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A Taxonomy of 3D Occlusion Management Techniques

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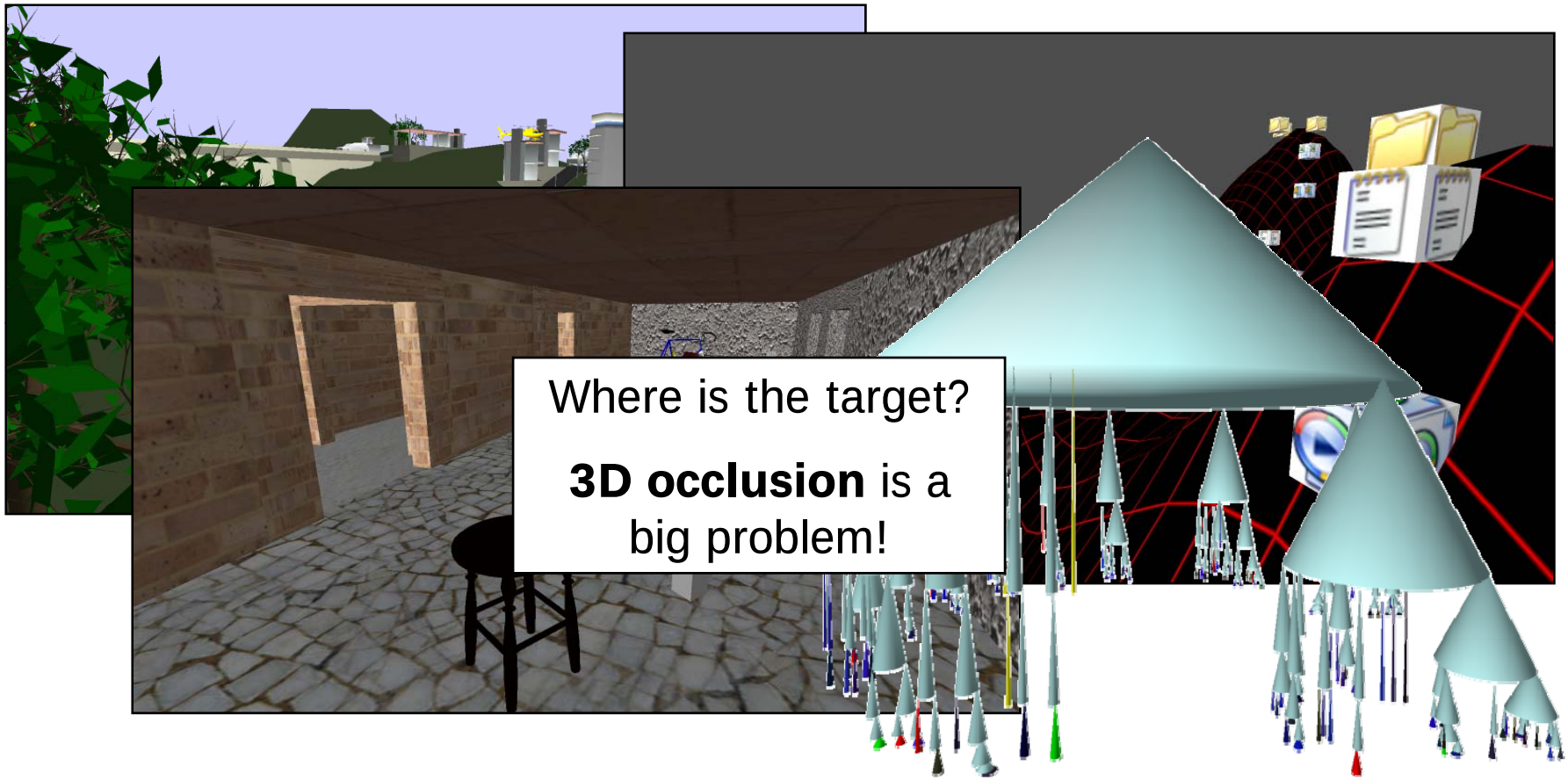
A Common Denominator…



Why a Taxonomy?

