



# Methodology for Smart Material Self-Inspection & Quality Checks

Dr. Federico Seri

Dr. Magdalena Hajdukiewicz

27-29 JUNE 2018 | AIX-LES-BAINS

| SP2018

[www.built2spec-project.eu](http://www.built2spec-project.eu)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 637221. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.



# Introduction

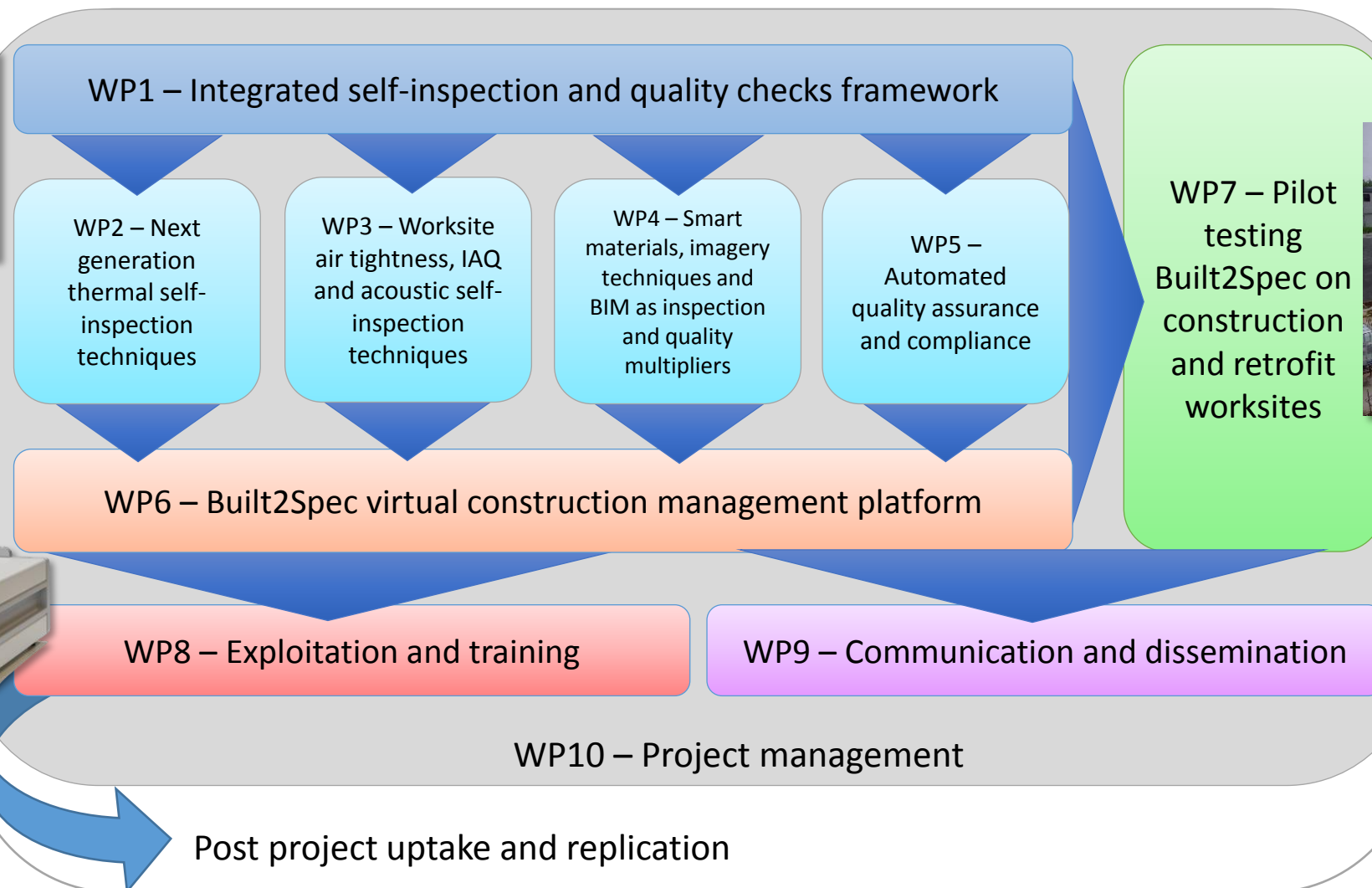
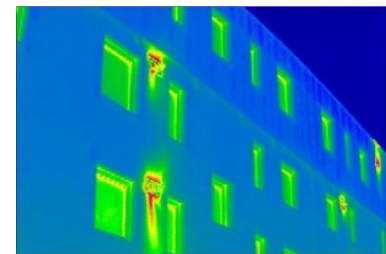
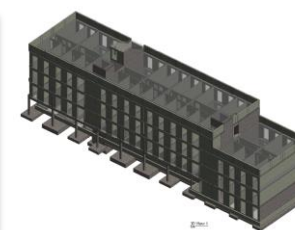
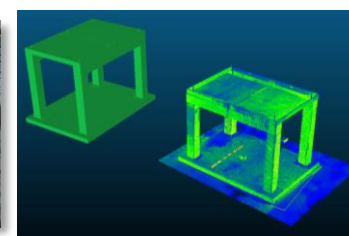
- Built environment in Europe accounts for:
  - >40% of the overall energy consumption;
  - 36% of the overall CO<sub>2</sub> emissions;
- Construction and the upkeep of buildings and infrastructure accounts for approx. 10% of global gross domestic product (GDP);
- **Directive 2010/31/EU** ensures all new buildings are almost NZEB by the end of 2020;
- Clear gap in the availability of **structured and systematic mechanisms** to support the decision-making, execution and commissioning phases of **construction processes**;



