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BIM-LCA Construction Project

Title: Revit software workflow tutorial

1 – Aims

The ability to create a Structural Model, generate schedules, and extract quantities for use in LCA, using Revit software.

Ability to transmit information using BIM.

2 – Learning methodology

The teacher will provide an explanation of how to use the tool. Students are expected to read and follow this guide. To assess the completion of the exercise, each student must create a complete Revit Structural model.

3 – Tutorial duration

The practice described in this tutorial will be implemented through the BIM-LCA platform by self-learning.

8 teaching hours (1 day) are suitable for this training.

4 – Necessary teaching recourses

Computer with necessary system requirements to support the software

Required software: Autodesk Revit, version 2023 or newer

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5 – Contents & tutorial.

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6 – Deliverables

A report of 4 pages showing the execution of the exercise.

7 - What we have learned

How to use BIM with Revit software

How to create a project and add levels, a terrain and building pad, place construction elements (walls, floor, roof, doors, windows, curtain wall, stairs and railings, ramp), views and add dimensions

How to create schedules in Revit

How you can use building information, with schedules in Revit, to complement data used in LCA.

8 – State of the art use of BIM and LCA to assess the sustainability of a building.

The state-of-the-art use of Building Information Modeling (BIM) and Life Cycle Assessment (LCA) to assess the sustainability of a building represents a pinnacle in modern architectural and construction practices. This cutting-edge approach harnesses technology and comprehensive data analysis to make informed decisions about building materials, design choices, and the long-term environmental impact of a structure. An integral part of this process is the utilization of schedules within BIM software like Revit, along with seamless integration into powerful LCA tools like "One-Click LCA."

Numerous studies have attempted to categorize the integration of Building Information Modeling (BIM) and Life Cycle Assessment (LCA). A study has given a systematic literature overview of different categorizations of BIM-LCA Integration [1]. Anton and Diaz [2] proposed two approaches: direct access to BIM data for real-time

environmental assessment and embedding environmental properties in BIM objects. Nizam et al. [3] categorized studies into four types, ranging from project-specific to impractical approaches. Soust-Verdaguer et al. [4] identified three integration types, including using BIM for energy and material data. Wastiels and Decuypere [5] classified integration into five types, from exporting BIM data to directly embedding LCA information into BIM objects, allowing for concurrent environmental analysis during project development. Figure 1 presents an adapted overview by [1] of the different integration types proposed by [5].

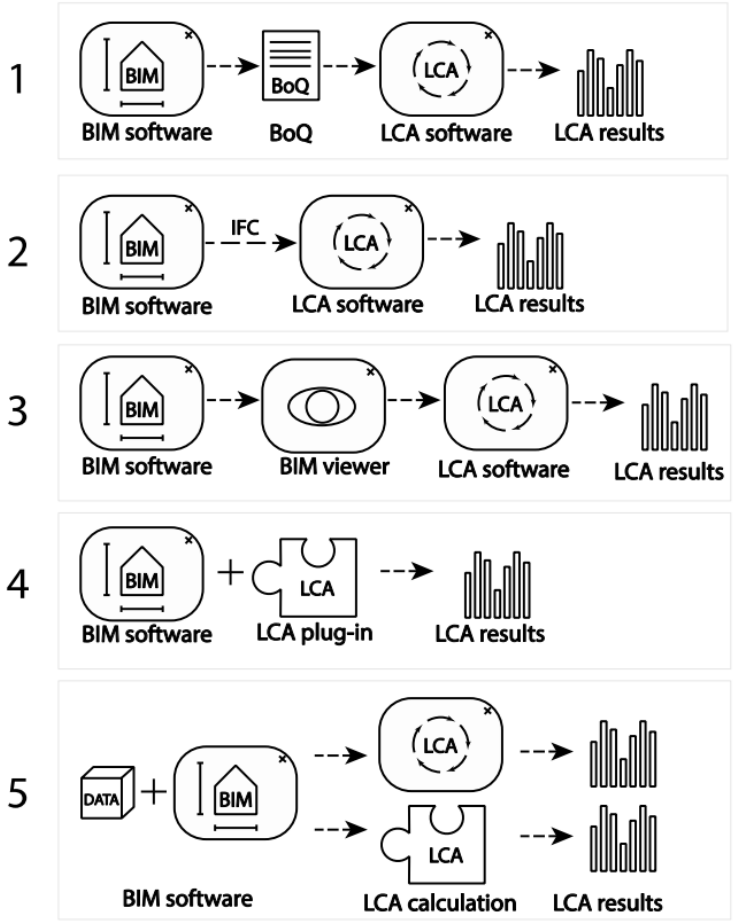


Figure 1: BIM-LCA integration types by [1] adapted from Wastiels and Decuypere [5]

This tutorial covers number 1 in the figure above.