- Occlusion is a fact of life in 3D
- Visualization designers (us) deal with it routinely
  - X-ray vision, bird's eye views, World-in-Miniature, etc...
  - **Occlusion management** techniques (most often 3D)
- But **how**? Motivation? Strategies?
- Formalizing occlusion and occlusion management
  - Provide common vocabulary
  - Facilitate comparison and benchmarking
  - Suggest suitable methods
  - Inform future research

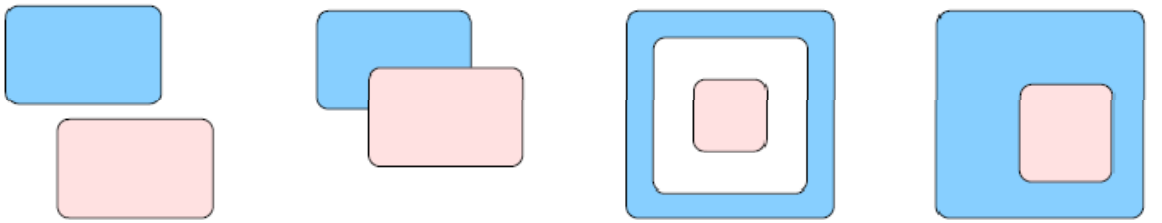
Taxonomy Design

- What goes in a taxonomy?
- Use as a **design space** as well as for **classification**
- Characteristics of occlusion management techniques?
- Six primary dimensions:
  - Primary Purpose
  - Disambiguation Strength
  - Depth Cues
  - View Paradigm
  - Interaction Model
  - Target Invariances

Taxonomy Dimensions (1)

- **Primary Purpose**
- Why do we need this technique?
- Domain: [*discovery, access, spatial relation*]

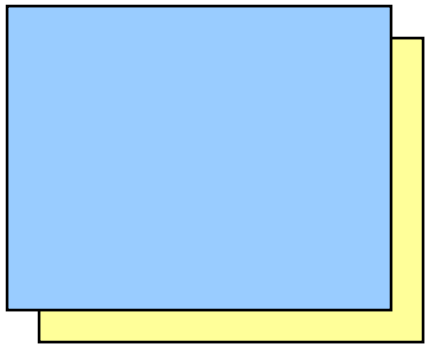
- **Disambiguation Strength**
- What can the technique handle?
- Domain: [*proximity, intersection, enclosement, containment*]

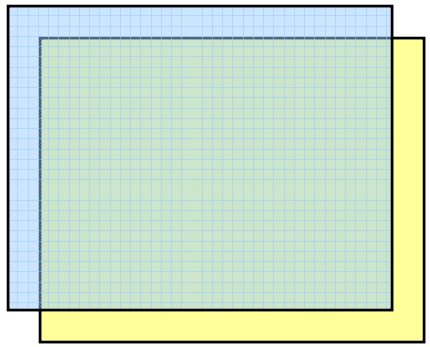


Taxonomy Dimensions (2)

- **Depth Cues**
- How much depth information is retained?
- Domain: [*low to high*]

- **View Paradigm**
- How are the views and view space managed?
- Domain: [*single/twin/multiple* x *int/sep*]



