Collaborative Mixed Reality Visualization of an Archaeological Excavation

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Multidisciplinary Team

Motivation

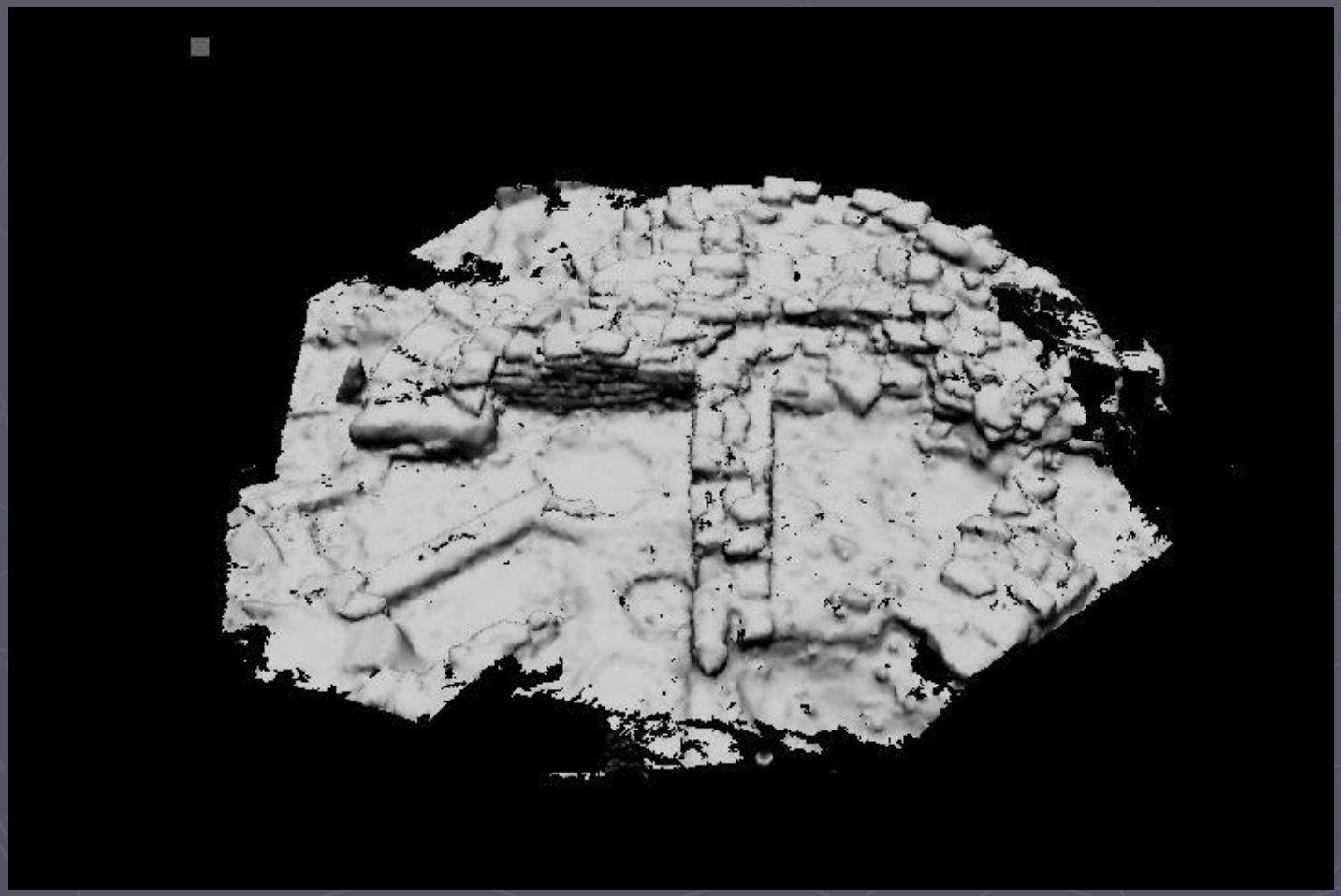
- Excavation is destructive and physically "unreconstructable" process
- Need to preserve as much data as possible for analysis
- Data interpretation happens off-site
- Current tools focus on 2D data and do not incorporate 3D information
- Many experts—collaboration is a must!

Archaeological Excavation at Monte Polizzo, Sicily, Summer 2003

Ian Morris, Director (Stanford University)

Working in the field!

Meshed 3D Model (13 scans)

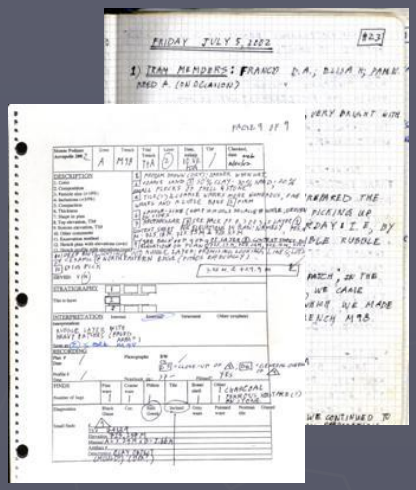


We have a 3D site model, now what?

