

BEST 402 Industrial Ecology

Guest Lecture: BIM-LCA

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Contents

- 1. Building Information Modelling (BIM) - Introduction**
- 2. Whole building LCA with BIM**
- 3. BIM-LCA Challenges**



Know each other:

Myself: Civil Engineering,, BIM, LCA,
Building Performance, Energy modeling

The Class:

1. Did you have internship/work experience?
2. What do you want to do after school?
3. Who are your employers?
4. What is your selling point? (software, certificates, training, projects)



1. Building Information Modeling (BIM)



What happens if the architect changed the design in the last minute?

How does the industry make these wood products?



What is BIM?

BIM Acronym

- Building Information Modelling (Model/Management)
- Technology? software? process? protocol?

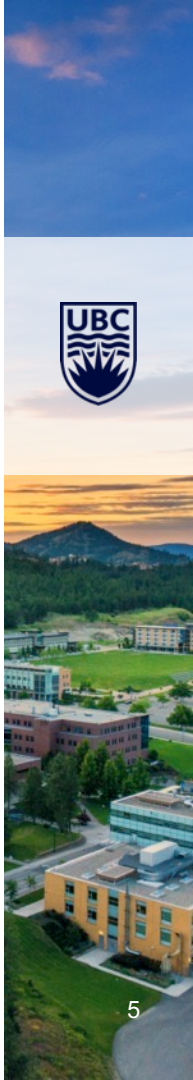
BIM Definitions

“...a modeling **technology** and associated set of **processes** to produce, communicate, and analyze building models.” – *BIM Handbook*

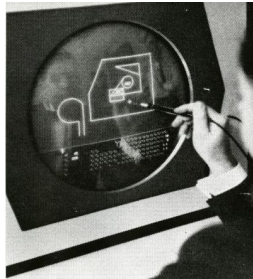
“...is a **digital** representation of **physical** and **functional characteristics** of a facility...serves as a **shared** knowledge resource for information about a facility, forming a reliable basis for decisions during its **life cycle** from inception onward.” – *National BIM Standard USA*

Watch Video: **What is BIM?**

<https://www.youtube.com/watch?v=suNadRnHy-U>



History of BIM



Sketchpad

Computer-aided Design (CAD) with graphical user interface



ArchiCAD

First BIM software available on a personal computer



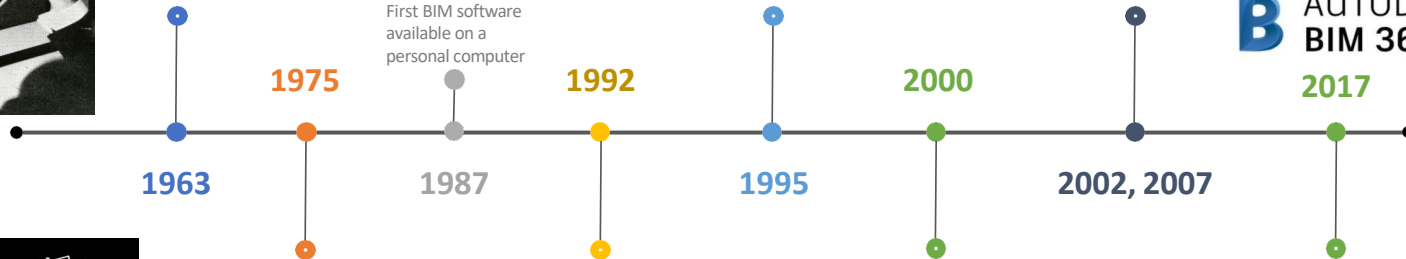
Industry Foundation Classes (IFC)

A platform neutral, open file format specification to facilitate interoperability in the AEC industry



Autodesk acquired Revit & Navisworks

Autodesk offers the most popular BIM ecosystem since then



1963

1975

1987

1992

1995

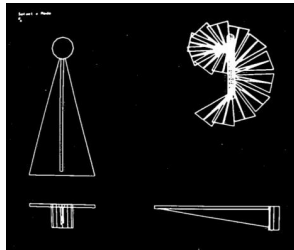
2000

2002, 2007

2017

Building Description System (BDS)

Parametric design, high quality computable 3D representations, with a "single integrated database for visual and quantitative analyses"



Building Information Modeling as official term

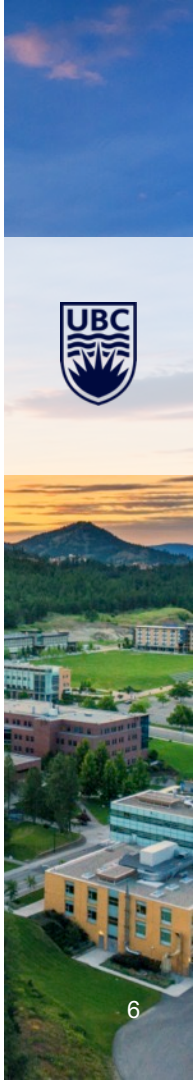
Appeared in a paper in the December 1992 Automation in Construction

Revit 1.0

Revolutionized BIM by using a parametric change engine made possible through object-oriented programming and a platform allowing time attribute to be added.

Autodesk launched BIM 360

A cloud-based platform for construction management to improve decision-making



Benefits and Impact of BIM

BIM Benefits

- Improves design and analysis
- Increases output quality
- Facilitates information sharing and management

