THINKINETIC

Pulldownit!

Maya Users Guide

Autodesk
Authorised Developer

Version 3.x

Table of Contents

page

Introduction

Pulldownit is a dynamics plugin intended for destruction effects as well as massive rigid bodies simulations. By using its technology digital artists are able to shatter objects in different styles and simulate easily the fracture of 3D models. Its core solver handles seamlessly scenes made of thousands of objects. The power of Pulldownit solver allows computing the collapse of large structures such buildings in a stable and realistic way. This is the official user guide for the Autodesk Maya Pulldownit plug-in.

What's New

The following are the most significant changes to the Pulldownit 3.0 since the previous version.

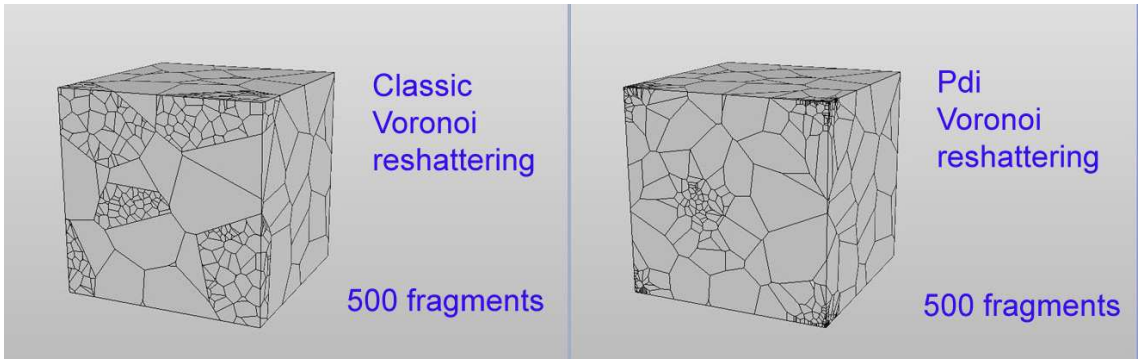
Shatter it! New Features:

Congruent vertex normals after shattering: Vertex normals are unified after shattering removing the visible seams of light reflection between the broken pieces.

Shattering of objects is now 20% faster.

New Preview Mode for Shattering: Allowing user to visualize any shatter parameter before breaking the geometry.

Voronoi Conform Reshattering: User is not longer constrained when reshattering a model, any shatter pattern can be added to the current set of fragments seamlessly, in addition new Conform Voronoi reshattering reduce the number of straight edges in the shatter pattern, hence improving the quality of the fragments generated.



New Width parameter for Radial Shatter.

New Undo Last button for undoing only the last shatter operation.

Pulldownit Dynamics New Features:

New Crackers Window: New window for controlling the cracking of surfaces, you count with several new parameters for adjusting the way the cracks are generated.

New Clusters Panel: User now can set clusters of fragment with different fracture parameters in the same fracture body, clusters can be edited at any time and are saved with the scene.

Bounded Force fields can break fracture bodies.

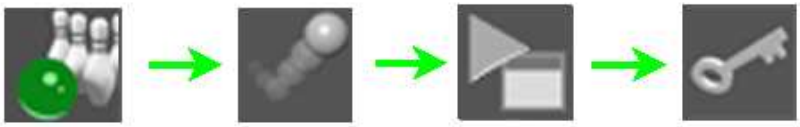
Speed up auto body creation: Creating many rigid bodies at once from complex geometry is much faster now.

Maya viewport 2.0 support in Maya 2015: Vieport 2.0 is supported in Maya 2015, however the performance of the tool is still faster using legacy viewport.

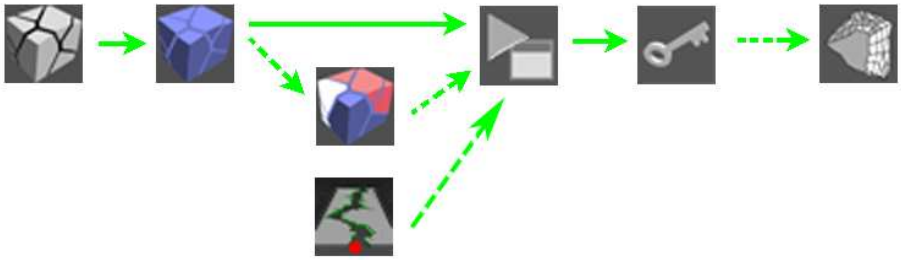
New Force convex shapes for fracture bodies creation, this new option speed up computation of fracture for hi-poly models.

Pulldownit Workflow

General workflow for rigid bodies simulations:



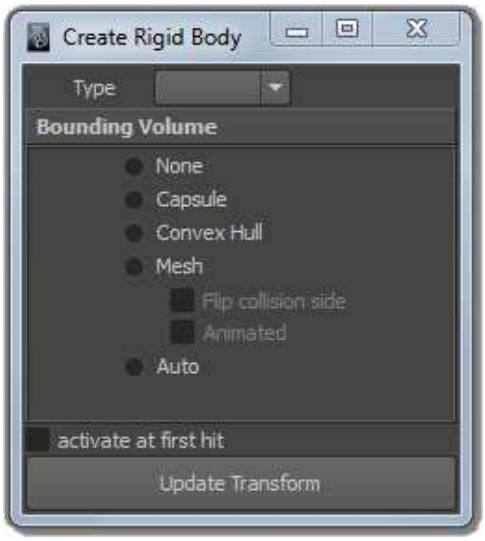
General workflow for fracture simulations



Pulldownit UI

Create Rigid Body Window

In this window users are able to set the collision shapes and type of the objects as single rigid bodies. It is disabled for objects that belong to a fracture body(fragments).



Type

Set the type of the rigid body in dynamics.

Dynamic: Object collides with other objects, object motion is computed by the dynamics solver,.

Static: Object collides with other objects but It doesn't move; you can build in this way grounds and barriers.

Kinematic: Object collides with other objects; object motion is driven by animation keys.

Tip: Auto Bounding Volume is assigned to bodies in creation; you can change it later if needed**.**

Bounding Volume Frame

In order to detect contact between geometric objects an auxiliary wrapping entity must be generated, the geometry of this object will determine the quality of the contact detection, the dynamics behaviour of the original object and the speed of computation. In Pdi! you have five possible choices.

None

The object has no bounding volume; you still can assign dynamics properties to it although it will pass trough other objects as a ghost.

Capsule

The object is wrapped by a capsule, this is the fastest volume to compute, any object with this volume will tend to roll easily so It is the right choice for sphere-like or cylinder-like objects

Convex Hull

This is the best volume regarding speed-quality; it wraps the object as a very tight plastic bag. By assigning it to a non-convex object it will detect collision outside its own mesh.

Mesh

This volume uses the own mesh of the original object for detecting collision, it is the right choice for objects with holes or shell models, however it it slow to compute and less stable than Convex hull. Mesh volume counts with two sub-options.

