

# GPU Destruction: Real-Time Procedural Demolition of Virtual Environments

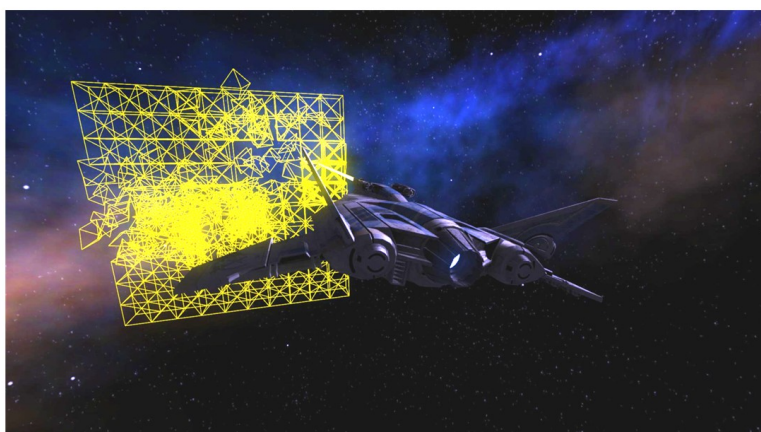
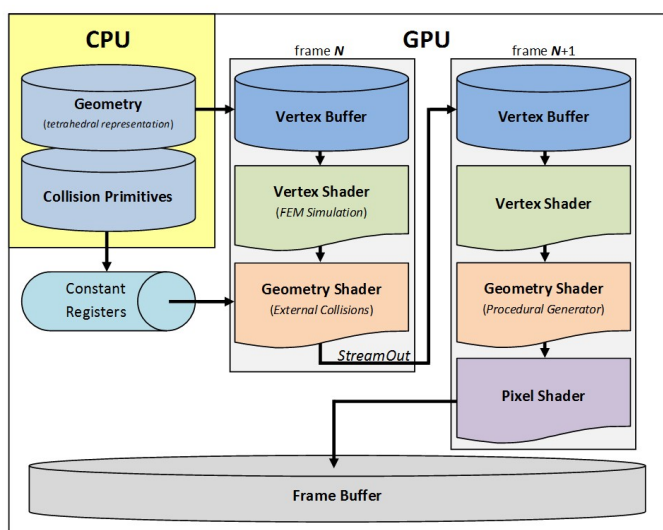
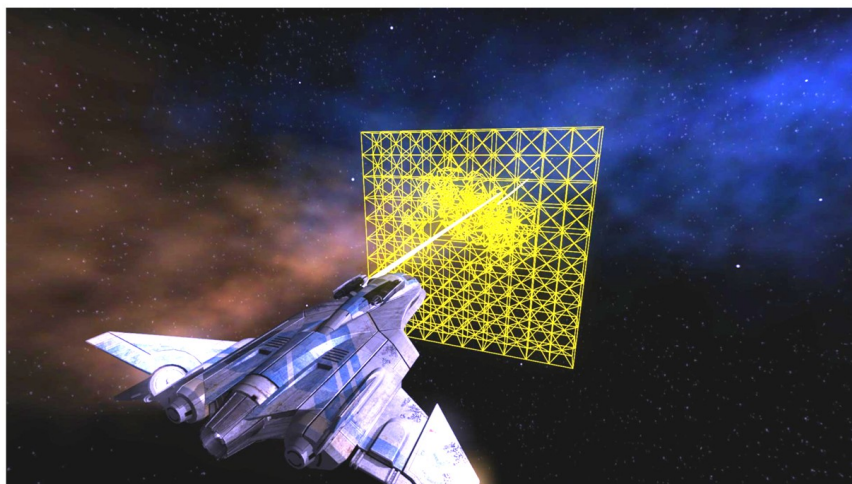
Derek John Morris and Eike Falk Anderson

Interactive Worlds Applied Research Group, Coventry University, United Kingdom

We present a real-time simulator for destructible materials for use within videogames and similar real-time computer graphics applications. Our method is based on the work presented by Parker and O'Brien [PO09], which is used in combination with other methods, migrating the majority of processing from the original concept onto the GPU (Graphics Processing Unit).

Our system provides:

- A real-time simulation of deformable and destructible materials suitable for implementation within a videogame environment.
- Full use of modern GPU features utilising implicit multithreading and consequently freeing up CPU resources for use in other game components.
- Procedural geometry creation techniques that save valuable content creation time.



3D assets courtesy of Tower 17 Games / Surface3D

For the destructible object an element stiffness matrix per tetrahedra is derived within the vertex shader and output into a custom vertex format. These stiffness matrices are then combined into an overall stiffness matrix that fully describes the material domain. This is combined with a fast method of processing collisions with external objects [Zin08] that allows simple primitive types to be transferred to the GPU via the hardware's constant registers. The results of the simulation timestep are output into a vertex buffer for further processing using the StreamOut mechanism. 'Splinters' of the damaged objects are then procedurally generated within the geometry shader.

Updates to this work are available from <http://sites.google.com/site/derekjohnmorris/masters>.

## References

- [PO09] Parker E.G., O'Brien J.F.: Real-time deformation and fracture in a game environment. In *SCA '09: Proceedings of the 2009 ACM SIGGRAPH/Eurographics Symposium on Computer Animation* (2009), pp. 165–175
- [Zin08] Zink J.: Dynamic particle systems. In *Programming Vertex, Geometry, and Pixel Shaders*. GameDev.Net, 2008. Available on-line at [http://wiki.gamedev.net/index.php/D3DBook:Table\\_Of\\_Contents](http://wiki.gamedev.net/index.php/D3DBook:Table_Of_Contents)