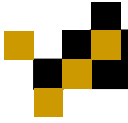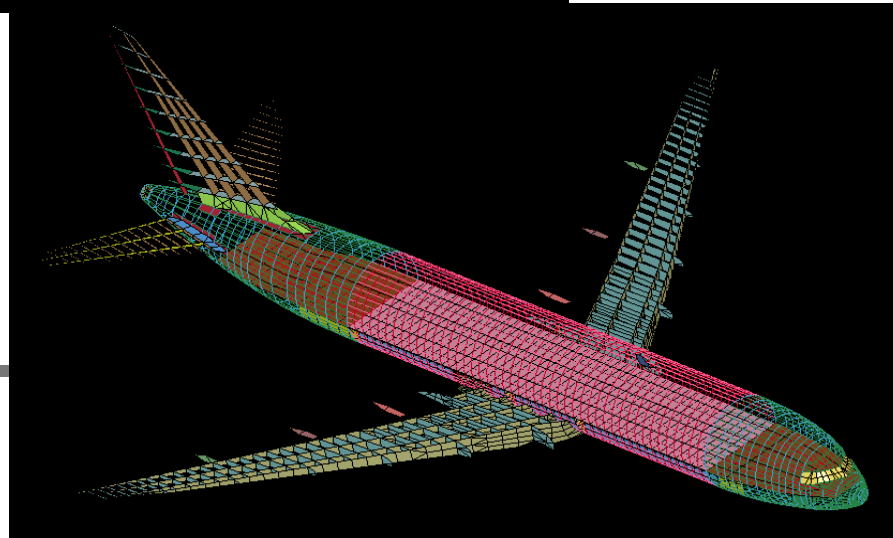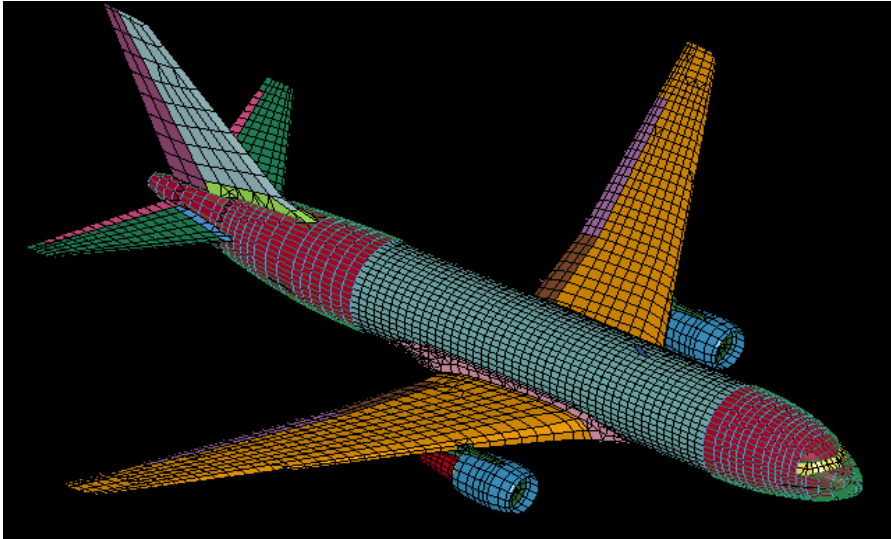# Visualizing the WTC

Paul Rosen
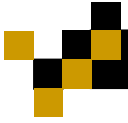
Voicu Popescu

Chris Hoffmann

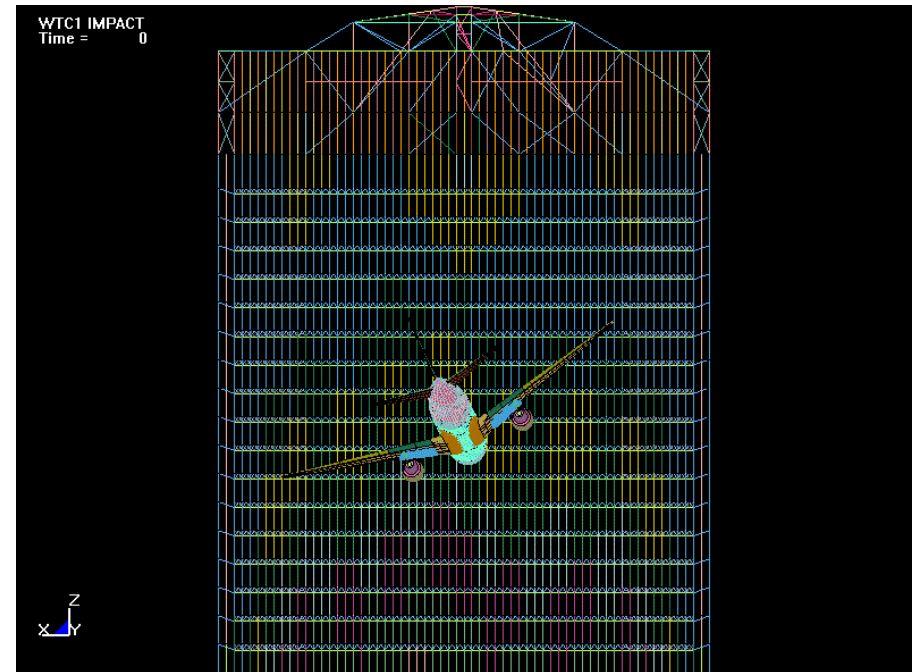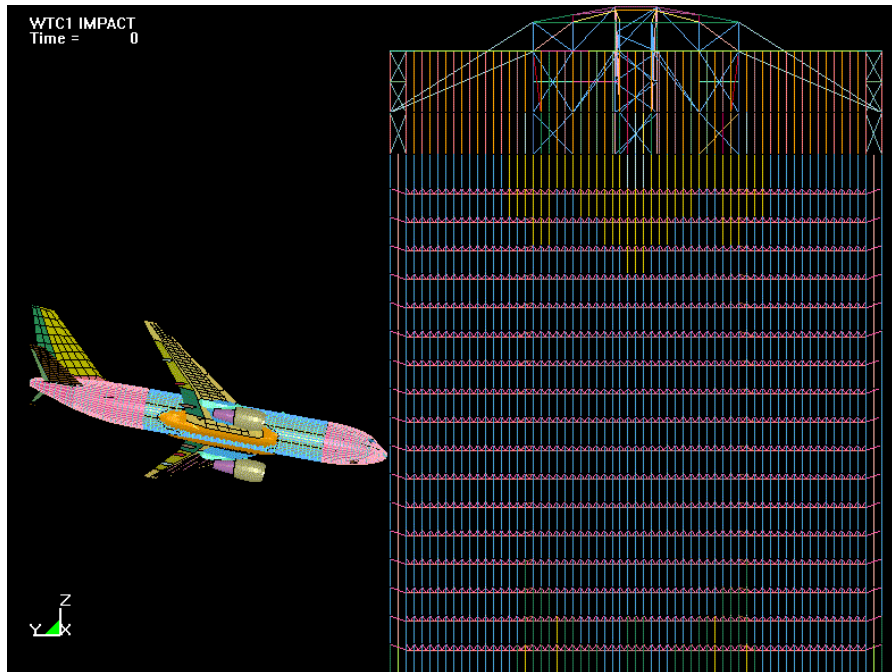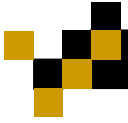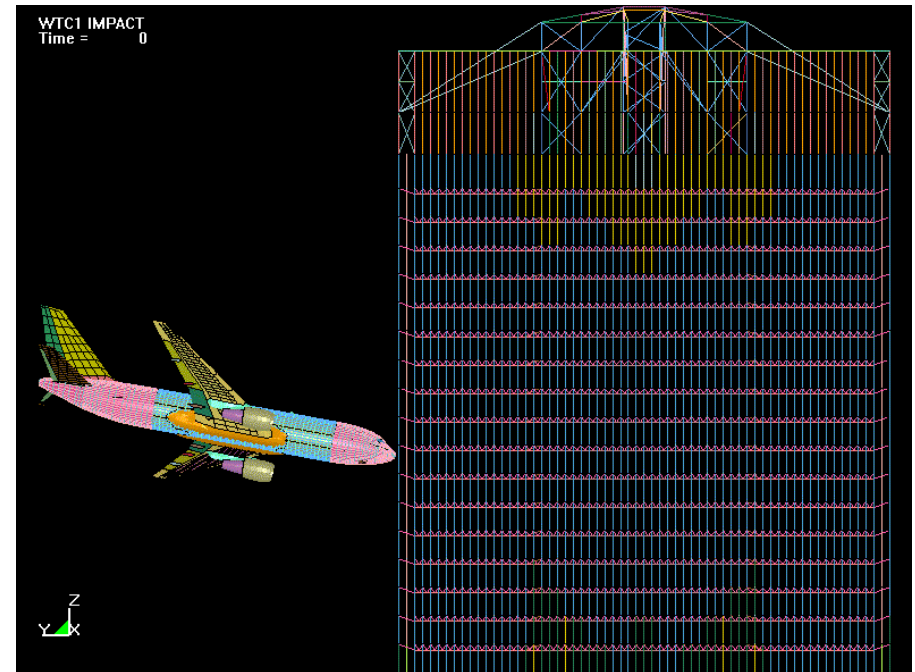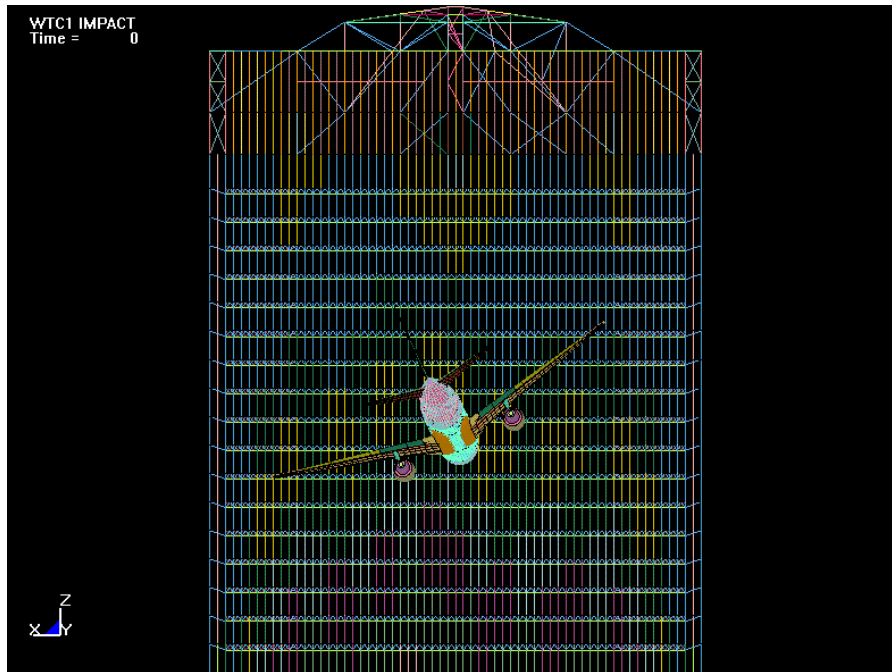Department of Computer Science
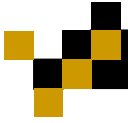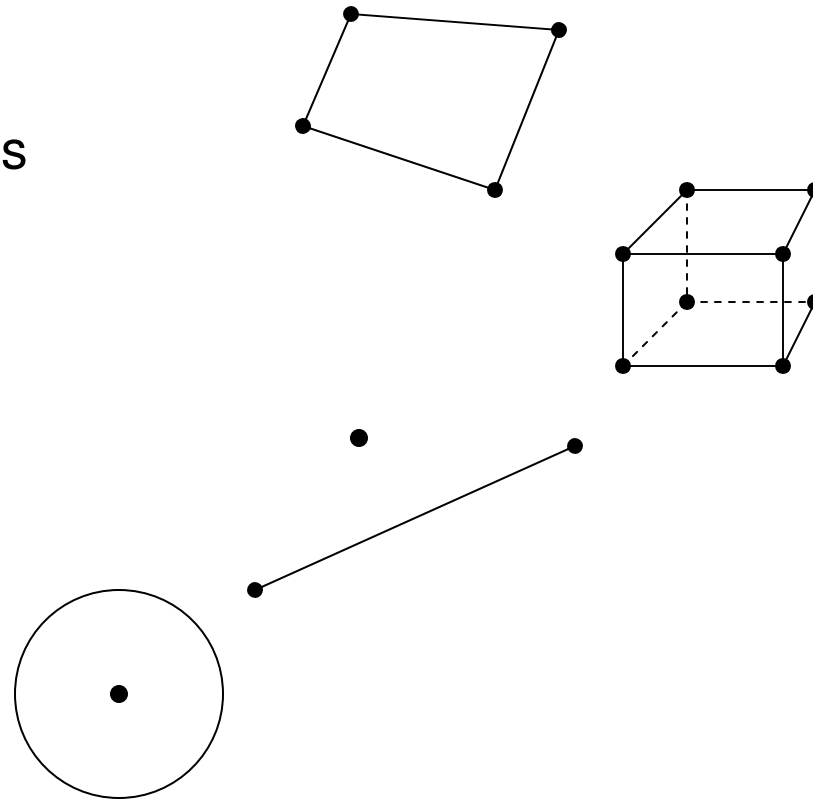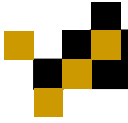
Previously

