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Embedding Building Information
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*A case study of the Unitec
National Diploma Programmes*

Author:
M. McGarrigle

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Embedding Building Information Modelling into Construction Technology and Documentation courses

A case study of the Unitec National Diploma Programmes

Malachy McGarrigle
mmcgarrigle@unitec.ac.nz
Phone: +64-9-815 4321 ext 8055
Unitec Institute of Technology

Abstract

The aim of this research is to generate a resource to assist construction lecturers in identifying opportunities where Building Information Modelling [BIM] could be employed to augment the delivery of subject content within individual courses on construction technology programmes. The methodology involved detailed analysis of the learning objectives and underpinning knowledge of the course content by topic area, within the residential Construction Systems 1 course presently delivered at Unitec on the National Diplomas in Architectural Technology [NDAT], Construction Management [NDCM] and Quantity Surveying [NDQS]. The objective is to aid students' understanding of specific aspects such as planning controls or sub-floor framing by using BIM models, and investigate how these could enhance delivery modes using image, animation and interactive student activity. A framework maps the BIM teaching opportunities against each topic area highlighting where these could be embedded into construction course delivery. This template also records software options and could be used in similar analyses of other courses within similar programmes to assist with embedding BIM in subject delivery.

Keywords: BIM embedment, construction technology, tertiary courses

Introduction

The purpose of this research paper is to investigate how BIM can be used to enrich a student's learning experience and help bridge the gaps in understanding encountered when teaching students the more difficult concepts of construction technology and design. The research is mainly a case study of a module (Construction Systems 1) delivered as part of the first year provision on the NDAT programme at Unitec.

The embedding of Information and Communication Technologies [ICT] and Information and Learning Technologies [ILT] into our learning landscape is something which most teachers would almost take for granted at the present time but it is a relatively recent development gaining momentum from the late 1990s onwards. Most lecturers would find it hard to imagine having to engage students now without employing the usual applications such as Word, Excel or PowerPoint but in the early days teachers were given incentives to pass on knowledge to their students using the innovative new technologies. For example, in the United Kingdom awards were given by British Telecom to teachers of further and higher education who actively embedded ILT into their teaching.

I believe that at this time we are on the threshold of a similar opportunity to take a quantum leap and embed BIM into almost every aspect of teaching construction. Recent developments in the built environment workplace (including the evolution of BIM software packages across almost all traditional design team disciplines) already make a very strong case for utilising BIM technologies in teaching. Furthermore, this doesn't take into account the potential to employ these technologies as powerful visual media across many forms.

This research demonstrates how integrating BIM models in teaching delivery will enhance student engagement and help communicate the more ephemeral and problematic concepts which students find difficult to comprehend.

An internet search to try and locate material relevant to my proposed research revealed quite a lot of BIM related documents but none quite aligned with the direction I have taken. The following report compiled in the United Kingdom probably came closest, in some ways, to what I was trying to achieve with this case study research.

The below findings were the result of a workshop held between a consortium of institutions from across the United Kingdom and Ireland to respond to the ever changing BIM landscape in the built environment industry and how that could impact on teaching. I identified some correlation with my own aims as highlighted in the table on the following page.

Embedding Building Information Modelling (BIM) within the taught curriculum.

The Higher Education Academy, BIM Academic Forum, United Kingdom, June 2013.

Figure 1. BIM Teaching Impact Matrix

(Source: Williams, A., & Lees, 2011)

	BIM Level:			
	Absent	Aware	Infused	Embedded
BIM descriptor	BIM is a nice research area but should not affect what and how we teach. Our students do not need to know about BIM.	BIM is a nice research area but should not affect how we teach. Our students should be aware of BIM and how it might impact their future.	Students should understand how BIM will affect their future and have chance to learn BIM in a discipline & multi-disciplinary context.	BIM is so important it should become the 'vehicle' for our students' learning experience. Teaching should be enabled by the BIM model.
Curriculum	No change	Key modules are identified and BIM knowledge incorporated.	Target modules identified for a BIM review. BIM impact identified in all areas of the curriculum but BIM use restricted to a few.	Full curriculum review to allow every module to identify changes required for delivery through a BIM model.
Structure	No change	No change	Structural review needed but impact on current structure likely to be minimal.	A complete review of structure to enable the BIM model to be the driver/vehicle for learning.
Staff	No change	Staff in the key modules will need an understanding of BIM and how it impacts of industry.	All staff require knowledge of BIM and how it is impacting industry. Some staff need full competence in use of BIM.	All staff would need to be fully competent in the use of BIM and understand how BIM is impacting on the industry.
Infrastructure	No change	No change	Significant investment required. BIM labs needed and some delivery space suitable for BIM enabled learning.	Significant investment in infrastructure required. BIM labs and delivery space sufficient for BIM being the learning vehicle.
Curriculum - Research gap	Can be large	No change	Has to be small in some areas but with some flexibility.	Has to be small for all areas of the curriculum. Genuine integrated direction between research and curriculum/delivery.

The main difference in the approach of this research and my own is that the BIM Academic Forum UK were attempting to identify opportunities and learning outcomes related to BIM concepts, definitions, guidelines and protocols and how these could be taught in an effective way within current programmes and courses. Alternatively I want to examine how we can identify, exploit and utilise in an optimum way the results and outputs of BIM software in its many forms. The ultimate intention of my research is to show how these can enhance, augment and improve our teaching and in doing so help bridge learning gaps that students may have at present. This research intends to demonstrate how this change is possible and also how, by embedding BIM outputs in teaching delivery, its use may become part of the mindset and culture of construction education as opposed to a mere add-on of traditional teaching methods. A successful outcome in this regard could help ease some of the present teething pains of BIM adoption within the industry and highlight how education can help respond to the needs of the workplace.

The methodologies involved in this research project include the following:

1. A **survey** of a current first year student stream who have studied the Construction Systems 1 paper in semester 1 of the 2013 academic year. This stream has been taught using both real and virtual models to explain principles of timber framed design.
2. Informal **interviews** with some lecturing staff on the Construction Systems 1 paper and those who have generated virtual BIM models as teaching resources.
3. A **curriculum review** of the Construction Systems 1 module to identify which topic areas provide the best potential to utilise BIM technologies in delivery of threshold concepts and core knowledge.
4. **Individual analysis** of selected topic areas from the module to demonstrate how the BIM methods may be effectively used to help student learning.

