



The Current State of the Vulnerability Assessment and Protection Option (VAPO) Software Program and its Applicability to the Explosives Safety Community

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NATIONAL SECURITY



ENERGY & ENVIRONMENT



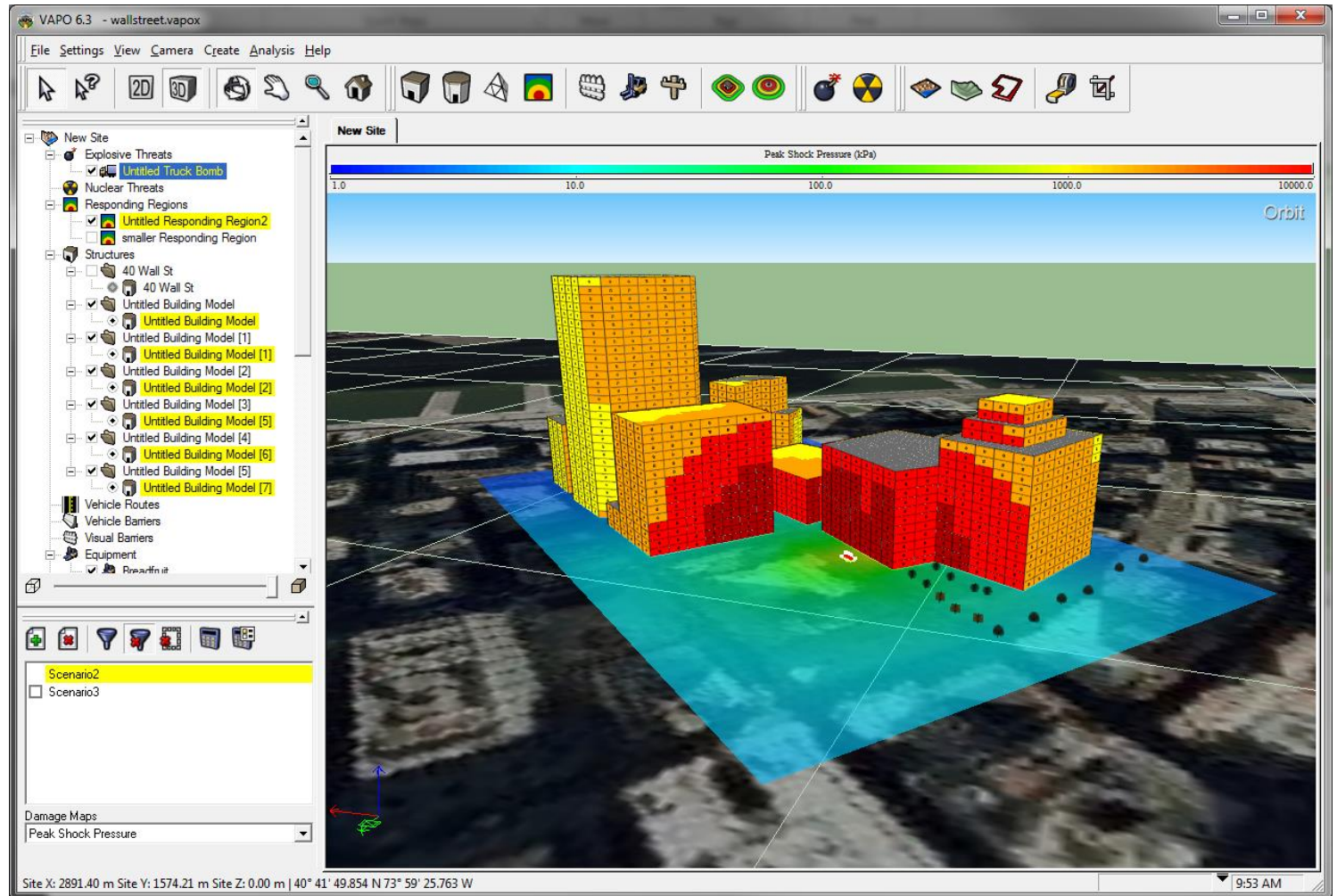
INFRASTRUCTURE



HEALTH SOLUTIONS

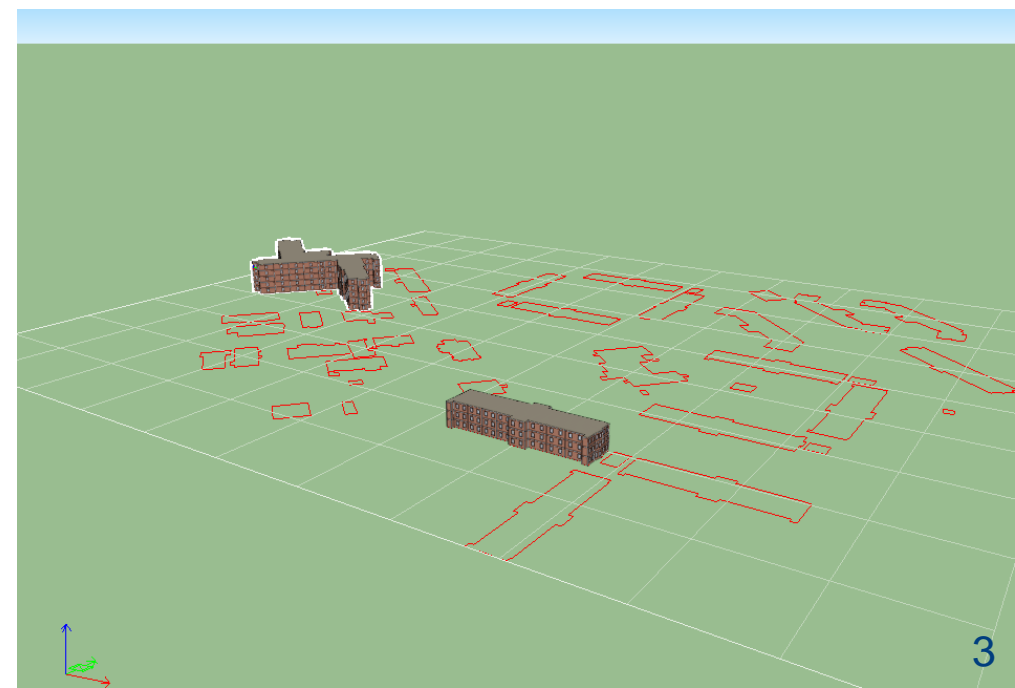
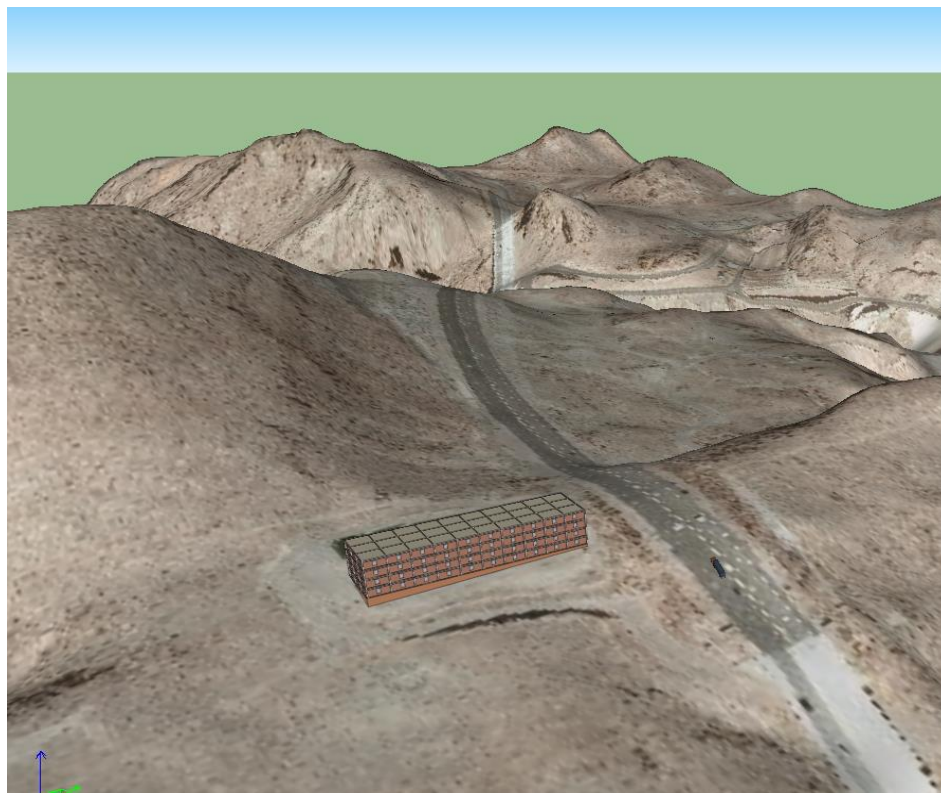
Background