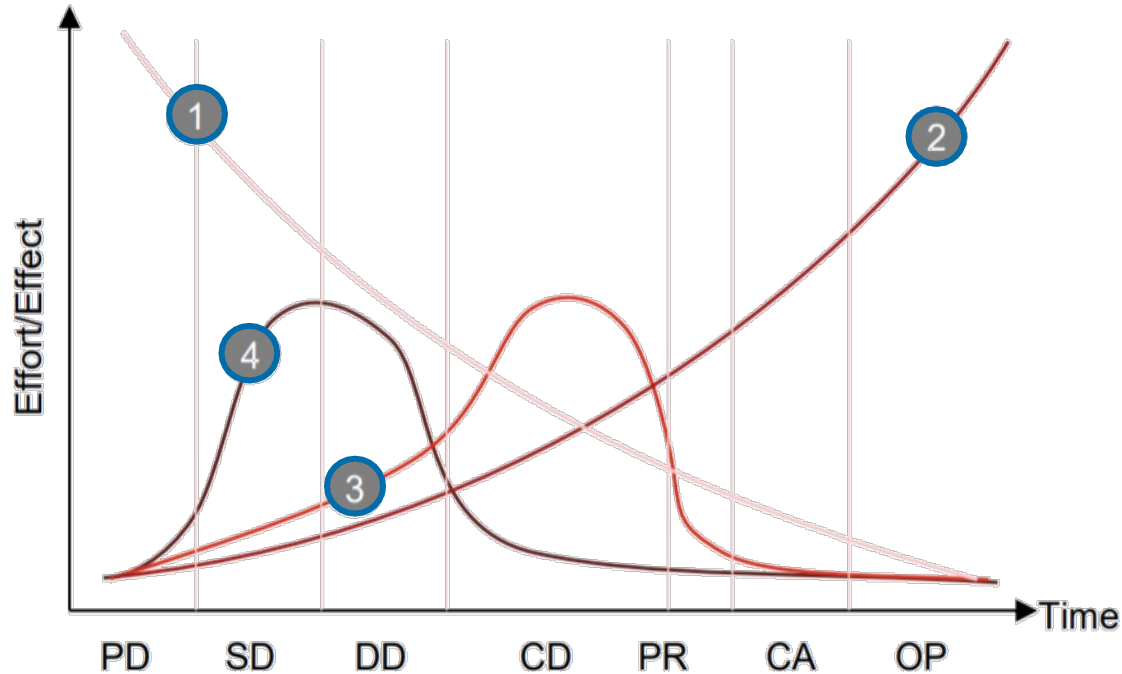
Impact on Project Performance

- 20% reduction in build costs
- 33% reduction in costs over the lifetime of the asset
- 47% to 65% reduction in conflicts and re-work during construction
- 44% to 59% increase in overall project quality
- 35% to 43% reduction in risk, improved predictability
- 34% to 40% better performing completed infrastructure
- 32% to 38% improvement in review and approval cycles

- UK Cabinet Office BIM Strategy Paper



Benefits and Impact of BIM



- buildingSMART UK, 2010

-
- 1 – Ability to impact cost and functional capabilities
 - 2 – Cost of design changes
 - 3 – Traditional design process
 - 4 – Preferred design process
-

PD: Pre-design

SD: Schematic design

DD: Design development

CD: Construction documentation

PR: Procurement

CA: Construction Administration

OP: Operation



BIM Adoption Worldwide

United Kingdom

- Mandatory to use BIM in all government projects
- BIM adoption rose from 10% in 2011 to 74% in 2018

United States

- Early pioneer but slow adopter
- Some states and government department mandate BIM
- 72% construction firms in the US are believed to be using BIM

Singapore – mandatory for projects over 5,000 sqm from 2015

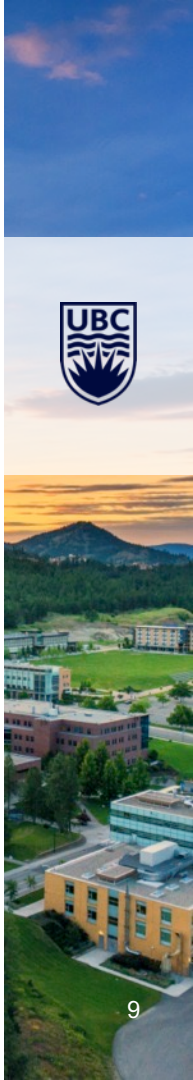
Russia – obligatory for all federal orders from 2017

Brazil – mandatory in 2021

Chile – obligatory for gov. projects in 2020

Italy – mandatory for projects over 100 million in 2019

Australia – wide-ranging but fragmented

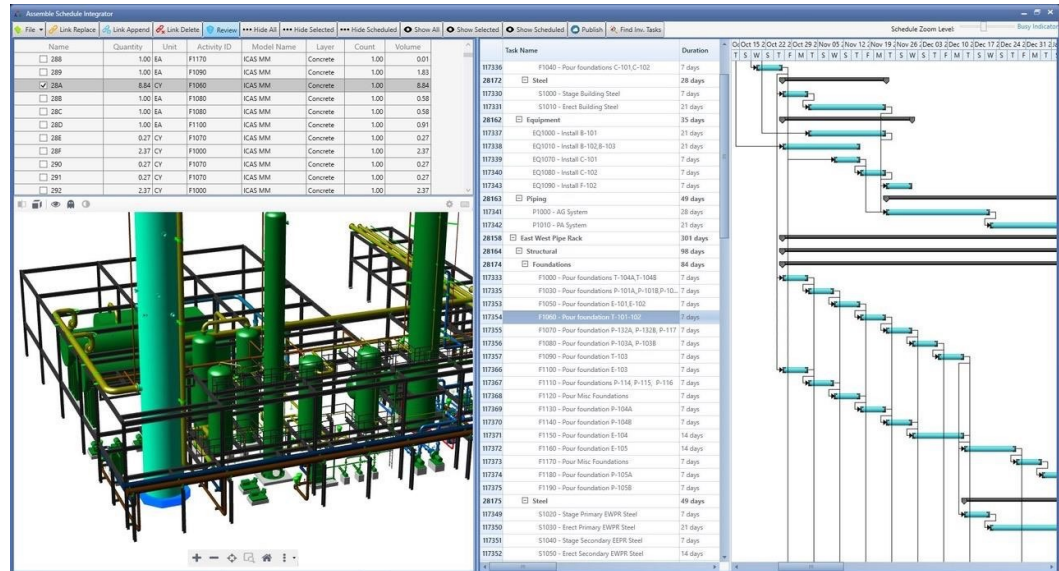


BIM Models

A BIM model is the **digital description** of every aspect of the built facility. It draws on information assembled collaboratively and updated at key stages of a project.


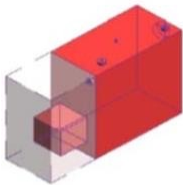



How is a BIM model different from a 3D model?

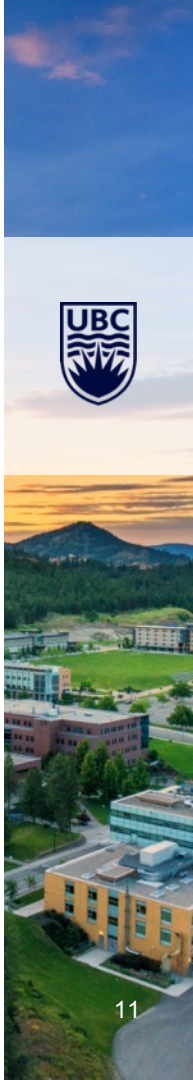
- Geometry and attributes
- Materials, cost, vendor, schedule, etc.
- Describe behaviours and relationship
- Parametric design