1. Student stream survey comments and results

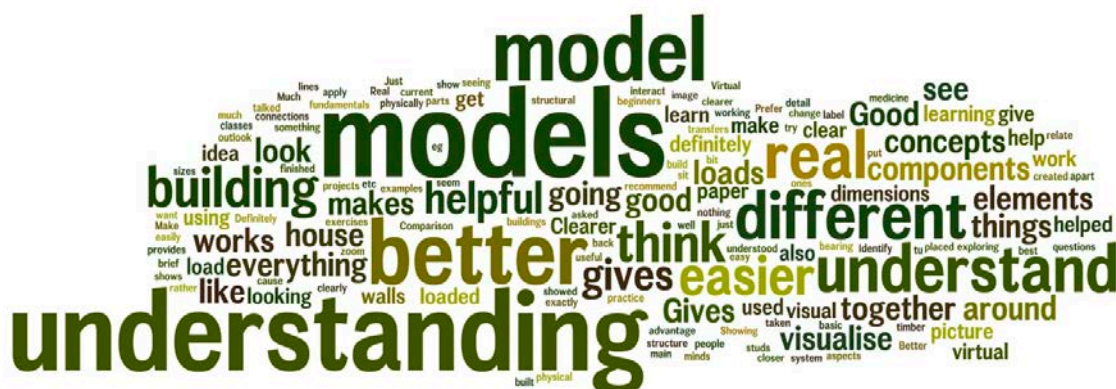
A small survey was distributed to a first year student cohort who studied the Construction Systems 1 course. This group had experience of exposure to building models both real and virtual in their teaching in this course and others in addition to an orientation session.

A copy of the mini survey showing graphics and questions is provided in Appendix 1. In an attempt to isolate the key words and opinions I gathered up all the students responses and comments into a text block to create a Wordle¹ word cloud.

¹ Wordle is a toy for generating "word clouds" from text that you provide. The clouds give greater prominence to words that appear more frequently in the source text. Source: www.wordle.net

Figure 2. Word Cloud

(Source: Feinberg, J. Retrieved from www.wordle.net)



Word clouds make the words which appear most frequently in a block of text appear bigger on the page to give emphasis and suggest possible keywords.

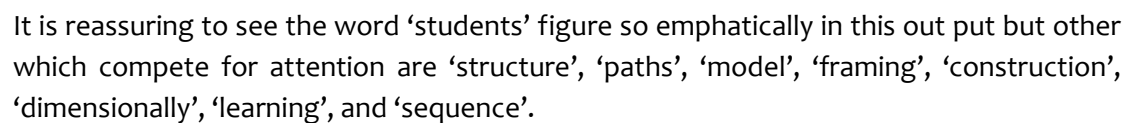
From the above it can be clearly seen that the words ‘understanding’, ‘models’, ‘model’, ‘better’ and ‘understand’ are most dominant with others such as ‘building’, ‘different’ and ‘real’ also featuring. This result would support my own personal observations that students need the most support in the comprehension of concepts and linkages to building elements and components. A possible reservation in regard to the above is that the students responses may have been led somewhat by the wording I employed in my survey questions. I would consider changing the language of the questions posed in similar future exercises to see if this was a factor in the final results.

2. Informal discussions with lecturing staff on the Construction Systems 1 paper and those who have generated virtual BIM models as teaching resources.

A number of informal exchanges were held with colleagues who I teach with on the multi stream Construction Systems 1 course and complimentary courses in Studio 1. Some these lecturers had developed their own BIM models for buildings of varying scales and I was interested to find out their primary reasons for generating these teaching resources. I make extensive use of a real balsa wood model a student had prepared in response to an assignment and I recognise how useful a visual aid it can be when teaching.

Summaries of the lecturer’s comments can be found in Appendix 2 and common aims stated are summarised below. I have also run the text through a word cloud to see if that would help to identify trends and common opinions or objectives.

(Source: Feinberg, J. Retrieved from www.wordle.net)



A software programme Sketchup appears in the lecturer cloud which is an intuitive package which students can pick up quite easily. Tutors have made extensive use of Sketchup at Unitec in generating visual aids to their teaching in the Department of Construction.

6

Common teaching objectives which emerged from the lecturers comments include the following:

1. **Visualisation** which helps students identification of individual building elements.
2. **Model interaction** to enable students to assemble and complete models in correct construction sequences. **Ability to embed information** about components and elements that students can discover by interrogation of the BIM model.
3. **Visualisation** which helps student to structurally analyse a building. Visualisation to highlight load paths, point loads, evenly distributed loads and to aid in student understanding of concepts used in New Zealand Standards such as loaded dimensions and bracing lines.
4. Ability of students to **work with the models** in a **flexible way**. This could include remotely at an off-campus site or at home and in their own time to help augment class based learning.

3. A curriculum review of the Construction Systems 1 module to identify which topic areas provide the best potential to utilise BIM technologies in delivery of threshold concepts and core knowledge.

I analysed in detail all the lectures and topic areas covered in this paper to identify all possible opportunities where BIM models may be of benefit in aiding learning and help communicate learning objectives. The framework devised can be viewed in Appendix 3 but a sample snapshot of its layout and typical content is given below.

The table on the following page (see figure 4.) shows an overview for each subject area where BIM models have been or could be of benefit. The findings are based on my experience of teaching this course to five separate cohorts across three academic years. The framework is not exhaustive and is seen as a work in progress. It applies to a course where unit standards are themselves embedded into the overall course but there is no reason why a similar approach could not be applied to individual standards or objectives identified in similar programmes such as Target Review of Qualification [TROQ].

An intention would be to refine this table into more bite sized headings that would form a less formidable initial interface which could then be unpacked into more detailed information as required by the lecturer. Some samples of how BIM models could and have been used in this curriculum are discussed in the next section.

Figure 4. Constructing Systems 1 Teaching Delivery Using BIM

(Source: Author)

Lecture content		BIM opportunities	AT/QS/CM	Software	Lecturer training
3. District Plans and Town Planning		Plot densities ,Planning controls eg- Height to boundary controls, Building set backs , Rolling heights . Building size and cost per M2			
4. Site Investigation 5. Surveying		Levels,contours ,existing services,Encumbrances,Topography,Site sections,soil types,rock,cut and fill requirements,excavations volumes. Need for retaining walls.Finished floor levels and height of piles above finished ground levels. Topography studies,terrain factors,sun studies,orientation.			
6. Timber Sub-floor - basic 7. Mid-floor Systems 8. Timber Sub-floor - Breakout	9. Timber Sub-floor - Advanced	Viewing and identification of elements in subfloor systems . Analysis of structural problems,load paths,loaded dimensions and spans.Definition of uniformly distributed loads and point loads. Measuring of dimensions and spans. Depth of embedment,pile spacings,footing types and forms .			
10. Concrete Slab 11. Timber Sub-floor - breakout		As above with possible layering of concrete slab element build up demonstrated using BIM model.Rules regarding general saw cuts and under loadbearing walls.Using site models to illustrate when slab on ground appropriate.Cut and fill,site levels and contours to modify site for slab.Demonstration of edge details. Cut away 3-d details and 2-d details from model.Effect of cut-outs for services. Rib Raft models.			

4. Individual analysis of selected topic areas from the course to demonstrate how the BIM methods may be effectively used to help student learning.

