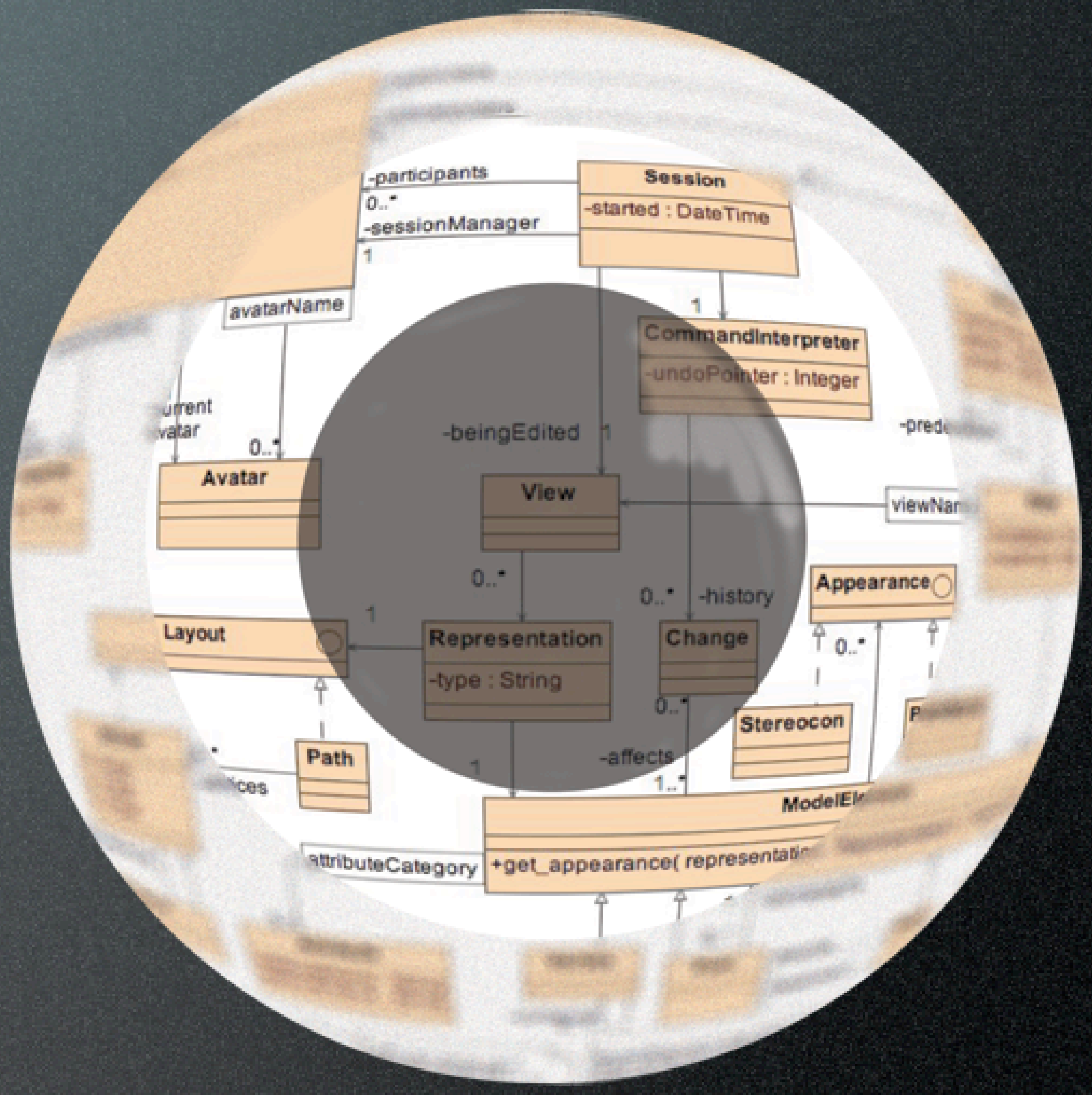
# Focus:

## Augmented Reality for Standards Development



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# About NIST

NIST is a national research laboratory that is part of the U.S. Department of Commerce, more specifically the Technology Administration.  Our mission is to improve the quality of life by working with industry to develop and apply technology, measurements, and standards.