Simulation Results

Simulation Results

Types of Elements

- **Shells**
  - 3 or 4 connectivity nodes
- **Solids**
  - 8 connectivity nodes
- **Beams**
  - 2 connectivity nodes
  - 1 orientation node
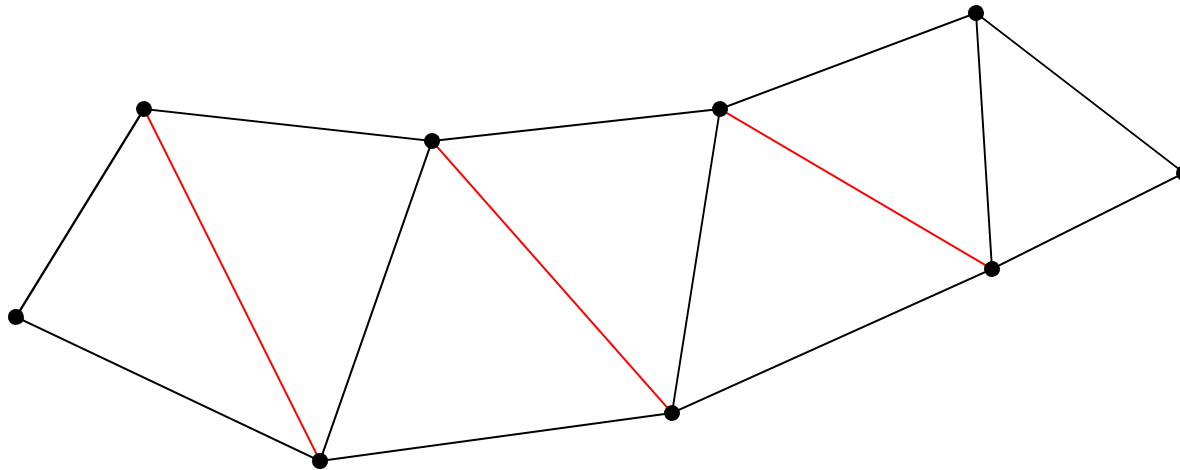- **SPH (Fuel)**
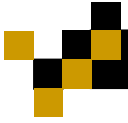 - 1 node
  - Radius of influence
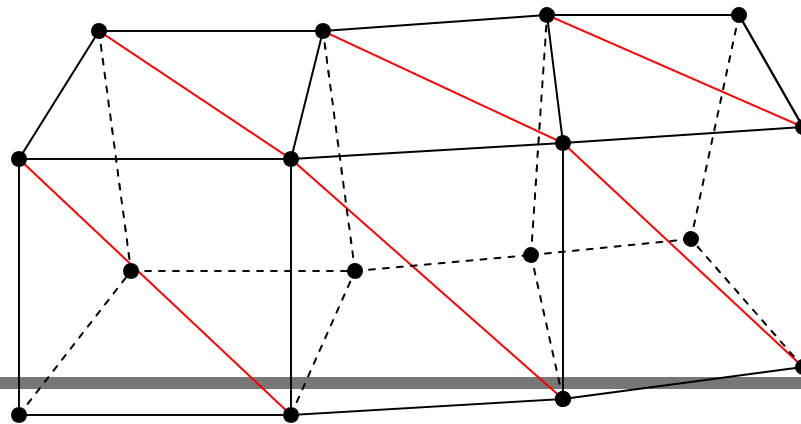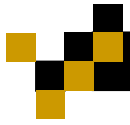
Meshing Shells

- Just triangulate

Meshing Solids

- Just triangulate
- Removal of internal faces will reduce triangle count, but is not necessary
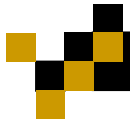
Meshing Beams

- Meshing beams is not as simple as other element types
- Beams have different cross section types
    - These cross sections introduce additional difficulties
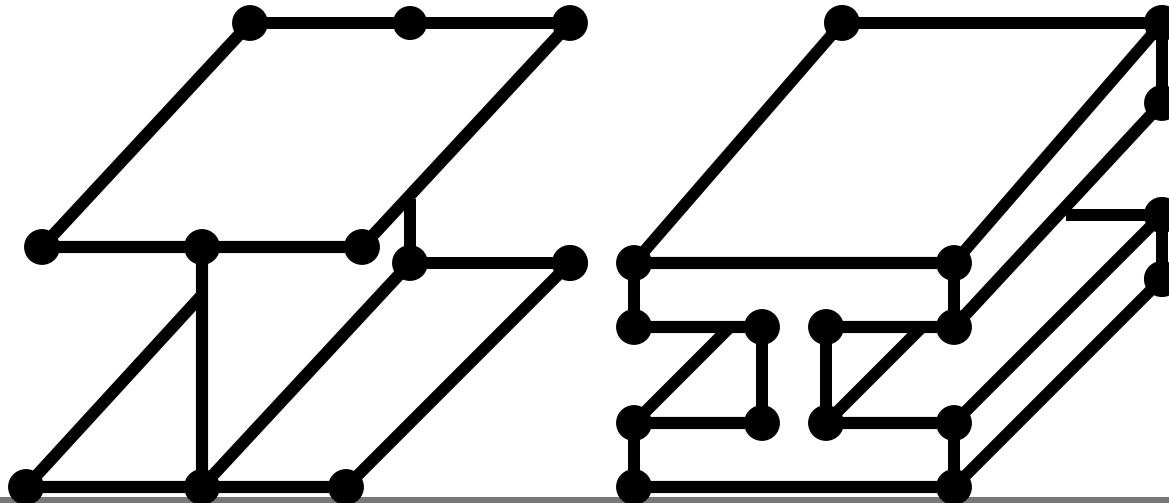- Examples (not all are used in the WTC)

□ Ⅰ Ｔ ○ ⊏ Ｌ

Meshing Beams
Cross Sections

- Take I-Beam as an example
- Expand each beam
  - Thin - 12 vertices, 3 faces*
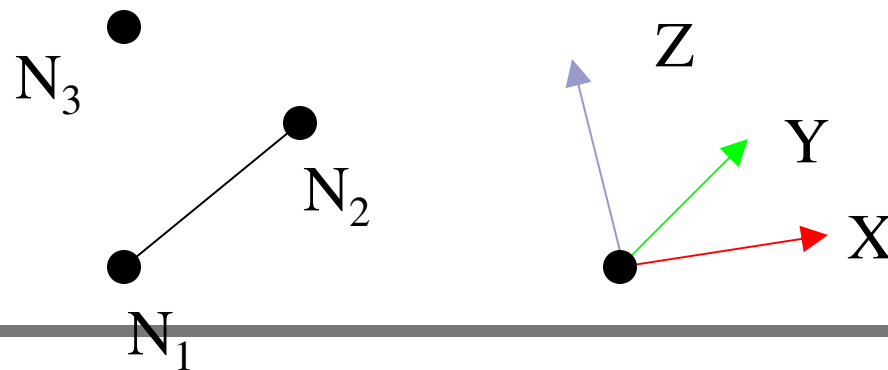 - Thick - 24 vertices, 18 faces*
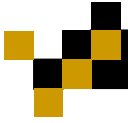
Meshing Beams Orientation

$$Y = \frac{N_2 - N_1}{|N_2 - N_1|}$$
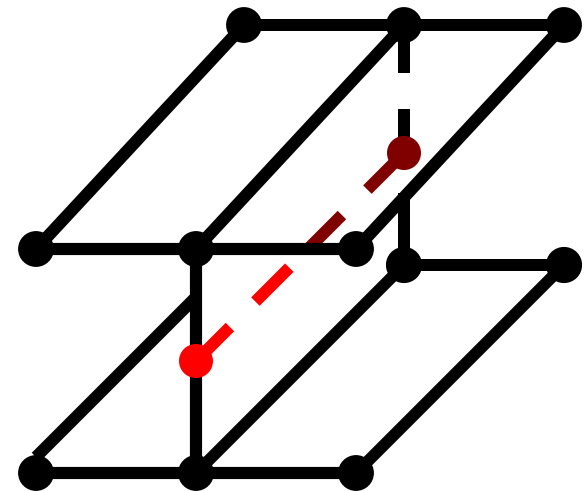
$$Z = \frac{N_3 - N_1}{|N_3 - N_1|}$$

$$X = Y \times Z$$

Meshing Beams
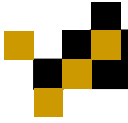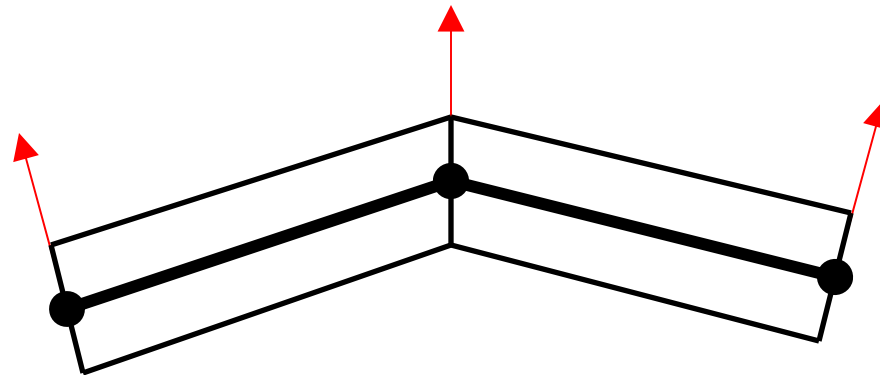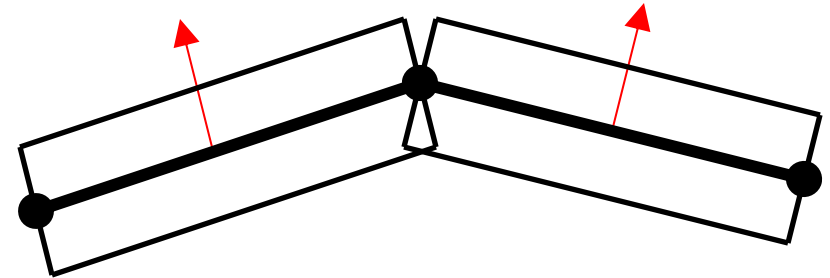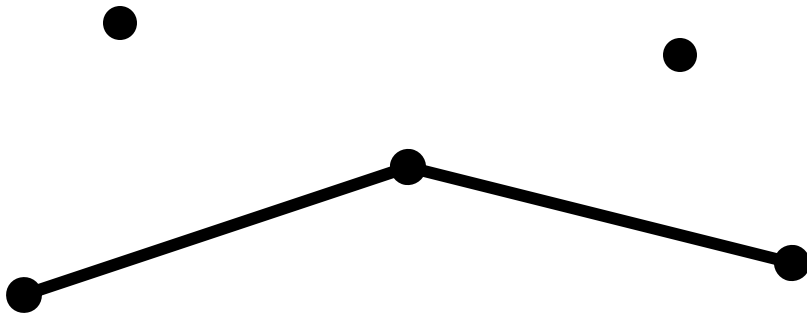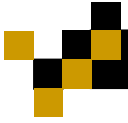
- Expanding line based representation to a large cross section introduces complications.
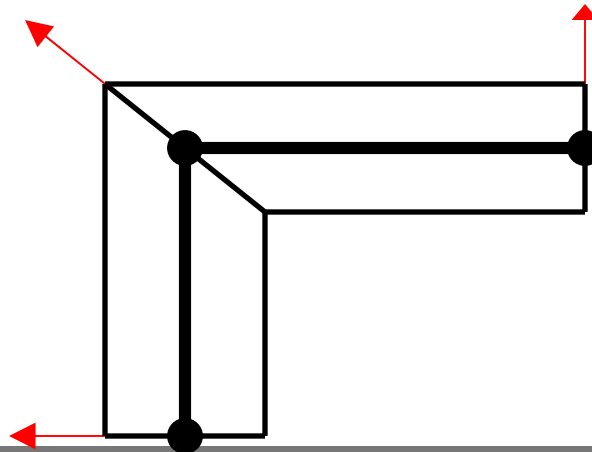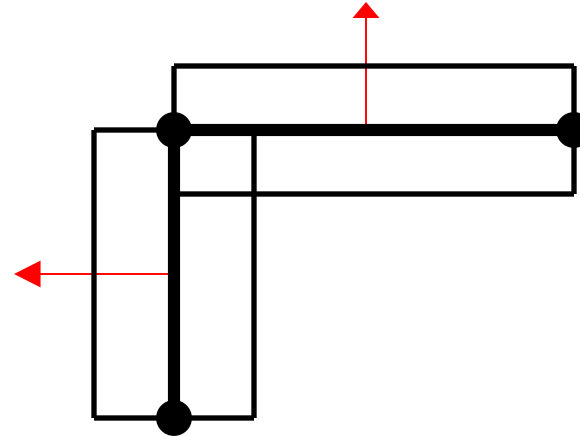 - Connected beams
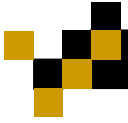 - Beams protruding through shell surfaces

