Technological and Methodological Solutions for Integrated Wide Area Situation Awareness and Survivor Localization to Support Search and Rescue Teams
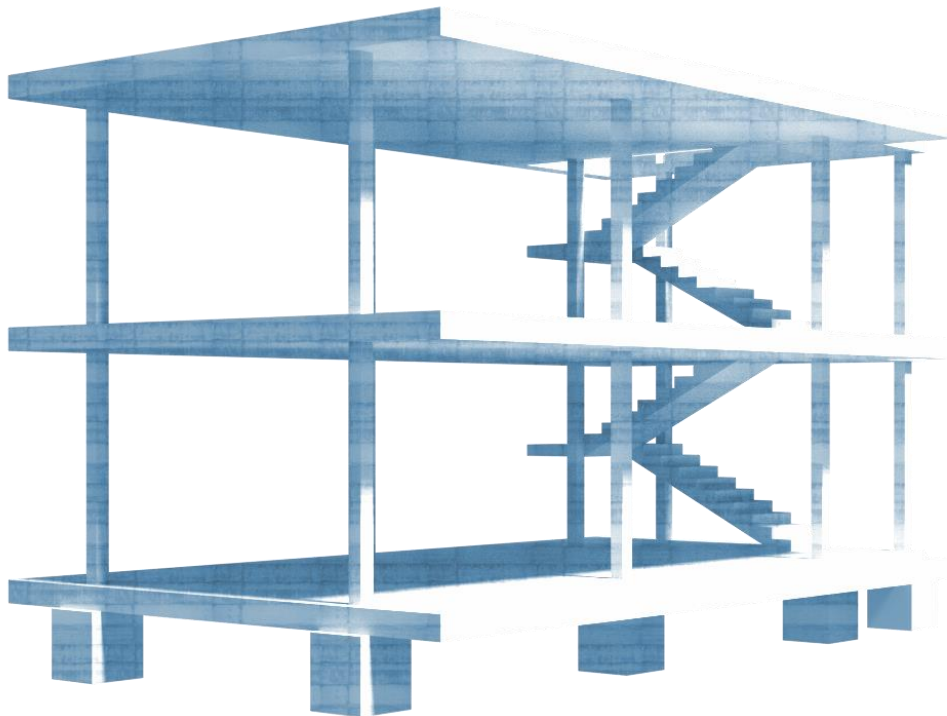
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Bullet Constraints Builder add -on

Guide for software Installation &
a simple collapse simulation

Preliminary version 2.0

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1. Introduction

The Bullet Constraints Builder (BCB) extends Blender´s basic physics functionality with a sophisticated toolset to simulate load dynamics in building structures. It establishes constraining connections between rigid bodies that incorporate real world behaviour and parameters. The BCB is suitable to simulate the effects of major structural deficiency such as the failure of load bearing elements like beams or pillars. To some extend it may also be used to simulate more subtle deficiencies such as the under-designed strength of an overall structure.

The BCB is a work in progress. The tool has been validated by comparison to a few real collapse cases[1], in which the simulation results showed a very good affinity to the real-world collapse shapes. However, virtual collapse simulation in general can't claim absolute authenticity and the results of this tool should be used with careful consideration if it is used in critical applications.

The BCB has a rich set of functionalities that allow specialists to setup respectively adapt building models and define the interdependencies between the structural elements. Nevertheless, the tool can also be used by amateurs. With a few simple steps the user can load predefined models, setup own collapse scenarios and start the simulation to observe the effects.

In a first part this guide will go through the steps necessary to install the software from scratch. In a second part an approach will be illustrated to simulate a simple building structure.

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[1] Prime Trust Heights, Moulivakkam, Chennai, India
   Pyne Gould Corporation building, Christchurch New Zealand

2. Installing the software

The BCB is a set of scripts that needs to be installed as an add-on from within Blender. After the installation the full functionality of the BCB becomes available in Blender´s user interface. It is strongly recommended to use the software versions that are specifically named in this guide to avoid incompatibility or error messages. The software is open source and can be downloaded and used for free.