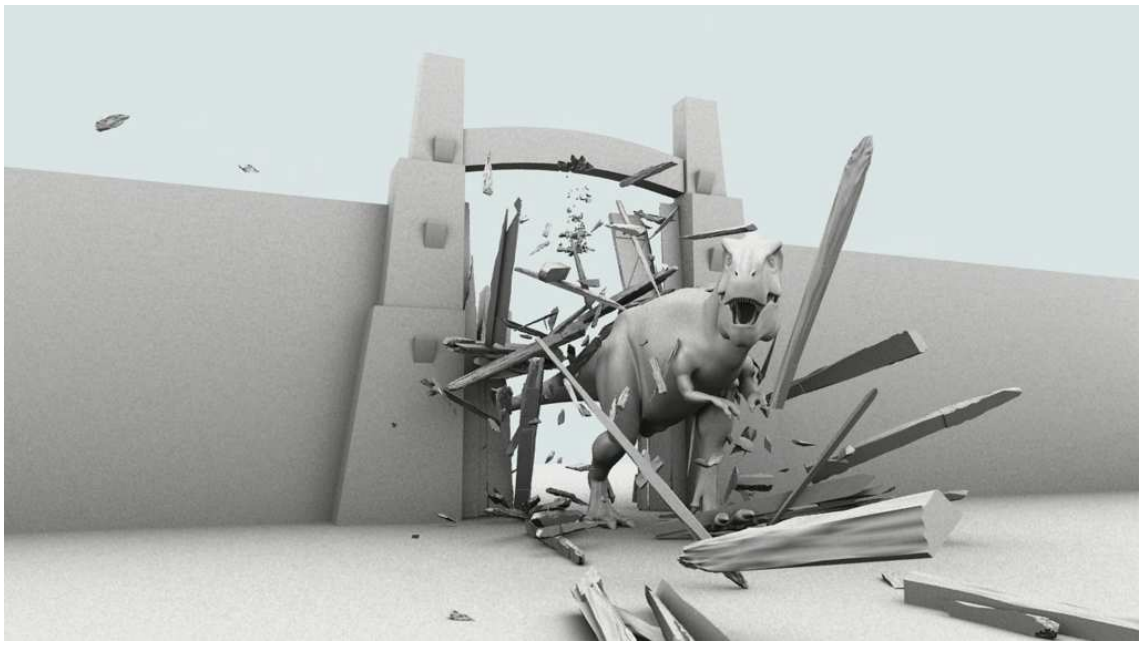
Flip Collision Side(Mesh)

When using the mesh volume you can select inside/outside collision but no both. Collision in both sides is numerically unstable.

Tip: Build your model double side if you want it colliding inside and outside.

Animated(Mesh)

By checking it, Pdi! will consider the deformation of the original mesh in contact queries, this option slow down the computation dramatically. It must be set only when the original mesh is animated.

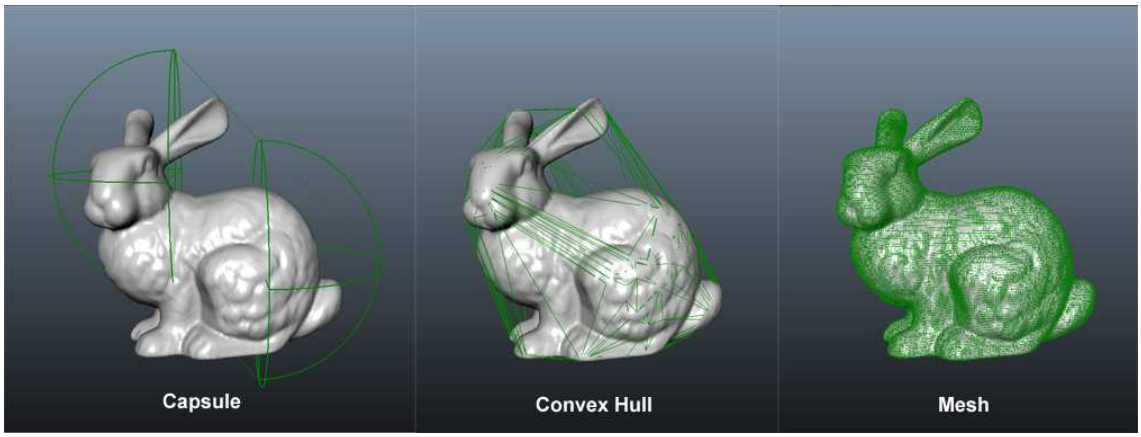


Breaking a wood wall with an animated character using Mesh->animated.

Auto

This option will select automatically the best suited bounding volume for the given geometry. It is the best choice by default.

Tip: *Auto* bounding volume is especially useful when selecting many different objects together



Activate at first hit

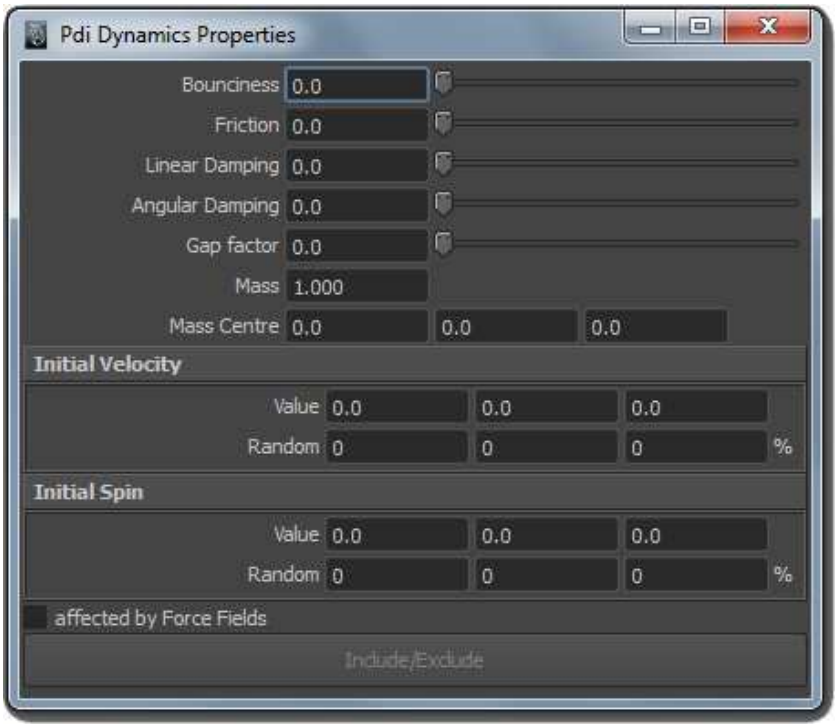
This parameter freezes the object until another dynamic or kinematic object hits it, this is a performance parameter for speeding up computations and especially useful when you want the object starting still in the scene with gravity or other forces not affecting it until first impact.

Update transform

This button updates the world transform of the selected object and recomputes its collision shape. You should use it when translating/rotating/scaling or modifying the mesh of an object already in dynamics.

Dynamics Properties Window

This window includes all the dynamics properties of the objects as single rigid bodies. It is disabled for objects that belong to a fracture body(fragments)



Tip: You cannot modify dynamics properties for a fragment belonging to a fracture body, detach it or delete the fracture body for getting access to rigid body properties.

Bounciness

This is the bounce coefficient in collision or contact, it goes from 0 to 1, usually it must be set less than 1.0 to assure dissipation of energy. The final coefficient applied is the minimum of both materials in contact.

Friction

This is the friction coefficient in collision or contact, it goes from 0 to 1, the final coefficient applied is the maximum of both materials in contact, therefore to make and object slide over other without friction you must set both of them friction 0.0.

