CSE 165: 3D User Interaction

Lecture #3: Displays

Announcements

- Homework Assignment #1
  - Due Friday at 2:00pm
  - To be presented in CSE lab 220
- Paper presentations
  - Title/date due by **entering into wiki table** on Ted by Sunday, January 17th

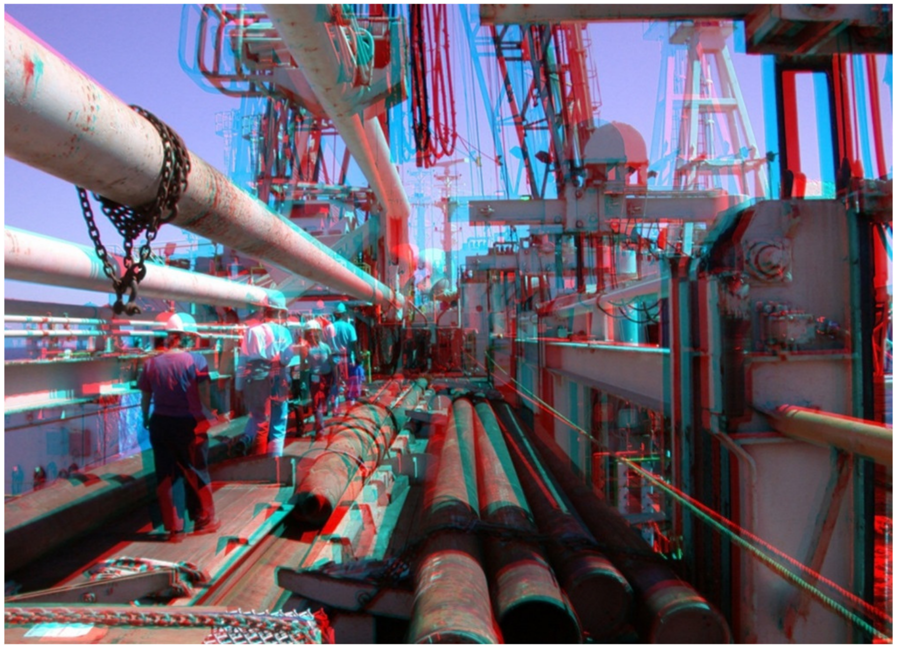
Stereo Imaging Techniques

Stereo Imaging: Concept

- General concept: each eye sees a slightly different image
- Example: Viewmaster:
  left eye is shown one image on the disc, right eye sees a different image

Stereo Imaging: Anaglyphic

- Anaglyphic
  - requires red/blue, red/green glasses
  - color is diminished (but not entirely lost)

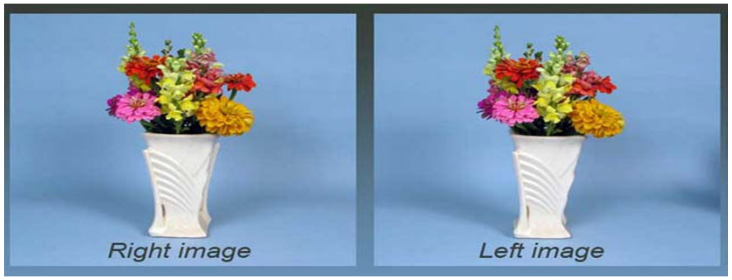


Core drilling ship (Andy Johnson, UIC/EVL)

Stereo Imaging: Side-by-Side

- Stereo can be seen by fusing images: converge eyes in front or behind the actual image plane

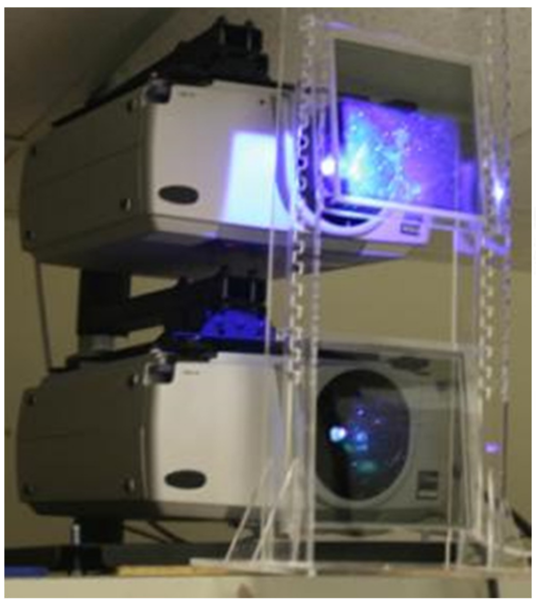
Eyes converge behind image plane



Eyes converge in front of image plane

Stereo Imaging: Polarizing Filters

- Linear polarization
- Circular polarization: creates circularly polarized light by adding a quarter-wave plate after a linear polarizer
- Polarizing glasses are inexpensive (~$2-10)



