

# Houdini First Steps

M11 - Dynamics



# Definition

## From Wikipedia

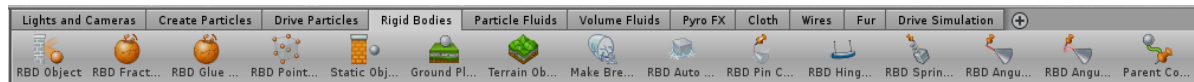
- In physics, rigid body dynamics is the study of the motion of rigid bodies. Unlike particles, which move only in three degrees of freedom (translation in three directions), rigid bodies occupy space and have geometrical properties, such as a center of mass, moments of inertia, etc., that characterize motion in six degrees of freedom (translation in three directions plus rotation in three directions). Rigid bodies are also characterized as being non-deformable, as opposed to deformable bodies.

## From Houdini Documentation

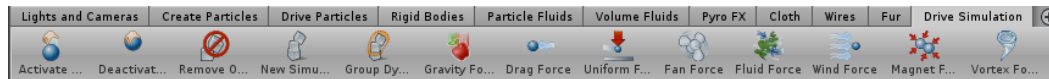
- The RBD solver simulates rigid bodies, solid objects that don't change shape, as they collide with other objects. RBD stands for rigid body dynamics.
- RBD objects can be active and passive. Active objects are affected by forces and collisions. Passive objects can be collided with by active objects, but don't move, and are not affected by forces.

# Shelf Tools

## Rigid Bodies shelf



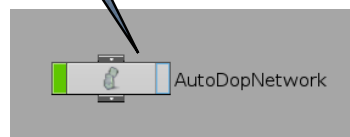
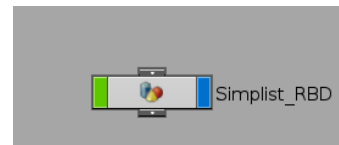
## Drive Simulation shelf



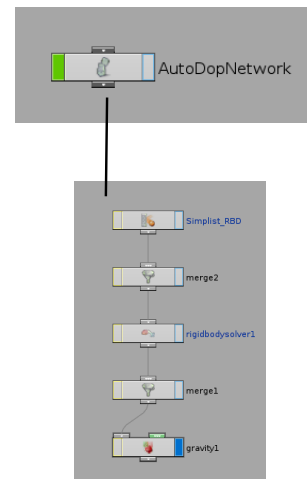
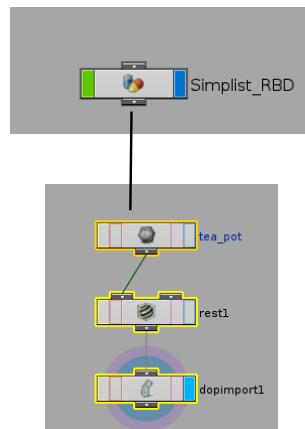
# Simplest RBD

- › Drop down a geometry node
- › Inside the geometry node drop a platonic
- › On the Rigid Bodies shelf click on RBD Object
- › Click on the Platonic and hit Enter/Return key

Notice  
at the obj  
level a new  
node is  
created.



# What Happened

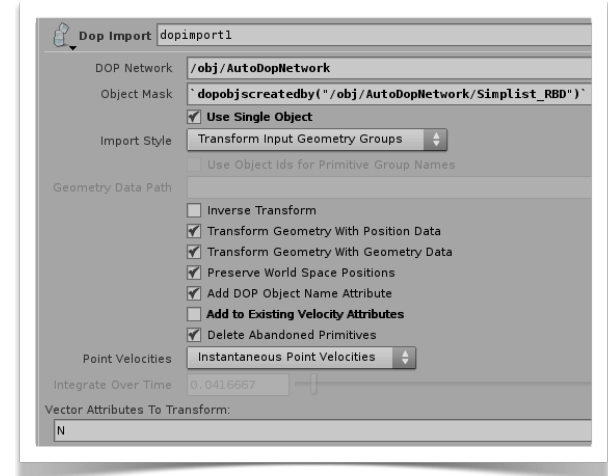
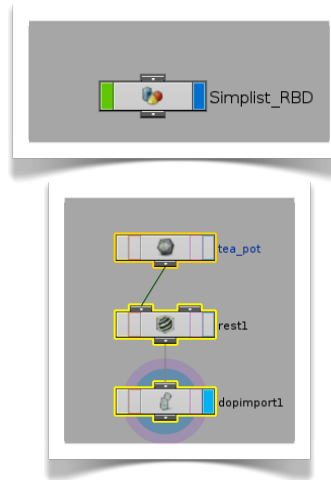