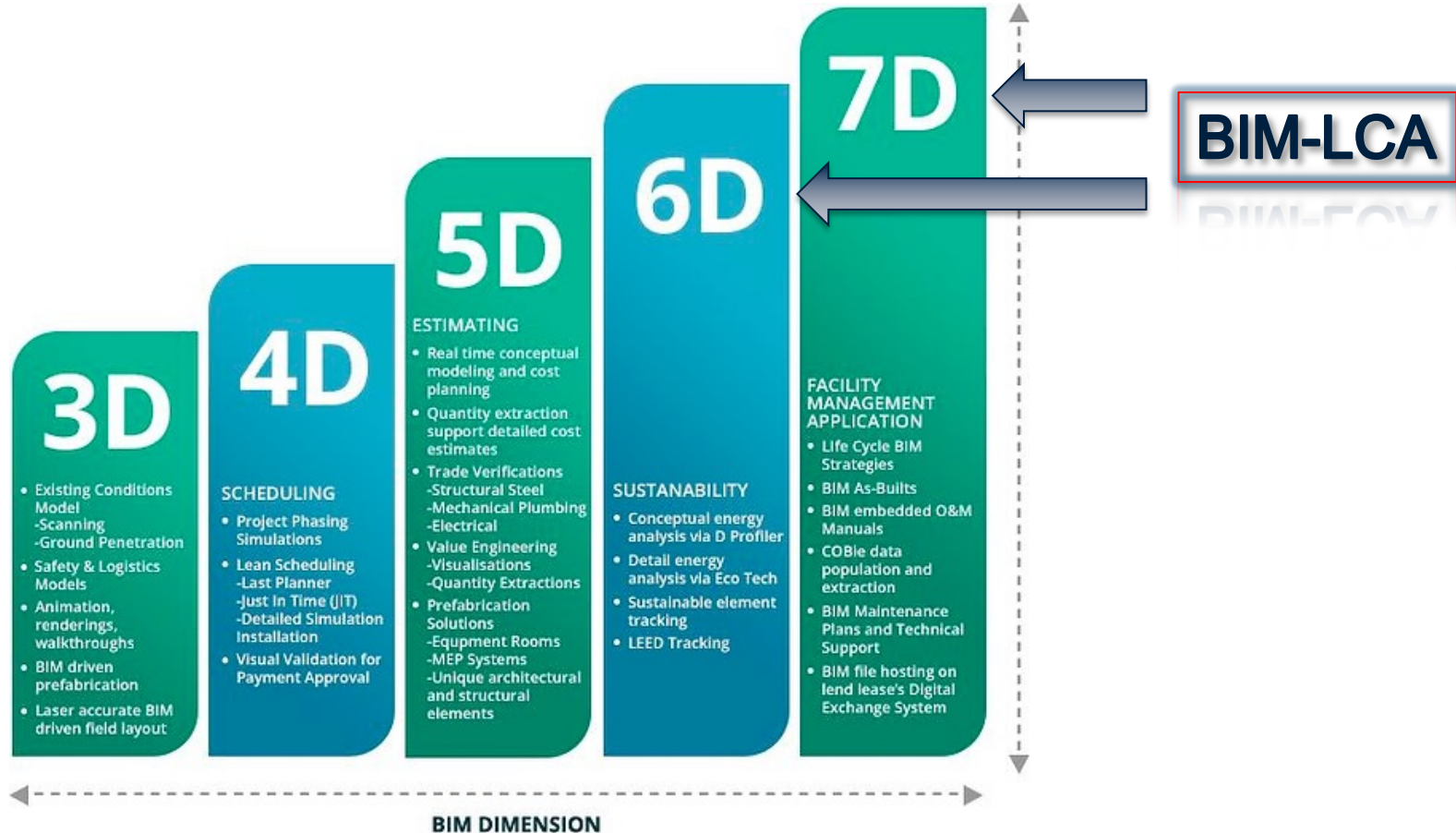
BIM – Levels of Developments (LOD)

- Defines the extent to which model elements are developed
- Provides clarity & certainty about that is expected from everyone involved in modelling

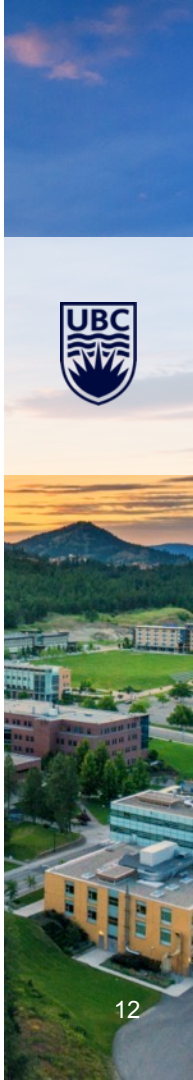
LOD 100 Conceptual	LOD 200 Approximate geometry	LOD 300 Precise geometry	LOD 400 Fabrication	LOD 500 As-built
				
<p>The Model Element may be graphically represented in the Model with a symbol or other generic representation, but does not satisfy the requirements for LOD 200. Information related to the Model Element (i.e. cost per square metre, etc.) can be derived from other Model Elements.</p>	<p>The Model Element is graphically represented in the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation.</p>	<p>The Model Element is graphically represented in the Model as a specific system, object, or assembly accurate in terms of quantity, size, shape, location, and orientation.</p>	<p>The Model Element is graphically represented in the Model as a specific system, object, or assembly that is accurate in terms of quantity, size, shape, location, and orientation with detailing, fabrication, assembly, and installation information.</p>	<p>The Model Element is a field verified representation accurate in terms of size, shape, location, quantity, and orientation.</p>



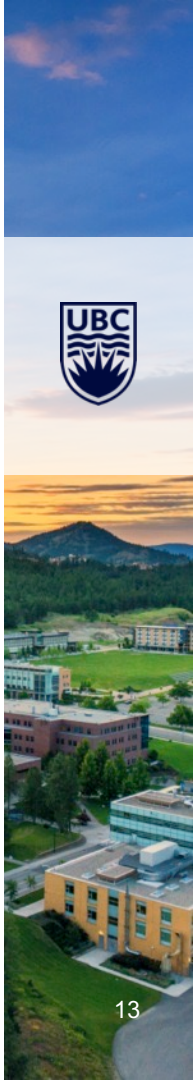
BIM – Dimensions



Source: <https://www.firstinarchitecture.co.uk/the-advantages-of-bim-and-its-future/>



BIM – Software



BIM – Software Revit

What is Autodesk Revit?

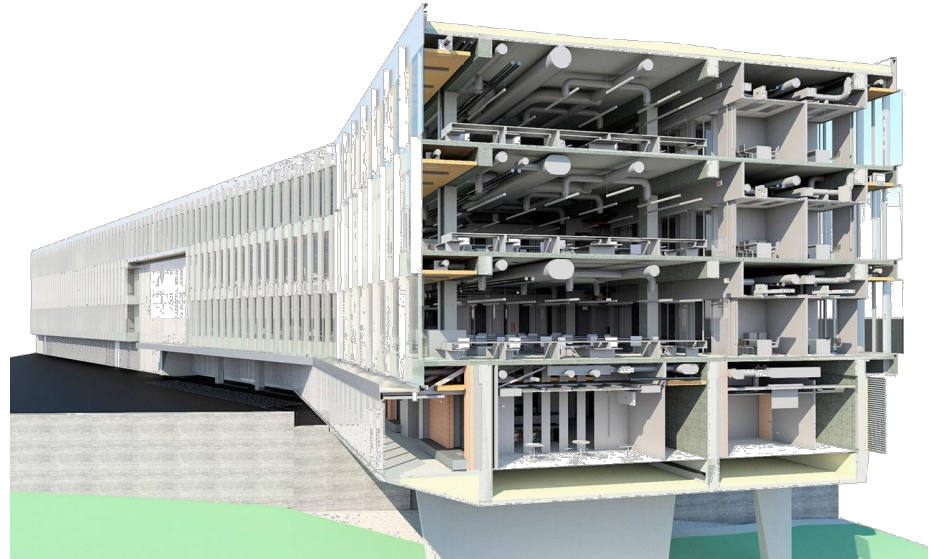
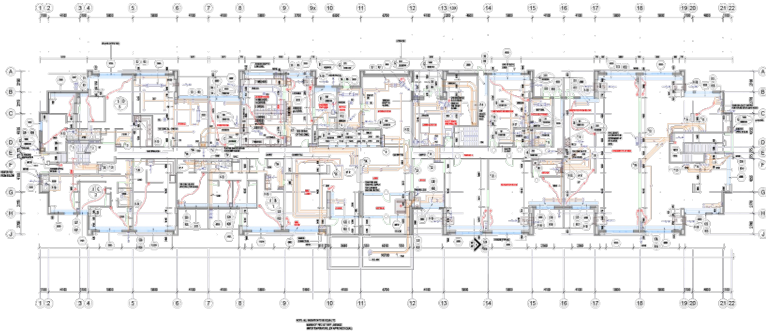
- BIM platform software (design authoring, model analysis & simulation)