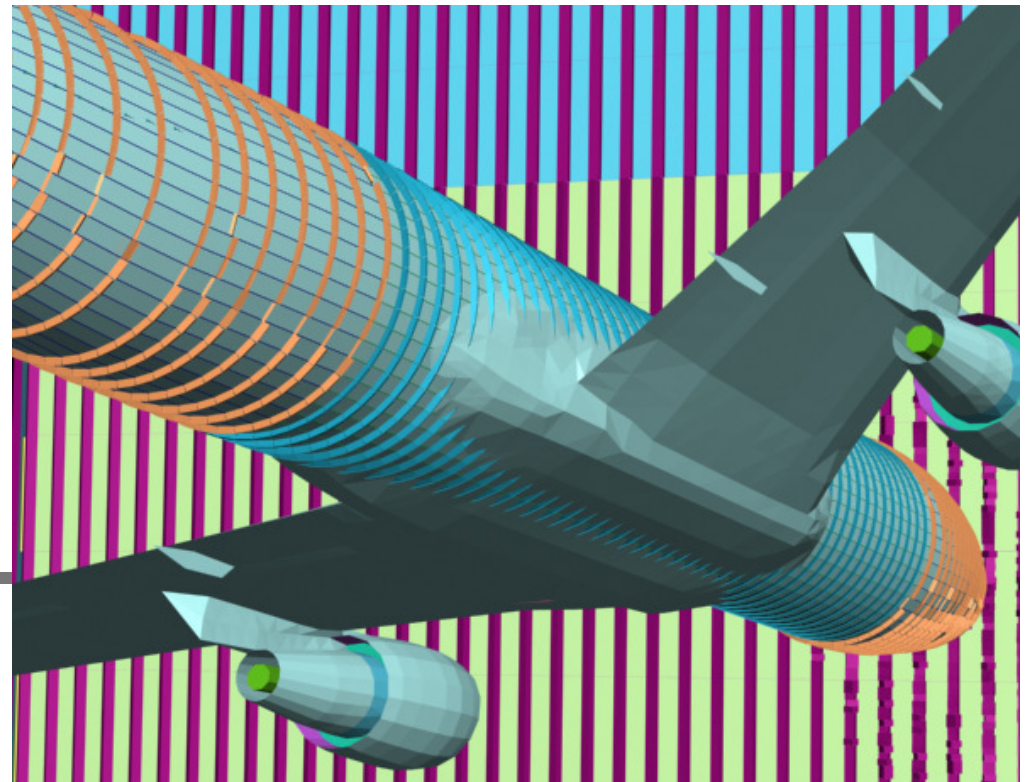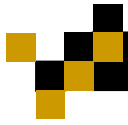# Meshing Beams

Meshing Beams

Meshing Beams

- Beams and shells share nodes
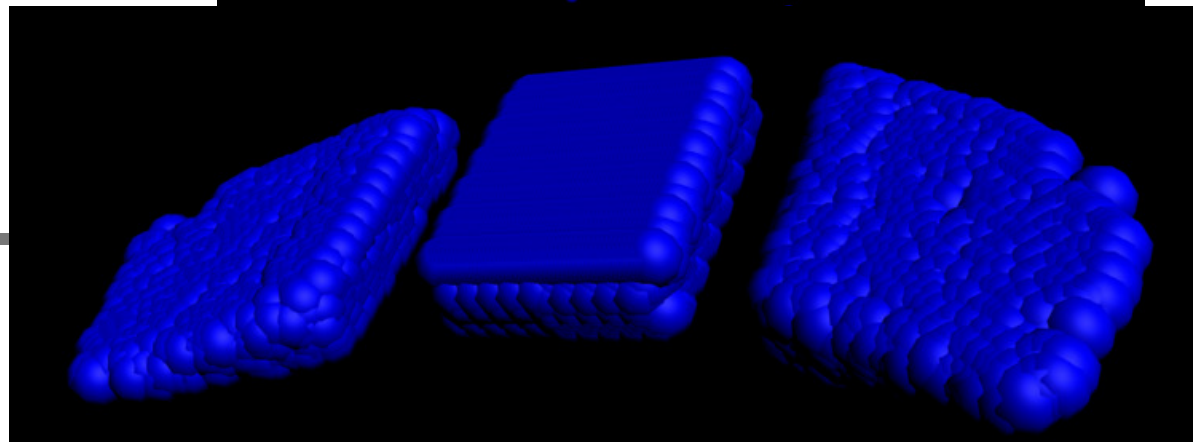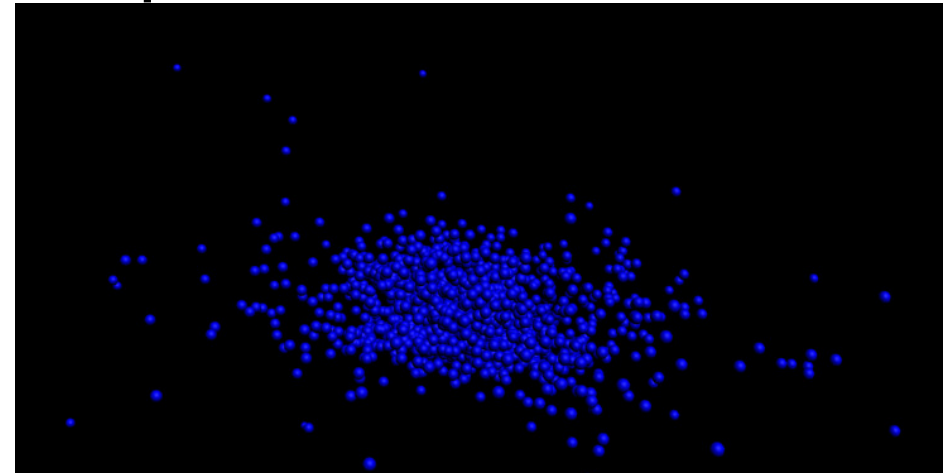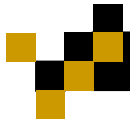- Causes beams to protrude out of the fuselage

Visualizing SPH Fuel

- **Currently imported as spheres**
  - Not working well
- **Possible solutions**
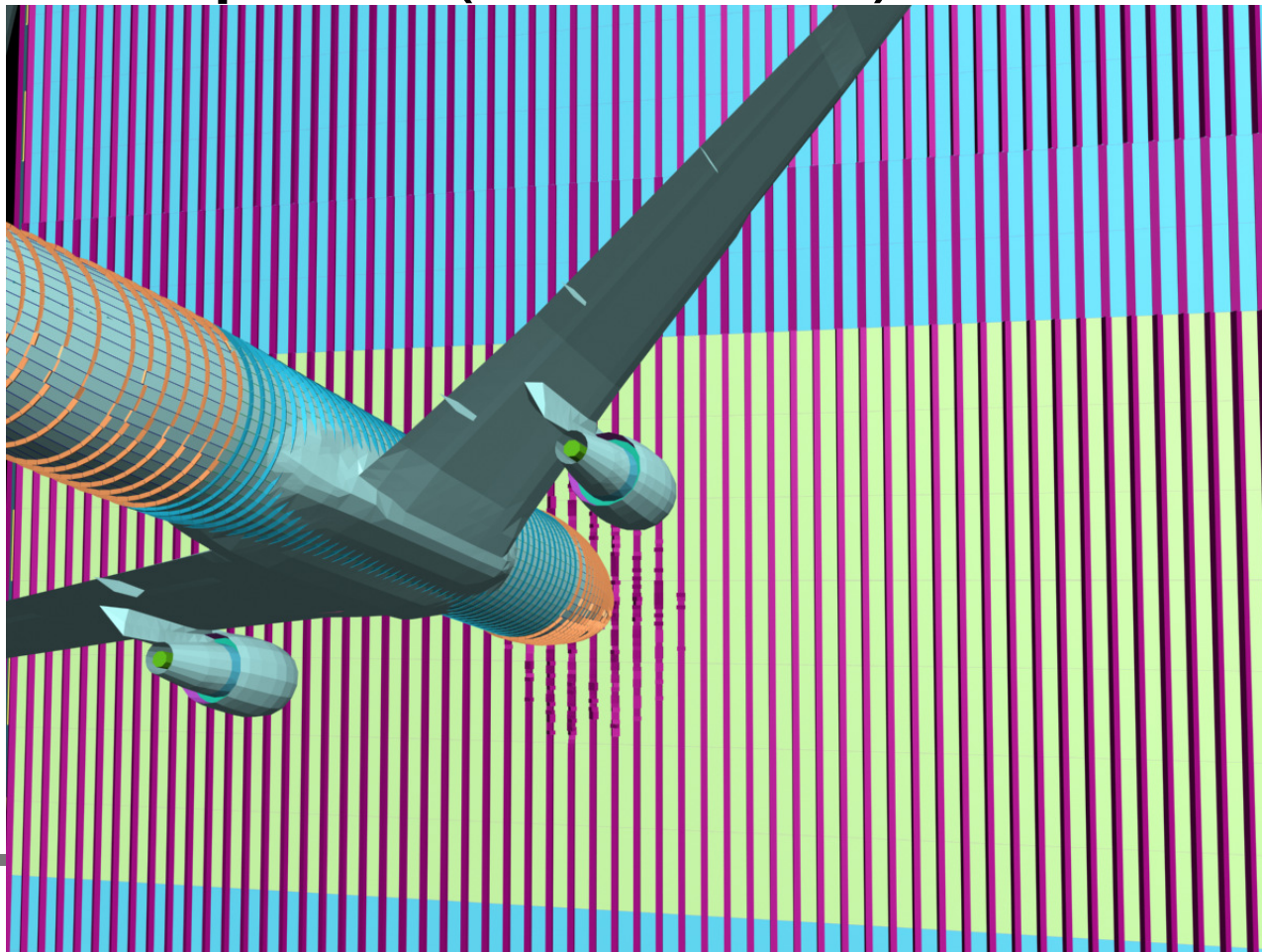 - Blob meshes
  - Space carving

Animation

- Can only import 1 frame of simulation at a time
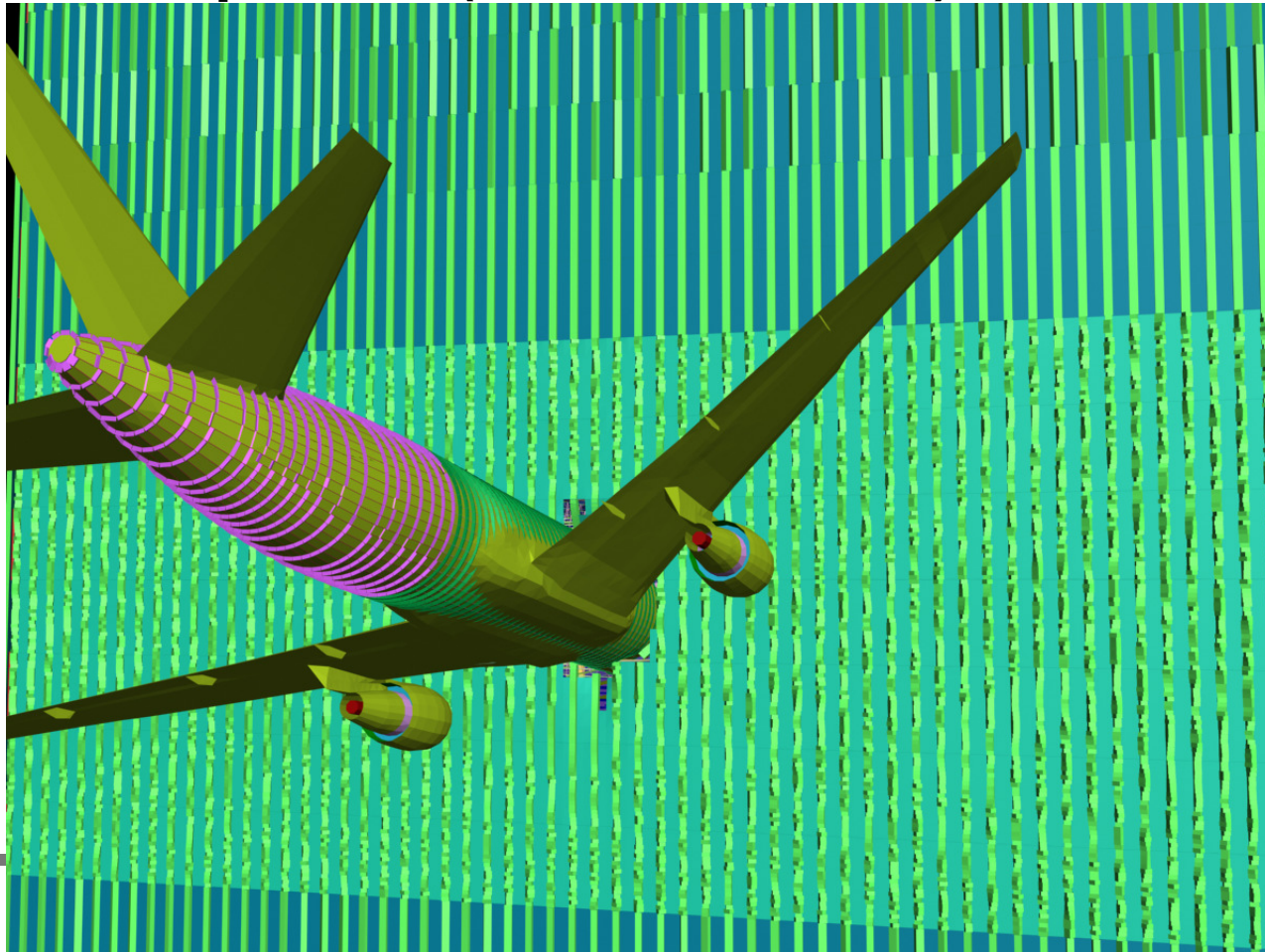 - Number of position controllers required overwhelms 3ds max
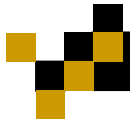
Some images
Front Impact (Frame 1)