- Fast-running, physics-based simulation tool for anti-terrorism and force protection
- VAPO 1.0 released in 2004
- 60 years of research investments by the Defense Threat Reduction Agency (DTRA)



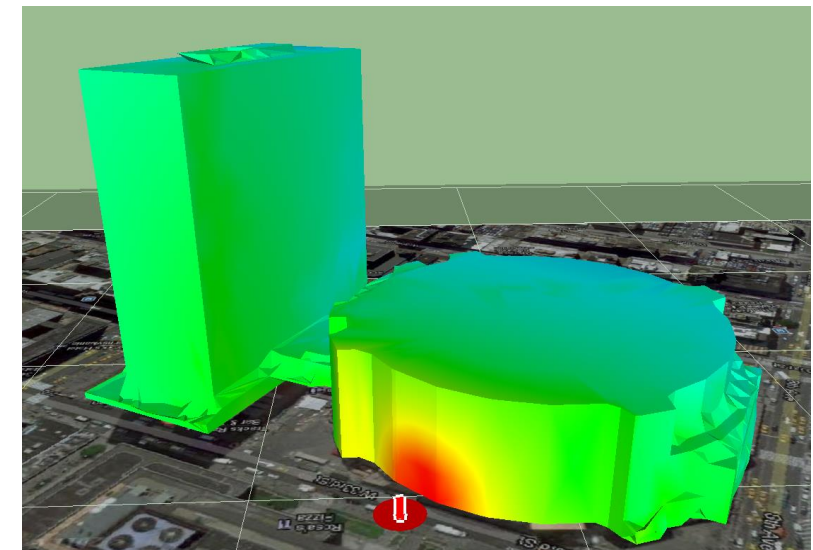
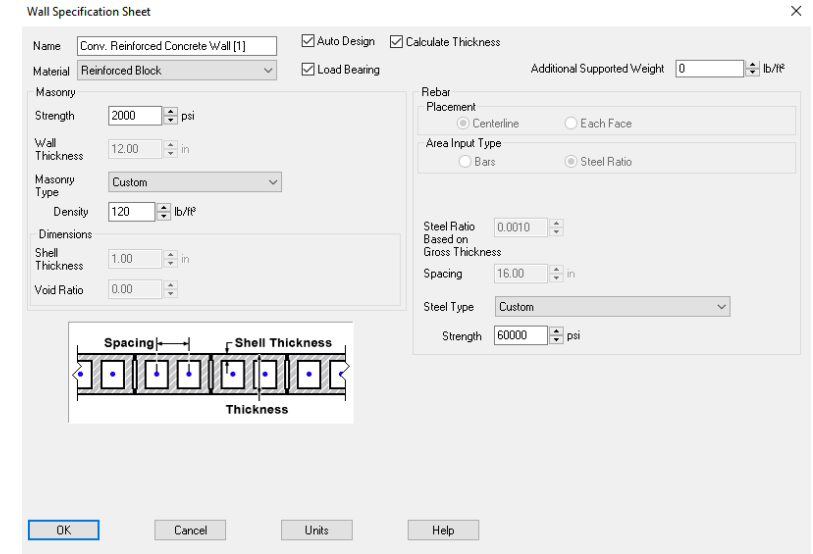
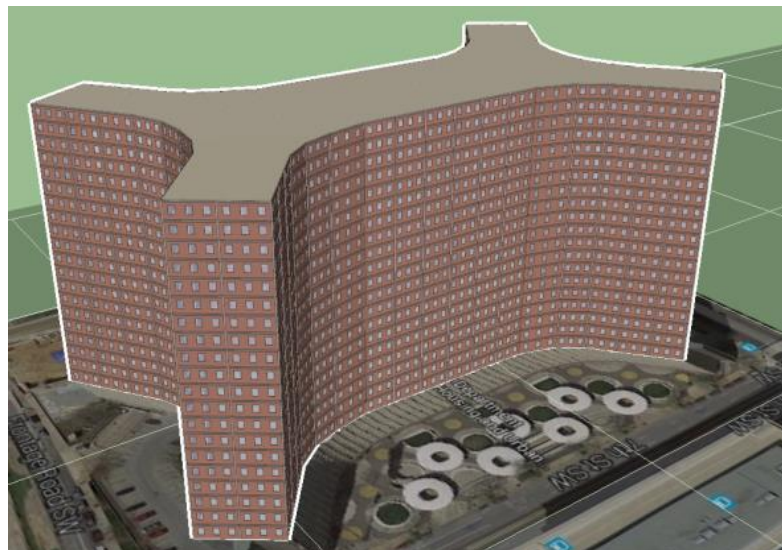
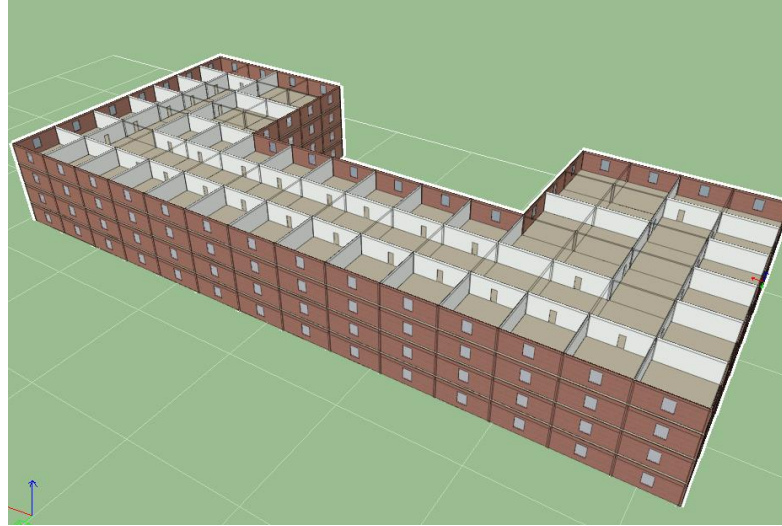
GIS Capabilities