- The Shelf tool created two nodes that got appended to the platonic. Rest, and dopimport

And Created the AutoDopNetwork at the obj level

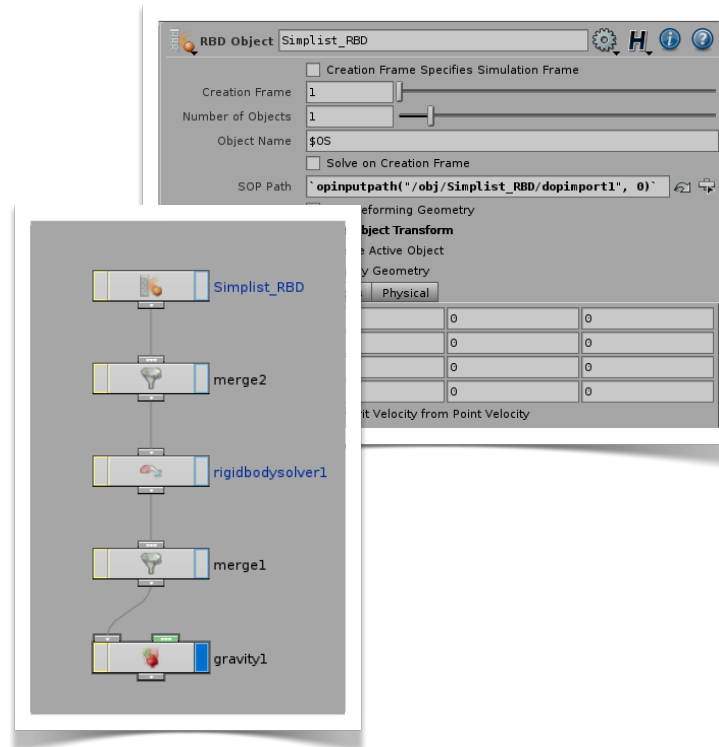
# Rest and DOP Import Nodes

- ▶ **Rest Node** - Make sure materials stick to geometry while being deformed
- ▶ **dopimport** - Think of it as a transform node. After simulation is cooked updates the geometry to current location, rotation

