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Haptic Rendering of Large-Scale VEs

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Perceiving the Sense of Touch

Important considerations:

- Burdea: Haptic response within 1KHz or better
- Severe limits on computation
- Devices types vary
  - Impedance Control.
  - Admittance Control.

The FCS HapticMASTER

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Device used:

- 3 DOF input 3 DOF output
- Admittance control
- Server PC controls arm
- VxWorks real-time OS
- FCS haptic API

Photo courtesy of FCS

The FCS HapticMASTER

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Device workspace:

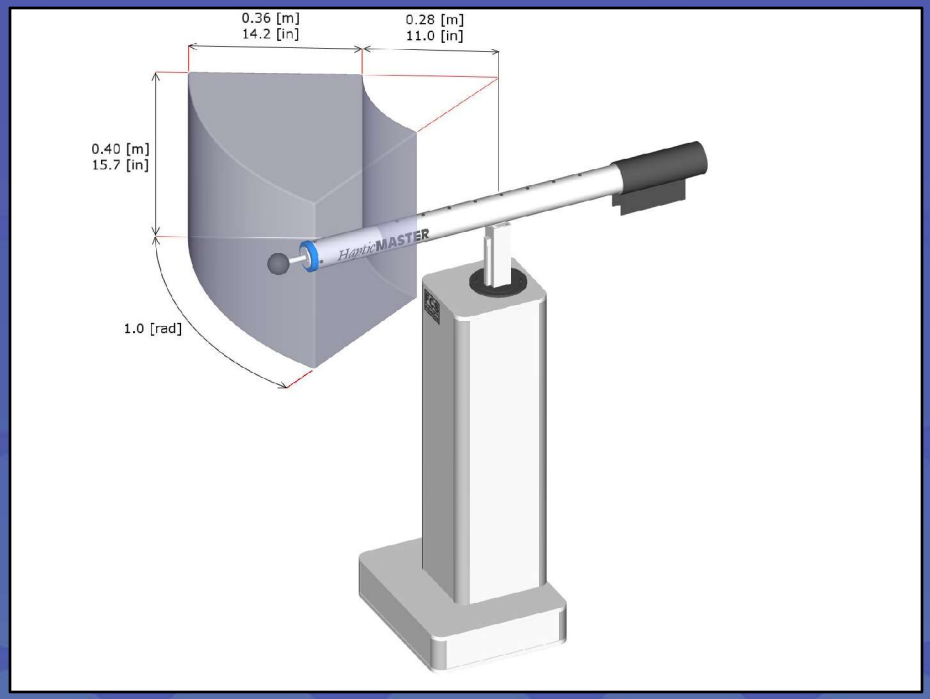

Image courtesy of FCS

Cohap3D

Vendor APIs are never enough:

- Researchers always want to do more than the API supports
- Building haptically enabled apps should be easy
- Application developer should not have to be aware of the needs/limitations of the haptic rendering
- Developers should not have to treat graphical/haptic representations separately

Cohap3D

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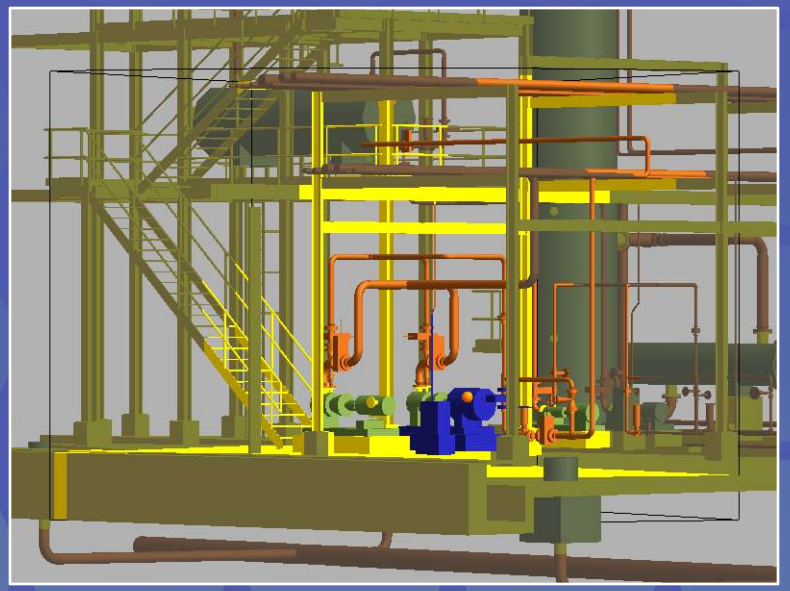
A VR system with Haptics:

- Graphical primitives manage haptic counterparts
- Transparent complexity management
- Accelerated Graphics
- Spatial partitioning
- Platform independent



Cohap3D

An extendable framework:

- Maverik++ - OpenGL based
- Both Maverik++ and Cohap3D are C++ libraries
- Cohap3D transparently uses the FCS haptic API to program the haptic server

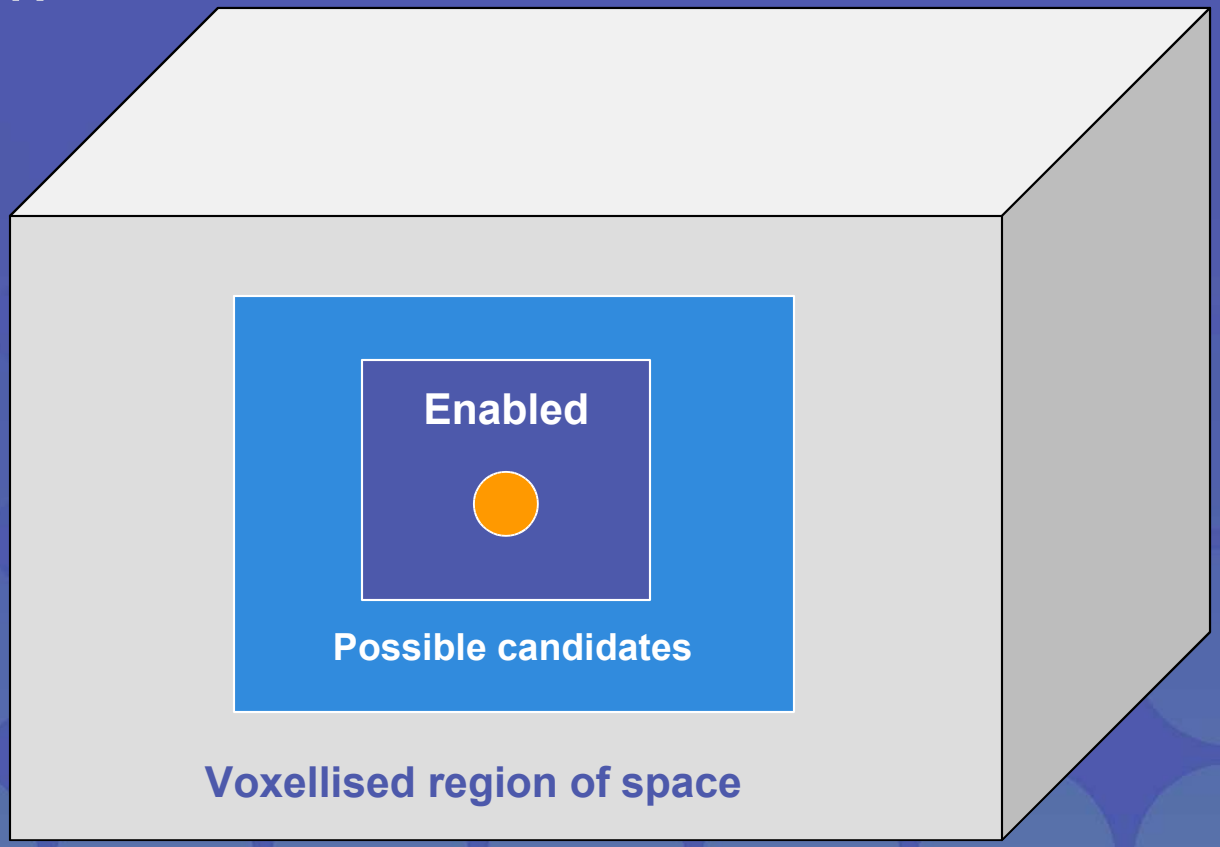
Cohap3D – Case Study

Haptic rendering of Large-Scale VEs:

- Haptic server handles limited number of primitives
- Automatic culling to a haptic region
- Cache mechanism takes candidates and chooses those to activate/de-activate
- Continually updates as the user navigates

Case Study – Caching policy

Overview:



Large-Scale Models

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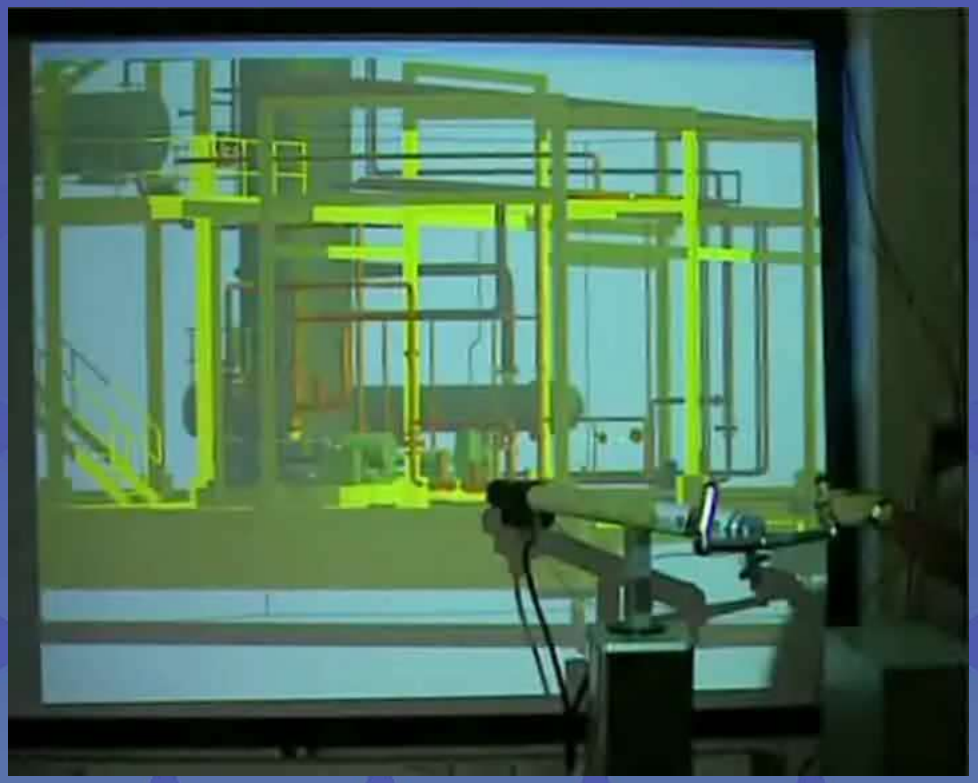
Video showing cached primitives added and removed as the user navigates:



Large-Scale Models

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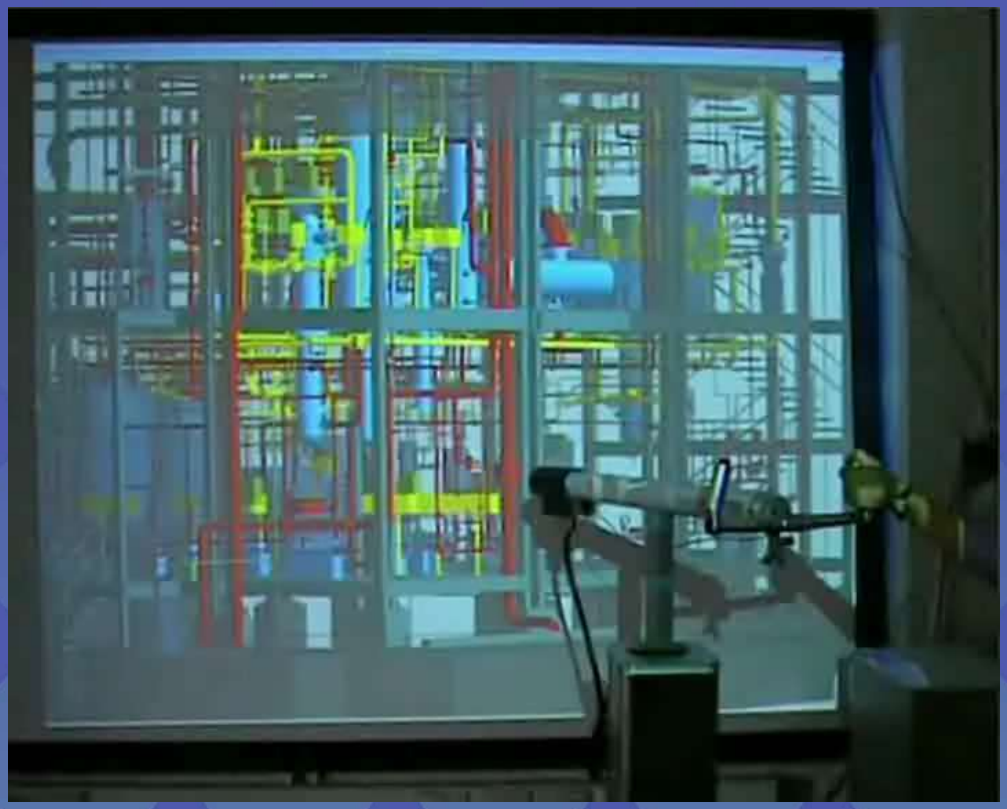
Video showing a user haptically interacting with a large model:



Case Study – Issues

Current issues which affect usability:

- Primitives may be enabled after the user has accidentally passed through them
- The application may start up with the end-effector inside a haptically enabled primitive
- Very small thin primitives may not offer much resistance
- Not all the primitives in our models are currently supported

Case Study – Performance

Performance:

- Number of primitives - > 25,000
- Polygon count - >half a million
- Average number of possible candidates - 300
- Haptically enabled primitives – 30
- Client PC spec – 3.2 GHz, 1GB RAM, NVidia GeForce 5950 FX
- Haptic server PC spec – low by modern standards

Additional Cues

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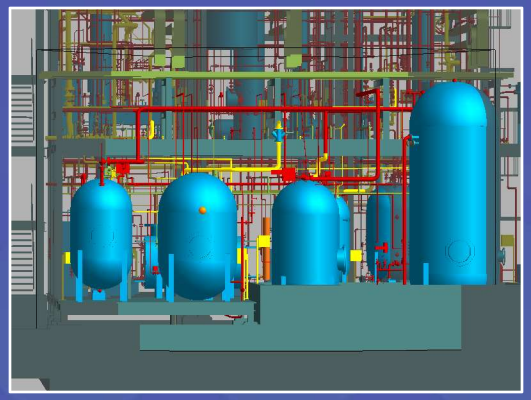
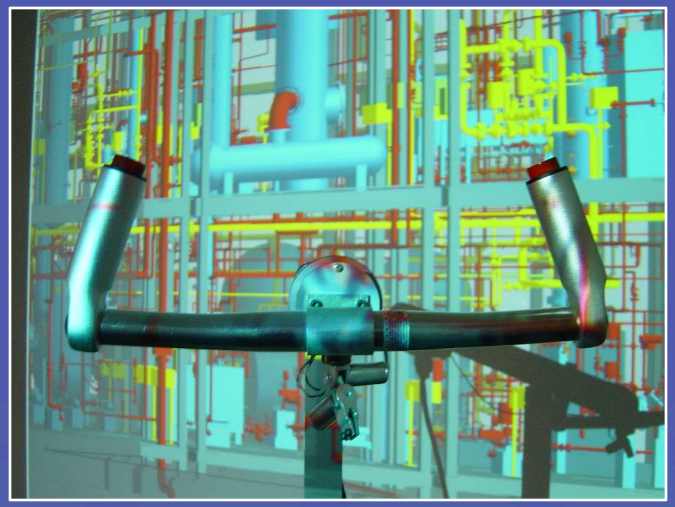
Model scale vs. device scale:

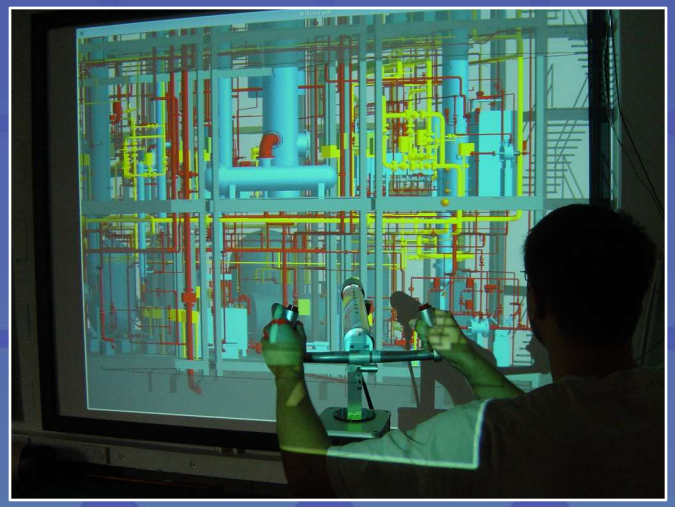
- Model scale is very large
- Operating scale of device is small
  - Only a small portion within reach
- Colour mask applied to everything outside the workspace
  - Improves user's ability to navigate/interact



Navigation

- We needed buttons!
  - Built our own
- Navigation scheme
  - Appears as a standard mouse
  - Similar to a rate controlled joystick





Limitations

Most Frameworks don’t do everything:

- Currently only supports a HapticMASTER device
- Haptically enabled primitives need to be generalised
- Currently only allows single user haptically enabled VE applications to be built

Future Developments

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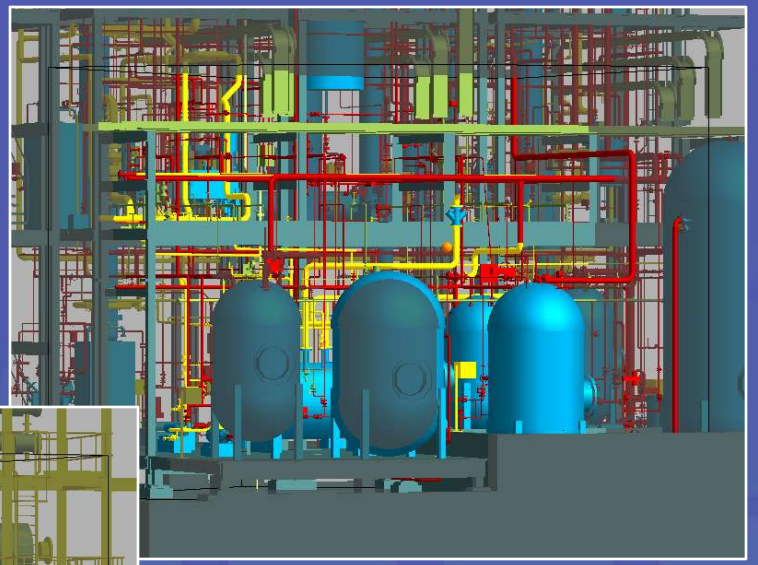
- Improve culling algorithms
- Extend API for Phantom
- Support collaboration



Further Information

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Further information about the research carried out by our group can be found at:

http://aig.cs.man.ac.uk