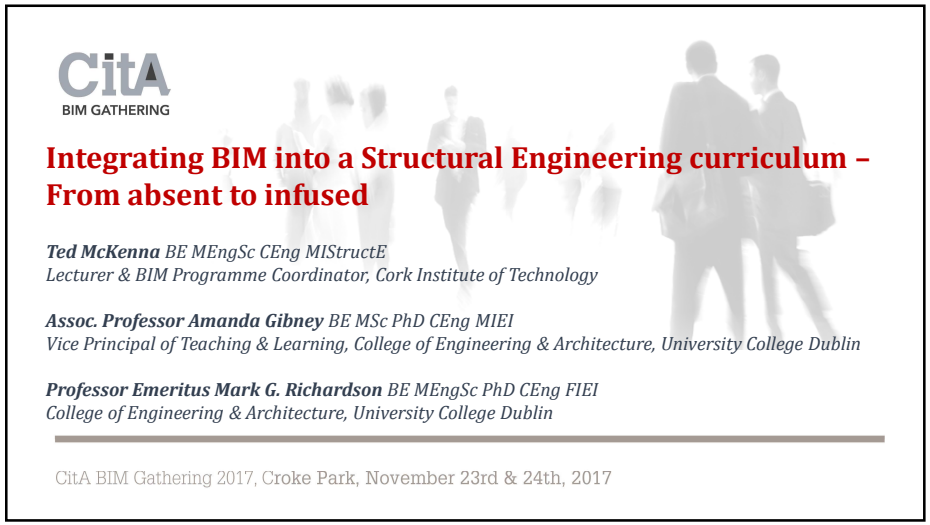

CitA
BIM GATHERING
Building Capabilities
in Complex Environments
CitA BIM Gathering 2017, Croke Park, November 23rd & 24th, 2017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Integrating BIM into a Structural Engineering curriculum – From absent to infused
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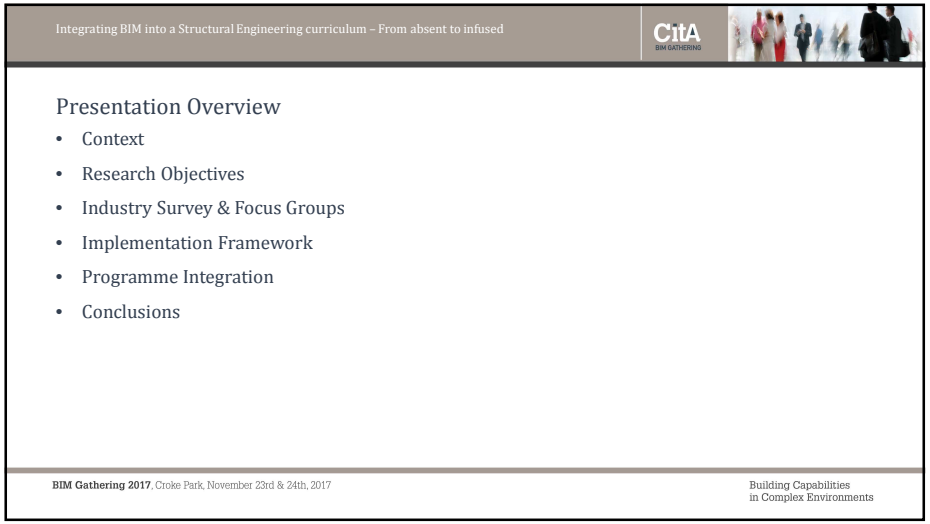
Integrating BIM into a Structural Engineering curriculum – From absent to infused
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Presentation Overview
• Context
• Research Objectives
• Industry Survey & Focus Groups
• Implementation Framework
• Programme Integration
• Conclusions
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Context

Context - General

- Increased adoption of BIM across the Irish AEC sector
- Core objective of BIM is to invoke collaboration to enabling better decision making
- Fast evolving technology, within fluid processes, are challenging existing professionals
- Perceived demand for BIM literate graduates
- Integration into the AEC curricula is critical to the implementation of BIM

