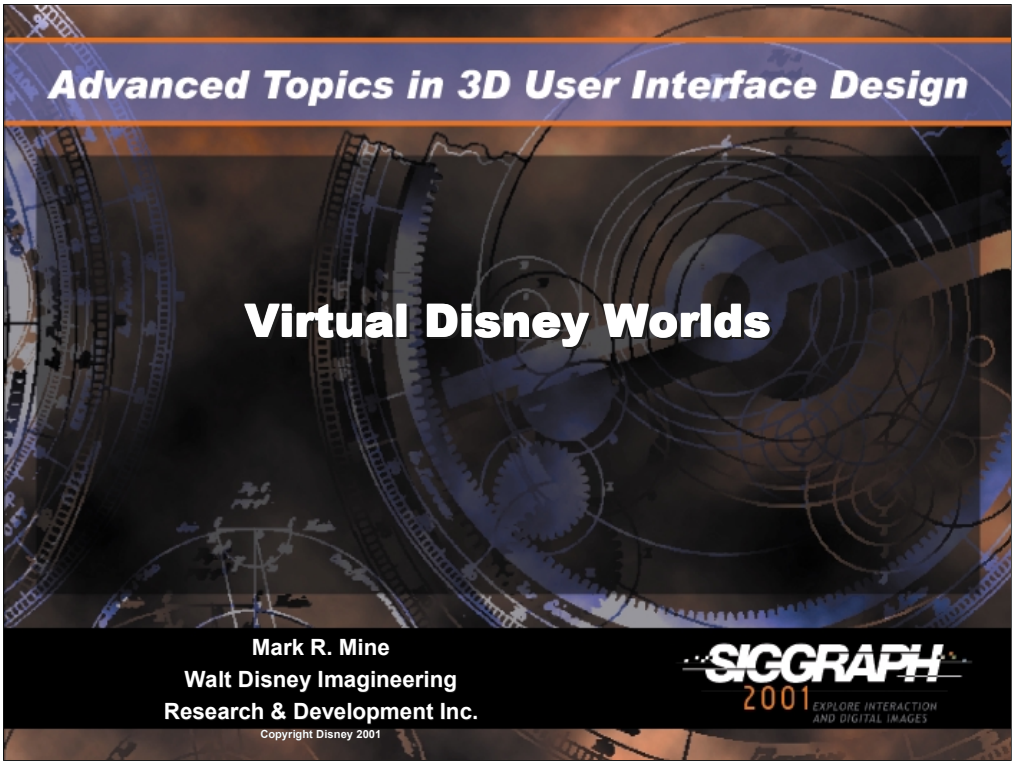
Advanced Topics in 3D User Interface Design
Virtual Disney Worlds
Mark R. Mine
Walt Disney Imagineering
Research & Development Inc.
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2001
EXPLORE INTERACTION AND DIGITAL IMAGES

Today what I'd like to do is give you an overview of the virtual worlds research at Disney

I'm going to begin by giving you an overview of the VR Studio.

Next I'll present some brief highlights of some of the projects we've been involved in the past, and talk about some of the things that we are currently working on.

Then I will discuss our experiences developing attractions for the Location Base Entertainment venue DisneyQuest

The remainder of the talk will focus on some of the work we've been doing in the area of simulation and visualization for theme park design. I'll will try to relay to you some of the lessons we've learned working with designers

•The VR Studio is part of Walt Disney Imagineering's (WDI) Research and Development Department

•WDI was traditionally responsible for the construction of Disney Theme parks. R&D was organized to develop new technologies to support that. Several years ago R&D's charter was expanded to encompass research and development for the entire company, and in particular help out with some of the new business units such as ABC.

•Originally we began developing an HMD/VR experience based upon the movie Rocketeer, but then changed focus to the movie Aladdin.

•Multiple versions of Aladdin

- •Aladdin Mark 1: single person, single scene
- •Aladdin Mark 2: single person, multiple scenes
- •Aladdin Mark 3: multi-player, multiple scenes

Now we have expanded our portfolio considerably to encompass many different aspects of interactive computer graphics

•DisneyQuest is an indoor interactive park that combines the magic of Disney with cutting-edge immersive technologies, such as virtual reality and real-time 3-D. Spanning five floors, DisneyQuest has four unique zones of entertainment bursting with attractions, rides, and games. DisneyQuest locations are open at the Walt Disney World resort in Orlando and in downtown Chicago at Ohio and Rush Streets (description from www.disneyquest.com)

•DisneyQuest boasts multiple high-end attractions emphasizing real-time, interactive, computer graphics

- •Cyberspace Mountain – Design your own roller coaster and ride it in a 2 axis, 360 degrees continuous rotation motion platform.
- •Invasion! An Alien Encounter – 4 Player, pod based shoot-em-up utilizing infinity optics
- •Ride the Comix – HMD based sword battle with cartoon characters
- •Virtual Jungle Cruise – River raft ride on WDI-R&D designed air cell motion platform
- •Aladdin's Magic Carpet Ride – VR Studio's HMD based multi-player ride through the movie Aladdin
- •Hercules in the Underworld – VR Studio's CAVE based attraction based on the movie Hercules – 4 players battle Hades in the underworld
- •Pirates of the Caribbean – CAVE based attraction developed by the VR Studio. Motion platform, cannons, pirates, sea serpents and more.