To assess the sustainability of a building using BIM and LCA, you can perform this at different levels for buildings and constructions by subdividing a building into smaller entities such as whole buildings, building components or building materials [6]

9 - References

[1] T. Potrč Obrecht, M. Röck, E. Hoxha and A. Passer, "BIM and LCA Integration: A Systematic Literature Review," *Sustainability*, vol. 12, no. 14, 2020, art.no 5534. https://doi.org/10.3390/su12145534

[2] L.Á. Antón and J. Diaz, "Integration of Life Cycle Assessment in a BIM Environment," *Procedia Eng.,* vol. 85, p. 26–32, 2014. https://doi.org/10.1016/j.proeng.2014.10.525

[3] R.S Nizam, C. Zhang; L. Tian, "A BIM based tool for assessing embodied energy for buildings," *Energy Build.,* vol. 170, pp. 1–14, 2018. https://doi.org/10.1016/j.enbuild.2018.03.067

[4] B. Soust-Verdaguer, C. Llatas and A. García-Martínez, "Critical review of bim-based LCA method to buildings," *Energy Build.*, vol. 136, pp. 110–120, 2017. https://doi.org/10.1016/j.enbuild.2016.12.009

[5] L. Wastiels and R. Decuypere, "Identification and comparison of LCA-BIM integration strategies," *IOP Conf. Ser.: Earth and Environ.* vol. 323, no. 1, IOP Publishing, 11.–14. September 2019. https://doi.org/10.1088/1755-1315/323/1/012101

[6] European Commission, Directorate-General for Environment, C. Spirinckx, M. Thuring, L. Damen et. al., "Study and related guidance documents on the application of the PEF method to a new office building," Publications Office, European Union, ENV.B.1/ETU/2016/0052LV, 2018. https://doi.org/10.2779/23505

[7] BACHELOR'S THESIS, Geopolymer Concrete: A future-oriented concrete, B23B02, 15.05.2023

5 – Contents & tutorial.

5.1 - Introduction

Autodesk Revit is a powerful software designed for architecture, design, and engineering experts, utilizing BIM technology to facilitate the development of various project systems. It covers everything from the architectural and structural aspects to complementary systems like plumbing, electrical, and mechanical. Revit enables the creation of highly precise and efficient digital building models. Each project includes comprehensive construction descriptions and all the necessary information for generating 2D and 3D visuals, specifications, and documents. This data is stored in a unified database, ensuring that all model components are interconnected. Any changes made in one view automatically propagate to all other project views, eliminating the need for individual adjustments to drawings. Revit also promotes collaboration among professionals, allowing them to work on the model concurrently or separately.

An educational version, suitable for students and educators, is available for free download via the following website:

https://www.autodesk.com/education/edu-software/

If you don't have access to the educational license, a 30-day trial version is also available at:

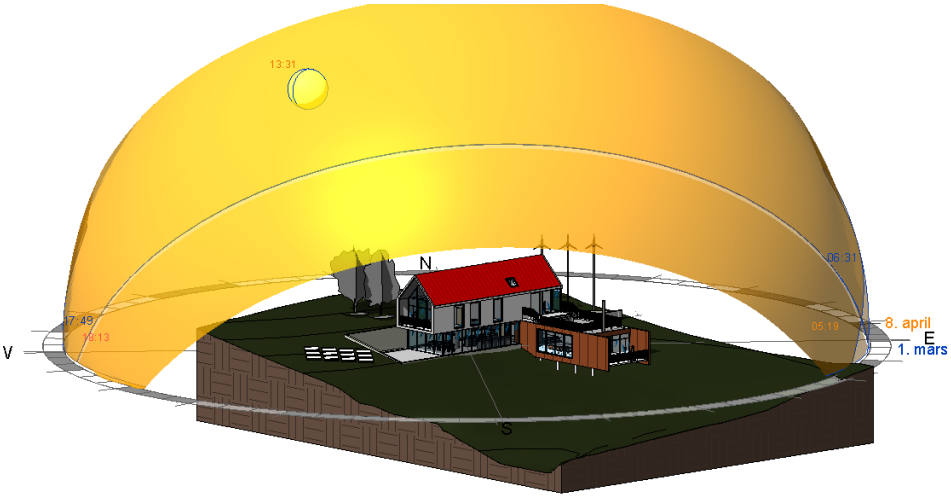
https://www.autodesk.com/products/revit/free-trial

5.2 - Understanding of Revit

Before starting a project in Revit, it is important to understand how the program manages information. Every building project contains a complete description of the building model as well as all the information required to display the model in both 2D, 3D, and schematic forms. This information is stored in a unified database, meaning in a file.

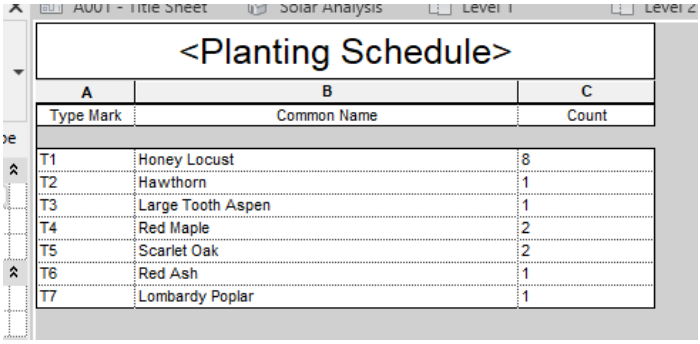
Views:

- 3D Views



- 2D Views

- Schedules

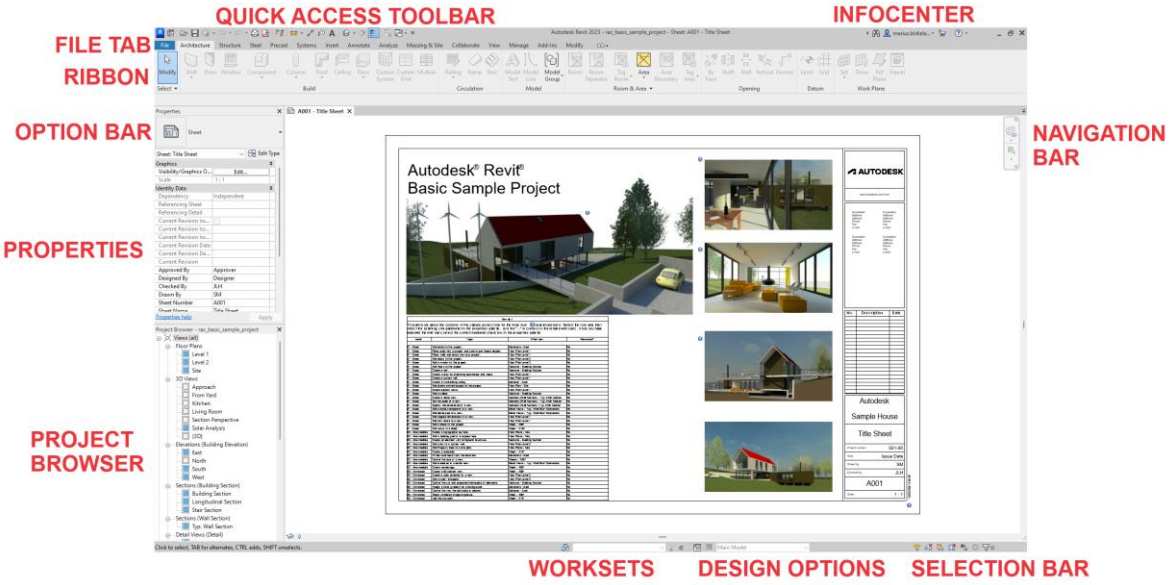


<Planting Schedule>

A	B	C
Type Mark	Common Name	Count
T1	Honey Locust	8
T2	Hawthorn	1
T3	Large Tooth Aspen	1
T4	Red Maple	2
T5	Scarlet Oak	2
T6	Red Ash	1
T7	Lombardy Poplar	1

The Revit user interface is based on the following main areas:

- **File Tab**
  This menu contains tools for file management.
- **Quick Access Toolbar**
  This toolbar can be customized by the user and includes a set of standard tools.
- **InfoCenter**
  This area provides information and assistance for the product.
- **Ribbons**
  All working tools are located on the Ribbons.
- **Options Bar**
  Settings and values are adjusted in the Options Bar depending on the command and element.
- **Properties**
  Properties for all elements and views are displayed in the Properties panel.
- **Project Browser**
  All project views are managed in the Project Browser.
- **Properties (Again)**
  Properties for the selected object are set here.
- **View Control Bar**
  View settings, such as scale, level of detail, cropping, etc., are adjusted through the View Control Bar.
- **Drawing Area**
  The drawing area is where the model is created.
- **Navigation Bar**
  Tools for navigating within the model are found here.
- **Selection Bar**
  Settings for linked files, underlays, and locked elements can be selected in the model.



Parameters:

All objects in a Revit project relate to each other. The term "parameters" refers to the ability for editing and coordination among all model elements that Revit provides. These relationships are created either automatically by Revit or by the user. An example of a relationship could be a roof edge drawn against the walls of the model. If the wall is subsequently moved, the roof edge will move with it because there is a connection. Parameters encompass all the information that can be attached to an object, such as height, width, material, fire rating, etc. These parameters are visible in the properties of the elements.

The Database:

In a project, modeling is done with the above-mentioned information-bearing elements. As walls, doors, windows, floors, etc., are added to the model, the Revit database is populated with this information, which can be continuously extracted into schedules. This makes it possible to track quantities throughout the entire design process. The information of elements can be edited, and new information can be added as needed.

5.3 - Get started: Video Tutorials

Below, we have opted to mention Autodesk's instructional videos for acquiring a grasp of the core functionalities of Revit. These videos align with the instructional training provided in a classroom setting for Revit, and it is advisable to watch them before progressing with the tutorial.

Note:
The links to Autodesk's instructional videos mentioned below are relevant to Revit version 2023. Please visit https://help.autodesk.com/ for instructional videos for other versions of Revit.

Part 1: Create a Project and Add Levels

https://help.autodesk.com/view/RVT/2023/ENU/?guid=GUID-3B3190C6-94CA-4C44-8EB9-C684A02DBB49

Part 2: Create Walls

https://help.autodesk.com/view/RVT/2023/ENU/?guid=GUID-F0889711-DC78-47FB-8747-9DC408CBEDA2

Part 3: Create a Terrain and Building Pad

https://help.autodesk.com/view/RVT/2023/ENU/?guid=GUID-BD22FE68-5DDC-4E17-8528-AE0BC868A372

Part 4: Create a Floor

https://help.autodesk.com/view/RVT/2023/ENU/?guid=GUID-C7E5CEA9-D741-4829-B39E-73BE40FC4B7E

Part 5: Create a Roof

https://help.autodesk.com/view/RVT/2023/ENU/?guid=GUID-DCA3C942-1284-4FC9-BC06-144DE88C2EFA

Part 6: Place Doors

https://help.autodesk.com/view/RVT/2023/ENU/?guid=GUID-EDD3FFB6-28D2-40D6-A8F0-D5E6C2807302

