

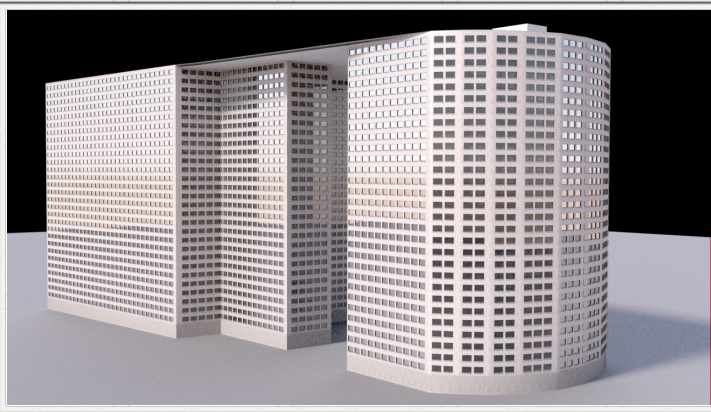


# Next Steps: Houdini Procedural Modeling

## M03: Creating Buildings Part 1 of 2

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**SIDE EFFECTS  
SOFTWARE**



## Goal of this Module

- ▶ Create a Procedural Building System for Background to Mid-ground Buildings
- ▶ Be able to define procedural windows
- ▶ Drop down uvs and texture

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SOFTWARE**

# Agenda

- ▶ Create a Procedural Window
  - ▶ Dimensions of Window, Sill, Setback
- ▶ Define the Foot Print of the Building
- ▶ Define the Number of Stories of the Building
  - ▶ First Floor - How tall?
  - ▶ Stories - How Tall?
  - ▶ Parapet - How Tall?

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SOFTWARE**

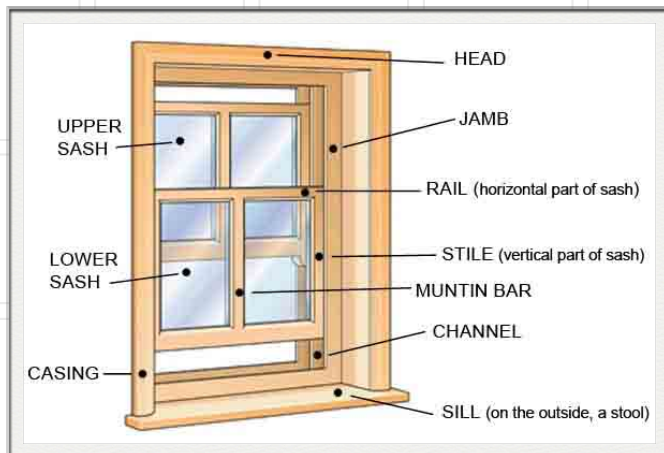


## Creating the Window

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SOFTWARE**



# Parts of a Window

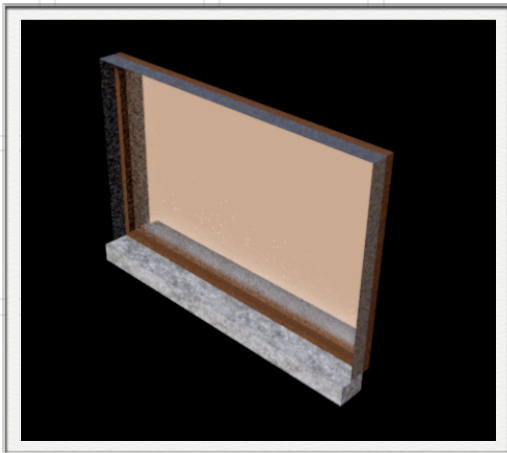


▶ We will be concerned with the:

- ▶ Head
- ▶ Jamb
- ▶ Casing
- ▶ Sill
- ▶ Sash

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SOFTWARE

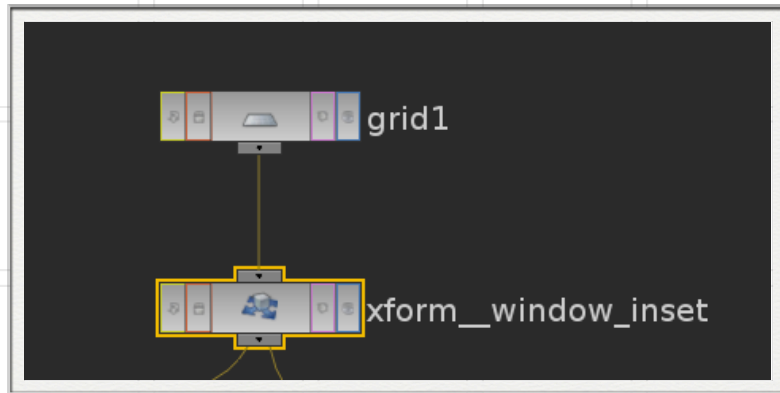
## Basic 4x2 Window



- ▶ Need to Define a Template of the Window Size to cut holes in the building we will build
- ▶ Need to define separate areas for the sill, casing, jambs, and sash

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## Defining the Size of the Window

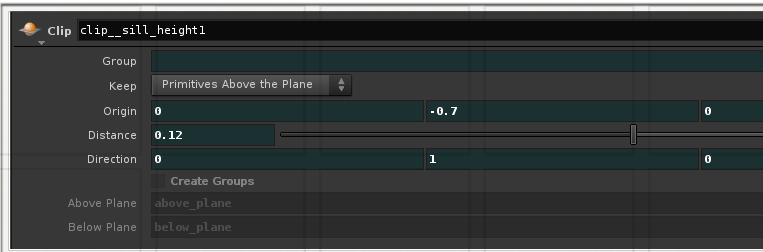
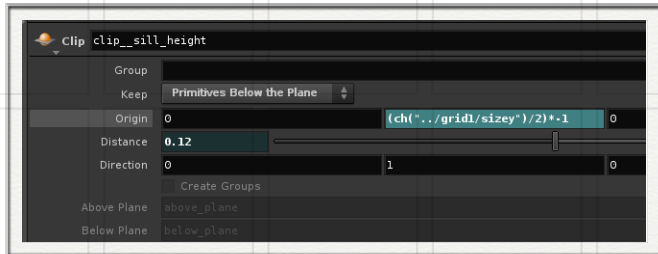
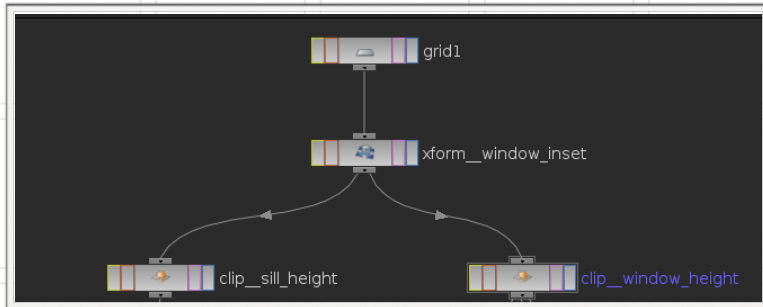


- ▶ Drop down a Geometry and dive inside
- ▶ Drop down a grid
  - ▶ The Grid will define the Width & Height (4x2)
  - ▶ Rows and Cols 2x2
- ▶ Append a Transform to Define the Window Inset
  - ▶ tz -0.11

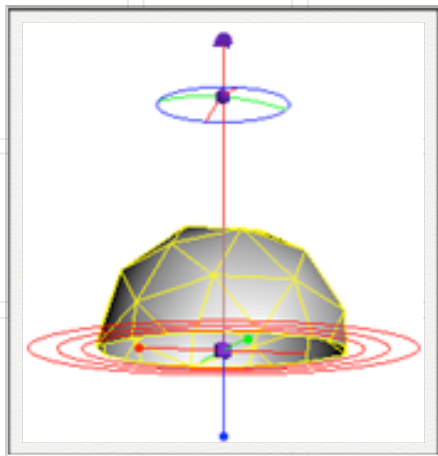
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## Clipping Parts of the Window

- ▶ Now we have to clip the height of the Sill from the Height of the Window
- ▶ Append two CLIP SOPS to the transform SOP
  - ▶ The First CLIP will define the Sill, the second the Window
- ▶ CLIP\_SILL\_HEIGHT
  - ▶ Origin -  $(ch("../grid1/sizey")/2)*-1$
  - ▶ Keep - Primitives Below the Plane
- ▶ CLIP\_WINDOW HEIGHT
  - ▶ Origin -  $ch("../clip\_sill\_height/originy")$
  - ▶ Keep - Primitives Above the Plane



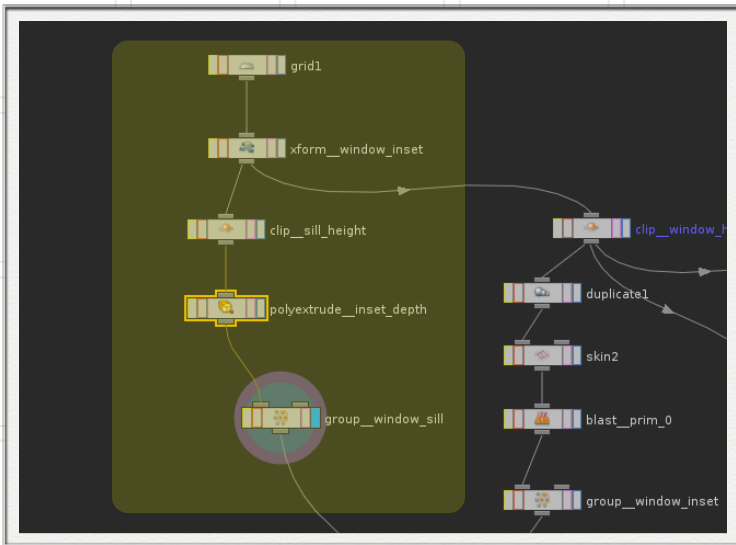
## What is the Clip SOP?