Context - Challenges

- Industry possibly leads academia when it comes to BIM
- Industry application proficiency needs often conflict with academic focus on disciplinary principles
- Optimum approach to integrating BIM, both within and across disciplines, is lacking
- 'No room' is a significant reported barrier to BIM adoption in education

Research objectives

Research Objectives

With the **BEng (Honours) Degree in Structural Engineering** at **Cork Institute of Technology**, as the *'test bed'*, the research seeks to:

- Contribute to the existing, but limited, body of knowledge
- Develop a programme wide integration framework
- Describe the evolution of the implementation programme

Industry Survey & Focus Groups

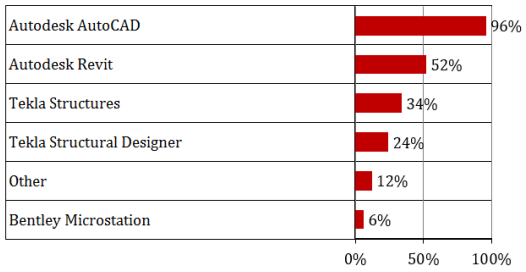
Survey

- Part of a larger study related to structural engineering education
- Four stakeholder groups considered:

  Students - **Graduate Engineers** - **Chartered Engineers** - Academics

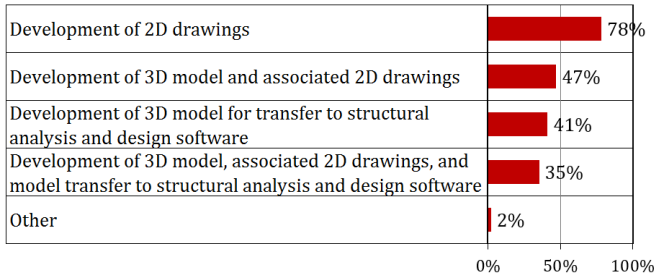
Survey of Graduate Engineers

Which structural drafting/modelling software options they had used in their postgraduate experience to date?



Survey of Graduate Engineers

What specific purpose was the software is used for?



Survey of Chartered Engineers

What issues do graduates experience in undertaking computational analysis and design?

- *"Understanding what is an appropriate level of detail to model"*
- Trying *"to model everything in 3D right away, when there may not be a need to over-complicate the model [as] sub-frames or 2D models would be more appropriate"*
- *"Diving straight into creating a model without spending some time planning the best approach"* was advised against in order to prevent development of *"models that are too complex too early without understanding the layers of complexity"*

Survey of Chartered Engineers

What is the correct course of action?

- *"Important to help the undergraduates to learn the use of software in the right context"*, while *"having the fundamentals correct"*
- *"Software should be used only to aid the student's understanding of engineering principles, not improve software skill levels, i.e. education is for knowledge generation, not skill development. Those with robust understanding will learn software skills quickly in the work place"*

Synthesis of opinions suggest that software analysis should be taught in tandem with first principles and approximate analysis

Industry Focus Groups

- Focus groups included practicing engineers at all levels, including graduates, project engineers, senior engineers and company directors
- General agreement with the sentiment that digital tools should be incorporated into undergraduate education
- Caveat articulated was that integration should not be at the expense of technical competencies

Synthesis of focus group opinions support survey findings

Implementation Framework

Implementation Framework

- Challenge was to evolve a largely traditional curriculum
- Developed framework is cognisant of academic programme design requirements
- Variety of pedagogical approaches
- Implementation was phased
- Curriculum integration was calibrated to align with the intellectual maturity of the learner
- Lack of 'room' issue had to be balanced with the necessity to retain technical competence

Integrating BIM into a Structural Engineering curriculum – From absent to infused

Implementation Framework

Phase 1 – Year #1

Focuses on the people aspect by developing student abilities to successfully undertake and complete collaborative group projects