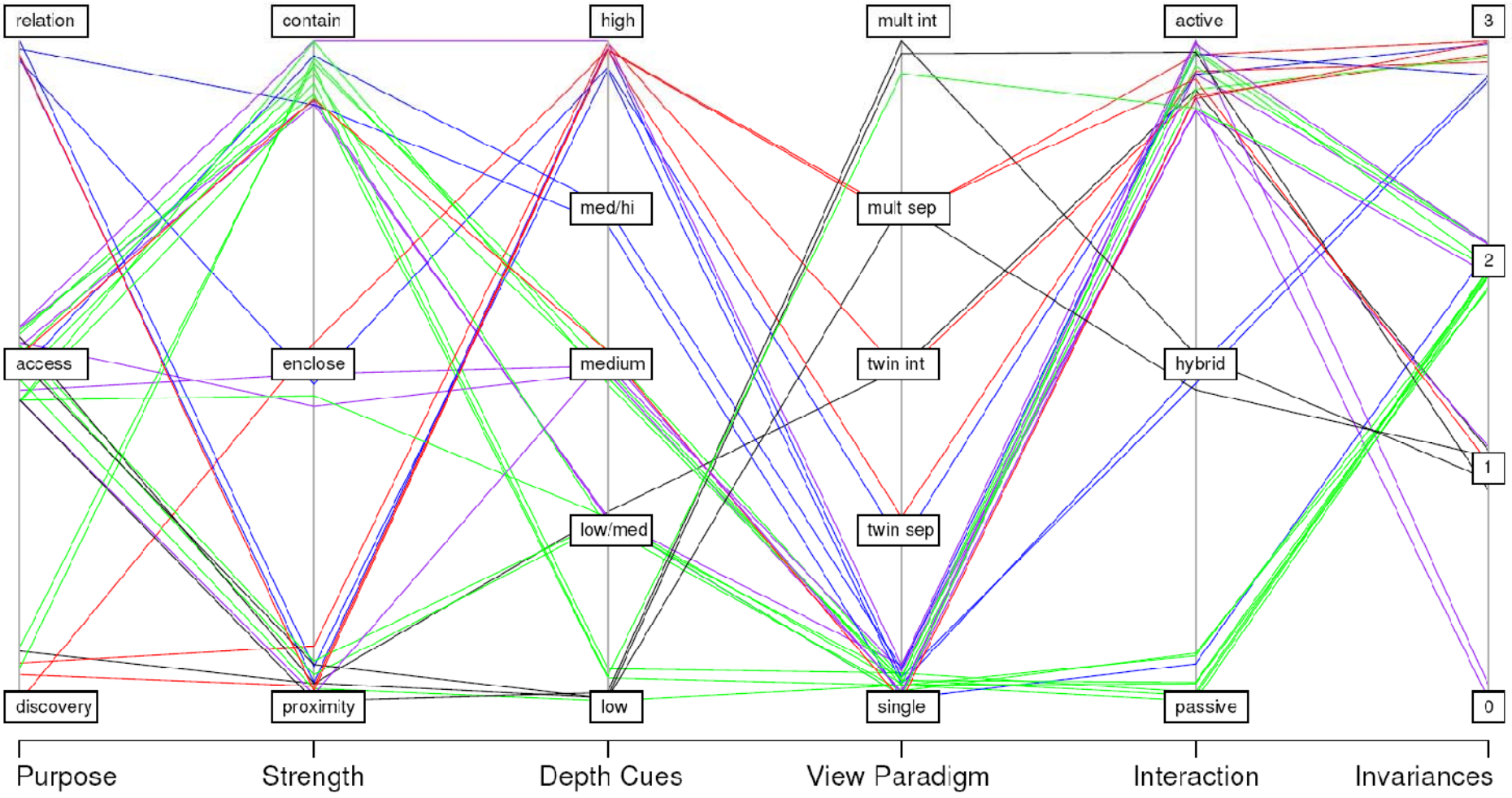


Taxonomy Dimensions (3)

- **Interaction Model**
- How do users actually activate the technique?
- Domain: [*active, passive, hybrid*]

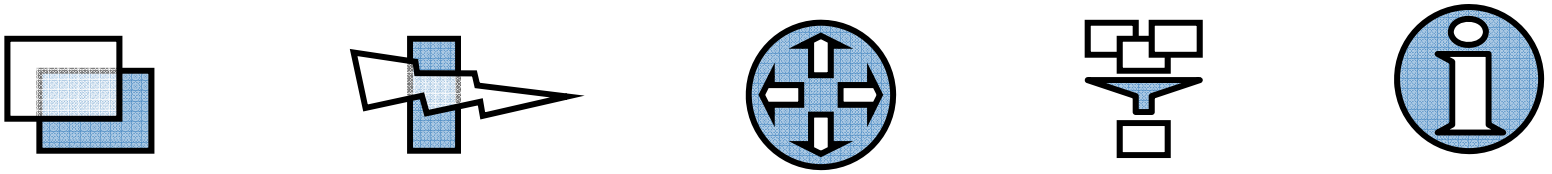
- **Target Invariances**
- What is the visual impact of the technique?
- Domain: yes/no for [*location, geometry, appearance*]