The installation is only necessary once and it is done in the two following steps:
1. download and install Blender 2.78a
2. download and install the BCB from within Blender

2.1. Installing Blender

Blender is available for the following operating systems:
- Windows Vista, 7, 8, 10 32-bit/64-bit
- Mac OS X 10.6+ 64-bit only
- GNU Linux 32-bit/64-bit

This guide will walk you through the windows installation. You can find descriptions for the installation for the other operating systems on the internet.

1. Download the Blender software version 2.78a here: https://www.blender.org/download/
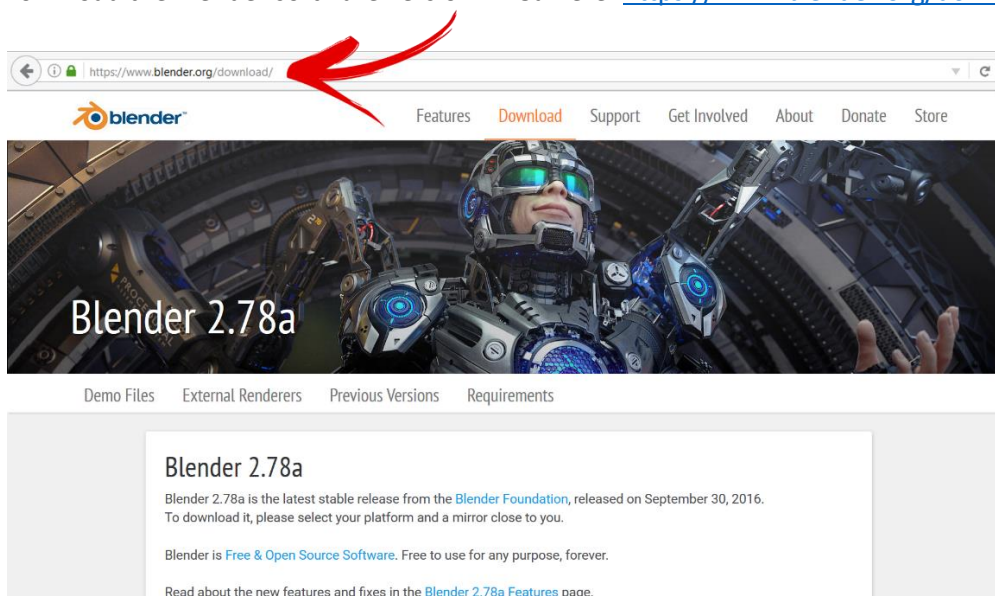
2. Based on your 32-bit or 64-bit processor choose the installer file from one of the mirror sites and save it to your hard disk.
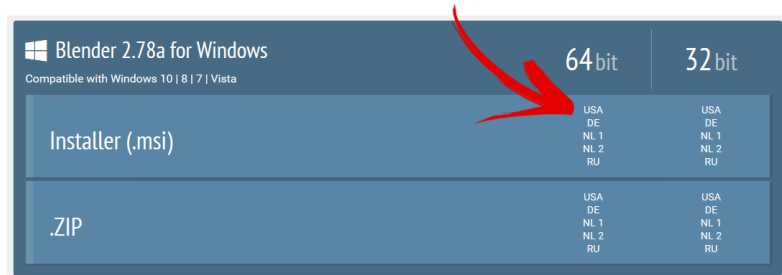