# Standards development...

- Current information transfer standards (e.g. PDX standards) require substantial knowledge of the domain being addressed
    - Tend to be designed by domain experts
- Information complexity rising as electronics become smaller and more feature-filled.
- Due to the complexity of the information being transferred, traditional methods of standards development are breaking down
    - Possible solution: apply existing, rigorous methods for software development to standards

# Problem & Solution

- An ad-hoc approach to standards development can result in standards that
  - are ambiguous -- unclear what a particular piece of data means
  - are redundant and/or missing information -- data included twice or not at all
  - are overly complex -- difficult to understand and maintain
- Confuse domain and implementation
  - Does not separate the problem (what information and interactions must be transferred?) from the solution (how it will be transferred)
- Data model allows the designer to describe the data and interactions with the appropriate amount of complexity, without being concerned with implementation at all.
  - Allows automation of much of implementation phase

# What are we trying to do?

- Help improve the quality of data exchange standards by allowing domain experts to create underlying data models.
- Allow more productive collaborative data modeling sessions between domain experts
    - For various reasons, people traveling less
    - Support easier consensus-building
    - Existing solutions
        - Audio -- picture is worth a thousand words; modeling tasks are visual
            - Web conference -- interactivity suffers
        - Video conference -- language is similar to audio conference, still one person leading

# Focus: a distributed 3D modeling tool

- Uses augmented reality to allow interactive, distributed modeling sessions between experts
- Combined with a 3D display device like a head-mounted display, allows more of the model to be viewed and understood at once than with a 2D display
- Design
  - to work with inexpensive, available hardware, built on free software
  - to be cross-platform
- Freely available for further development

# Focus architecture: Augmented Reality

- "...Applications that involve the overlay of virtual imagery on the real world."
  -- ARToolkit home page