Approximate coefficients of friction for common materials (source: Wikipedia)

Material1	Material2	Friction coeff
Aluminum	Steel	0.61
Copper	Steel	0.53
Brass	Steel	0.51
Cast iron	Copper	1.00
Cast iron	Zinc	0.85
Concrete (wet)	Rubber	0.30
Concrete (dry)	Rubber	1.00
Concrete	Wood	0.62
Copper	Glass	0.68
Glass	Glass	0.98
Metal	Wood	0.2-0.6
Polythene	Steel	0.2
Steel	Steel	0.8
Steel	Teflon	0.04
Teflon	Teflon	0.04
Wood	Wood	0.25-0.5

Linear Damping

This value will damp the translational motion of the object; usually it must be set to a little value.

Angular Damping

This value will damp the rotational motion of the object; usually it must be set to a little value.

Gap factor

this value ranges from 0.0 to 1.0, the solver forces non interpenetration of the object regarding the selected threshold. This parameter is able to remove almost any interpenetration issue; however it must be used in a per object basis with caution because its effect can increase instability of the simulation, as higher is its value as more possible instabilities could happens.

Mass

This is the mass of the object as a rigid body, Pdi! computes by default the uniformly distributed mass of the object when assigning it a bounding volume, you can modify it later; to reset to the default mass just click on Update Transform button. Objects which are less massives are pushed by object more massives in collision. You can increase this value to increase object strength (momentum) in collision without modifying its velocity.

Tip: click on Update Transform button to recover default computed mass.

Centre Mass

Pdi computes by default the mass centre of the object, you can modify it later, the rotational motion of the object is always around the mass centre.

Initial Velocity

This is the initial linear velocity of the object, random param add some noise in the initial velocities when a group of objects is being set.

Initial Spin

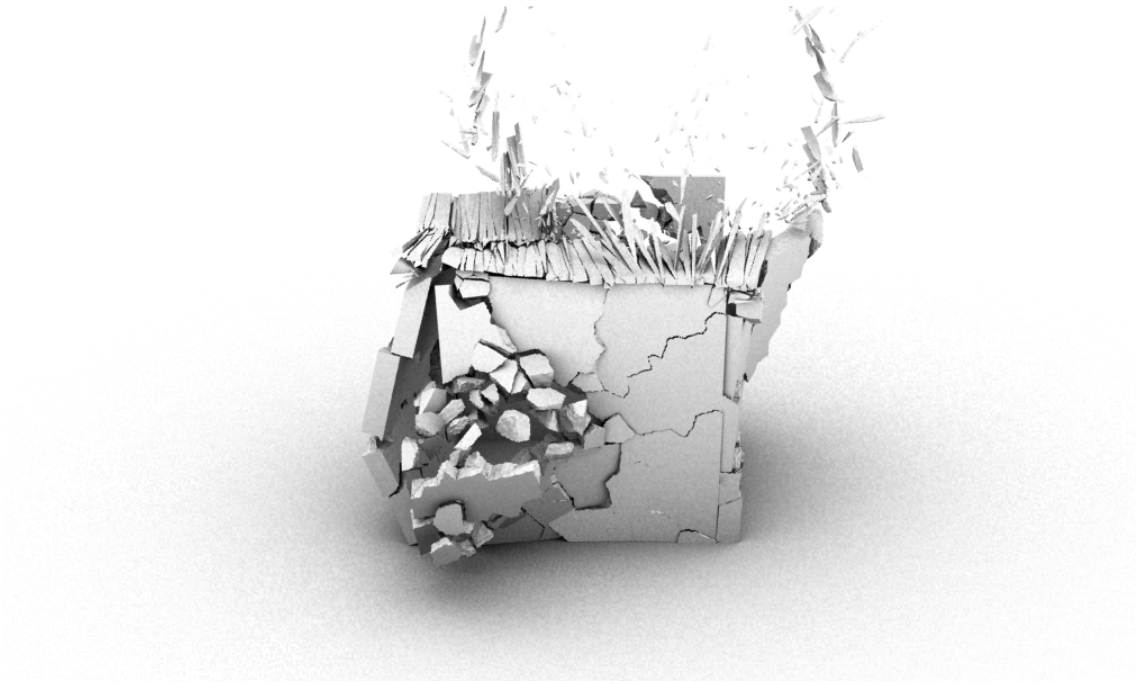
This is the initial rotational velocity of the object, random param add some noise in the initial spin when a group of objects is being set.

Affected by Force Fields

When checked, the object will be affected by any of the Maya force fields present in the scene; the magnitude of the effect is dependent in the mass of the body.

Include/Exlude

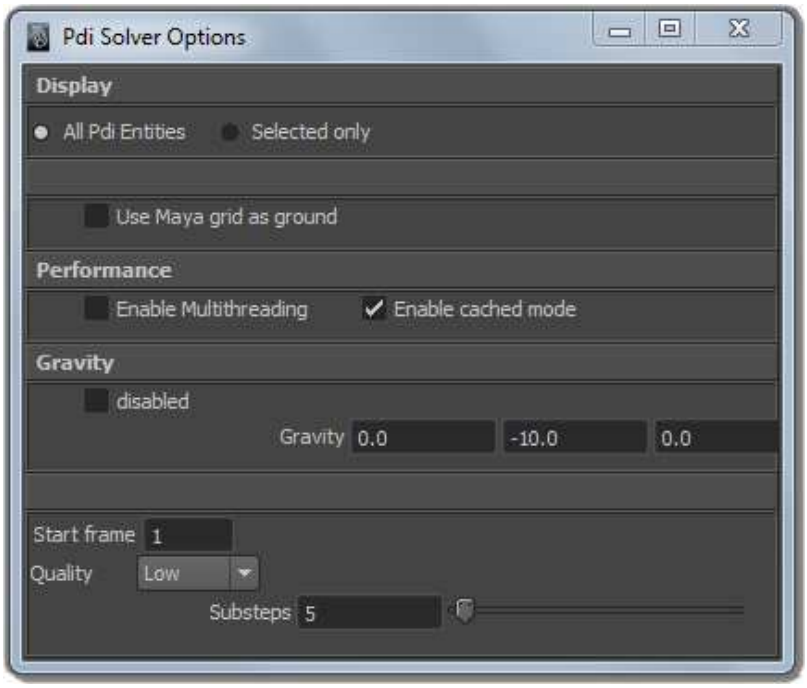
This button open a window in which you can select which of the force fields present in the scene will affect the dynamics of the selected objects.



Applying force fields to make the house explode.

Pdi Solver Options Window

In this window users are able to set the global parameters for the Pdi scene in both dynamics and performance.



Display Options

All Pdi Entities: Display all Pdi wrapper objects in scene.

Selected only: Display currently selected Pdi wrapper object only.

Use Maya grid as ground

Enablle/disable the maya grid as a static collider.

Performance Options

Enable Multithreading

When checked, all available CPU cores are used in simulation, multithreading computing is faster in massive scenes(1000 objects in scene or more).

> **Important Tip:** Multithreading computing is not repeteable, that means you will get different dynamics outcomes after resetting, because of this it is disabled by default.

Enable Cache mode

When enabled, Pdi solver saves the dynamics data in a memory cache, after finishing the simulation, that is, when reaching the end of the time range, the cache mode becomes active and users can play the simulation back and forward for checking it before baking keys, in addition the baking process is much faster when the cache mode is active.

Important Tip: If you are planning to tweak parameters when looping the simulation, you should disable cache mode to get the new parameters value working. Also the cached mode works only partially when force fields are present, you can still go back and forward but when reaching the start of the time slider, it is cleared.