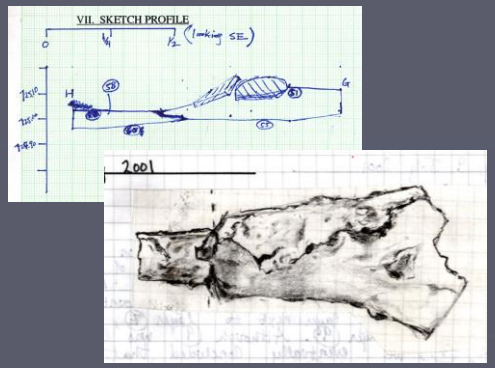
Real

Virtual

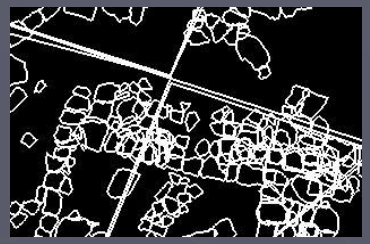
Field Notes



Drawings



GIS Data

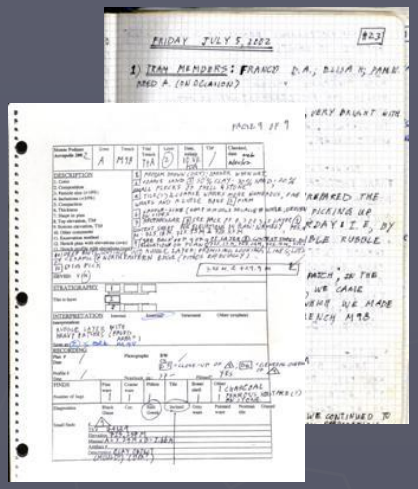


High Resolution Images

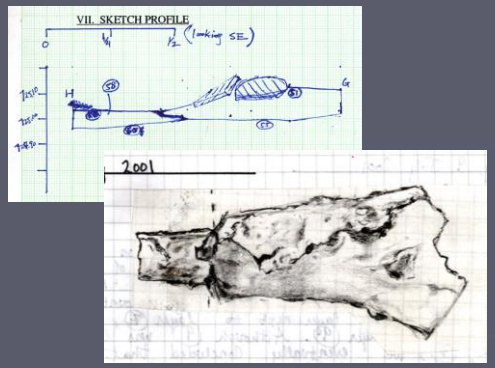
Videos

Panoramic Images

Field Notes



Drawings



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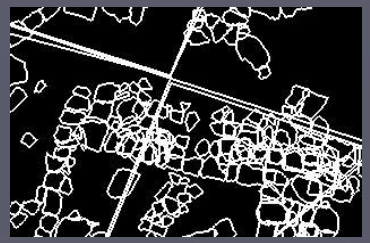
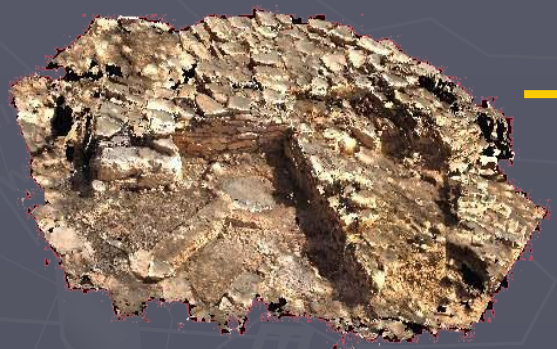


High Resolution Images

Database

3D Site Model



3D Object Models

Panoramic Images

Videos

Two Problems

- How to combine all this data in one seamless environment?
- How to make it easy to interact with?