Degraded energy and comfort performance of new structures and retrofits



# Built to specifications





# Smart building components

## Site measurements

Thermistors



Strain gauges



Weather station



## Real time physical data

Laboratory testing



Building information model (BIM)



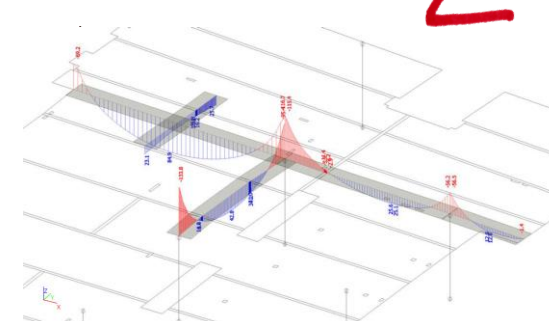
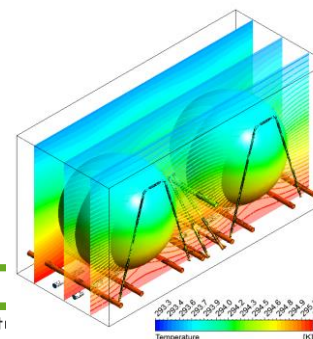
Innovation

Optimised designs



Demonstrator buildings  
@ NUI Galway

Numerical modelling – finite element (FE)  
& computational fluid dynamics (CFD)