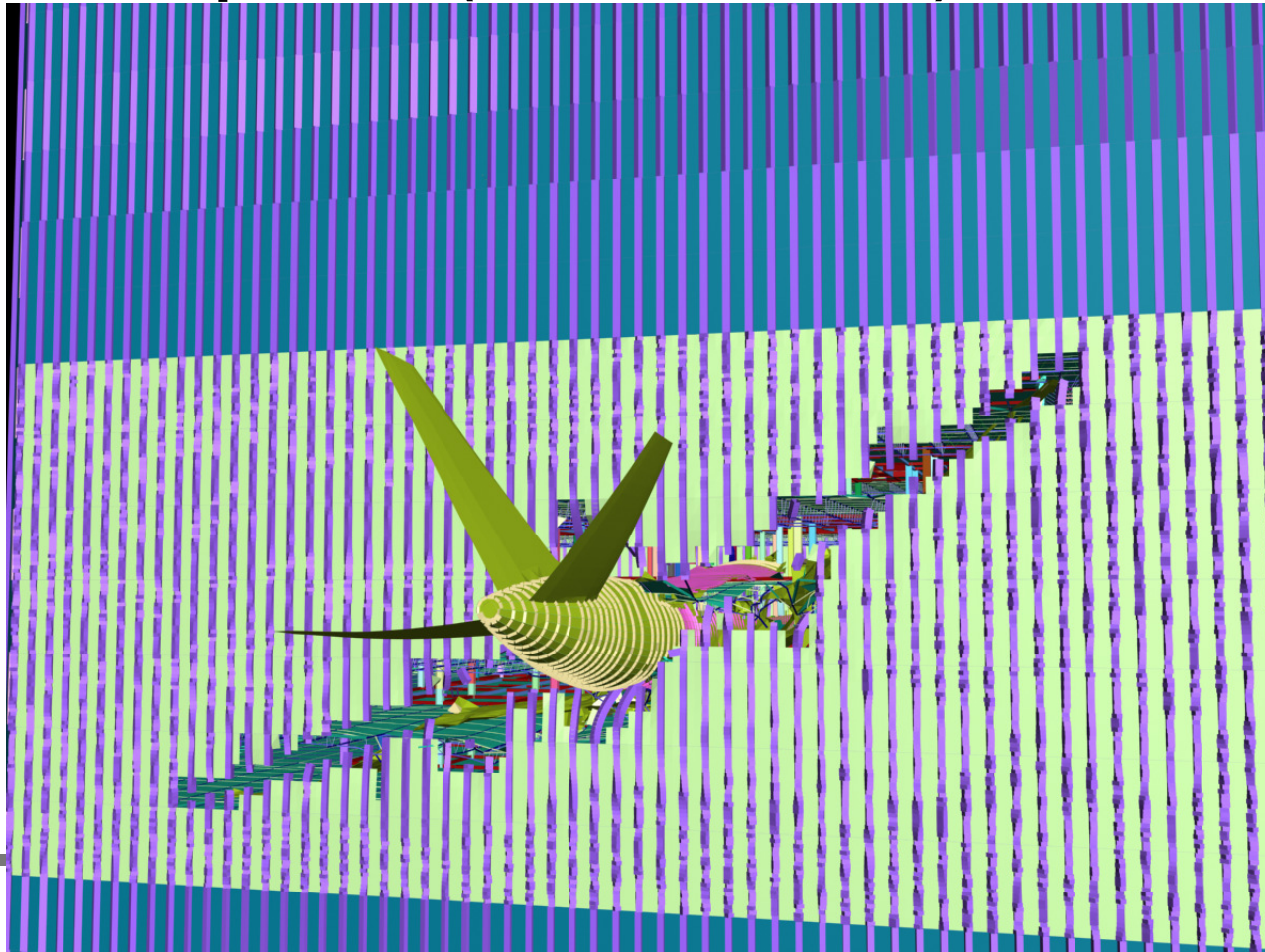# Some images
Front Impact (Frame 25)
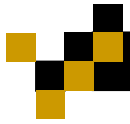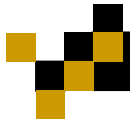
Some images
Front Impact (Frame 50)

Some images
Front Impact (Frame 75)
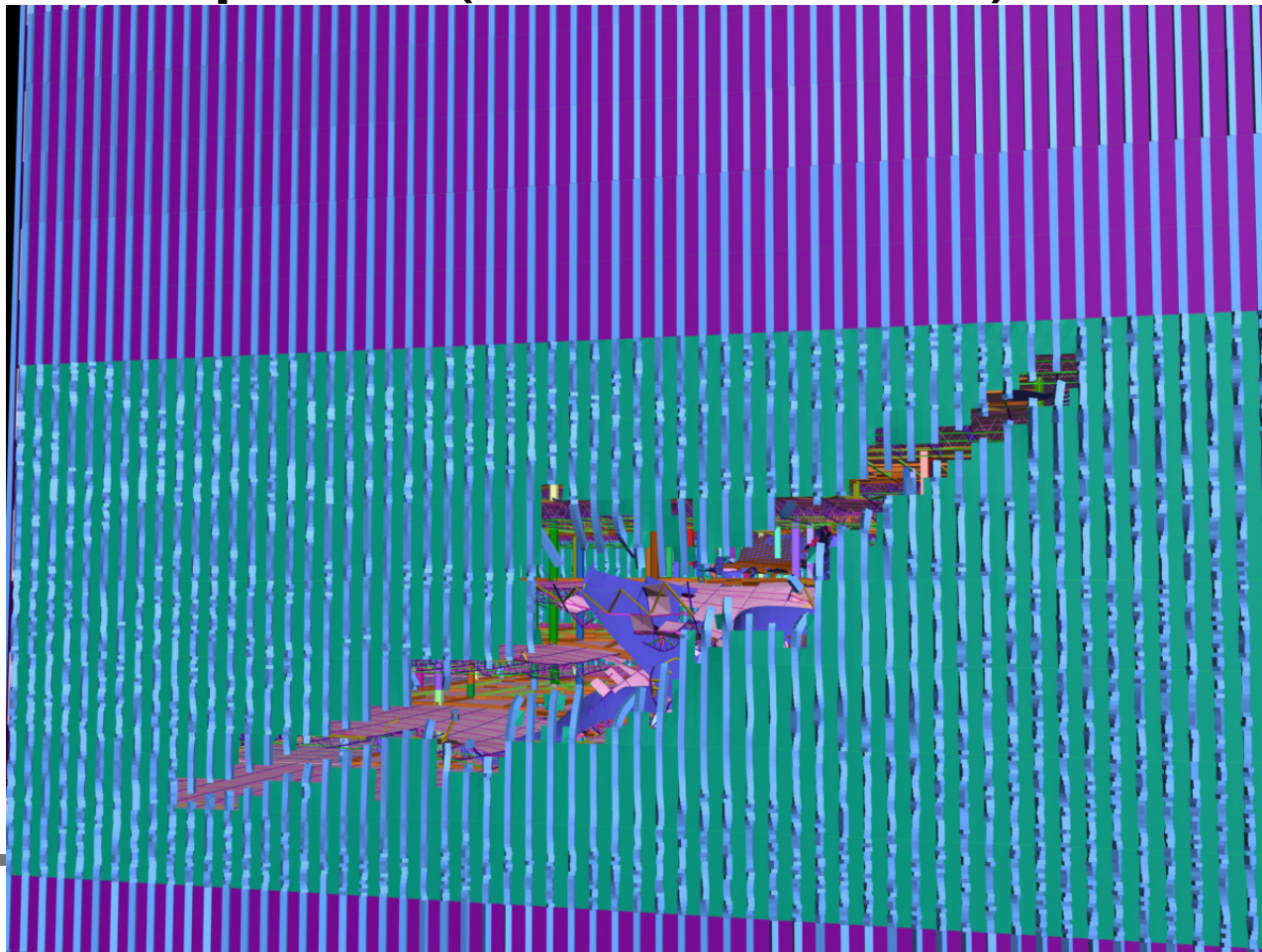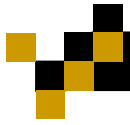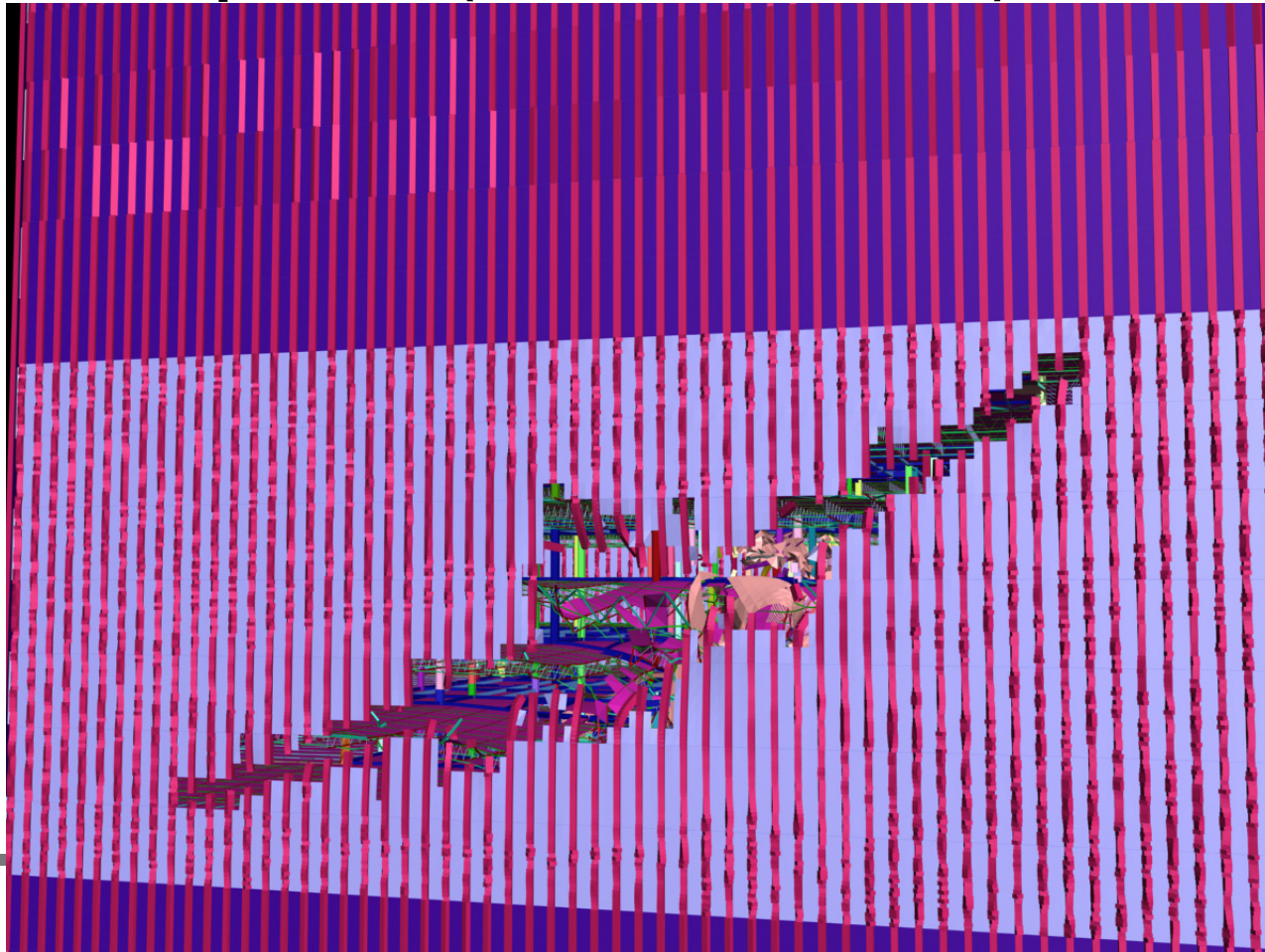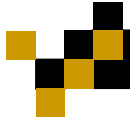
Some images
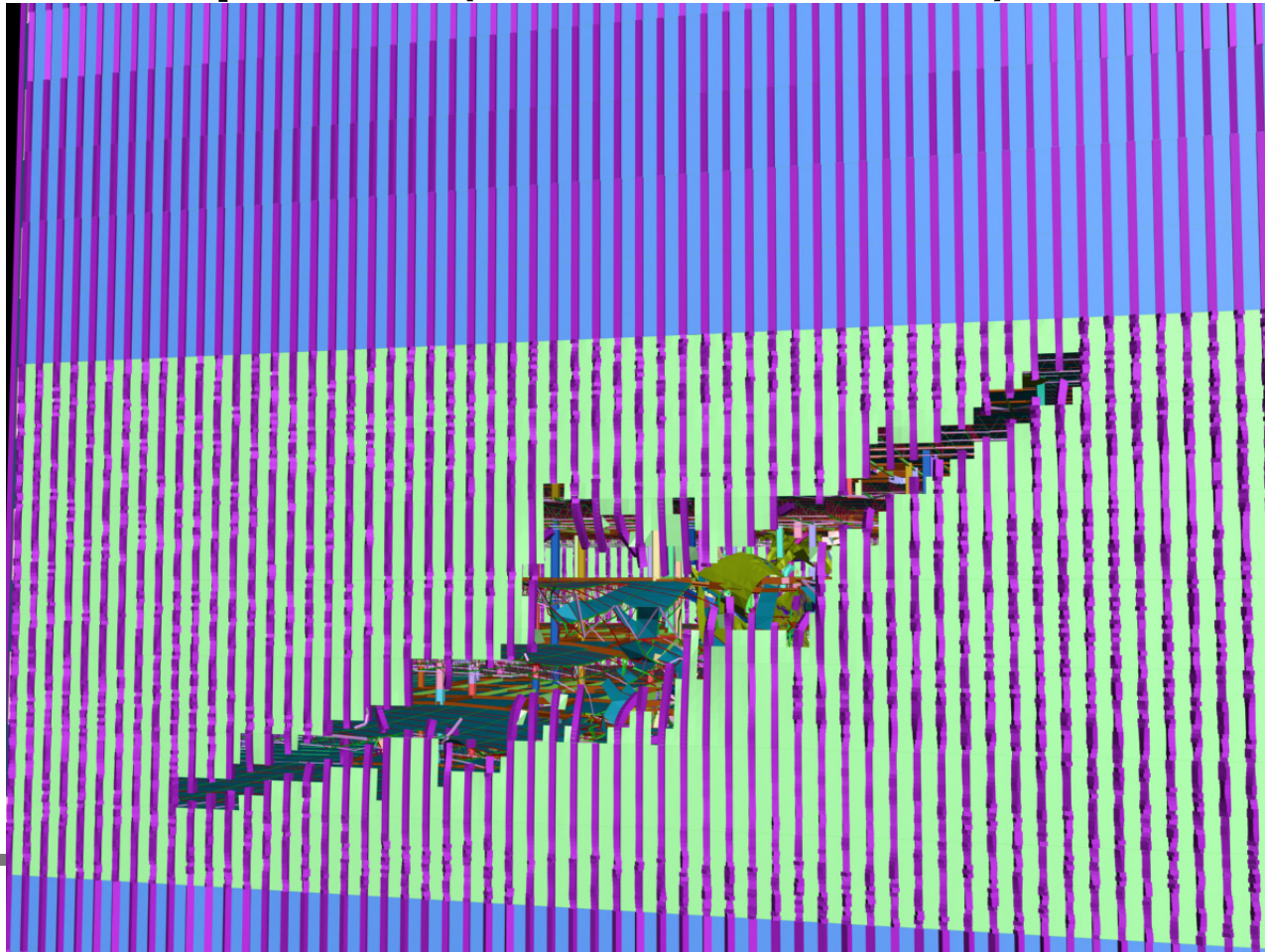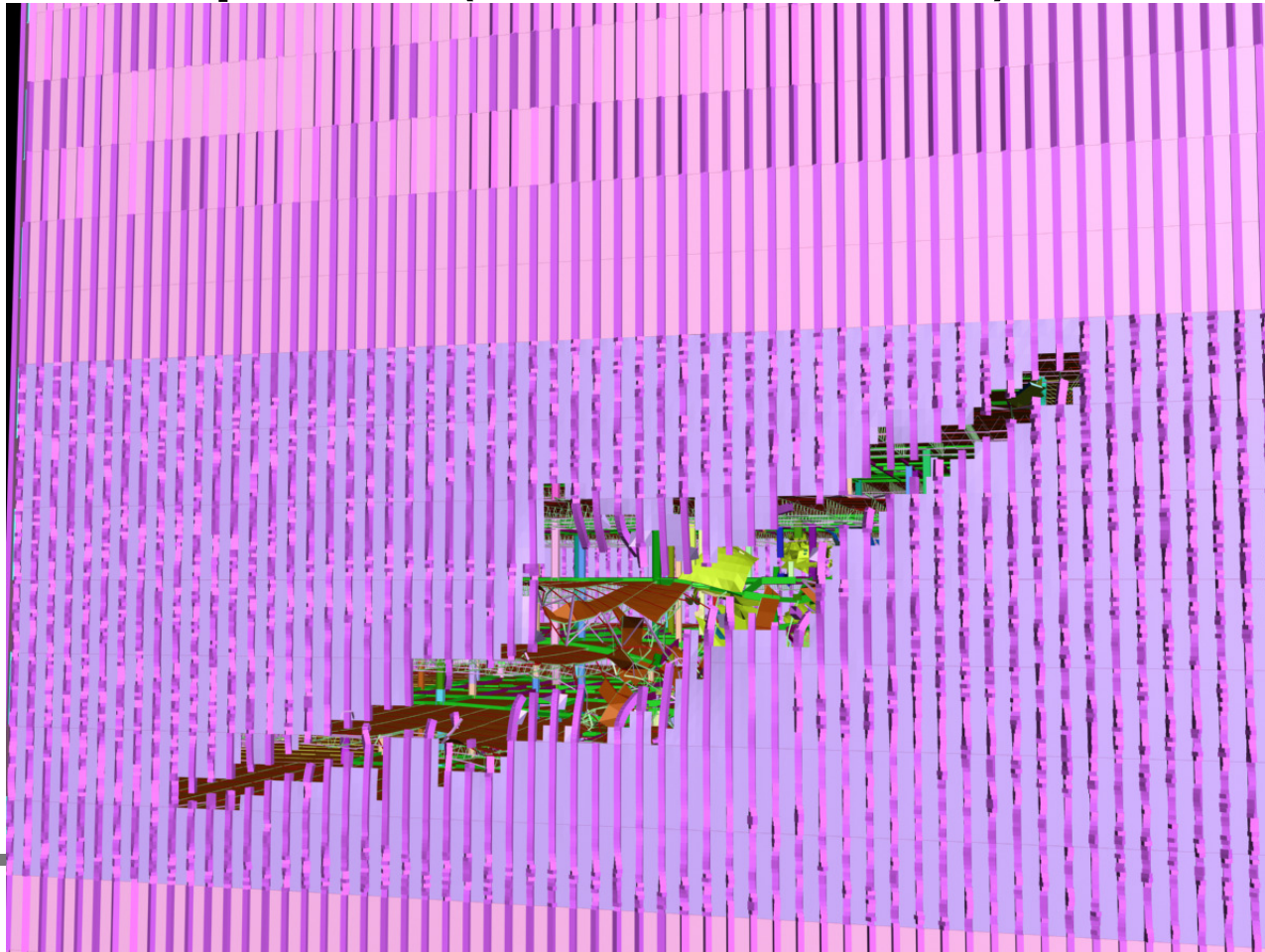# Front Impact (Frame 100)