Classification

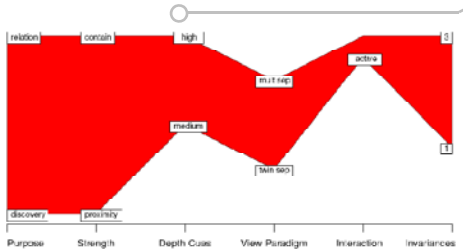


Design Patterns

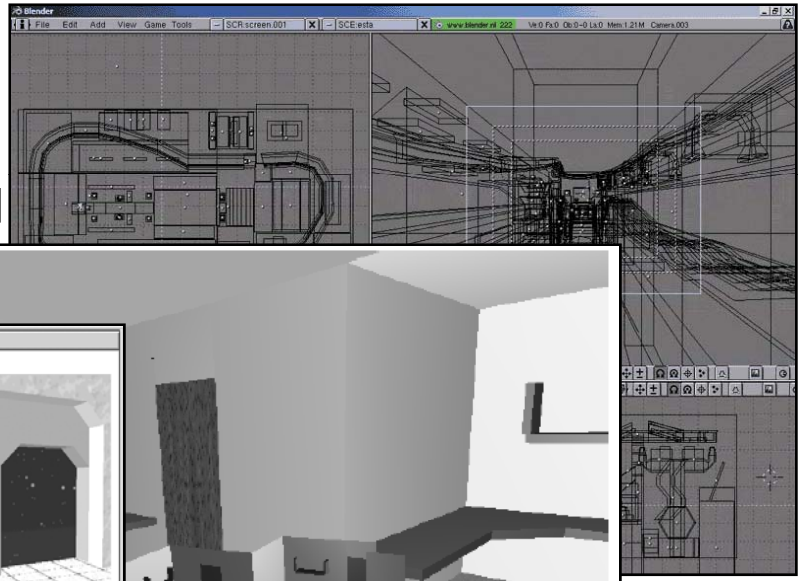
- Analyze classifications of 25+ techniques
- Related trends crystallize – extract **design patterns**
- Design pattern: [Alexander 1976]
  - Generic and reusable solution to a commonly occurring problem

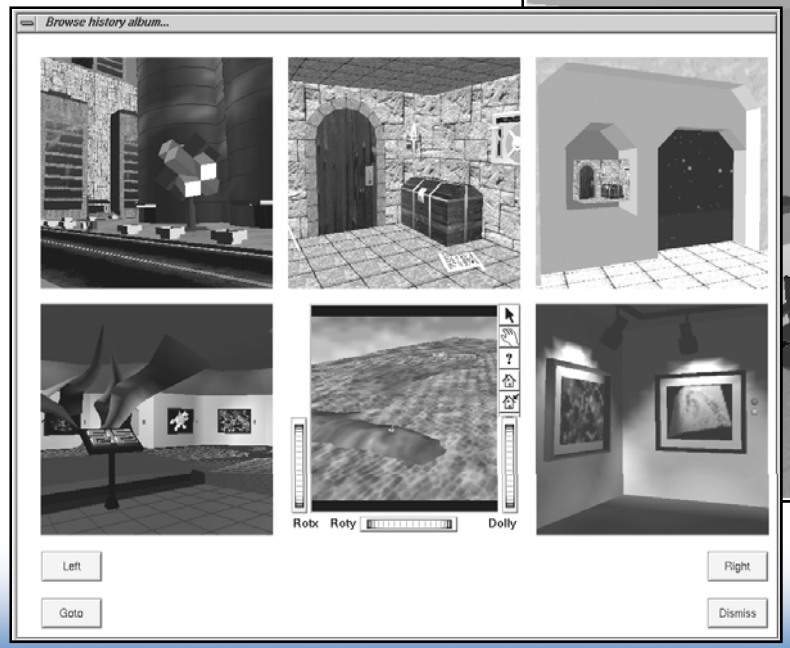


Multiple Views

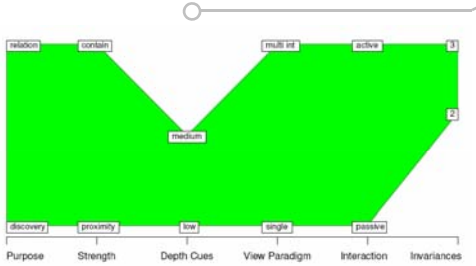


- Provide additional 3D views to reduce occlusion
- **Characteristic techniques**:
  - CAD programs
  - Worlds in Miniature [Stoakley et al. 1995]
  - Worldlets [Elvins et al. 1997]