Revit is NOT BIM

- BIM is a methodology; Revit is a platform for BIM tasks & collaboration

Difference between AutoCAD and Revit

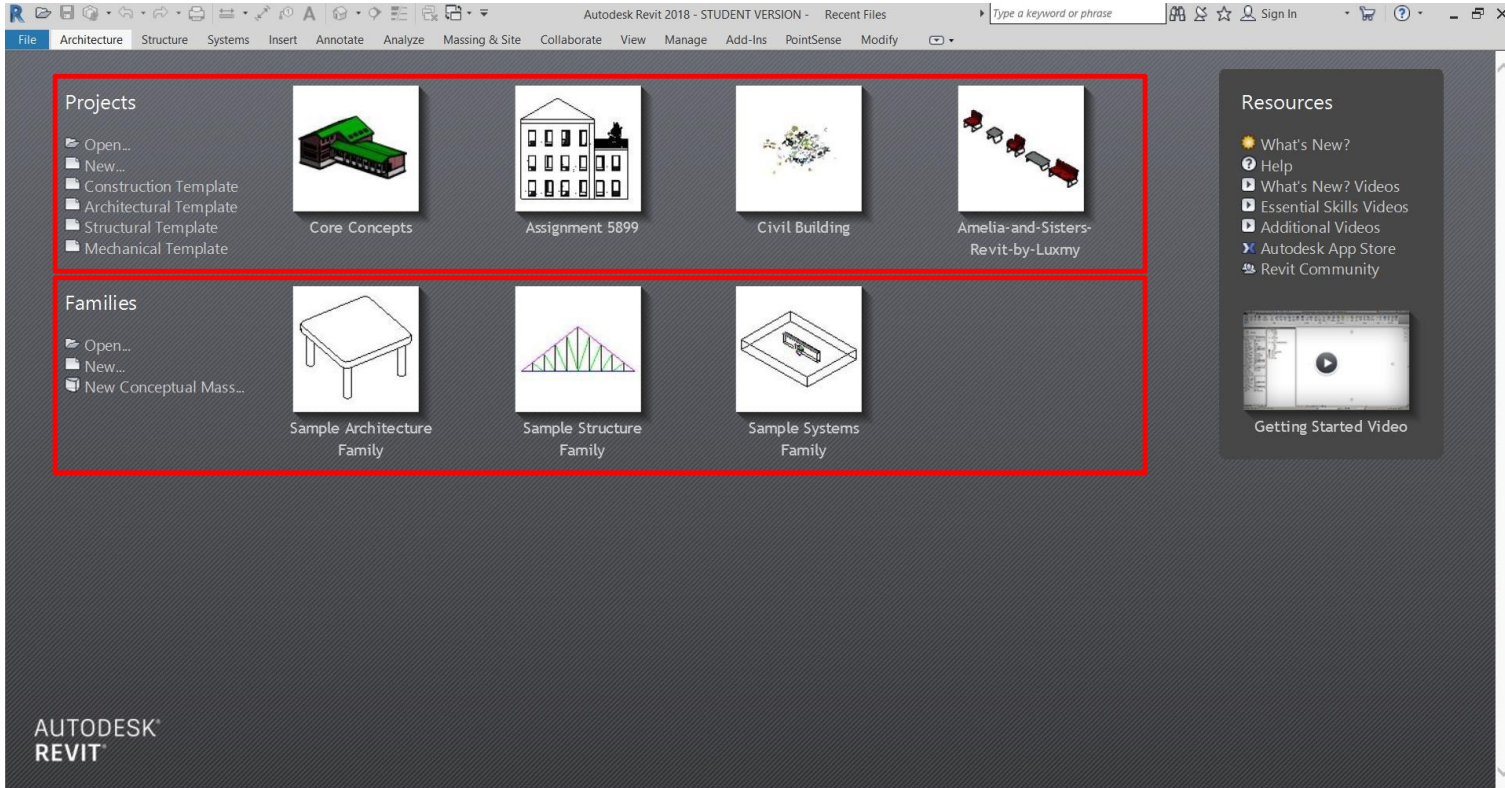
- Digital drawing vs. intelligent modelling