- ▶ Removes or groups geometry on one side of a plane, or creases geometry along a plane.
- ▶ When Keep is not “All primitives”, this operator attempts to clip all input primitives above or below the plane. If clipping would destroy the primitive’s structure (polygons, particle systems), the primitive is simply deleted.
- ▶ You can use this operator as a modeling tool, or to manually clip polygons outside the field of view to reduce scene complexity.

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SOFTWARE**

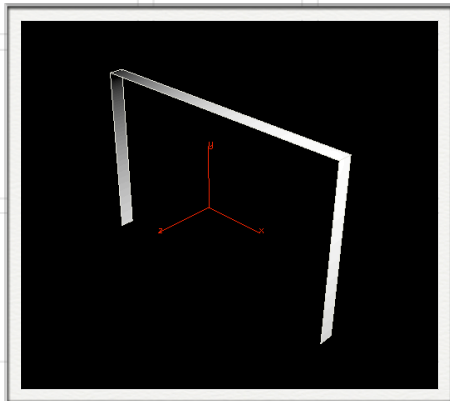
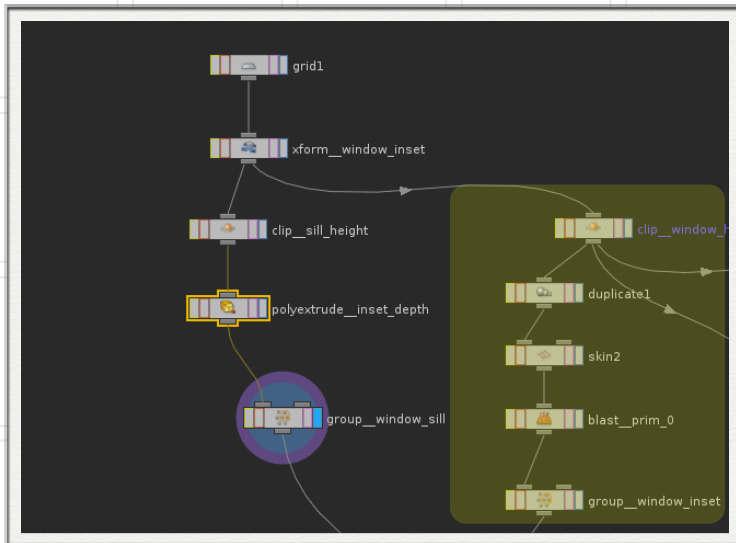
## PolyExtrude the Sill



- ▶ Append a PolyExtrude to CLIP\_SILL\_HEIGHT
  - ▶ Pull out the thickness of the SILL
  - ▶ tz - -0.2
- ▶ Append a Group SOP
  - ▶ Entity Primitives
  - ▶ Group\_Name - Window\_Sill (For future Material Assignment)

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SOFTWARE

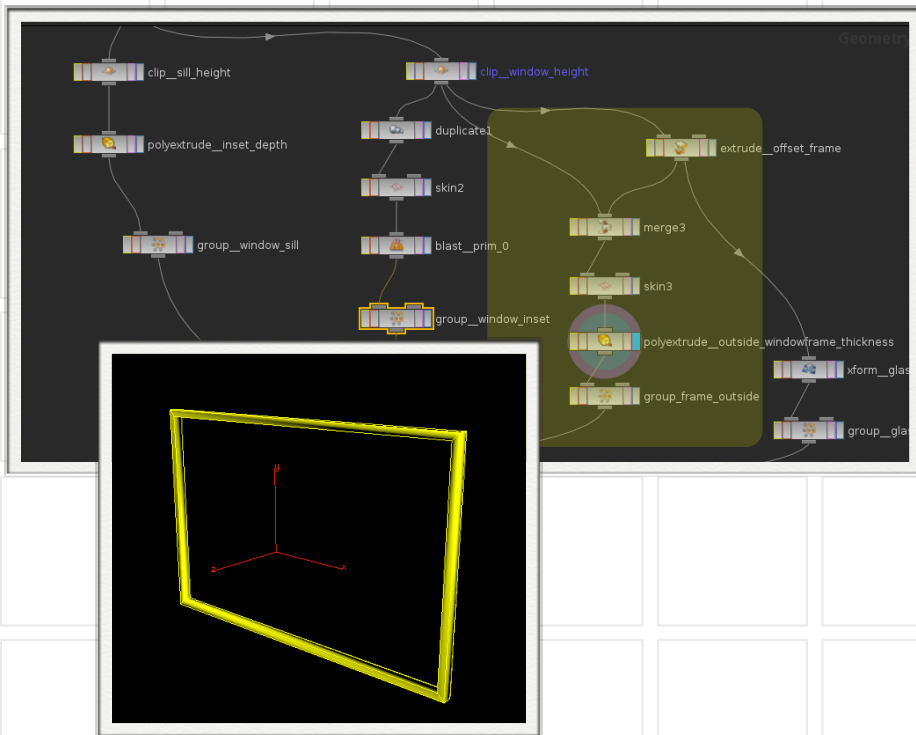
## Create the Window Inset



- ▶ Append a Duplicate to the Clip\_Window
  - ▶ Number of Copies - 1
  - ▶ tz - 0.1
  - ▶ Append a Skin
- ▶ Append a BLAST SOP to remove the primitive that will coincide with the Sill
  - ▶ Group - 0
- ▶ Append a Group SOP
  - ▶ Entity - Primitives
  - ▶ Group Name - Window\_Insert (For future Material Assignment)

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## Create Outside Frame

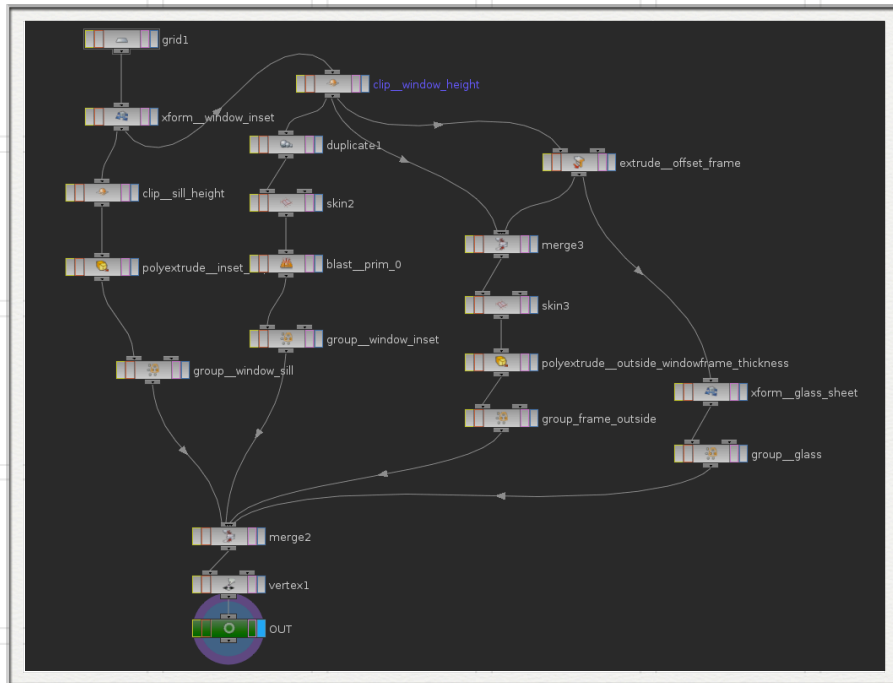


- ▶ Append an EXTRUDE SOP to the CLIP\_WINDOW\_HEIGHT
  - ▶ Give it a negative THICKNESS OFFSET - -0.04
- ▶ Append a MERGE SOP - Merge the CLIP\_WINDOW\_HEIGHT
- ▶ Append a SKIN SOP
- ▶ Append a POLYEXTRUDE and do a small extrude
  - ▶ tz - 0.055
- ▶ Group the Frame Outside (For future Material Assignment)