- Terrain
 - GeoTiff
 - DTED
 - DEM
 - JP2
 - ArcInfo
 - ASCII Grid
- Imagery
 - GeoTiff
 - Bmp
 - Jpeg
 - Png
- Shapefiles



Building Characterization

- Buildings with interiors
- Shell buildings
- Import of 3D visualization models (i.e., COLLADA format)



Automated Structural Designer

- Automatically builds realistic buildings based on initial inputs (e.g., number of stories, material properties)
- Incorporates Minimum Design Loads for Buildings and Other Structures (ASCE 7-10)
- Users can manually control loads applied before building elements are sized

User-Defined Building Type ✕

Risk/Occupancy Category ▼ 2 - All facilities not classified as Categories 1, 3, or 4 (e.g., typical office buildings)

Exposure Category ▼ B - Urban/suburban

Floor Load

Category User-Defined Superimposed Dead Load 20.0 psf

Light manufacturing facilities Live Load 125.0 psf

Snow/Roof Load

Category User-Defined Snow/Roof Load 21.0 psf

Ground Snow Load ▼ Moderate 30.0 psf

Seismic

Category User-Defined Out of Plane LB Wall Weight Ratio 1.33

Out of Plane NLB Wall Weight Ratio 0.53

Seismic Map Acceleration

Minimal ▼ Short Period Spectral Response Acceleration, S_g 5.00 %g

Wind

Category User-Defined Pressure 21.6 psf

Basic Wind Speed ▼ Normal Inland 115 mph

Contours

- Building Contours

- Structural
- Unified Facilities Criteria (UFC)
- User-defined

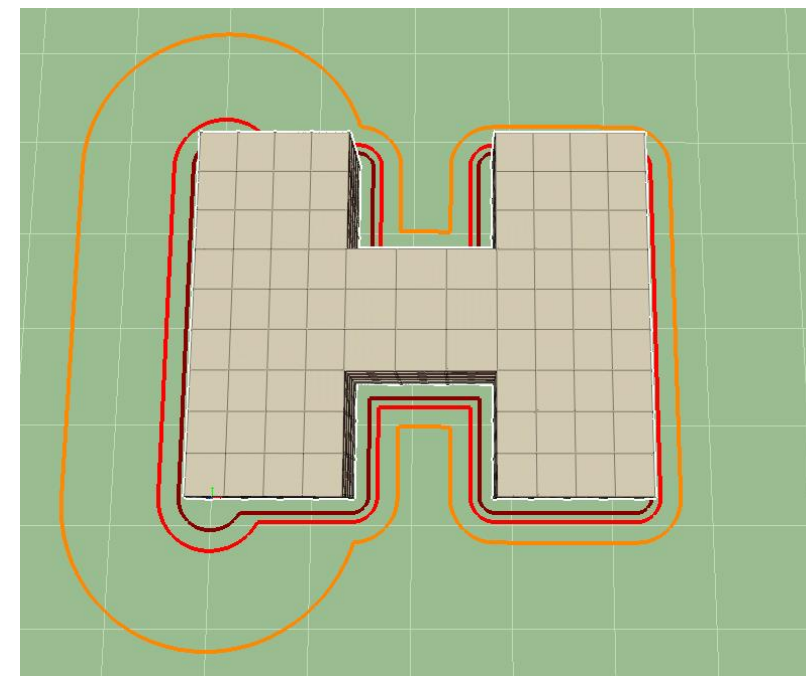
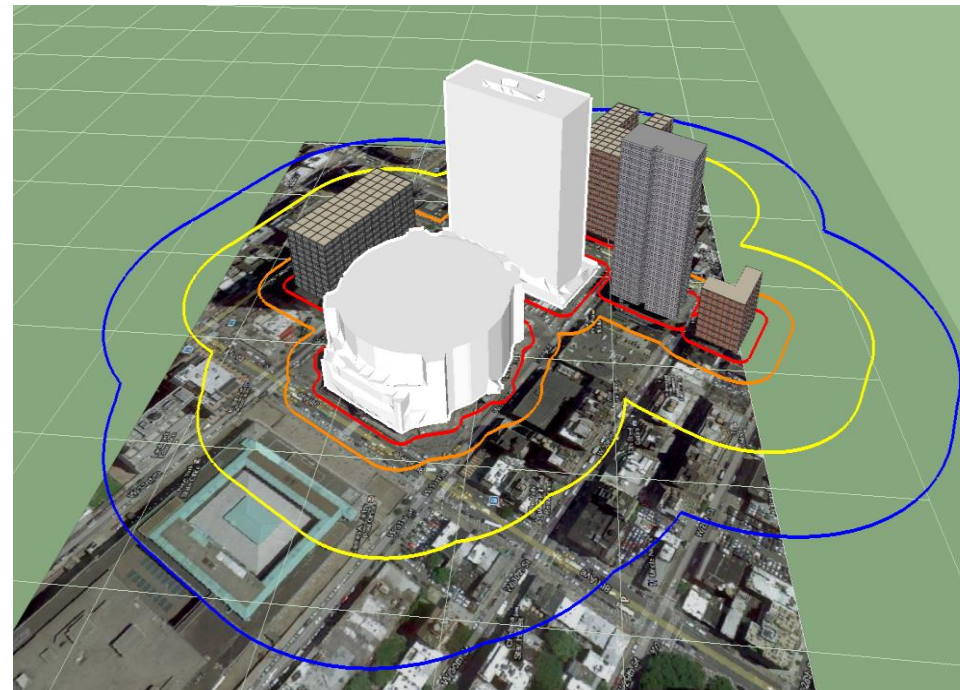
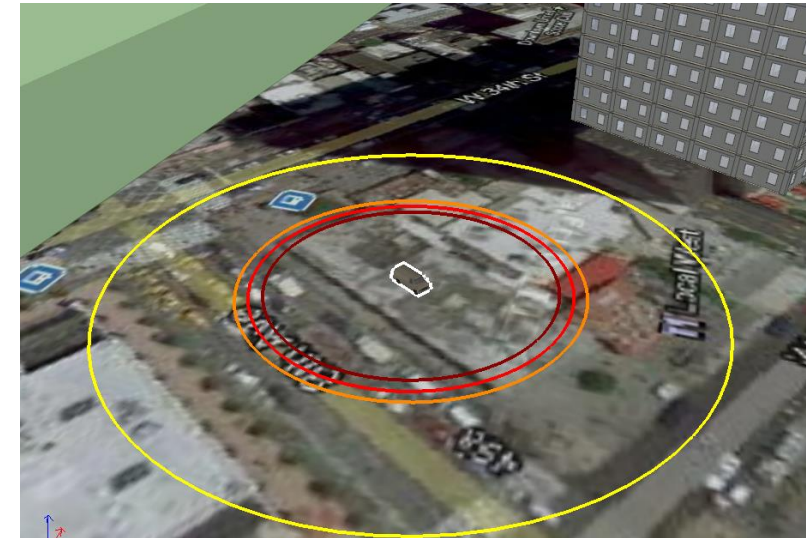
- Threat Contours