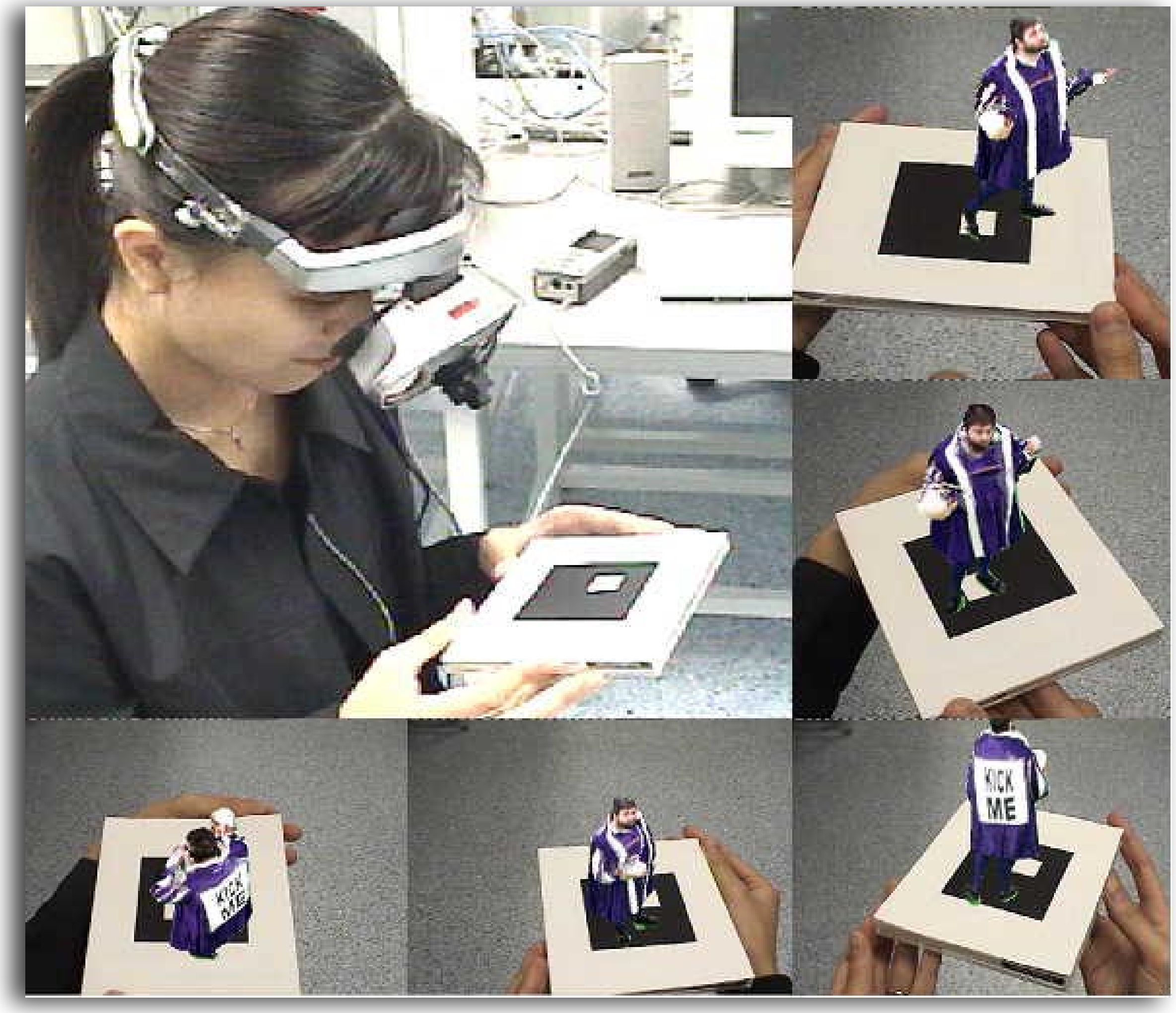
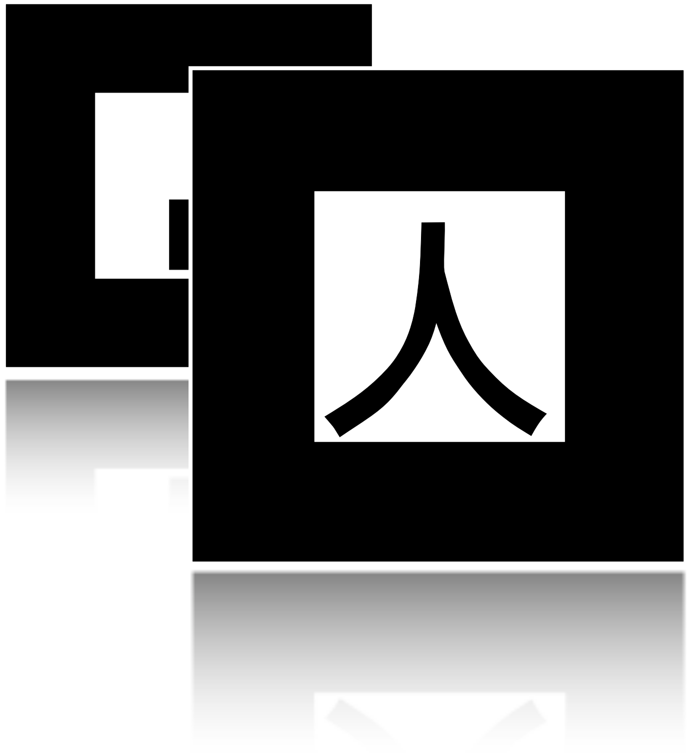