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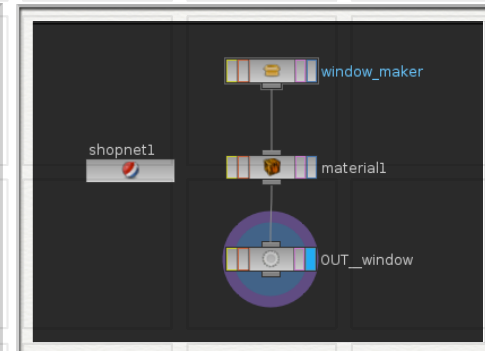
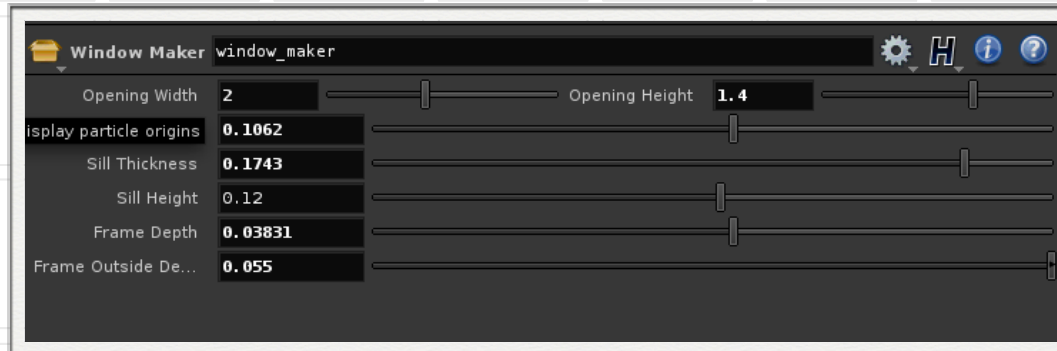
## Create the Sash (Window Pane)



- ▶ Append a TRANSFORM to the EXTRUDE\_OFFSET\_FRAME
- ▶ translate tz - -ch("../polyextrude\_outside\_windowframe\_thickness/lz")
- ▶ Append a Group SOP for Material assingment

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# Convert Window to a Digital Asset



► Afterwards Assign Materials

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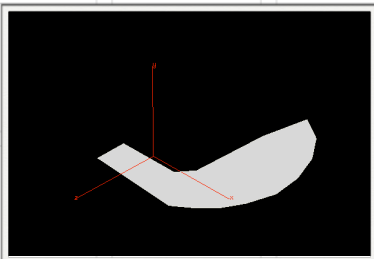
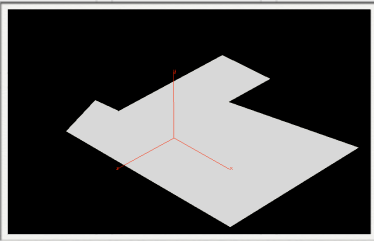
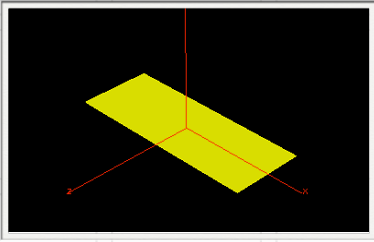


# Creating the Building Footprint

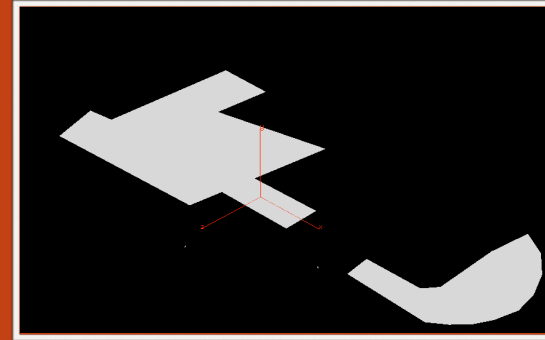
Remember from the last week - Separate Inputs from the Procedural Engine

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## Building the Footprint



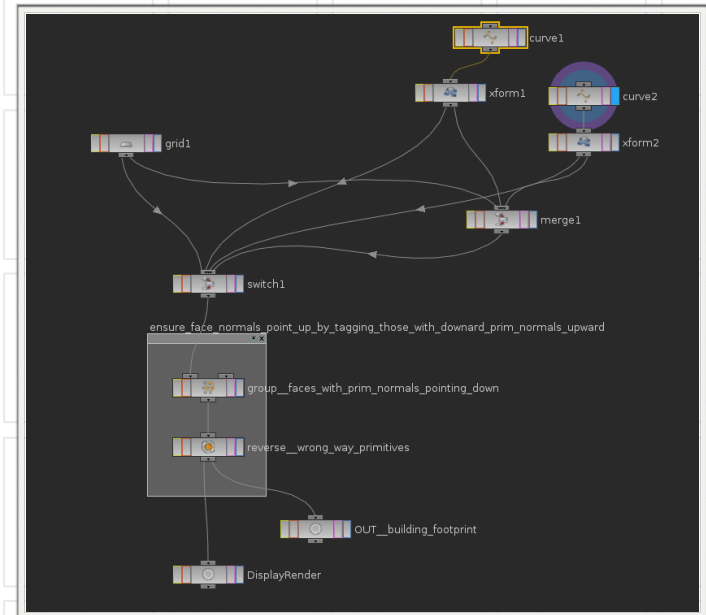
The Building's footprint can be created out of any shape or combination of shapes.



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# Footprint Node Network Overview

- ▶ Notice the Gray Network Box
  - ▶ First Test to see if any Normals are facing downward and place in own group - “reverse\_me”
  - ▶ Entity = Primitives
  - ▶ Turn off Number Enable
  - ▶ Select Normal Tab
  - ▶ Direction (diry) = -1
  - ▶ Spread Angle = 45
- ▶ Append a Reverse SOP
  - ▶ Group - “reverse\_me”
  - ▶ Vertex - Reverse U



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## Create The Building

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SOFTWARE**

## Constants that have to be Determined



- ▶ First Floor Height
- ▶ Floor to Floor Height - What is the standard floor height from floor 2 to the room floor minus 1
- ▶ How many stories in building
- ▶ What is the parapet Height - How far is the roof sunken in

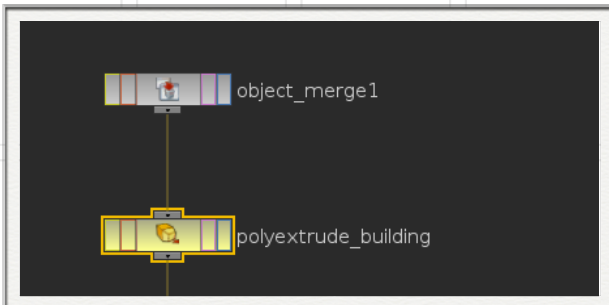
Total height of building = First Floor Height + (Floor to Floor Height\*Number of Stories) + Parapet Height

Total height of Building = 4m + (2.5m\*30) + 0.6  
Total height of Building = 79.6m

First Floor Height	4m
Floor to Floor Height	2.5m
Parapet Height	0.6m
Number of Stories	30

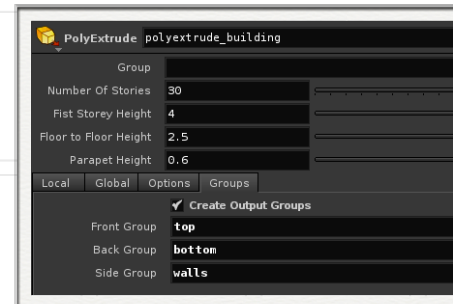
**SIDE EFFECTS  
SOFTWARE**

## Creating the Building's Shell



- ▶ At the Object Level Drop Down a Geometry and Dive in
- ▶ Drop Down an Object Merge and bring in the Building Footprint  
-/obj/building\_footprint/OUT\_building\_footprint
- ▶ Append a PolyExtrude
  - ▶  $\text{ch}(\text{"first\_storey\_height"}) + (\text{ch}(\text{"number\_of\_stories"}) - 1) * \text{ch}(\text{"floor\_to\_floor\_height"}) + \text{ch}(\text{"parapet\_height"})$