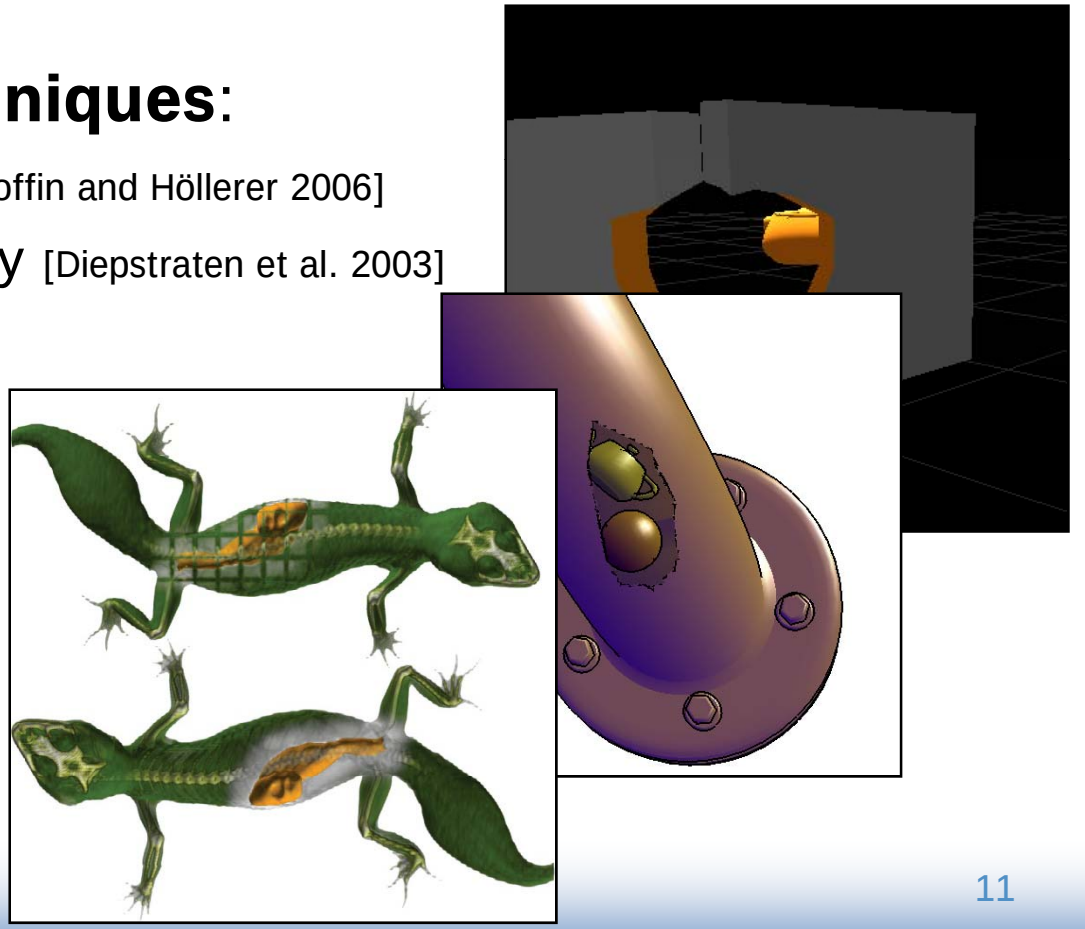




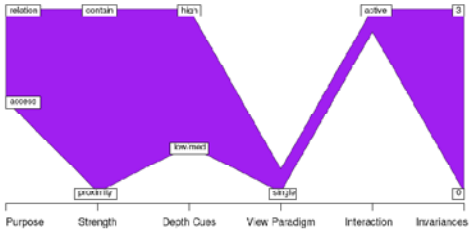
Virtual X-Ray



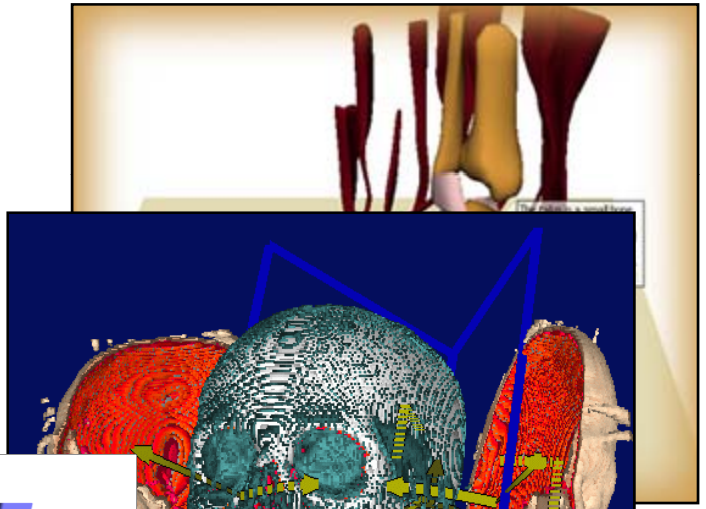
- Make interfering surfaces (semi-)transparent to show hidden targets
- **Characteristic techniques**:
  - Perspective cutouts [Coffin and Höllerer 2006]
  - Interactive break-away [Diepstraten et al. 2003]
  - IDVR [Viola et al. 2004]