The topic areas to be looked at in more detail including ideas as to how BIM models could be embedded in their delivery are as follows:

Topic area 3: District plans and town planning	<ul style="list-style-type: none"> • Plot densities, planning controls (eg height to boundary controls), building set backs, rolling heights. • Building size and cost per M2.
Topic area 6: Timber sub-floor design basic	<ul style="list-style-type: none"> • Viewing and identification of elements in subfloor systems. • Analysis of structural problems, load paths, loaded dimensions and spans. • Definition of uniformly distributed loads and point loads. Measuring of dimensions and spans. • Depth of embedment, pile spacings, footing types and forms.
Topic area 10: Concrete slab	<ul style="list-style-type: none"> • As above with possible layering of concrete slab element build up demonstrated using BIM model. • Rules regarding general saw cuts and under load bearing walls. • Using site models to illustrate when slab on ground appropriate. • Cut and fill, site levels and contours to modify site for slab. Demonstration of edge details. • Cut away 3D details and 2D details from model. • Effect of cut outs for services. • RibRaft models
Topic area 12: Wall framing systems	<ul style="list-style-type: none"> • Model used to identify load paths and different types of loads. • Loaded dimensions and where trimming studs and lintels required. • Demonstration of stud set out, sizing and spacings, nogs, dwangs and fixings • Layering details to show framing and relation to wall wrap, battens and final cladding. • Model used to identify wall system elements and terminology. • Different models to relate to the house types to which 3604 Tables refer. • Effect of span directions of joists on whether wall is load bearing or not.

Topic area 3: District Plans and Town Planning

When a student refers to the North Shore district plan to access information on Residential Planning Controls, the aspects relating to the rules on heights to boundary constraints can seem somewhat daunting. The pertinent text reads as follows:

‘16.6.1.3 Height in Relation to Boundary

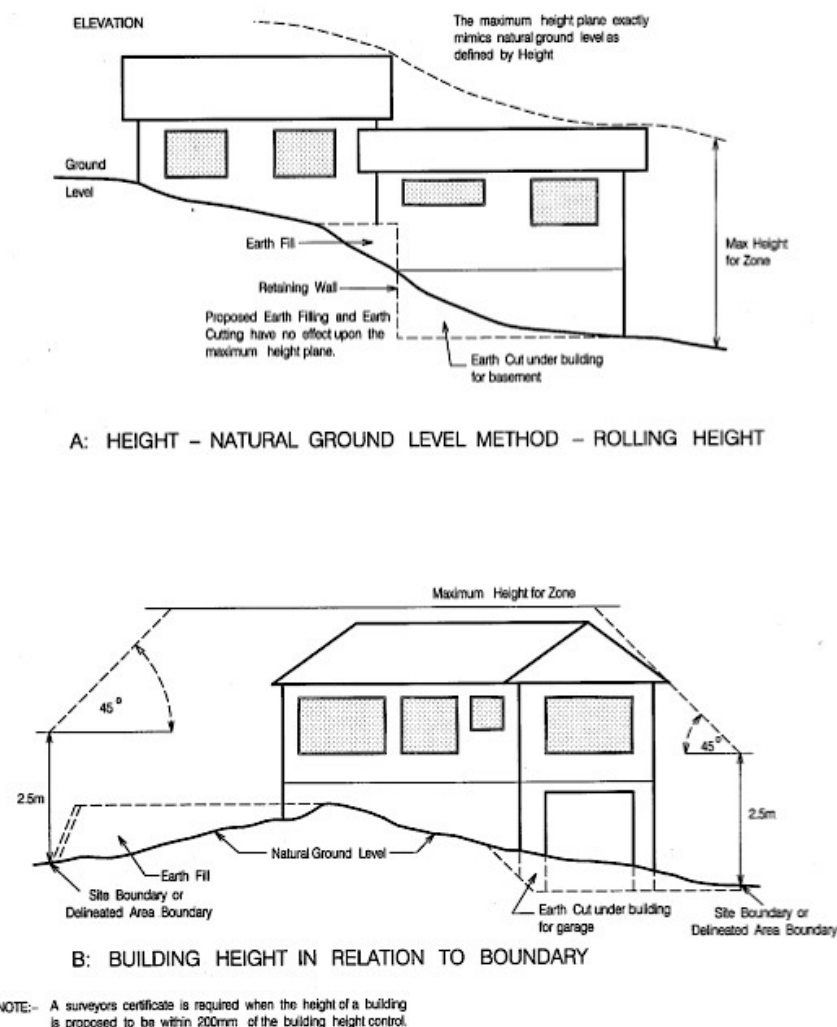
a) All residential zones except Residential 3 zone in Devonport

No part of any building shall exceed a height equal to 2.5 metres plus the shortest horizontal distance between that part of a building and any site boundary’
(Auckland Council, 2011, p. 54)

A little more clarity is provided when the relevant diagrams are located in the Definitions section of the plan.

Figure 5.

(Source: Auckland Council, North Shore District Plan, Section 16 Residential)



Having a virtual building model (such as that shown below) is useful as it allows clearer visualisation of the building, the rules and constraints which apply and the implications of any contraventions and possible means to resolve.

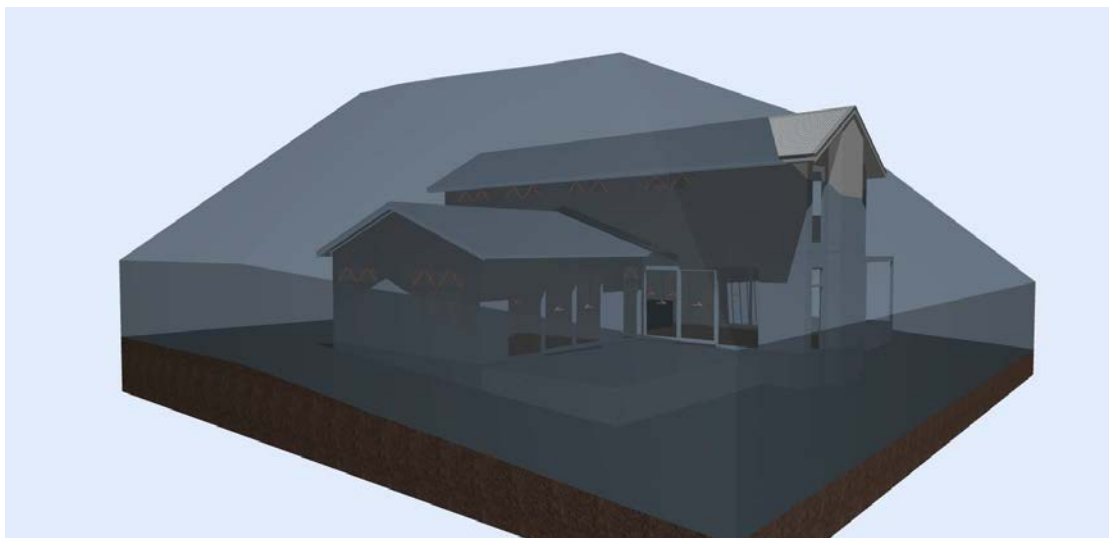
Figure 6. Virtual model generated in Archicad showing a proposed dwelling on its site with the local planning rules applied to produce a building envelope.

(Source: Richard Kelly, Unitec, 2013)



Figure 7. View of the BIM model showing very clearly how the proposed dwelling contravenes the planning rules by penetrating the 3D representation of the planning constraints generated by the software.