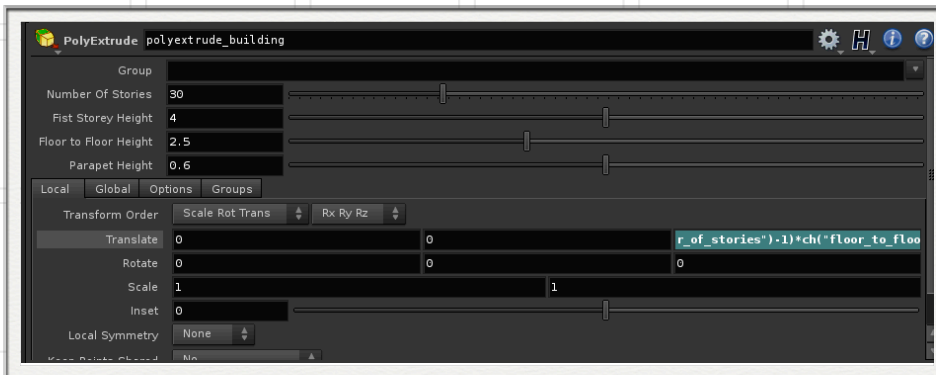
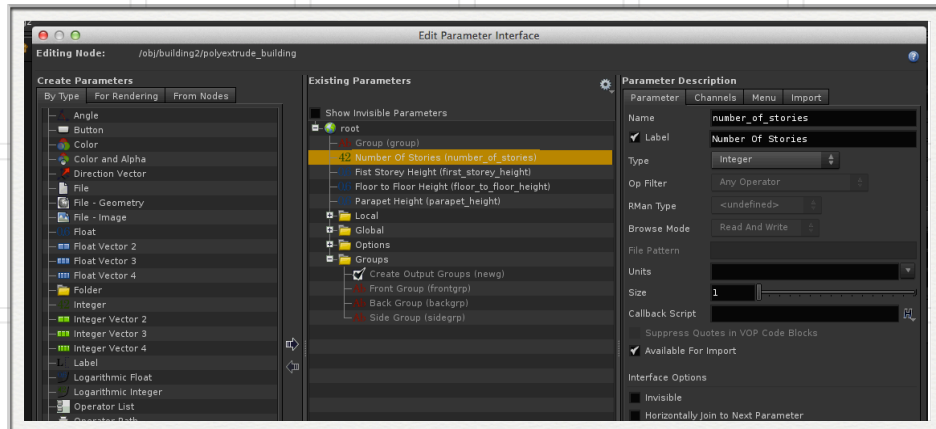
Let us examine this some more!  
(cont. on the next slide)



**SIDE EFFECTS  
SOFTWARE**



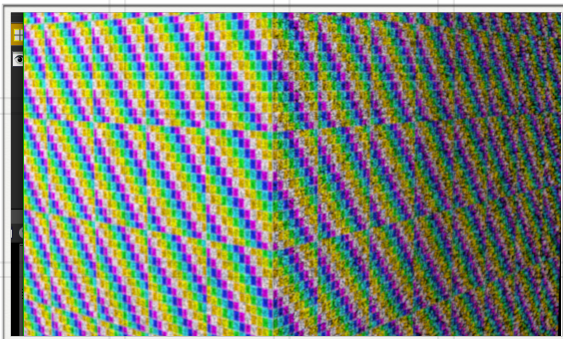
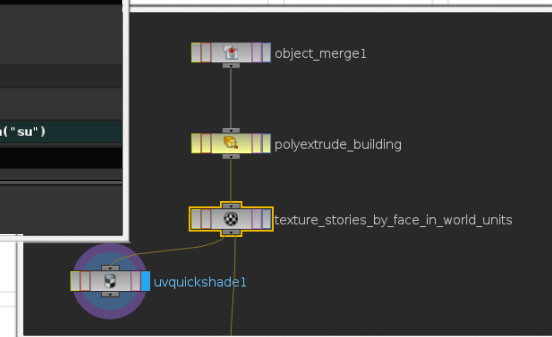
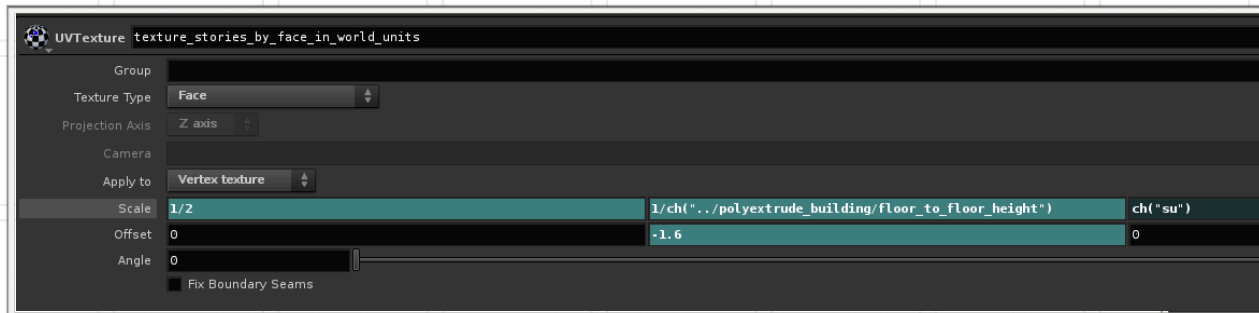
## Creating the Building's Shell (cont.)



Add Parameters to a node such as a “PolyExtrude” is a very good method to create flexibility and even more importantly readability to your network

**SIDE EFFECTS  
SOFTWARE**

# Setting Up UVs



- ▶ Append a UVTEXTURE SOP to the PolyExtrude
  - ▶ We will focus on getting the UV correct for the floor to floor height
  - ▶ In the Scale-y (sy) channel -
    - ▶ `1/ch("../polyextrude_building/floor_to_floor_height")`
    - ▶ Adjust sx & sz to give square uvs
  - ▶ Test with UVQUICKSHADE

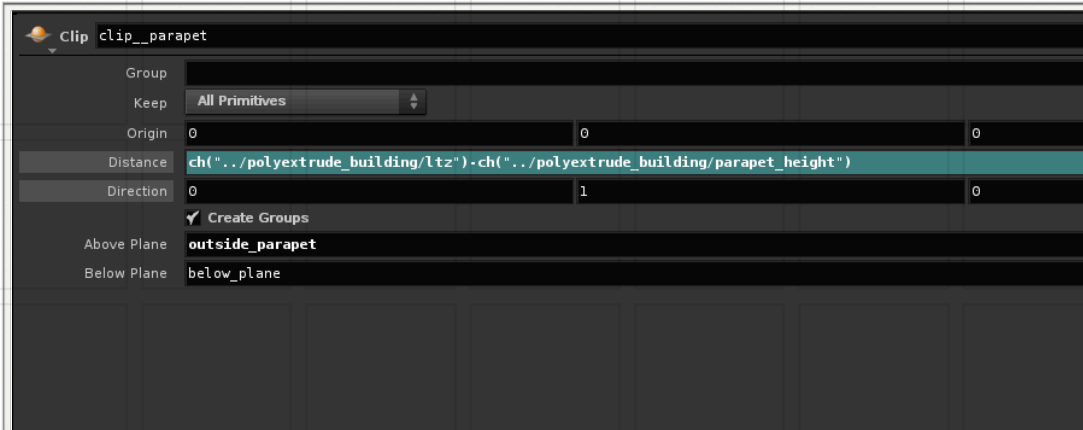
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## Clipping the Parts of the Building

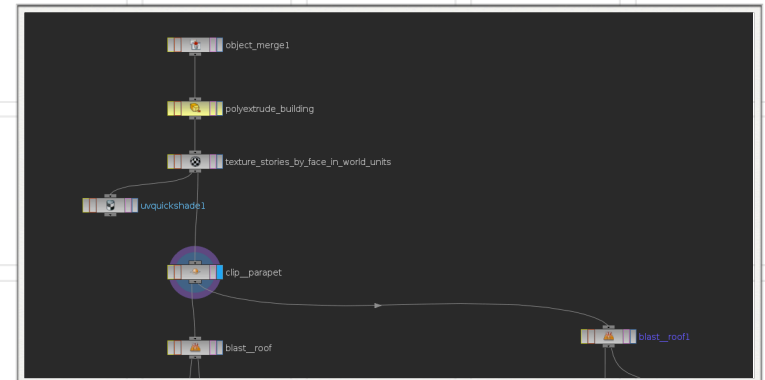
- ▶ Now we have the Shell of the Building we are going to go through the same process of clipping we did on the window
  - ▶ Clip the Parapet
  - ▶ Clip the Ground Floor
  - ▶ Clip each Story - within a FOREACH

SIDE EFFECTS  
SOFTWARE

## Clipping the Parapet

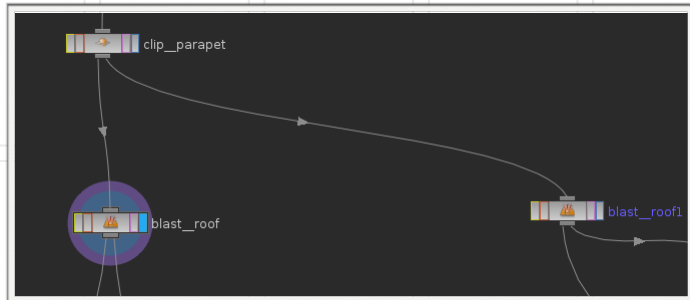


- ▶ We are first just going to define the group above the parapet plane and below
  - ▶ Keep All Primitives
  - ▶ Distance - `ch("../polyextrude_building/ltz")-ch("../polyextrude_building/parapet_height")`
  - ▶ Above Plane - outside\_parapet
  - ▶ Below Plane - below\_plane

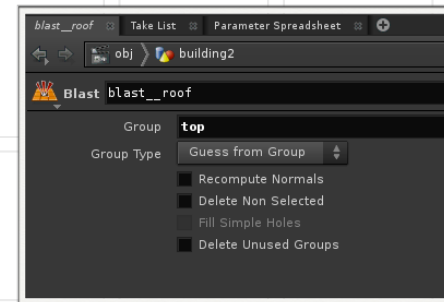


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## Clipping the Parapet (cont.)

