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Title: An introduction to BIM 4D, BIM 5D and Navisworks Manage

1. Aims

The objective of this tutorial is to allow the students to became acquainted with the Navisworks software and be able to understand and describe the principles of BIM methodology, related with the quantification of activities and constructive works. Students should, in addition, identify the required resources needed for each activity measured, perform the quantification of the price of each activity or task and calculate the final budget.

According to the resources available, students must be able to identify the more logical organization and economic planning for the construction works.

2. Learning methodology

The teacher will give an explanation about the use of the tool.

Students will read this tutorial and explore the tool.

To assess the achievement of the practice, each student will write a report.

3. Tutorial duration

The teaching described in this tutorial will be carried out in a computer classroom.

It will last 3 teaching hours.

4. Necessary teaching resources

Computer room with PCs with internet access.

Required software: Navisworks Manage.

Hardware required: computer with the capacity to support the software.

5. Contents

5.1 BIM 4D and BIM 5D

5.2 4D and 5D Construction Planning with Navisworks: an Introduction

6. Deliverables

The student will have to answer the submitted test questionnaires.

7. What we have learned

The student has become acquainted with the principles of BIM methodology applied to the measurement of construction works and to the calculation and control of the construction budget. In addition, the student has become acquainted with the application of construction techniques to the planning of works using the BIM methodology.

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5. Contents

To measure BIM models and create a Gantt diagram measurement tables for each activity or task will be established, considering the 3D models using Revit, Navisworks, Presto or others modulation software. Any design change or the results of clashes detections will reproduce the necessary modifications in the measurement results. In addition, these measurement results allow a list of work activities or tasks for the construction to be created.

The measurement units and results should be the same as those that apply to the common measurement rules: unit, length, area and volume, for instance.

According to the type of work, the required supply of materials, equipment, human resources, or work labour is defined. A prevision of the work resource efficiency is considered and the number of resources is set, according with the amount of work for each activity or task (always considering the time available for the construction).

The main objective is to carry out a schedule analysis and understand the critical path method management, using Gantt charts or PERT/CPM diagrams. The analysis of the graph also

enables the critical path to time control (progress and delays) to be Identified during the works.

For each work a task precedence analysis is made to clarify the most logical and economic path for work construction. Several hypotheses can be analysed to define the most efficient technical option.

Therefore, the duration of the construction, the individual duration of each task and the total time are estimated. Each task will have a date to begin and a date to end, and could be represented, for instance, in a Gantt chart. The horizontal axis of the Gantt chart corresponds to the time duration of the task (such as minutes, hours, days, weeks, months, and years). The vertical axis represents the project task or the activities list of the construction.

In the Gantt chart, each task will have a time localization for its execution and duration tab. The chart view provides a visual representation of the several tasks. The task can run sequentially, in parallel, or overlapping.

Visually, a graphic representation is created to define a project timeline using management software, with an association of the necessary resources for each task (Figure 1).

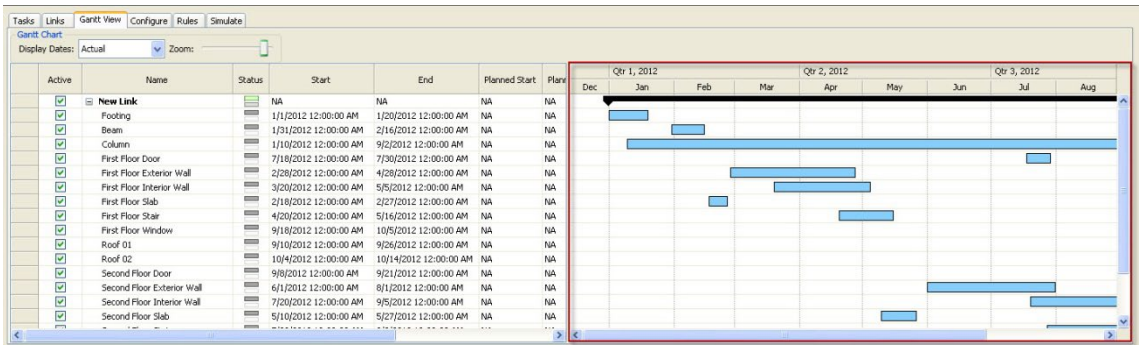

Figure 1: Example of a Gantt chart view in Navisworks (form https://forums.autodesk.com/autodesk/attachments/autodesk/372/2867/1/Gantt%20View.jpg)

With the visual representation of the tasks, it is possible to do a comparison between the planned date and the delay (or finishing ahead of time). This analysis enables the required changes to be made to the number of resources considered or to the duration of a task (extend or shorten). Any changes are automatically updated in the software task view. Likewise, modifying a field in the task view changes the corresponding field in the Gantt chart view.

5.1.3 – Planning BIM 5D Projects

According to the work programming elaborated and a correct activities or tasks measurement, it is possible to produce a real cost analysis and the definition of the required resources for each one. This complete interaction is called a 5D BIM model.

For a more useful result, software that combines budgeting and management tools has to be used, to allow complete planning with real activities costs. This software could be Navisworks, with a more direct interaction with the previous modulation phases if Autodesk modulation software is used. However, it is possible to use other software such as Vico or Bexel Manager.

In this design phase, it is possible to study several hypotheses that will enable estimate cost for any construction option to be produced and a final cost for the construction to be defined.

Data with the cost of each resource can be created. As a result of the association with the required resources, according to the unit measurement and resources efficiency, a direct cost for the activity or task is generated.

It enables data to be created with the selling price of each activity or task. Thus, with the execution of a task, it is possible to control the direct cost (that the construction company will have with the resources affected) and a billing forecast, according to the budget accepted for the construction.