(Source: Richard Kelly, Unitec, 2013)



Topic area 6: Timber sub-floor design basic

The sections within New Zealand Standard [NZS] 3604 pertaining to the design of timber sub floors throw up many concepts which students find challenging. In my experience one of the most difficult for them to grasp is that of the loaded dimension. This is defined in the text of NZS 3604 as follows: “A measure of the weight of construction contributing to the member under construction”. (NZS 3604: 2011 p 1-17)

This is not an easy explanation for a lecturer to attempt to clarify to students in the early stages of their construction education and though the NZS does provide diagrams, they are simplistic and in some places contradictory and confusing. Students find it easier to comprehend when they can view the elements in the actual context of a house frame and see where the contributing loads originate. I have used a real balsa wood model to convey this knowledge but a virtual BIM model can be just as effective and offers some advantages as students can view the model in their own time, remotely or simultaneously if they download a copy to their own data storage media.

Figure 8. A BIM model view with selected elements visible relevant to the area of study such as sub floor structures, both slabs and timber framing.

(Source: Richard Kelly, Unitec, 2013)

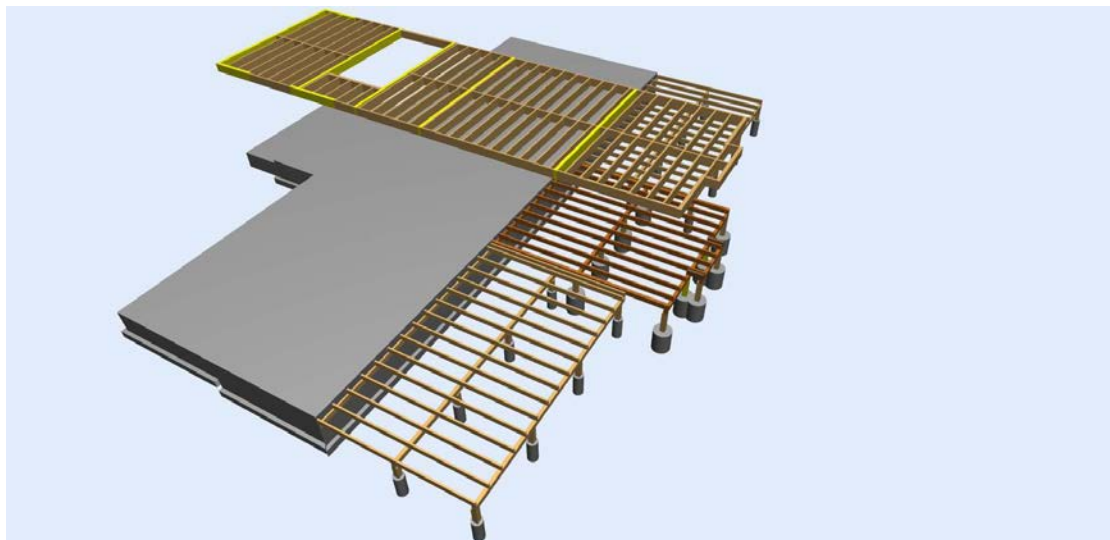


Figure 9. Diagram from NZS 3604 2011 defining loaded dimensions using clear spans.

(Source: Standards New Zealand, 2011, p. 33)

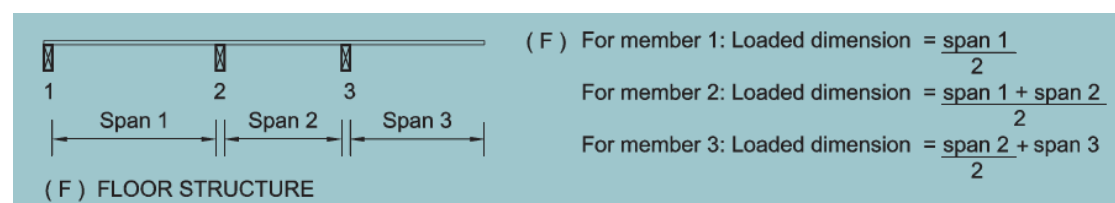


Figure 10. Diagram from NZS 3604 2011 defining loaded dimensions using effective span.
(Source: Standards New Zealand, 2011, p. 33)

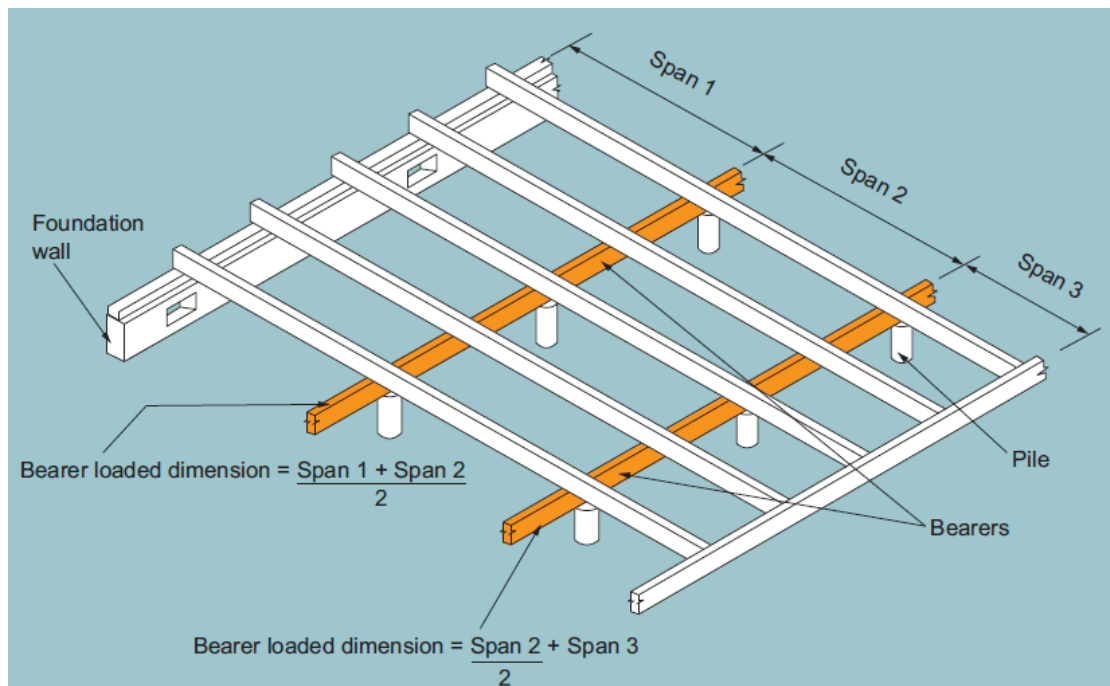


Figure 11. BIM model of dwelling highlighting the elements required in a timber sub floor in their context.
(Source: Richard Kelly, Unitec, 2013)