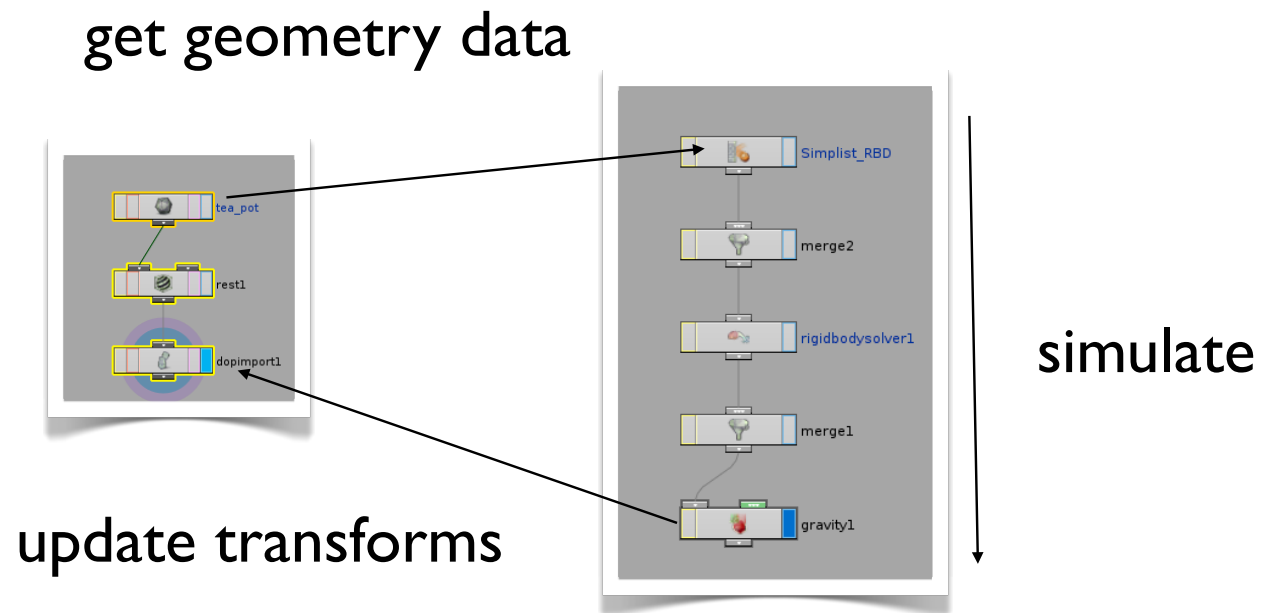


# AutoDOPNetwork

- RBD Object - Imports path of geometry to cook simulation.
- Merge nodes are “hooks” to allow other geometries to be part of simulation
- RBD solver - The simulation engine
- Gravity - external force



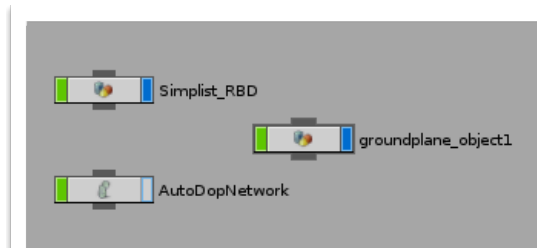
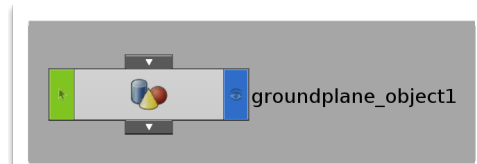
# Simulation Cycle





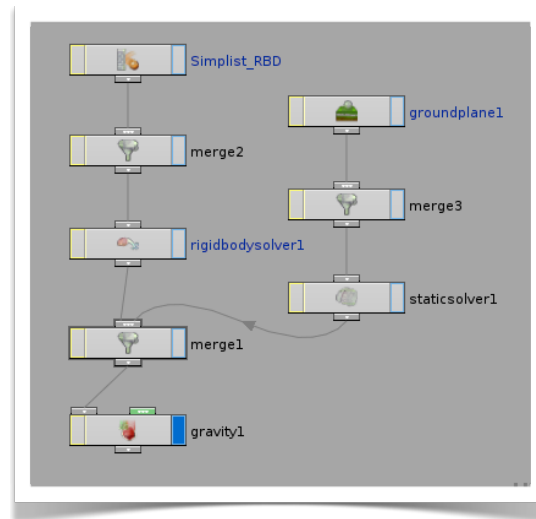
# Simplest Collision

- On the Rigid Bodies Shelf Tool click on Terrain Object
- If we look inside the `groundplane_object1` all it contains is a dopimport but... (next slide)



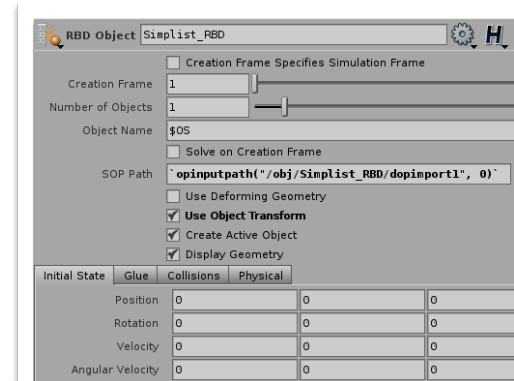
# Simplest Collision

- Inside the AutoDopNetwork three new nodes are added to the second merge
- **Ground Plane** - infinite large plane that has a volume for collision. Contains path to obj level
- **Static Solver** - Nothing gets updated on each time step of geometry attached to static solver. Used as collision info for RBD objects