At the end, a financial schedule is defined for the direct costs and a basis for forecasting the billing of is the work carried out. With any change to the work program created, it is possible to view the financial adjustment that occurred and visualize the financial consequences of it.

The instant visualization of the deviation effect enables some correction to be made to the initial prevision of the required resources affected, analysing the project duration and the financial outcomes.

5.2 – 4D and 5D Construction Planning with Navisworks: an Introduction

The construction planning can be detailed using management software such as Navisworks, Vico or Bexel Manager. For that, the complete design of the models, the identification of the activities or tasks and the definition of the necessary resources for each one are mandatory. Any change during the design phase will be easily reproduced in the planning phase elaborated.

A short explanation of the type of information that can be provided with Navisworks is showed in the next chapters (Figure 2).

Figure 2: Navisworks Manage (image from https://www.autodesk.com.br/content/dam/autodesk/www/products/autodesk-navisworks-family/fy21/overview/family/navisworks-manage-large-1920x1080.jpg)

5.2.1 – An introduction to Navisworks

Navisworks is a review software package to control project outcomes. Navisworks Simulate and Navisworks Manage are tools that enable greater coordination, construction simulation, and whole-project analysis for integrated project review.

Navisworks Simulate is a 3D model review and provides a 5D analysis with project details, quantification and simulation tools. Navisworks Manage enables clash detection and includes advanced coordination, with interference management tools. Navisworks Manage provides a better control project outcome, using tools for coordination and clash detection, 5D analysis, quantification and simulation.

This tutorial will be focused on the Navisworks Manage, with more features. The objective of this Navisworks Manage tutorial is:

- Learning about the use of Navisworks as an open collaboration tool, to built-in clash detection and team management;
- Knowing about how to use this tool to involve everyone in a BIM project and to deliver what is needed by the project team.

Therefore, Navisworks is a project review software package to improve BIM (Building Information Modelling) coordination. It is used for clash detection, simulation, analysis and quantification of activities in construction. The software combines design and construction data into a single model, in a photorealistic rendering, joining data from multiple trades to better control outcomes, identify and solve problems before the construction.

Navisworks can capture material quantities from 2D or 3D designs and export take-off data to Excel for analysis. The software also allows a planning and timing control (4D) and a costs planning (5D) to be organised using simulation directly from the project model, creating tables with the tasks information. It is also possible to import schedules and cost items from external project management applications.

With Navisworks it is also possible to organize the Facility Management (BIM FM 6D) of the maintenance and operation of a construction, and manager the asset lifecycle (7D).

5.2.2 – How to Start

Autodesk provides an educational access to some products and services, which includes the Navisworks software. Students and educators can get free one-year educational access, renewable as long as they remain eligible. It is mandatory to create an account. The useful links for it are:

- To create an account (Figure 3):
- https://accounts.autodesk.com/register

- To download the software (Figure 4, sign in and choose Navisworks): https://www.autodesk.com/education/edu-software

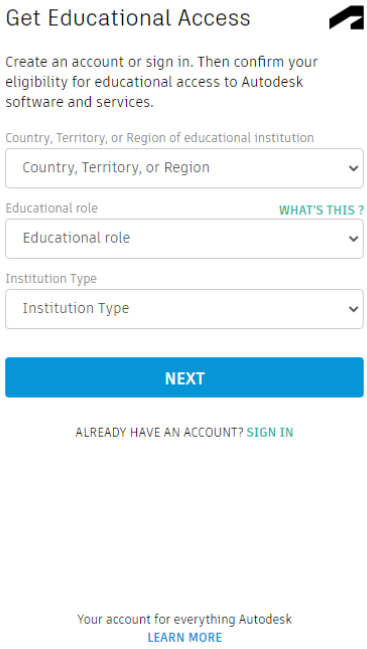

Figure 3: Create an educational account in Autodesk

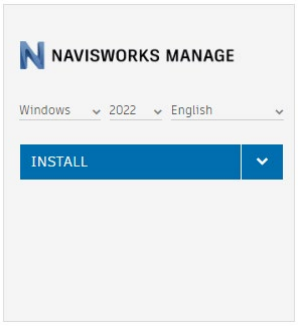

Figure 4: Installation of Navisworks Manager

5.2.3 – Interface

Figure 5 shows Navisworks workspace and the main menu. Figure 5: Example of Navisworks workspace and main menu.