Phase 2 – Year #2

Technology intensive, with a largely instructional pedagogical approach

Phase 3 – Year #3

Seeks to reinforce people and technology aspects of BIM while introducing elements of process. This is achieved by adopting a more constructivist learning approach which takes the form of a group design project

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Implementation Framework

Phase 4 – Year #3

Examines potential benefits of adopting a BIM approach within the discipline of Structural Engineering

Phase 5 – Year #4

Investigates the fundamentals which underpin BIM, presented via theory discourse as part of a module which also addresses management strategies and leadership

Phase 6 – Year #4

Provides the opportunity for engagement in a multi-disciplinary team project

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Programme Integration

Year #1

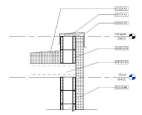
Creativity, Innovation & Teamwork

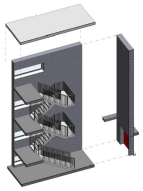
- Students work in teams
- Projects vary in size and type
- Students' skills (e.g. communication, teamwork) and attitudes (e.g. motivation, ethics) are developed.

Year #2

Structures & Design

- Learners receive step-by-step instruction
- Direct questions and feedback opportunities
- Supported with audio-video tutorial material

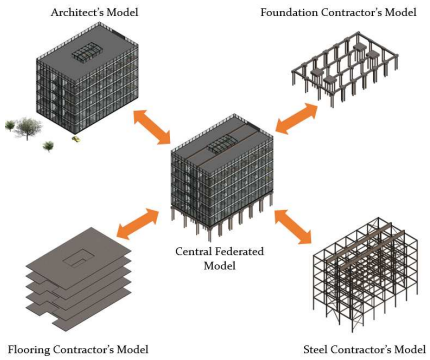




Year #3

Structural Steel & Timber Design 2

- Group design project
- Groups required to design the steel element of multi-contract design and build project
- A 'just-in-time' teaching approach is adopted
- Challenge is for 'teacher' to develop models of 'other' project stakeholders
- Individuals required to reflect and synthesise a strategy for improving performance



Year #3

Digital Structural Engineering

- Module focuses on the exploitation of the BIM model information in the development of the Structural Information Model (SIM).
- Students are required to develop 3D object-based models, including models of existing conditions based on point cloud data
- Digital tools in the execution of BS/PAS 1192 compliant BIM processes
- Progressive lessening of tutor delivered instruction serves to further transfer responsibility for learning to the student
- Developing self-directed learning capabilities is crucial given the fast paced evolution in technology
- Industry professionals deliver guest lectures

Year #3

Digital Structural Engineering

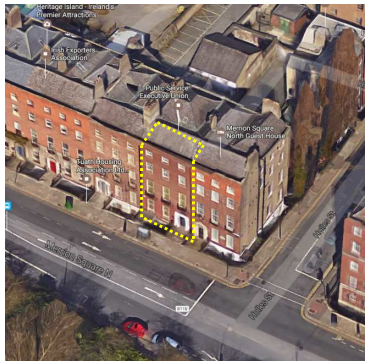
Challenges include:

- Three different software applications within one module
- Ensuring that learners are not using the powerful and very capable software solutions to an end that is beyond their current knowledge levels, as all output must be verified and validated.
- Efficiency of transferring from BIM to SIM is instantaneously impressive but the myriad of interoperability issues which arise follows almost immediately,

