ

- Classification mapping automation

- PPE detection on construction sites

- Case studies
  - *Common Data Environment for Team Collaboration*
  - *Quantity Take-Off (QTO) Tool*

Highlighted Projects

- BIMSafe – Health & Safety through Building Information Modelling (BIM)
  - *Immediate impact across 3 years*

- Managing whole-of-life building information
  - *Changing behaviour in industry*
  - *Medium-term software tool development impact*

- Artificial Intelligence (AI) approaches to Code Compliance Checking
  - *Influencing (local and national) government thinking*
  - *Longer-term research impact*

Digitalisation of the New Zealand Building Industry

Capturing the Benefits of Digital Technologies on the Planning, Design, Construction and Management of Buildings.

Appendix A: BiP Survey Results
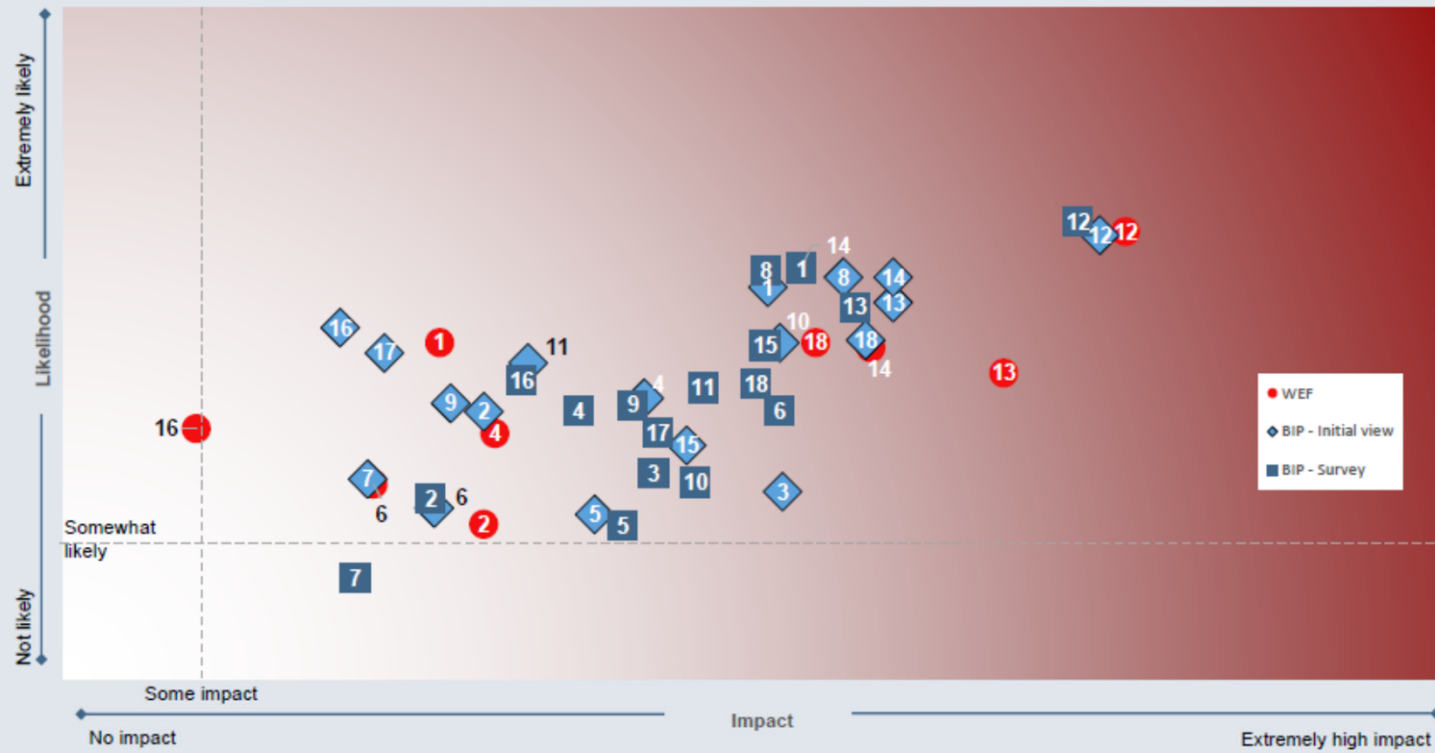
Where:

1 – 3D Scanning	8 – BMS/BAS	15 – Simulation
2 – Additive Manufacturing	9 – Computer vision	16 – UAV (drones)
3 – AI/KBS/ML	10 – Digital Twin	17 – ubiquitous connectivity and tracking
4 – Immersive Reality	11 – Generative/Parametric design	18 – Wireless monitoring/Internet of Things (IoT)
5 – Autonomous construction equipment and robotics	12 – integrated BIM	
6 – BDA	13 – Prefab building components	
7 – Blockchain	14 – real-time mobile collaboration	

BIMSafe

Project Partners

Project Funding Partners

Kindly Supported by

Managing whole-of-life building information – the Golden Thread

- Difficulties managing information for whole-of-life
  - *What is the appropriate Level of Information (LOI)*
  - *Who provides the information and when*
  - *Is it quality assured*
  - *Can it be reused*

Asset *Information* Lifecycle: Plan → Design → Construct → Manage → Replace → Retire
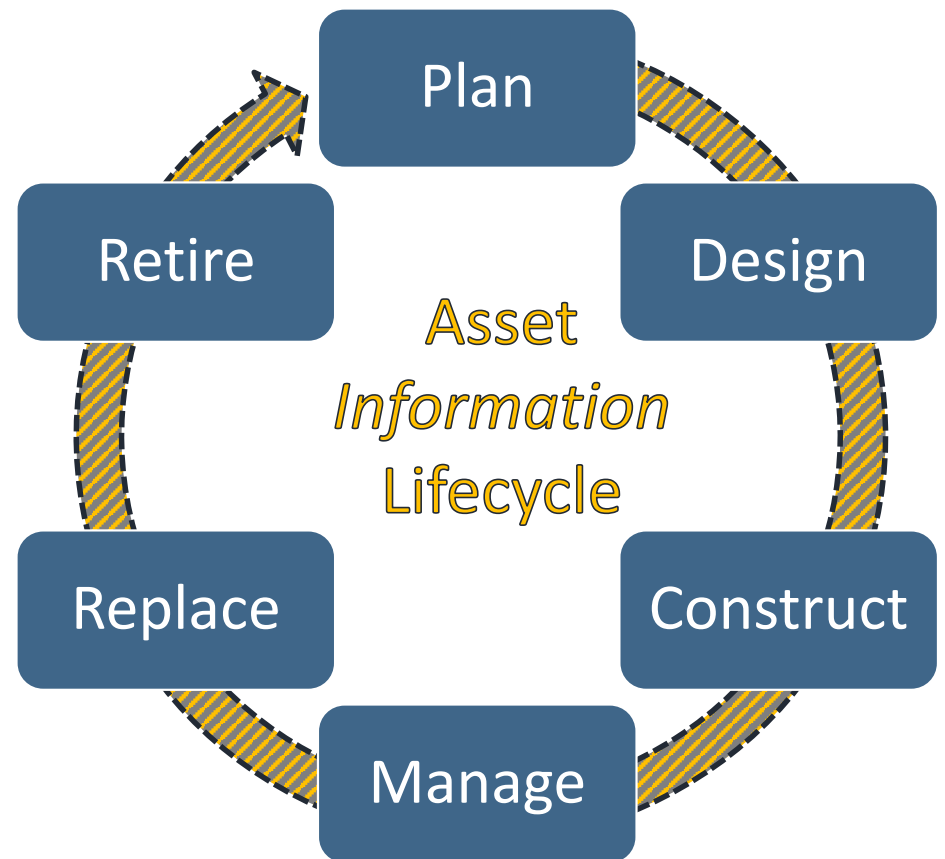
Benefits from Partnerships

- University of Canterbury as an asset owner
    - *Rec centre design*
- UoC developed new approaches and understandings
- BIP developed new technology on a real project
- Case studies published for wider industry