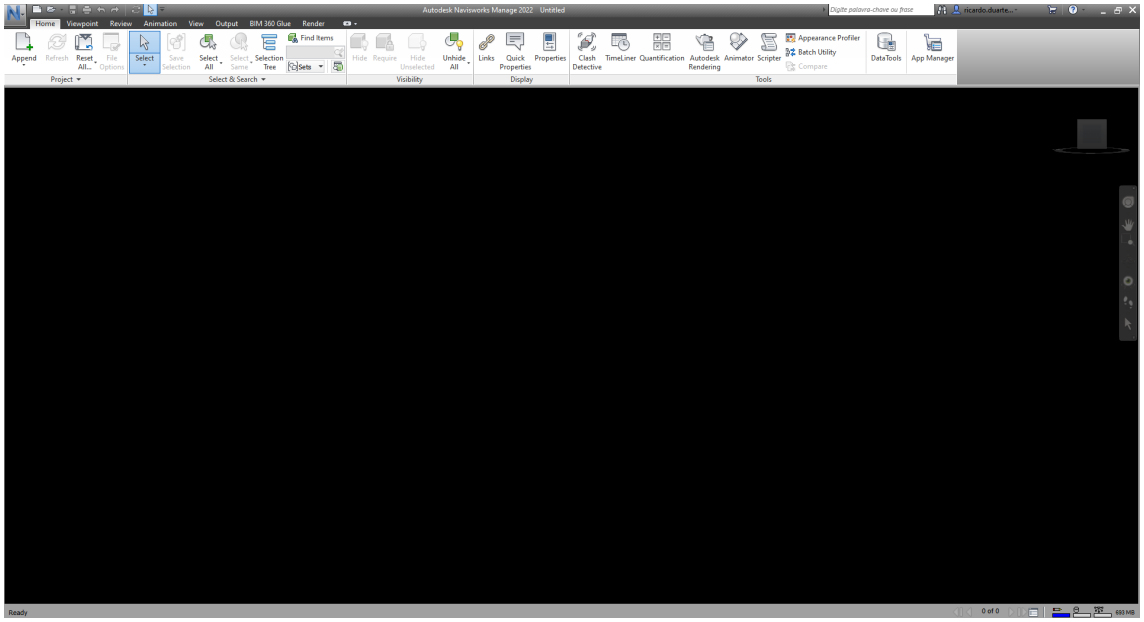

Figure 6: Example of Navisworks workspace and main menu

The ***Ribbon*** area is located at the top of the workspace and the appearance will change when a different tab is selected. The personalization could cause a different tabs presentation. It is possible to customize and save the display layout, personalizing the interface and the workspace.

The ***Options*** menu is accessed by the ***Application Button*** (the one with the big blue ***N***) or clicking with the right button of the mouse and then ***Global Options***, or using the keyboard ***F12*** key. In this menu, it is possible to do the intended customization such as: the file location; the interface options like the unit type or the selection highlight; the file renders; among others (Figure 6).

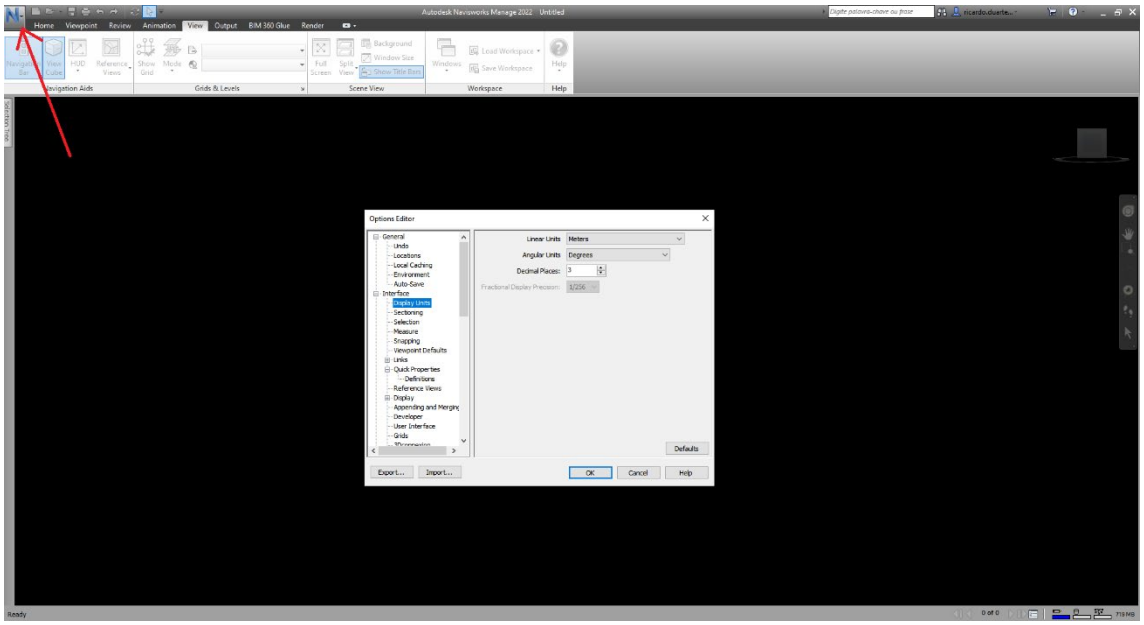

Figure 7: Options menu

The ***View*** menu allows other visualization options and the activation of some toolbars, such as the ***Navigation bar*** and the ***View cube***, with UCS orientation, visible in the right part of the workspace (Figure 7).

After personalized workspace view customization, it is necessary to save the changes in a different profile. To do that, use the ***View***, ***Workspace*** and ***Save Workspace tab*** (Figure 7). It is possible to load the different workspaces created (Figure 8).

