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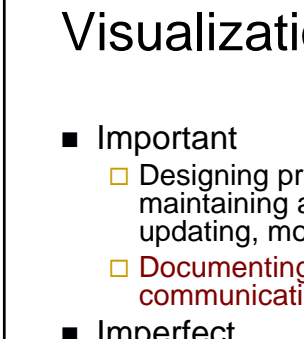
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FEA Visualization by Outsourcing

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and
Christoph Hoffmann

Purdue University

Slide 1



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Visualization in FEA and CAD

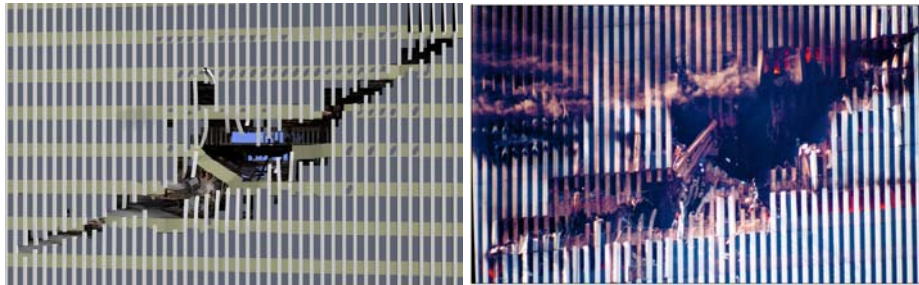
- Important
 - Designing products, validating product designs, maintaining and repairing products, updating, modifying and evolving products.
 - Documenting products, marketing products, communicating events and analyses
- Imperfect
 - Not the core mission of FEA or CAD
 - Yesterday's graphics and visualization algorithms
 - Geared towards engineers, not necessarily easy to understand for non-expert users

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Importance of Realism

- Visual vocabulary common to all
- Proficiency without training
- High-bandwidth from low-level perception



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Graphics in Movies, Games, and Animations

- Defines state-of-the-art
 - Drives research in graphics
- Realistic
 - Speaks eloquently to anyone
- Alas, bigger than life
 - Little emphasis on physical correctness
 - Hard to make strictly equal to life

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Graphics in Animation



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Our approach: “Outsourcing”

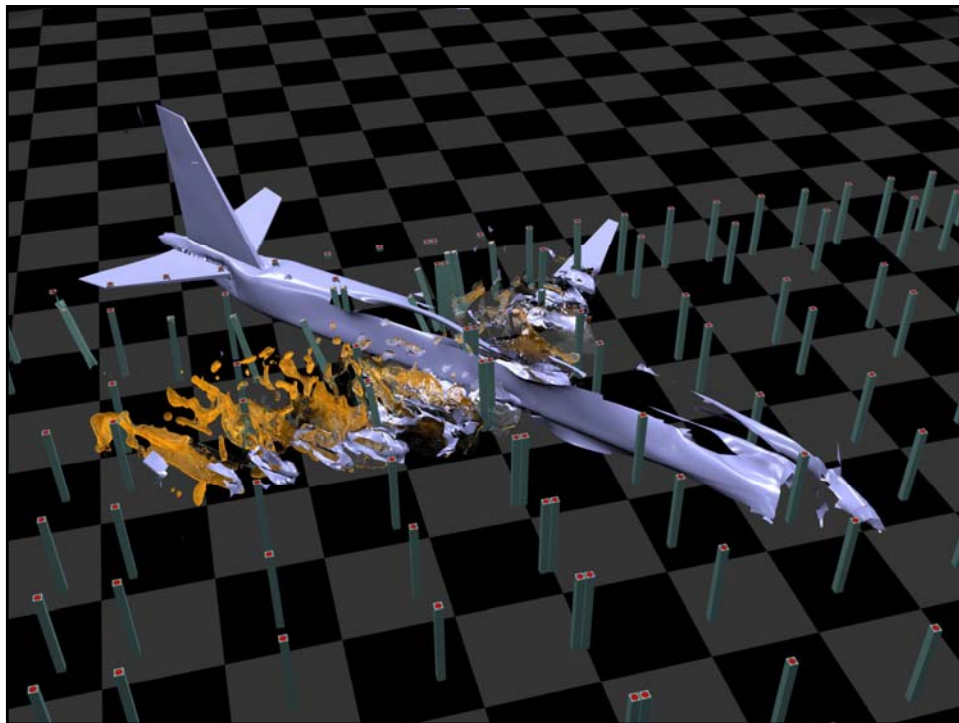
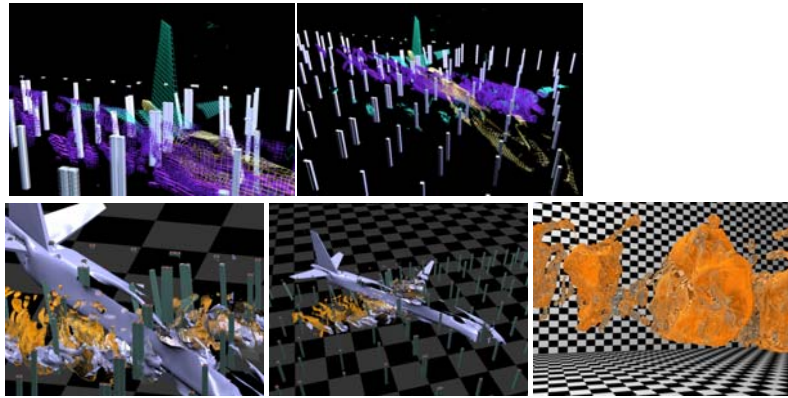
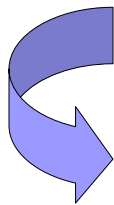
- Federate FEA and CAD systems with animation system
 - Automatically convert FEA data into animation scene
 - Compute visualization in animation system