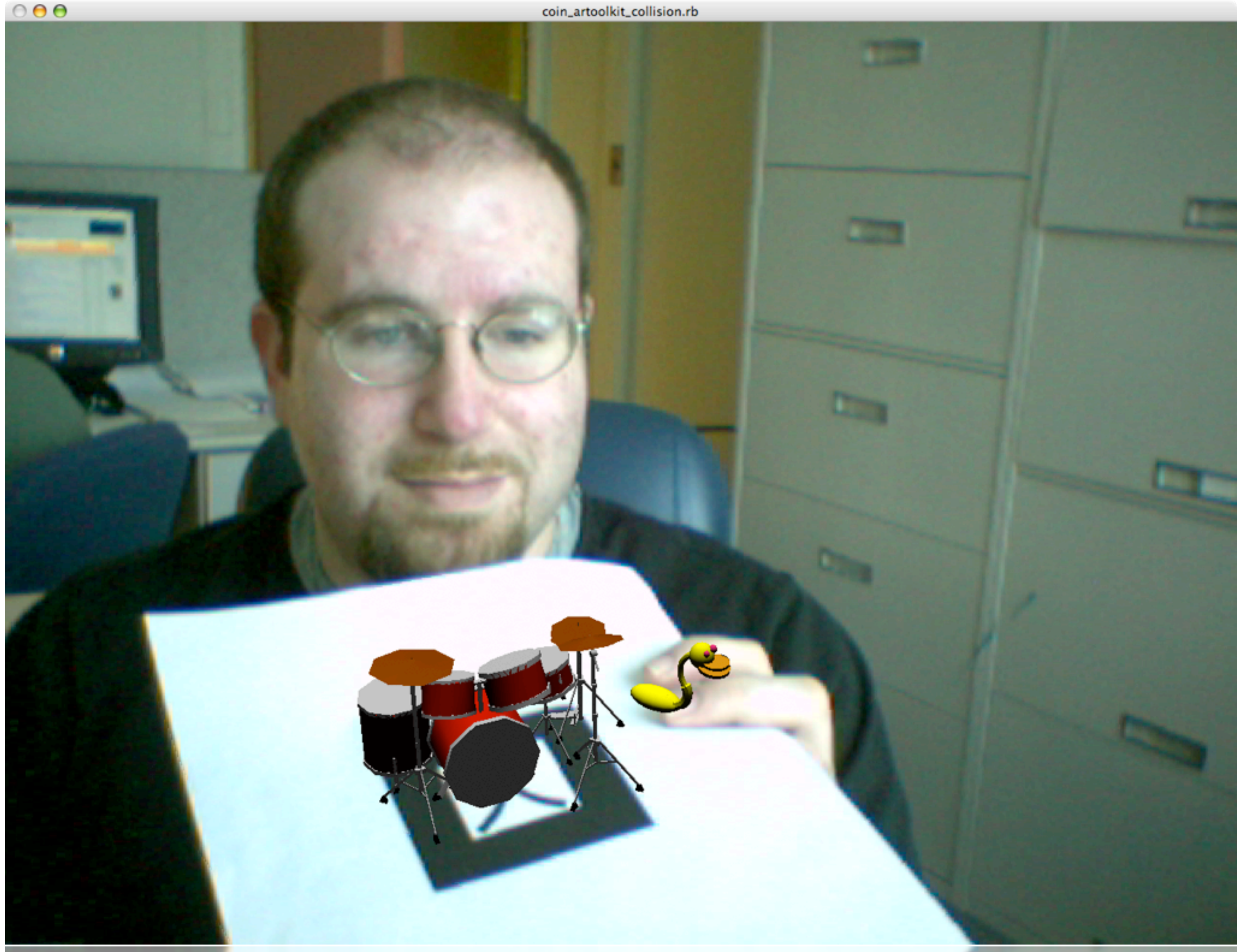