Gravity Frame

Gravity is enabled by default, its value is set regarding the system units; users can disable it, make its effect stronger or weaker, and modify the direction of this global force.

Disable (Gravity)

By checking this option, objects in simulation will behave as they were in the space outside.

X,Y,Z (Gravity)

This is the direction of the gravity force, it is set by default towards the ground.

Start Frame

Set the global start frame for dynamics

Quality

This parameter is binded to substep, it counts with four levels.

Preview: Very fast computation speed and low collisions quality.

Low: Fast computation speed and acceptable collisions quality in most cases.

Medium: Acceptable computation speed and high collisions quality.

High: Slow computation speed and very high collisions quality.

Tip: Set Preview quality for tweaking fast force fields effects, set Medium or High quality when there are animated meshes in scene.

Substep

This parameter sets the number of computed cycles per simulated frame, increasing it will improve the quality of the simulation but also slow down the computing speed. The default value is only five cycles per frame as the Pdi! solver is very stable; users should increase it when artefacts like excessive interpenetration appears or there are high speed objects present in the scene.

Manage Pdi World Window

In this pop up window users are able to add or remove rigid bodies from the simulation, also delete all PDI entities to clean the scene or start again from scratch if needed.

Add

Add the selected bodies in the viewport to the simulation, the objects are automatically added when created the *bounding volume* in the *Properties Window*. You can add them again it they have been previously removed.

Remove

Remove selected rigid bodies from the simulation, useful to disable temporally a Pdi body without destroying it.

Remove All

By clicking it all the rigid bodies in simulation will be disabled but not destroyed, it is useful to disable temporally all rigid bodies.

Delete All Pdi Bodies

This action will destroy all the Pdi bodies and fracture bodies in the simulation world, to start from scratch. It can be useful after the simulation keys have been baked for freeing resources.

Delete All Pdi Entities

This action will clear any dependence with Pulldownit plugin in the scene, after that features like Pdi jagginess cannot be applied anymore, recommended use ti only after baking keys to save a new Maya standard scene.

Tip: When this window is open, It is continuously processing messages form the viewport in the background and this can be time consuming for big scenes so it is recommended to use it just to add or remove objects to the solver, then close.

Select Non-solid Objects

This tool select non-solid objects of the current Pdi scene, this helps to find problems in geometry, like flipped -normals or open edges. You have to create rigid bodies on scene before using this tool.

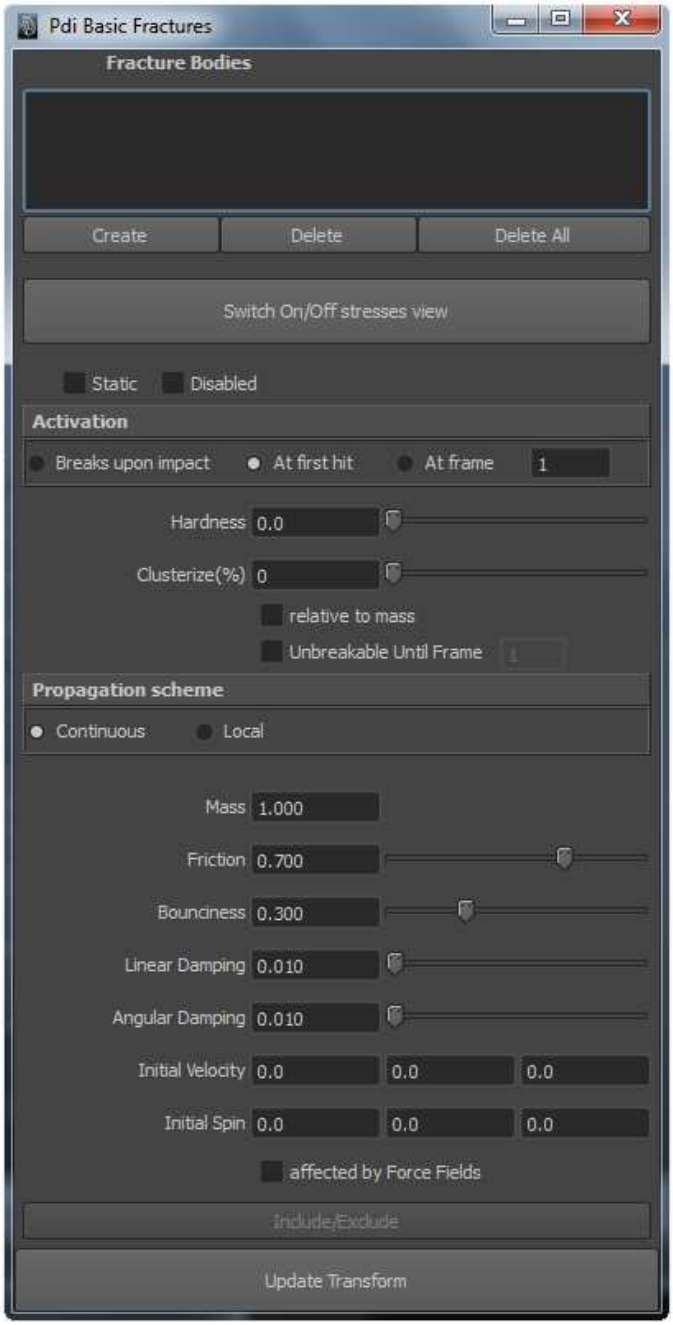
Tip: After shattering an object, some non-solid fragments could have been created, remove or fix them using **Select Non-solid Objects** before going in Dynamics to prevent from unstabilities**.**

Transferring scenes to systems without Pulldownit plugin installed:

If you want to transfer a pdi scene with baked keys to a system without Pdi installed, click on **Delete All Pdi Bodies** and after that on **Delete All Pdi Entities** to remove any dependence with the plugin.

Basic Fractures Window

In this window user can create Fracture Bodies selecting geometry in scene; also set the global parameters of the fracture bodies.



Create

It opens the *Set up fracture body window* for the current selection of objects in viewport.

Delete

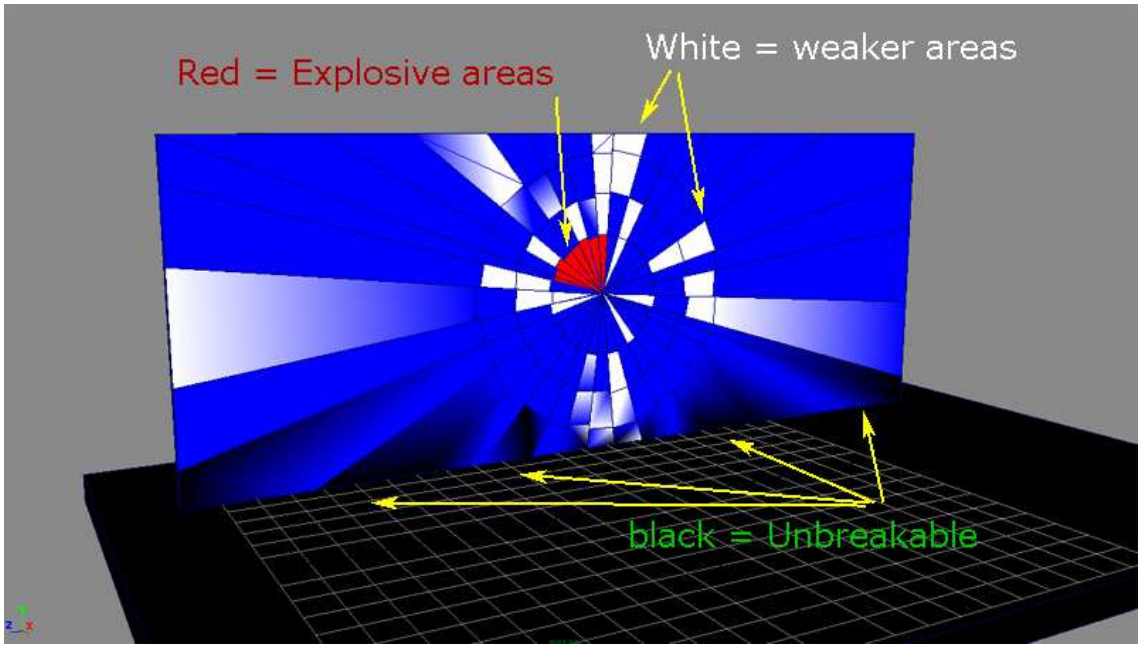
Delete the selected fracture body from the Pdi world, the fragments remain as single rigid bodies in dynamics.