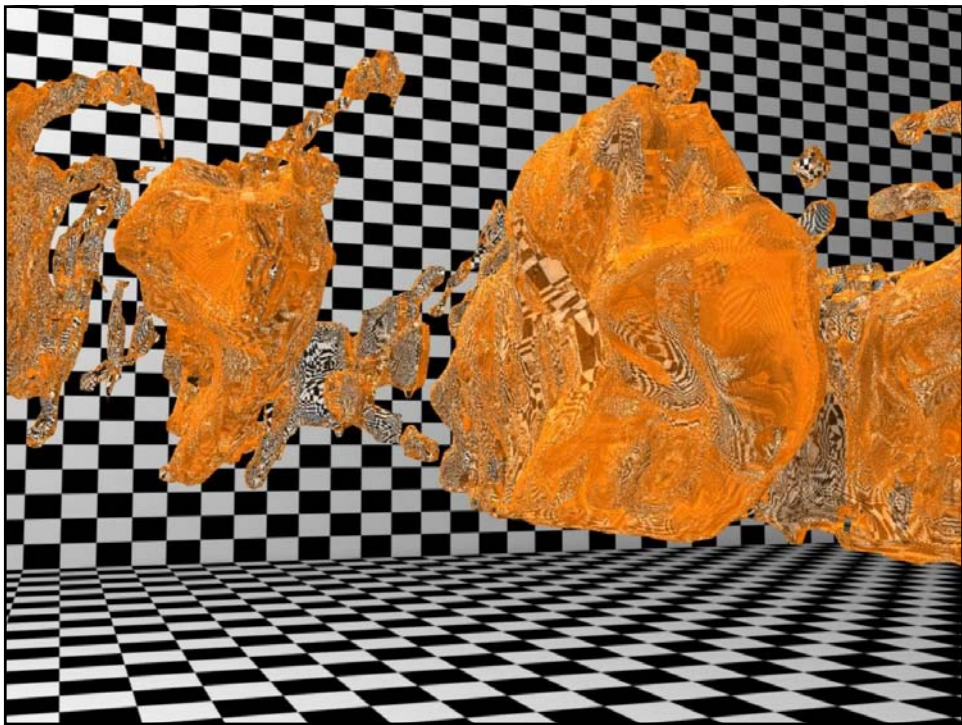
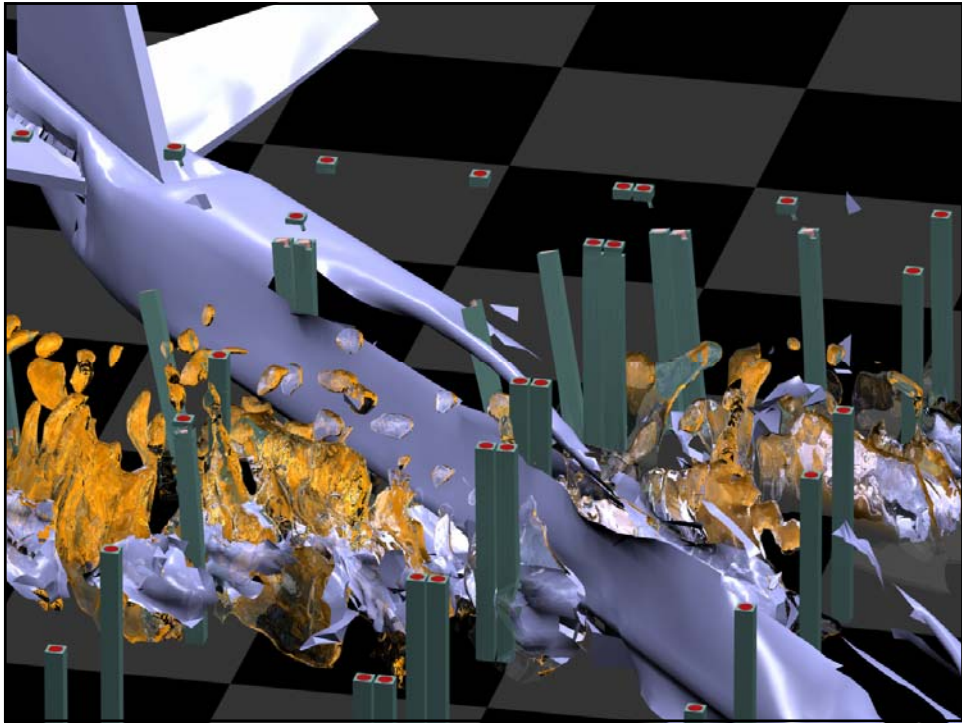
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Example: Simulation of 9/11 Attack on Pentagon (2003)