image is from the ARToolkit project's paper "Real World Teleconferencing" available at http://www.hitl.washington.edu/artoolkit/Papers/2002-CGA-RealWorldTeleConf.pdf

# Focus architecture: Augmented Reality

- Use specified markers (*fiducials*) to position rendered 3D objects within a video stream





- Live video and virtual objects are combined and rendered for the user

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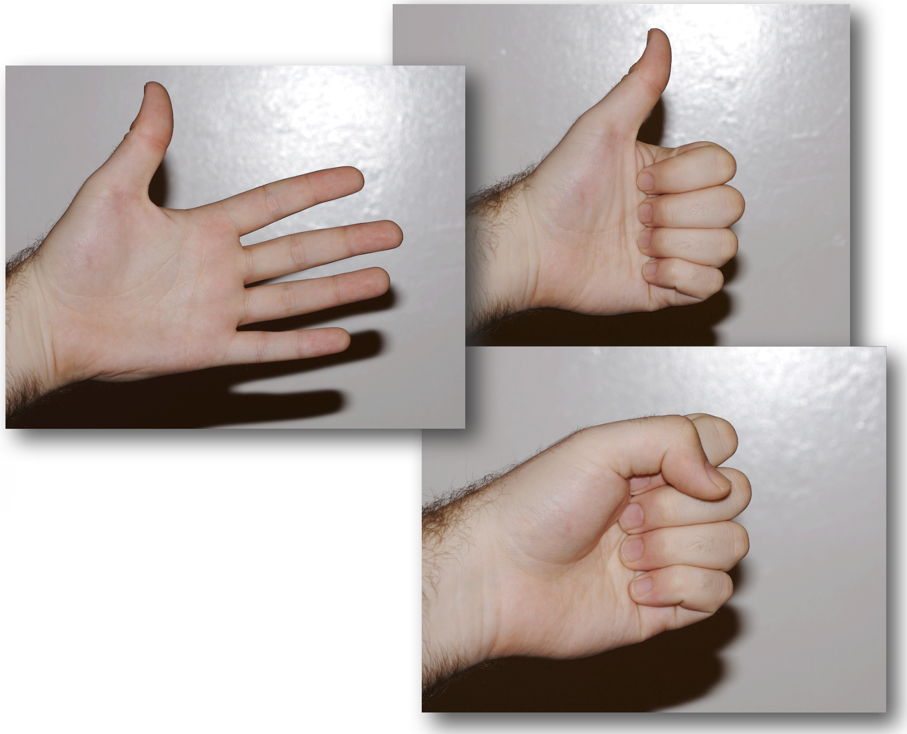
# Focus architecture: tracking the user

- User tracking
  - Position trackers
    - One main, absolute reference object: the data model (a fiducial)
    - Head: relative to data model
    - Hand: absolute, tracked with a second fiducial in the same video feed
  - Gesture/mouse input
    - Gesture language made as simple as possible