# RBD - Initial State

- **Position, Rotation** - I prefer to set at obj level.
- **Velocity, Angular velocity.** Initial velocities of sim should be set on the RBD Object





## RBD - Collisions Tab

- ▶ **RBD simulation processes all collisions at the start of the time step rather than at the exact time that the collision occurs. This simplifies complicated interactions, but can result in visual artifacts. A fast moving object may appear to bounce back from a surface before it reaches it, for example, as the impulse from hitting the surface is applied to the objects position at the start of the time step.**

Increasing substepping will reduce these artifacts by ensuring the object is closer to the surface when the collision is detected.

- ▶ **Increase substepping if objects move large distances within a single frame. An object should move less than half of its smallest important feature in a single step to avoid temporal aliasing problems.**

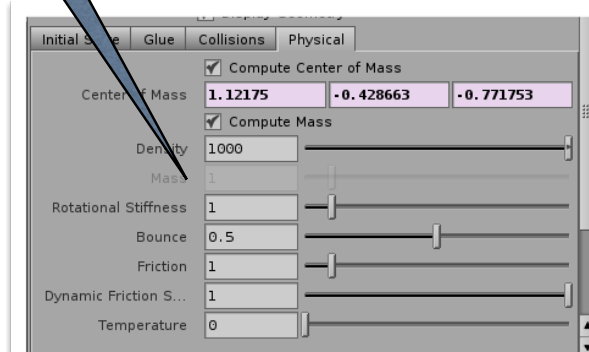
Increase the **Maximum Substeps** to allow the automatic substep calculation to determine the right substepping to avoid temporal aliasing. This is a function of the velocity of your objects and the resolution of the volume representation of those objects. It is then scaled by the CFL condition - a smaller CFL condition will result in more substeps.

Increasing the **Minimum Substeps** can ensure that the substepping never takes fewer than the given number of substeps. This is required if deforming collision geometry is used because the collision geometry is not taken into account in the automatic sub step computation.

# RBD - Physical Tab

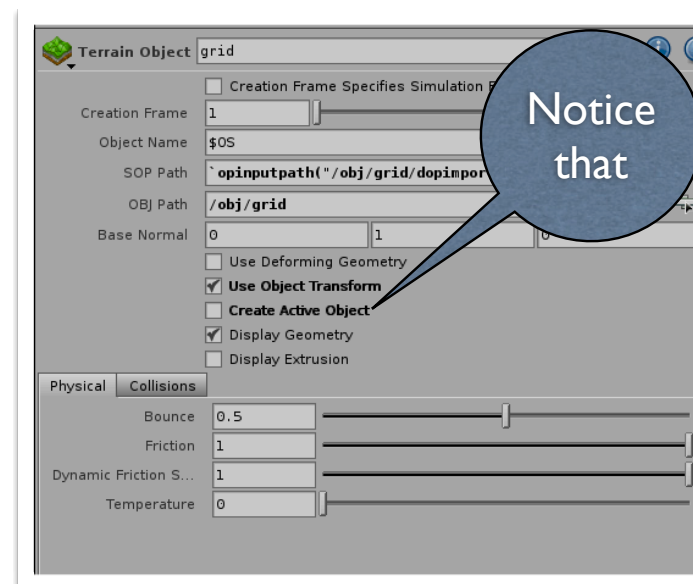
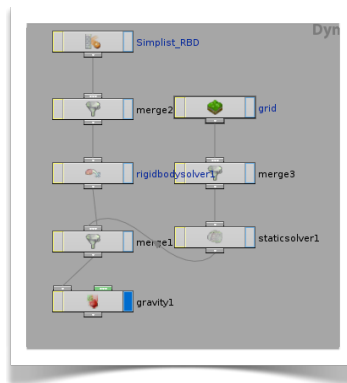
- Automatically compute Center of Mass
- Automatically calculate mass from density. Higher density, higher mass!
- Energy retained when object bounces back
- Friction against motion
- Sliding Friction