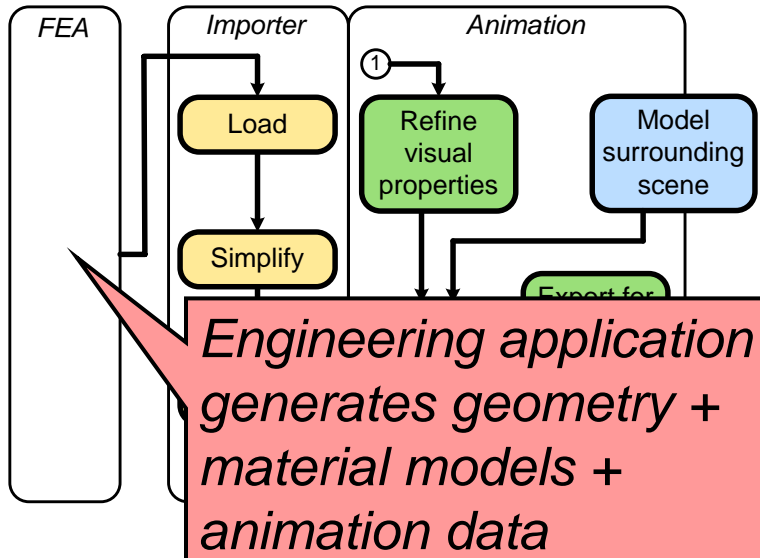
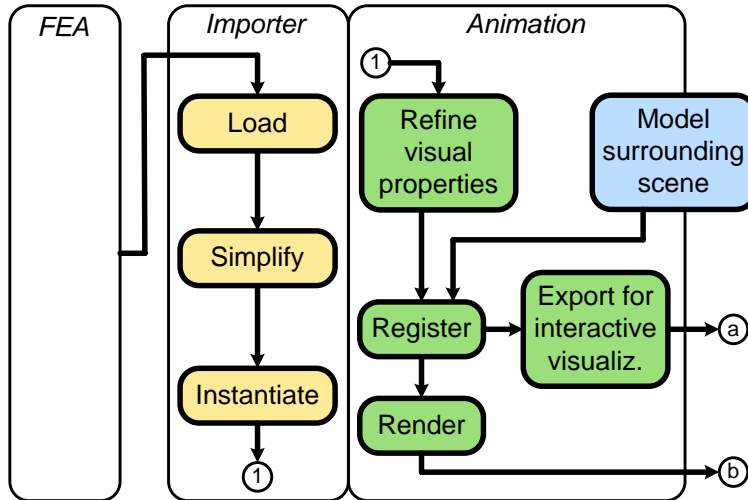
- FEA simulation computed in LS-DYNA imported into 3DS-Max