Required structural & environmental

building performance

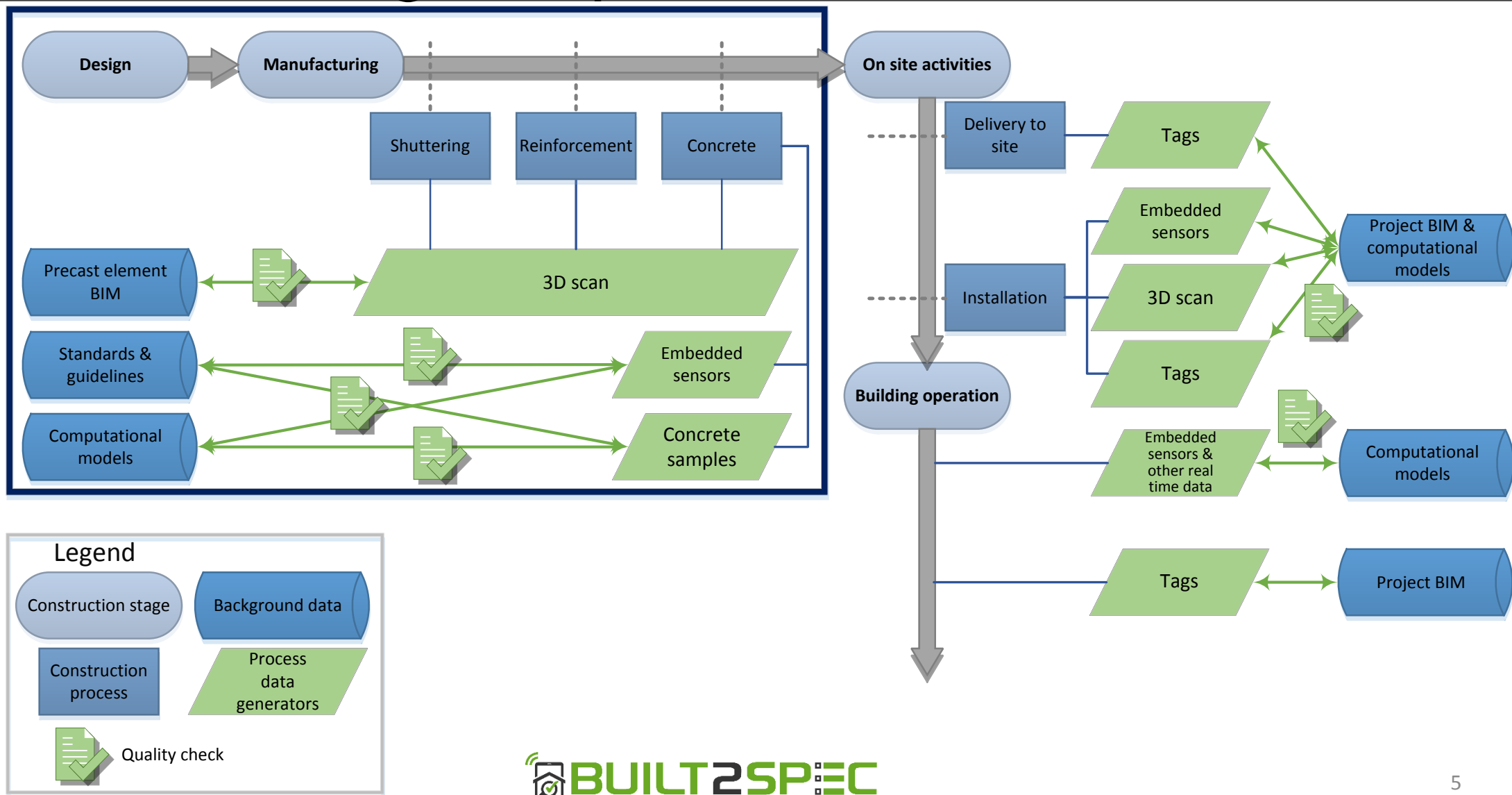
Quality manufacturing  
& site installation



 **BUILT2SPEC**  
Tools for the 21st Century Construction Worksite



# Smart building components





# Use of smart elements at different project stages

## Design

- Define Loads, structural system, properties of structural elements
- Apply standards (i.e. BS EN 1990, Eurocode; BS EN 1991, Eurocode1; BS EN 1992, Eurocode2)

## Manufacturing

- Define: Materials, manufacturing techniques, Quality tolerances
- Apply Standards (i.e. ISO 9002; EN 13369)

## On-site construction

- Apply standards (i.e. BS EN 1992, Eurocode2)

## Building operation

- Apply standards for indoor environmental quality (i.e. ASHRAE Standards)
- Reduce energy consumption, mainly due to HVAC (Directive 2010/31/EU)

- Install thermistors, vibrating wire gauges and tags in precast concrete;
- Monitor & assess temperature profiles of curing concrete;
- Monitor & assess strains in concrete components;

- Install thermistors & vibrating wire gauges in the in situ concrete;
- Monitor & assess temperature profiles of curing concrete;
- Monitor & assess strains in concrete components;