3D Interface Design for LBE

- **Highly constrained by the unique nature of an LBE attraction**
  - Short 4 – 5 minute experience
  - Must be enjoyable by people 8 – 80
  - Operational considerations preclude the use of complex devices
- **Interaction primarily limited to navigation**
- **Usability key – focus on natural skills**

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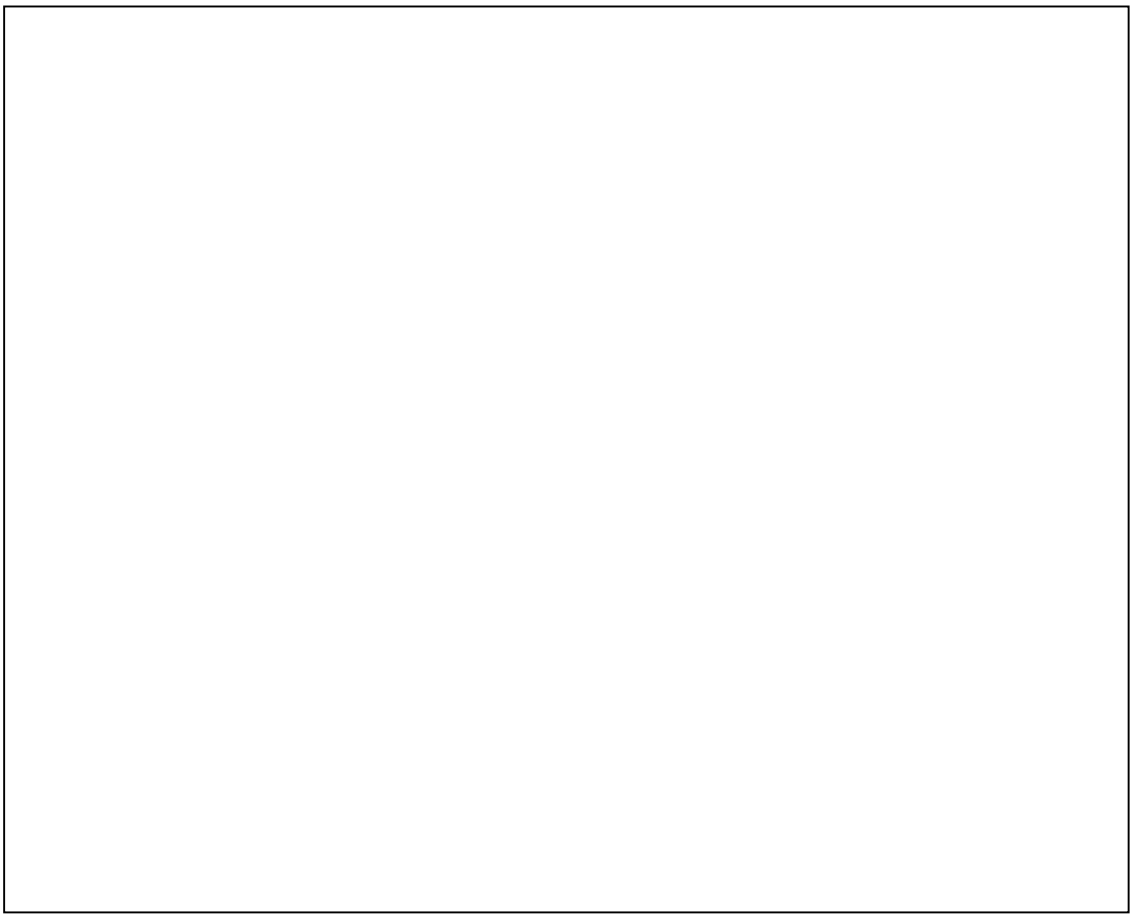
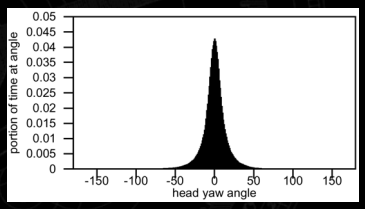


Screen shot from Aladdin's Magic Carpet ride. Entrance into the Sultan's palace.

Aladdin Interface Challenges

- **Intuitive interface for 3D navigation**
  - How do you fly a magic carpet?
- **Directing guest attention**
  - Complicated by limited HMD FOV



- **Encouraging interaction between guests in a shared virtual space**
  - Shared audio key

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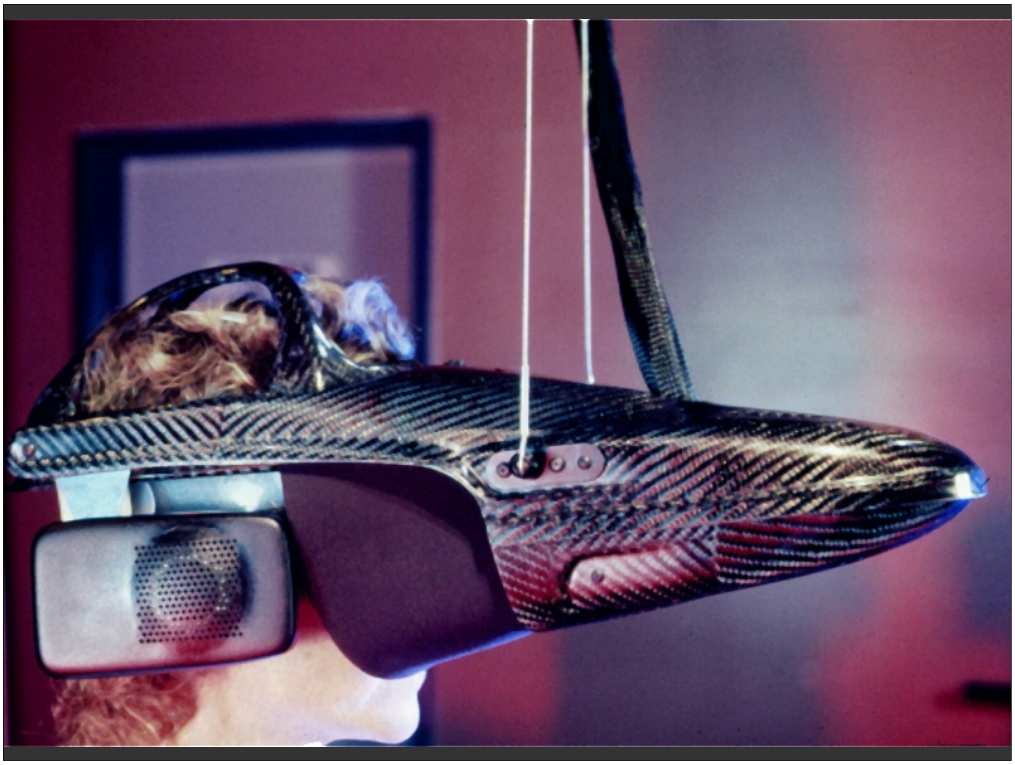
Graph is from: *Disney's Aladdin: First Steps Toward Storytelling in Virtual Reality,* Randy Pausch, Jon Snoddy, Robert Taylor, Scott Watson, Eric Haseltine, **ACM SIGGRAPH 96 Conference Proceedings**, August 1996