BIM – Software Revit

Basic UI windows and functions

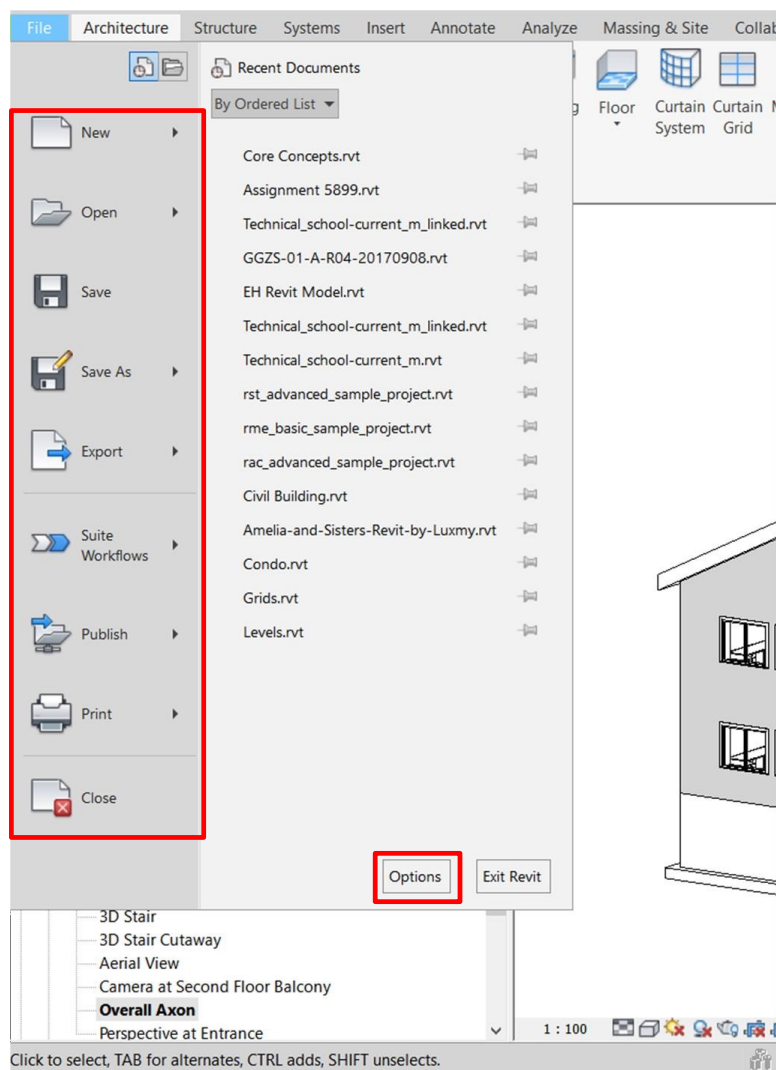
- Lunch Screen



BIM – Software Revit

Basic UI windows and functions

- Lunch Screen
- Application Menu



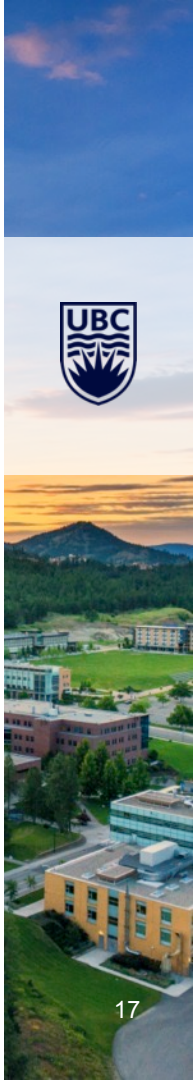
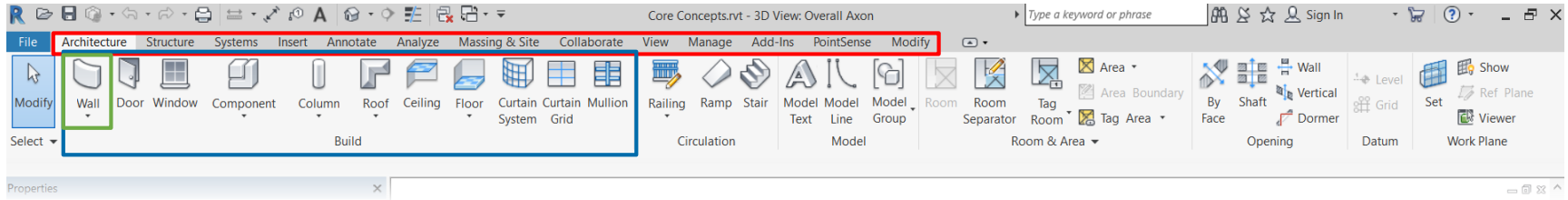
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.



BIM – Software Revit

Basic UI windows and functions

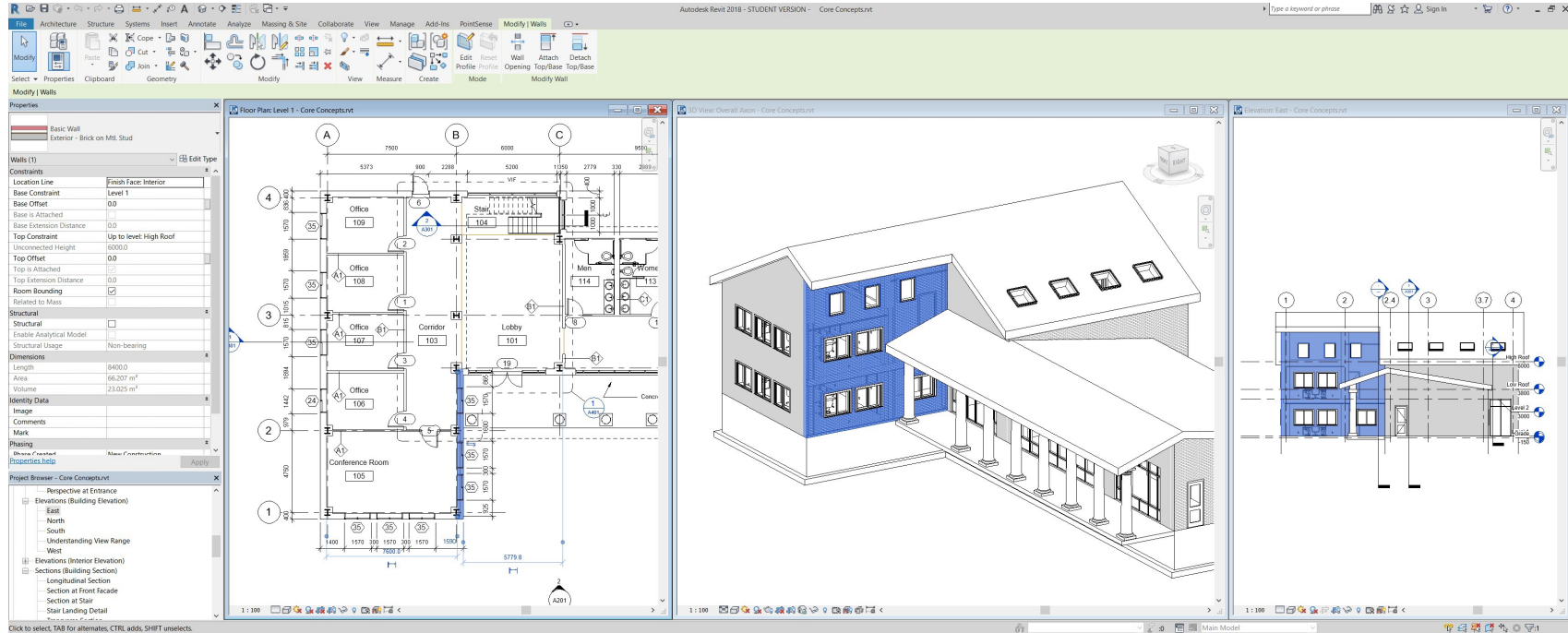
- Lunch Screen
- Application Menu
- Ribbon Menu (tabs, panels, tools > tooltips)



BIM – Software Revit

Easy-to-use interface

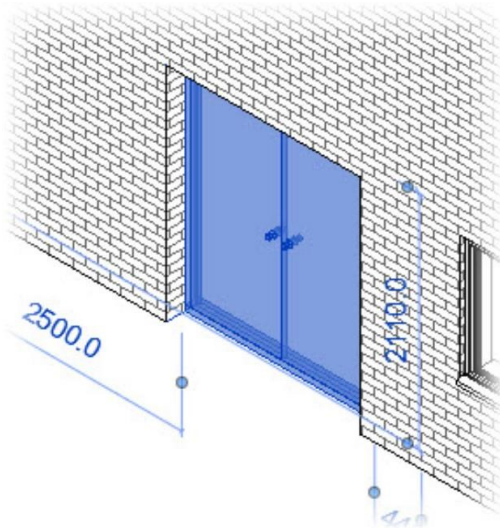
- Drag-over hints, smart cursor, well-organised menu