Look familiar from



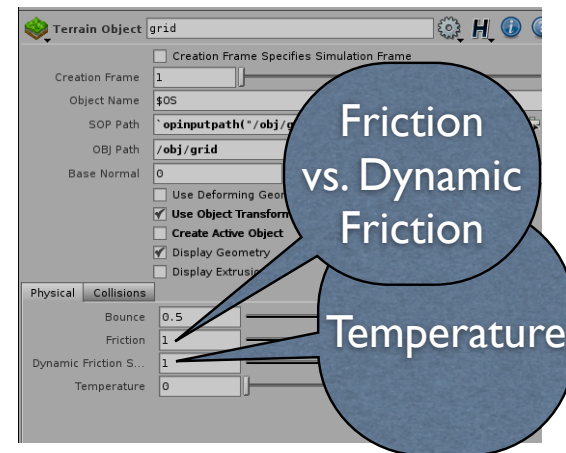
# Terrain Object

- If you do not want an infinite plane (object falling off a cliff) use a terrain object shelf tool



# Friction & Temperature

- Friction is for static friction. If the body is at rest what is its coefficient of friction.
- 0 is frictionless.
- Effects tangential velocity
- Dynamic Friction Scale - If the geometry is in motion what scale does friction have?
- 0 - as soon as friction is overcome, geometry becomes frictionless
- 1 - Geometry friction remains same as friction
- Temperature - Used for Gas Solvers





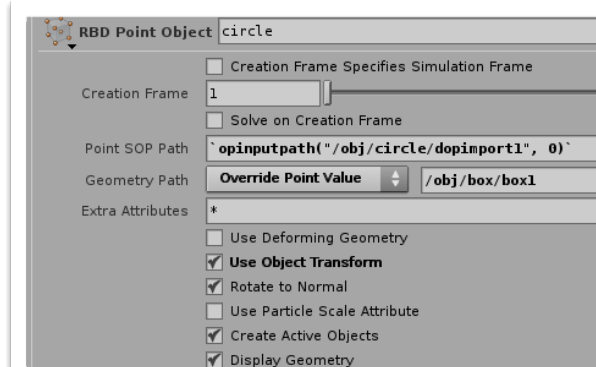
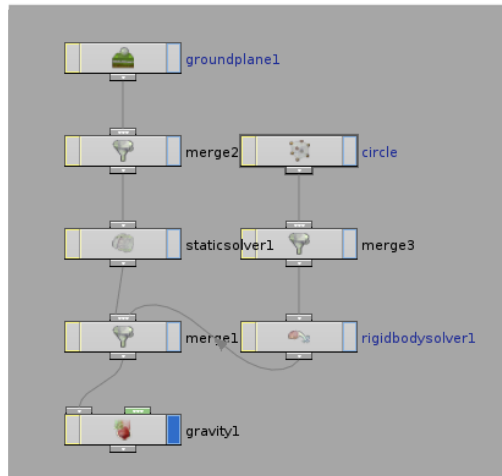