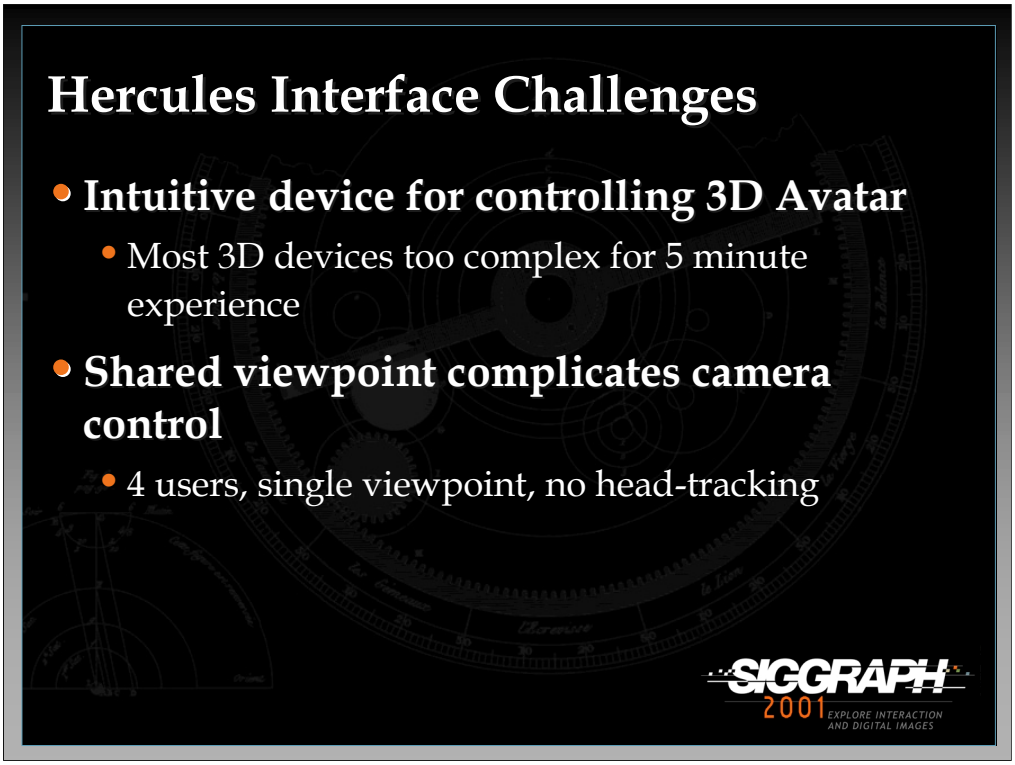
Control seat and HMD used in Aladdin's Magic Carpet ride.

Control seat and HMD used in Aladdin's Magic Carpet ride.



Close up of “GatorVision” HMD developed by R&D for Aladdin’s magic carpet ride (subsequently marketed by nVision). High-res, CRT based design. Note cables attached to the front of the HMD used for weight relief. HMD also included an adjustable/detachable head unit which was given to the user before they entered the ride. Optics and earphones then quickly snapped onto head unit. This greatly improved ride load/unload times and made it possible for the head unit to be cleaned between users.

Screen shot from the CAVE based attraction, Hercules in the Underworld. 4 guests control four avatars (Hercules, Megara, Pegasus, and Phil) using 2 axis joysticks.



Interfaces for LBE attractions face the arcade challenge…arcade games typically have room for only three instructions, and by default the first two are:

1) Insert coin

2) Press start

Interfaces must therefore be immediately intuitive. The simple joystick is hard to beat.

Several techniques were used to augment Hercules camera control:

•Layout of the world was designed to prevent guests from wandering too far apart.

•A "bubble" surrounding guests was used to keep the camera centered on the avatars.

•A "pusher" mechanism was implemented to gently nudge guests along the story path if they stayed in one area too long.

•Story points were added that could be used to transport guest instantly to new scenes.

Interior shot of the prototype Hercules CAVE, 5 rear-projection screens (5 sides of a hexagon – only 3 visible in this shot). Projectors were turned on their side for greater vertical aspect ratio. Joysticks are custom designed with 1 inch thick steel shafts down the middle to withstand the rigors of daily use.

IMAX active stereo glasses used in the Hercules attraction (same glasses were used for the Pirates of the Caribbean ride). Blinders at the side of the glasses were removed to maximize peripheral vision (so guests could see screens to the side and behind them – though not in stereo they would at least provide motion cues).