BIM – Software Revit

Parametric Modelling

- Everything is driven by parameters



Properties

Doors_ExtDbl_Flush
1810x2110mm

Doors (1) Edit Type

Constraints	
Level	Level 0
Sill Height	0.0
Construction	
Frame Type	Type A
Materials and Finishes	
Frame Material	Metal
Finish	Satin
Identity Data	
Image	
Comments	
Mark	5
Phasing	

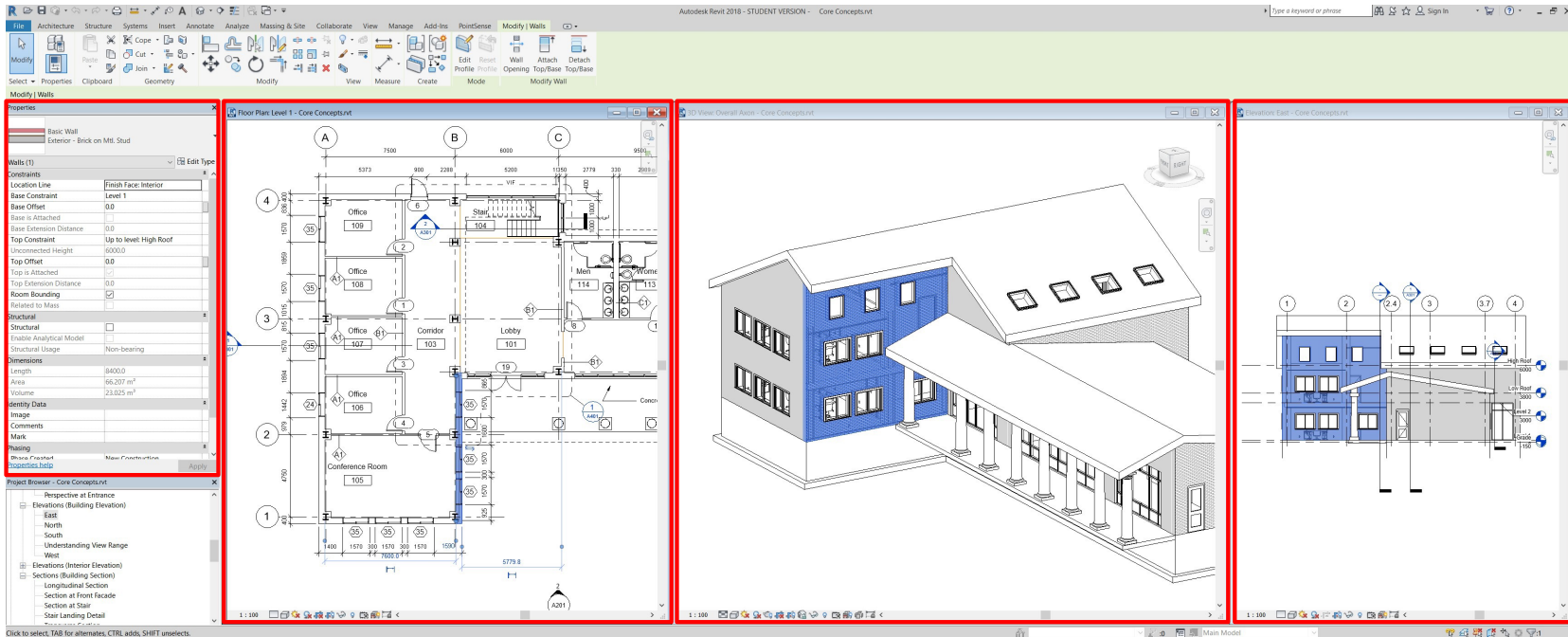
Watch Video: Revit
Live Demo:
https://www.youtube.com/watch?v=_IXmHsQbakM



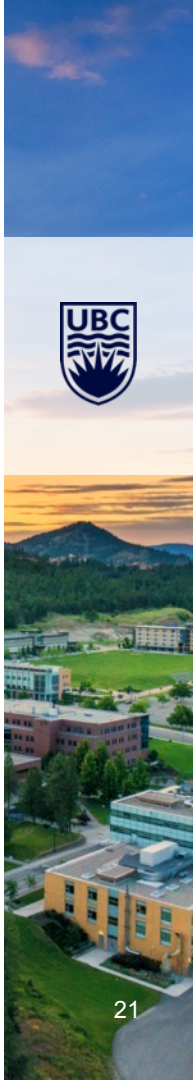
BIM – Software Revit

Parametric Modelling

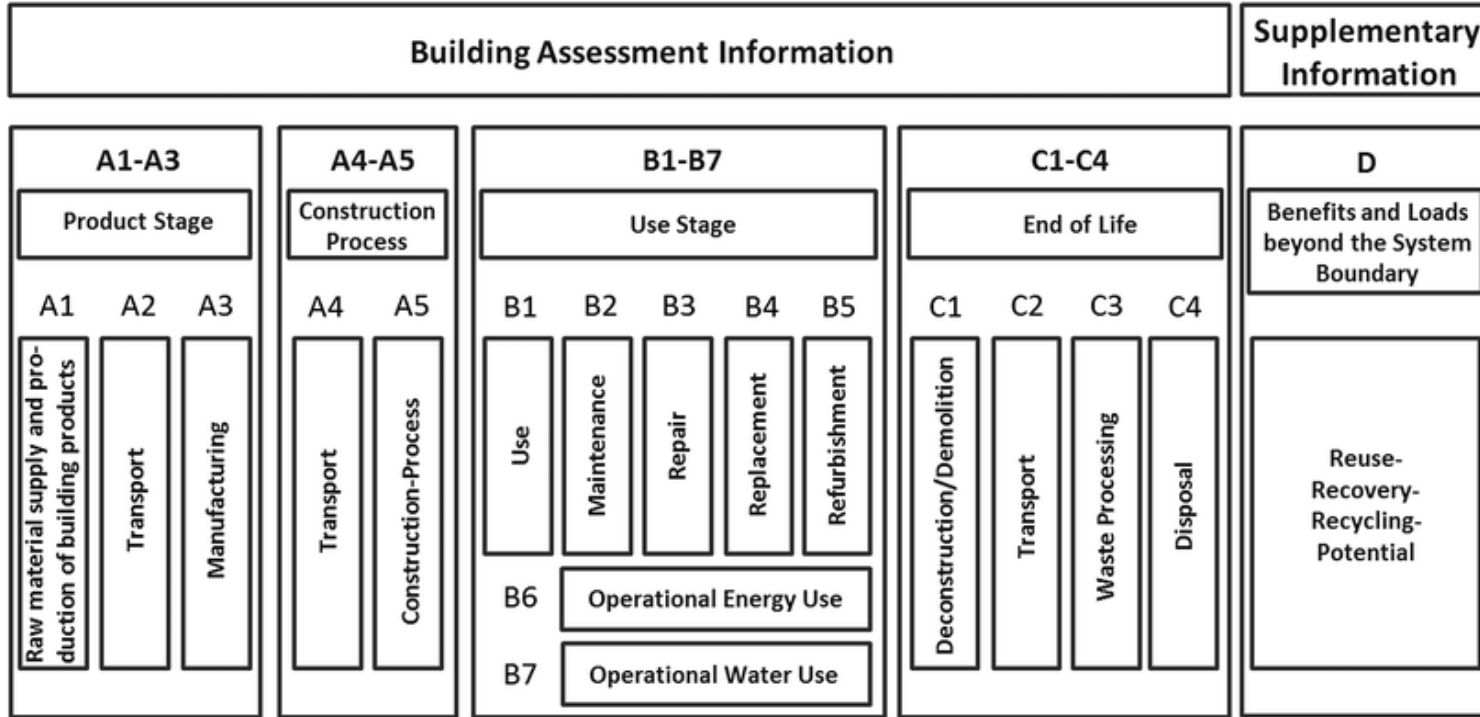
- Everything is driven by parameters
- One model, one database; Change it once and it changes everywhere!