- Lung Collapse
- Eardrum Rupture
- Skull Fracture
- User-defined

Structure Contours - First Floor Analysis Only

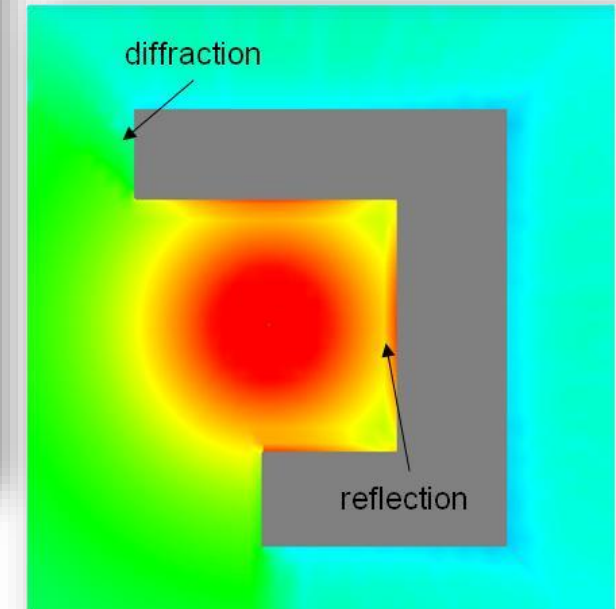
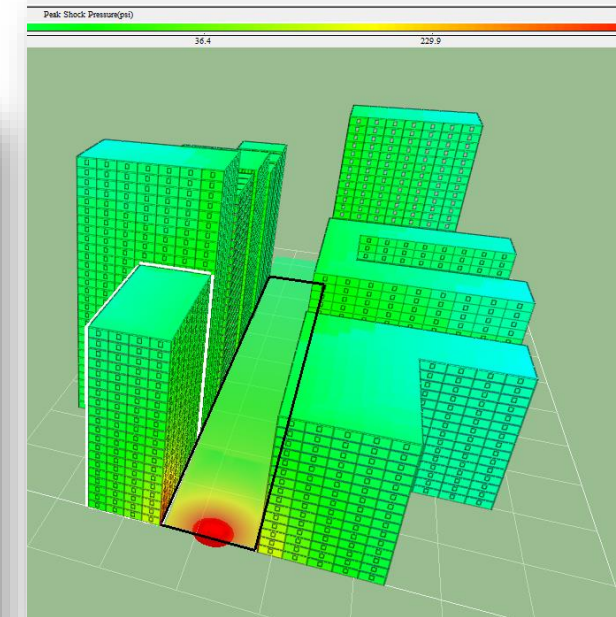
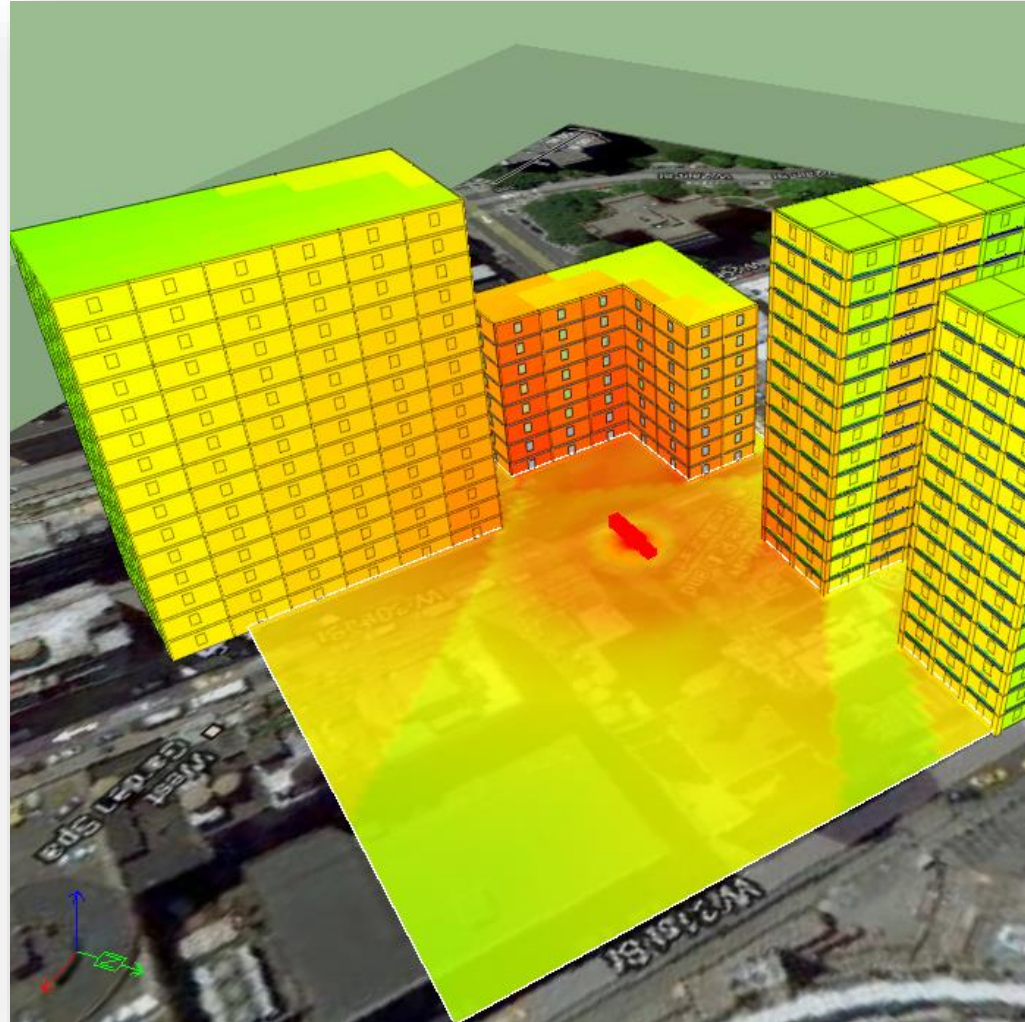
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<input type="checkbox"/>	User-Defined		33 ft		<input checked="" type="checkbox"/>		4

Buttons: Compute, Cancel, Units, Help, Apply Retrofits



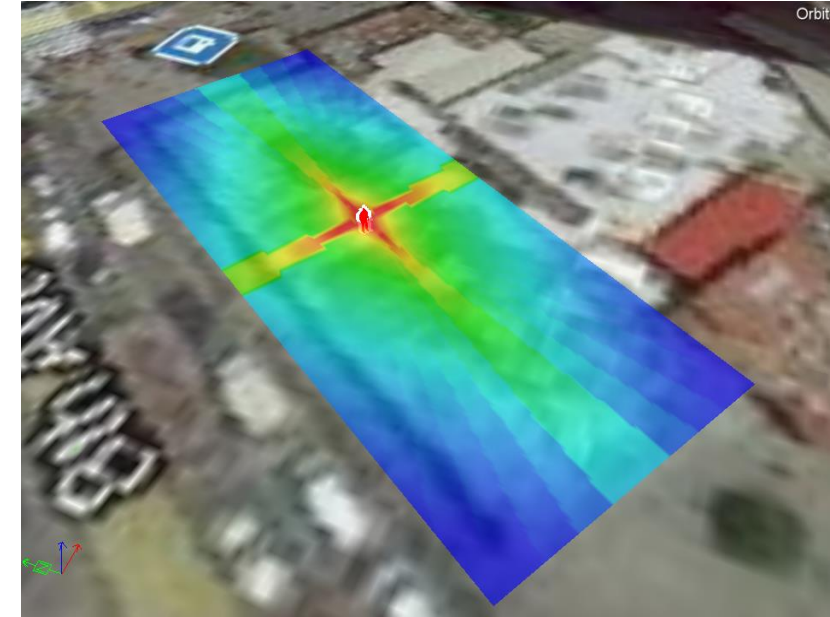
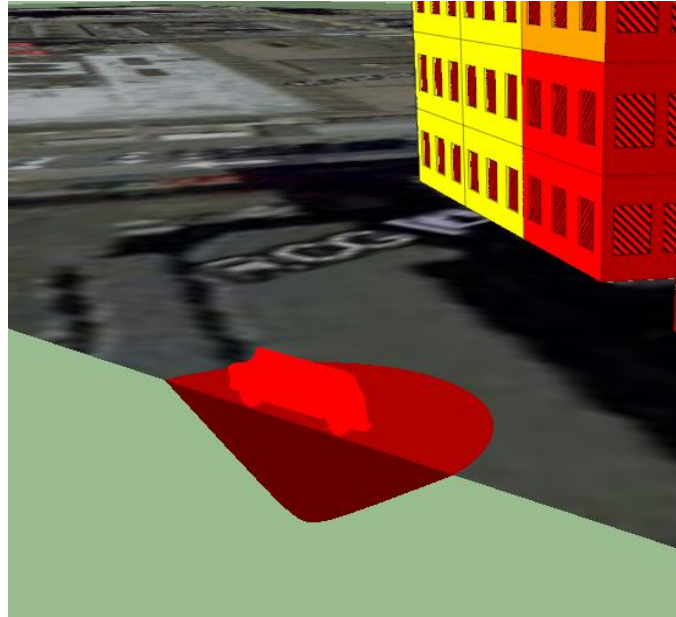
Airblast