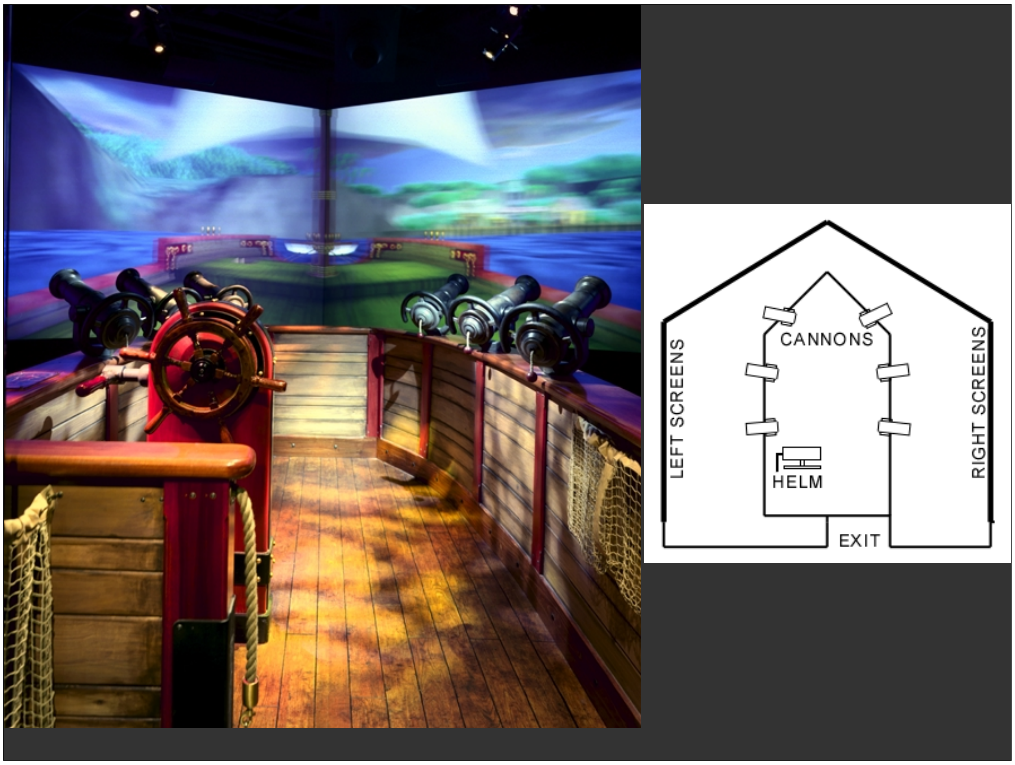
Screen shot from Pirates of the Caribbean – Battle for Buccaneer Gold – the latest CAVE based attraction developed by the VR Studio (winner of the 2001 THEA award from the Themed Entertainment Association)

Images from the original Pirates of the Caribbean attraction at Disneyland.

Extensive research was conducted in the original Pirates attraction. Here the authors interviews one of the animatronic figures in the ride.

Early storyboard sketch of the virtual pirates attraction.

Photo illustration of the final product (actual display screens not shown)



Screen shot and schematic diagram of a single Pirate's CAVE. Four rear-projection stereo displays. Air cell motion platform in the center with 6 physical cannons and a single helm. With one guest steering at a real helm, the other three guests man six real cannons to defeat virtual enemy pirate ships, forts, sea monsters and ghostly skeletons to collect and defend as much gold as possible in the five minute experience. *Pirates* uses wrap-around 3D screens, 3D surround sound, and a motion platform boat to fully engage the guest as a pirate.

Note: images are doubled on the screen due to stereo display.

Exterior of one of the Pirate's CAVEs. In order to ensure the high throughput that theme parks demand, there must be no time wasted acclimating the guest to the story, interface, or game rules. One thing *Pirates* makes extensive use of is an incredibly rich back-story that every guest can relate to – that of being a pirate. The attraction title, music, and theming of the queue line immediately gets the guest in the correct mind-set to play. They know what to expect, what is expected of them, and can then focus on the details of the interface and game rules.

Overview of the game world in the virtual pirates ride. A version of this map can be seen outside the entrance to the pirates CAVE in the previous slide. Since guests are free to roam throughout the world, exploring islands and battling ships, its important to acclimate them to the environment before they begin playing the game.

Pirates make extensive use of soft-skinned animated characters. Here Jolly Roger the Ghost Pirate explains the roles of the captain and gunners, and encourages the players to sink many pirate ships in order to get their gold.

Lessons Learned

The importance of physical interfaces…
Especially for facile camera control

- Aladdin's flying carpet interface
- Pirate's steering wheel
- Pirate's cannon

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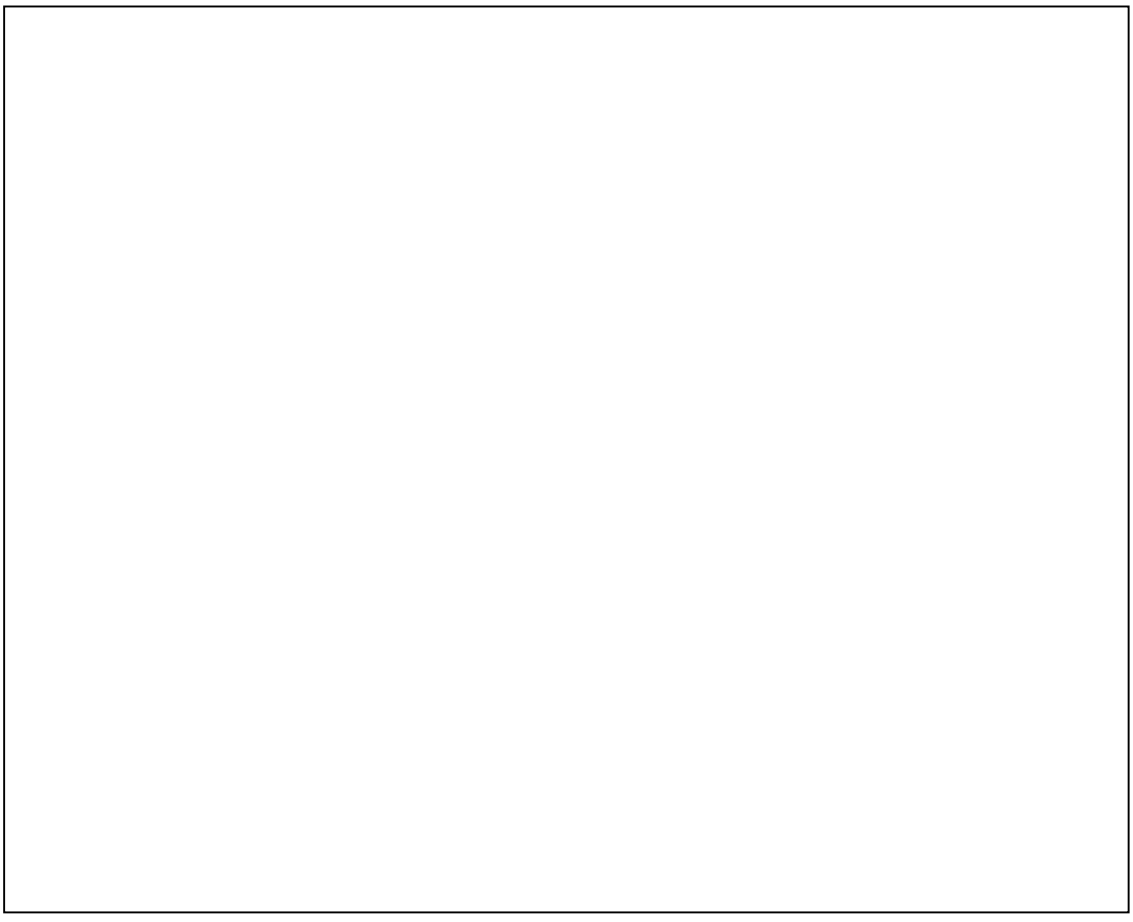


At this point, what I'd like to do is focus in on some of the work we've been doing in the area of simulation and visualization for theme park design.