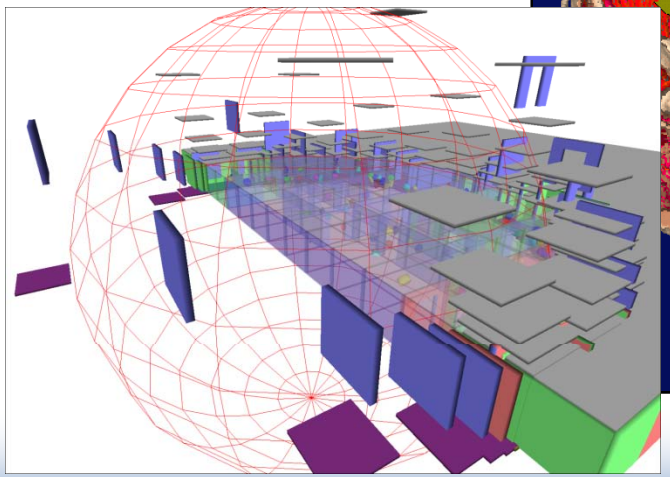


Interactive Exploder

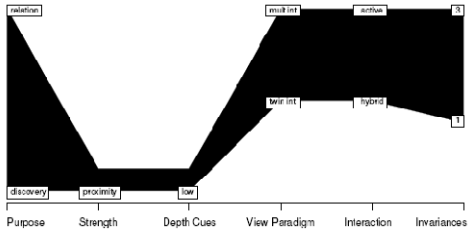


- Interactively displace objects → separating targets or removing distractors
- **Characteristic techniques**:
  - 3D explosion probe [Sonnet et al. 2004]
  - Deformation-based volume explosion [McGuffin et al. 2003]
  - BalloonProbe [Elmqvist and Tudoreanu 2006]