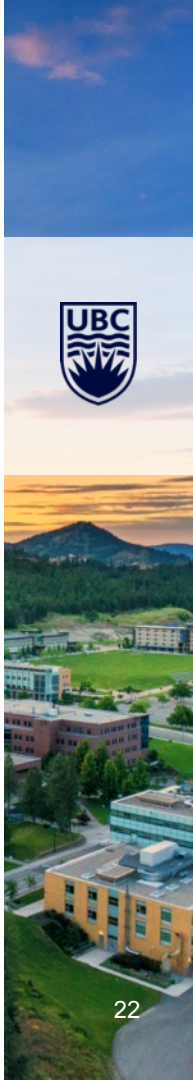
2. Whole Building LCA with BIM



Whole Building LCA

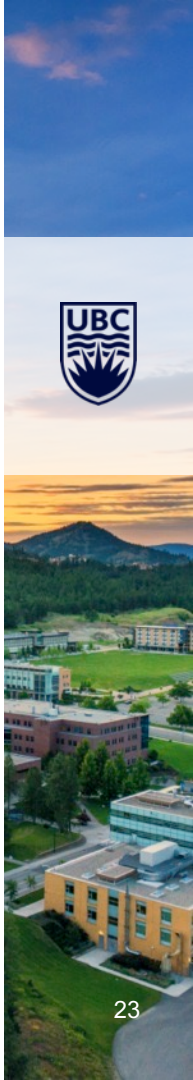


Source: EN15978



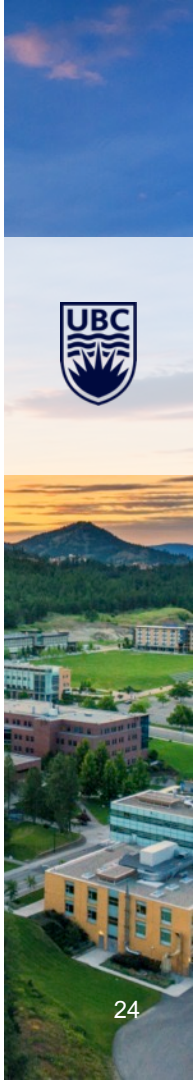
Whole Building LCA

- Code-compliance
- Think about the impact of a building in a 60-year lifetime
- Whole-building life cycle assessment professional (BCIT) –
Micro certificate

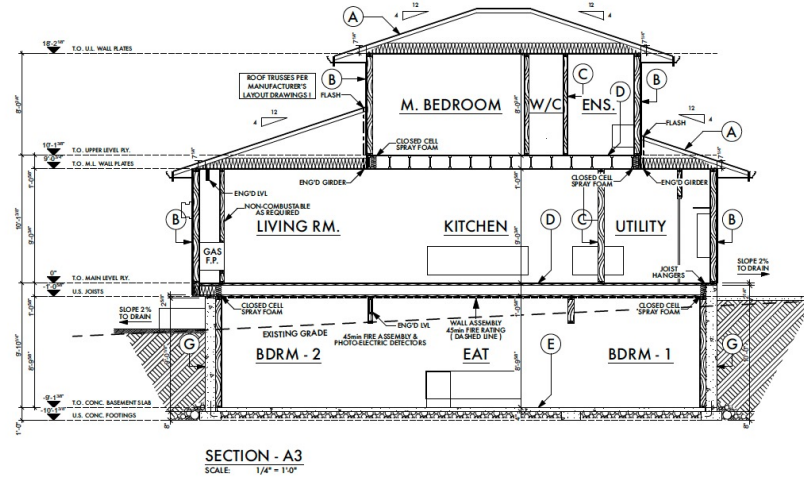


BIM-LCA

- Support architects on early design
- Material/design option selections
- Overall building environmental impacts
- BIM model is the key for LCA accuracy