Part 7: Place Windows

https://help.autodesk.com/view/RVT/2023/ENU/?guid=GUID-15BBE1F7-38FD-4AA0-ADA4-CE8923343DC1

Part 8: Place a Curtain Wall

https://help.autodesk.com/view/RVT/2023/ENU/?guid=GUID-96F003AD-5559-479F-91F3-263A0E8A7D8A

Part 9: Create Stairs and Railings

https://help.autodesk.com/view/RVT/2023/ENU/?guid=GUID-842A4DB6-4CA1-4ECD-9009-962769FFB19C

Part 10: Create Views

https://help.autodesk.com/view/RVT/2023/ENU/?guid=GUID-6BFB71DA-BCE6-4623-8ECD-D378E1C9C7F7

Part 11: Add Dimensions

https://help.autodesk.com/view/RVT/2023/ENU/?guid=GUID-6573039B-9E1A-45E5-B625-7E02ACC38FF1

5.4 - Schedules

Creating schedules and lists for projects has traditionally been a complex task that requires manual counting every time something changes. This information helps provide an overview of the project and assists in making the right choices in relation to the client's requirements and expectations.

Building Information Models, as mentioned earlier, are databases that can be viewed in various ways. One way to view them is through schedules, called Schedules in Revit, which display elements in rows and columns. A Schedule updates automatically and continuously as the building model is created. Schedules can be used for information

while modeling, but they can also be brought into sheets for documentation or exported to formats such as spreadsheets.

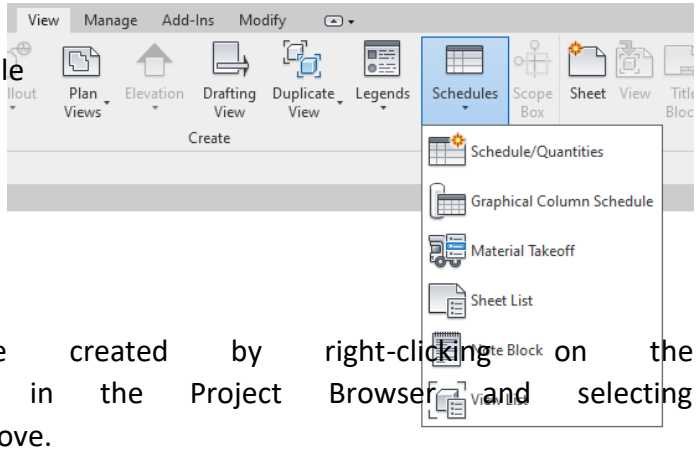
Definition of Schedules:

A Schedule is formatted based on the criteria set by the user. The information is retrieved from the Properties of the model's elements. Each Property value is brought into a defined field in a Schedule. A Schedule can display all inserted elements in rows or aggregate/group them and show information such as quantity, volume, etc., in a single row.

Types of Schedules:

There are five basic types of Schedules that can be created using the "Schedules" tool from the Ribbon Tab View. The six types are:

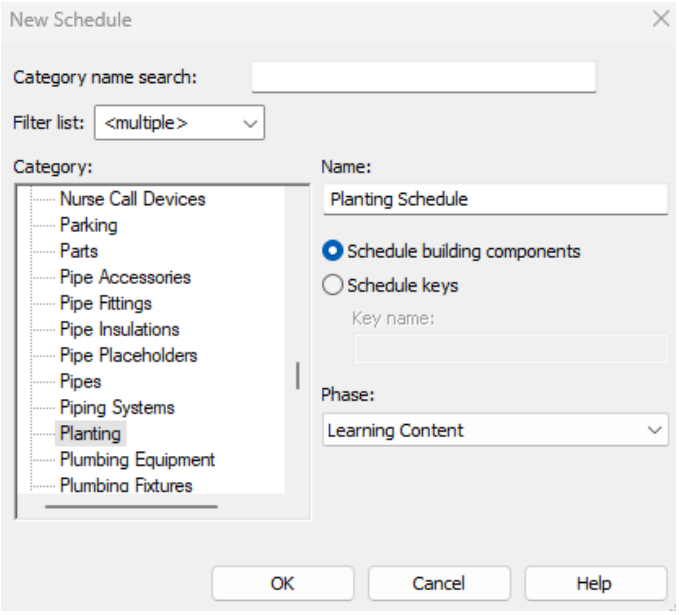
- Schedule/Quantities
- Graphical Columns Schedule
- Material Takeoff
- Sheet List
- Note Block
- View List