Year #3

Digital Structural Engineering

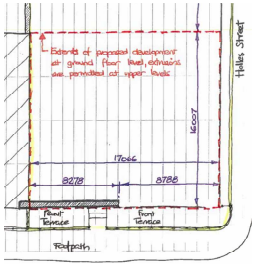
Third party point cloud

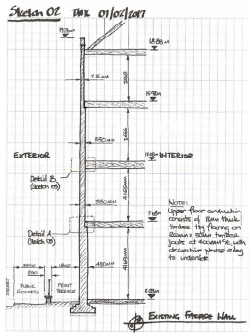


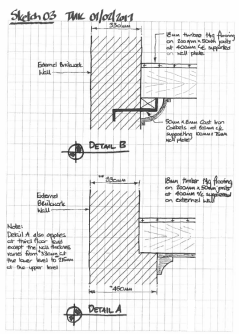
Year #3

Digital Structural Engineering

Engineering sketches



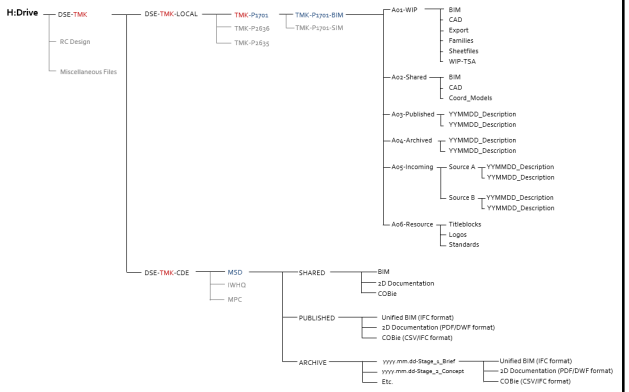




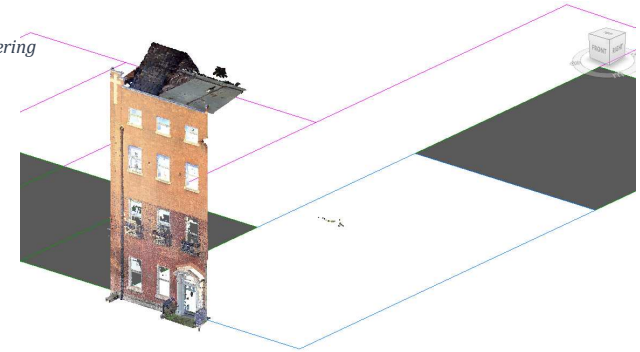
Year #3

Digital Structural Engineering

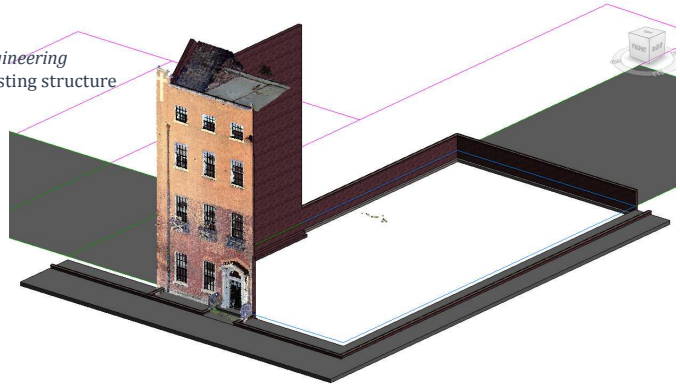
The file map!



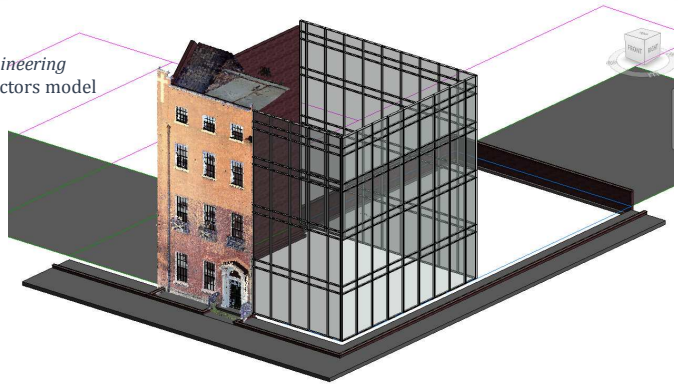
Year #3
Digital Structural Engineering
Project coordinates