Delete All

Delete all the fracture bodies from the Pdi world, the fragments remain as single rigid bodies in dynamics.

Switch On/Off Stresses view

Turn On/Off the stresses colour map. When the colour map is enabled, you can visually check the distribution of hardness in your fracture group, lighter intensity means weaker stresses so the fracture body is more probably breaking in these areas. You can modify the stresses distribution with the *Clusterize* parameter or using advanced fractures.



Activation Frame

In this frame you set the way static fracture bodies activate.

Breaks upon impact

Fracture bodies breaks upon impact with other objects but doesn't move as a whole

Activate at first hit

This parameter freezes the Fractutre body until another dynamic or kinematic object hits it, this can be a performance parameter for speeding up computations and especially useful when you want the object starting still in the scene with gravity or other forces not affecting it until first impact.

Activate at frame

Fractutre body behaves as **Static** until the selected frame

Tip: Set Static if the Fracture body start to break before first impact with dynamics objects.

Disabled

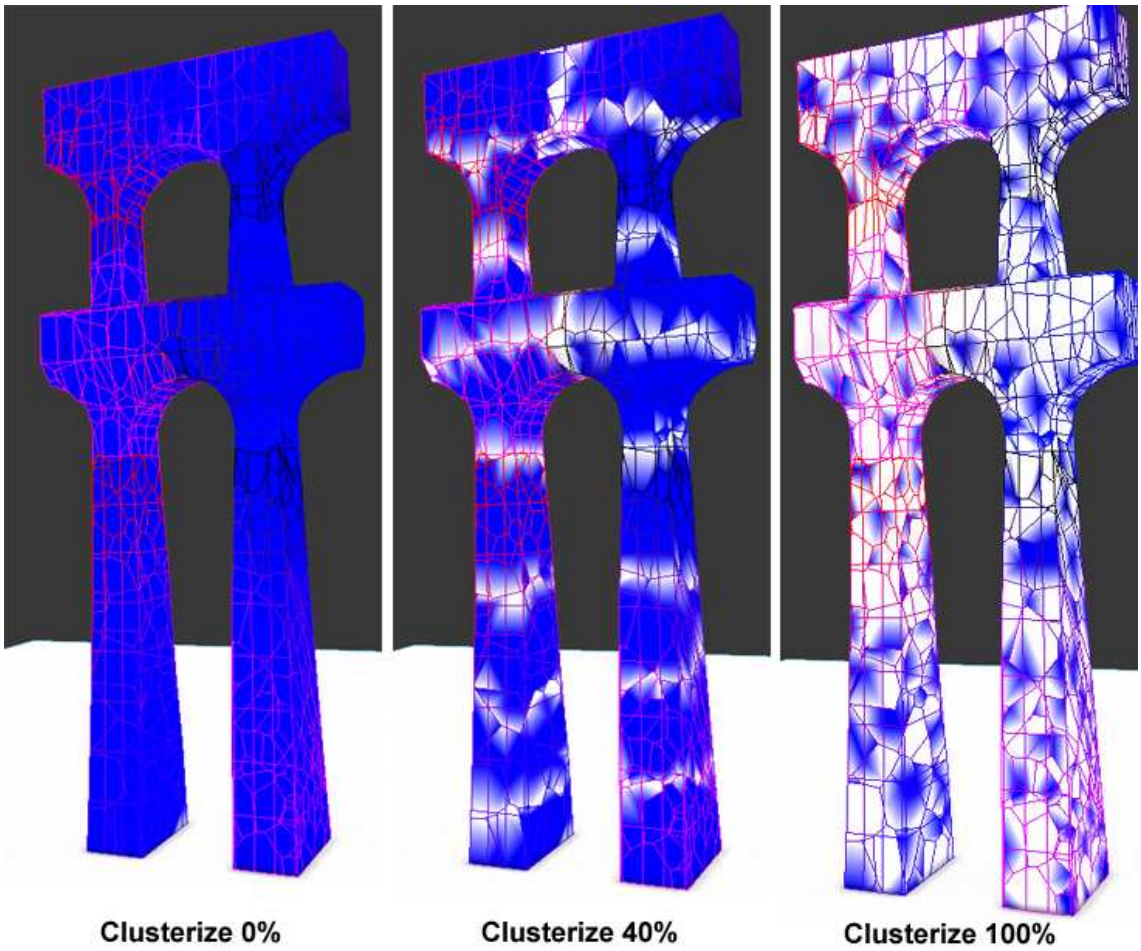
Fracture bodies are enabled by default; you can disable any of them temporally. This is useful to fix any issue in the scene regarding other entities, as the computation time will be faster while the fracture bodies are disabled.

Hardness

This set the brittleness of the Fracture Body as a whole. By setting a high value it becomes unbreakable.

Clusterize

This parameter creates clusters of fragments with hardness among them defined by the above parameter and a weaker strength with the rest; it allows breaking the object in shards of average similar size, a low value will generate bigger shards, a high value little ones, setingt it to 0 you get no clusters at all.



Relative to Mass

When checked, stresses break threshold will be averaged with the fragments mass, so little clusters of shards will break easier than big ones; this option is set by default.

Propagation Scheme Frame

In this frame user sets how the fracture propagation works.

Continuous

This is the default, when checked the fracture bodies are consider as a continuous material, the crack waves originated at a collision point traverse the whole object and can create new cracks.

Local

When checked the fracture bodies are consider as a discontinuous material, the crack waves originated at a collision point affect the object only locally.

Mass

This is the mass of the fracture body as a whole. Objects which are less massive are pushed by objects more massive in collision. You can increase this value to make a fracture body stronger in collision without modifying its hardness.

Friction

This is the friction coefficient in collision or contact, it goes from 0 to 1, to make and object slide over other without friction you must set both of them friction 0.0.

Bounciness

This is the bounce coefficient in collision or contact, it goes from 0 to 1, usually it must be set less than 1.0 to assure dissipation of energy.

Initial Velocity

This is the initial linear velocity of the fracture body as a whole.

Initial Spin

This is the initial rotational velocity of the fracture body as a whole.

Affect force fields

When checked, the fracture body will be affected by any of the Maya force fields intended for rigid bodies present in the scene; the magnitude of the effect depends in the mass of the fracture body. Force fields affect the motion of fracture bodies but actually cannot break them.