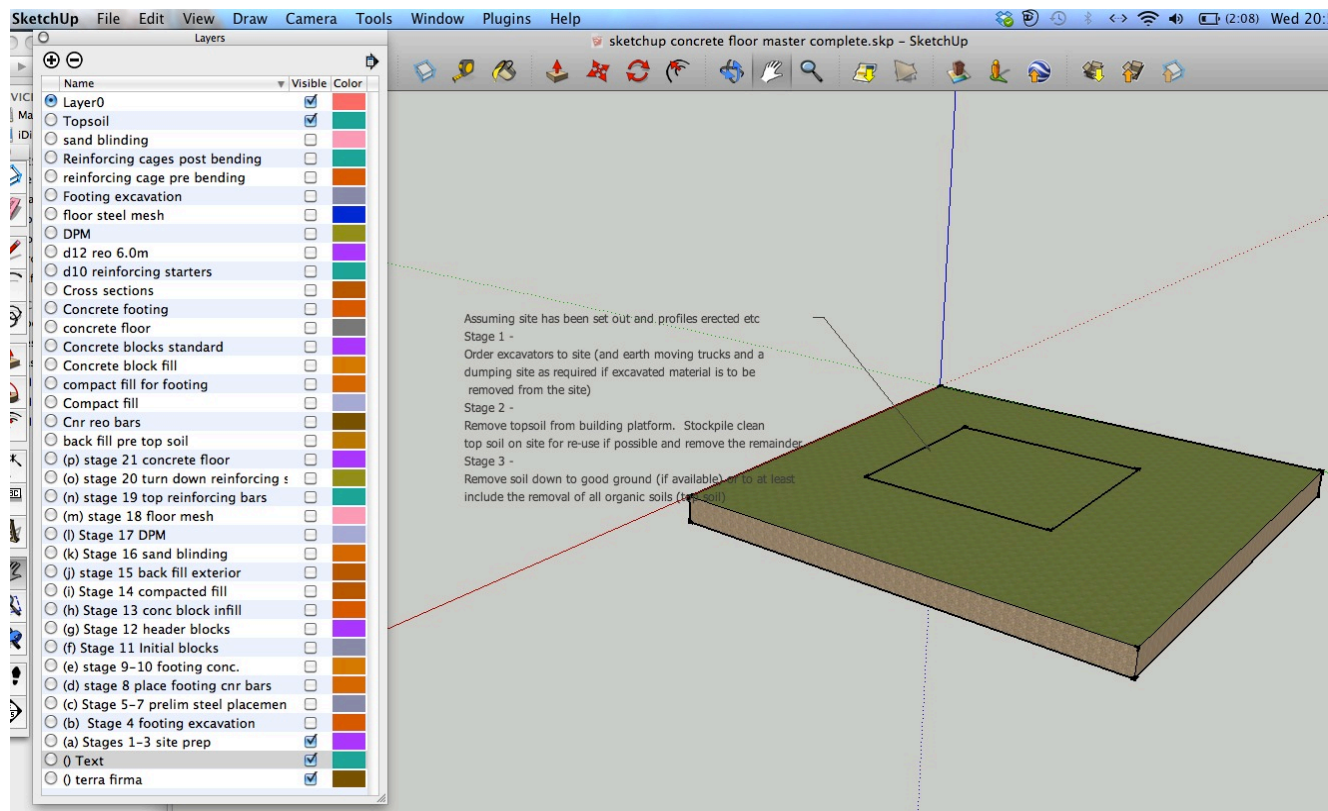
Topic area 10: Concrete slab

When teaching this subject content the main problems students seem to encounter are envisaging the elements which combine to make up the overall construction and comprehending the actual sequence in which the components of a slab are put in place. Jim Cornes, a colleague in Unitec has sought to address these issues by employing

Sketchup to develop models which allow student interaction and interrogation. Students can turn layers relating to individual elements off and on to inspect each in detail and find out more data. A version is envisaged where students have to turn on the various layers in the correct order to demonstrate understanding of the sequence of construction.

Figure 12. Sketchup interface showing layers assigned to the various elements of the slab. View showing interactive model at initial construction stages.

(Source: Vince May. Unitec, 2014)



Sketchup is a very versatile software package freely available for students to download. It is intuitive and relatively easy for students to acquire sufficient skills to open, save and work with the models devised by their lecturers. Its' interface is easily understood by students and not just those from within design disciplines. It has been applied within Unitec across courses in materials, construction and site planning and organization where the ability to convey the construction sequence has been found to be of particular value.

Figure 13. View of same Sketchup model with further layers made visible assigned to the concrete, footing walls and reinforcement.

(Source: Vince May. Unitec, 2014)

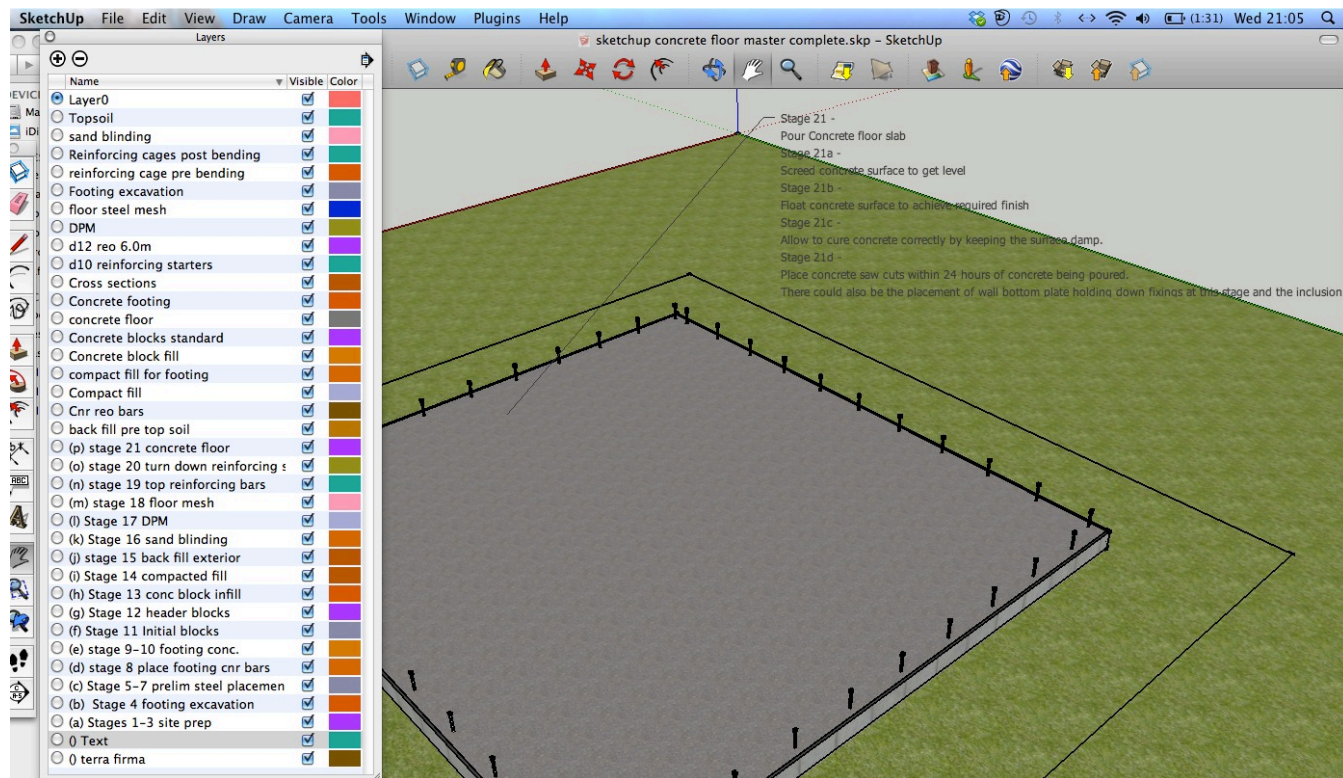
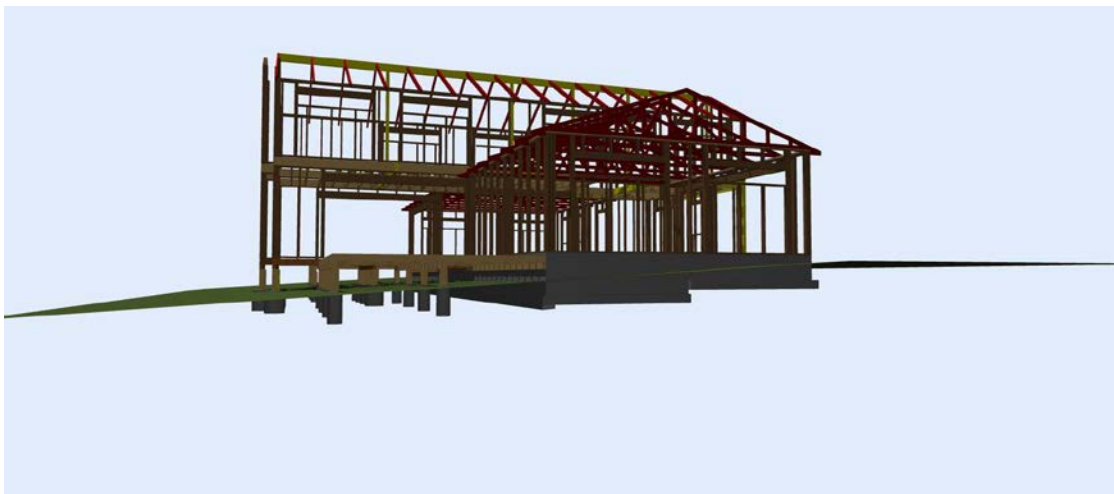