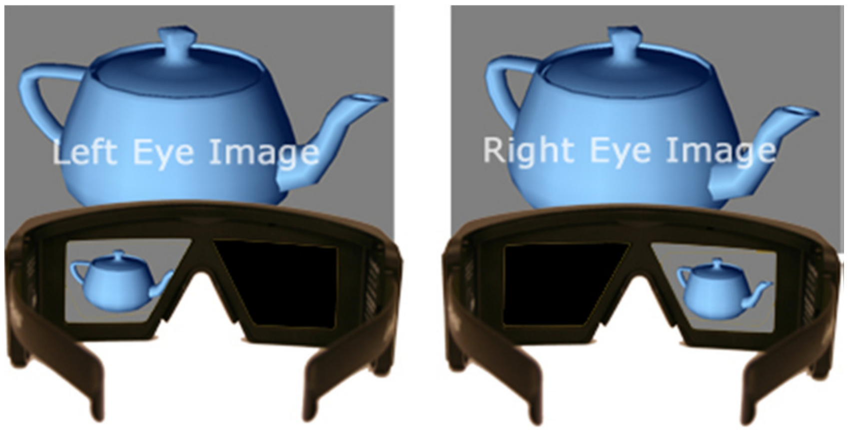
Polarizing glasses

Stereo projectors

Stereo Imaging: Active Stereo

- Display alternates between images for left and right eyes at 120+ Hz
- Shutter glasses
  - synchronized to display refresh rate
  - more expensive than passive glasses (~$30+)
  - require batteries

CrystalEyes shutter glasses

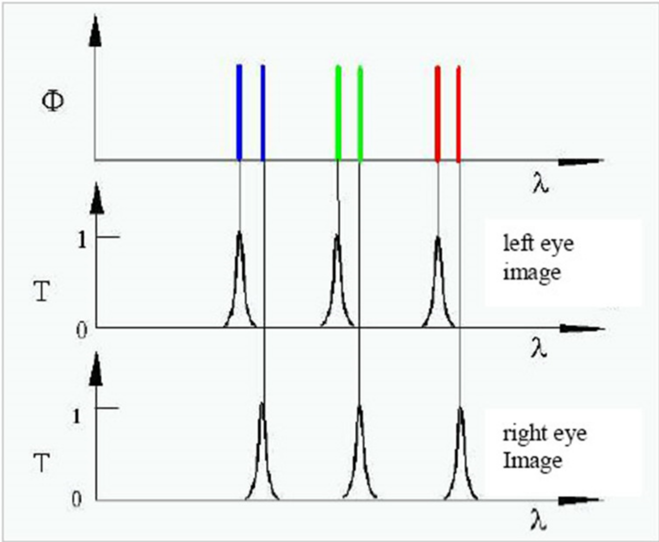


Stereo Imaging: Infitec

- Clever technology, based on wavelength multiplexing
- Two separate primary color triplets are filtered by glasses to generate two sets of primary colors
- Infitec resulted from a research project at DaimlerChrysler