Include/Exlude

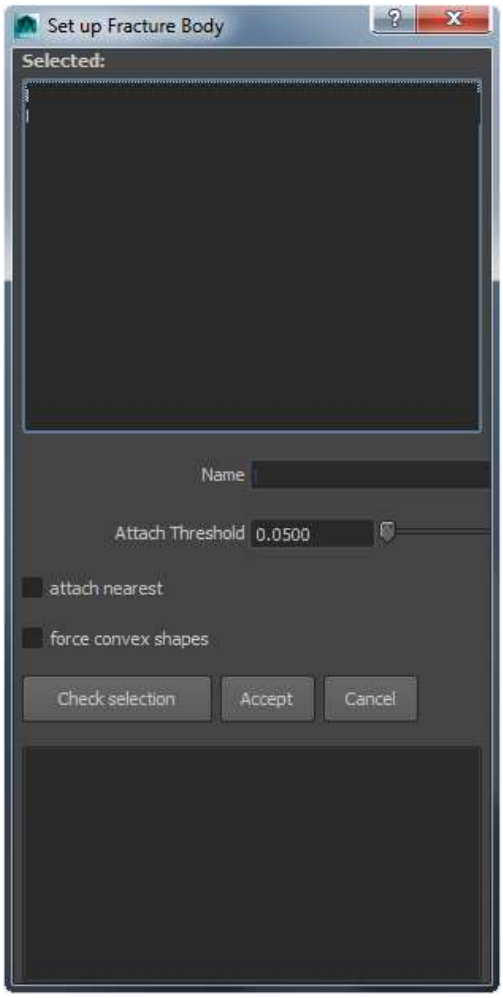
This button open a window in which you can select which of the force fields present in the scene will affect the dynamics of the selected fracture body.

Update Transform

Click on this button after manually translating or rotating the fracture body to update its world transform.

Set Up fracture body Window

In this pop-up window, you can check the actual selection for fracture bodies, set the name of the fracture object, and select the distance threshold for attaching the fragments together.



Selected (List)

This list shows the actual selection for fracture, if you are not agreeing with the selection you can cancel the operation.

Name

Set the name of the fracture body.

Attach Threshold

This is a performance and security parameter; it defines the distance threshold for the objects to become attached. Usually it must be set to a low value so if you has selected a scene object not in the fracture group by mistake, it will be discarded.

Attach Nearest

By setting this parameter, all objects selected will be included in the fracture body, regardless of the attach threshold. This is useful for complex structures where it is difficult to define a correct threshold and for attaching objects which are far away from each other.

Force Convex Shapes

By setting this parameter, all selected objects will have a convex collision shape in dynamics regardless its visual shape, this option speed up fracture for hi-poly meshes.

Check Selection

This button will trigger a checking of the objects selected, the couples of objects duplicated or too much interpenetrated will be showed in the frame below, this is a fast test that actually only works properly with rectangular-like object.

> **Tip:** Attach function will fail if all the selected objects are static, at least one object must be active in your selected group.

Advanced Fractures Window

This window allows users to have more control in the way objects fracture, you can define the location and start frame of the cracks as long as the break threshold of selected areas in the object, also modify the fracture body by detaching parts of it.

Name

Modify the name of the fracture body selected.

> **Tip:** When opening this panel it displays the name of the current selected fracture body, if no name is displayed, either you haven't created any fracture body yet or you have to select it by clicking in the fracture bodies list.

Secondary Cracks Frame

When enabled, clusters of fragments of overall volume bigger than the threshold will break upon collision with static objects, it is enabled by default.

Fragments Frame

This frame will show the actual selection of fragments, it is updated automatically by changing the selection in the viewports.

Set Static

Set the actual selection of fragments as static, so they don't move anymore. Static fragments appear as black colour in stresses view.

Set Dynamic

Set the actual selection of fragments as dynamic so they can break and move.

Detach

Detach the actual selection from the fracture body, and create another fracture body with it.

Create Cluster

Create a cluster for the current selection of fragments

Clusters Frame

In this frame you can set fracture parameters for clusters independently of those of the fracture body, in this way you can create areas with different hardness.

Delete

Delete the cluster highlighted on the list

Delete All

Delete all the clusters on the list.

> **Tip:** Delete all clusters works like a reset, it is useful to come back to the default parameters for the whole fracture body without having to create it again.

Name Field

Set the name of the current cluster

Hardness

This set the brittleness of the highlighted cluster regardless of the same value of the fracture body. When the *stresses view* is enabled the *clusters* are displayed in the range from white(weakest) to black(strongest) intensity.

Unbreakable Until Frame

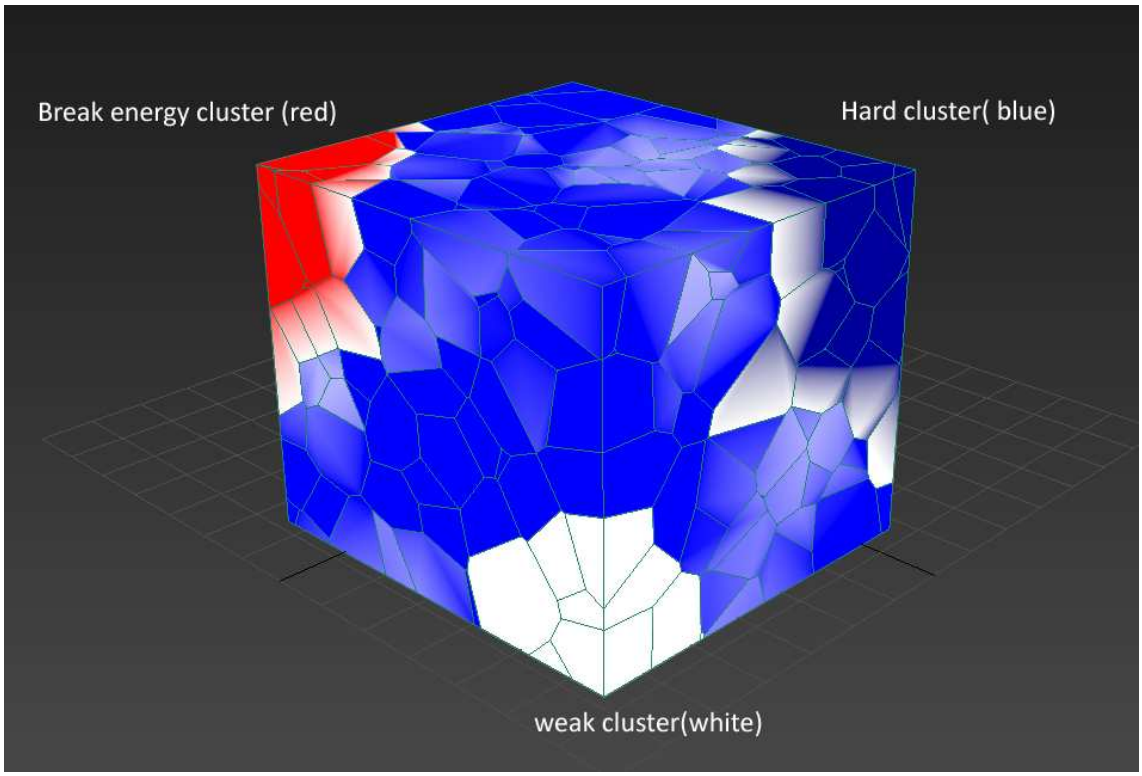
By enabling this checkbox, you set to break apart the cluster at a specific frame. When the *stresses view* is enabled, the *breakable by frame clusters* are displayed in white intensity.