Figure 14. Views of a BIM model showing the stepped foundation walls and used to clarify issues of depth of embedment related to cleared ground levels. The site topography is clearly visible in a mesh generated by the software package Archicad using contour data that would be provided by a surveyor. Students can clearly see the relationship between ground levels and the foundation structures.

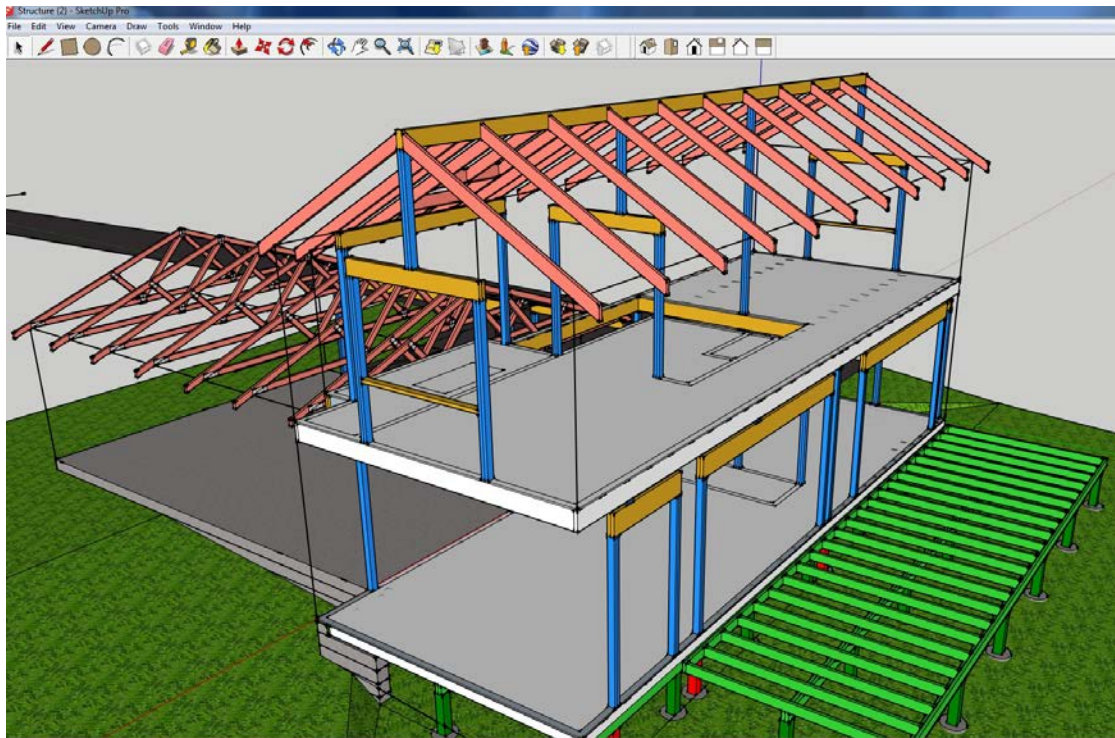
(Source: Richard Kelly. Unitec, 2013)



Topic area 12: Wall framing systems

This is a wide ranging topic but a recurring theme is the need to recognise the load paths being sustained by the elements of the timber frame. The ability to structurally analyse even a simple project is an invaluable skill fundamental to the repertoire of an Architectural Technologist and useful to almost all construction disciplines. It was for this reason that Jim Cornes, a Unitec lecturer decided to generate a Sketchup model of a major house project being undertaken by first year students in their Documentation 1 course. This course is where students are expected to demonstrate and apply the skills and knowledge they acquired in their Construction Systems 1 course. The lecturer colour coded some of the elements to help students identify paths of forces, possible need for specific engineering input and extra elements such as timber sub floor piles.