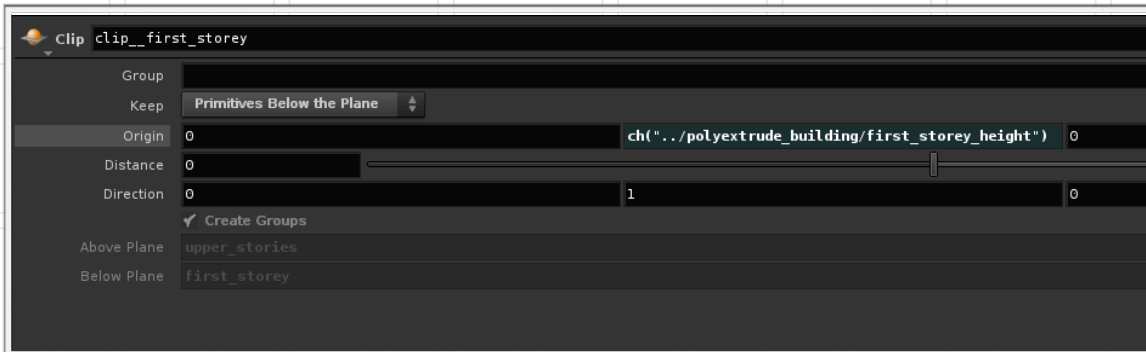


- ▶ Now we need to delete the plane that represents the roof because we will build our own parapet
  - ▶ Append two separate BLAST SOPs - One will be used to generate the stories and first floor the other the parapet
  - ▶ Distance - `ch("../polyextrude_building/ltz")-ch("../polyextrude_building/parapet_height")`
  - ▶ Above Plane - `outside_parapet`
  - ▶ Below Plane - `below_plane`

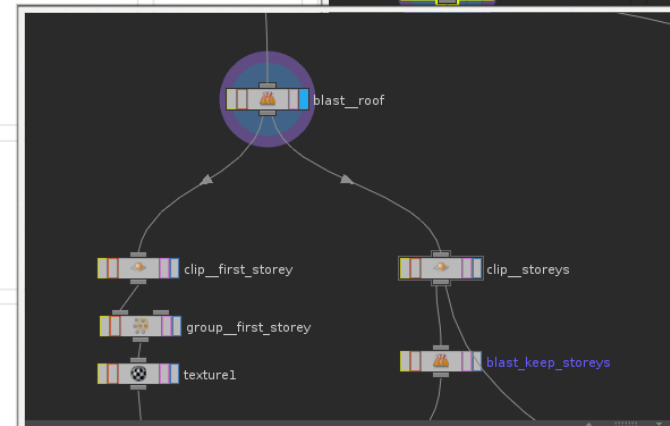
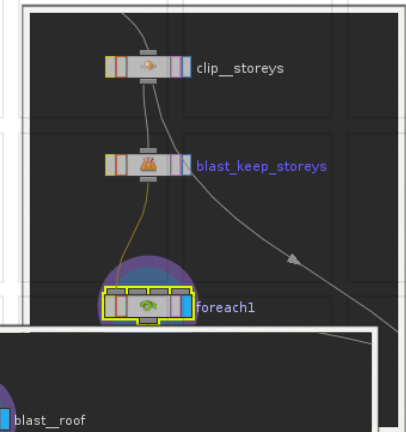


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## Clipping the First Storey

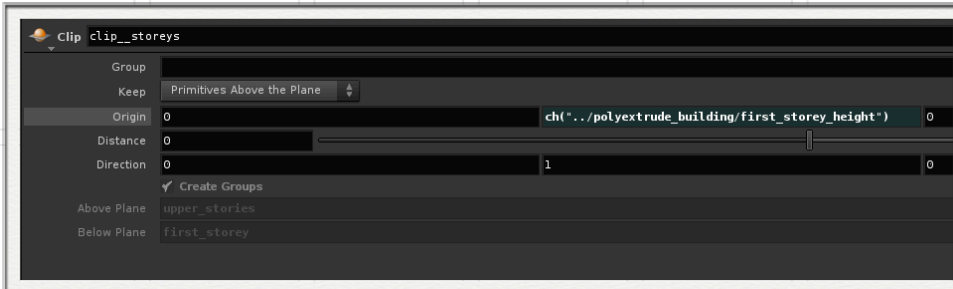


- ▶ Now we will use the first story height parameter from the POLYEXTRUDE
- ▶ Group the first story by primitive - first\_storey
- ▶ and place a uvtexture - this time we will use the value of the first story height
- ▶  $1 / (\text{ch}("../polyextrude\_building/first\_storey\_height") - \text{ch}("../polyextrude\_building/floor\_to\_floor\_height"))$

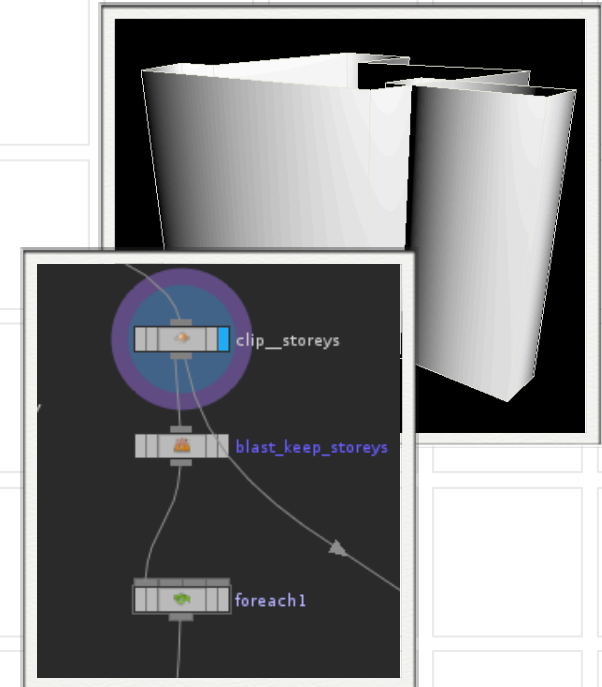
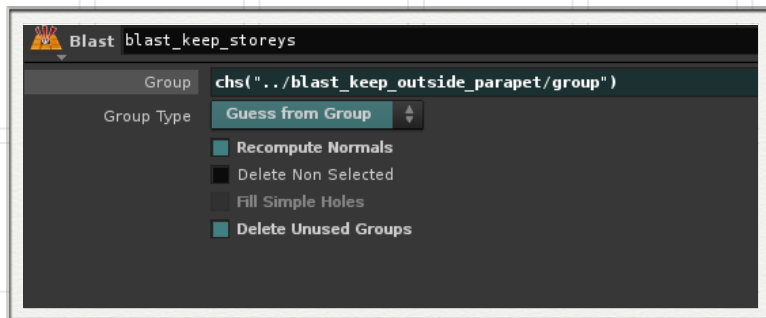


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## Clipping the Stories

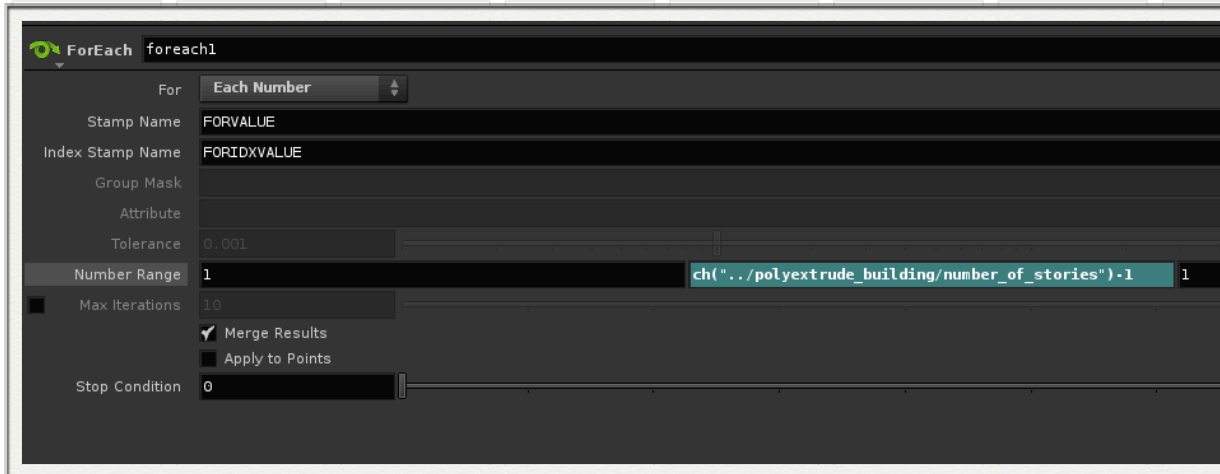


- ▶ Clip the Stories by
  - ▶ `ch("../polyextrude_building/first_storey_height")`
- ▶ Blast away by
  - ▶ `chs("../blast_keep_outside_parapet/group")`