Some images
Front Impact (Frame 125)

Some images
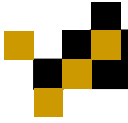# Front Impact (Frame 150)
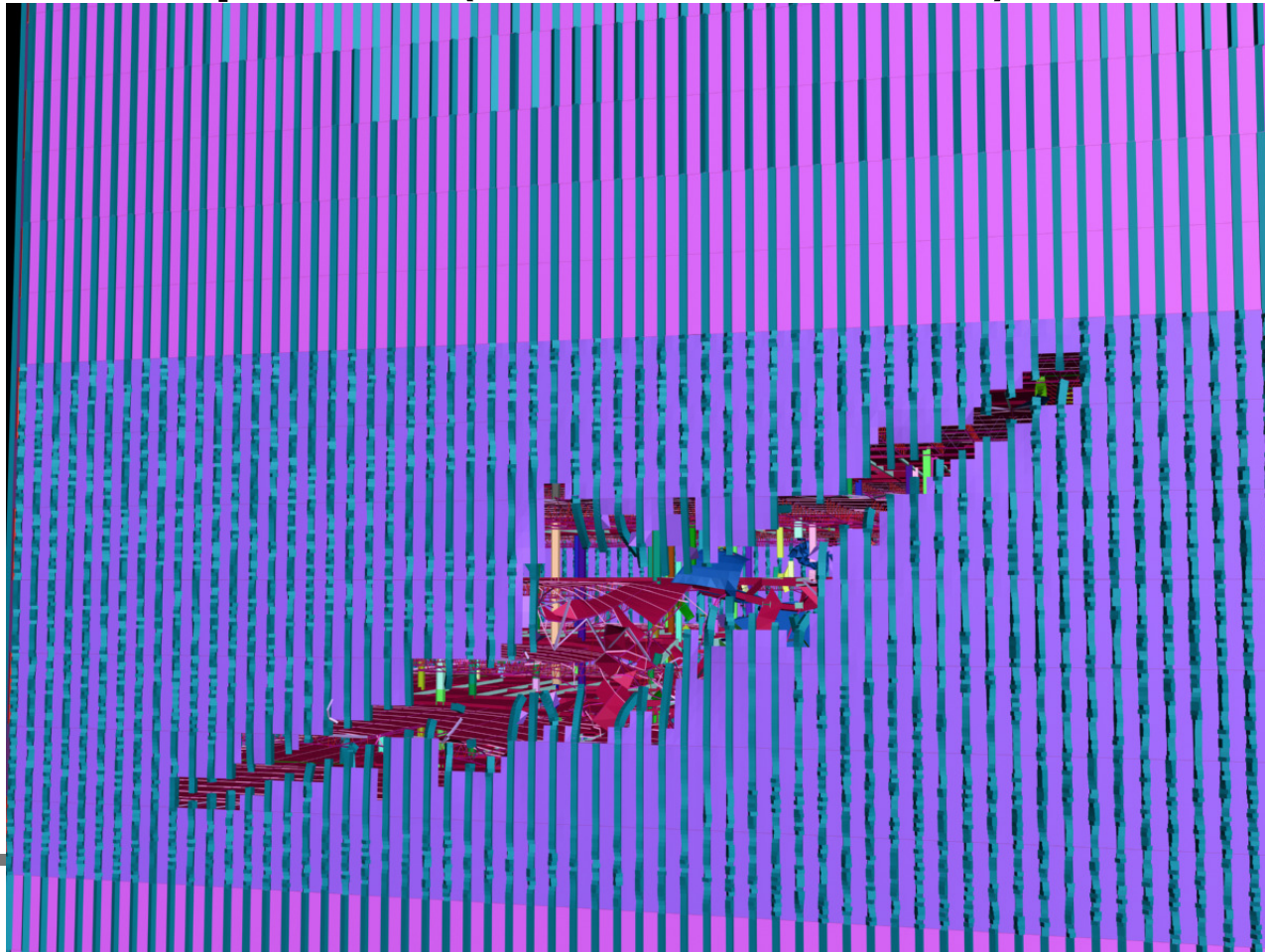
Some images
Front Impact (Frame 175)
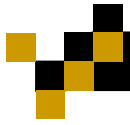
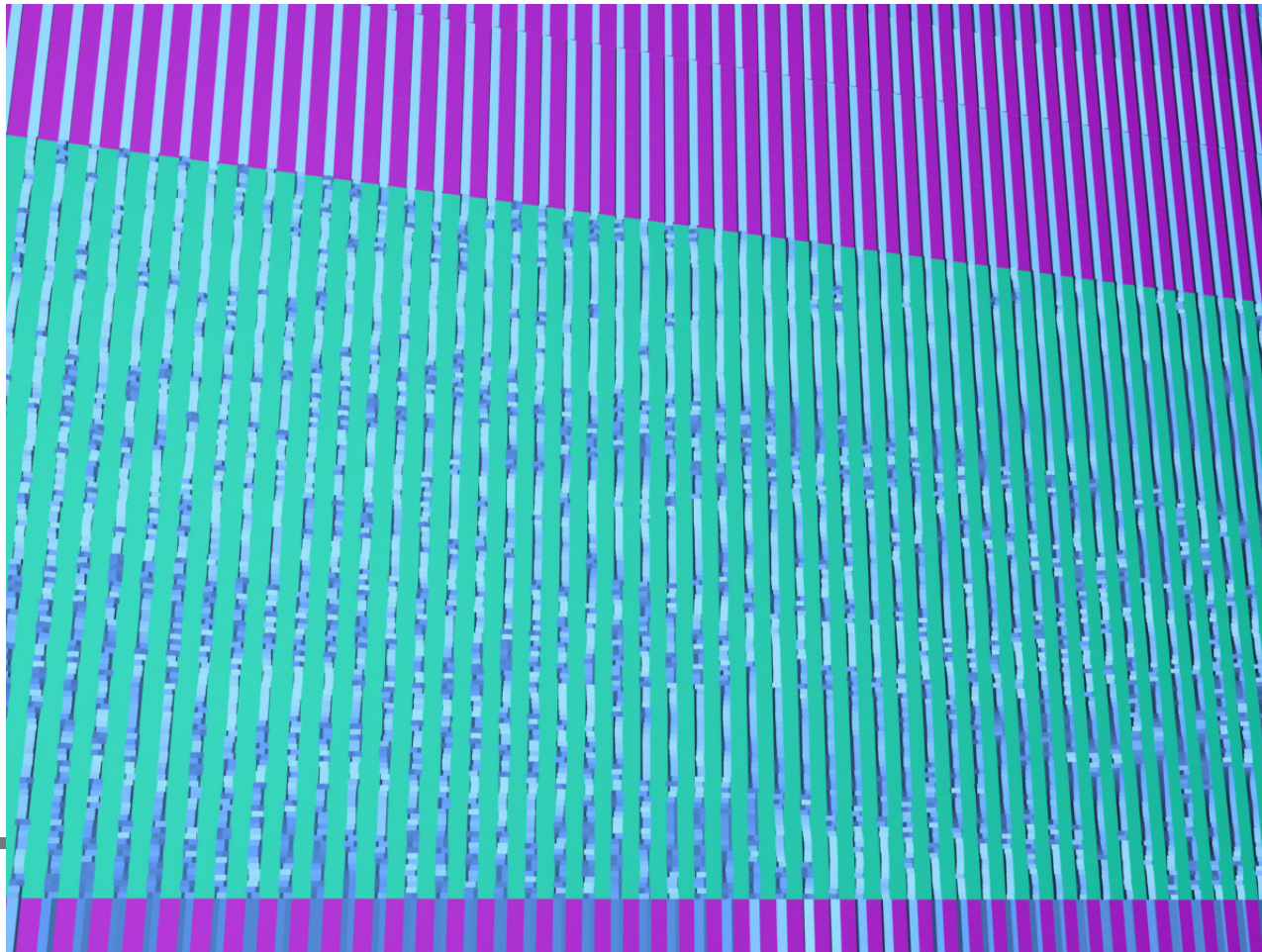# Some images
Front Impact (Frame 200)