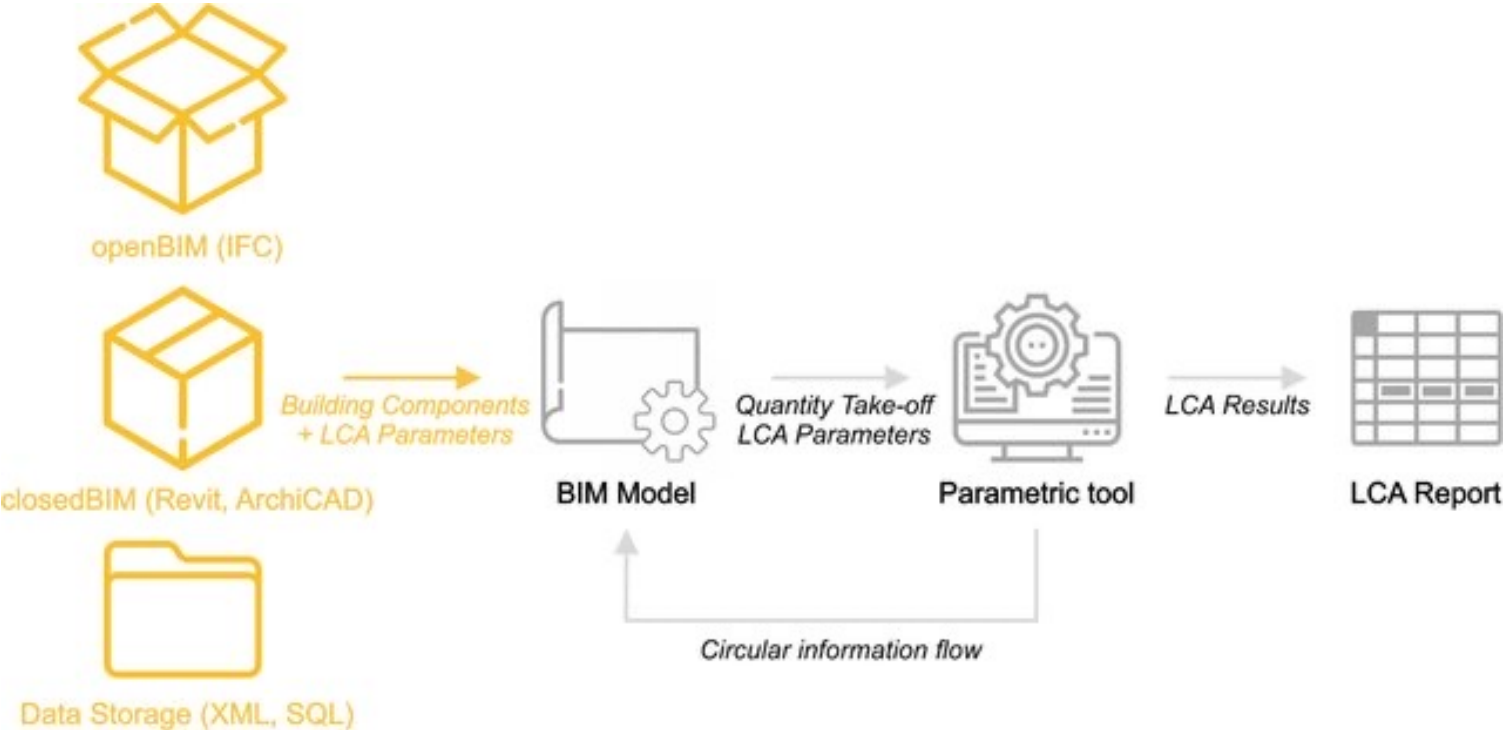
BIM-LCA – Model development



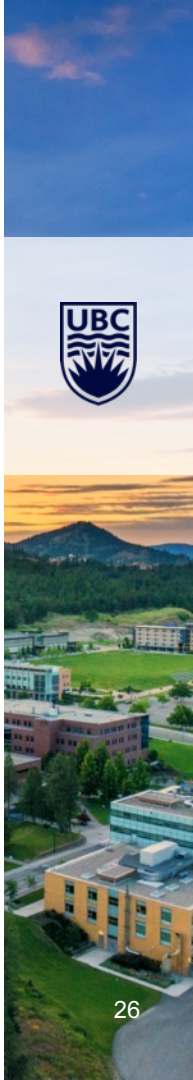
1. Existing BIM model from architect
2. Simplified BIM model
3. 2D Cad drawing
4. As-built pdf
5. Blueprint



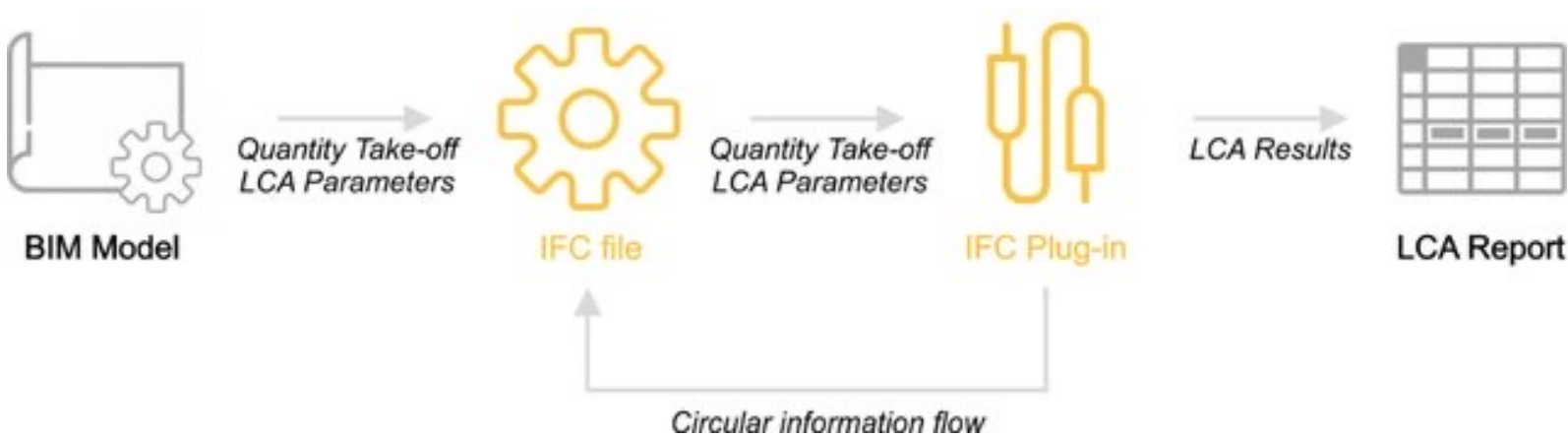
BIM-LCA – Option 1



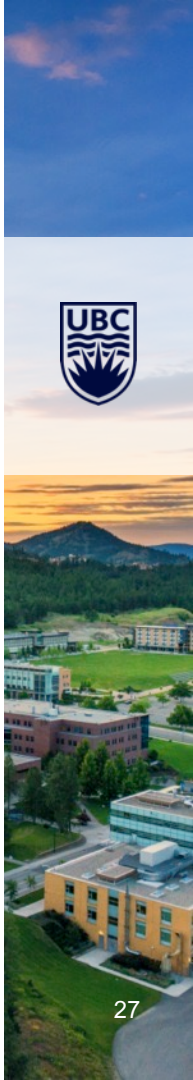
Source: Neneva et al. 2020. (DOI: 10.3390/su12093748)



BIM-LCA – Option 2



Source: Neneva et al. 2020. (DOI: 10.3390/su12093748)



BIM-LCA Tools

- Athena Impact Estimator (Link: <https://calculatelca.com/>)
- BIM Tally (Link: <https://choosetally.com/download/>)
- One Click LCA (Link: <https://www.oneclicklca.com/>)



Athena
Impact Estimator
for Buildings

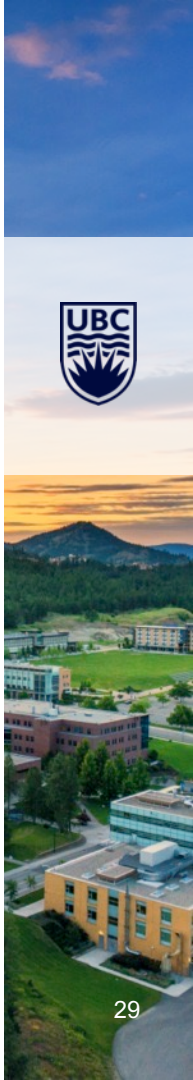


Foundation: Be familiar with building drawings



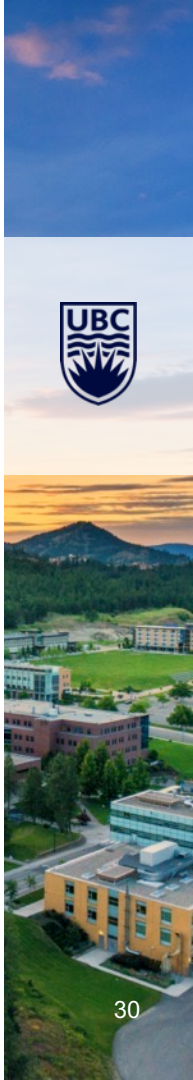
One Click LCA Demo

<https://www.oneclicklca.com/>



BIM-LCA Challenges

1. Software database limitation for design option
2. Information missing from BIM model transfer (ifc, gbxml, rvt)
3. Material impact data source (EPD)





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