Projectors with Infitec filters

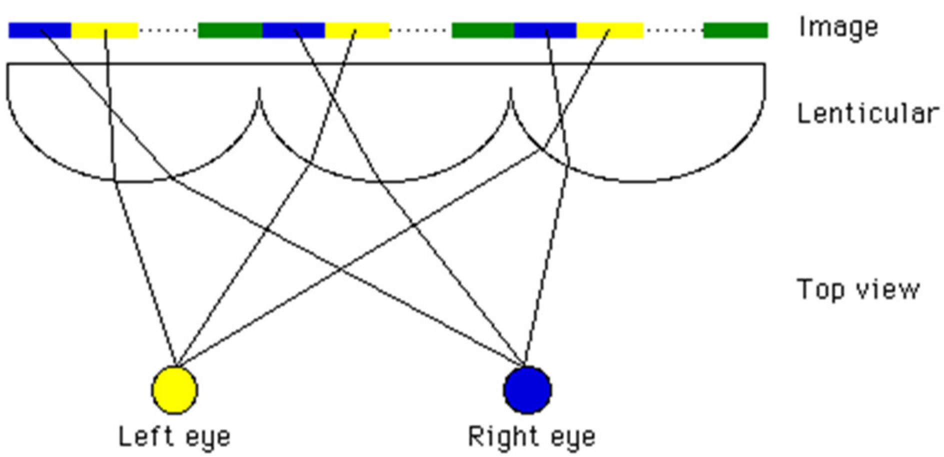
Infitec glasses



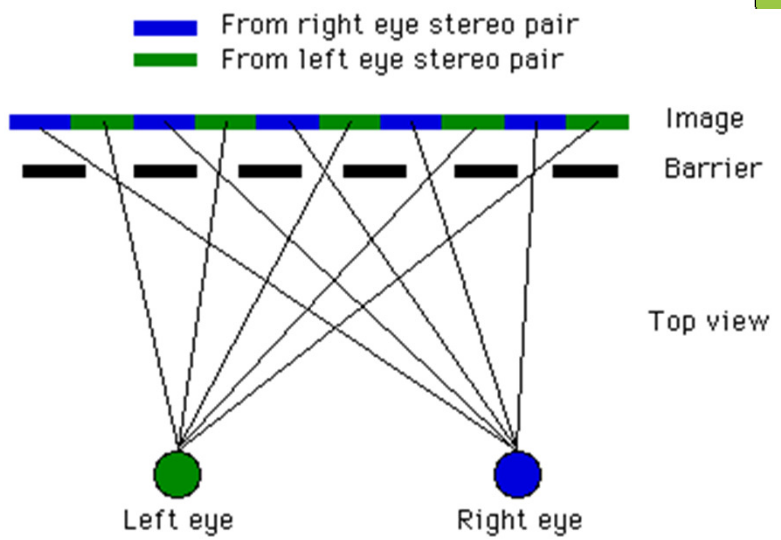
Primary color triplets

Autostereoscopic Displays

- Light sent separately to each eye from a monitor
- No headgear required
- Tracked (dynamic) vs. non-tracked (static, sweet spot)
- Approaches:
  - lenticular screen
  - barrier screen



Lenticular screen



Barrier screen

3D Displays

Introduction To Displays

- *Display*: device which presents perceptual information
- Often term "display" is used for "visual display"
- Goal: display devices which accurately represent visual perception in a simulated world

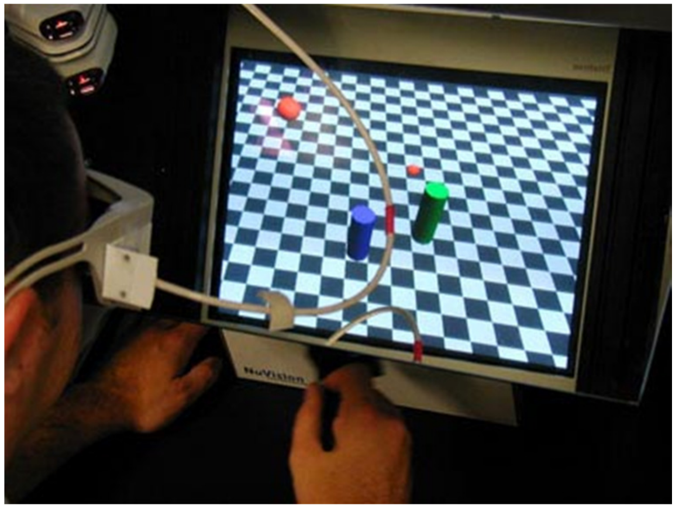
Visual Display Characteristics

- Field of View (FOV) and Field of Regard (FOR)
  - FOR – amount of physical space surrounding viewer in which visual images appear
  - FOV – maximum visual angle seen instantaneously
- Spatial Resolution
  - number of pixels and screen size
- Screen Geometry
  - rectangular, hemispherical, etc…
- Light Transfer Mechanism
  - front projection, rear projection, laser light, etc…
- Refresh Rate
  - not the same as frame rate
- Ergonomics