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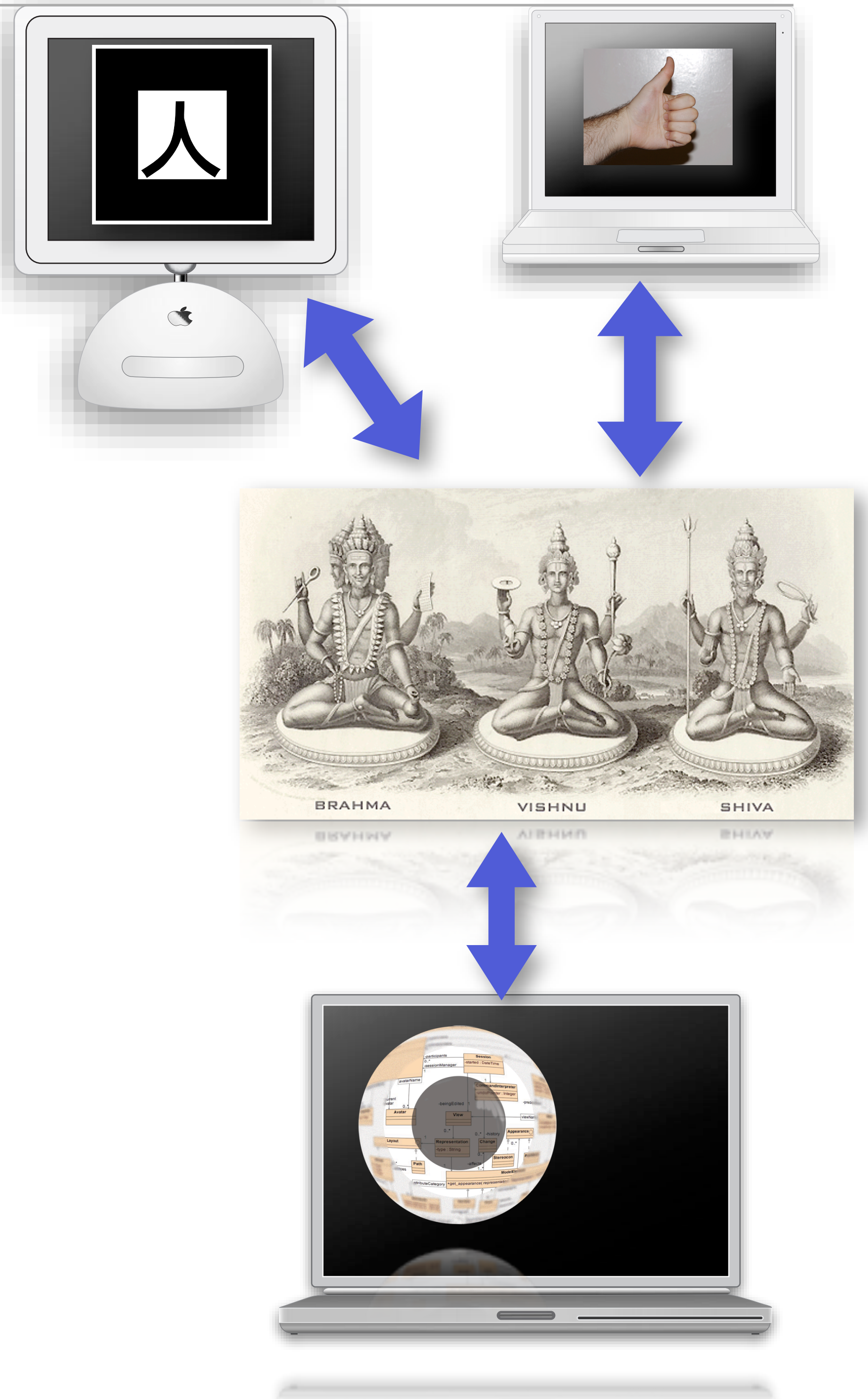
# Focus architecture: modular and distributed

- Modular, distributed-computing-friendly
  - Uses NIST-developed Trimurti framework for assembling modular applications
  - Dependency injection used to decouple application modules
    - Each component knows what it provides and requires
    - Trimurti connects the components based on this information
    - Easy to swap in new functionality
    - Requirements may be supplied remotely



# Software

- ARToolkit (http://artoolkit.sourceforge.net) for augmented reality tracking and real video
- Coin3D (http://www.coin3d.org) for 3D scene management and rendering
  - Able to intersperse some more low-level OpenGL code when necessary
- Libp5glove (http://www.audiomulch.com/simulus/p5glove/) to interface with the data glove
- DRb (http://www.chadfowler.com/ruby/drb.html) for the underlying distribution of our modules
- NIST-developed dependency injection framework

# Software: Communication

- All components not initially capable of communicating in Ruby
  - Created ARToolkit, Coin3D, and libp5glove Ruby bindings using SWIG (http://www.swig.org)
  - Advantages
    - Higher level, object oriented language
    - Didn’t have to reinvent the wheel

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# Hardware

- Aim: keep the cost at or below that of a standard video conferencing system
- Apple iSight camera
  - Standard firewire video interface, supported by Video4Linux framework as well.
- P5 data glove
  - Also works with standard mouse and tracking fiducial
- Head-mounted display (HMD)
  - eMagin Z800
  - iGlasses PC 3D Pro
  - both ~$1000

images from http://www.apple.com/isight/, http://www.vrealities.com/P5.html, http://www.3dvisor.com/

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# Design for the user

- Simple interaction
  - Whenever possible, an action is performed ON the model
    - New objects are created with the “Create” gesture at the position of the user’s hand
    - New vertices are added to association lines by grabbing and pulling on the line.
- Instant feedback
  - when an action is invalid, the user is told during the action rather than after failure (e.g. item turns translucent, item turns red, etc.)