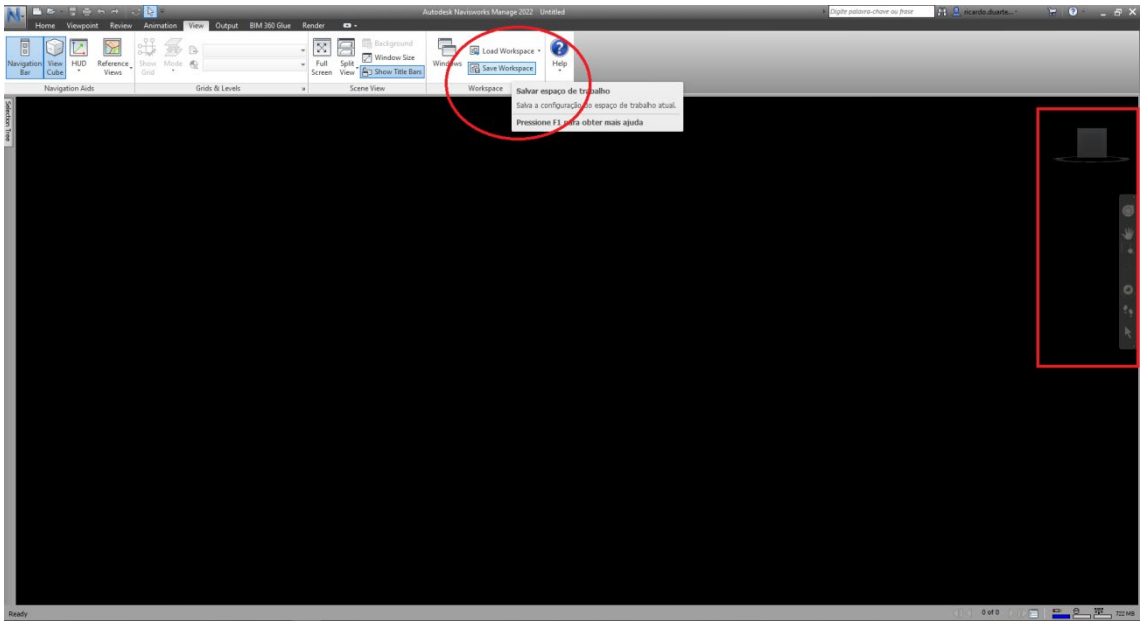

Figure 8: Save the personalization of the workspace Figure 9: Load the personalize workspace

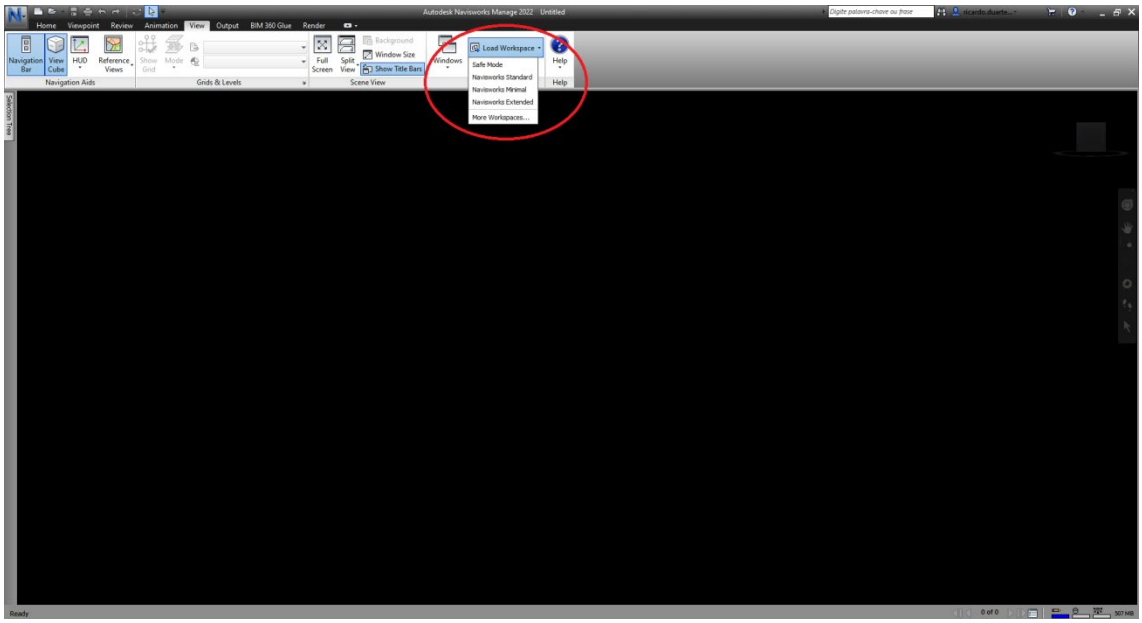

Figure 10: Load the personalize workspace

It is also possible to position a box menu by pressing and dragging the box to the intended position. Several arrows represent the position possibilities in the workspace, as illustrated in Figure 9.

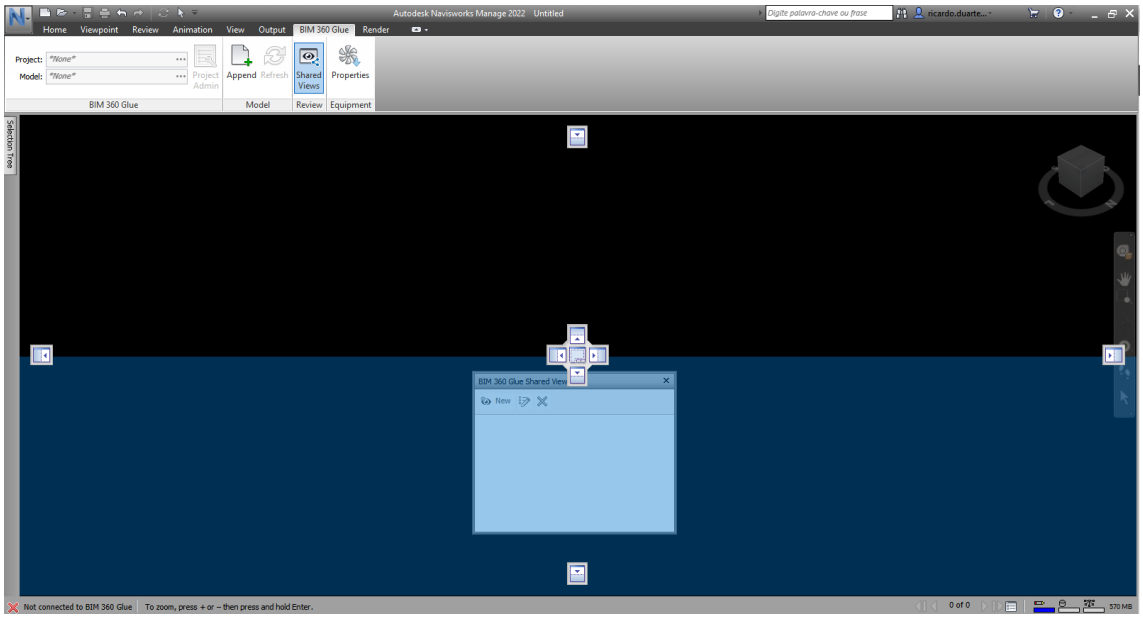

Figure 11: Press and drag a box menu

5.2.4 – Home Tab

The ***Home*** tab (Figure 10) is where the most common commands are located, such as the ones from the ***Project***, ***Select & Search***, ***Visibility***, ***Display*** and ***Tools menus***.