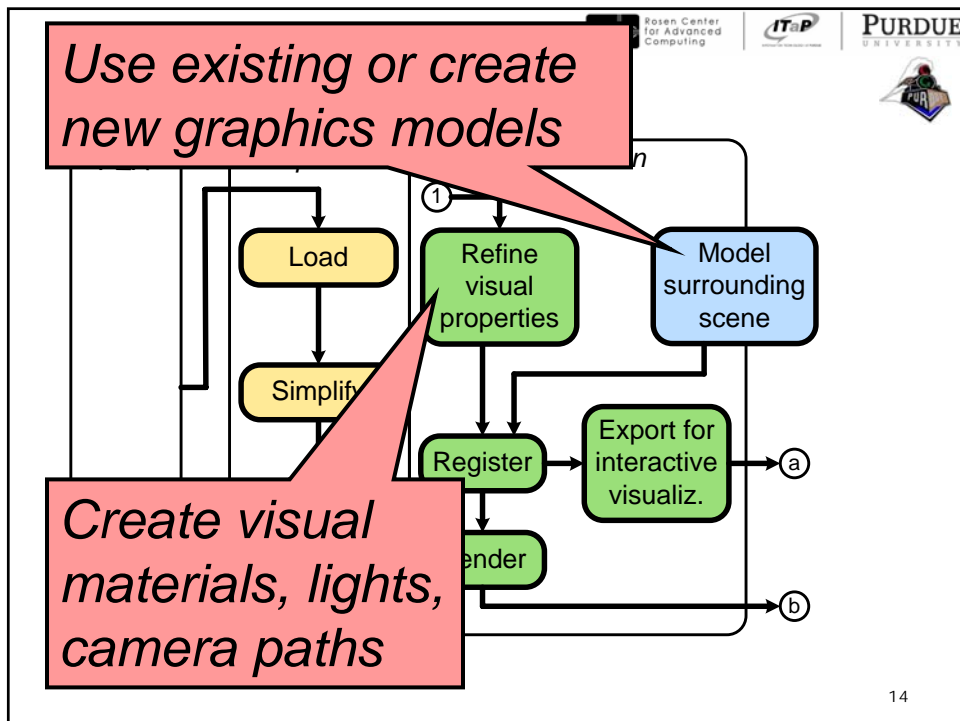
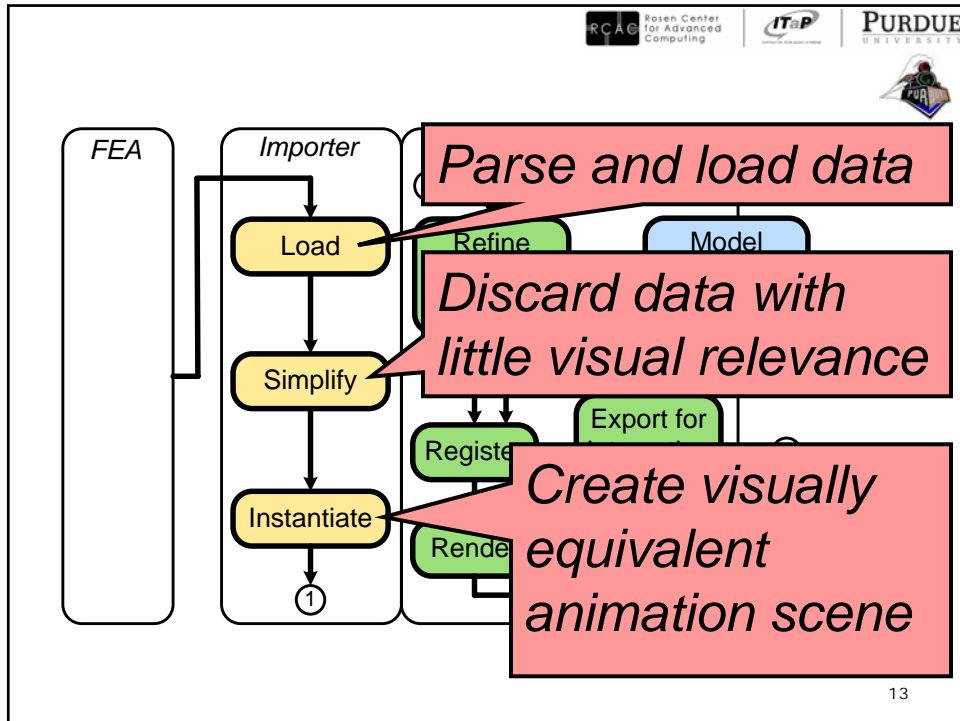






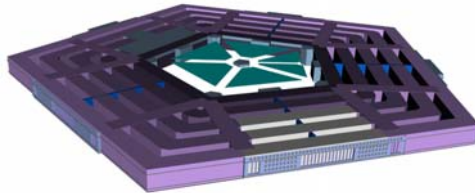
Our approach: "outsourcing"







Modeling surrounding scene: *geometry*



Autocad Pentagon building model constructed from blueprints
and Boeing 757 model Courtesy Amazing Graphics

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Modeling surrounding scene: *color*



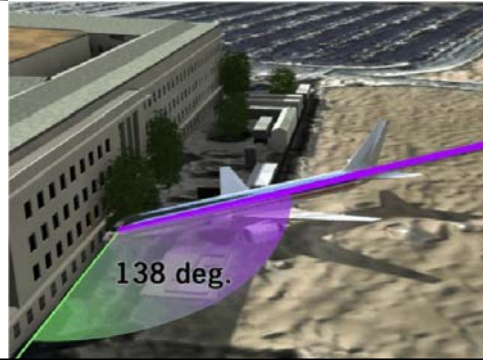
Satellite (courtesy Space Imaging) and
aerial (courtesy ASCE) images for realism