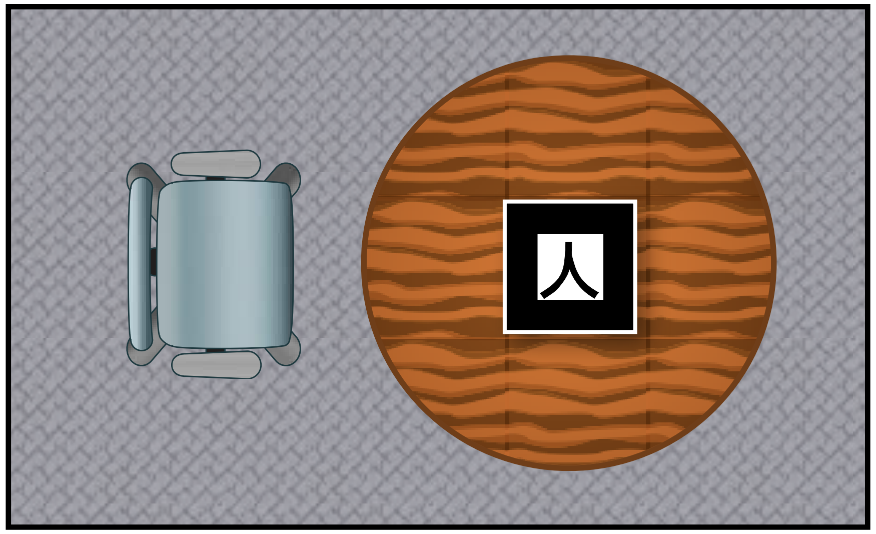
# Design for the user: Search

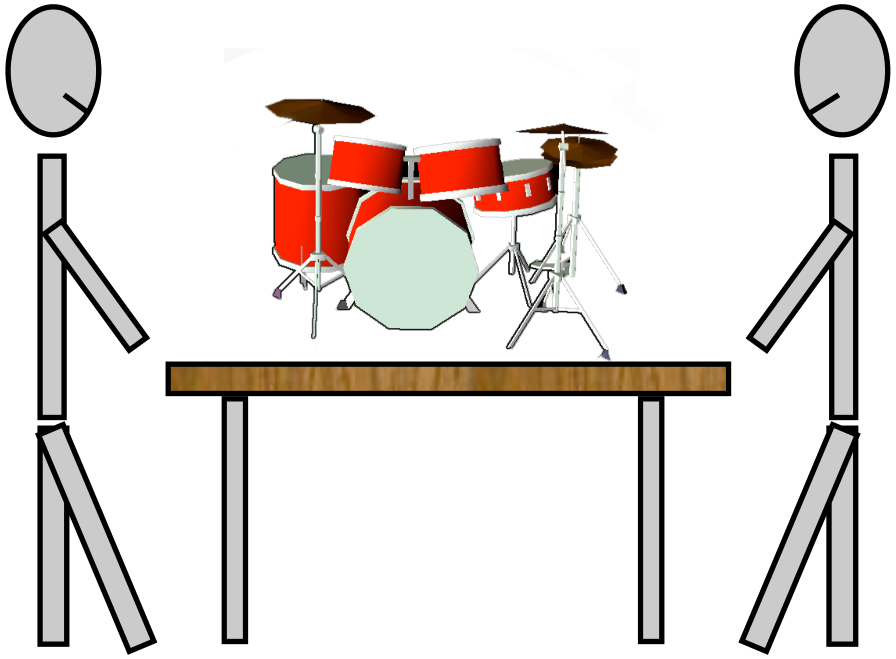
- Powerful, real-time searches
  - Results are highlighted in the scene as you enter search terms
  - Search criteria might include any information about an object
    - Traditional (occurrence of text)
    - Spatial (proximity to user or selection)

