Technical featurette #1

Car damage

1. Car damage technical featurette

1.1 Introduction

Bugbear Entertainment has always focused on developing advanced driving games that push the technology envelope and provide a highly compelling game play experience. One of the absolute core experiences of the FlatOut series has always been vehicular destruction: using your car to deal out damage to your rivals and to the environment.

The end result of vehicular destruction is of course always car damage (be it to your car or to a rivals car). Creating a truly compelling car damage modeling system in FlatOut has been an absolute key feature and we've dedicated a number of people thruout the projects to ensure that FlatOut is always pushing the technology envelope.

For FlatOut Ultimate Carnage our goal was to simply deliver the best car damage we've ever done. Now, let's see how that works out in practice.

2. General about FlatOut's cars

FlatOut Ultimate Carnage boasts 12 cars racing side by side. Each of these cars is lovingly modeled with approximately 25 000 polygons (roughly 3 times the average of 7500 polys in FlatOut 2) and polished with a number of highly detailed shaders (e.g. metal shaders, paint flake shaders). Things of beaty indeed – and ready to be demolished! :-)

12 cars shooting off from the starting grid. Closest to the camera we have Speedevil, the star of this crash test.

The car used in as an example in this technical featurette is called Speedevil. This particular consists of over 30 000 polygons and another 16 000 polygons for its crash model.

The car damage modeling systems builds on four main components:

- Deformable mesh
- Detachable parts
- Damage textures
- Particle system

Speedevil in all its pristine glory. Let's see how we can tear this baby apart.

3. Deformable mesh

In essence, each car is modeled twice. First in a pristine condition and second time as completely, and utterly wrecked condition. These two different car meshes create the ends of the spectrum for the car deformation sub-system. When the car is hit, the vector of that impact (i.e. the impact point, the direction of the force and amount of force) is used to deform that particular point of the vehicle. Thus everytime the car is hit, the car deforms where it was hit and according to the force of that hit

The great thing about a deformable mesh is that allows for almost infinite number of different types of deformations to occur and those deformations match the impact very closely. . Effectively this means that when the player hits a telephone pole head on, that pole creates a wedge in the front of your car, but if you hit a large building head on the whole forward section of your car deforms simultaneously.

Two examples of deformable mesh.
***Above**: Speedevil impacts with a concrete divider smack in the middle. See how the center section of car has deformed including the crumbling hood.*

***Left**: Speedevil front right corner impacts with a telephone pole. See how the right corner of the car's forward section has bent with the force of the impact.*

4. Detachable parts

Each car in FlatOut is composed of approximately 40 different detachable parts. Typically these include the hood, doors, windows, side mirrors, spoilers, mufflers, headlights and even tyres. These parts can be ripped of by the force of an impact or they can be damaged so that they start to swing on its hinges and eventually tear off with subsequent damage.

For example, if a door of a car is hit and the set damage level is reached by either one or several impacts, that door's lock will open and the door will start swing on its hinges depending on the car's movements. If the driver powersliding around a corner, you'll often see damaged doors swinging with the car's powerful movements.

Once that door reaches critical damage it will tear off completely leaving the cockpit and the driver exposed.

To create this effect that interiors of the vehicles need to also be modeled in proper detail. For example, when the hood of the car is torn off, the engine compartment will be visible. You'll even see the engine's cooling fan rotating inside the compartment.

Here we can see the whole forward section of the car exposed. The tyres and the engine are completely exposed after detachable parts have ripped away in crashes.

The detachable parts can also leave parts of themselves behind. For example, if the car's windshield is shattered, this will leave shards around the edges of the windshield.

This level of detail creates a highly compelling feeling of driving in a car that's just short of a trip to the wrecking yard.

This baby's been totally hammered. The hood is missing, the doors are swinging open on their hinges, thefront bumpers are gone, the windshield has shattered and the engine is on fire. Slam on the gas for more action!

5. Damage textures

Even with the full car mesh deforming uniquely with each hit and car parts tearing off from the force of those impacts, the impression of damage is not completely unless the car displays also scratches, peeling paint and other damage to its paintwork. This effect is created by using damage textures which are created uniquely for each vehicle to showcase damage that would be appropriate for this particular car.

When a particular area of the car is hit, the force of that impact determines not only how the car deforms and whether any car parts are torn off, but also what scratches, dents, grooves and paintwork damage is shown. The damage modeling system blends the car's texture between the pristine texture and the damage texture. The impacts on the car, the more of the damage texture is shown and thus more scratches and dents (and so on) are visible.

This blending effect provides a gradual increase in damage shown to the car and greatly complements the other major damage modeling systems.

See how the door hanging open has dents and stratches on its surface. These are created by the damage texture effect.

6. Particle system

The particle system for each vehicle is responsible sending sparks, mud, exhaust gases and nitro flames in to the air as the player tears thru the tracks. As part of the car damage modeling system, the particle system creates the final touches for point of impact moments and the car's state thereafter.

When the car impacts with another vehicle or with a track side object, the particle system is responsible for sending car part particles flying thru the air (e.g. bits of metal and glass shards) as well as fire streaks, mud, smoke and exhaust gas. This creates the effect of car shedding parts in the violent crashes.

See how the engine is just catching fire (is not yet completely engulfed by flames), sparks are flying as the car hits the object under water and how the car splashes the water in its wake.

After the point of impact, the particle system of the car is adapted based on the changed state of the car. For example, the car's engine block can get on fire and that fire can gradually become larger and larger thus increasing the size of the flames and the amount of smoke billowing out.

The detachable parts also affect the how the particle system works. If for example, a muffler and the attached exhaust pipe are torn off, the exhaust gases and nitro flames naturally start to come directly from beneath the engine block. Another example is that if a car tyre is torn off and the driver keeps on going, the brake discs will tear into the road surface sending sparks flying.

Speedevil hits a concrete wall sending shards of glass, bits of metal and sparks flying thru the air.