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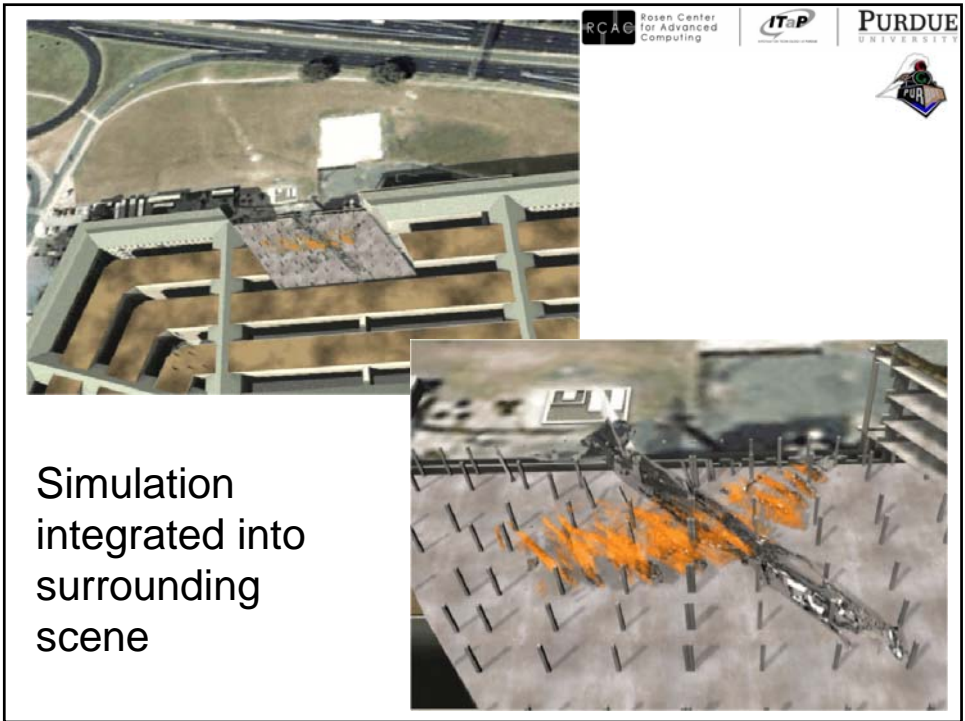
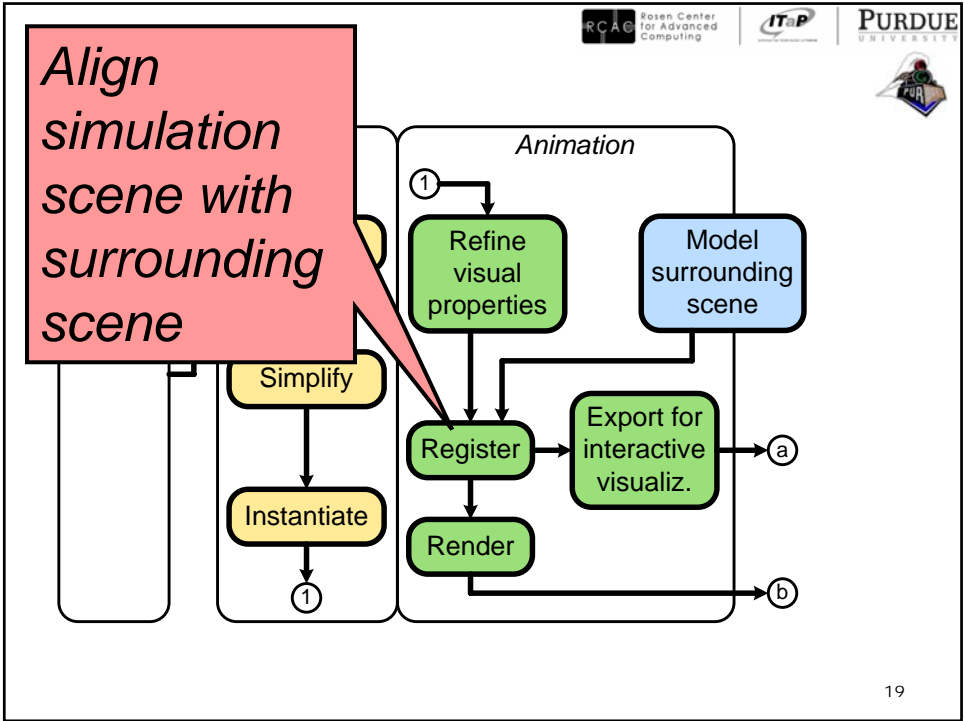
Integration with simulation data