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## Now Blast Each Floor Separately Using a ForEach

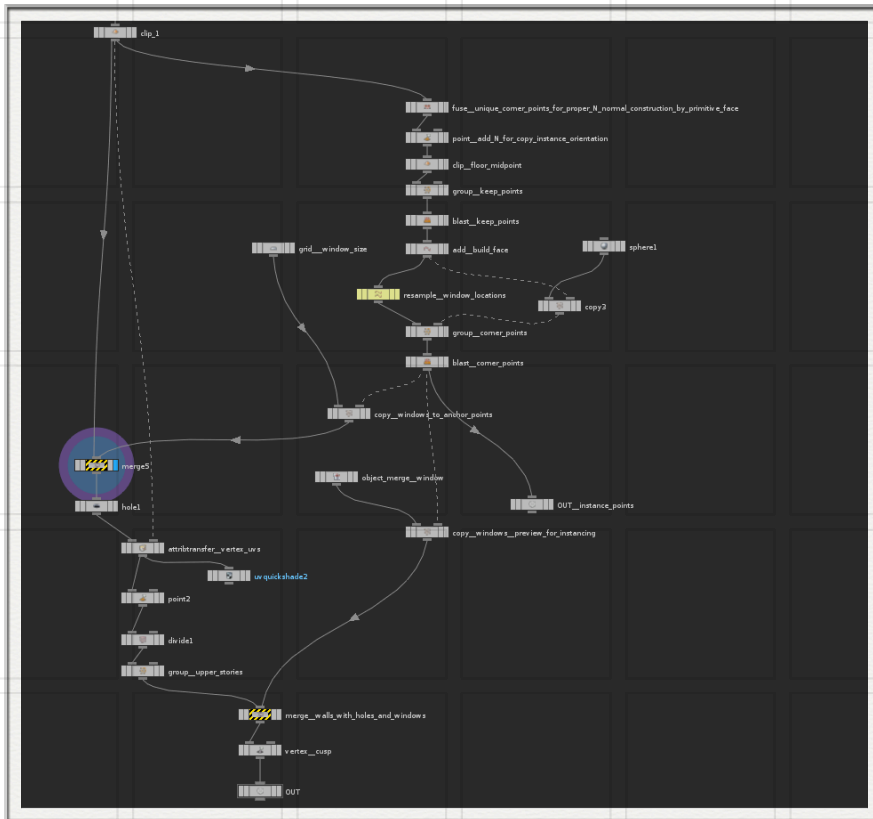


- ▶ Since we know the Number of Stories we can set the FOREACH to calculate by “Each Number”
- ▶ The Number Range will go from 1 to `ch("../polyextrude_building/number_of_stories")-1`
- ▶ Dive inside the ForEach

**SIDE EFFECTS  
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# ForEach Network Overview

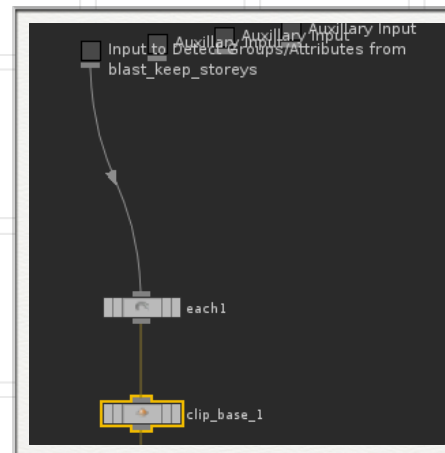
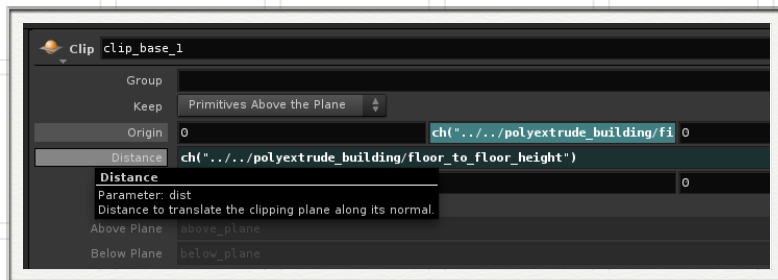


- ▶ Goals for the ForEach Node
  - ▶ Clip each floor individually
  - ▶ Resample points to place windows
  - ▶ Remove Corner Points to make sure windows will not be placed there
  - ▶ Cut away holes for Windows
  - ▶ Create UVs for walls
  - ▶ Place Materials for Walls
  - ▶ Place Windows in Holes

**SIDE EFFECTS  
SOFTWARE**

## Clip the Base of Each Floor

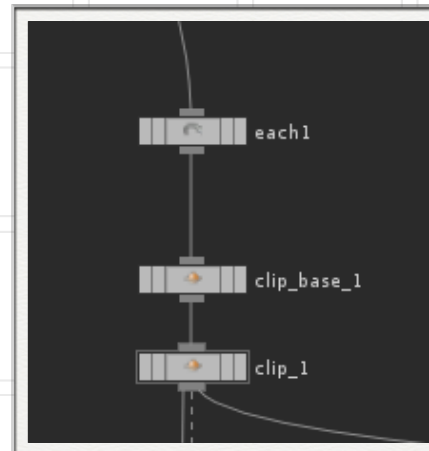
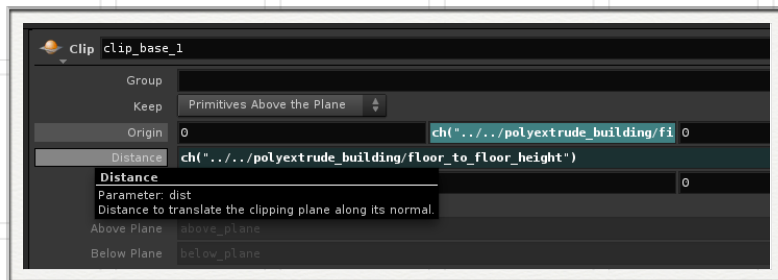
- ▶  $\text{ch}("../polyextrude\_building/first\_storey\_height") + \text{ch}("../polyextrude\_building/floor\_to\_floor\_height") * (\text{ch}("../each1/attribval1") - 2)$
- ▶  $\text{Distance} = \text{ch}("../polyextrude\_building/floor\_to\_floor\_height")$



SIDE EFFECTS  
SOFTWARE

## Clip the Ceiling of Each Floor

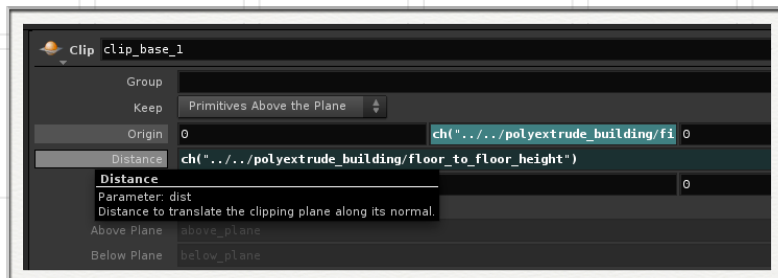
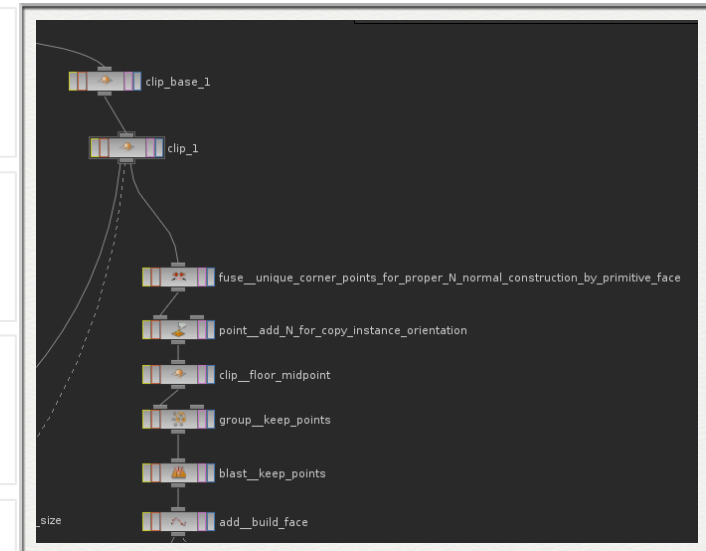
- ▶  $\text{ch}("../polyextrude\_building/first\_storey\_height") + \text{ch}("../polyextrude\_building/floor\_to\_floor\_height") * (\text{ch}("../each1/attribval1") - 1)$
- ▶  $\text{Distance} = \text{ch}("../polyextrude\_building/floor\_to\_floor\_height")$



