

DMM TUTORIAL5: Using Glue Regions

Most objects are made of more than one material. With DMM you can build the different parts of an object, assign different material properties to each part and then glue all these parts together to form one object.

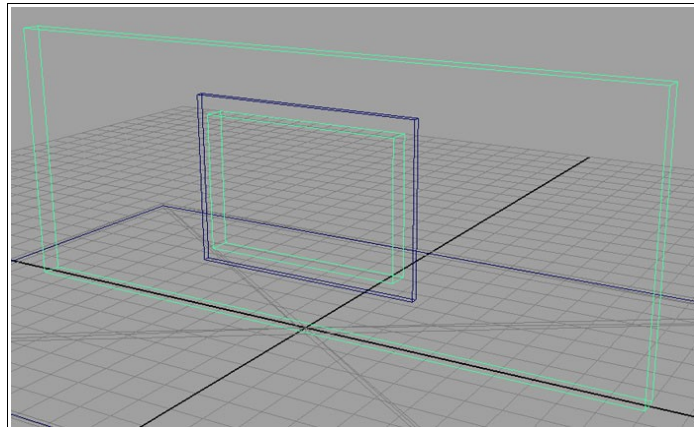
In this tutorial you will


- glue two objects and see the difference in the simulation when you destroy it.
- create a multi-material object and see how it simulates when you destroy it.
- see how glued objects react if one of them is animated with Maya.

Gluing a wall and a window

We are going to create a concrete wall with a glass window. We will then break the window by throwing a DMM sphere at it and see how the simulation changes when the window and the wall are glued together.

1. Create a new scene
2. Create a DMM passive floor plane with the following dimensions: Width: 12 / Depth: 8 (For more information about creating a floor plane see Tutorial 1)
3. Create a polygon wall of the following dimensions: Width: Height:10 / Height: 4 / Depth:0.3 with a hole for the window.
4. Create a polygon window slightly bigger but slightly thinner than your hole. Place it in the hole.




5. Apply desired Maya materials to your objects.
6. Convert both objects to DMM objects
 - Select the object
 - Select *DMM Asset / Create DMM Object from Polymesh* or 
7. Adjust the triangulation density for the window
 - Open the *DMM Asset Manager (Edit DMM / Asset Manager)*
 - In the *Triangulation & Tet Generation Parameters* change the *Density Area* to 0.2

8. Apply a concrete DMM material to the wall


- Select the wall
- Select *DMM Material / Assign New DMM Material / Concrete_Medium*

9. Apply a glass DMM material to the window

- Select the window
- Select *DMM Material / Assign New DMM Material / weak_crystal*
- Open the *DMM Material Node* attributes (*In the DMM Asset Manager click on the Select button next to DMM Material Node or select *)
- Adjust the following parameters: Youngs: 3500000, Toughness: 1500
- Rename the material as glass

Your two DMM objects are ready. We will now create the DMM sphere and animate it to break the window.

10. Create a DMM Sphere

- Select *DMM Asset / Create DMM Object Primitive / Sphere* or 
- Modify it's radius to 0.3

11. Apply to it the same concrete DMM material as the wall

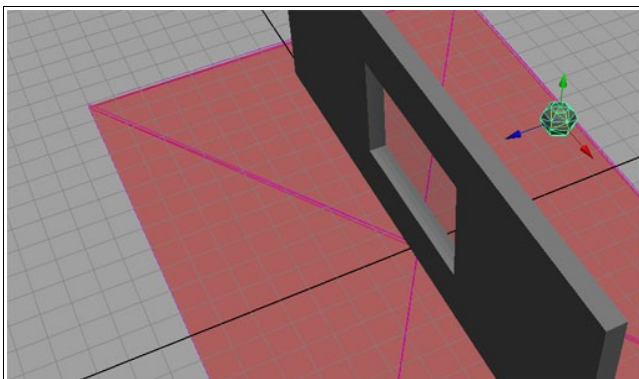
- Select *DMM Material / Assign Existing DMM Material / Concrete_Medium1*

12. Turn the sphere into a passive object so it will follow the key framed animation. (For more information about DMM and key frame animation see tutorial 3).