3. On your computer navigate to the blender-2.78a-windows64.msi file that you just downloaded and double click it. Confirm all the following installation notifications. Blender is now installed on your system.
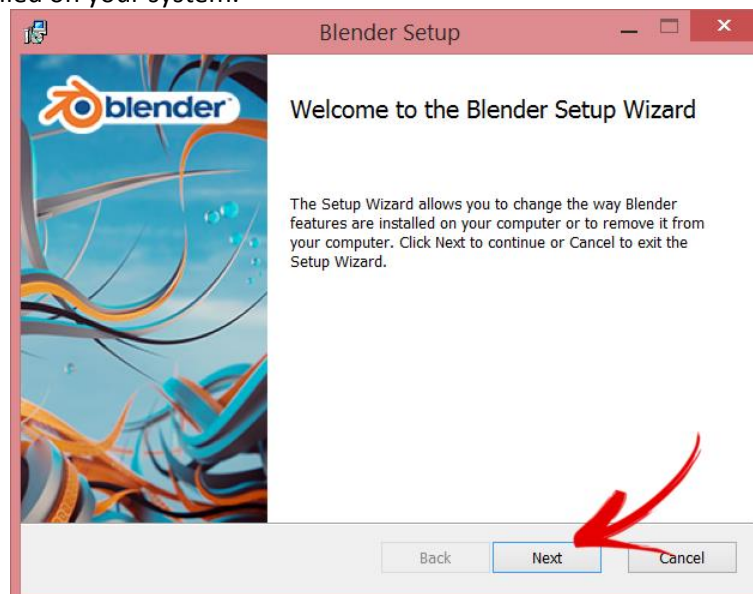

2.2. Installing the BCB

1. Download the BCB from this site: https://github.com/KaiKostack/bullet-constraints-builder Localize the file "**kk bullet constraints builder.zip**", click the filename and on the next page click "Download", right click and "Save As" won't work!
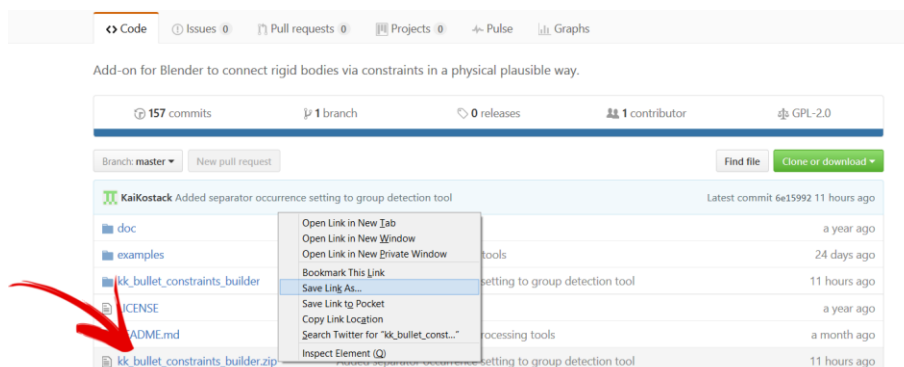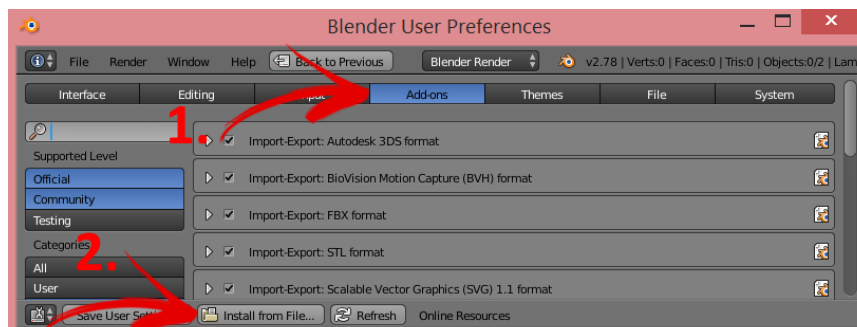