Display Types

Stereo Monitor

- Active or passive stereo
- "Fishtank VR"



Stereo Monitor – Advantages

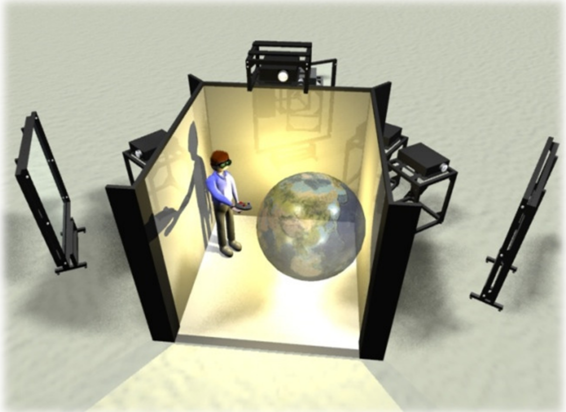
- Inexpensive
- Crisp image at HD or more
- Keyboard and mouse work as usual
- Can be used with most 3D input devices

Stereo Monitor – Disadvantages

- Not very immersive
- User seated, cannot move around
- Does not take advantage of peripheral vision
- Stereo can be problematic
  - Active: user's 3D glasses need to face emitter
  - Passive: blank pixel lines can be perceptible
- Occlusion from physical objects can be problematic

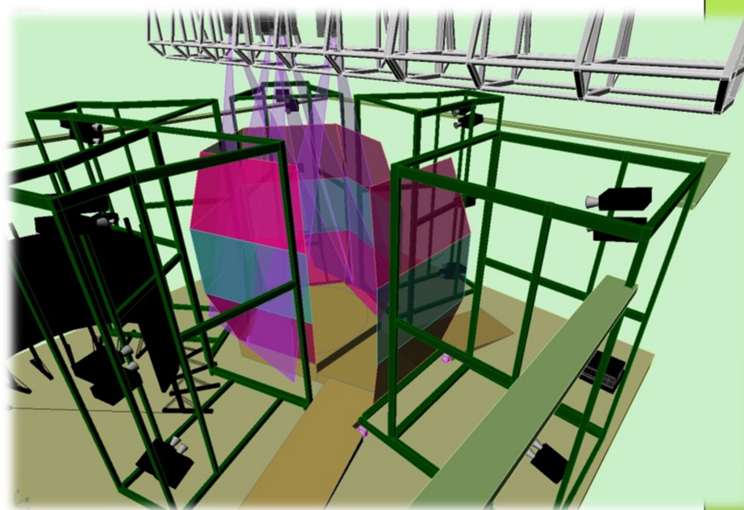
Surround Screen VE

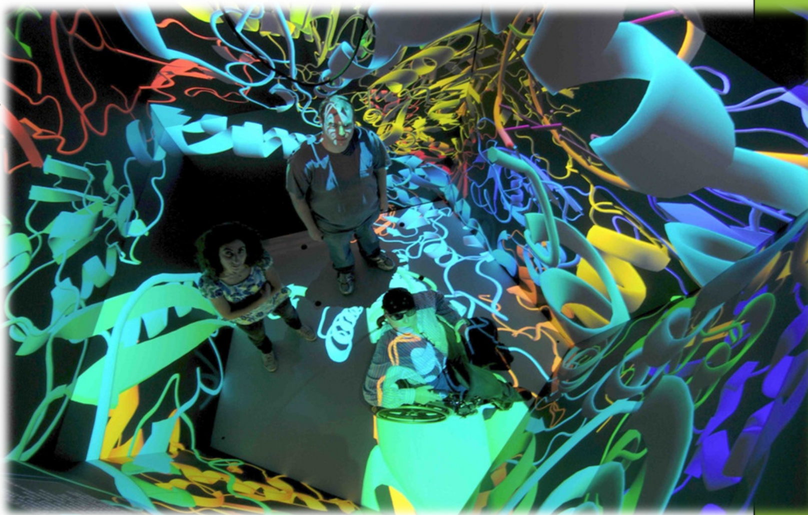
- Has 3 to 6 large screens
- Puts user in a room for visual immersion
- Usually driven by a single or group of powerful graphics engines
- Requires elaborate head/wand tracking