- Fast-running (seconds to minutes)
- Exterior and interior propagation
- Accounts for reflections and diffraction around buildings
- Prototype urban canyon model



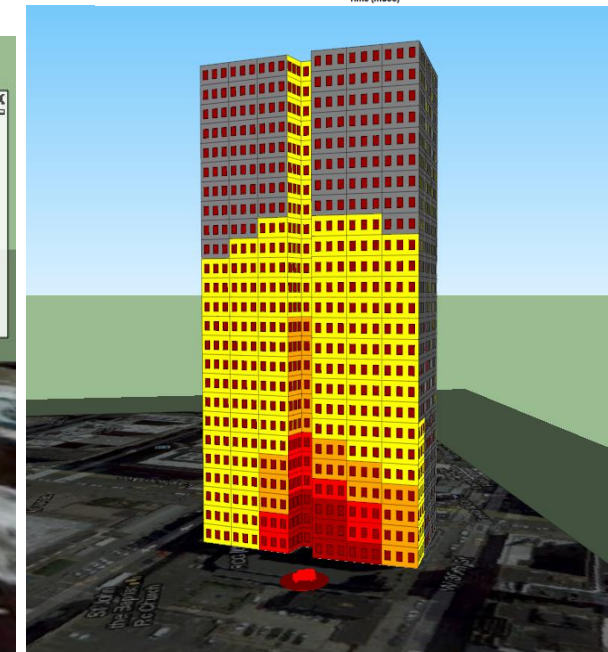
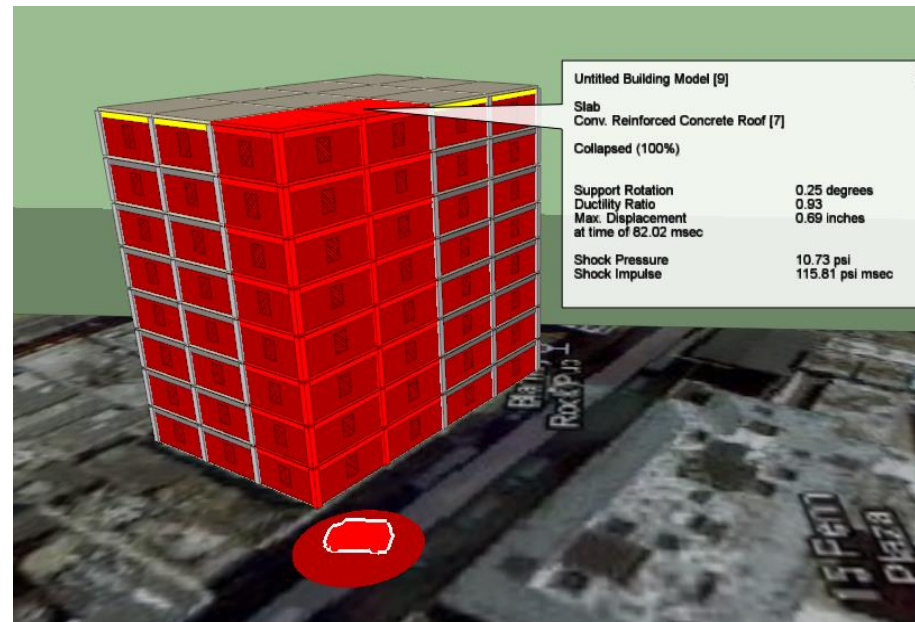
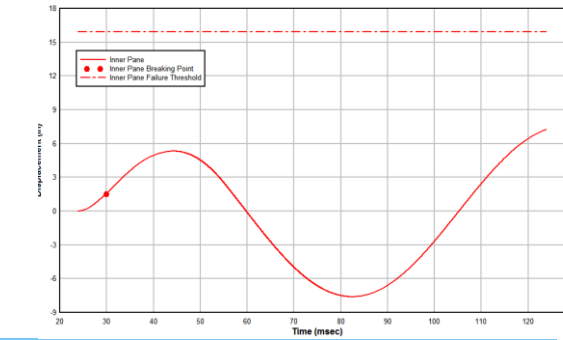
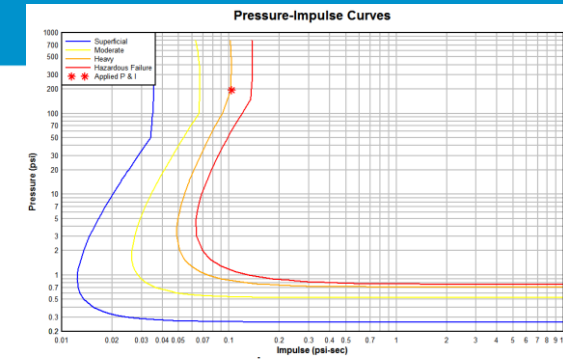
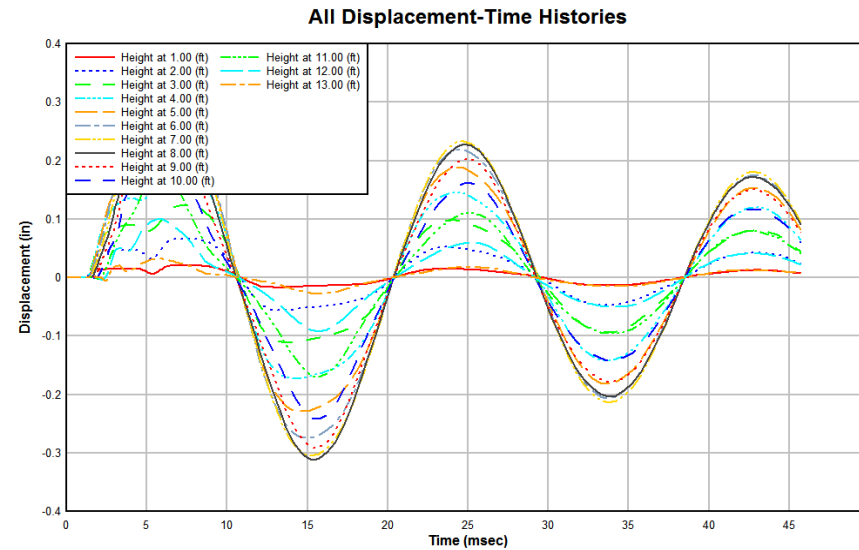
Cratering and Fragmentation