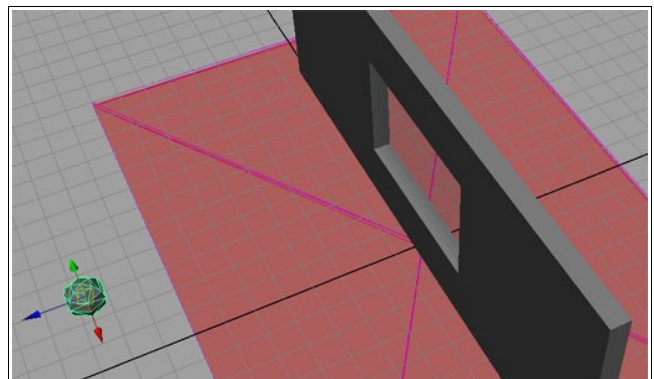
- Open the *DMM Asset Manager (Edit DMM / Asset Manager)*
- In the *General Settings* click the box next to *DMM Passive*

13. Animate the sphere

- Create two key frames to "throw" the sphere through the window (frame 0 and 40)



Frame 0



Frame 40

Try playing the simulation without any glue. You can see that once the window is broken it just falls out of the wall. (tutorial5_video1.mov). We will now add a glue region and see the difference in the simulation.

14. Add a Glue region to the wall and window

- Select the wall and window

- Select *DMM Asset / Add New Glue Region to DMM Object* or



This creates a polymesh cube of the size of the bounding box encompassing the selected objects and assigns it as a Glue Region to these selected objects.

Important note: Even though the glue region covers the entirety of both objects, only the **intersecting** parts will be glued. Glue Regions define which intersecting tetrahedron of two distinct tetrahedral meshes will be glued together. If no actual tetrahedron are intersecting within a Glue Region, the region will have no effect.

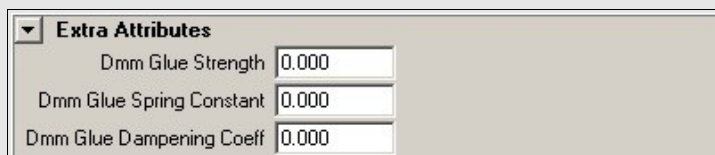
15. You can edit the glue region so that it includes only the intersecting parts of the objects. This does not change anything for the simulation, but it may be clearer visually as to which part of an object is glued.

16. Save your file. (This scene is also provided in tutorial5.zip: tutorial5_01.ma)

If you play the animation, you can see that the window now stays attached to the wall even when it breaks. (tutorial5_video2.mov).

Additional notes about Glue Regions:

- 1) Any number of DMM Glue Regions can be added to an object and they can be shared between multiple DMM Objects.
- 2) If a shape other than a box is preferred for a DMM Glue Region then any convex shape can be used.
 - Select a polymesh
 - Select *DMM Asset / Make Polymesh into Glue Region* or
- 3) The Glue is computed on the second frame of the simulation, using the position of the tetrahedrons at the frame. Once the Glue computed, the simulator remembers which pairs of tetrahedrons are glued together and simulates frame after frame using that information.
- 4) The glue breaks when the two tetrahedrons don't intersect anymore. At that point the Glue information is lost. If the tetrahedrons happened to intersect again during the simulation, the Glue won't be recreated.
- 5) The nature of the glue can be modified by selecting the Glue Region and then by editing the extra attributes of the node in Maya's Attribute Editor.



Glue Strength :how hard the glue will hold. 0 is a special value and creates an almost "unbreakable" glue.

Spring Constant : how stiff the glue is – larger values mean stiffer, smaller values mean more elastic.

Dampening coefficient : how much energy the glue dissipates as heat when under stress.

Creating a table with metal feet and a wooden plane

1. Open the table_start.ma file which is provided in tutorial5.zip

For each part of the table you have two meshes. One will be used for the Tet Cage, the other for the Surface Mesh. (For more information on how to create a DMM object with a Surface Mesh see tutorial 2).