StarCAVE at Calit2

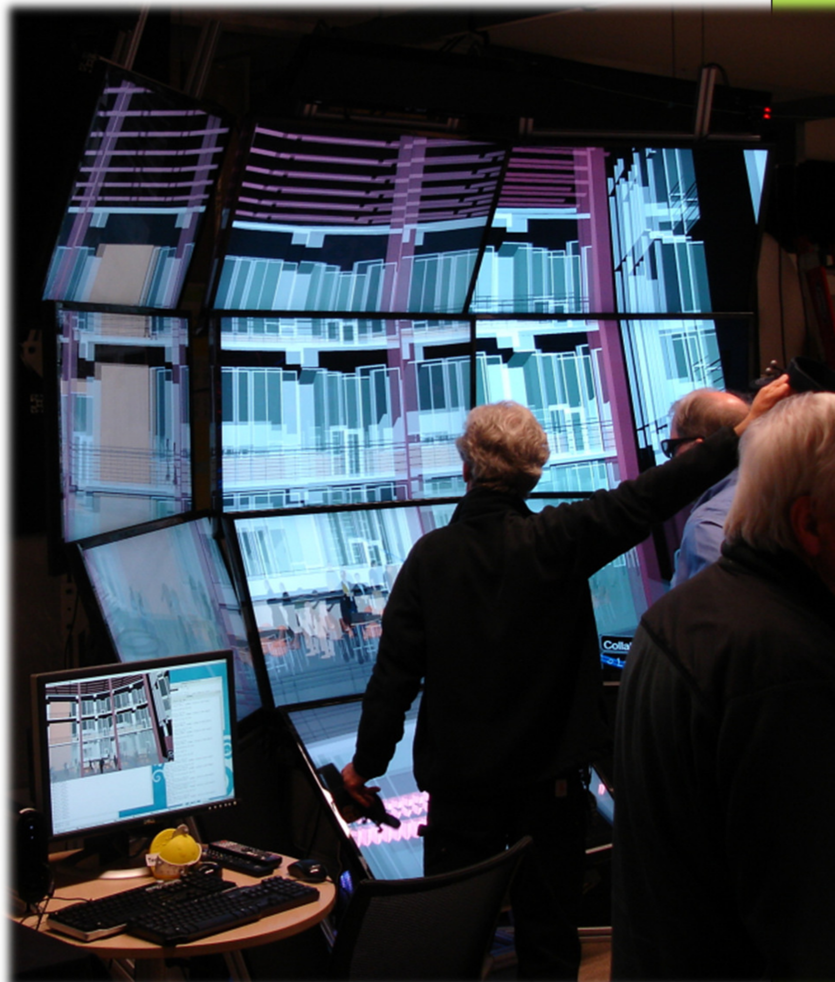
- 18 graphics workstations
- Dual graphics cards per node
- CentOS Linux
- 34 HD projectors:
  ~34 megapixels per eye
- 360 degrees immersion
- Passive stereo, circular polarization
- 15 screens on 5 walls, ~8 x 4 foot each, plus floor projection
- 4-camera optical tracking system





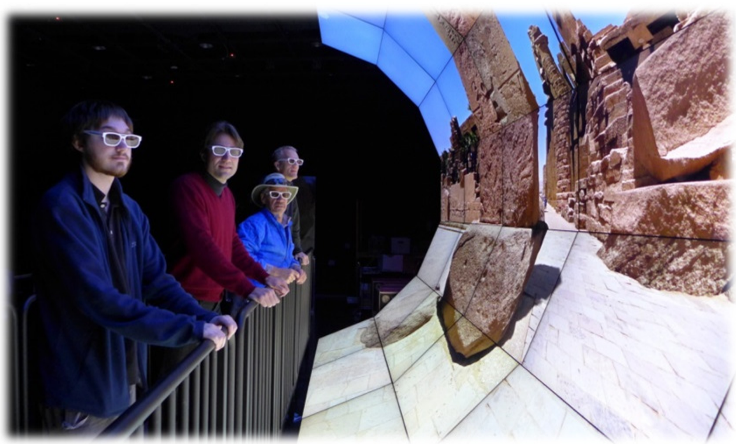
NexCAVE

- First LCD-based CAVE
- 14 42” HD passive stereo displays
- 8 rendering PCs
- 2-camera optical tracking system