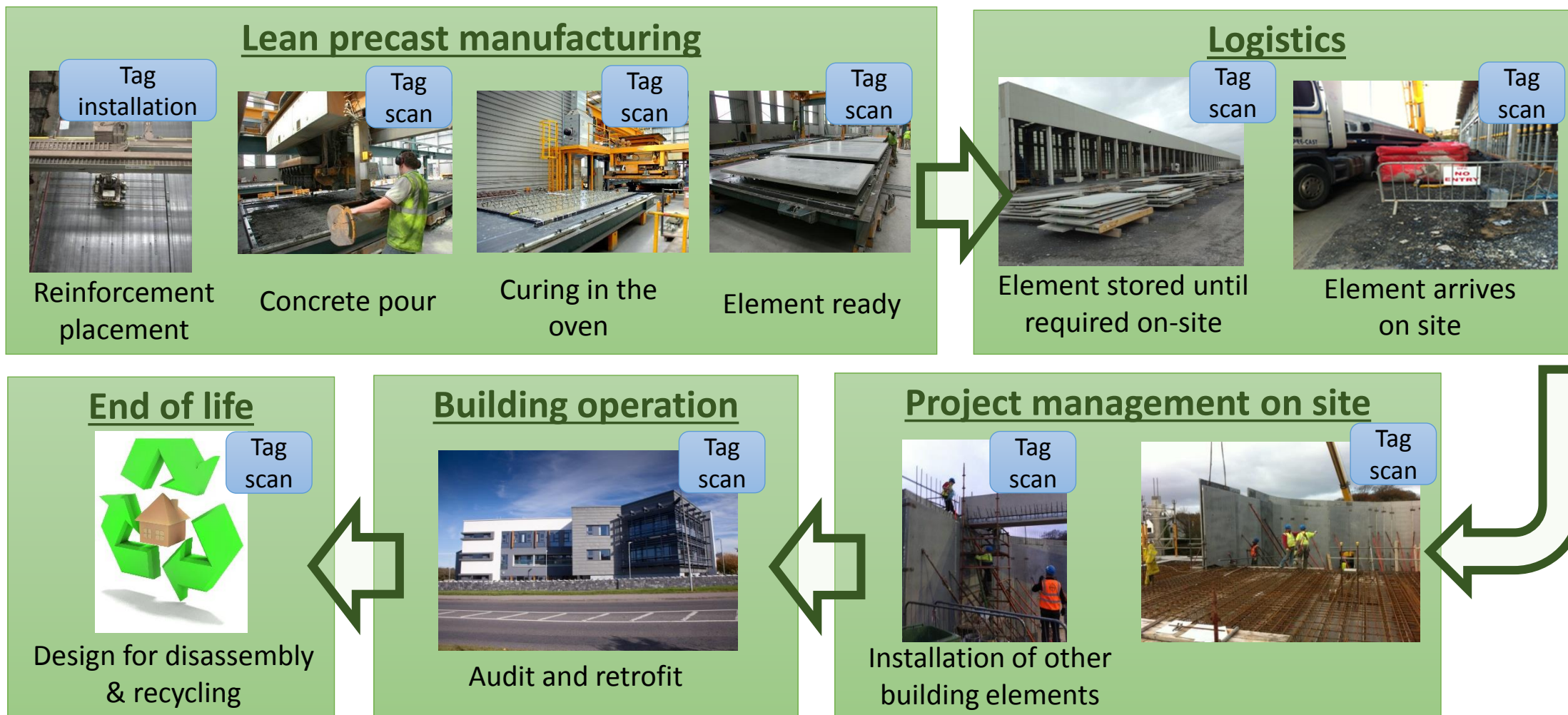
- Monitor & assess temperature profiles & strains in concrete components;