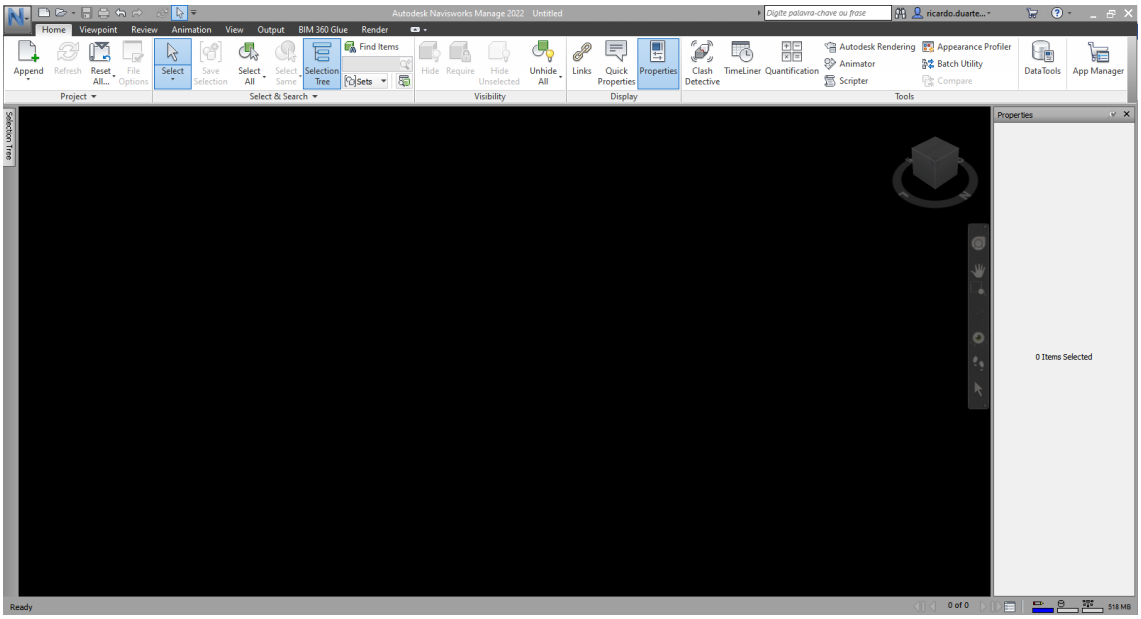

Figure 12: *Home* Tab

On stopping the selection icon under any command, the command name and a short description of its skills are shown (Figure 11). Figure 13: Example of an instruction in a command

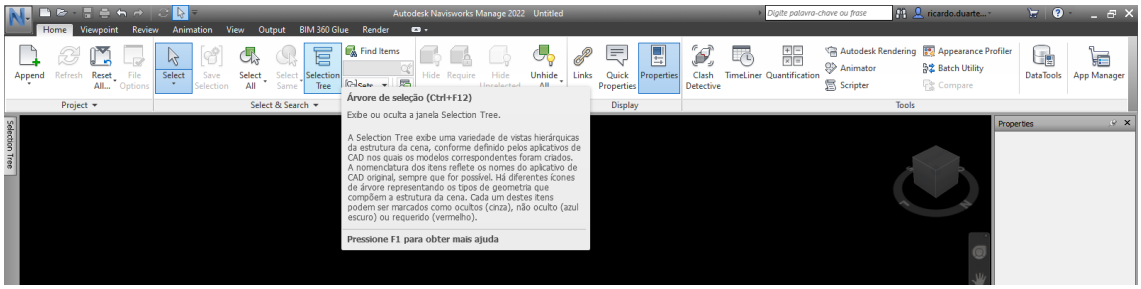

Figure 14: Example of an instruction in a command

In the ***Home*** tab (Figure 12) the functions related to clash detection of the objects could also be found (***Clash detective*** function) and the data information could be loaded (***DataTools*** function).

It is also possible to make a time planning (***TimeLiner*** function) adding tasks with time consumption, definition of the necessary resources to produce each one (work labour, materials and equipment), defining the precedence between them and runing the simulation of the whole process. In the planning phase, it is possible to simulate and improved the construction process. Figure 12 illustrates some of the mentioned menus.