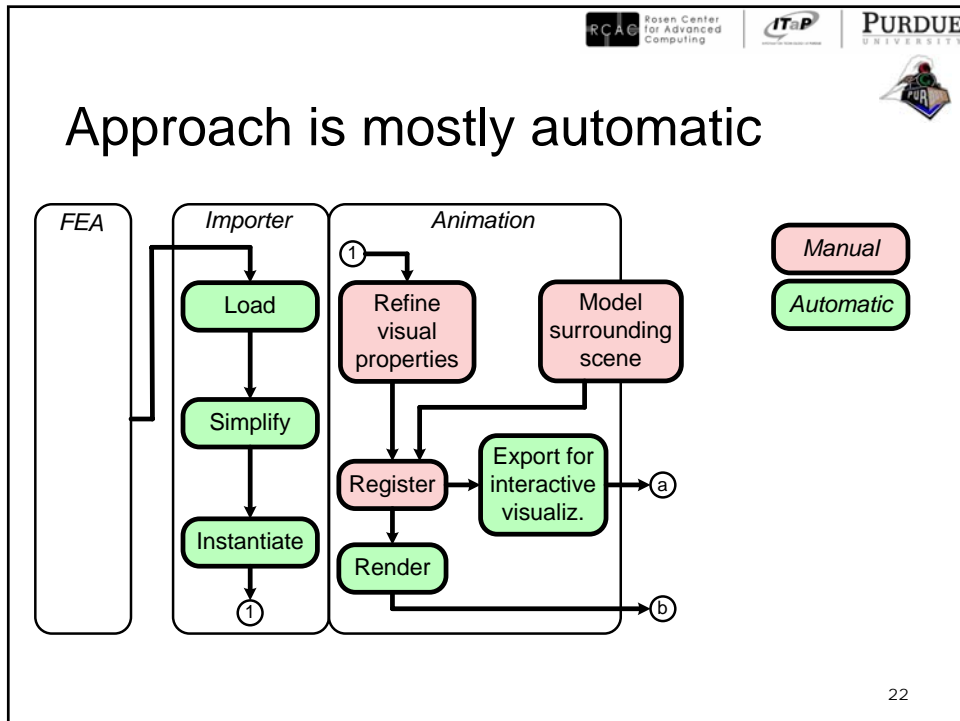
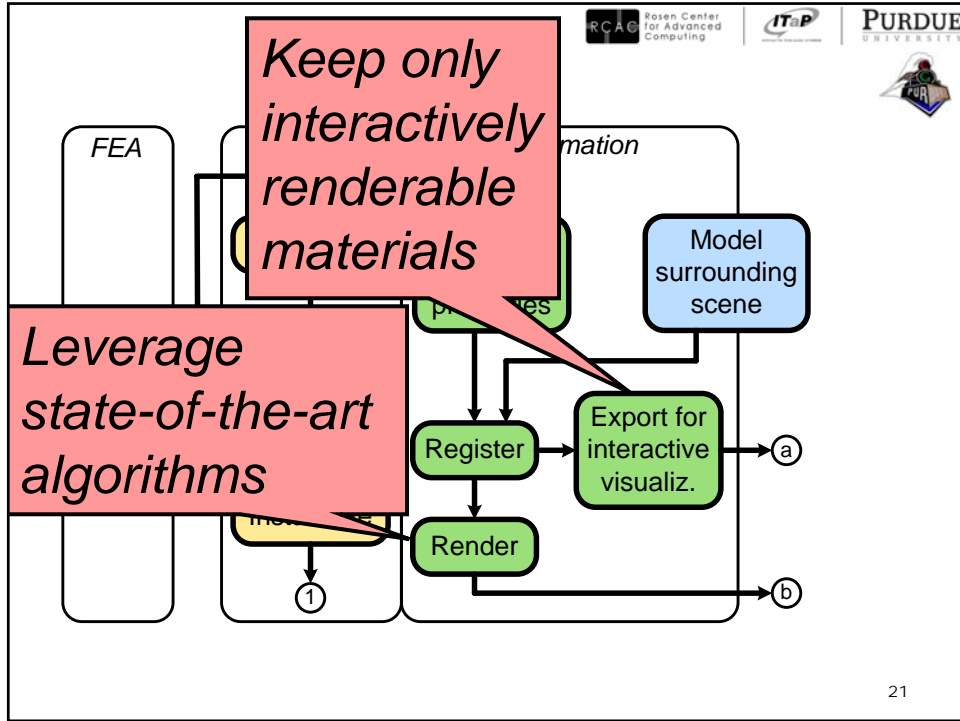
Pre-impact scene



Post-impact scene



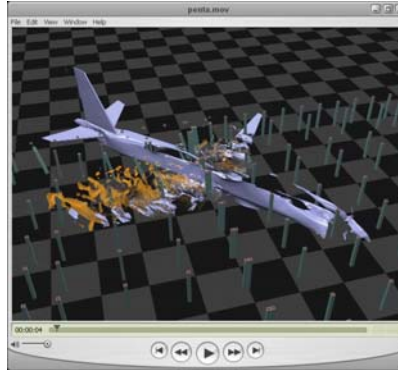






Video

- penta.mov



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Conclusions

- Approach makes sense
 - Translate data instead of replicating functionality
- State-of-the-art readily available which accelerates visualization research
- Realistic visualization is a good starting point for multidisciplinary collaboration
 - Not a replacement for scientific / engineering / information visualization, but a great vehicle for general compelling communication

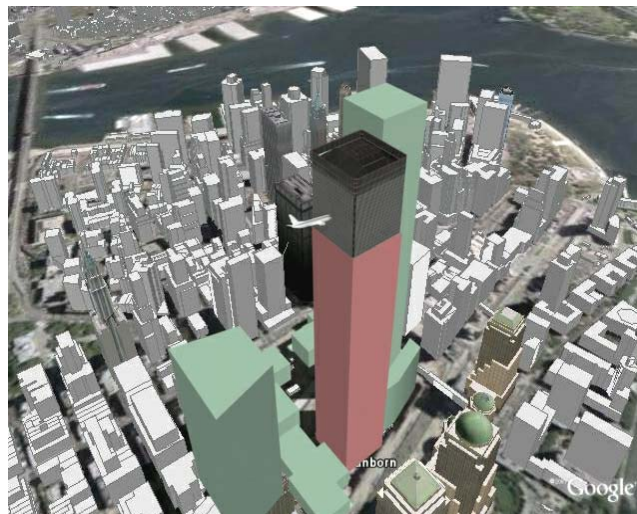
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Recent Results