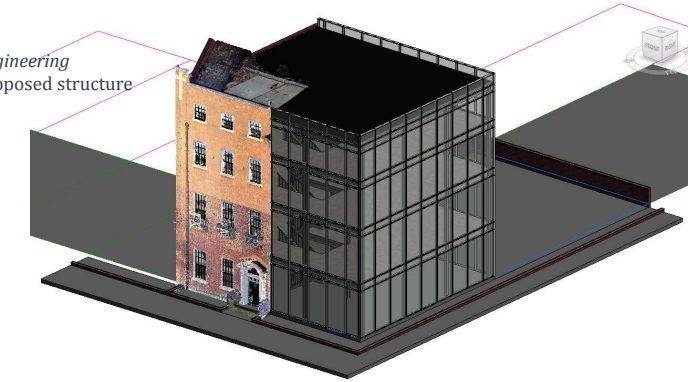
Year #3
Digital Structural Engineering
Develop model of existing structure



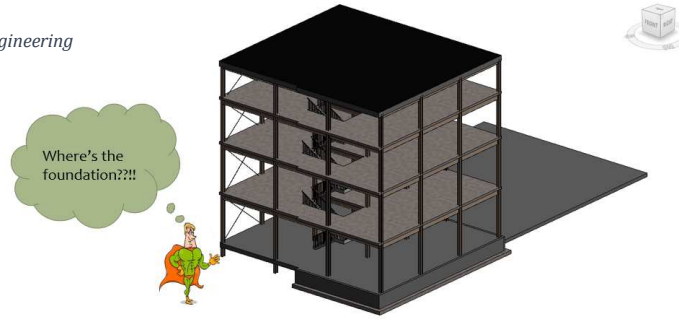
Year #3
Digital Structural Engineering
Link in Façade contractors model



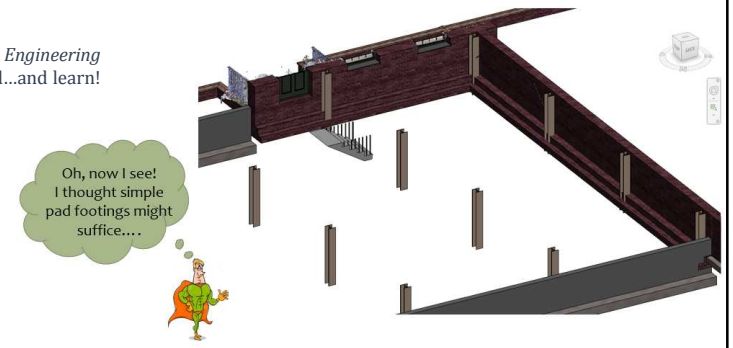
Year #3
Digital Structural Engineering
Develop model of proposed structure



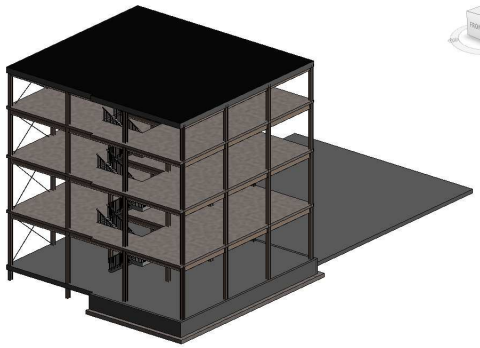
Year #3
Digital Structural Engineering
Review.....



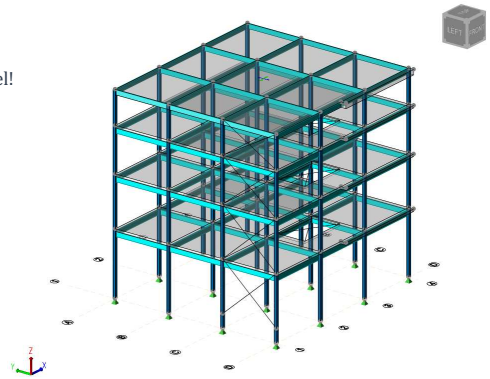
Year #3
Digital Structural Engineering
...and understand...and learn!