Smart precast concrete elements



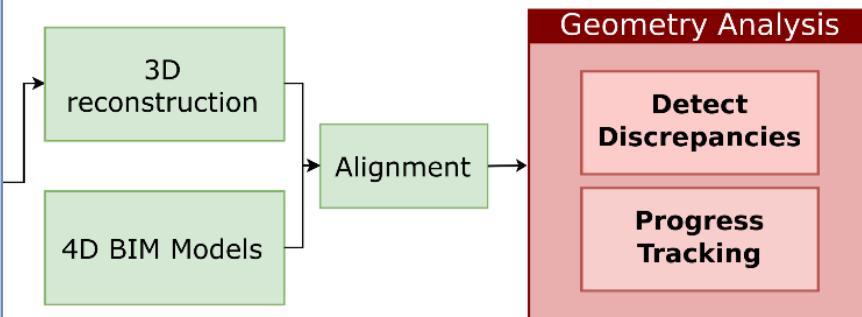
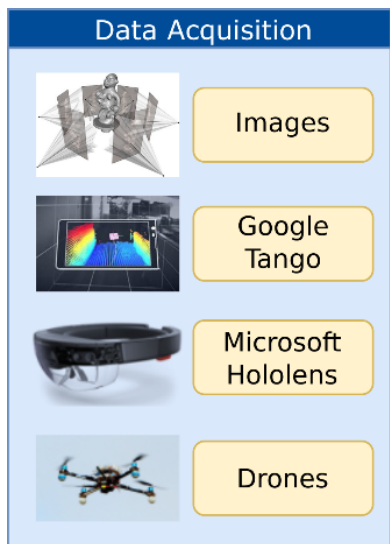