Figure 15. Sketchup model generated to help students analyse a house in structural terms.
(Source: Jim Cornes. Unitec, 2012)



In regards to the use of the Sketchup model Unitec lecturer Jim Cornes said the following:

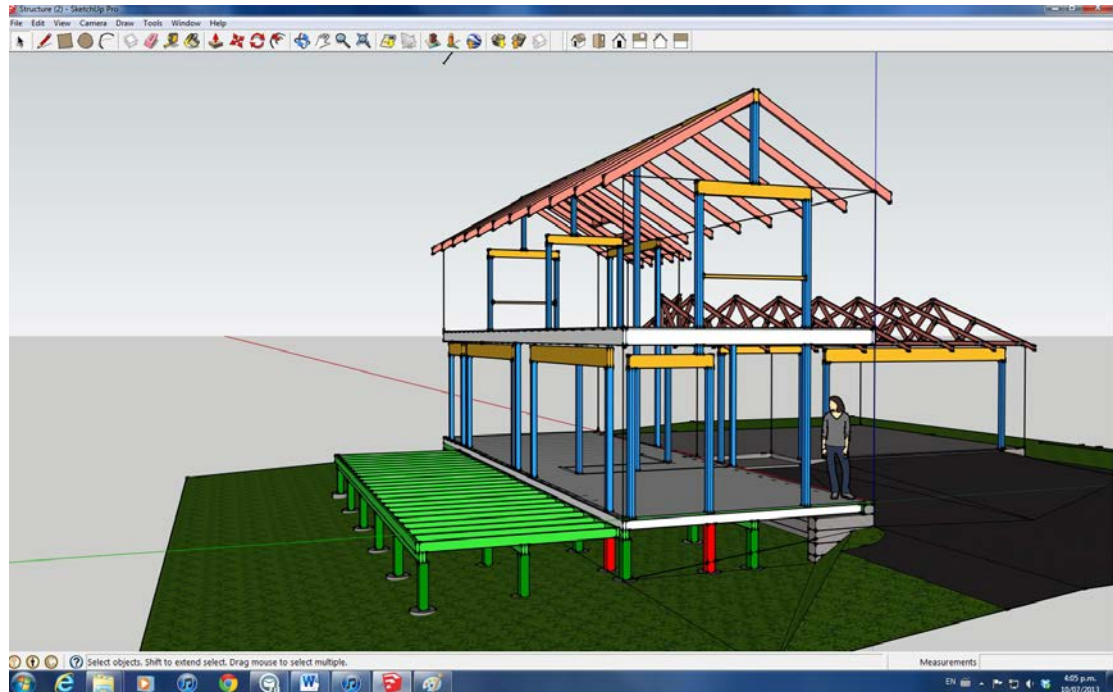
“It is primarily the application of the NZS 3604:2011 knowledge taught in Construction Systems 1, being applied back to our Documentation 1 Project House.

“The problem for the students, is that we draw (teach) from the Foundation Plan upwards, whereas they need to understand the contributing loads from the framing members above, coming down three dimensionally through the structure.

“So at the stage of drawing a lower foundation or sub-floor framing plan, they can't visualize those load paths or the structure above, so I provided the Sketchup model as a teaching tool ... I can demonstrate those load paths through the structure and the students can also take the Sketchup model with them, to work at home, or after studio teaching times, to assist with their learning”. (Jim Cornes, Department of Construction, Unitec, June 2013)

Figure 16. Another view of the same model but orientated to highlight where certain load paths necessitate the use of extra piles in the sub floor framing. The model author has coloured the extra piles in red for emphasis. Realisation of the need for these piles would be far from obvious without a structural overview of the dwelling frame and the ability to analyse and track the paths of forces from top to bottom.

(Source: Jim Cornes. Unitec, 2012)



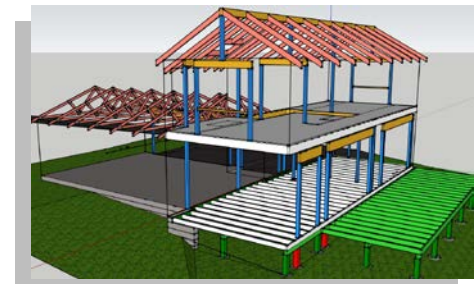
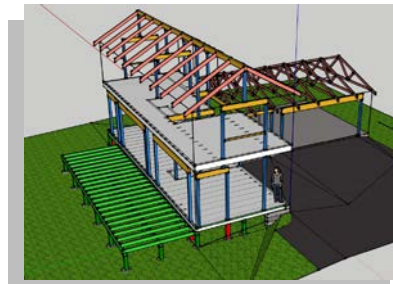
Conclusion

In many respects this research has revealed things that I was already aware of but has also exposed some new ideas and opportunities to help improve construction education in the tertiary sector in New Zealand (and if not beyond into secondary schools). Emerging from this short study are the following:

- There are already some great BIM resources that have been generated by lecturers and used by them in their content delivery across various papers in the National Diploma in Architectural Technology at Unitec.
- At present we do not embed BIM into our teaching enough. There are many opportunities to exploit the BIM products of software packages such as Archicad, Revit, Sketchup and others to enhance student engagement and learning.
- If education has been able to successfully embed other ILTs such as Word and Excel programs into teaching across a wide spectrum, then possibilities surely exist to weave BIM software and products into education for the built environment.
- Perhaps institutions in New Zealand should look at forming a consortium similar to the UK Higher Education Academy BIM Forum to further promote the use of BIM in teaching.

APPENDIX 1: MINI SURVEY DISTRIBUTED TO NDAT YEAR 1 STUDENT STREAM

Brief survey of learning gaps and visual aids related to Cons Sys 1.



Q1 Do you as a student find that using models helps you to understand the principles of timber framed construction or concepts from 3604 such as loaded dimensions ?

Q2 Briefly list or explain why you find models such as the one in the pictures to help your learning and understanding ?

Q3 Do you find that virtual models work as effectively as real models in supporting your learning and understanding?

Q4 Would the ability to open and investigate a virtual CAD model in your on time and possibly off campus at home be an advantage in helping you to learn?

Q5 Can you list in what ways real and virtual models have been or could be used to make your learning experience more interesting and rewarding?

Q6 Have you ever heard of BIM and do you know what it stands for or means?

APPENDIX 2: COMMENTS COMPILED FROM INFORMAL TUTOR DISCUSSIONS

Vince May, Department of Construction Unitec, 18th June 2013

“I originally created the models so that the students could see three dimensionally how the structure went together. Whilst creating the models I realised that I could also use the components, as opposed to an actual completed model and have the students assemble the building in a virtual reality.

“The third learning outcome for me materialised with the ability to in-bed information about each element in the component as I created it so that students could then interrogate the elements in a completed model to discover for instance how big a lintel is and why it was selected with references back to standards that the students are familiar with.

“My next wish is to create informative animations for construction so that students can select a sequence for construction and the software will animate the sequence halting when and highlighting issues when a program error has occurred”.

Polisi Faumina, Department of Construction Unitec, 18th June 2013

“Why??? Visualisation. Tactile - being able to touch the elements. Interaction with the model. Helpful in explaining concepts like loaded dimensions. Also in assisting students to analyse buildings in a structural way as regards the paths of the structural forces”.

Taija Puolitaival, Department of Construction, Unitec 4th December 2012

“Quite right, the idea is to embed Building Information Modeling as part of all our programmes (ND, BCONS, GDCPM). I would emphasise the word embed, because like discussed we are not going to run any separate BIM courses, but trying to weave it into the existing topics.”

Jim Cornes, Department of Construction Unitec, 18th June 2013

“It is primarily the application of the NZS 3604:2011 knowledge taught in Construction Systems 1, being applied back to our Documentation 1 Project House. The problem for the students, is that we draw (teach) from the Foundation Plan upwards, whereas they need to understand the contributing loads from the framing members above, coming down three dimensionally through the structure. So at the stage of drawing a lower foundation or sub-floor framing plan, they can't visualize those load paths or the structure above, so I provided the Sketchup Model as a Teaching Tool ... I can demonstrate those load paths through the structure and the Students can also take the Sketchup Model with them, to work at home, or after Studio Teaching times, to assist with their learning”.