ISO 19650-aligned Digital Information Management for Asset owners & operators

Stakeholder requirements	Contractual requirements	Deliverables	
Organisational Information Requirements (OIR)	Provides the input to		Strategy
informs	Asset Information Requirements (AIR)	specifies → Asset Information Model (AIM)	Management
Project Information Requirements (PIR) → Informs	informs → Exchange Information Requirements (EIR)	specifies → Project Information Model (PIM) / Informs	Project

The 'golden thread' of asset information

AIS Tool Benefits

- Vastly simplified information management

- Standardized procurement of asset information

- Easily replicable process between projects

- Explicit set of information requirements

- Supports automated population of requirements in design software

- Automated schema generation to reduce design costs

- Being tested and further developed by KiwiRail

- Commercialization Model investigated OPEN PLAN

Digital Asset Owners Forum

- Major asset owners
  - *Antarctica NZ, ARA, Auckland Airport, Auckland DHB, Auckland Transport, City Rail Link, Contact Energy, FP Healthcare, Infracom, Kāinga Ora, Kiwirail, Lincoln University, NZDF, NZTA, Transpower, University of Auckland, University of Canterbury, University of Otago, Waitematā DHB, Watercare, Wellington CC*

- Re-launched with support from Construction Sector Accord

Artificial Intelligence (AI) approaches to Code Compliance Checking

- Addressing the bottleneck of building consents

- Three major inputs required to automate code compliance checking
    - *BIM populated with sufficient quality information*
    - *Codes and standards in a computable form*
    - *BCA process (checklist) used to interpret a code*
        - Potential for a national set of agreed processes across BCAs

- Around 600 codes and standards are applicable when consenting
    - *15 codes translated into a computable form (NSC project)*

- Can we train an AI-system to interpret our codes and standards?
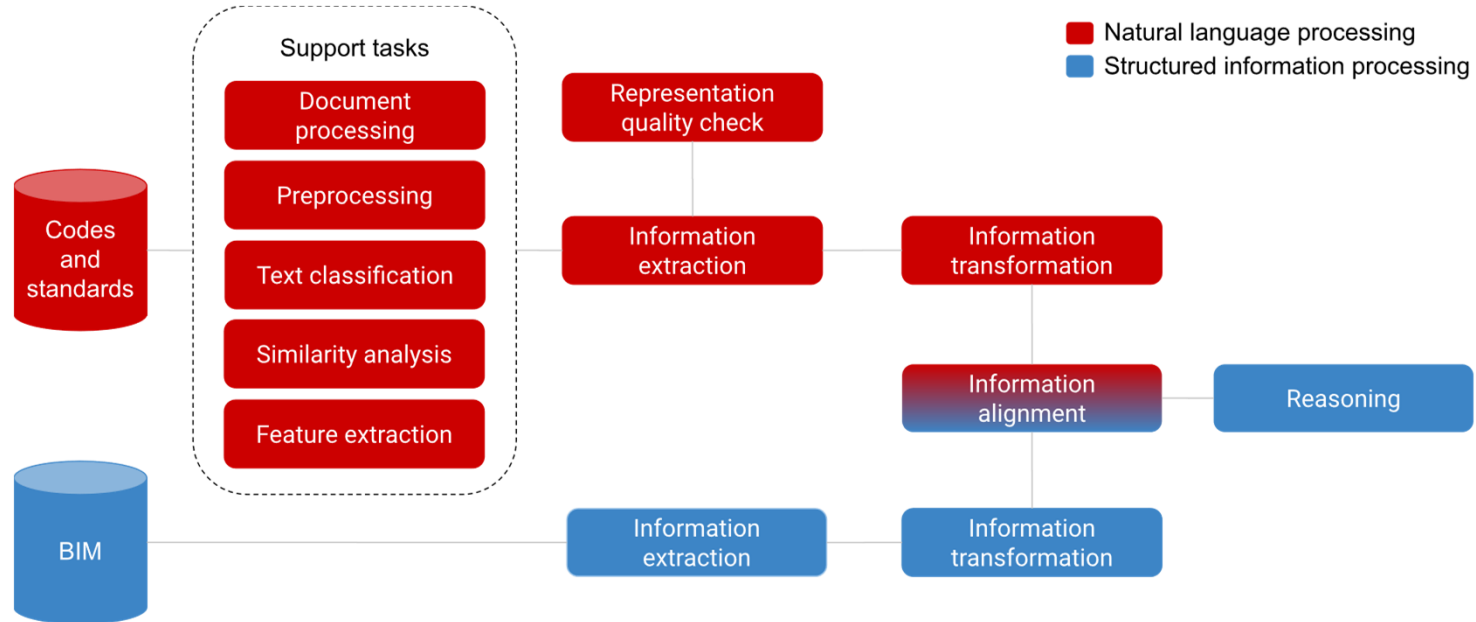
Industry Day Push for AI
March 2021