# Use of tags to improve project life cycle

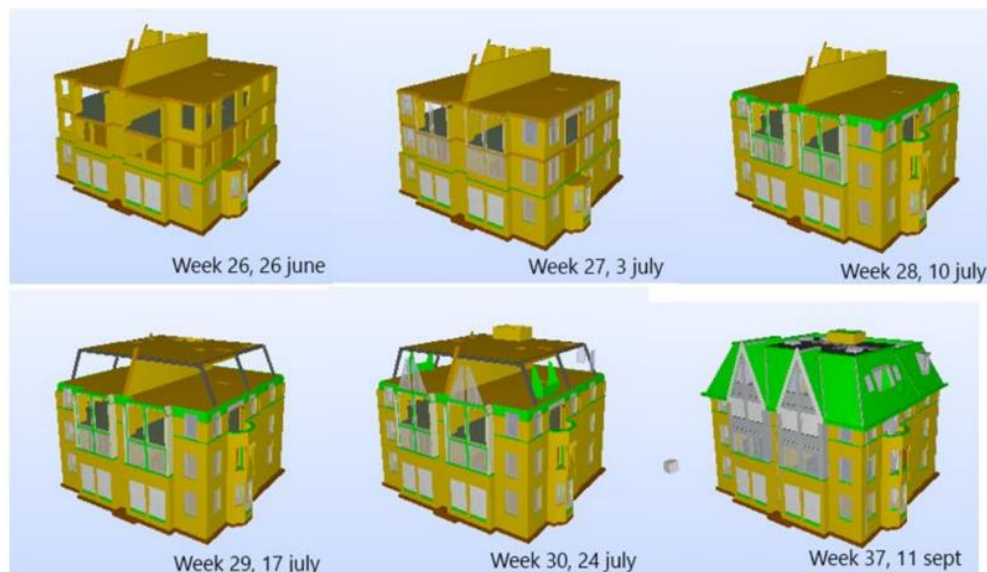




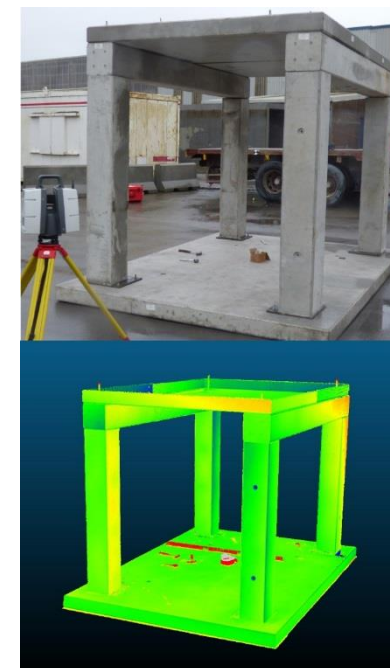
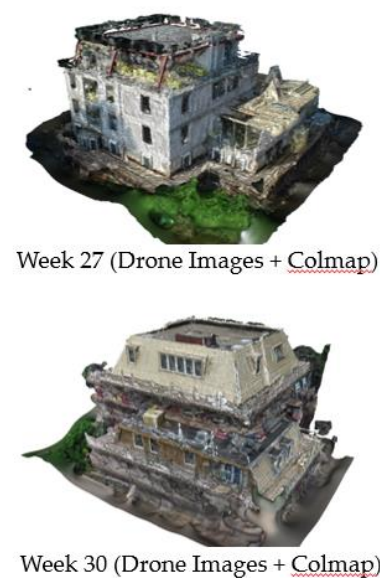
# 3D scanning and imagery techniques



**Temporal BIM**



**Temporal 3D Scan**

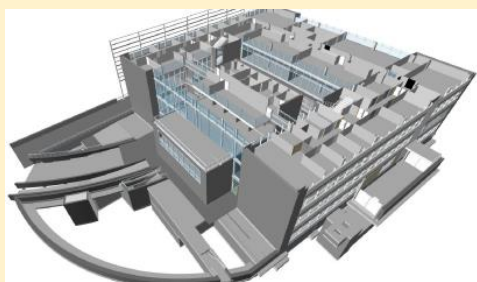


**ETH** zürich





# Human Biology Building, NUI Galway



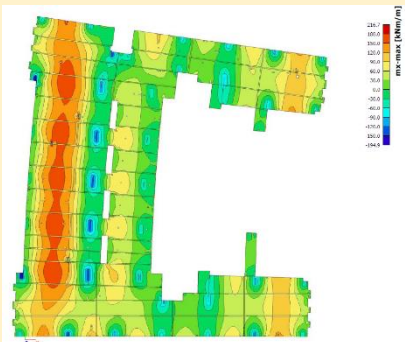
- 8 000 m<sup>2</sup>
- BMS + 30 thermistors and 120 strain sensors embedded in concrete floor slabs