- Cratering routines based on UFC 3-340-01, “Design and Analysis of Hardened Structures to Conventional Weapons Effects.”
- Fragmentation based on straight-line with gravity calculations



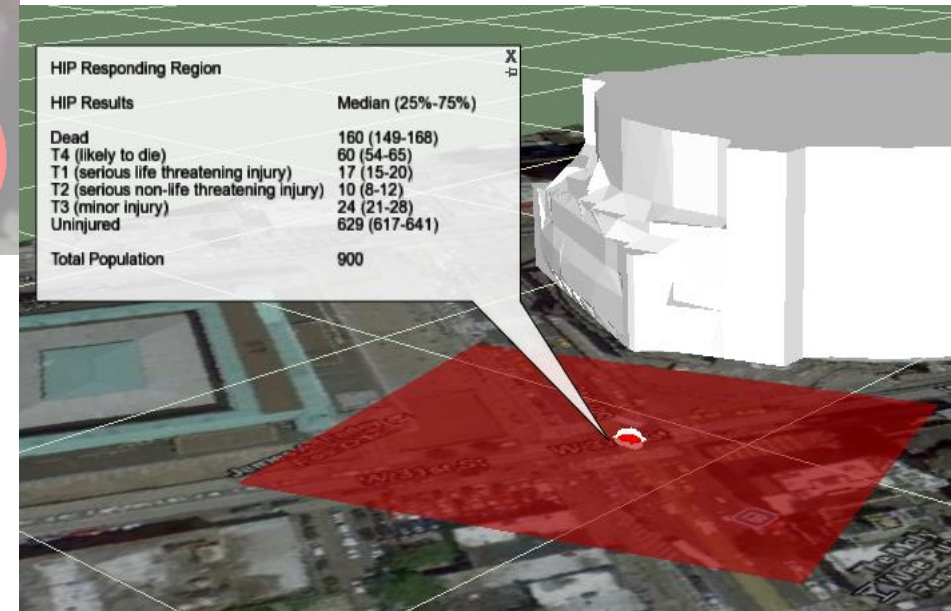
Structural Damage

- Pressure-Impulse Curves (P-I)
- Single-degree-of-freedom (SDOF)
- Multi-degree-of-freedom (MDOF)
- Collapse



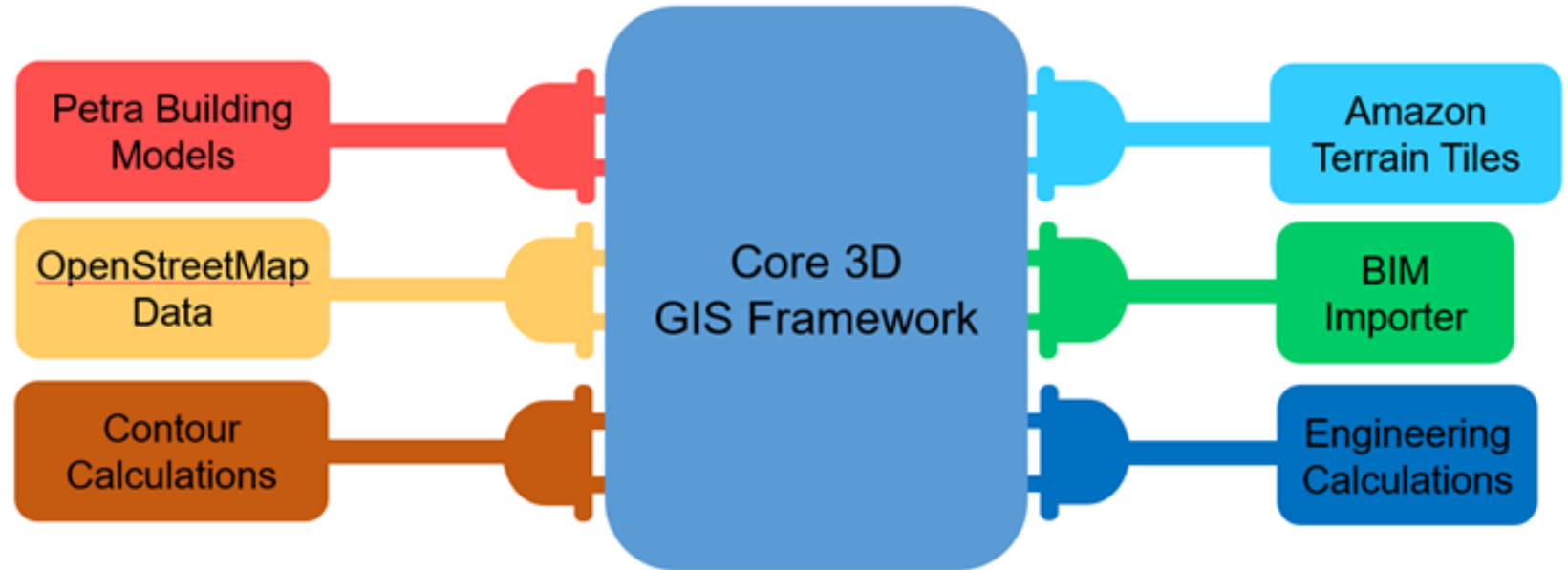
Human Injury

- Building injuries calculated using the Building Injury Calculator and DatabaseS (BICADS) methodology
- Exterior injuries calculated using the UK Defence Science and Technology Laboratory (DSTL) Human Injury Predictor (HIP) methodology