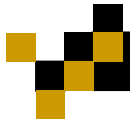# Some images
Front Impact (Frame 225)

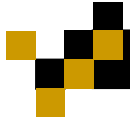# Some images
Back Impact (Frame 125)

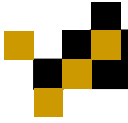# Some images
Back Impact (Frame 150)

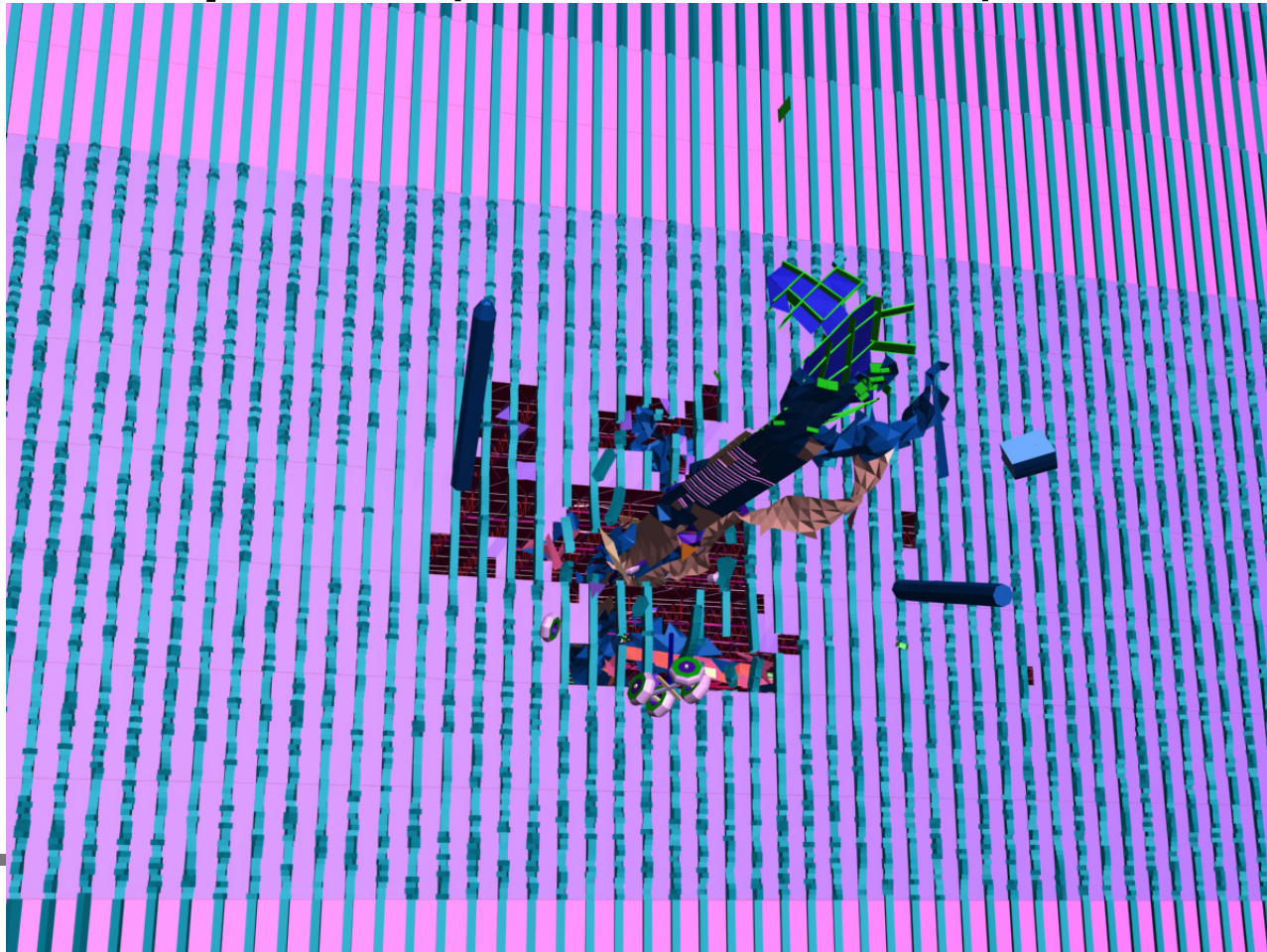# Some images
Back Impact (Frame 175)

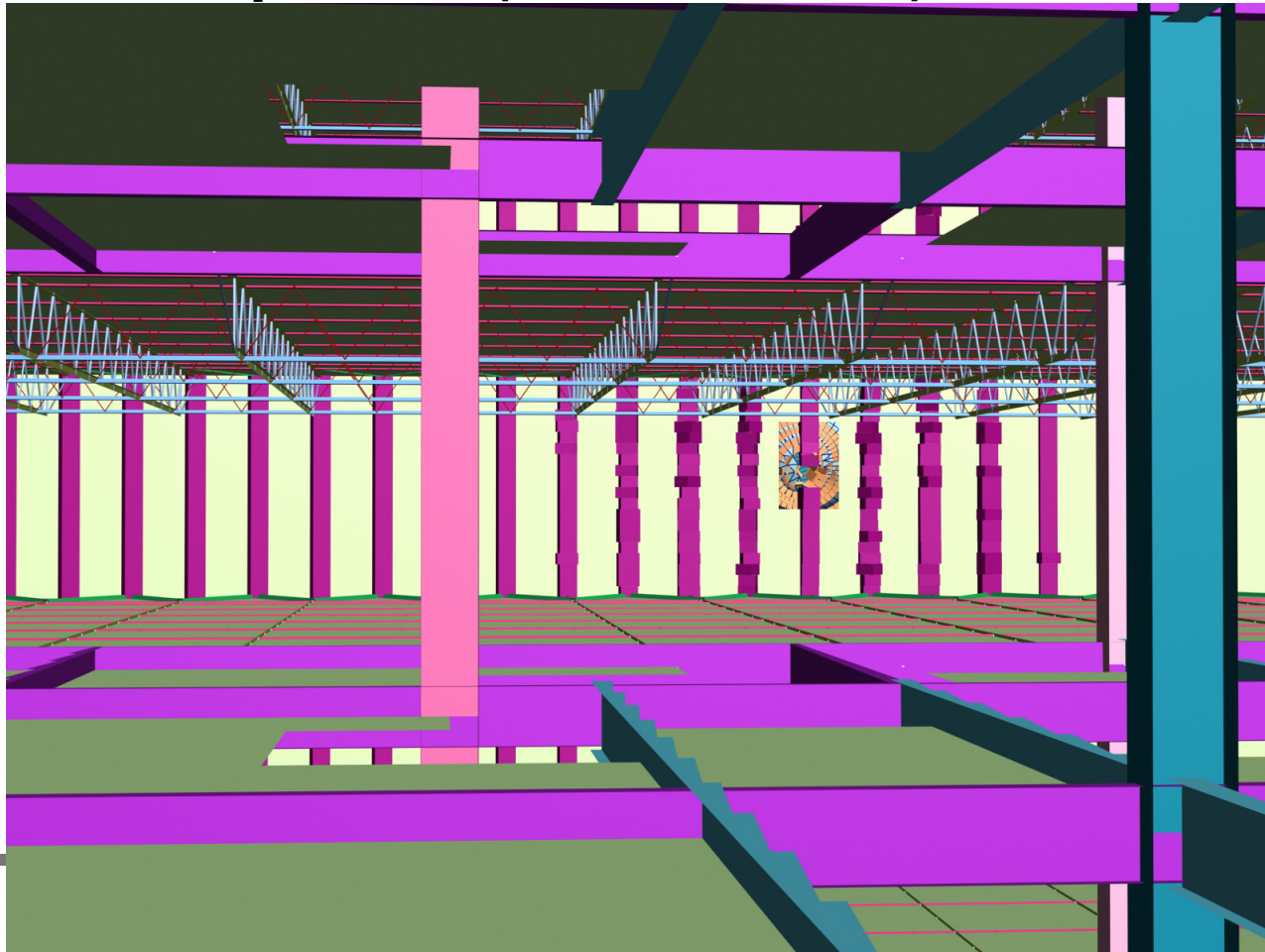# Some images
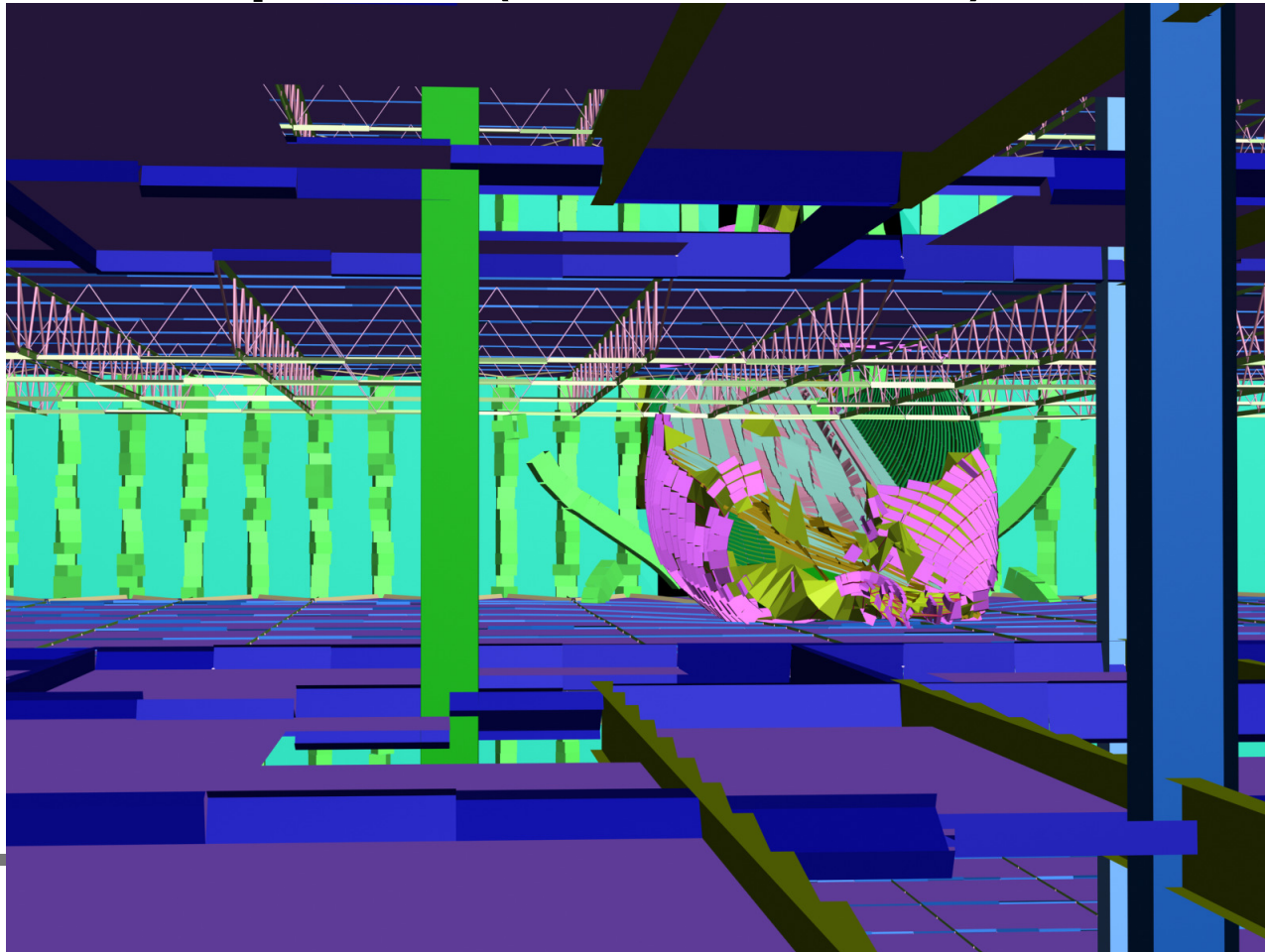# Back Impact (Frame 200)

Some images
Back Impact (Frame 225)