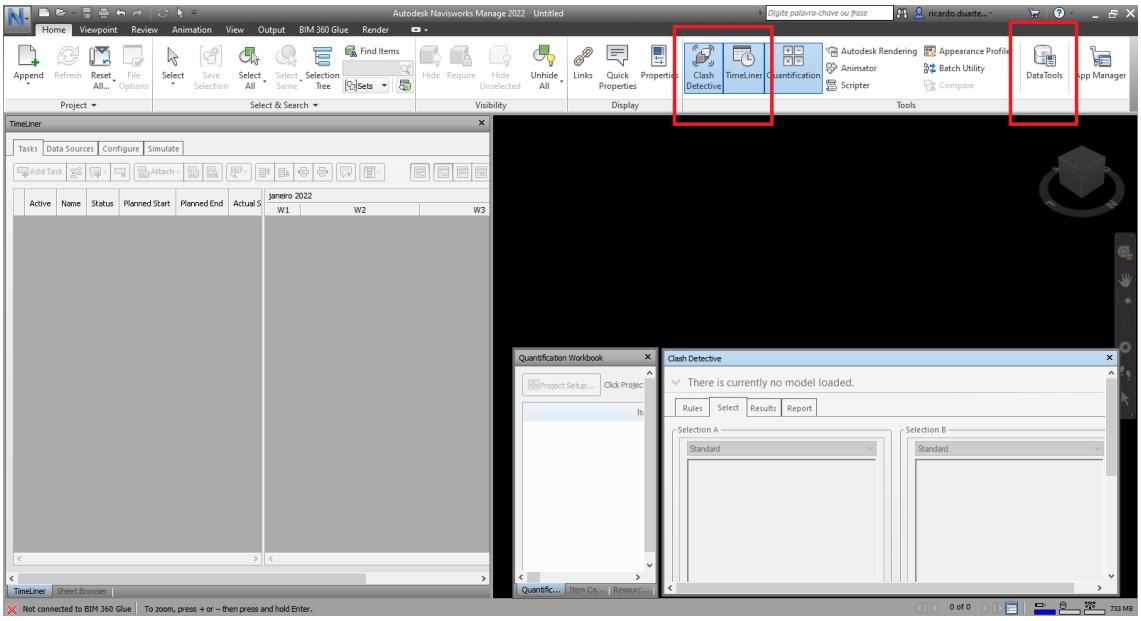

Figure 15: TimeLiner, Clash Detective and Quantification Workbook menus

5.2.5 –Viewpoint Tab

The Viewpoint tab (Figure 13) brings together all the options related with the visualization, such as the ***Save***, ***Load & Playback***, ***Camera*** options, ***Navigate*** mode, ***Render Style*** possibilities, ***Sectioning*** and ***Export*** menus.

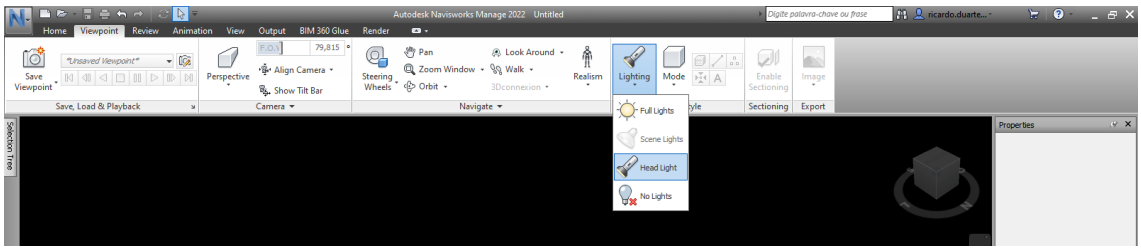

Figure 16: Viewpoint Tab

5.2.6 –Review Tab

The Review tab (Figure 14) is where all the options related with the review of the project, such as ***Measure***, ***Markup***, ***Tags*** and ***Comments*** are located.

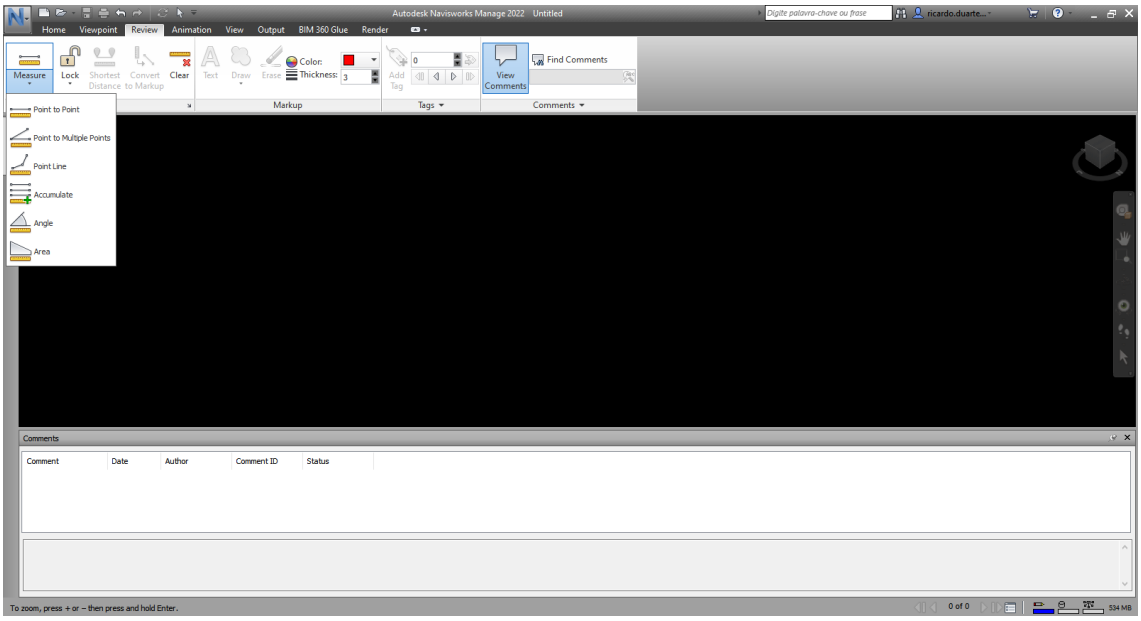

Figure 17: Review Tab

5.2.7 –Animation Tab

The Animation tab (Figure 15) presents all the parameters related with the videos produced with the model information: ***Create, Playback***, ***Script*** and ***Export***.