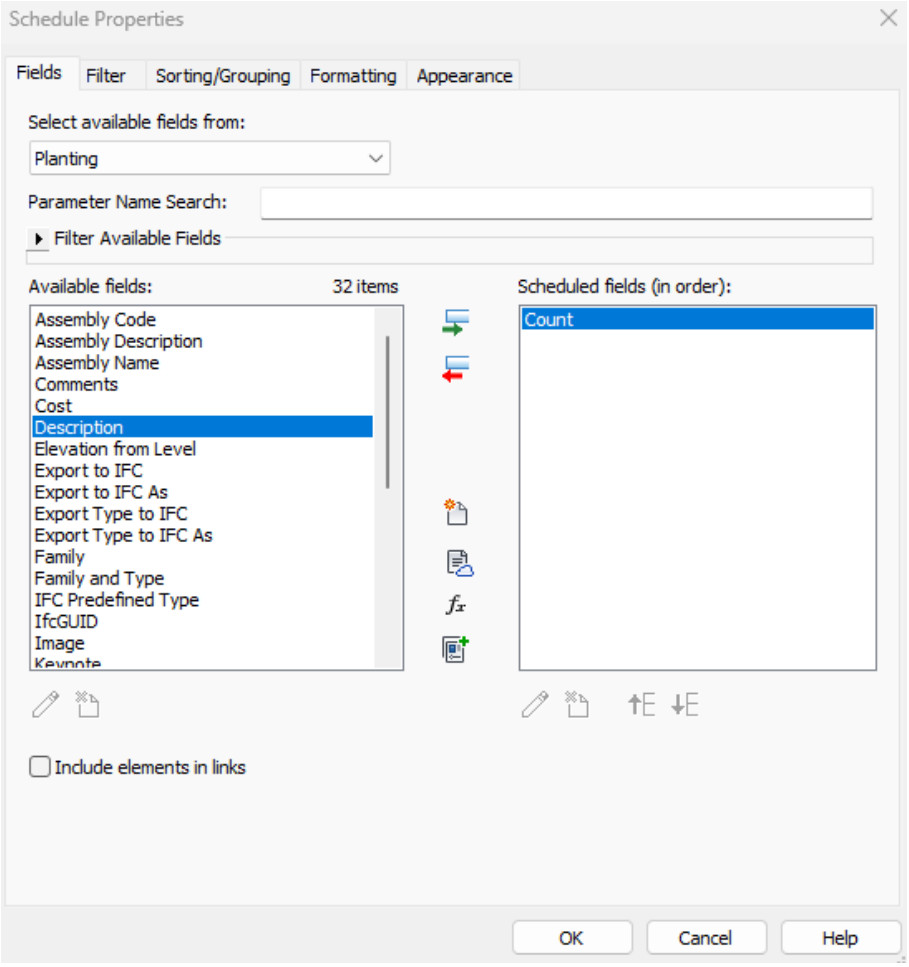
Note:
Schedules can also be created by right-clicking on the Schedule/Quantities category in the Project Browser and selecting the appropriate type as shown above.

Creating Schedules:
In the dialog box displaying an overview of the elements from which quantities can be extracted, select the desired category. Naming is located at the top right. There is the option to extract data from the building elements or create a configuration list (Schedule keys) in the database, which can be added to other schedules of the same category. If

phases are set up, quantities can be extracted from each phase.

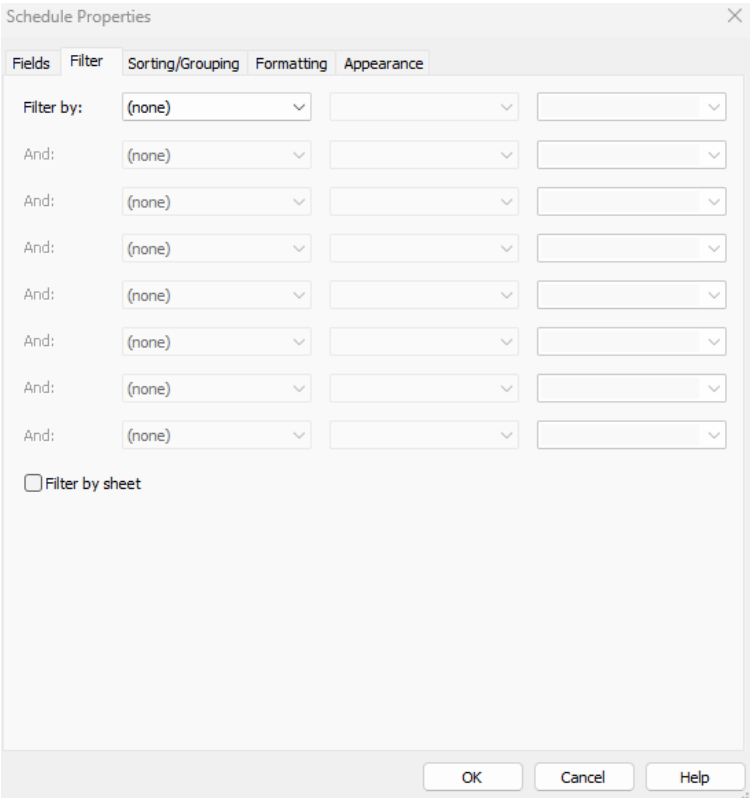


After clicking OK, the properties of the schedule appear in a dialog box:

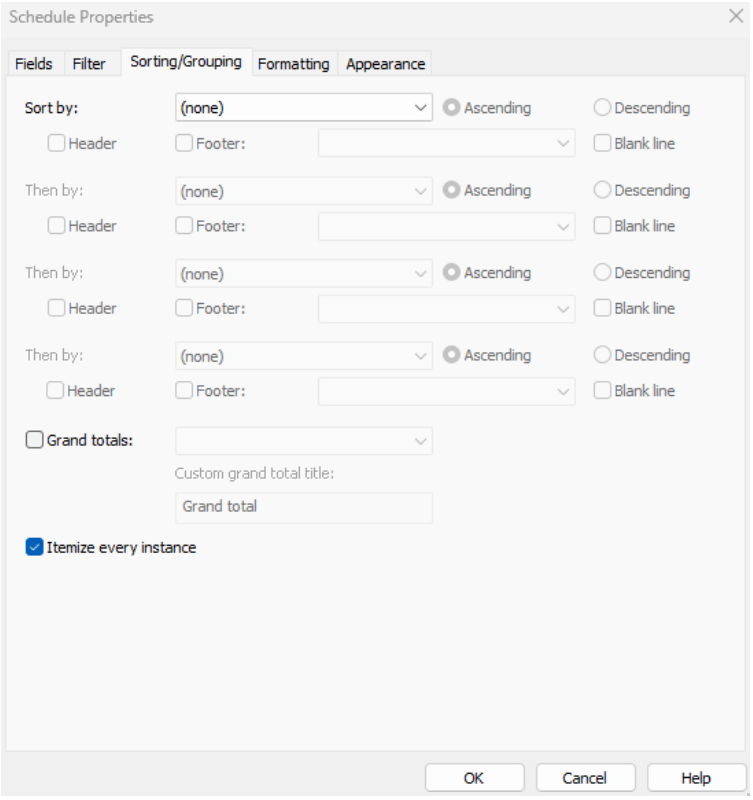


Fields: Here, the data fields that are to be displayed in the schedule are added. For wall schedules, the properties available for the wall family are provided. The list of fields varies depending on the family category to be scheduled.

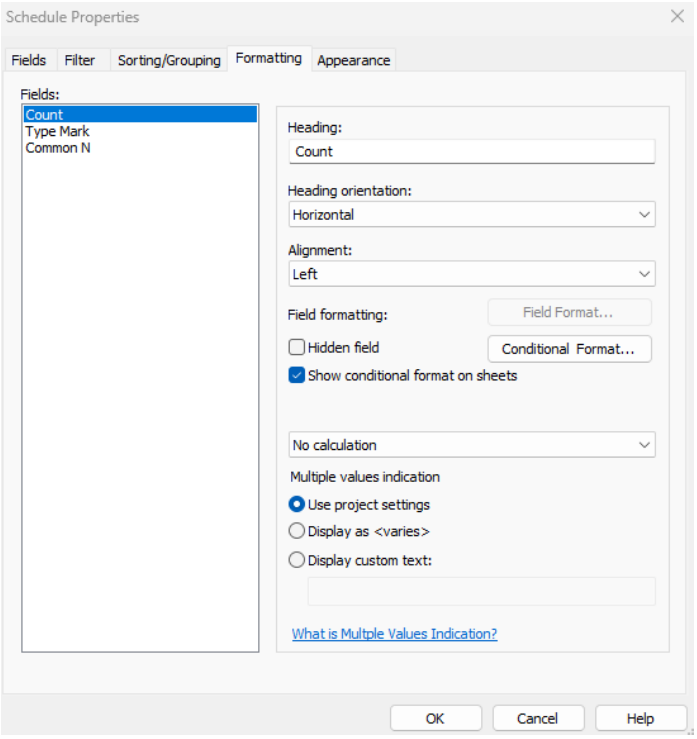
Filter: The ability to filter the data fields selected for the schedule. For example, if only doors from the 1st floor are desired, other floors can be excluded using filters. Another example could be filtering by materials, so that only walls with concrete are included in the schedule.



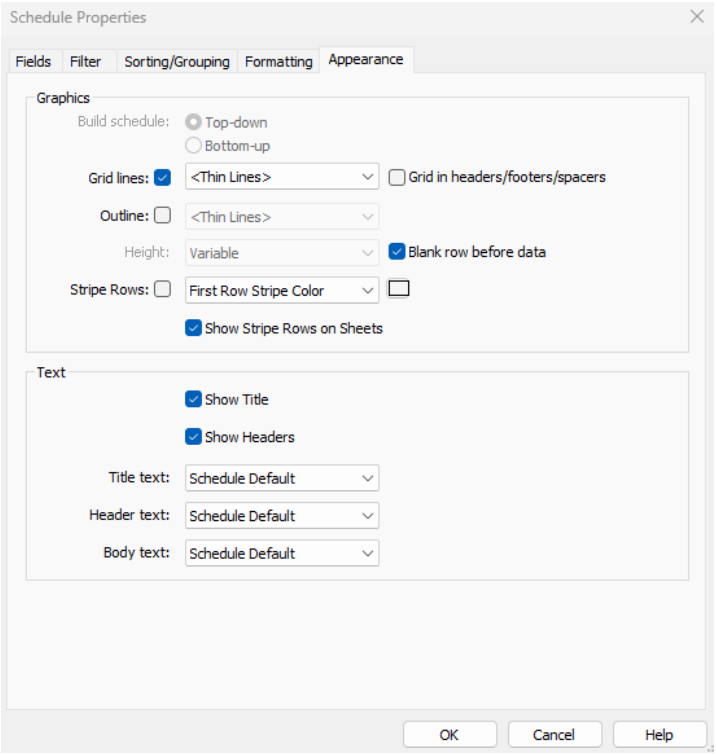
Sorting/Grouping: Here, you can optionally sort by Family types so that it appears in alphabetical order in the schedule. You can add a summary line after the sorting, as well as an overall summary of all the objects in the schedule.