The goal was to apply our experience in the design of virtual spaces for location-based entertainment to the design of physical spaces for theme parks.

It was clear to us in the studio that we could provide the theme park designers some effective tools for visualization of future rides and attractions. Our challenge was to incorporate these tools into the existing design process.

What we were competing with is a 45 year tradition of building scale models for the visualization of these rides. To call these things models is to sell them short, these are incredible, high level-of-detail works of art. Furthermore, these models have many desirable characteristics which are hard to match in our current virtual systems.

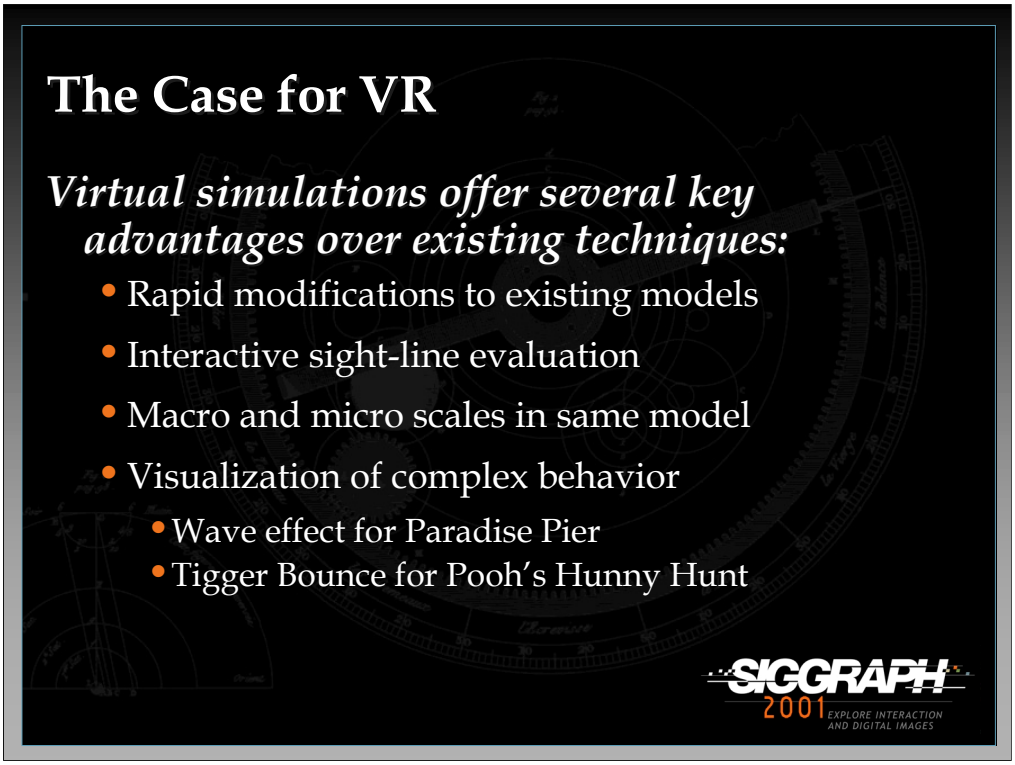
Photograph of a physical scale model built for the Indiana Jones Ride at Disneyland.

Photograph of a different view of the same model.

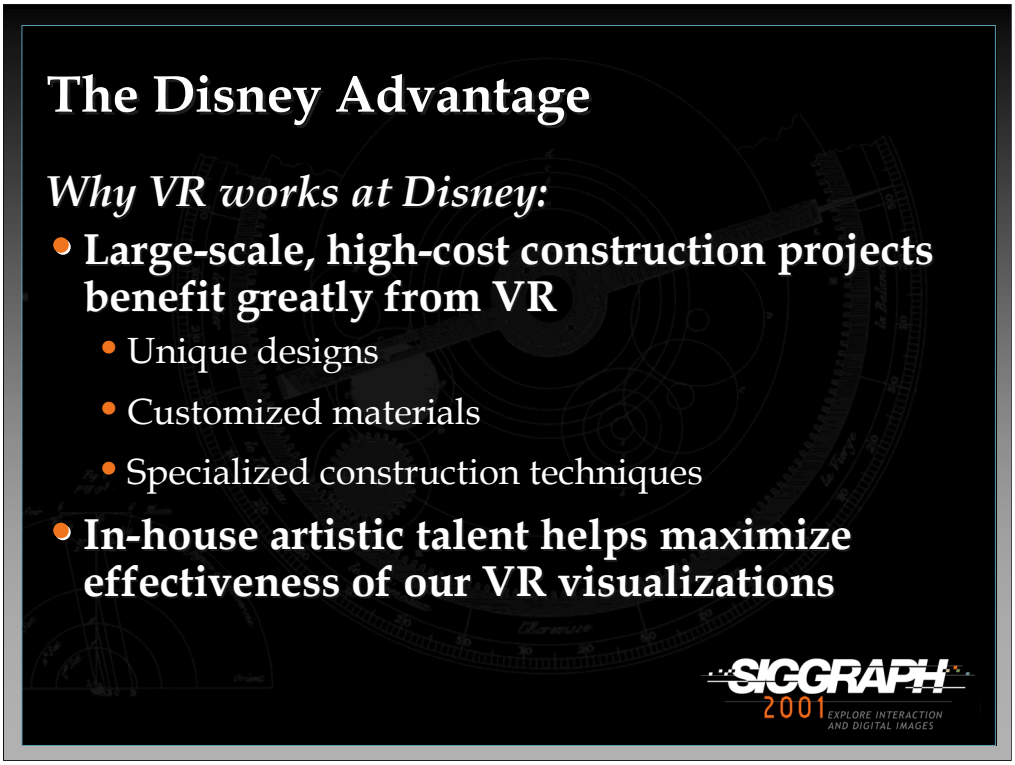
Photograph of the same scene in the actual ride.