Break Frame

Set the frame at which the cluster will start to break regarding it hardness.

Break Energy

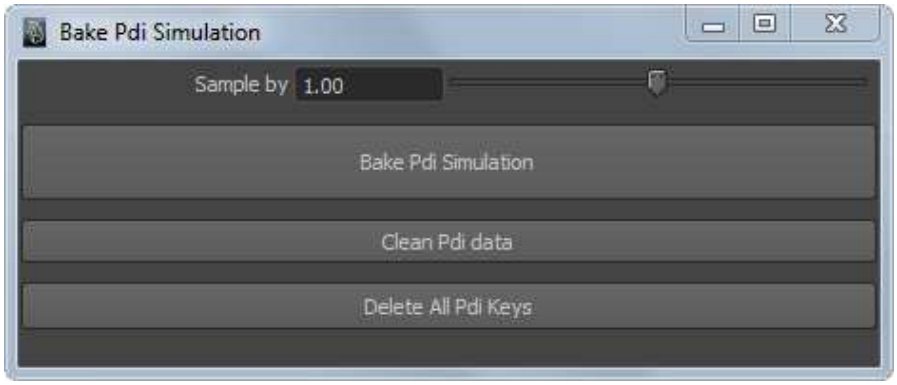
You can add extra energy when a cluster is broken to get and explode-like behaviour on fracturing. Adding this value to a cluster allows to start breaking it without having to hit it with a dynamic object. When the *stresses view* is enabled, the clusters with break energy are displayed in red intensity.



Some clusters created over a fracture body.

Bake Simulation Window

In this window users can bake dynamics to animation keys; also some utilities regarding system resources are present.



Sample by

Set the sample rate for keys, default 1.0

Bake Pdi Simulation

By hitting this button, the keys for the actual simulation start baking, you can cancel the process by pressing ESC.

Clean Pdi data

This button will open “Manage Pdi World” Window; after baking keys, if you are agree with the result, you should click this button to ”Delete All Pdi bodies”, in this way you release Pdi resources, getting a less heavy scene.

Tip: Save the scene with a diferent name after bake Pdi keys and clean Pdi data to not override the original one..

Delete All Pdi! Keys

This action will destroy all the Pdi keys, useful to make changes and start baking again.

Exporting PDi scenes to Alembic:

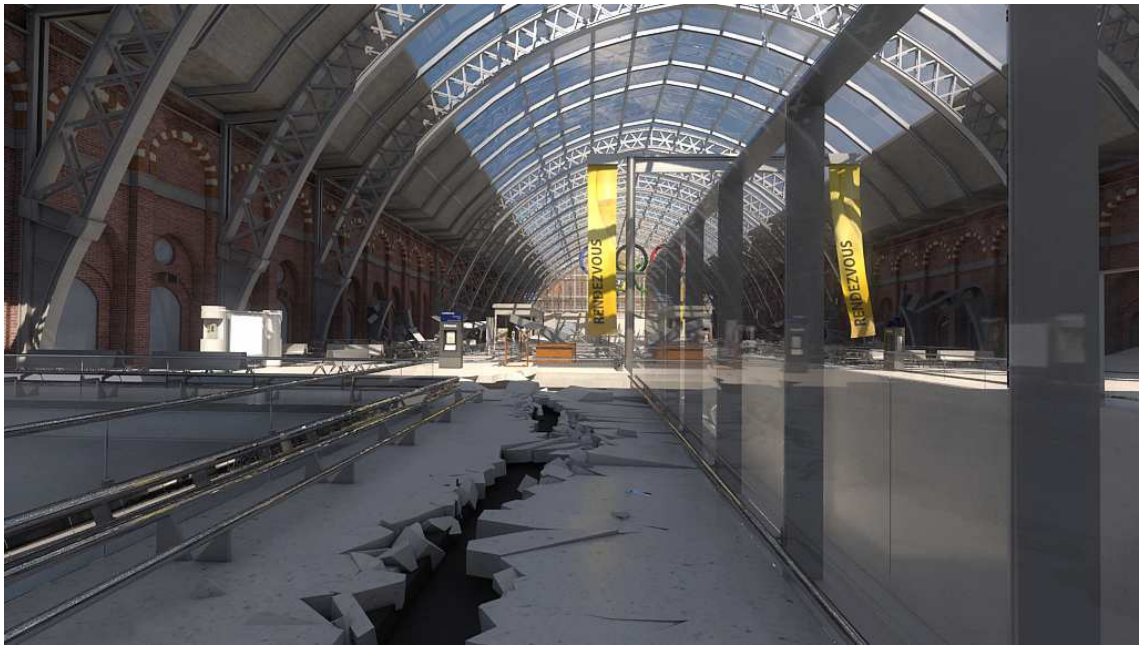
Bake Pdi simulation, to get standard keys for the animation

Manage Pdi world->Delete all pdi bodies follow by **Delete all Pdi Entities**, to clean the scene of Pdi data

Now you can export the scene to Alembic,

Pipeline Cache->Alembic Cache->Export all to Alembic

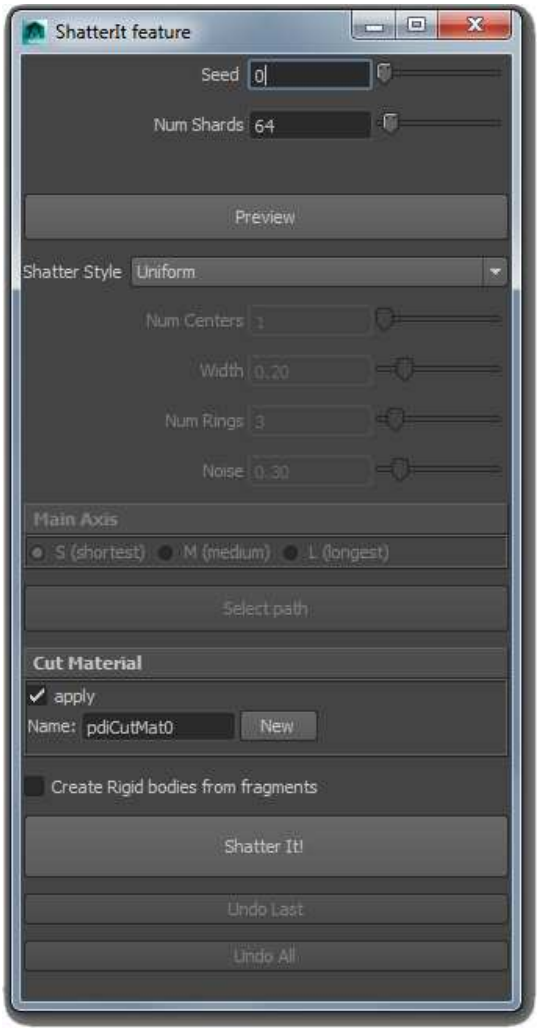
Recommended to set the write visibility option to hide the original not fractured objects



After baking animation keys the scene is ready for render.

Shatter it! Window

Shatter It! is the pre-cutting tool of Pulldownit, in this window users can define the shatter pattern, number of fragments and other options. You can shatter any polygonal mesh, convex, concave or with holes. Although Shatter It can be used independently of the rest of the plug-in, its mayor advantages comes when computing dynamics for the prefractured object with the Pulldownit solver.