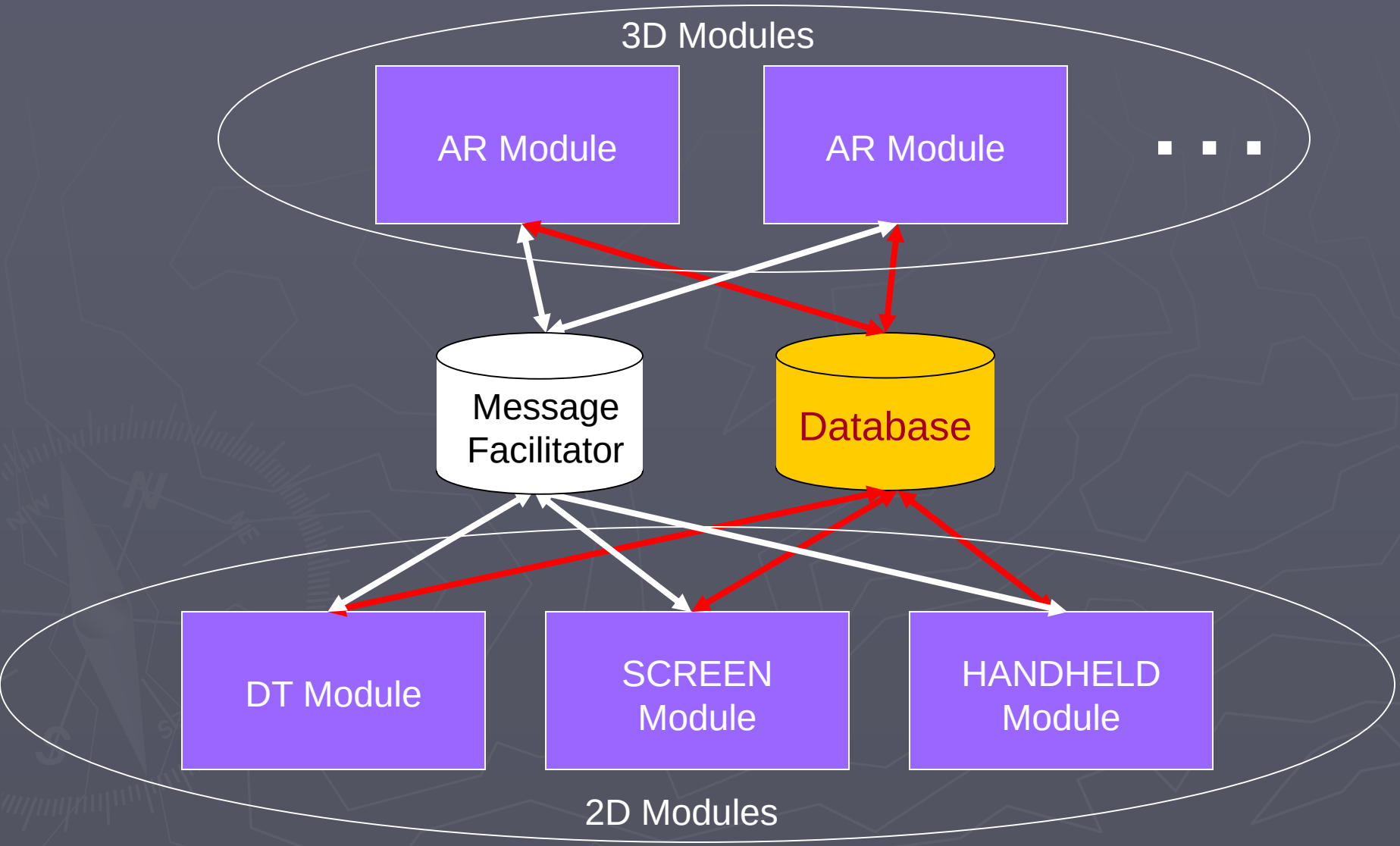
VITA:
Visual Interaction Tool *for* Archaeology

- Multiple users
- Multiple displays
  - Projected tabletop
  - Handheld
  - High-resolution monitor
  - See-through head-worn
- Multiple interaction devices
  - MERL DiamondTouch table
  - EssentialReality P5 gloves
  - Speech input
  - 6DOF tracker

Design Considerations

- Use the most appropriate display for the given data
- Facilitate both human-system and human-human interaction

Modular Architecture



AR Module Components

Sony Head-Worn Display
(LDI-D100B)

Head Tracker
Hand Tracker
(Intersense IS900)

Microphone

P5 Glove
(Essential Reality)

DiamondTouch Table
Connector
(MERL)