Photograph of the physical scale model built for the Pooh's Hunny Hunt attraction at Tokyo Disneyland.

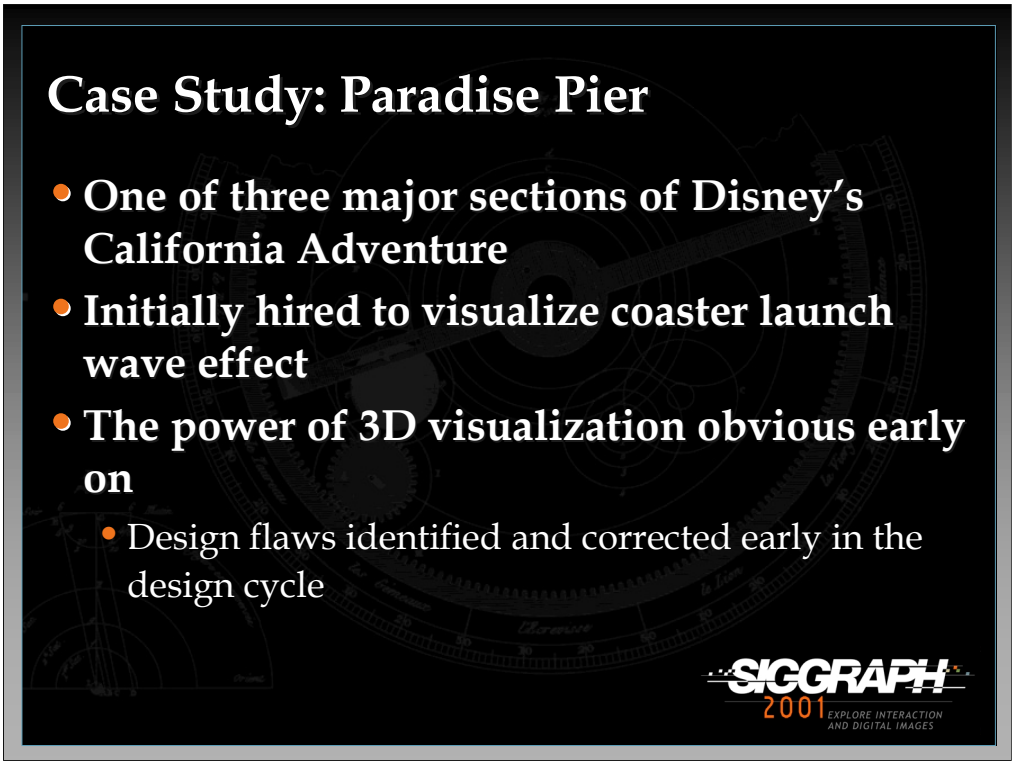
Close up of the model showing the incredible level of detail in the model.



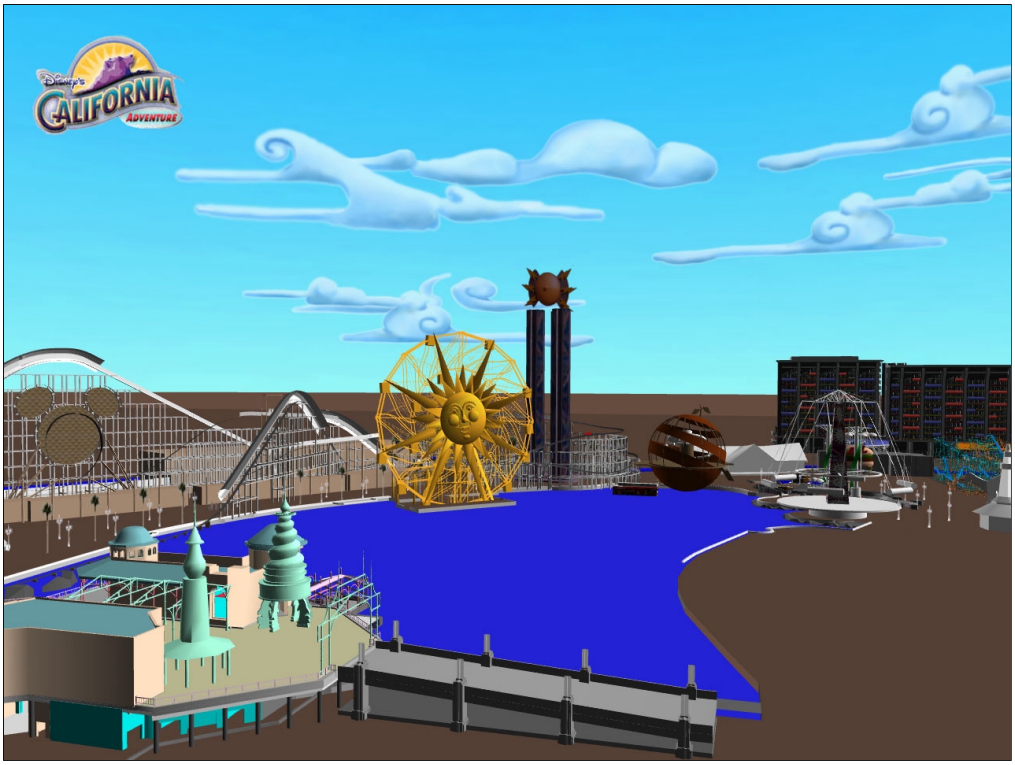
What key advantages do we have to offer the designers with our virtual systems?