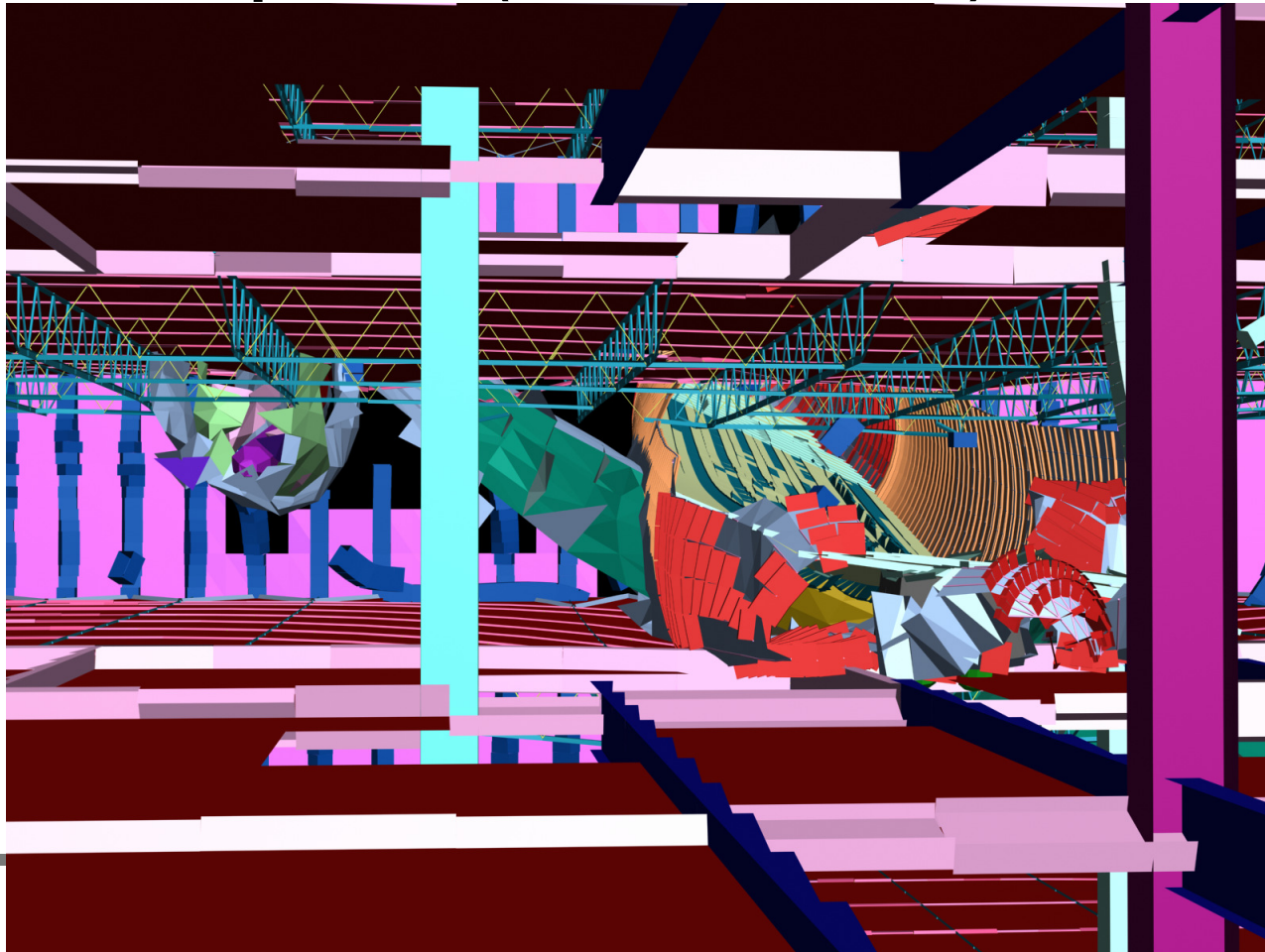# Some images
Inside Impact (Frame 1)

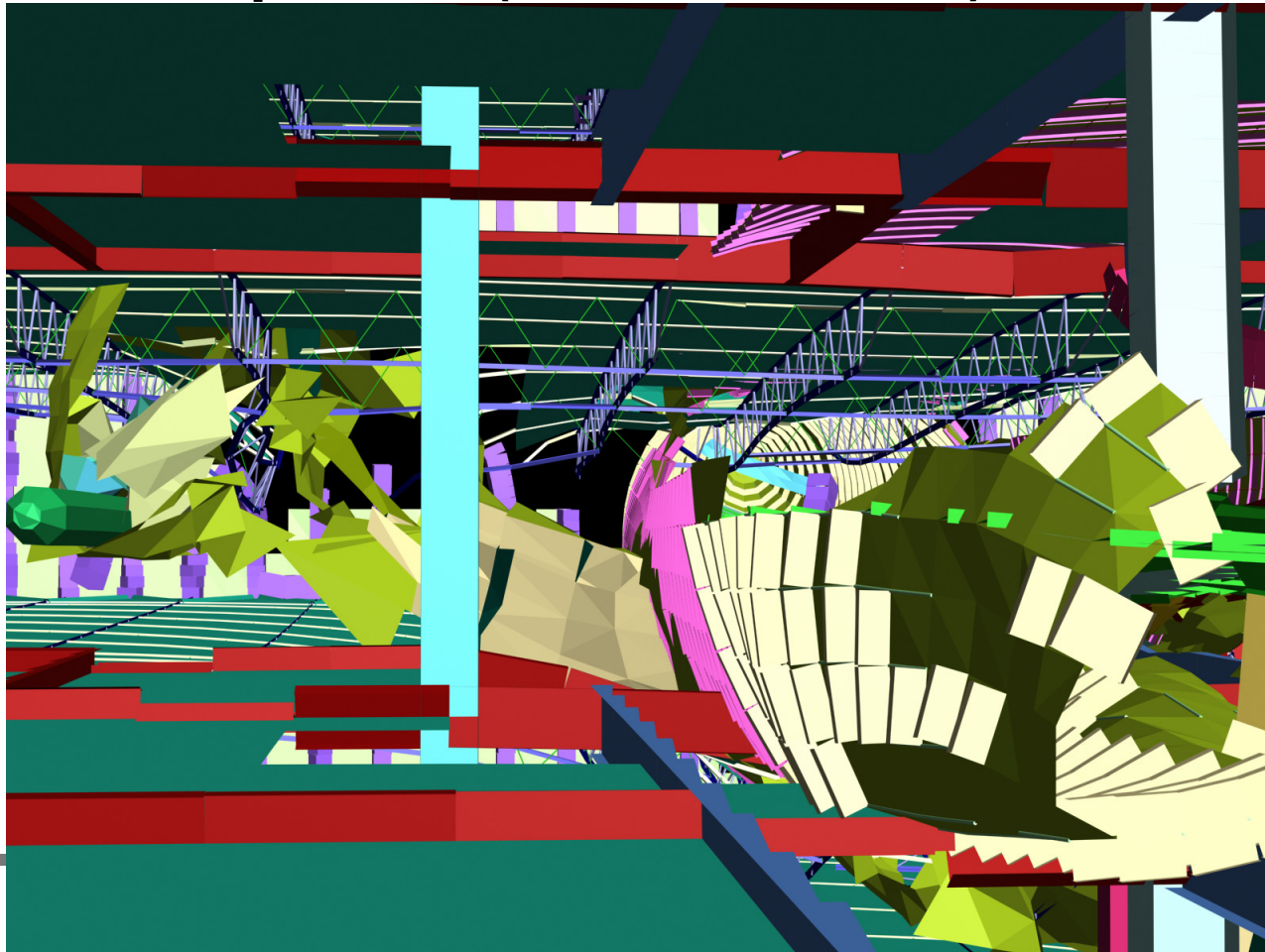# Some images
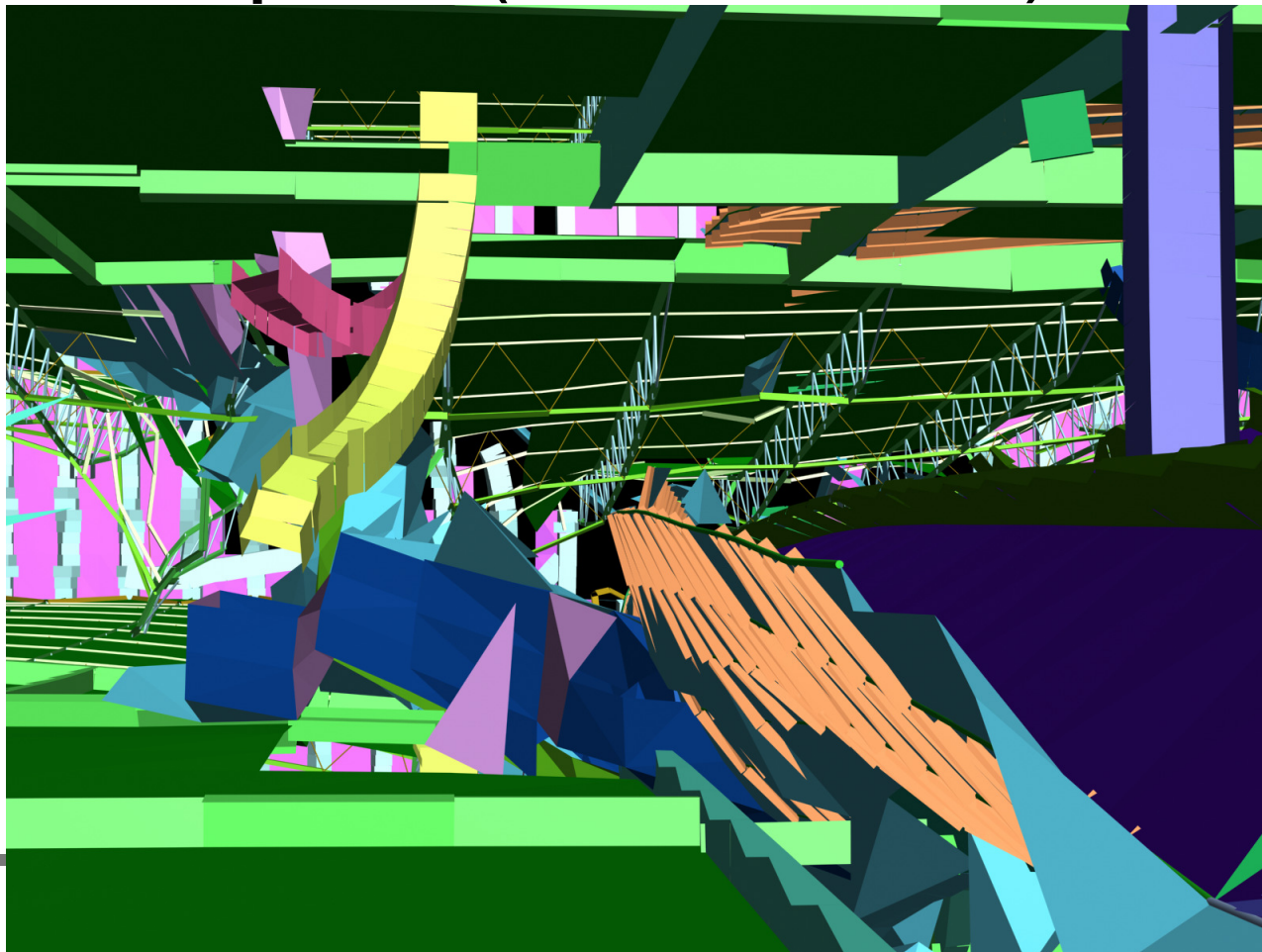# Inside Impact (Frame 25)

Some images
Inside Impact (Frame 50)

Some images
Inside Impact (Frame 75)
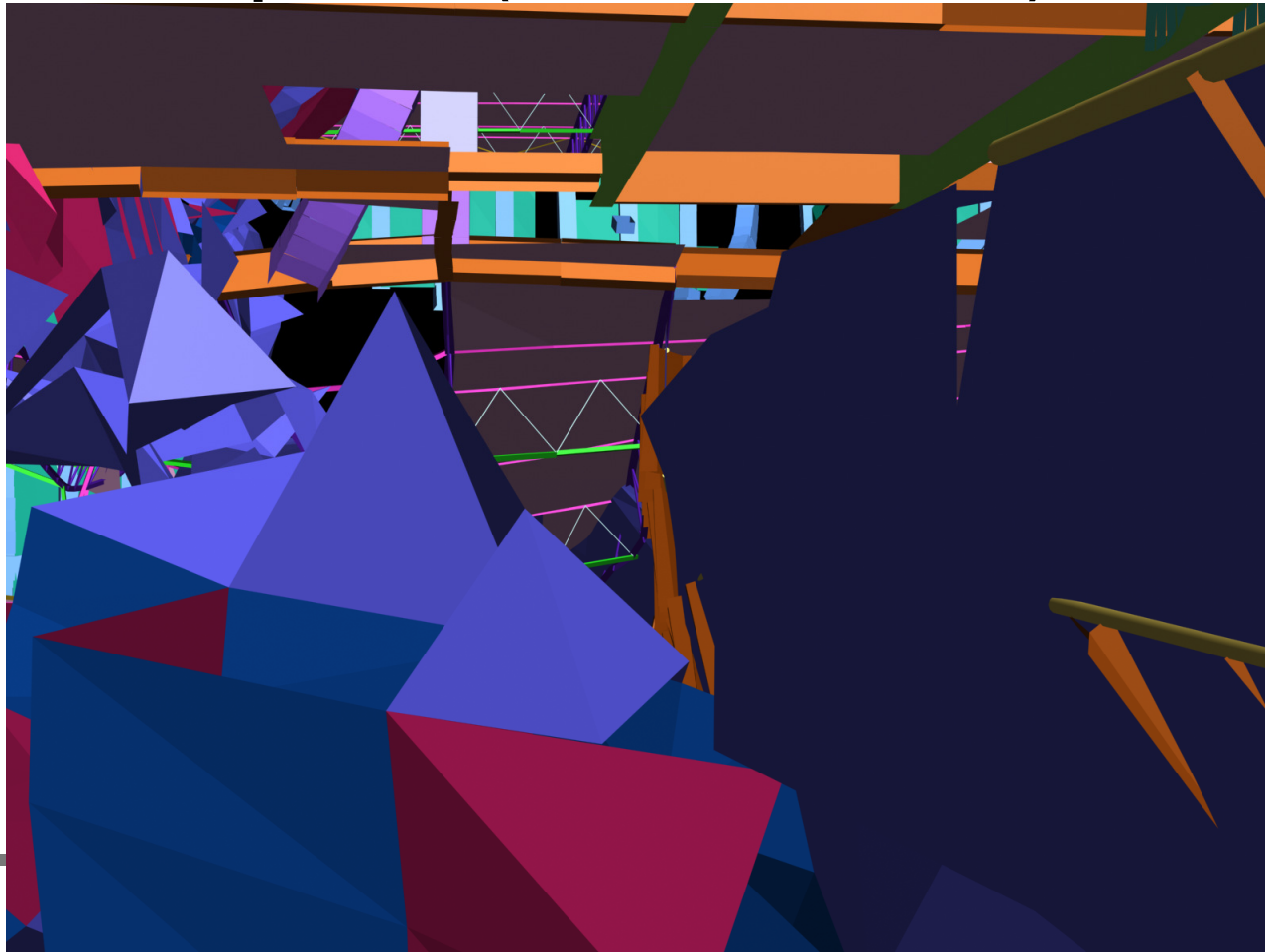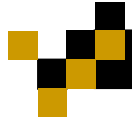
Some images
Inside Impact (Frame 100)