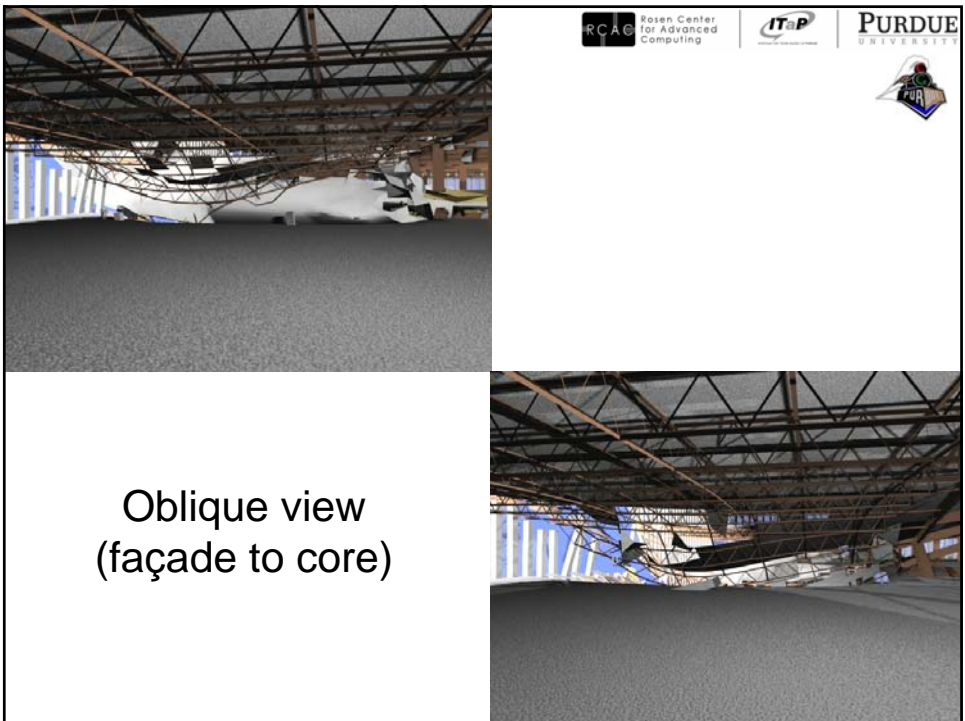
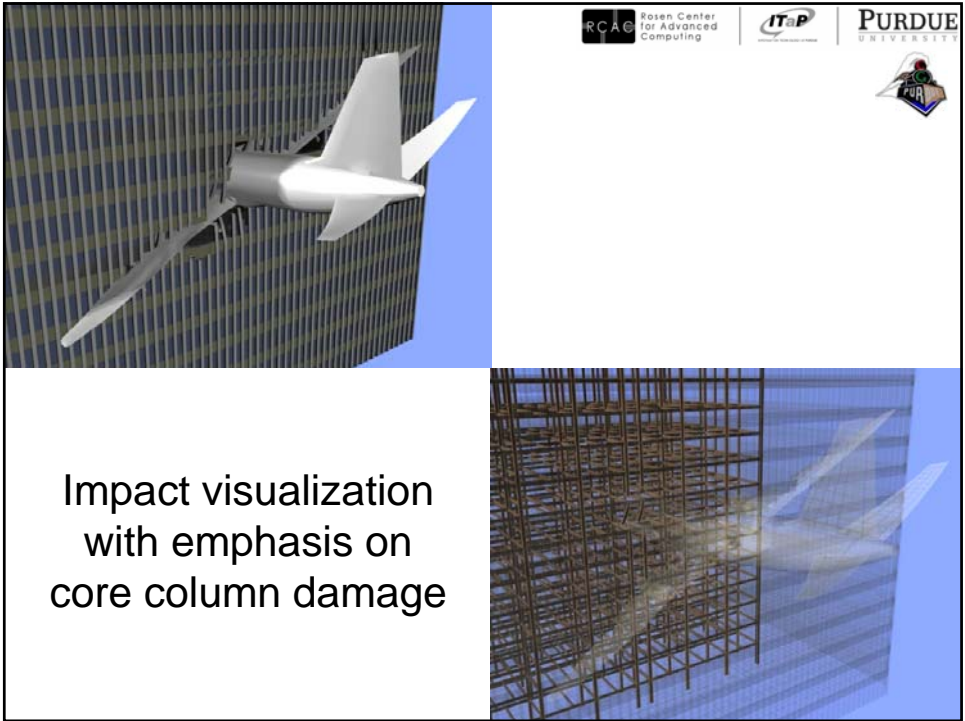
- Simulation controlled addition of visual detail
 - Complex beam profiles
 - Eroding elements used to seed dust effect
 - Fuel SPH elements used to visualize fire
- Used in the context of 9/11 World Trade Center Simulation