Formatting: Here, formatting is set up for the properties added to the schedule. Fields containing numbers can be configured to be summable. Conditional rules can be created to color fields according to the rule.



Appearance: The appearance of the schedule, such as lines and text, can be configured. Options include whether headers should be displayed, text font, text size, and graphical settings for text such as bold and italic.

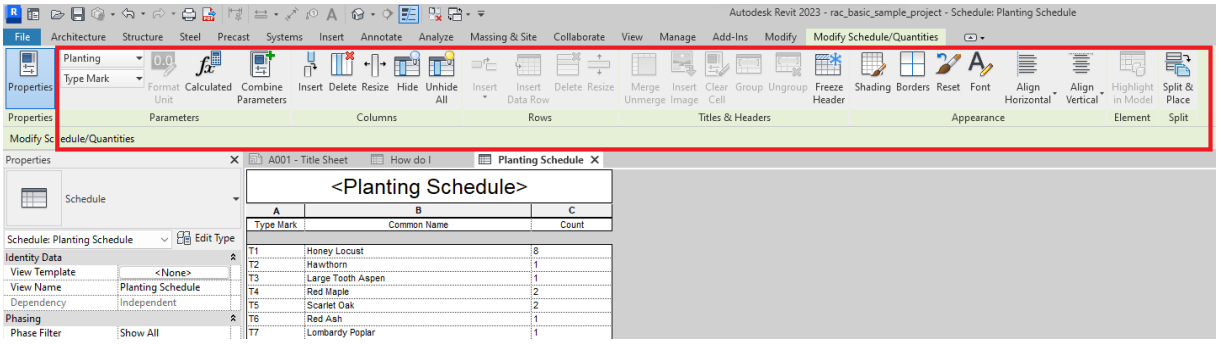


Setting and sorting of schedules:

Created schedules are continuously updated based on what is added and removed in the model.
The post-processing of a schedule is therefore solely about its appearance and possibly filtering of elements.

Editing existing Schedules:

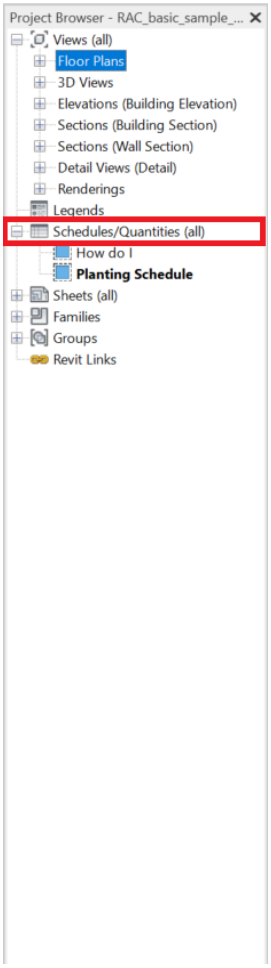
Editing the schedule is done in Properties and from the Context Tab.



Export schedules in Revit:

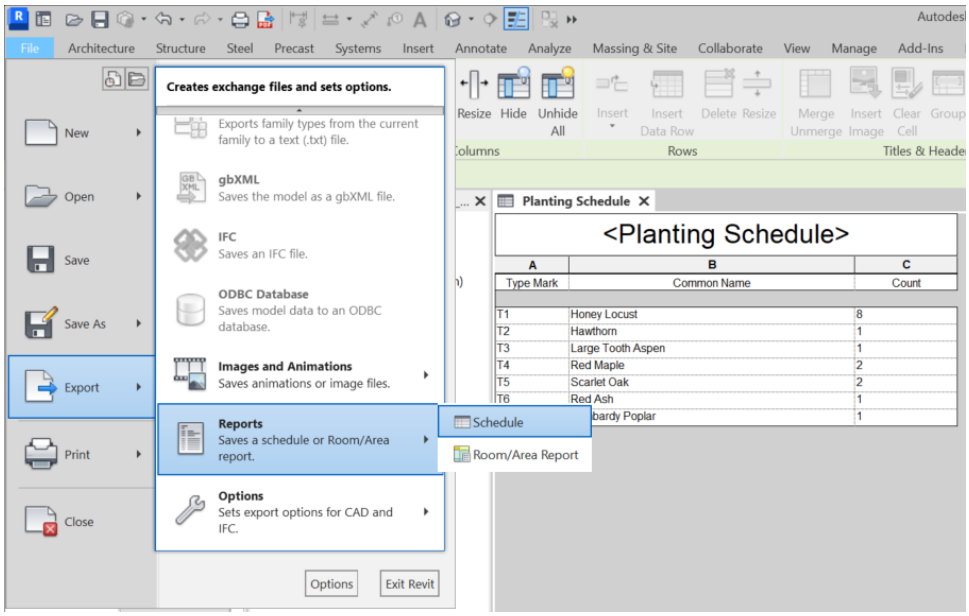
Exporting schedules from Autodesk Revit is a useful feature that allows you to further analyze and manipulate your project data.