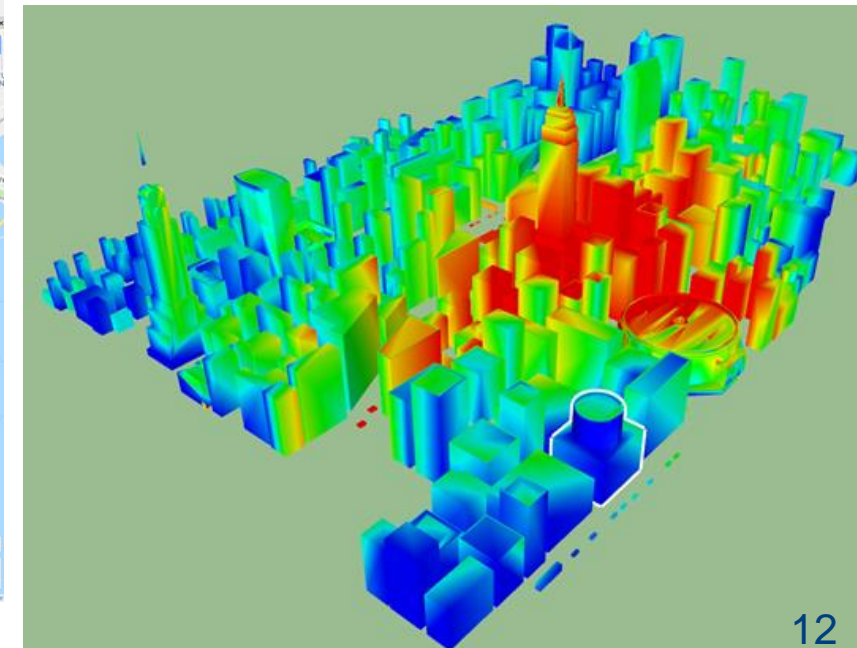
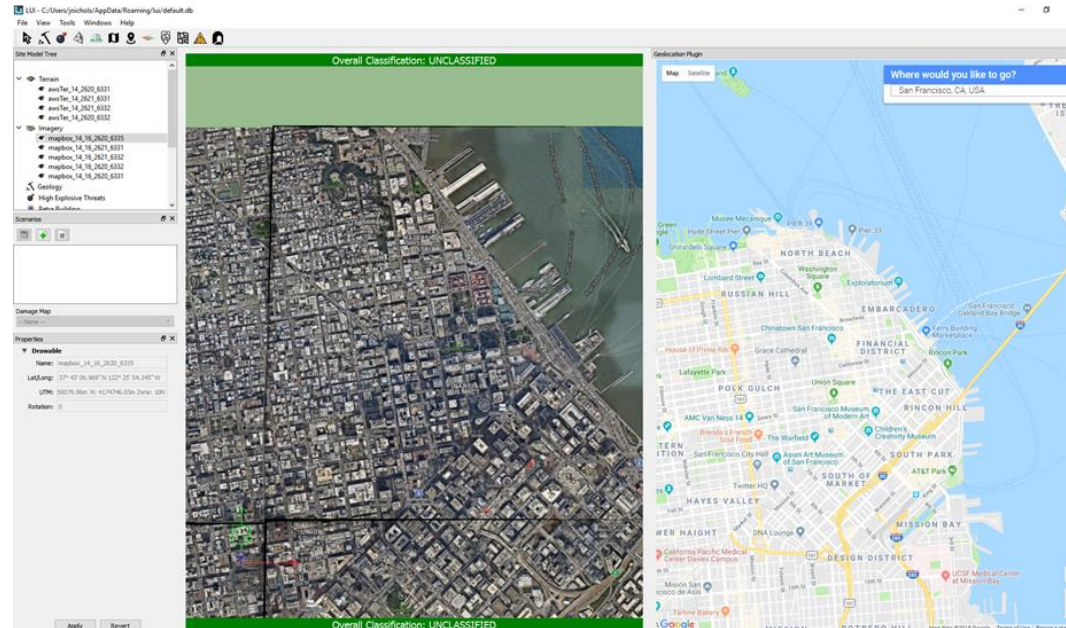
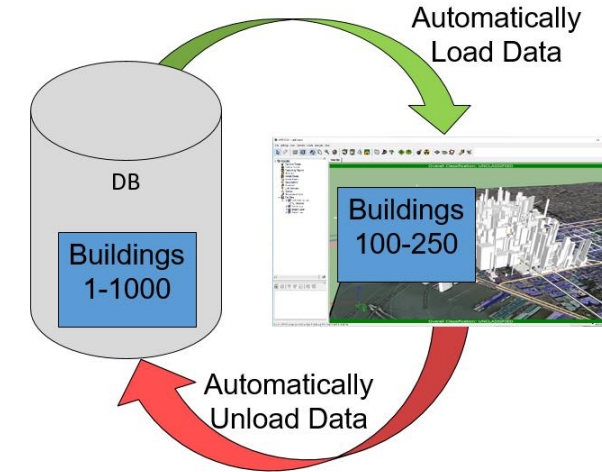
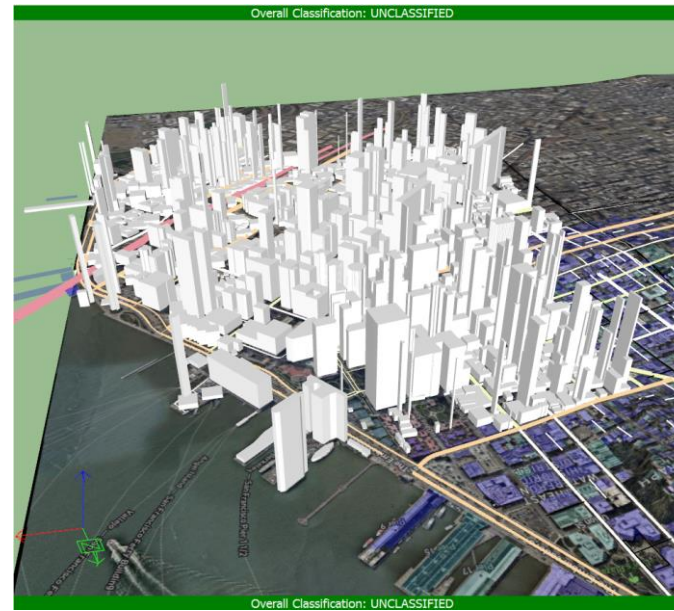
Current Work

- Plug-in architecture
- Domestic and international project agreements
- Open source data
- New domains
 - Tunnel systems
 - Emerging threats



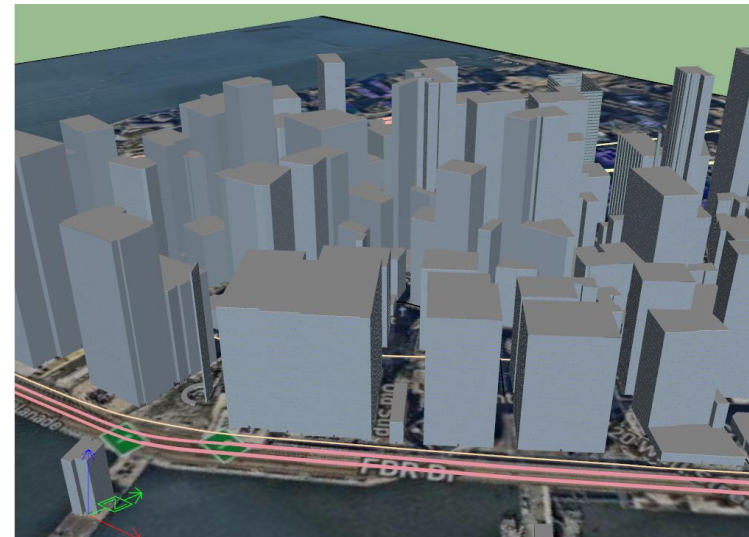
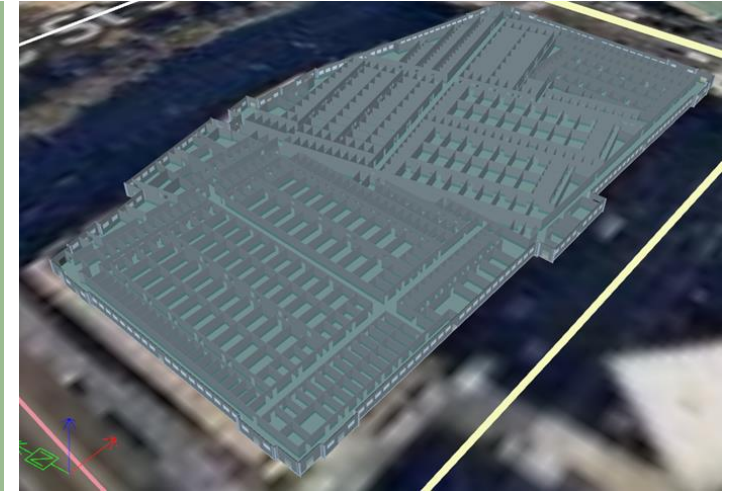
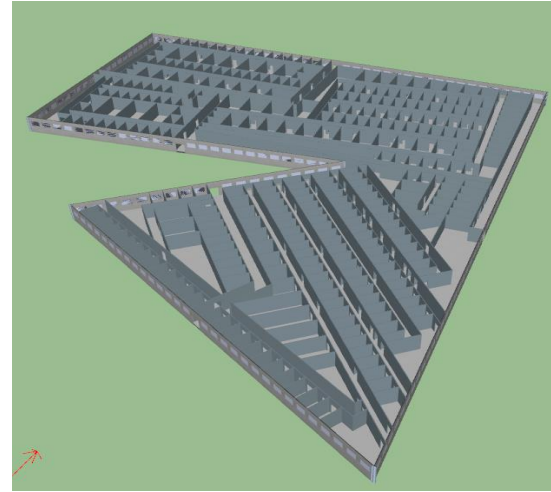
Scalability