*Note: The zipped file should not be unzipped! Blender will do this instead!*

2. Start Blender and click "**File" (1)** on the left upper corner of the Blender interface, in the fly-out menu find "**User Preferences**" **(2)** and click that as well.
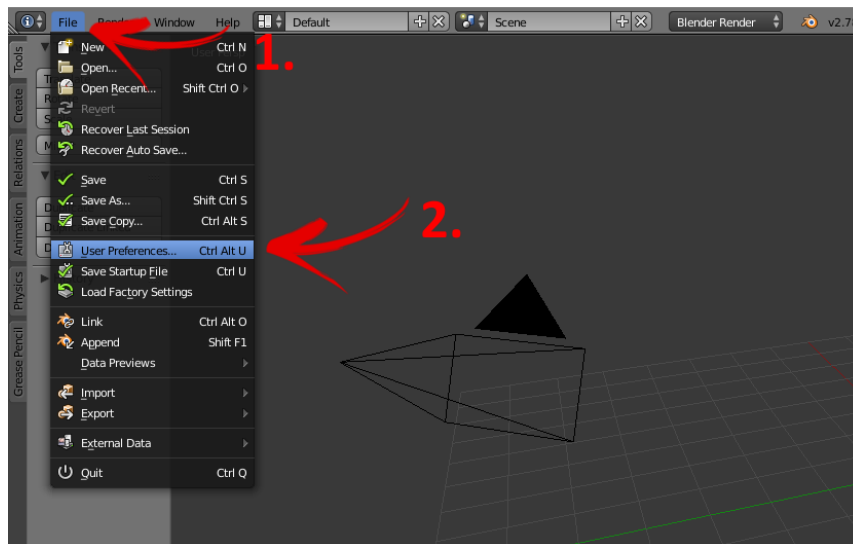

3. In the User Preferences window activate "**Add-ons" (1)** and then click on "**Install from File"(2).**


4. Browse to the file "**kk bullet constraints builder.zip" (1)** that you just downloaded mark it and then click "**Install from File" (2)**.
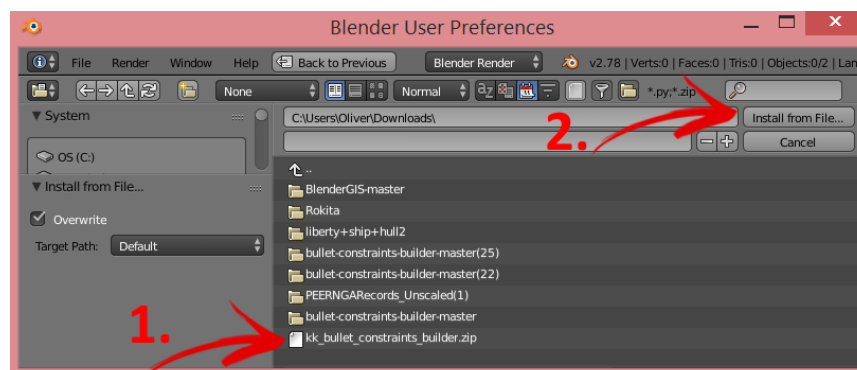
5. You can bring the script to the forefront by typing "Bullet Constraints Builder" to the search field. Activate the script by checking the **check box (1)** and then click "**Save User Settings" (2)**. Close the User Preferences window.
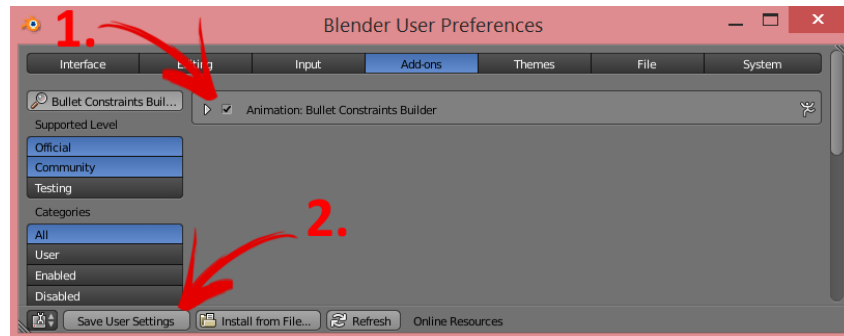