- Identified a low uptake of AI approaches in AECO

- Look to identify and trial test projects

    - *Codes and Standards*

    - *Analysis*

    - *Identification*

    - *Quality Assurance*

NLP Process for Code Compliance Checking

High Performing Translations

```
1    1.8.2 Concrete; Chimneys of reinforced concrete, shall comply with the relevant clauses of NZS 3109 for
2    ordinary grade concrete.
3    Prediction: if(and(expr(fun(is),atom(rel(construction),var(chimney)),data(concrete)),
4                       expr(fun(is),atom(rel(construction),var(chimney)),data(reinforcedConcrete)))),
5                  then(obligation(expr(fun(complyWith),atom(rel(construction),var(chimney)),
6                              data(nzs_3109_clause_2.1))))
7    Ground truth: if(and(expr(fun(is),atom(rel(construction),var(chimney)),data(reinforcedConcrete)),
8                       expr(fun(is),atom(rel(grade),var(concrete)),data(ordinary)))),
9                  then(obligation(expr(fun(complyWith),atom(var(chimney)),data(nzs_3109))))
```

Building Code Specific Performance

Document	Size[+]	BLEU*	F1-Score*
Baseline[1]	574 (518/56)	58.8% (6.4)	46.0% (0.5)
B1/AS1	580 (518/62)	52.9% (1.0)	**40.7%** (1.3)
C/AS2	573 (518/55)	59.4% (1.4)	**42.8%** (0.6)
Others[2]	529 (518/11)	48.2% (9.5)	47.2% (1.4)
G14/VM1[3]	556 (518/38)	65.3% (0.6)	48.2% (1.6)
D1/AS1[3]	528 (518/10)	66.7% (1.0)	49.2% (1.9)
B2/AS1[3]	526 (518/8)	55.9% (8.5)	50.2% (1.9)
E2/AS1[4]	760 (518/242)	58.6% (3.7)	50.8% (0.2)
G15/AS1	539 (518/21)	64.8% (0.4)	52.4% (1.8)
G12/AS2	573 (518/55)	59.5% (4.4)	53.4% (1.6)
E1/AS1	579 (518/61)	61.1% (3.3)	53.8% (0.9)
B1/AS3	578 (518/60)	61.4% (3.1)	54.9% (1.1)
G13/AS1	550 (518/32)	64.1% (2.0)	**57.4%** (0.6)
G13/AS2	571 (518/53)	67.5% (3.2)	**57.6%** (1.2)
G12/AS1	570 (518/52)	68.4% (2.5)	**59.6%** (1.8)
Random[4/5]	600 (518/82)	73.9% (2.5)	67.3% (1.2)
Random[5] full	760 (684/76)	74.2% (3.7)	**71.6%** (4.0)

Computable Codes Potential Applicability

- BCA Consenting
  - *ACABIM*
  - *National Consensus on Interpretation of Codes*

- Architects and Engineers pre-consent
  - *ACABIM*

- Design Tools
  - *Bracing Tool (NZS 3604:2011), Central Innovation*
  - *NZS 4218:2009 calculation method tool*
  - *ALF 4.0: Thermal Modelling Tool (H1/VM1)*
  - *Bracing Calculation Sheets (NZS 3604:2011)*

In the wings

- Penlink Alliance
    - *Expansion of BIMSafe to horizontal infrastructure*
    - *BIM for the Environment*

- Watercare/ Beca
    - *Measuring the effectiveness of BIM*

- Auckland Airport
    - *BIM application areas*

Questions?