APPENDIX 3: CONSTRUCTION SYSTEMS 1 CURRICULUM REVIEW FOR BIM EMBEDMENT OPPORTUNITIES.

Construction Systems 1 teaching delivery using BIM

(Source: Author)

Lecture content		BIM opportunities	AT/QS/CM	Software	Lecturer training
3. District Plans and Town Planning		Plot densities ,Planning controls eg- Height to boundary controls, Building set backs , Rolling heights . Building size and cost per M2			
4. Site Investigation Surveying	5.	Levels,contours ,existing services,Encumbrances,Topography,Site sections,soil types,rock,cut and fill requirements,excavations volumes. Need for retaining walls.Finished floor levels and height of piles above finished ground levels. Topography studies,terrain factors,sun studies,orientation.			
6. Timber Sub-floor - basic 7. Mid-floor Systems 8. Timber Sub-floor - Breakout	9. Timber Sub-floor - Advanced	Viewing and identification of elements in subfloor systems . Analysis of structural problems,load paths,loaded dimensions and spans.Definition of uniformly distributed loads and point loads. Measuring of dimensions and spans. Depth of embedment,pile spacings,footing types and forms .			
10. Concrete Slab Timber Sub-floor - breakout	11.	As above with possible layering of concrete slab element build up demonstrated using BIM model.Rules regarding general saw cuts and under loadbearing walls.Using site models to illustrate when slab on ground appropriate.Cut and fill,site levels and contours to modify site for slab.Demonstration of edge details. Cut away 3-d details and 2-d details from model.Effect of cut-outs for services. Rib Raft models.			
12. Wall Framing systems 13. Wall Framing Systems 14. Wall framing - Breakout		Model used to identify load paths and different types of loads.Loaded dimensions and where trimming studs and lintels required.Demonstration of stud set-out ,sizing and spacings, nogs and dwangs,fixings?Layering details to show framing and relation to wall wrap,battens and final cladding.Model used to identify wall system elements and terminology.Different models to relate to the house types to which 3604 tables refer. Effect of span directions of joists on whether wal loadbearing or not.			

16. Measuring an existing Building		Use BIM model to show what was generated from rough survey sketches and compare survey drawings with model plans and views.Dimension checks and relationship of building to context i.e. site.Demonstrate how survey info from a data logger taken across in dwg. form to software package to model up a site. Photogrammetry or digital elevation surveys?Building Conditions surveys and comparison of design details. Existing services.			
15. Roof Framing Systems 17. Roof framing Systems 18. Roof framing - Breakout		Use of a digital model of timber framed house to identify individual elements of roof framing required for the various system types. Truss roofs,Skillion roofs, Couple close. Highlighting load paths and supporting structures below necessary for different proposals.Identification of LOADED DIMENSION and introduction to bracing.Effects of wind on different roof shapes and forms.Digital model build ups and overlays to demonstrate sequence of construction and detailing.			
19. Bracing 20. Bracing 21. Bracing - breakout		Using animations to show effect of lateral forces and identify the two main types that residential designers have to deal with.Models need not be residential to introduce bracing implications for buildings.Model used to stress effect of roof form and how the RIDGE plays important part in determining wind demand.Use model to highlight and stress design factors in establishing demand and providing capacity e.g.Wind along,across,Ground to apex and height to eaves.Use model to identify the building forms that each table refers to and to explain concept of bracing lines.Layered up detail models to show how we can construct and build in the capacity necessary to meet demand,e.g. braced piles,GIB boards,diaphragms and proprietary systems on the market.			
22. Wall Claddings		Digital models to show various types and profiles of cladding.How they effect final house elevations. Using digital models to explain differences between direct fixed and drained cavity systems and 4 D's approach to functional requirements and detailed design of junctions openings etc. 3-d models produced to help students visualise the details given in E2- AS1 as acceptable solutions.			
23. Weathertightness 24. Risk Assessment - Breakout		RISK MATRIX DESIGN -something where a digital model could be used to demonstrate the principles to this method of achieving compliance with Building Code and deriving data to put into Archicad or Design Navigator. Basic model could convey the risk matrix design factors under headings used in DBH document and help in their interpretation by students.			

25. Roof Claddings		Use of digital models to demonstrate design factors such as roof pitch, context, site topography and location and effect of cladding choice. Limitations of materials in terms of pitch and implications for roof form and shape. Roof drainage demonstrated, falls, materials compatibility at junctions or run offs, proprietary systems and fixings using models from industry.			
26. E2-Roof Junctions and penetrations 27. E2 Breakout		Use 3-d models possibly building up in layered animations or which allow student to control layers to help identify individual elements which make up acceptable solutions in E2/ AS 1.			
28. Internal Linings, fittings and finishes		Use of model and perhaps individual room elevations to help generate finishes schedules and zone different areas according to their proposed purpose, use and finishes required. Touch on need for services integration in kitchens, bathrooms, en-suites and laundry areas. 3-d details to help show methods of fixing.			
29. Stairs and handrails		Use a model of a stair to help explain various terms, and stair shapes and forms both in plan, section and in overview. Identification of pitch, goings/ treads, risers, landings, nosings, stringers, handrails, guard rails and how to design stairs compliant with code.			
30. Decks and Handrails 31. Stair design - Breakout		Build up a model of a deck to show construction elements, design factors, junction with the house and methods to connect compliant balustrades guard rails. Sequential animation or model with layers to allow students to interrogate individually.			
32. Insulation		Layered 3-d models could be used to identify elements necessary to create a thermal envelope around the dwelling. Demonstration of principles of heat loss and where these occur throughout the house. Identification of potential cold bridging problems and possible detailing solutions produced as 3 - d models. Proprietary systems and details employed if available.			
33. Insulation - Design 34. Insulation - Breakout		Use of software like Archicad to identify design factors for energy conservation or for input into ALF or Design Navigator.			
35. Windows and Doors		Use of BIM to identify these components in CAD drawings and representation in drawings such as plans, sections elevations, and component drawings such as schedules. 3-d models of systems whether generic or proprietary and range of materials used in the NZ industry influence the design of bespoke units. Identification of window elements such as mullions, transoms, awnings, louvres, opening lights and ironmongery used.			

36. Alternative Construction - Overview		Overview of non 3604 houses such as pole houses and perhaps generation of a BIM model to highlight and compare/contrast this approach with the NZ standard design house. Model of a masonry block house generated or 3 d details of block walls and tying in with concrete slabs . Do companies have any digital resources we could utilise or develop.			
37. Alternative Construction - Overview		Introduction to Lightweight steel framing by developing a basic house model. Load paths, connections and similar outcomes to timber lecture content depending on level of use in the industry and with reference to the NZ standard which applies.			
38. Light Steel framing		Industry representative.			
39. Brick Veneer		Generation of a model to demonstrate how this cladding system works with a timber frame and perhaps also steel. 3-d models of critical details and to illustrate how cavity is drained and vented.			
40. Sustainable Design					
41. Concrete Masonry .		Industry representative.			

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