6. If there is now a tab named "**Misc**" on the left-hand side of Blender´s user interface the installation was successful and you are ready to go. Activate the "**Misc**" tab and the BCB interface will open. From now on, when starting Blender, the BCB will automatically be loaded.
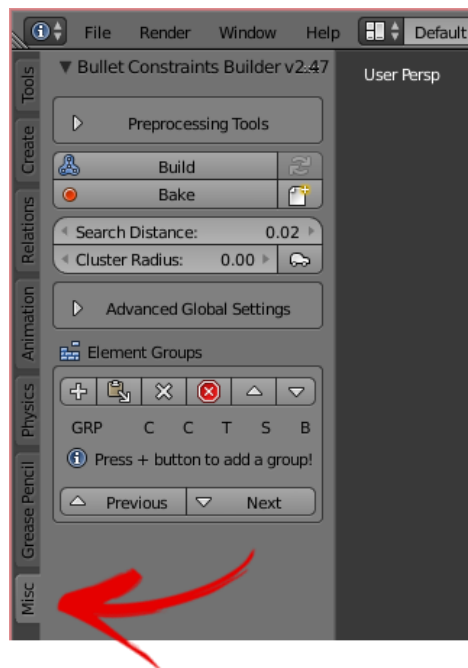
3. Performing a simple sample simulation

3.1. Loading the model

Download the sample model from here: Sample model [2]. It is a simple two storey concrete structure, the Dom-ino house by the architect Le Corbusier. Open this model in Blender. Make sure the "**Misc**" tab is selected (red arrow) by clicking on it, the BCB user interface will then show up. The time line displays the total length of the simulation of 250 frames. By adjusting the time line slider different stages of the simulation can be tuned in to once the simulation has been finished.
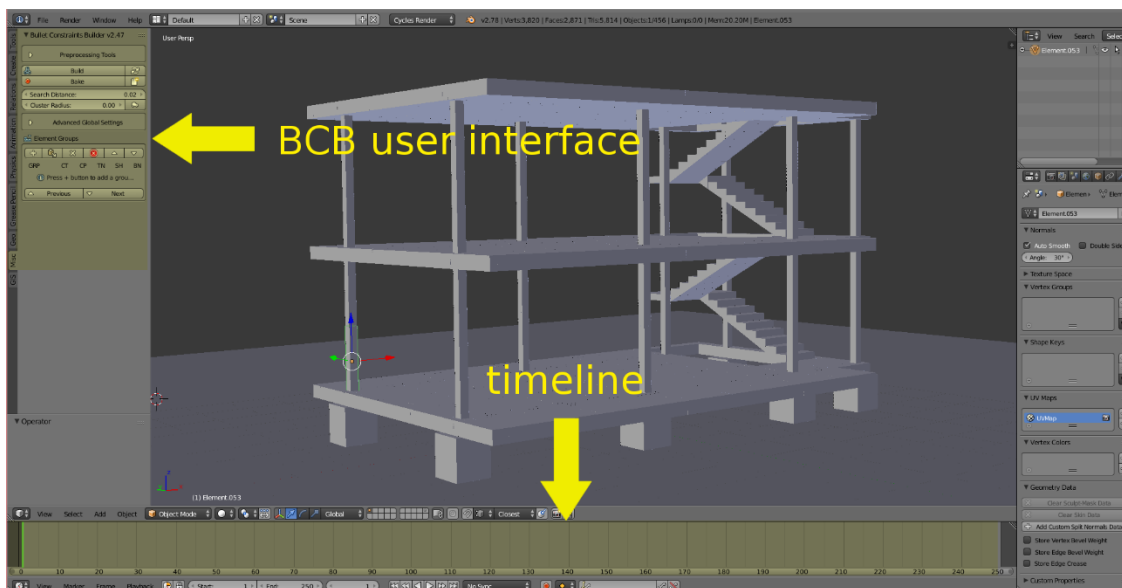

3.2. Prepare the model for simulation

In the BCB- user interface **load configuration settings (1)**, this will load the material settings for the model. **IMPORTANT!** Make sure that all elements in the scene are selected by pressing "**A**" on your keypad. The elements will be marked with a green outline. Now press "**Build**" **(2)**, this will connect the building elements in the scene with each other. This process may take around 30 seconds.