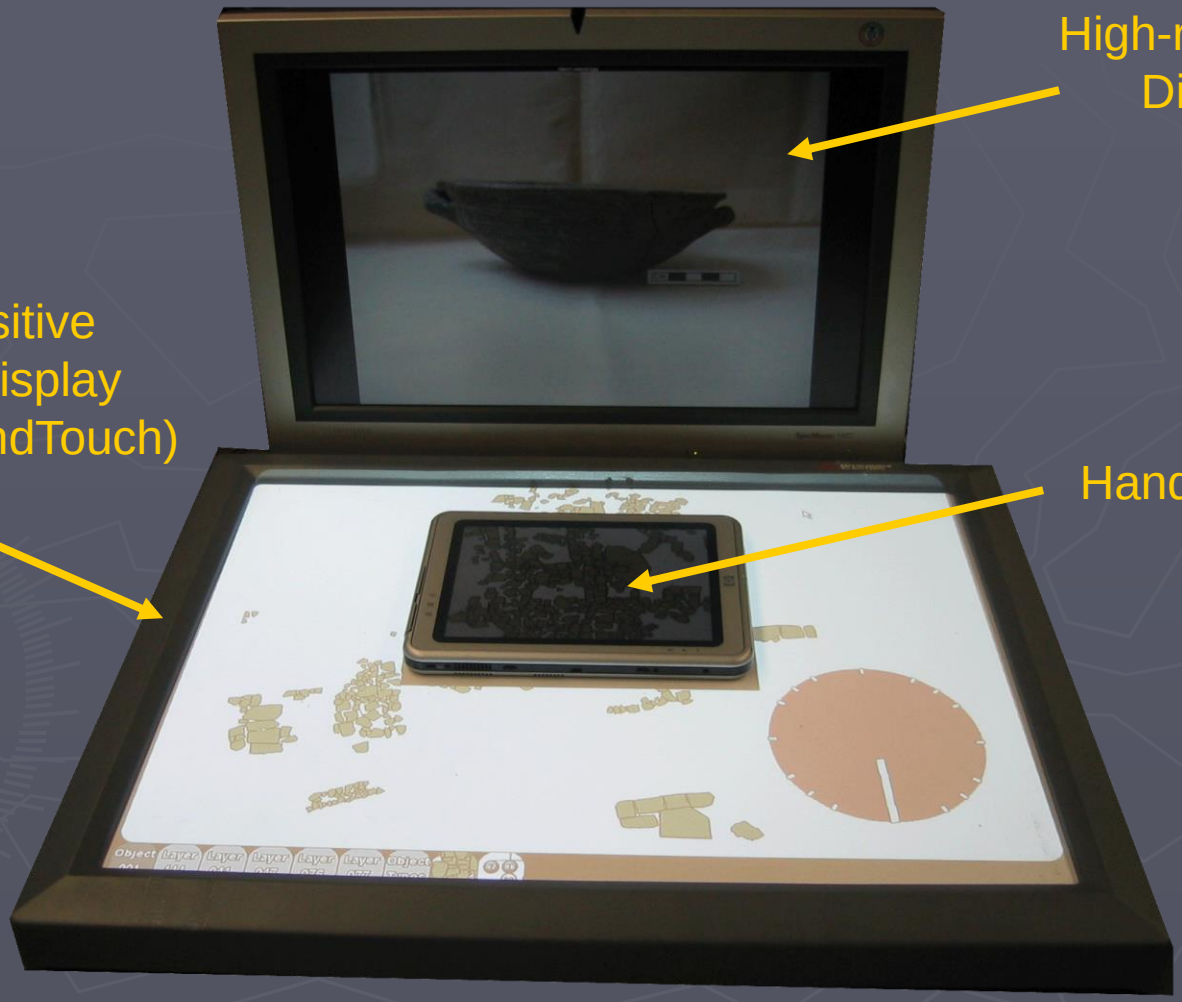
Life-size Immersive Exploration

3D Multimodal Interaction

- Provide natural interaction mechanism for our 3D environment
- Modalities
  - Speech: IBM ViaVoice 10
  - Gestures: EssentialReality P5 glove
  - Selection statistics: SenseShapes
- Focus on selection
  - Based on collaboration with Phil Cohen et al. (*ICMI 2003*) and SenseShapes (*ISMAR 2003*)