Navigate to the schedule you wish to export. Schedules are typically located in the "Project Browser" under "Schedules"



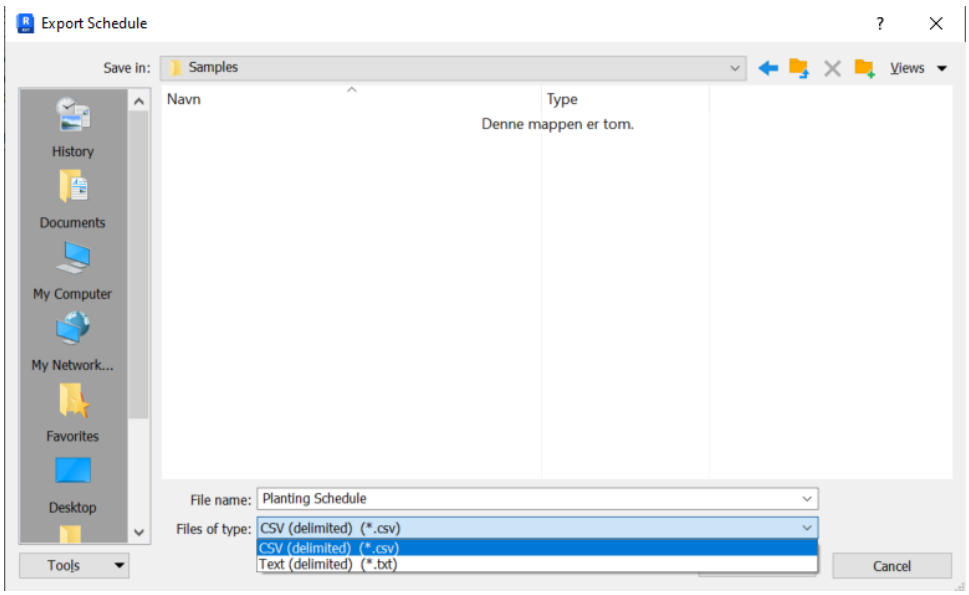
Click on the schedule to select it. Ensure it is active.

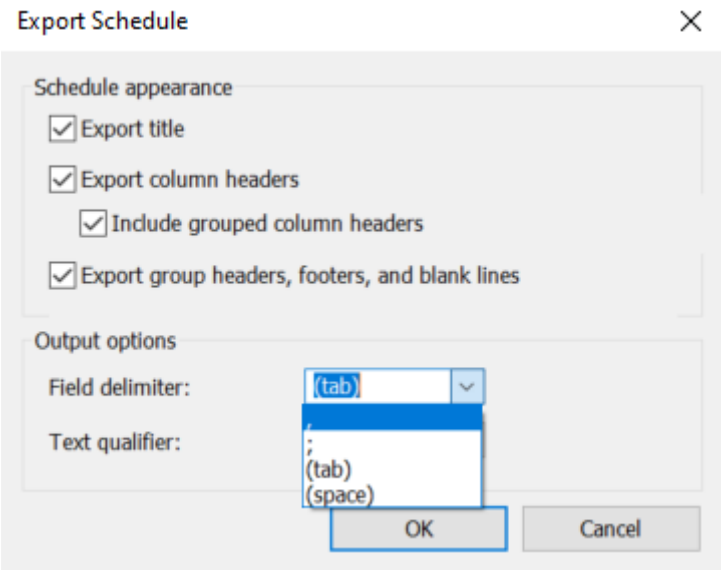
Go to "File" menu and select "Export" > "Reports" > "Schedule". This will open the "Export Schedule" dialog box.

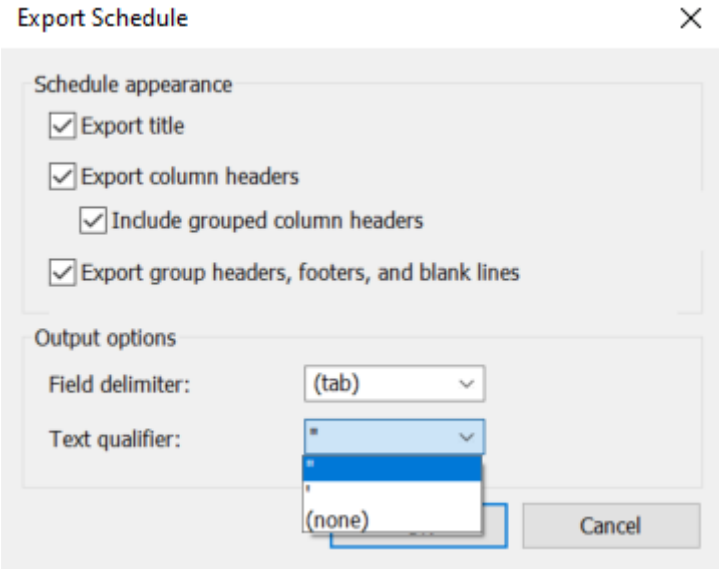


In the export dialogue box, you can customize the export settings:

- **File Name:** Choose a name and location for your exported Excel file.
- **Files of Type:** Select "CSV (delimited) (*.csv)" or “Text (delimited) (*.txt)” as the file format.
- **Field delimiter:** Choose a delimiter for separating data. You can use a comma (,), semicolon (;) tab or space.
- Text qualifier: Choose a text qualifier to distinguish the start and end of contents. You can use double quotation mark (“), single quotation mark (‘) or (none).
- **Schedule appearance:** Check these boxes if you want to include title, column and group headers in the file.







Once you've done configuring the settings, click the "OK" button to initiate the export process

You have now created a delimited file that can be opened either as a .txt file or delimited file for Microsoft Excel (*.csv).

Review and further edit can be done in respective file format.