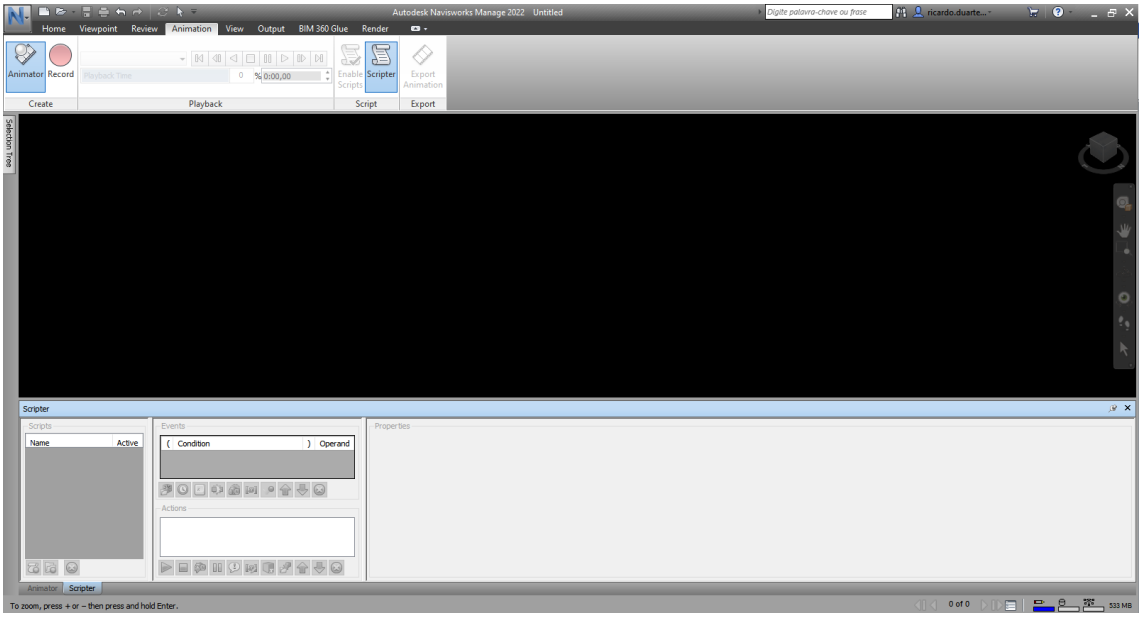

Figure 18: Animation Tab

5.2.8 –View Tab

The View tab (Figure 16) presents all the parameters related with the workspace visualization options, as mentioned in the interface point: ***Navigation Aids***, ***Grids & Levels, Scene View***, ***Workspace*** and menu ***Help***.

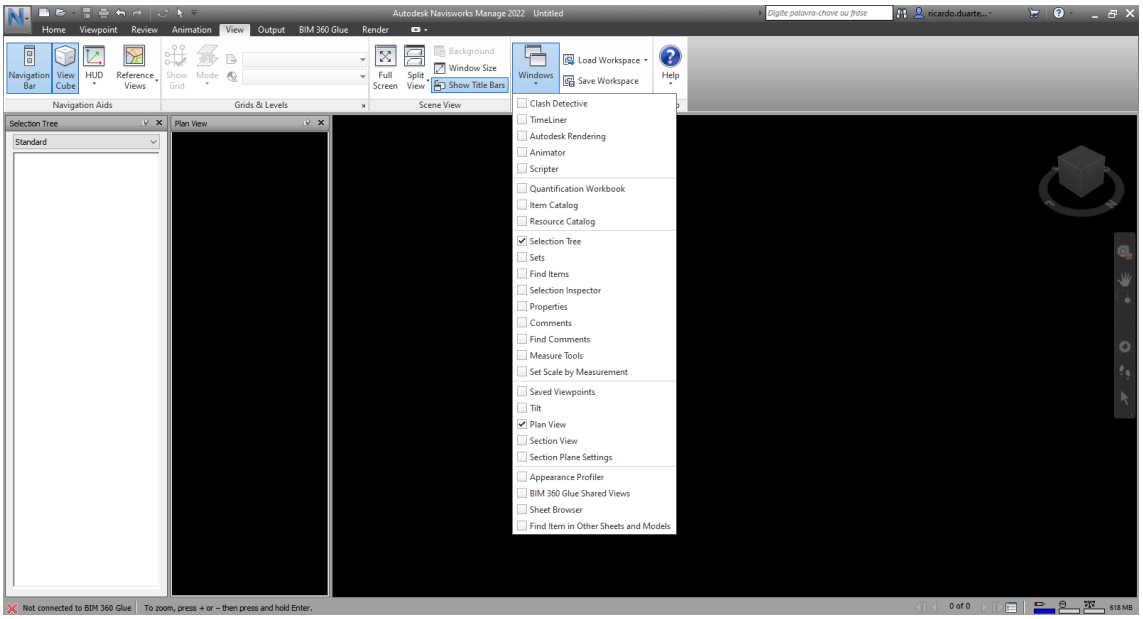

Figure 19: View Tab

5.2.9 –Output Tab

The Output tab (Figure 17) brings together all the parameters related with the output of the model and with the information and data produced: ***Print***, ***Send***, ***Publish***, ***Export Scene***, ***Visuals*** and ***Export Data***.

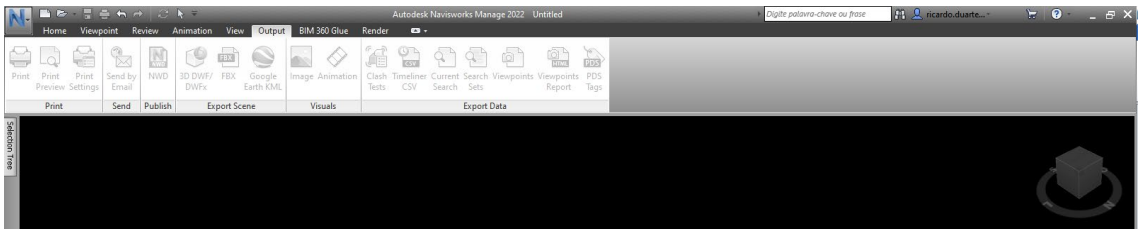

Figure 20: Output Tab

5.2.10 –BIM 360 Glue Tab

With an Autodesk account in a BIM 360 server, it is possible to import the project information to the Navisworks model. The BIM 360 Glue tab (Figure 18) allows this task with the menus: ***BIM 360 Glue***, ***Model***, ***Review*** and ***Equipment***.