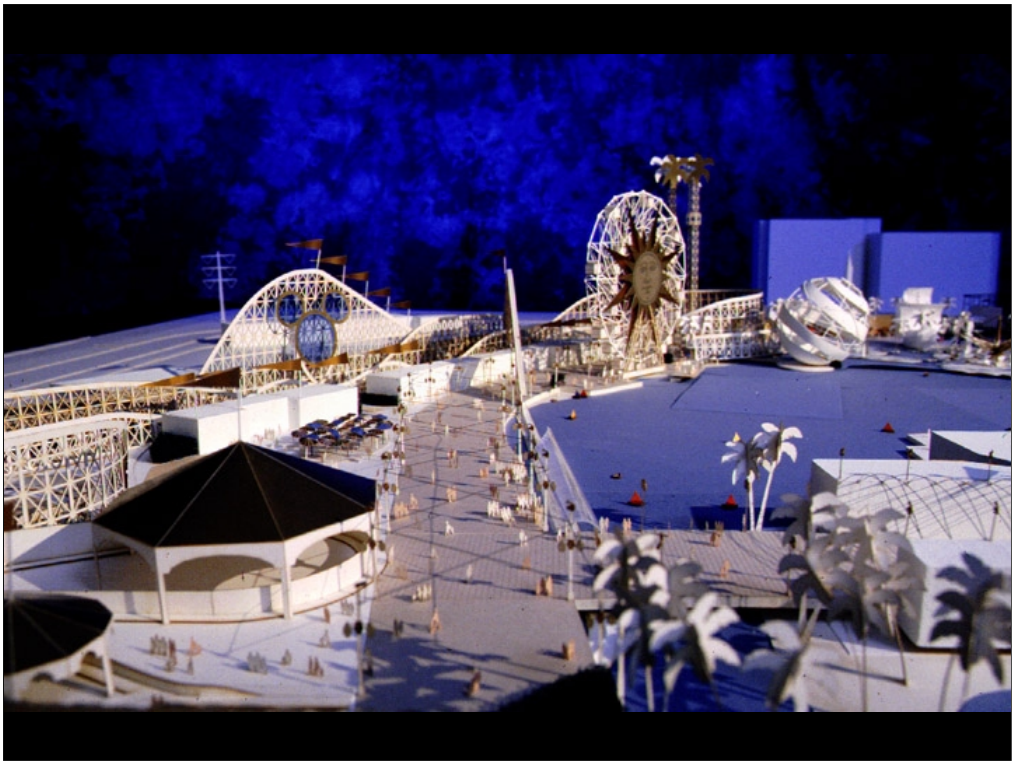
A keen understanding of lighting and form enables talented Disney artist to create highly effective models for virtual simulations.



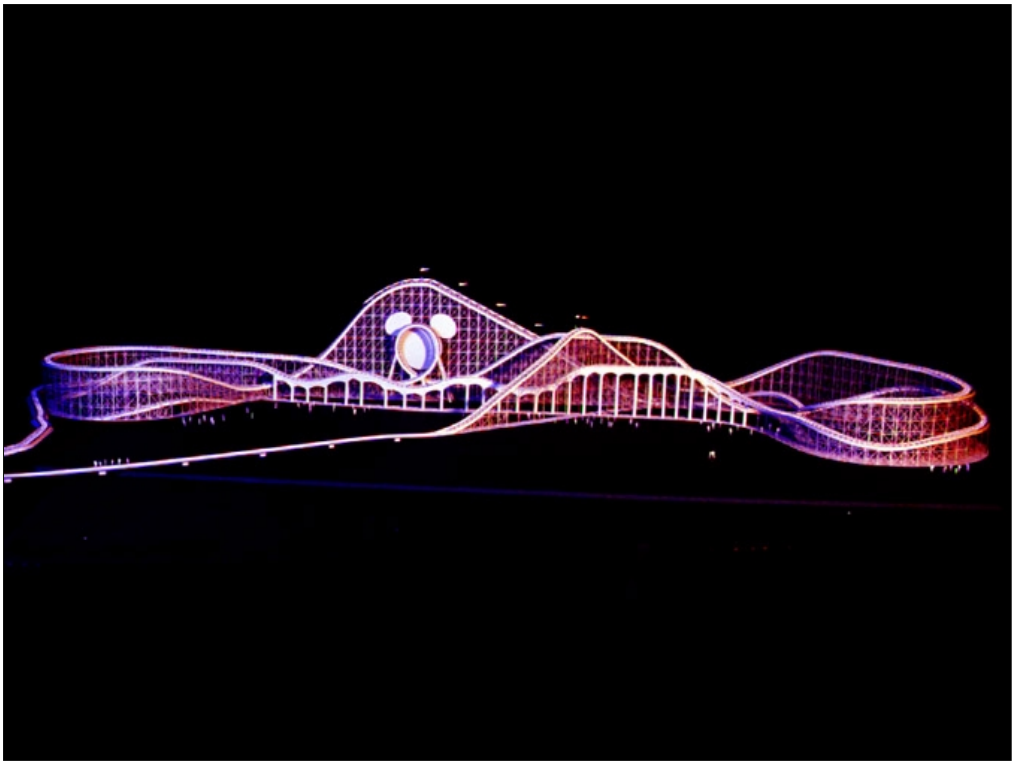
Designers quickly realized that virtual walkthroughs made it easy for them to spot and correct sightline problems early on (avoiding costly corrections during the construction process).