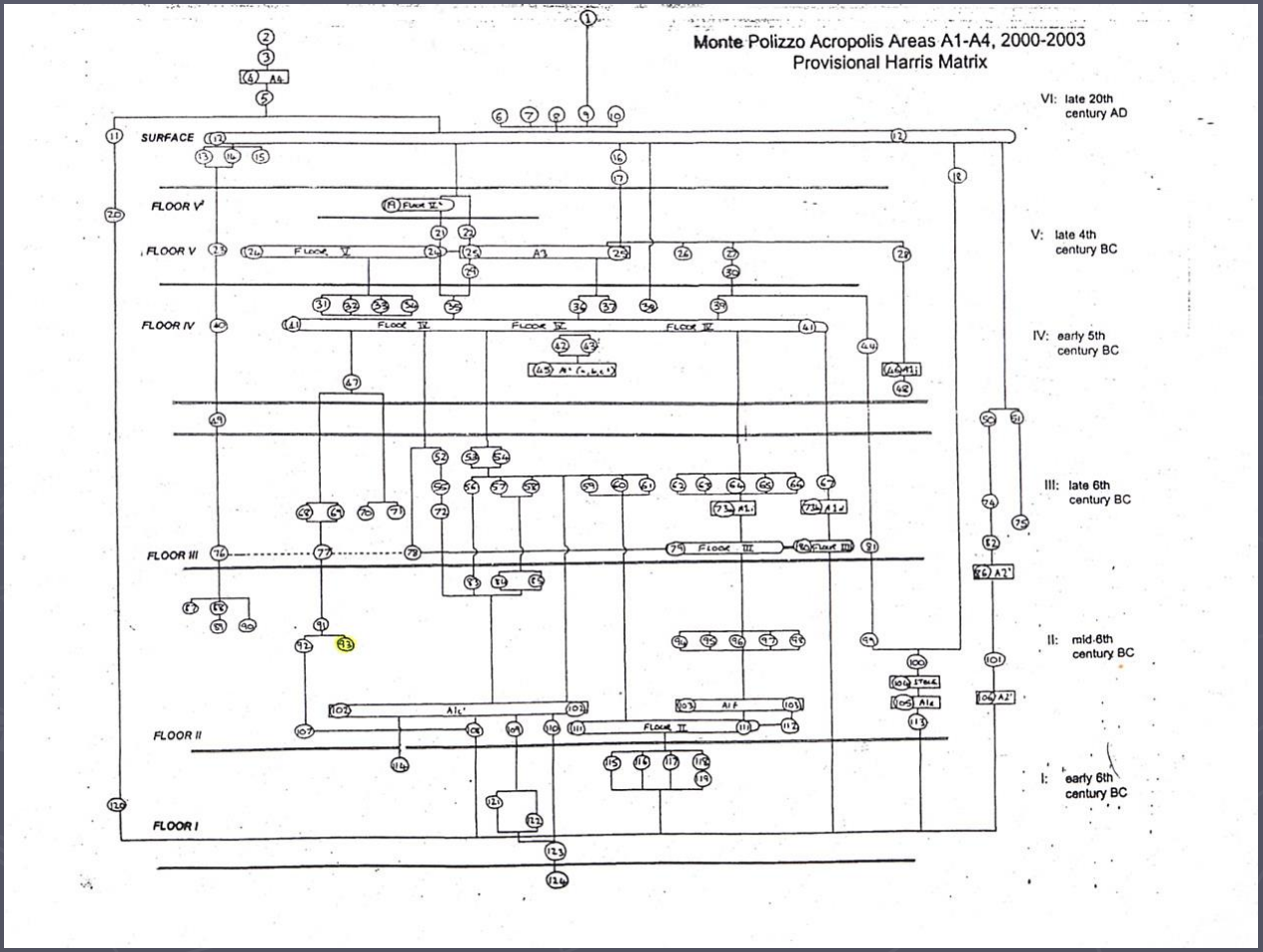
VirtualTray

Desktop Components

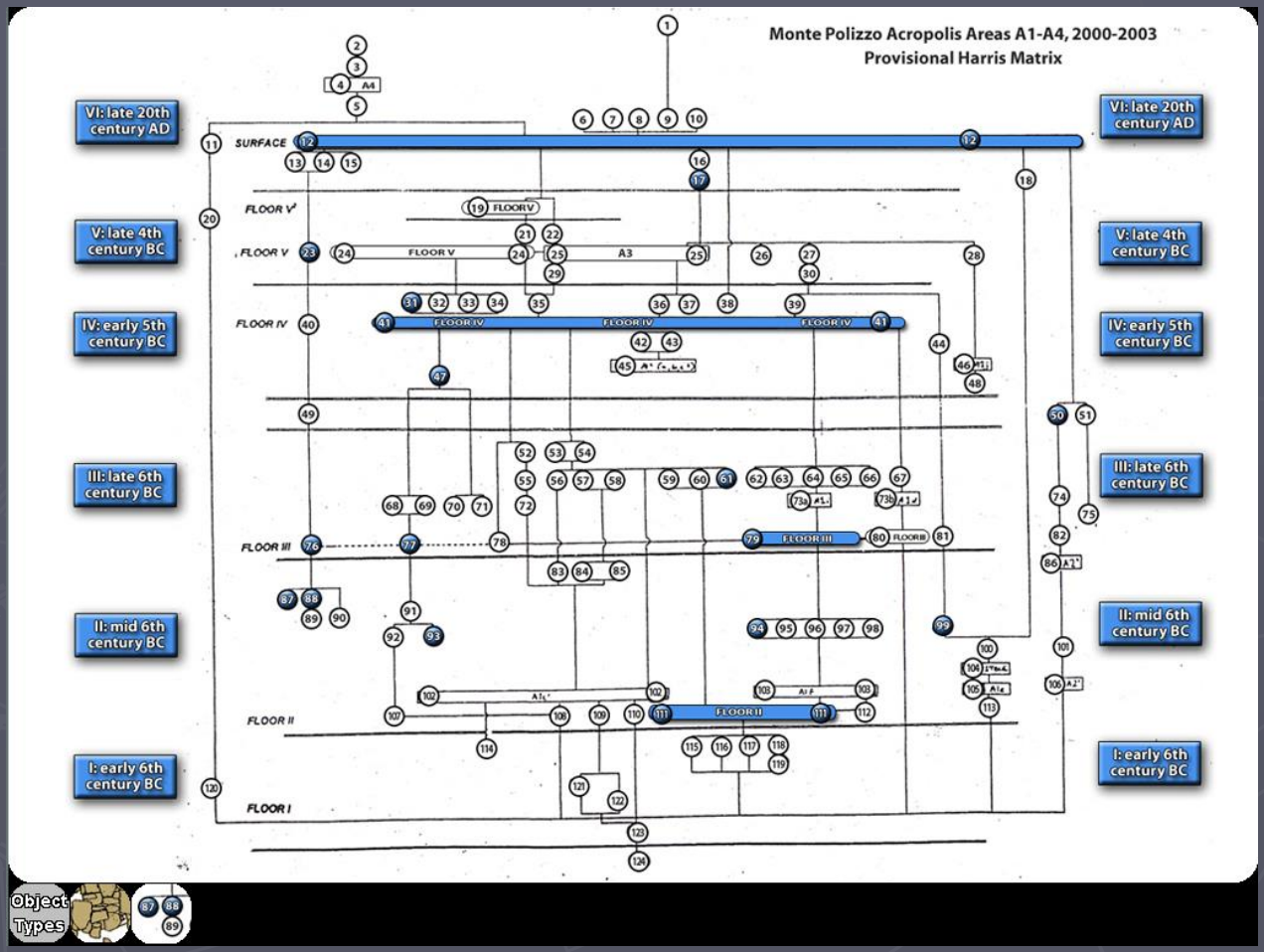


World-In-Miniature