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Simulation in context by Google Earth™
model of downtown Manhattan

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Two floors viewed in chronological order

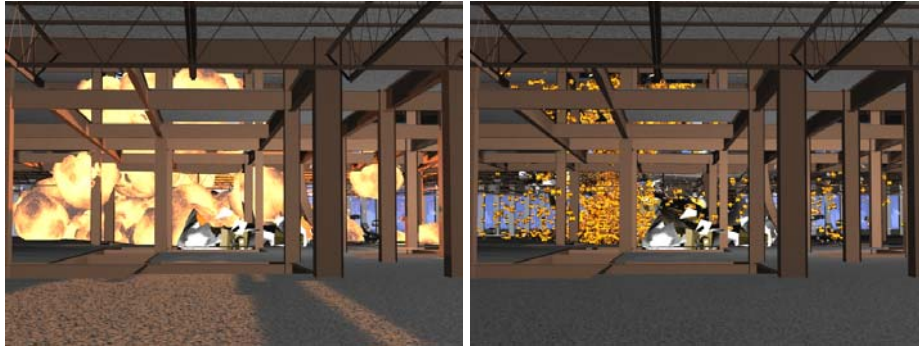
The image displays a sequence of three views of a building's structural frame. The top-left view shows a clean, empty steel frame. The top-right view shows the same frame with yellow and white debris scattered on the floor. The bottom view shows the frame with a significant amount of debris, including what appears to be a large piece of glass, on the floor. Logos for RCA@, IT@P, and PURDUE UNIVERSITY are visible in the top right corner.

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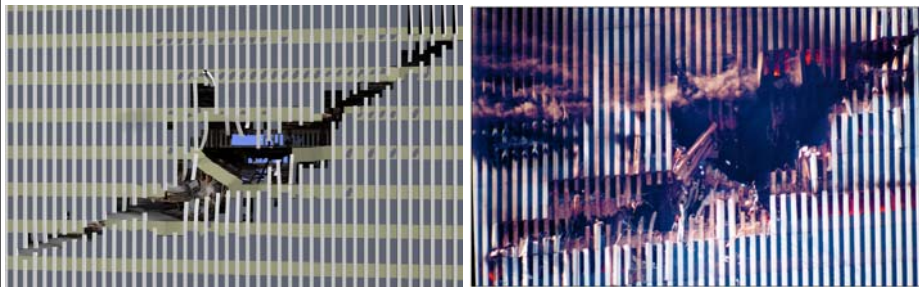
Dust and glass debris visualization

The image displays two side-by-side views of the same structural frame. The left view shows the clean frame with some debris. The right view shows the same frame with a large amount of white dust and glass debris floating in the air, creating a hazy atmosphere. Logos for RCA@, IT@P, and PURDUE UNIVERSITY are visible in the top right corner.



Fire visualization (*left*)
controlled by SPH fuel elements (*right*)

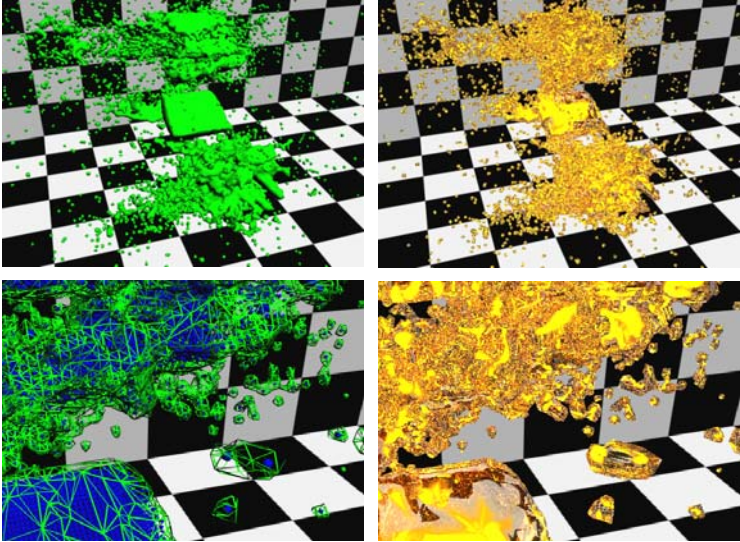
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Comparison between simulated (*left*)
actual Façade damage (*right*)

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Visualizations of SPH simulated jet fuel

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Video

- wtc.mov



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Acknowledgments

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- **Tellabs Foundation, National Science Foundation, DOE, IBM, Intel, and Microsoft**

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www.cs.purdue.edu/homes/cmh/simulation/

www.../simulation/wtc1.mov (133 MB)

www.../simulation/penta.mov (45 MB)



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