Procedural Methods For LARGE SCALE DESTRUCTION

NAFEES BIN ZAFAR **DREAMWORKS ANIMATION**

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Dante's Peak (1998)



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Pirates 3 (2007)

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The Problem For CG



Concept Art: Fissure



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Concept Art: Downtown





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Tons of geometry





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Tons of geometry Lots of objects





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Tons of geometry

- Lots of objects
- Many different materials





Why not just use CG???



Collision detection is SLOW!!!



"2012" (2009)





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How Did We Do It?







- Choices
 - Havok
 - PhysX
 - Bullet
 - etc.



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 - Havok
 - PhysX
 - Bullet
 - etc.

• Fast collision detection



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- Clever constraint solvers



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- Active developer community



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- Fast collision detection
- Clever constraint solvers
- Active developer community
- Expertise from games people





- Faster solution for 90% of cases
 - Solver is a black box
 - Fast RBD solver: Bullet
 - 100,000+ objects with 200,000+ constraints



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 - Use constraints
 - Smart constraint rigs



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- Material behavior
 - Use constraints
 - Smart constraint rigs
- Optimize object management
- Optimize rigging workflow



DATA REPRESENTATION










































Dataflow





A Simple Sim







- Geometry is polygon soup
 - Unique body ID on each primitive
 - { Group ID, Object ID }



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 - { Group ID, Object ID }
- Body point cloud
 - ID, proxy shape, state
 - Mass, position, velocities, forces



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- Constraint point cloud
 - Target body IDs
 - Type
 - Yield limits
 - Stiffness
 - Motor values



Outputs



Outputs

- Body data
 - Transform, and velocities
 - State
 - Activation time



Outputs

- Body data
 - Transform, and velocities
 - State
 - Activation time
- Collision info
 - Sum of collision impulses
 - Max collision
 - Number of impacts



More Outputs



More Outputs

- Contact points
 - Location
 - Local velocities
 - Penetration amount
 - Collision pairs



More Outputs

- Contact points
 - Location
 - Local velocities
 - Penetration amount
 - Collision pairs

- Constraints
 - Current state, error
 - If broken
 - Time of break
 - Break threshold





• All body and constraint settings are accessible as point clouds during simulation.



MATERIAL BEHAVIOR



Keyframed Activation



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Automated transition from animated to dynamic



- Automated transition from animated to dynamic
- Method
 - Accumulate collision impulses on each body
 - Threshold against impulse



Constraints







Constraints

- Breakable constraints
 - Stretched beyond limit
 - Penalty impulse threshold







Constraints

- Breakable constraints
 - Stretched beyond limit
 - Penalty impulse threshold
- Ablative constraints
 - Dynamically lower stiffness
 - Distance or impulse based





Breaking Constraints



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• Brittle or stiff behavior



- Brittle or stiff behavior
- Compound objects
 - Multiple hulls
 - Common parent transform



- Brittle or stiff behavior
- Compound objects
 - Multiple hulls
 - Common parent transform
- Yield criteria
 - Release on collision impulse threshold
 - Individual hull or entire compound







Rigging





Constraining bodies



- Constraining bodies
- Constraint Placement
 - Nearest neighbors bodies
 - Grouped
 - Between groups



- Constraining bodies
- Constraint Placement
 - Nearest neighbors bodies
 - Grouped
 - Between groups
- Constraint Settings
 - Control parameters: stiffness, damping
 - Types: Point to point, limited rotation axis, hinge















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2 ×



LAP_059_040_fxcomp_v026















Rigging: Power Lines





Rigging: Power Lines



2





Rigging: Power Lines



2





Rigging: Props







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LAP_060_210_fxcomp_v076



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previs lens: 35mm





Demolishing Skyscrapers





















TITLE

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• Stiffness set with noise



- Stiffness set with noise
- Create weak areas



- Stiffness set with noise
- Create weak areas
- Paint on top of noise as needed



- Stiffness set with noise
- Create weak areas
- Paint on top of noise as needed
- Assign different strengths based on object type







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Input Resolution: 1920x1080

LAP_060_250_fxcomp_v034

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Layering Sims












ALLEY .



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NAMES AND DESCRIPTION OF THE OWNER OWNE THE STREET

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Intuitive procedural workflow for RBD sims



- Intuitive procedural workflow for RBD sims
- Helps a lot to have the engine source



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- Helps a lot to have the engine source
- Use particle system-type approaches



- Intuitive procedural workflow for RBD sims
- Helps a lot to have the engine source
- Use particle system-type approaches
- Using lots of constraints creates complex behavior







Mass and collision dependent parameters are not intuitive





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- Need to relate constraint parameters to desired material behavior





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- Need to relate constraint parameters to desired material behavior
- Are we using constraints efficiently?





- Mass and collision dependent parameters are not intuitive
- Need to relate constraint parameters to desired material behavior
- Are we using constraints efficiently?
- Deformable bodies are really interesting





Destroying Other Things Too



"Tron: Legacy" (Wed @ 2pm in Ballroom A/B)

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comp/bf8105_comp_l_v56



BM169 Transformers 3



BM169_fx_v109

DIGITAL DOMAIN

Tue April 26 2011

Transformers 3



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BM169_comp_l_v305





Transformers 3

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MN012_comp_l_v303





Back to blowing up stairs



None AT0180_howto_comp_v01

X-MEN: FIRST CLASS Digital Domain



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Thu 12 May 15:14:33

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Thanks eh!

Merci