SIDE EFFECTS  
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## Clip the Ceiling of Each Floor

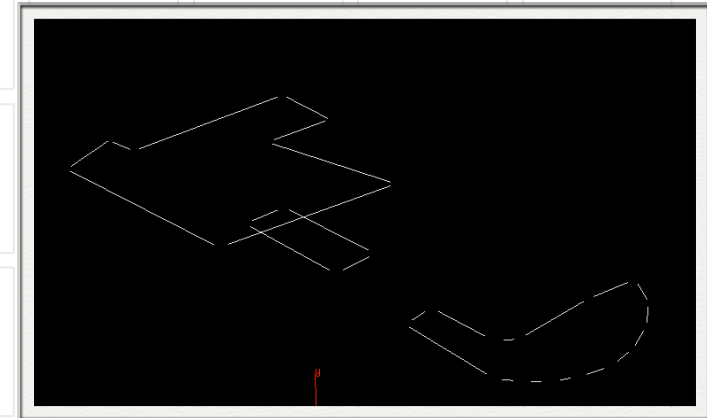
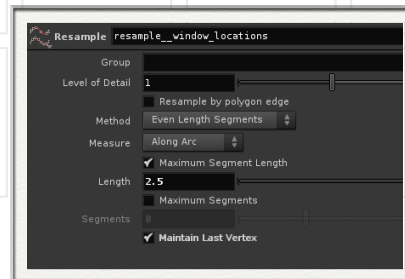
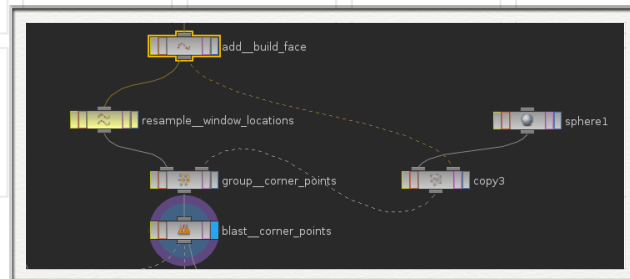
- ▶ Append a FUSE SOP and set it to “Unique” want to make sure corner points are fused
- ▶ Append a POINT SOP and add Normals for Orientation
- ▶ Clip the Input of each floor to get a midpoint top place Windows
- ▶ Group by Bounding Box the Mid Points
- ▶ Keep the Points by blasting the other points away
- ▶ With an ADD SOP we are going to rebuild the lines of the walls where the windows will be - Group of N Points (where N is 2)



SIDE EFFECTS  
SOFTWARE

# Resample Points for Windows and Delete Corners

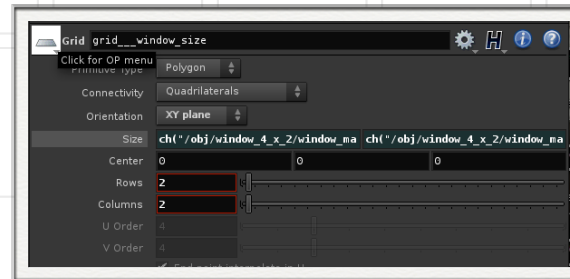
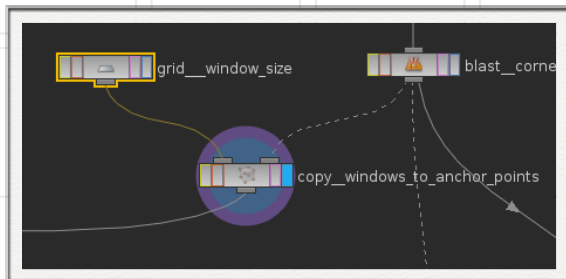
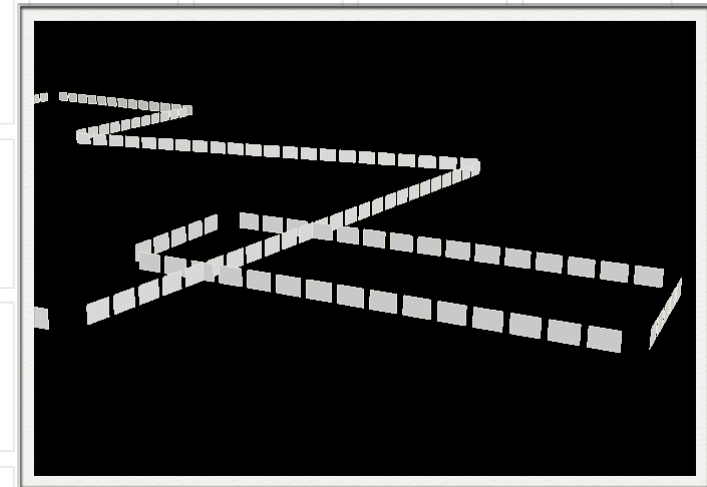
- ▶ Append a RESAMPLE SOP for Window Placement
- ▶ Append to the ADD SOP a COPY SOP
  - ▶ We will COPY SPHERES to each Corner so we can eventually delete those points (we do not want windows to overhang the corners of the building)
  - ▶ Put the COP and the Resample into GROUP SOP - We will group the corner points by the radii of the spheres
  - ▶ Blast the Corner Points - so windows will not be placed there



SIDE EFFECTS  
SOFTWARE

## Copy Windows Templates to Points

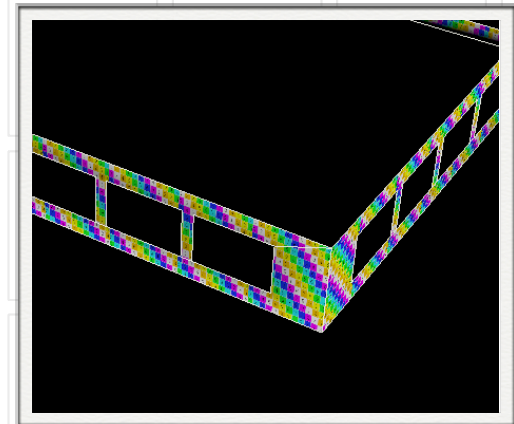
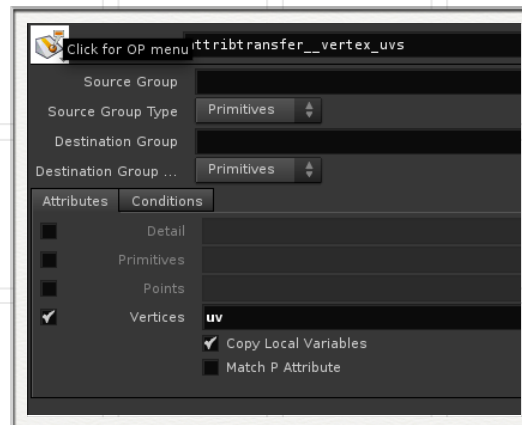
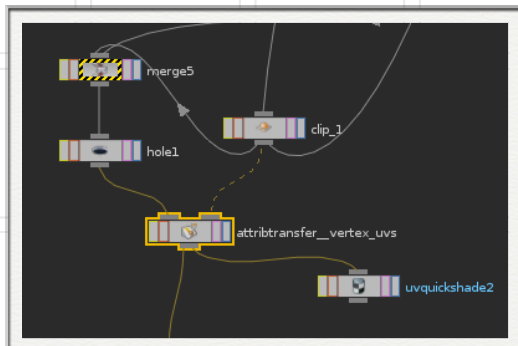
- ▶ Next we are going to copy grids that are the same size as the windows o the points. They will be used to cut holes for eventual window placement
- ▶ Size of Grid
  - ▶ `ch("/obj/window_4_x_2/window_maker/opening_width")`
  - ▶ `ch("/obj/window_4_x_2/window_maker/opening_height")`
  - ▶ Rows/Cols 2x2