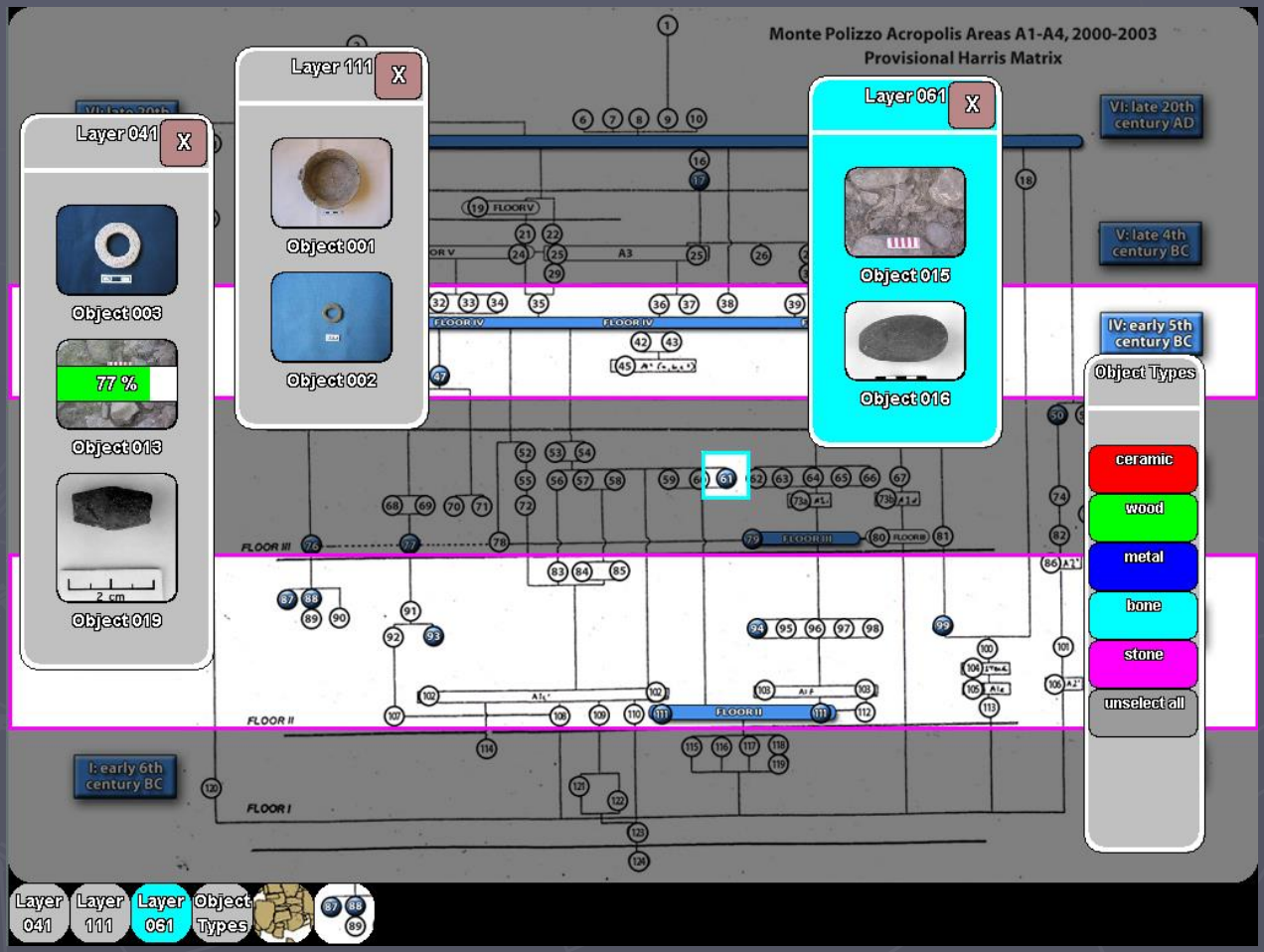
Harris Matrix



Enhanced Harris Matrix



Enhanced Harris Matrix



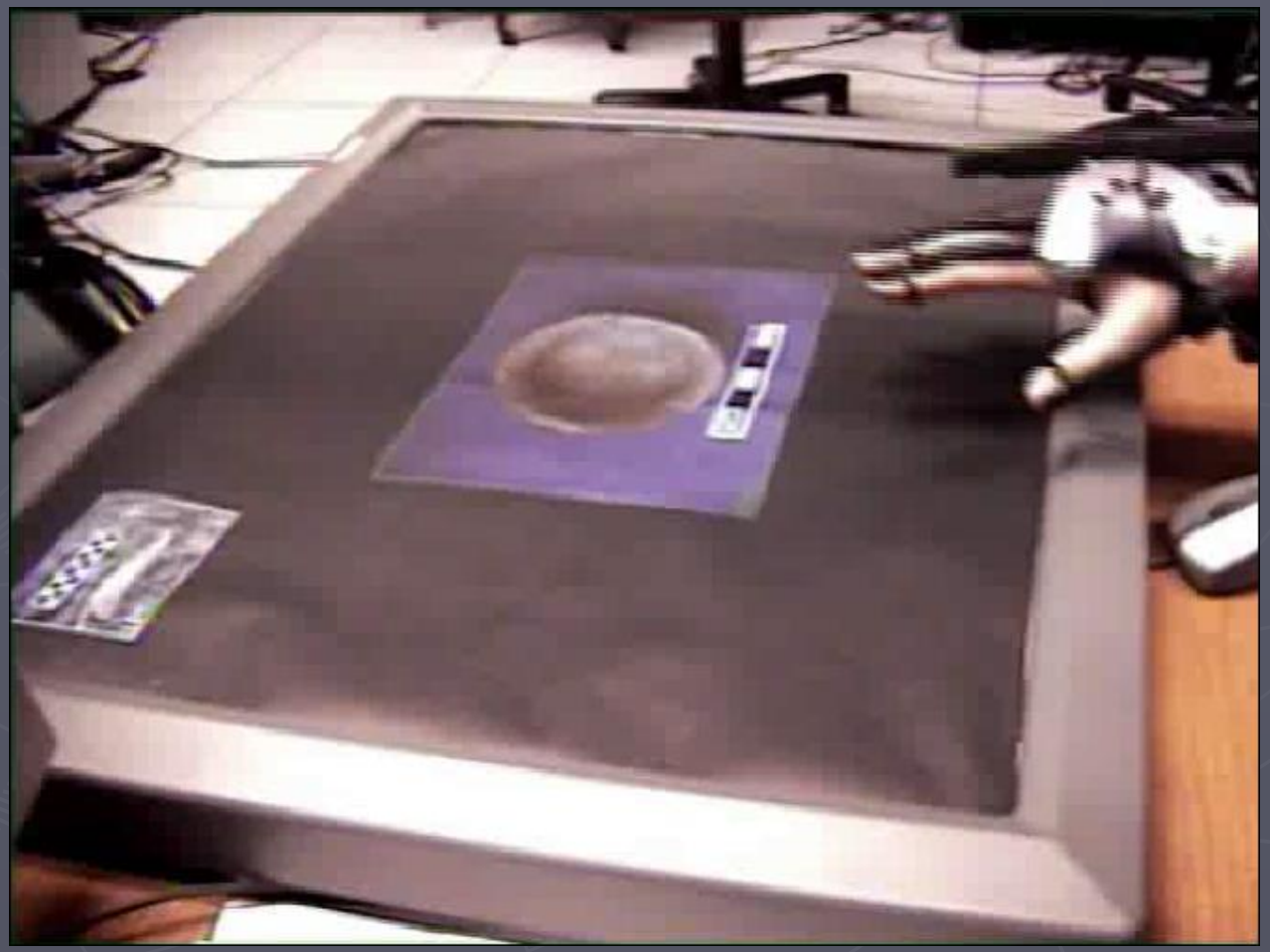
Cross-Dimensional Hybrid Gestures

- Synchronized 2D and 3D gestures
- Facilitate seamless transition across dimensions