# RBD Point Objects

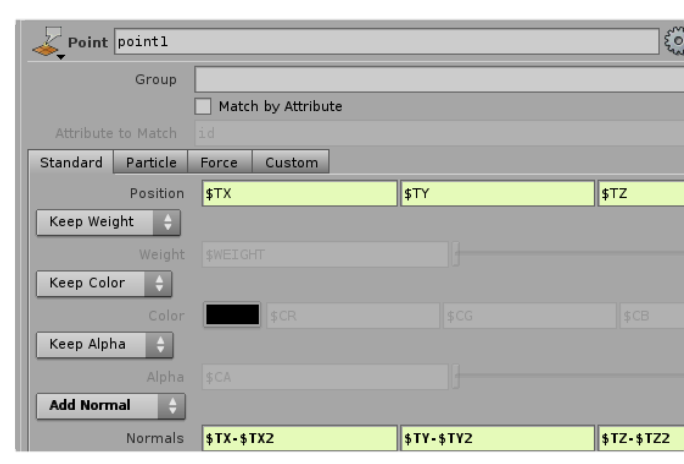
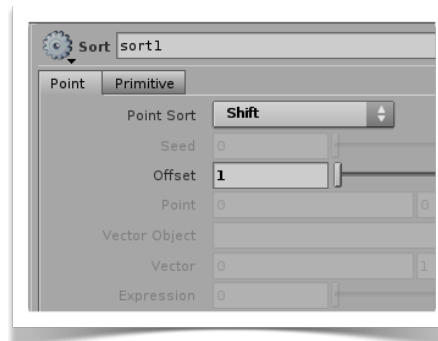
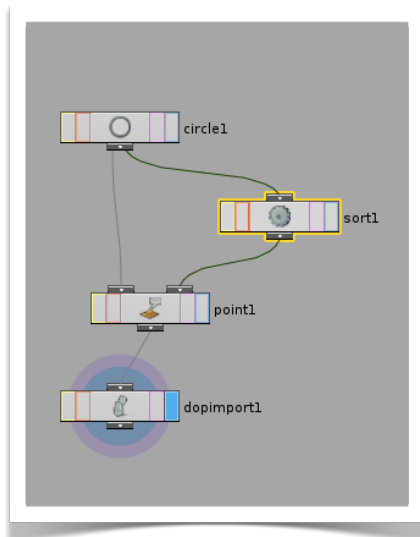
- RBD Point Object works much like the COPY SOP.
- Can not use the COPY SOP because the RBD SOLVER will treat all objects as one mass



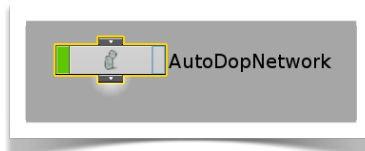
# RBD Point Objects



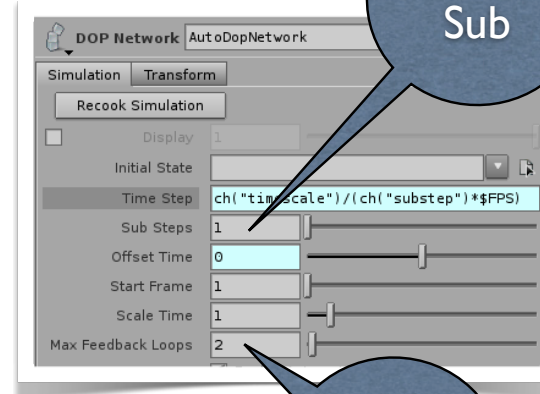
# Fixing Tangents



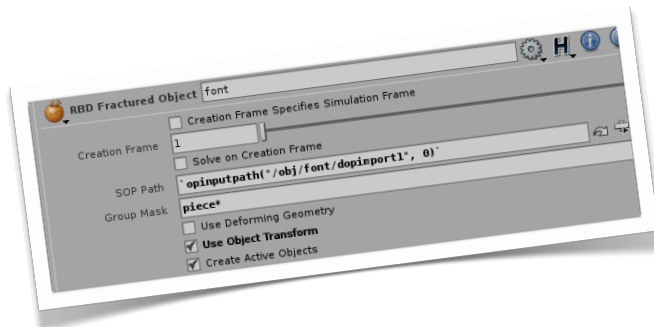
# Accuracy in Simulation



- › **Sub Steps** - Number of times simulations is calculated per frame
- › **Max Feedback Loops** - When using multiple solvers in sim (e.g., RBD, Cloth, Wire) increasing value can make sim more accurate. Keep at 2 for fluids.



# RBD Fracture Object



- Notice in the RBD Fracture Object the Group Mask