Design



Construction



Delivery to site

In situ installation

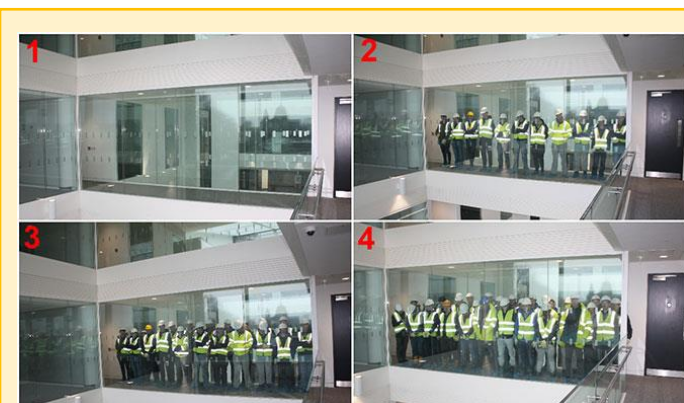


Props erected to support the planks

Finished in situ concrete topping



Operation

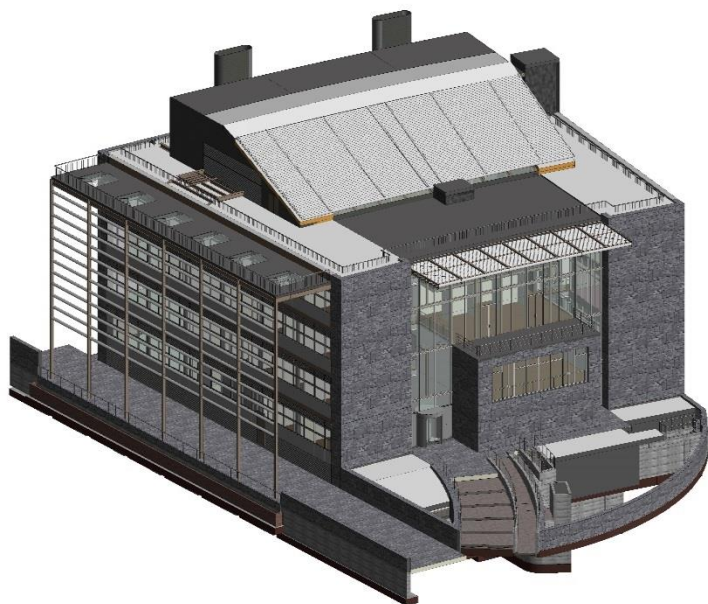




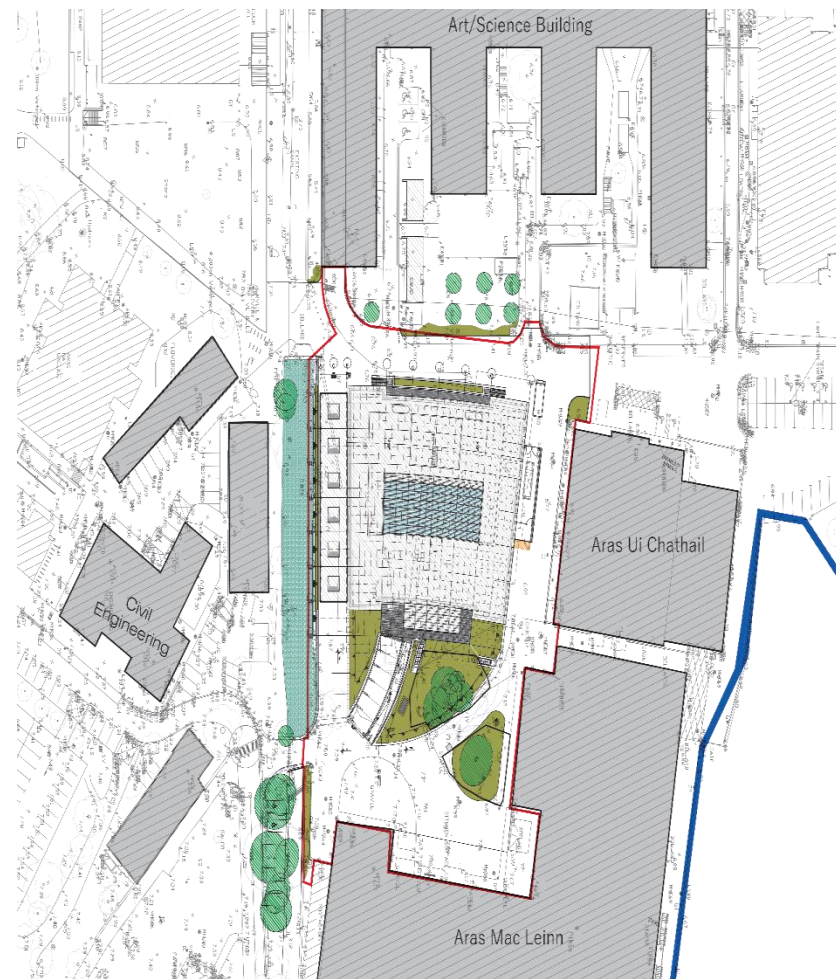


# Building Information Modelling (BIM)

Exemplary  
Building



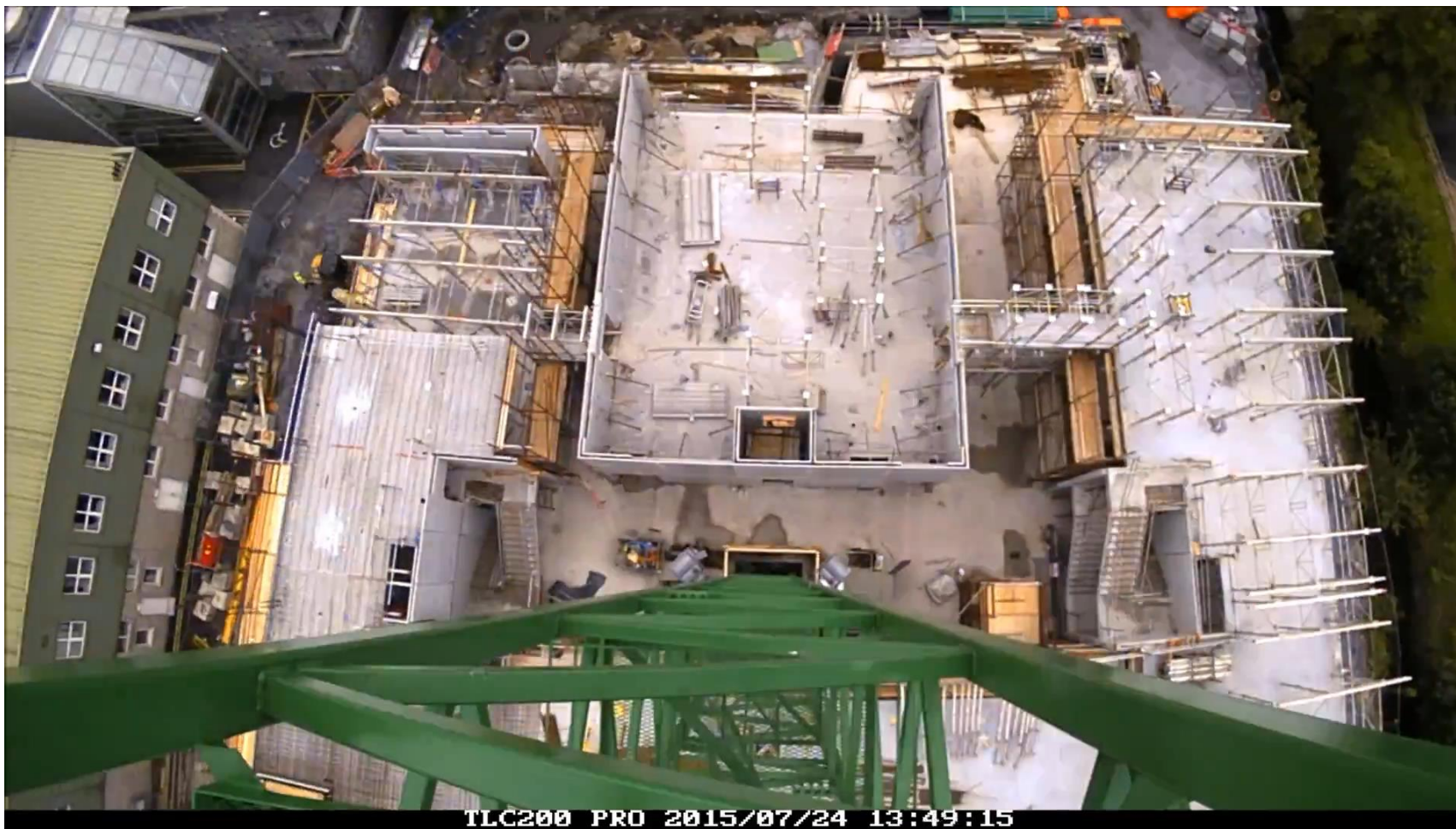
Human Biology Building (HBB) on the  
NUIG Campus  
Currently under Construction



Scott Tallon Walker Architects 2013



# Cameras – fixed or Drones



Construction sequence of the Human Biology Building, NUI Galway (<https://youtu.be/5ukUaDcgOSI>)





**THANK YOU FOR YOUR ATTENTION!**

**Dr. Federico Seri**

federico.seri@nuigalway.ie

Website: <http://www.iruse.ie/iruse>

**Dr. Magdalena Hajdukiewicz**

magdalena.hajdukiewicz@nuigalway.ie

Ref. S. Newell, J. Goggins and M. Hajdukiewicz,  
*Real-time monitoring to investigate structural performance  
of hybrid precast concrete educational buildings,*  
*Journal of Structural Integrity and Maintenance, 2016*

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