- Ability to handle dense urban areas
- Dynamic data paging
- Sophisticated level-of-detail visualization system

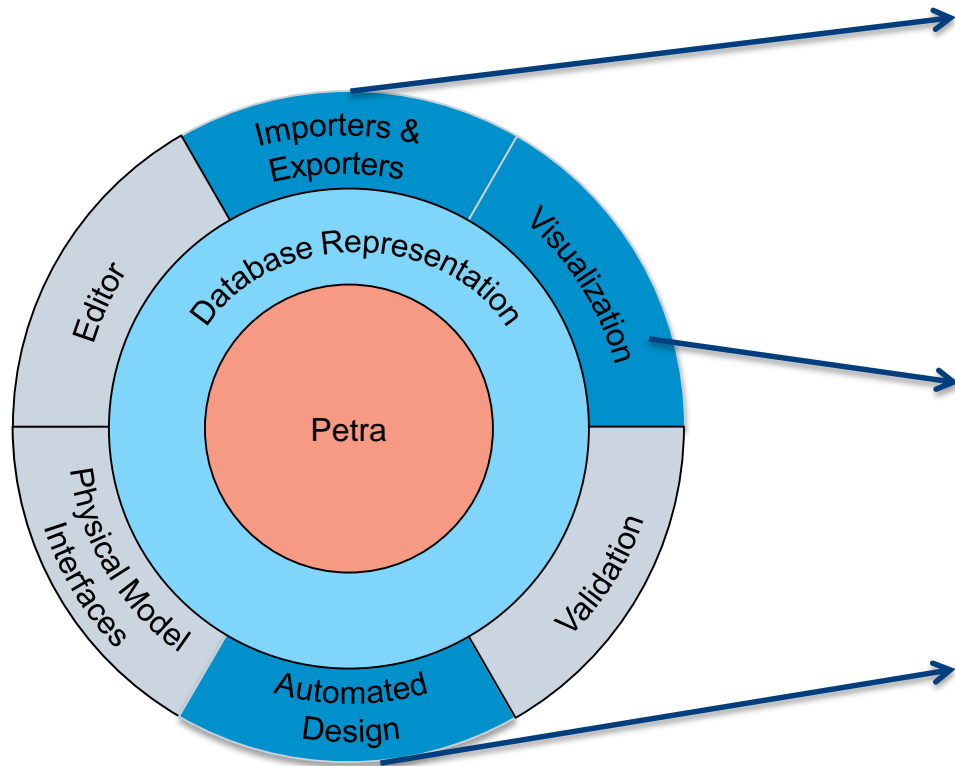


Petra Building Model

- New building model format
- Flexible and extendable
- BIM-friendly (e.g., IFC importer)



Petra Ecosystem



PetraIO

- Importer and exporter to both an internal and IFC formats
- Currently only supports IFC2x3

PetraViz

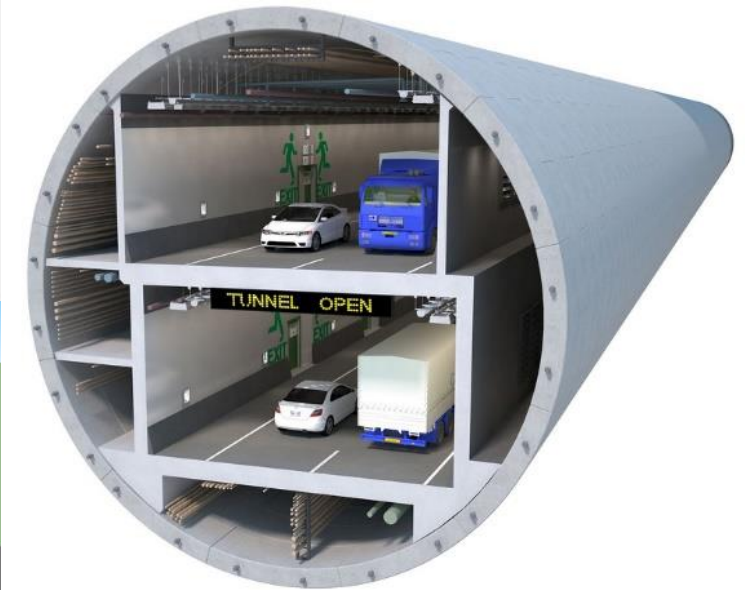
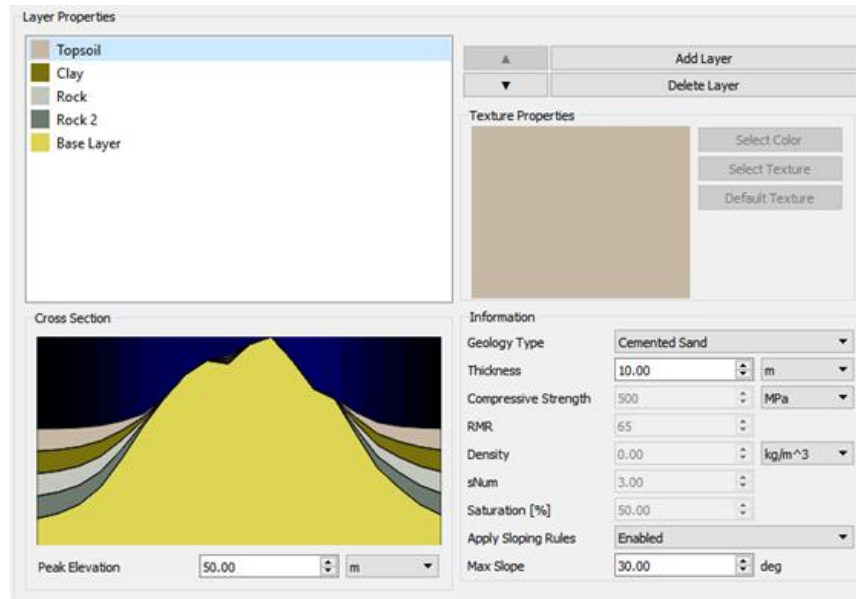
- Creates a separate, closed, triangular mesh for each installation (building component)

PetraTBD

- Separated into two parts: layout (architect) and structural design (engineer)

New Domains

- Geology
- Tunnel modeling
- Emerging threats
 - Underground
 - Drones



Summary

- Overlap of phenomenology between the vulnerability assessment and explosive safety communities
- DTRA is developing a modular architecture that can be re-used across domains
- Plug-ins can be developed independently within particular agencies/divisions, but also easily shared if developed with appropriate interfaces
- DTRA hopes to start/continue discussions on how to save costs on re-developing similar methodologies, allowing agencies to push forward and solve emerging problems

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