Seed

This parameter set the seed for shatter pattern, default 0 value get different shatter patterns in each shatter operation over the same objects, setting it to a different value you get the the same pattern in all shatter operations with same parameters over the same objects.

Num Shards

This parameter defines the desired number of fragments of the shattered model for the current selection of objects, the maximum number allowed is 4096 fragments for one operation, but if you want more of them just reshatter the object. The number of fragments is approximate, for non convex objects, it can generate a few less fragments than expected

Tip: When several objects are selected together each of them is going to be shattered independently For shattering a selection of objects in a uniform way, you have to combine all of them as a single object.

Preview

Allows user to visualize shatter points in advance, all shatter params can be visualized in preview mode.

Shatter Style

Users can choose between ***Uniform*, *Local, Radial, Wood Splinters and Path Based*** cutting styles, you can combine all of them at your pleasure by continue cutting the generated shards until achieving the desired look.

Uniform: Classic Voronoi pattern, fragments generated are overall same size.

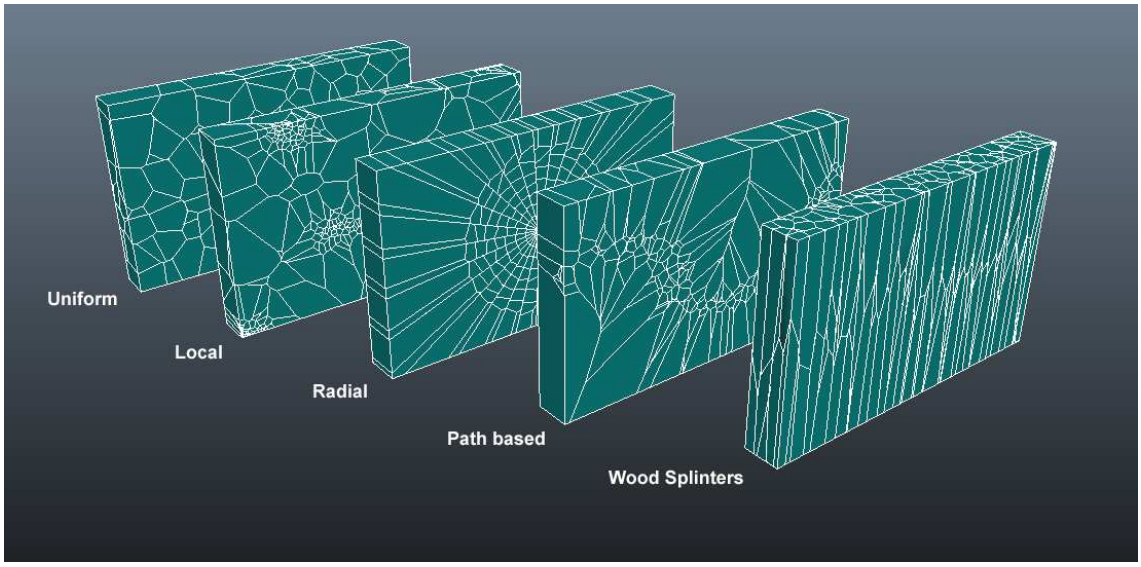
Tip: When preview mode enabled Uniform pattern can be offsetted and squeezed

Local: This pattern get clusters of little fragments over surface and corners areas, this is the best pattern for stucco and concrete materials.

Radial: Suited for breaking glass-like effects.

Wood Splinters: Generated large thin fragments, you can get high realistic wood splinters adding jagginess as a post-process.

Path-Based: this style allows for the creation of long dynamics cracks



Tip: Uniform, Radial and Local patterns extend by default to selected fragments region when reshattering

Num Centers

Intended for Local style; Set the number of local centers to generate the clusters of fragments, centers are generated at random.

Width

Intended for Local, Wood-Splinters and Path-based styles, it set the overall spread of the clusters of fragments

Number of rings

This parameter is intended for *Radial* cutting style, it sets the number of circle rings of the shatter pattern.

Noise

This parameter is intended for *Radial* cutting style, it adds some noise to the shatter pattern. Set it to 0.0 for a perfect circle pattern.

Axis frame

In this frame you choose the cutting axis for radial style and Wood Splinters, the default is S (shortest) suited for breaking glass-like effects, selecting L (longest) generates large thin fragments suited for wood-like planks.

Select path

This button turn active when choosing the *path based* style in order to select the spline defining the breaking path.

Create Pdi Objects from fragments

When checked, the fragments generated by shatter it! are automatically included in the solver as rigid bodies, nevertheless in most of cases creating a fracture body from them is recommended.

Cut Material Frame

In this frame you can assign a new material to the faces created when shattering the object, The deafault name of this shader is “pdiCutMat”, you can create different cut materials by pressing make new or simply typing a new name.

Shatter it!

This button triggers the shattering process.

Undo

Undo the last shatter operation, same as Press Ctrl+Z once..

Breaking a wall with a combination of uniform and local shatter and jagginess.

PDI Crackers Window

In this window you can setup cracker objects intended for creating long dynamics cracks over surfaces, you count with several parameters to adjust the cracks behaviour.

Select Cracker Path

Click on this button to select the path of the cracker highlighted on the list

Delete

Delete the cracker highlighted on the list

Delete All

Delete all crackers on the list

Disabled

Enable/Disable the cracker highlighted on the list

Size

Modify the size of the cracker highlighted on the list

Tip: modifying the size of the cracker object to set the distance at which it can push fragments

Create: Name field

Modify the name of the cracker object

Create: Assign Path

Assign a curve for the cracker object

Create: New Cracker

Create a new cracker object

Impulse direction: Align to path

Cracker push fragments in the path direction, this is the default

Impulse direction: Align to surface

Cracker push fragments in the surface direction regarding the camera

Impulse direction: Custom

Cracker push fragments in the direction specified by user(x,y,z)

Multiplier

Modify the strength of the pushing by cracker

Randomize

Randomize the effect of the Multiplier

Tip: increase randomize parameter to get more realistic long cracks

Long crack using path-based style and crackers for dynamics, jagginess deformer applied.

Jagginess Deformer Window

In this window you can add jagginess to fragments to get a less polygonal look and rough faces. You can add jagginess to fragments generated with Shatter it! Tool before or after computing dynamics, to get better simulation performance adding it after baking keys is recommended.

Select Pdi Fragment

Select any fragment on the viewport to add jaggines to it or its shatter group. Only fragments generated with Shatter it! Tool are allowed.

Add Jagginess

Add jaggines to selected group, cut faces are tessellated and deformed and cut edges are twisted.

> **Tip:** You can accelerate Jaggines computation by saving the scene right before applying jaggines, this seems to be because of a defect of Maya but it works!

Remove Jagginess

Remove jaggines from selected group, cut faces becomes planar and cut edges turn again straight..

Affect Frame

In this frame you set the level of affecting fragments,

Single: Jagginess affects only the selected fragment

Sub-Group: Jagginess affects only the shatter group of the selected fragment.This is the default.

Shatter-Group: Jagginess affects the whole pre-fractured object.

Strenght

After adding jaggines to a fragment you can affecgt the strength of the effect by tweaking this parameter.

Resolution

Sets the resolution of the tessellation, can be set only before applying jaggines.

Soften Edges

Soften edges of the jaggy faces to get a smoother look.

Jaggy fragments present twisted edges and rough faces.

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