SIDE EFFECTS  
SOFTWARE

## Create UVs for Story

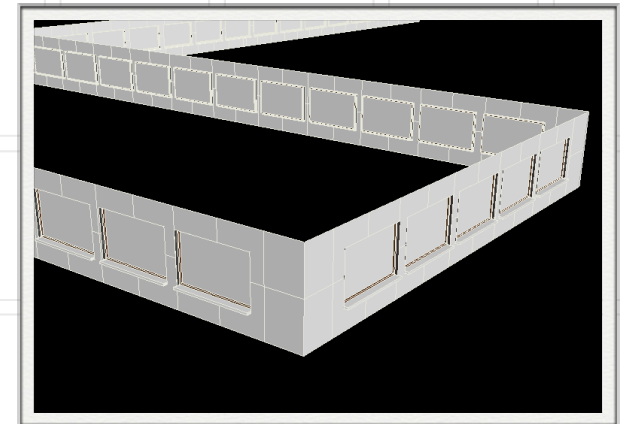
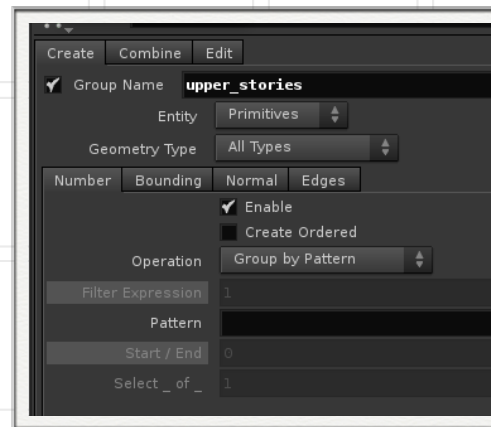
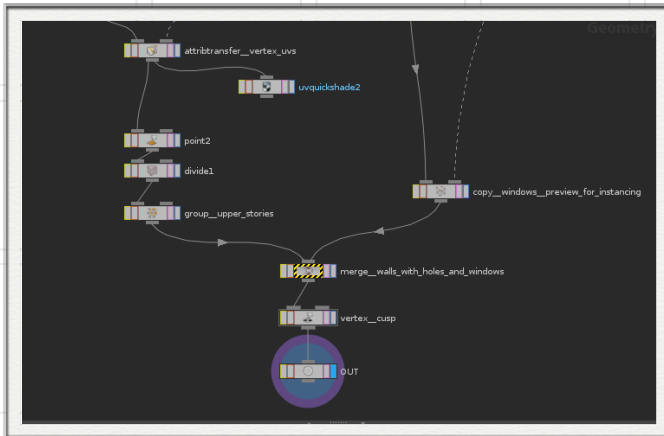
- ▶ Append an Attribute Transfer to the HOLE SOP
- ▶ Transfer from the CLIP the vertices uv



**SIDE EFFECTS  
SOFTWARE**

## Merge Walls and Windows

- ▶ Append an Point SOP and Delete Normals
- ▶ Clean Up the Geometry using a DIVIDE SOP with Bricker Polygons
- ▶ Group the Stories together
- ▶ Merge the windows
- ▶ Vertex Cusp the Polys to flatten for Render

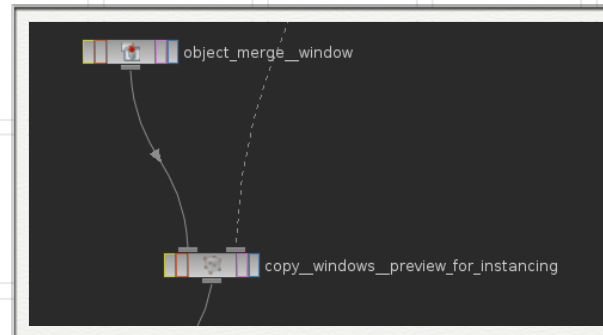
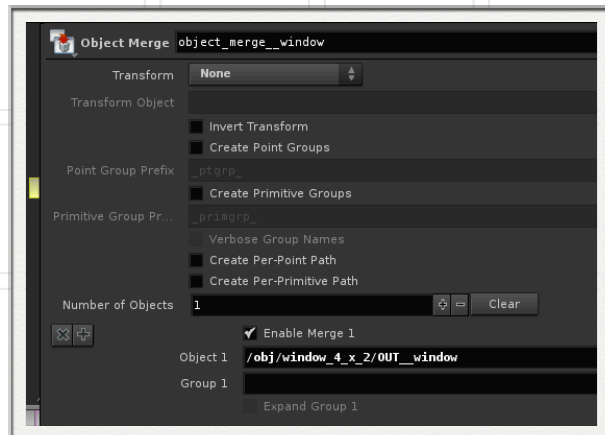


SIDE EFFECTS  
SOFTWARE



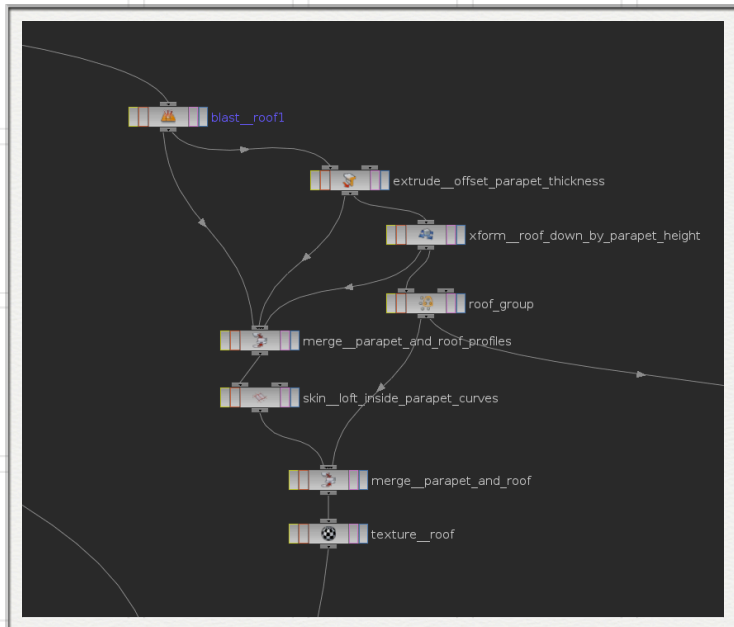
## Bringing in the Windows

- ▶ Forgot to Mention that the Windows were brought in with a Simple Object Merge



SIDE EFFECTS  
SOFTWARE

## Creating the Roof

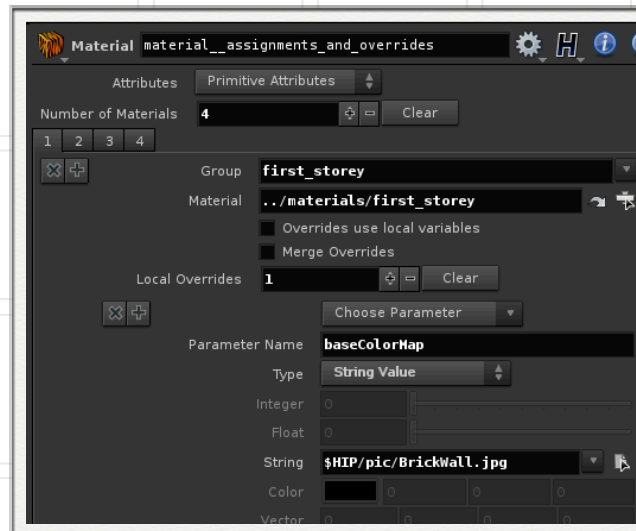
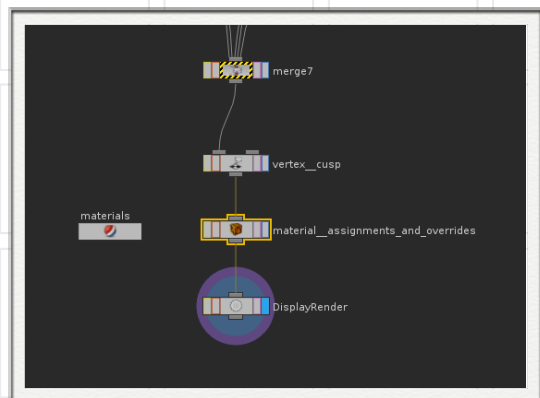


- ▶ Simple Extruding and Skinning to Get the Roof you Desire



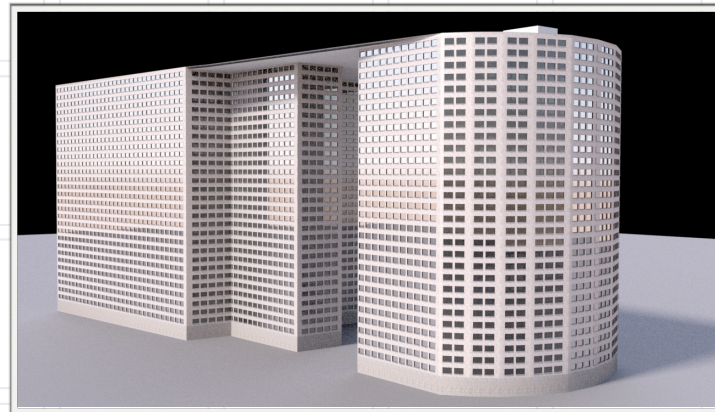
**SIDE EFFECTS  
SOFTWARE**

# Merging the Floors Together and Attaching Materials



SIDE EFFECTS  
SOFTWARE

# Final Result



**SIDE EFFECTS  
SOFTWARE**



## End Module 03

**SIDE EFFECTS  
SOFTWARE**