2. Turn the table legs into a DMM object.

- Select tableLegs
- Select *DMM Asset / Create Bare DMM Object / From Polymesh*
- Select tableLegs and tableLegs_Surface

- Select *DMM Asset / Add Surface Mesh to Bare DMM Object* or



3. Apply an iron material to it

- Select tableLegs
- Select *DMM Material / Assign New DMM Material / iron*
- Open the *DMM Material Node* attributes (*In the DMM Asset Manager click on the Select button next to DMM Material Node* or select )
- Adjust the following parameters: Youngs: 110000000, Youngs Dampening: 200000, Poissons: 0.0000, Density: 2000, Toughness: 0, Friction: 0.5

4. Turn the table plane into a DMM object

- Select pPlane1
- Select *DMM Asset / Create Bare DMM Object / From Plane Polymesh*
- Adjust the Triangulation parameters to Density: Area 0.100 / Scaling: Magnitude 4.00 , X 4.00

Note: The scaling parameter allows you to create a Tet Mesh which is stretched in up to two directions. A DMM Object will be stronger in the directions that its Tet Mesh is stretched. This can be useful to create a wooden object for instance. By stretching the Tet Mesh in the direction of the grain of the wood, it will make the wood stronger against the grain. Adjusting tetrahedral mesh shapes like this is a very effective method of getting anisotropic behavior.

Note that the magnitude needs to be higher than 1.0 to enable the scaling.

- Select pPlane1 and pPlane1_Surface. Make sure pPlane1_Surface is entirely inside the pPlane DMM Object.

- Select *DMM Asset / Add Surface Mesh to Bare DMM Object* or



- Make it breakable. (In the *DMM Asset Manager* select the *Breakable* box in the *Surface Mesh* section.)

5. Apply a wood material to it

- Select pPlane1
- Select *DMM Material / Assign New DMM Material / wood*

6. Place the plane on top of the legs (don't forget to make them intersect!) and glue them together.

- Select the plane and the legs

- Select *DMM Asset / Add New Glue Region to DMM Object* or



7. Save your file. (This scene is also provided in tutorial5.zip: table_finished.ma)

Your table is complete, now lets see how it simulates!

Animating part of the table

1. Import your table into the wall and window scene.
2. You now have two DMM scene nodes in your Maya scene. (For more information on DMM scene nodes see tutorial 8). In order for everything to simulate together you have to merge these scenes.

- Select *DMM Scene / DMM Scene Manager*
- Select the non-active scene
- Click the *Merge Highlighted Scene into Active Scene* button
- Click OK

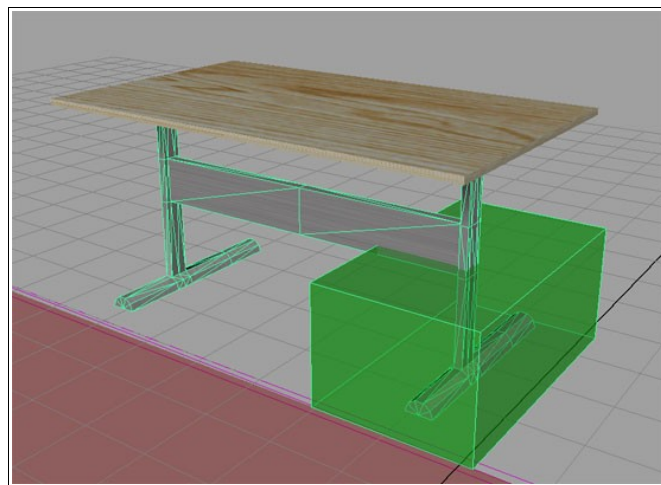
3. Add a *Passive Region* to the table but only on one of it's feet

- Select tableLegs

- Select *DMM Asset / Add New DMM Passive Region to DMM Object* or



- Edit the Passive region to look like this



- Parent the passive region to the table legs
4. Move the table (legs and plane) to the same starting position as the sphere.
 5. Create the same animation for the table legs (not the plane) as the sphere but start at frame 2.

Important note: As previously stated, the Glue is computed on the **second frame** of the simulation, using the position of the tetrahedrons at that frame. Therefore, it is recommended not to animate any DMM Object before the second frame.

6. Delete the sphere
7. Play the animation. You can see that even though only the feet are animated, the plane follows as they are glued together. (tutorial5_video3.mov)

This scene is available in tutorial5.zip: tutorial5_02.ma

Additional note: Global Glue

The DMM Scene node has a "Glue All" attribute. When enabled, all intersecting tetrahedrons of all DMM objects in the selected DMM scene are glued together.

- This Global Glue (also called "implicit glue") is disabled by default.
- The default parameters of the Implicit Glue make it very weak.
- You can change these parameters in the DMM Scene Attributes (*DMM Scene / Select Active DMM Scene Node*)
- The effects of the Glue Regions override the Implicit Glue