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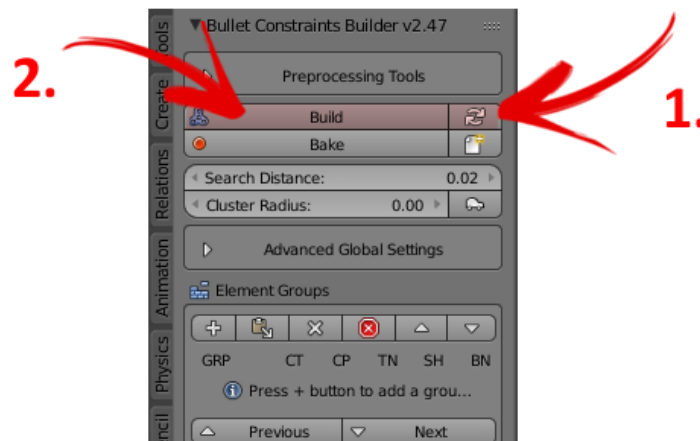
[2] https://github.com/KaiKostack/bullet-constraints-builder/blob/master/examples/example_dom-ino_house.blend

3.3. Create your own collapse scenario

Press the **right mouse** button repeatedly while you move the cursor over the model. You will notice that elements will be selected one by one which is indicated by a green outline around the selected element. Now select any of the pillar segments, press "**delete**" on your keypad. You can repeat this process and delete more elements if you like.
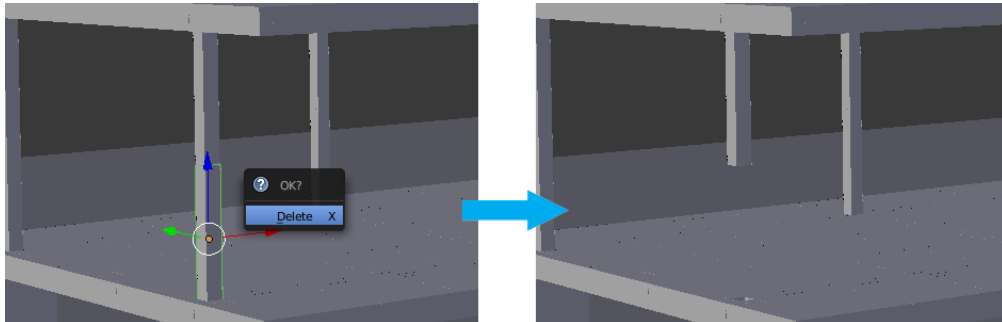
3.4. Start the simulation

When you are curious to see how your structural changes affect the stability of the structure, start the simulation by pressing "**Bake**" in the BCB. The process of the simulation can now be followed in real time. The program calculates a total time span of 250 frames by default, but the calculation can be shortened at any time by pressing "**escape**" on your keypad. By moving the slider on the timeline the simulation can be scrolled back and forth.
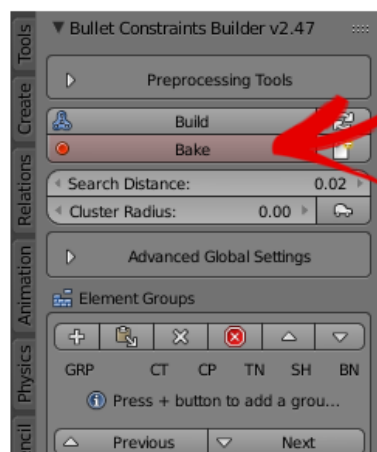
3.5. Change the collapse scenario

To change the collapse scenario the previous deletion of the elements should be undone: To restore the original condition of the model press "**CTRL+Z**" on your keyboard. New collapse scenarios can be explored by deleting other elements. The new simulation can be started by pressing "**Bake**" in the BCB interface. If for some reason the model behaves differently than described in this guide, please re-open the model and repeat each step carefully.