# So how does it work?

- A modeling project is created on the server
- User places a fiducial, e.g. on the desk in front of them, to position the model
- User puts on HMD and glove, connects to the server, authenticates for a particular project
    - User is then participating in that project
    - Data model appears atop the fiducial
    - Other users' representations (*avatars*) appear based on their relative locations to the model

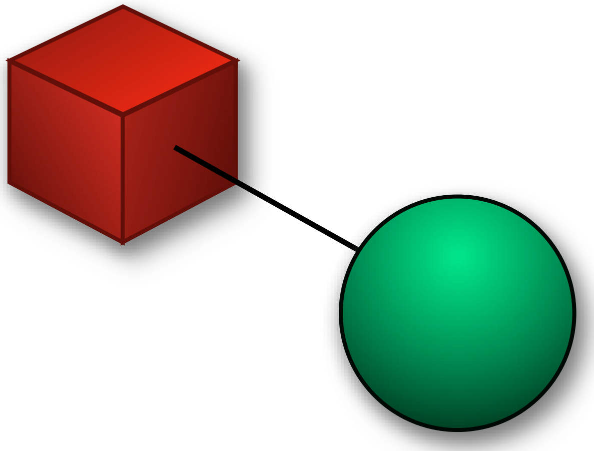
from above

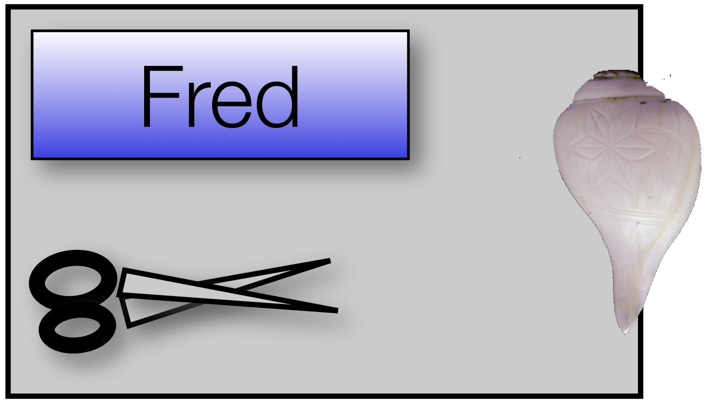




# So how does it work?

- Each object in the model has a representation in 3D
  - Classes
    - e.g. A circuit board class
  - Associations and other connections between objects are drawn as lines
- The users share a palette of tools that may be applied to the model
  - New user's (inactive) palette has: representation of the active tool, the active user, and a control button
  - When control is relinquished by the active user, the new user may modify the model
    - This control is enabled by default to enhance collaboration, but need not be





# So how does it work?

- Basic tools perform functions familiar to users of graphical editors
  - select, move, delete, etc.
  - different types of object that may be created
- Other tools may be added as necessary

# Status

- Design phase (complete)
    - Use case catalog
    - Publication on Focus architecture
    - Investigated component technologies
    - GUI design whitepaper complete, available soon
- Implementation phase (ongoing)
    - I/O hardware purchased
    - Components developed and tested
    - Components demo in progress
    - Full system demo soon

# Conclusions

- Improved data modeling for new standards
  - Data complexity - molehill becoming a mountain
  - Let the experts do what they know
  - Borrow technique from software industry
- Collaborative
  - Possible for distributed groups to work directly on a live data model
  - Provides experience more like face-to-face meetings than traditional options
- Result: Better Standards

# Some references...

- M. Billinghurst, A. Cheok, S. Prince, H. Kato. Real World Teleconferencing. IEEE Computer Graphics and Applications, Nov/Dec 2002, Vol 22, No 6, pp. 11-13.
  - http://www.hitl.washington.edu/artoolkit/Papers/2002-CGA-RealWorldTeleConf.pdf
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- Trimurti
  - http://raa.ruby-lang.org/project/trimurti/

# Questions?

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