Destroying Metro City: An Artist-Friendly and Efficient Demolition Pipeline for "Megamind"

David Lipton Greg Gladstone Fangwei Lee Eli Bocek-Rivele Mark Carlson*
DreamWorks Animation

1 Introduction

The Megamind FX team was challenged with the destruction of Metro City, which was populated with a mixture of hand-modeled and procedurally generated buildings. Bidding the film told us that that over a third of all effects in the film would be destruction work, revealing that we needed a system that was controllable, easy to set up and use, and simple to pass on downstream. To meet this challenge we created a demolition system unique in that artists can precisely control how debris pieces are broken apart using tools they are already familiar with. This system consists of three key components: Demolition, Dust, and the overall Pipeline.

2 Demolition

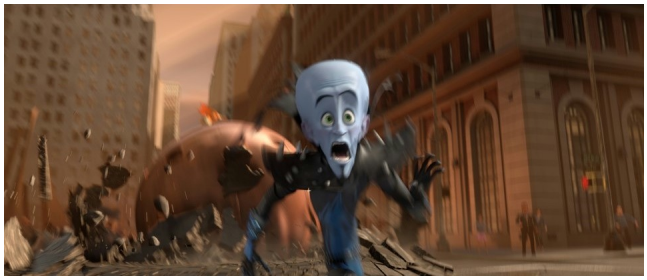

Figure 1: Art-directed shapes and timing can be achieved through controls in the demolition system.

The Maya portion of the demolition system is an elaborate set of tools around the BlastCode plugin, allowing artists to quickly setup and simulate very large simulations within a single scene. The artist has control over not only when and where pieces are broken apart, but also the general shape of the flying debris (Fig. 1). The system detects the type of surface being destroyed (stone, glass, wood), and automatically generates a fractured mesh with the correct settings. A 3D icon in the scene allows the user to quickly specify the origin, size, aim, and intensity of the demolition, with separate control over cracking and breaking. Additionally, the system can create a rigid body support structure which can be collapsed by animating a single sphere over the support's constraints.

The system uses NURBS surfaces as the driving force of a simulation; when a surface has deformed beyond a threshold amount debris pieces are released to the simulation. As a result, artists are free to use traditional deformation techniques (lattices, clusters, etc.), which gives fine control over when and where demolition occurs and allows artists to achieve art-directed shapes (Fig. 2). It also means that artists can quickly achieve the required look using tools they are familiar and experienced with. To achieve certain blast shapes the artist deforms the underlying surface in the shape they want; since the broken pieces track this surface the more deformed areas create higher velocity debris, thereby shaping the resulting blast.

Additionally, to support shots requiring rigid body simulations, we wrote a Maya plugin based on Bullet, called Rumble, that is tightly integrated with (but not limited to) core BlastCode functionality.

3 Dust

We defined four different types of destruction dust based on how they are produced and how they move: debris, trail, impact, and ambient. All created via fluid simulation, the first is based on the position and motion of the demolition geometry; the rest can be hand placed as needed by the artist.

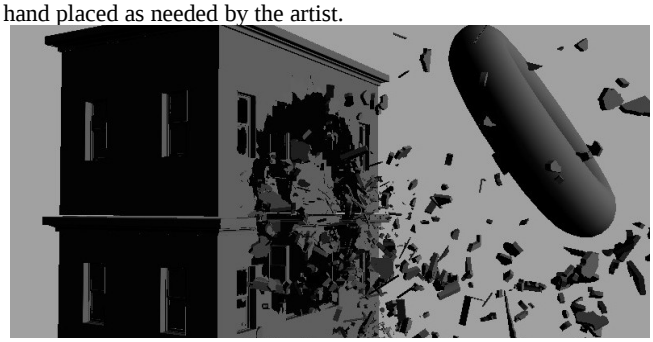

Figure 2: By animating underlying NURBS surfaces unique demolition shapes, such as this doughnut shaped hole, could be achieved.

One important technique in coupling the dust flow to the demolition is to cluster particles on the demolition chunks, which emit density and velocity in to the fluid grid (Fig. 3). Therefore, by incorporating rotation, in addition to position, we inject detailed motion in to the simulation.

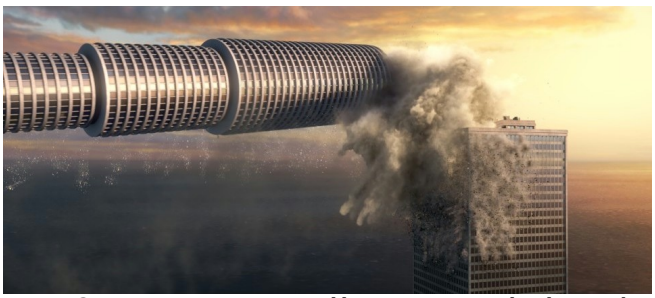

Figure 3: Incorporating rotation, in addition to position and scale, in to the fluid emission gave more interesting and dynamic dust.

4 Destruction Pipeline

The demolition system pipeline was written so artists are able to quickly author their effects and distribute them to other departments. It was also designed to address the fact that in the film we revisit scenes of prior destruction and therefore needed a way to propagate the resulting destruction from a single shot to others with as little overhead (time and disk space) as possible.

The pipeline allows for parallel, batch exports, intelligently breaking scenes up based on used specified chunk size and rigid body collisions requirements, simulating small sections in parallel on multiple render farm machines, and recombining to generate the output mesh. The hand-off to downstream departments involves little FX artist interaction; the pipeline inserts the destructed object into the scene so that downstream departments don't need to change their setups.

Finally, demolished assets can be propagated to other shots and sequences via the same dynamic asset pipeline; additional shots simply need a pointer back to the source simulation. In continuity shots the demolition system inserts the demolition mesh from the last frame of the specified source shot. However, since the source shot might have debris in motion, the system removes any piece that isn't still connected to the original building, thereby removing dynamic debris and leaving only the resulting hole.

ISBN 978-1-4503-0921-9/11/0008.