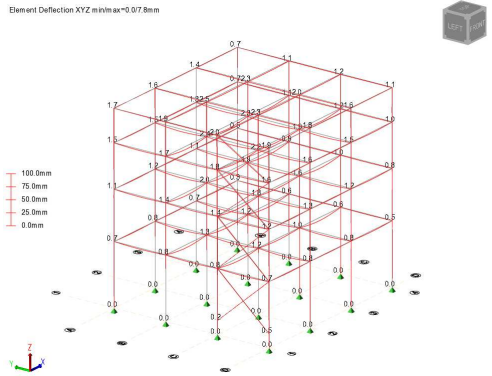
Year #3
Digital Structural Engineering
BIM model to .....



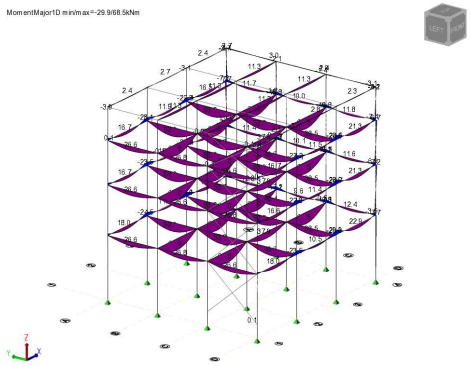
Year #3
Digital Structural Engineering
.....SIM (i.e. sub-discipline) model!



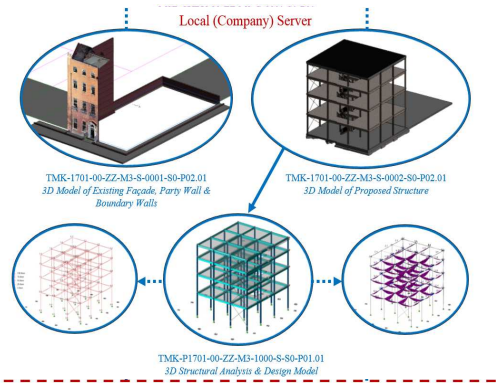
Year #3
Digital Structural Engineering
Run structural analysis…..



Year #3
Digital Structural Engineering
….and some more analysis…..
Engineers love analysis!!

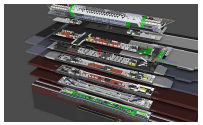


Year #3
Digital Structural Engineering
Local and CDE environments



Year #4
Project Management & Leadership

- Fundamentals which underpin BIM are presented
- Students identify, summarise and critique a published BIM case study
- Assesses learner knowledge, understanding and attitudes towards BIM
- Approach seeks to extend the students' own learning experiences to the wider industry context



Crossrail
Ref:www.thebimhub.com/2014/08/07/canary-wharf-crossrail-station/#.WhXSmVV1_IU

One World Trade Centre
Ref: www.aecom.com/projects/one-world-trade-center/

Panama Canal
Ref: www.theb1m.com/video/expanding-panama-canal-with-bim

Year #4

Design Office

- Final year (Level 8) structural engineering and architectural technology students work in groups
- Project is worth 10-15% of overall module grade (Module is worth 5 ECTS)
- Each group is presented with a project brief
- Groups collaboratively undertake the concept stage (i.e. Stage 2 according to PAS 1192-2)
- All information is required to managed in accordance with BS/PAS 1192 series of standards

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Year #4

Design Office

Focus on the early phases of a project are twofold:

1) Time constraints within courses thus restricting scope to undertake a more complete design.
2) Placing emphasis on increased effort earlier in a project timeline is fundamental to a BIM approach, as it enables greater flexibility in decisions as illustrated by the MacLeamy curve

The '*holy grail*' if expanded to include other disciplines!

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Conclusions

Integrating BIM into a Structural Engineering curriculum – From absent to infused

Conclusions:

- Research presents example of full curriculum integration within a Structural Engineering programme
- Responsibility for learning is progressively transferred to the student
- Achieved by altering the facilitation and removing the scaffolds
- Anticipated legacy is effective lifelong learners

.... this is perhaps the most significant learning outcome, as BIM is a fast developing phenomenon!

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Thank you
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