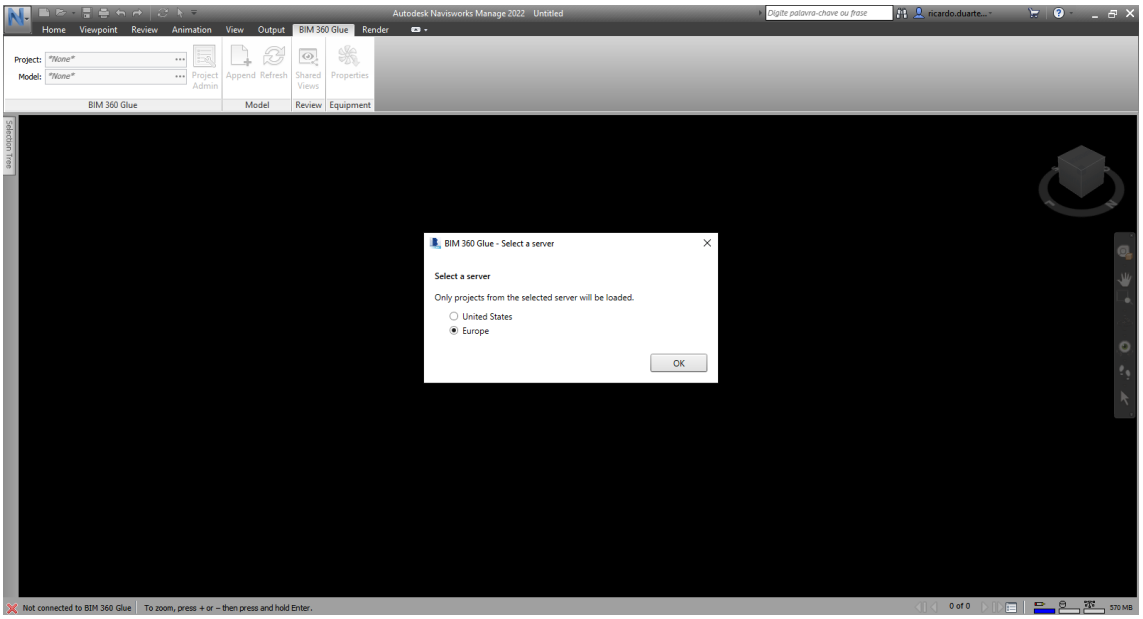

Figure 21: BIM 360 Glue Tab

5.2.11 –Render Tab

With the Render tab (Figure 19) it is possible to customize the appearance of objects in rendering, for image export, with the functions: ***System*** (with ***Autodesk Rendering*** options and a ***Render Gallery***), ***Interactive Ray Trace*** and ***Export*** images menu from the model.

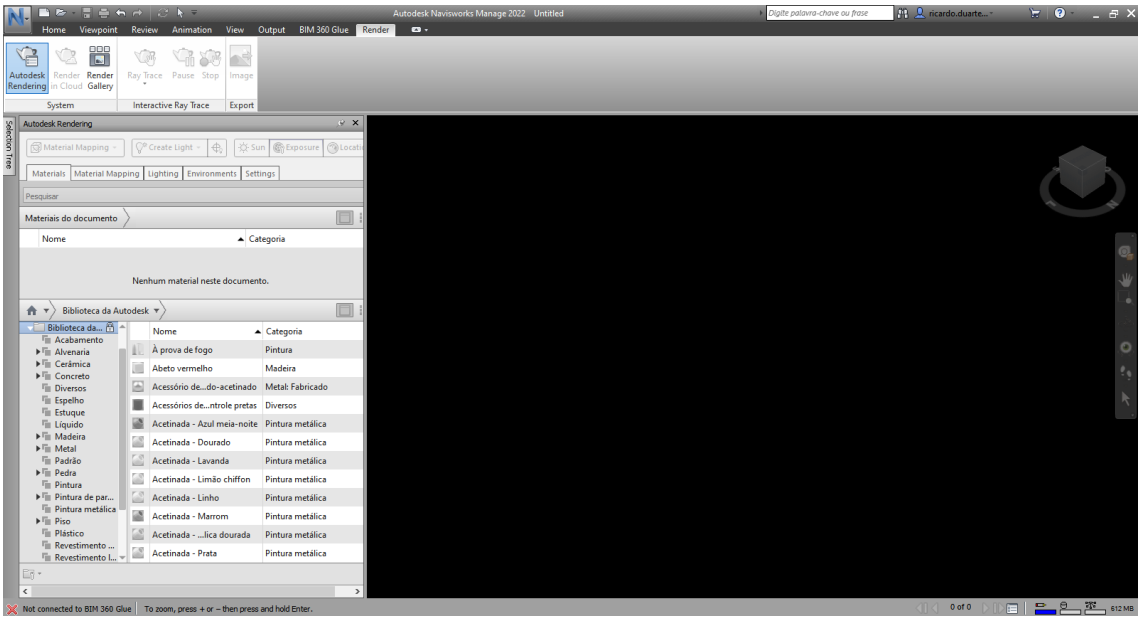

Figure 22: Render Tab