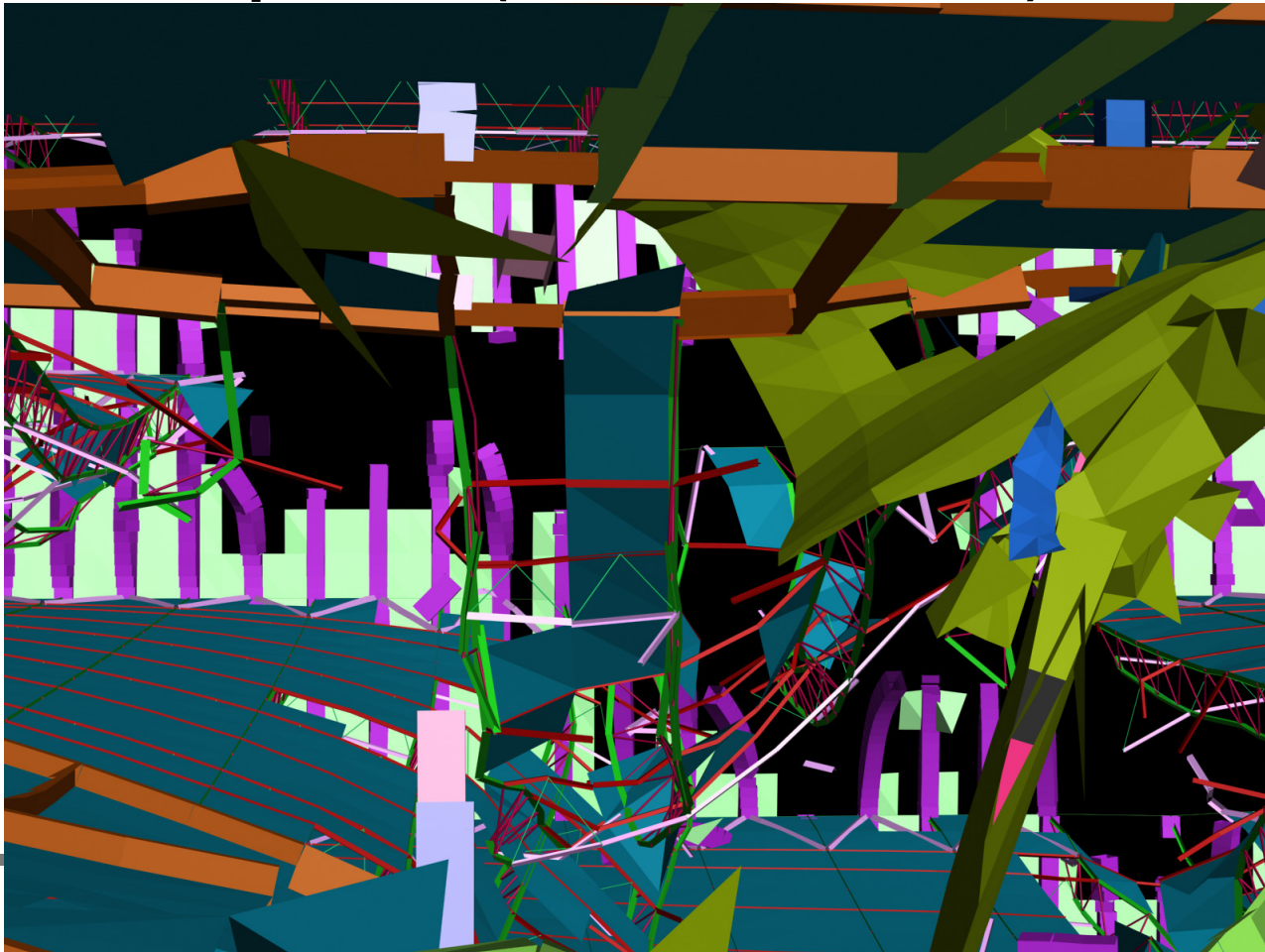# Some images
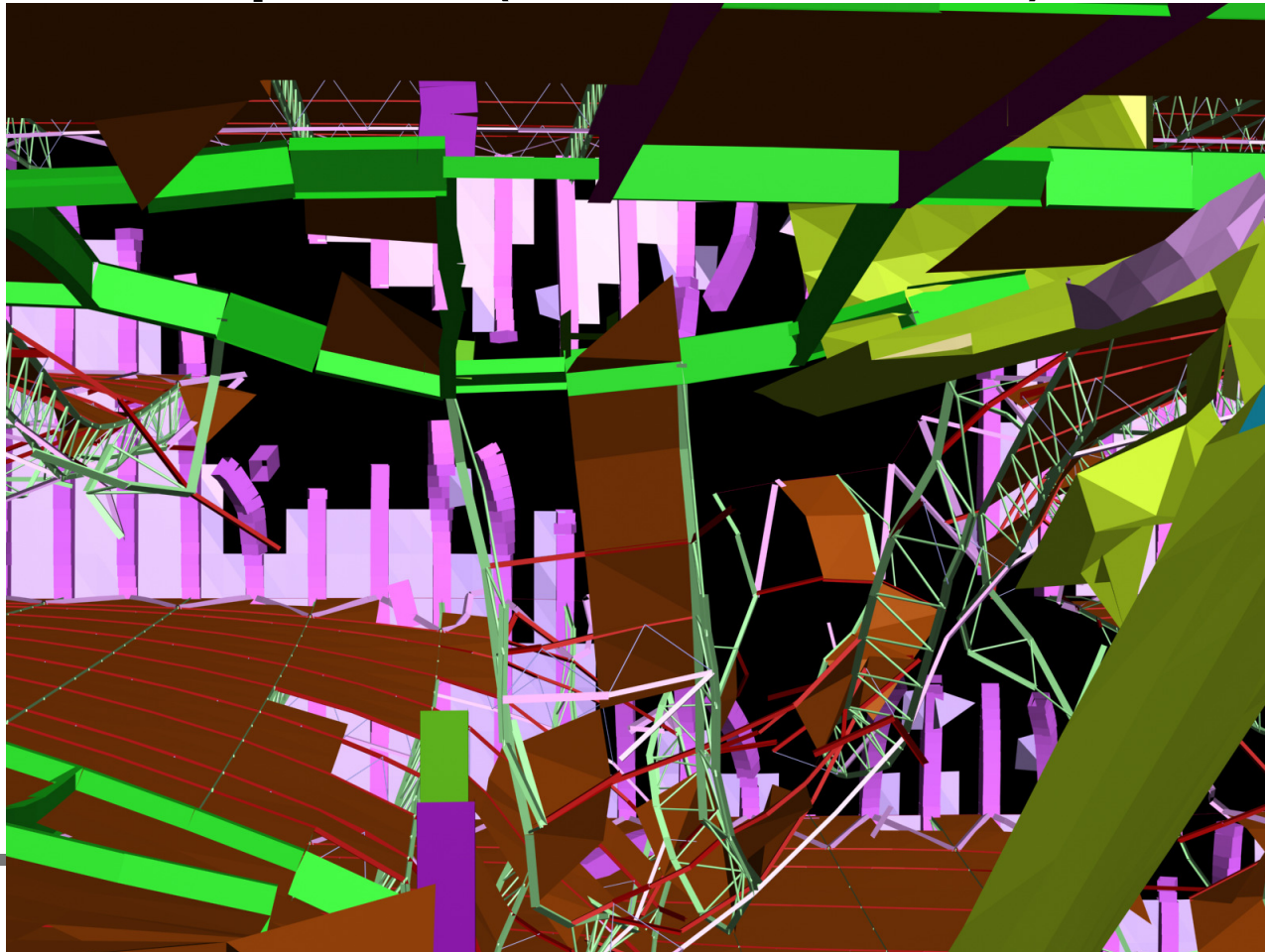# Inside Impact (Frame 125)

Some images
Inside Impact (Frame 150)

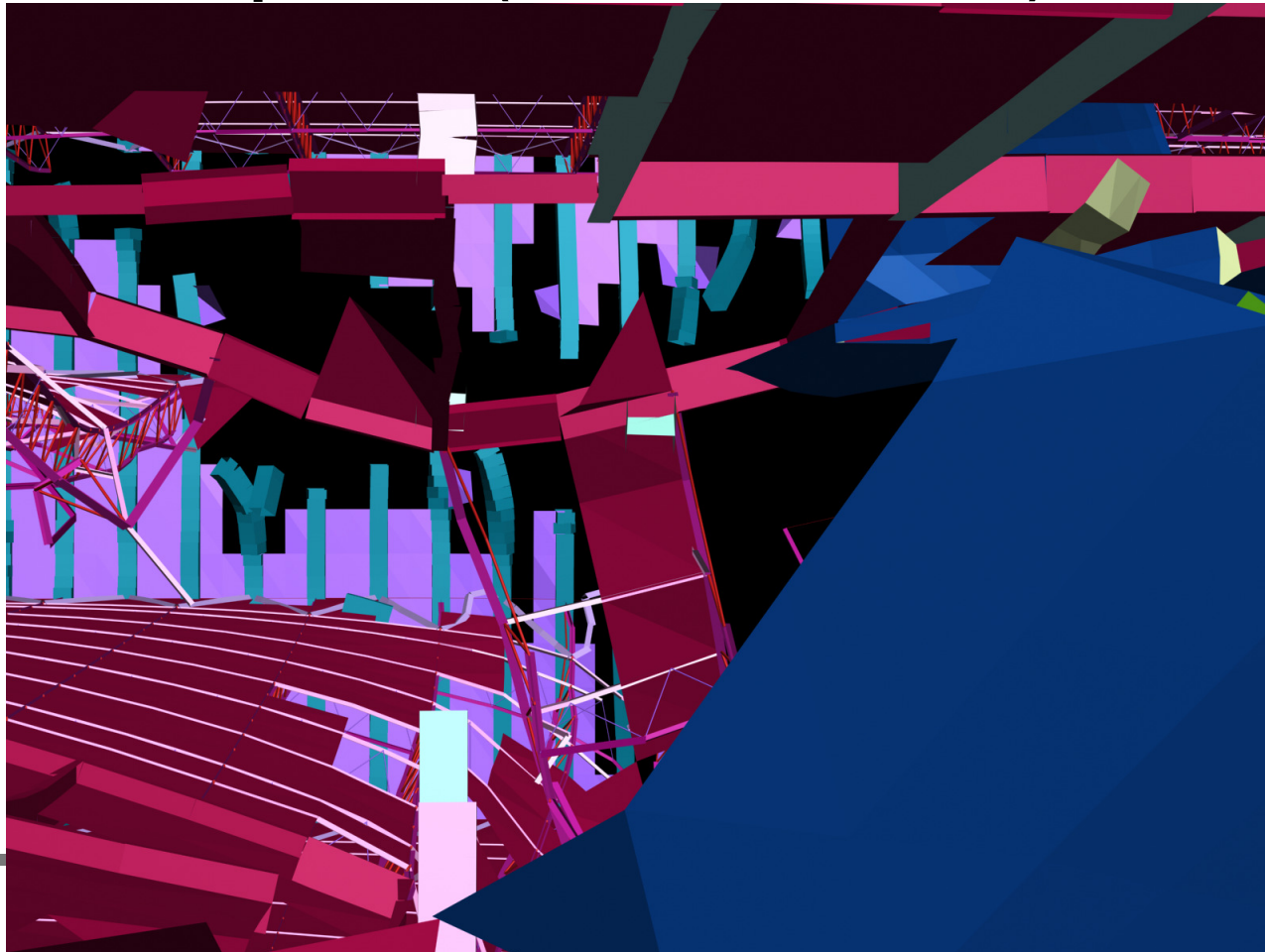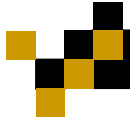# Some images
Inside Impact (Frame 175)

Some images
Inside Impact (Frame 200)

Some images
Inside Impact (Frame 225)

Thanks