To appear in IEEE VR 2005

Cross-Dimensional Hybrid Gestures

Pull
Push



To appear in IEEE VR 2005

Cross-Dimensional Hybrid Gestures

Pull
Pin
Drag
Rotate
Push

To appear in IEEE VR 2005

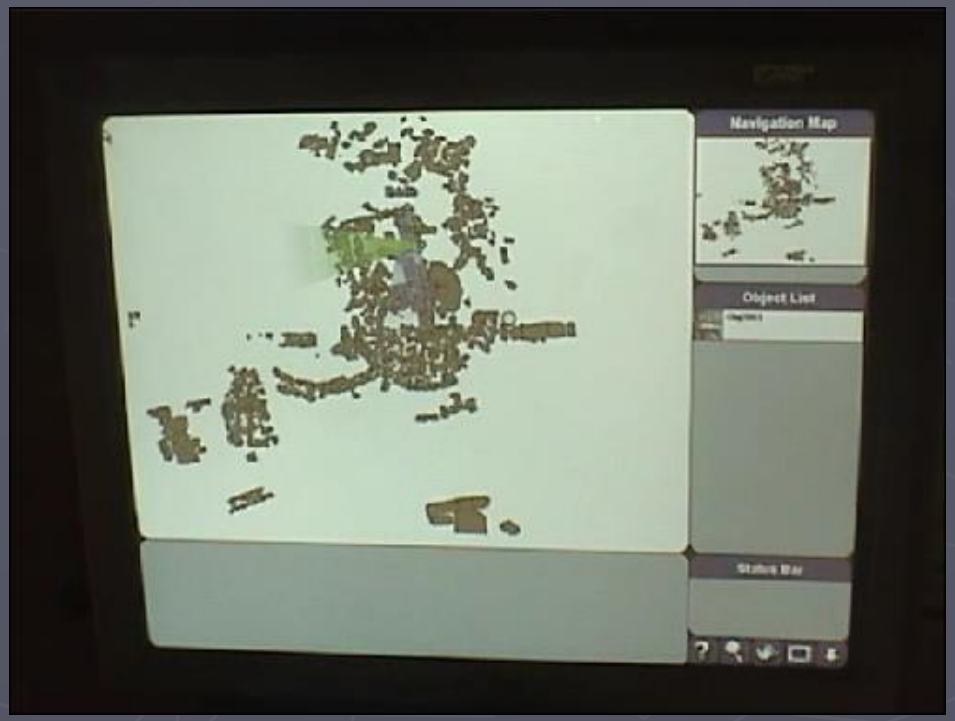
Cross-Dimensional Hybrid Gestures

Pull
Connect
Scale
Disconnect
Push

To appear in IEEE VR 2005

Handheld Focus-in-Context Display

- Movable high-resolution inset
  - Tracked by DiamondTouch
  - Projection suppressed in its bounds
  - Physical magic lens



Tabletop Interaction

User Feedback

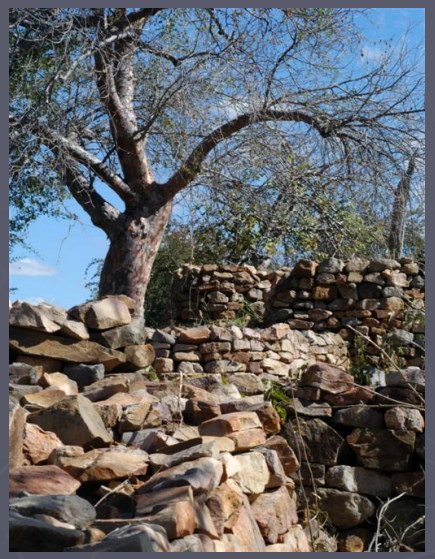
- Overall very positive reaction
- Archaeologists benefited from:
  - Temporal–Spatial connection
  - Aggregated collection of all data
  - Accurate 3D model
  - Simple touch-based interactions
- Potential for increased collaboration

Room for Improvement

- Reduce wires
- Reduce weight
- Eye occlusion hinders communication
- Missing data:
  - More objects, features, notes and pictures
  - More scans during excavation (time-lapse spatial record)
- Missing features:
  - Virtual scale measure (implemented since)
  - Variable site model scaling
  - Improved selection in world-in-miniature

Current and Future Work

- Larger Site:
  - Summer 2004 - Thulamela, South Africa
- Personalized user experience based on expertise
- Environment management



Acknowledgments

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Questions?