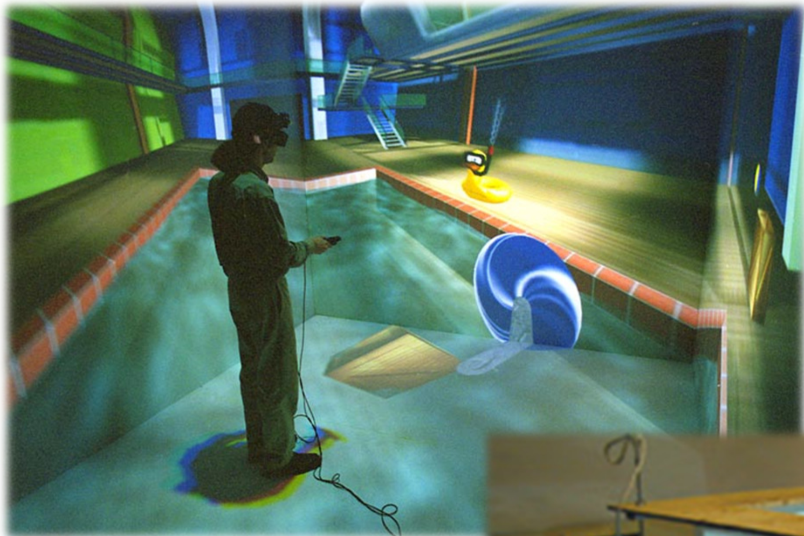


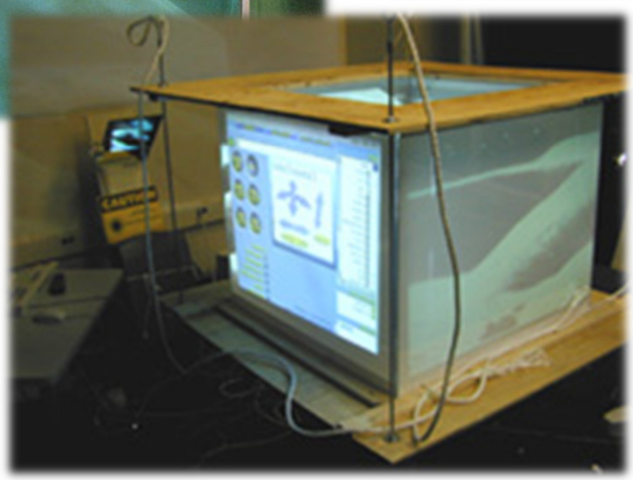
WAVE

- 35 55" HD monitors with narrow bezels
- 18 rendering PCs
- Passive stereo
- 9600x7560 pixels combined



Other CAVEs





Surround Screen Virtual Environments – Advantages

- Provide high resolution and large FOV
- Passive stereo: user only needs a pair of light weight glasses for stereo viewing
- User has room to move around
- Real and virtual objects can be mixed
- A group of people can use the space simultaneously

Disadvantages

- Expensive (typically >$100k)
- Require a large amount of physical space
- Projector calibration must be maintained
- Normally only one user head tracked
- Stereo viewing can be problematic (ghosting, focal plane far away)
- Physical objects can get in the way of 3D image

CAVE Interface Design

- Do not need to represent physical objects (i.e. hands) as graphical objects
- Can take advantage of the user's peripheral vision
- Do not want the user to get too close to the screens
- Developer can take advantage of the space for using physical props (i.e. car seat, treadmill)

VR Workbenches etc.

- Similar to CAVEs but only one or two displays
- Can be a desk or a large single display (e.g., PowerWall)
- Traditionally a table top metaphor

VR Workbenches etc.

VR Workbenches etc.

zSpace

- Full HD resolution
- Active stereo screen
- Passive glasses
- Tracked glasses and stylus
- Stylus with infrared markers and gyroscope

Workbenches – Advantages

- High resolution
- For certain applications, makes for an intuitive display
- Can be shared by several users

Workbenches – Disadvantages

- Limited movement
- Typically only one user head-tracked
- No surrounding screens
- Physical objects can get in the way of graphical objects
- Stereo can be problematic

Workbenches – Interface Design

- Ergonomics are important especially when designing interfaces for table displays
- User can take advantage of direct pen-based input if display surface permits
- No need to create graphical representations of physical objects