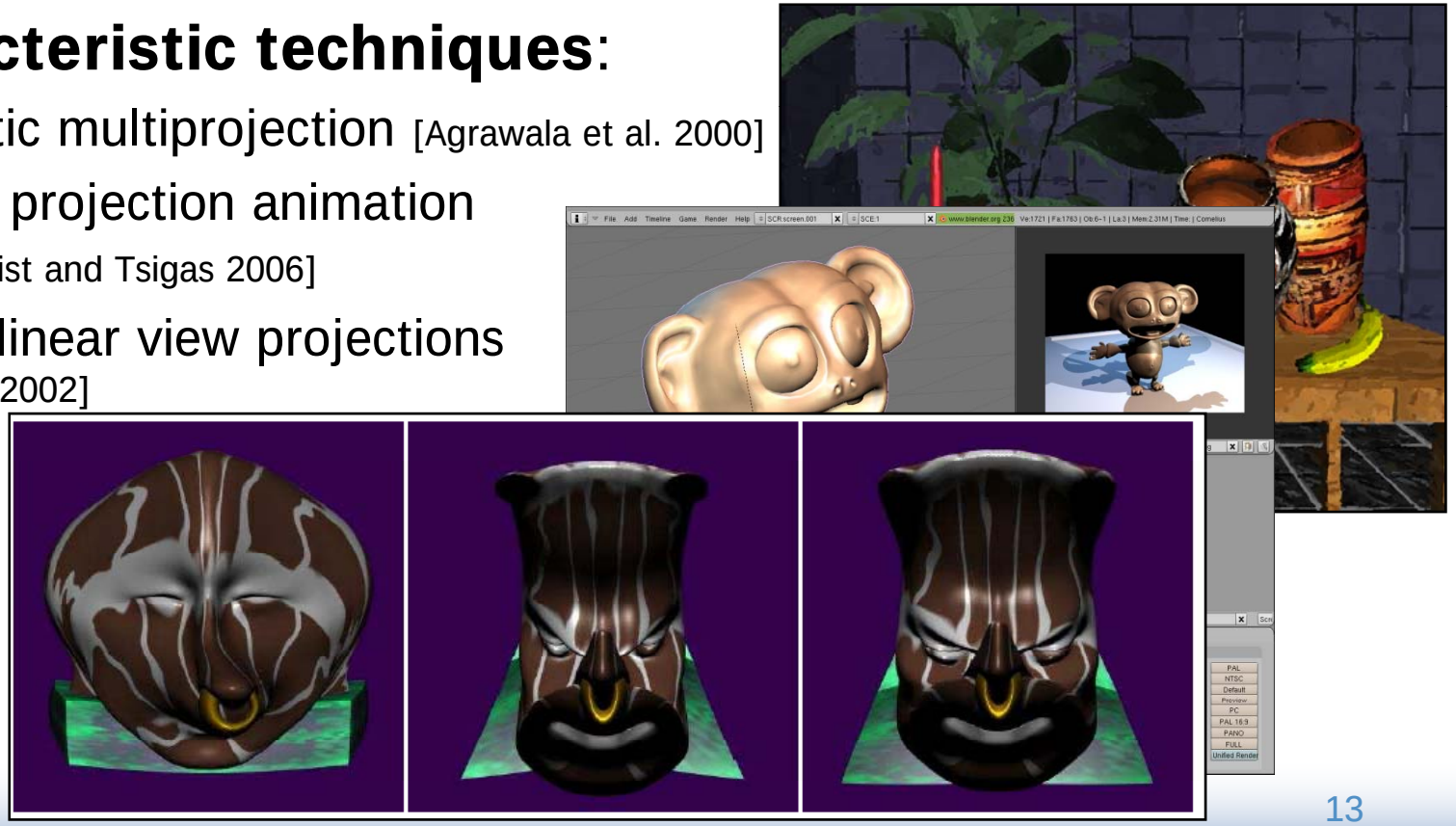




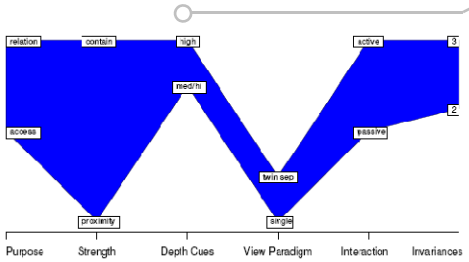
Projection Distorter



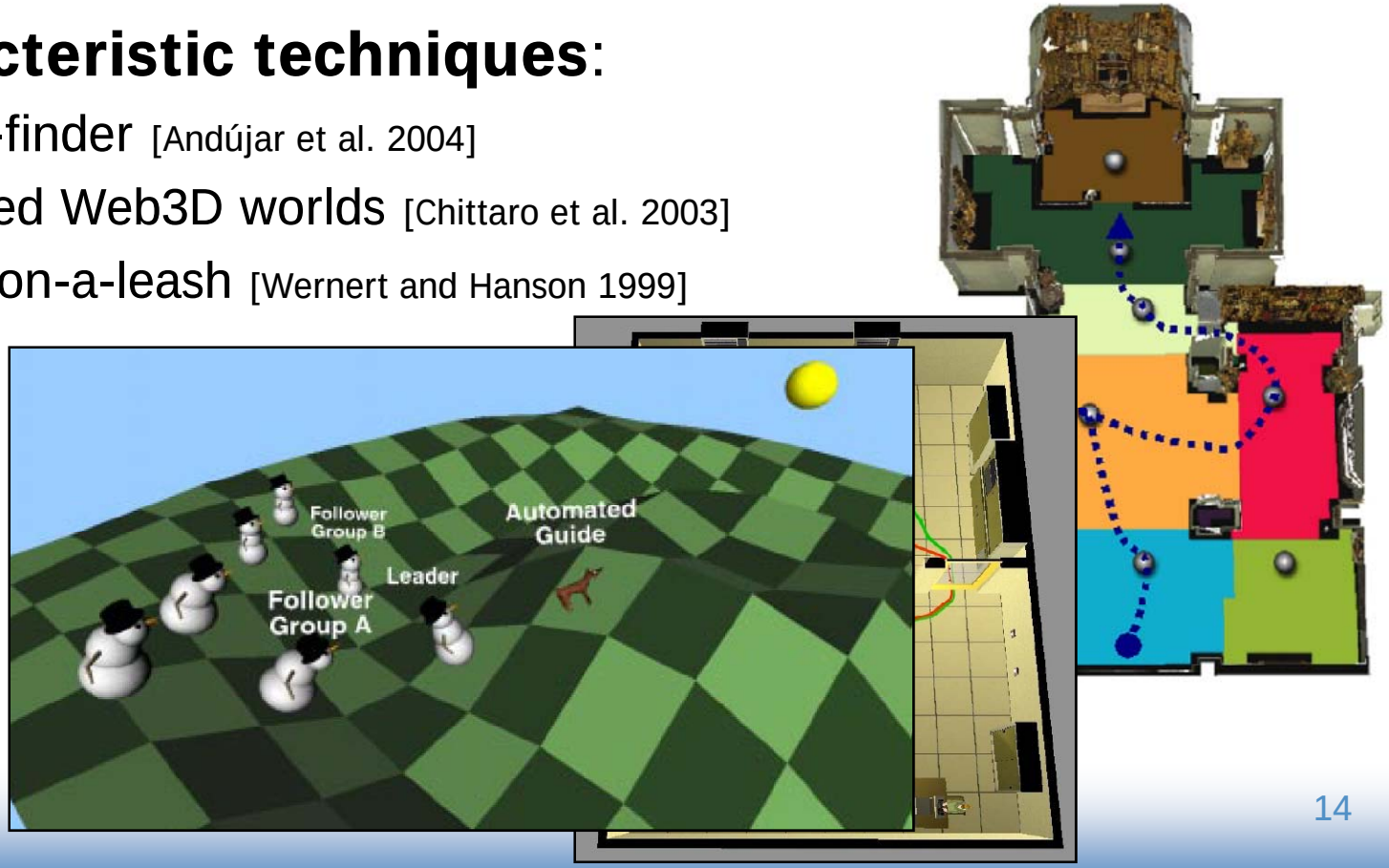
- Integrate several 3D views into a single one in the view (projection) space
- **Characteristic techniques**:
  - Artistic multiprojection [Agrawala et al. 2000]
  - View projection animation
    [Elmqvist and Tsigas 2006]
  - Non-linear view projections
    [Singh 2002]



Tour Planner

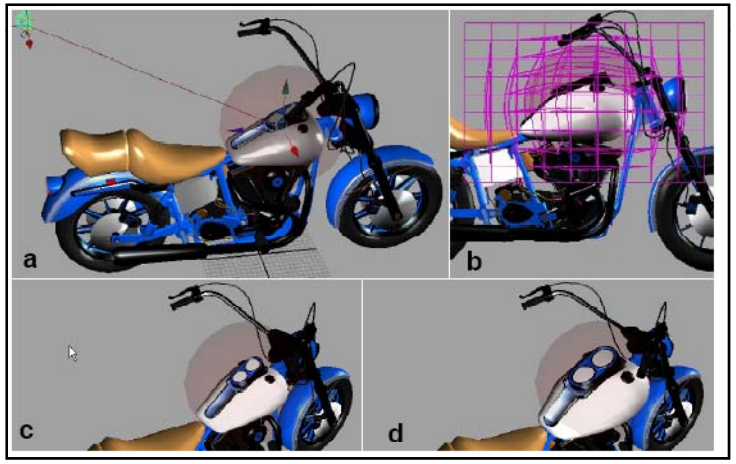


- Build and take user on a **grand tour** that reveals the whole 3D world
- **Characteristic techniques**:
  - Way-finder [Andújar et al. 2004]
  - Guided Web3D worlds [Chittaro et al. 2003]
  - Dog-on-a-leash [Wernert and Hanson 1999]



The Future?

- Patterns extracted from existing work
  - Not complete, other patterns possible!
  - Example: scene index, view management, cutting planes
- Future research directions
  - Combinations of patterns
  - Awareness
  - Previous interaction to inform target selection [Singh and Balakrishnan 2004]
- Additional perceptual mechanisms
  - Augmented perception...



Conclusions

- Taxonomy for occlusion management
  - Classifying existing work and extract patterns
  - Suggest future research directions
- **Strategy space** distinguishing factor:
  - **Image space**: virtual X-ray
  - **View space**: projection distorter and multiple viewports
  - **Object space**: interactive exploder
  - **Temporal space**: tour planner
- Future: combinations, awareness and hybrid interaction
  - More patterns?

Questions?

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