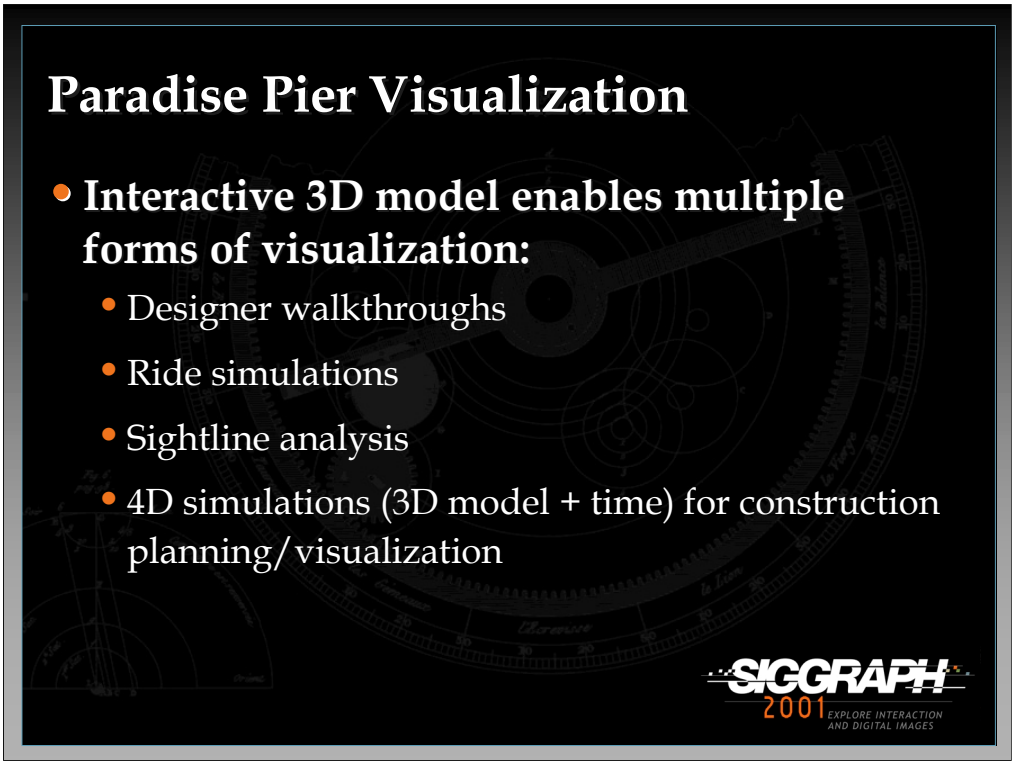
Screen shot of the virtual simulation done by the VR Studio of the Paradise Pier section of Disney's California Adventure. Large building in the background is the Paradise Pier hotel which is across the street from the park.



A scale model built during the design of Paradise Pier.



Physical model of the California Screamin' roller coaster. Though it conveys a good understanding of the form of the ride, designers can not get a sense of the ride experience from the model.



We amortized the cost of building the 3D model by reusing it in multiple simulations:

- Lagoon show design/development
- Crowd flow simulation/analysis
- Rescue/safety simulation/analysis

Exterior view of the R&D CAVE. 5 sided design similar to that used in the Hercules attraction.

Paradise Pier Video

Paradise Pier Flythrough
4D Simulation
California Screamin' Simulation

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Case Study: Pooh's Hunny Hunt

- **Major attraction developed for Tokyo Disneyland**
- **Originally hired to visualize Tigger bounce effect. Can we make the guests feel like they're bouncing with Tigger?**
  - 1 bouncing car
  - 2 layers bouncing scenery
  - 4 layers bouncing video

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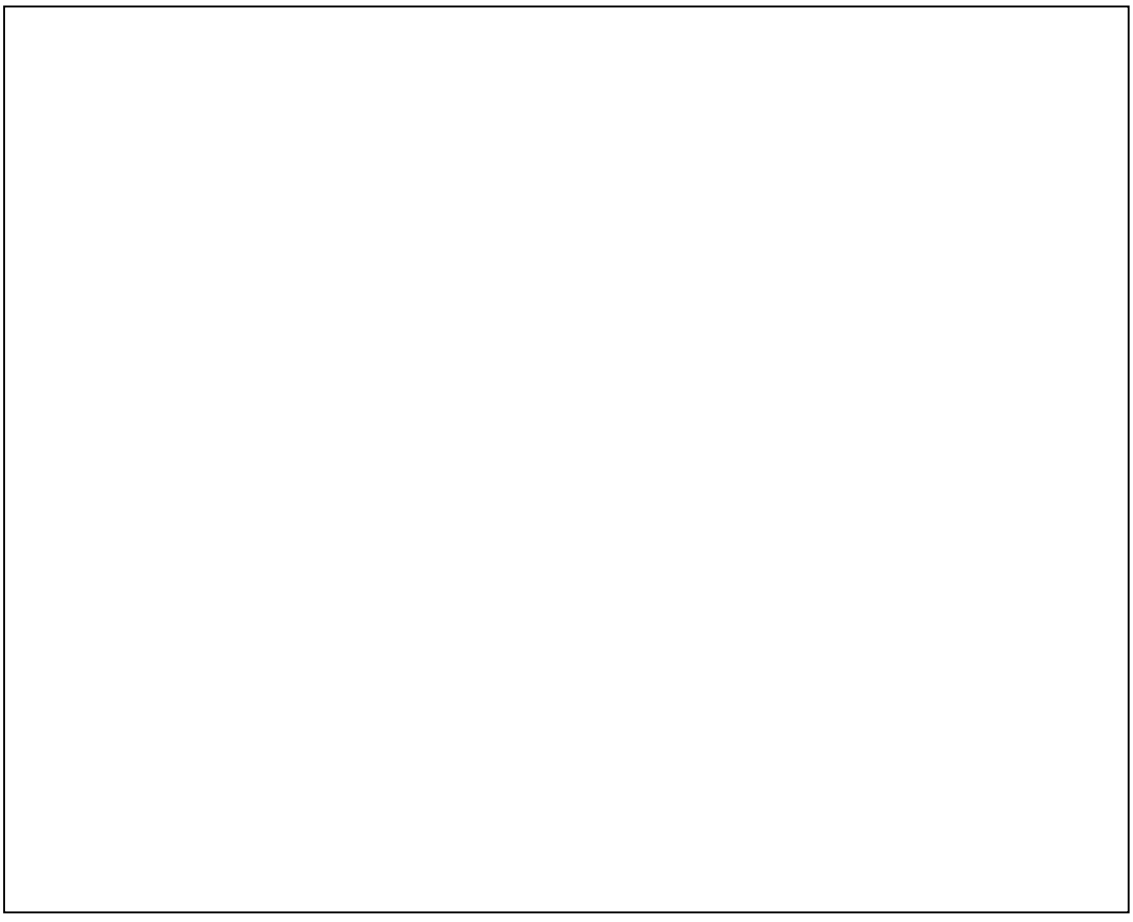
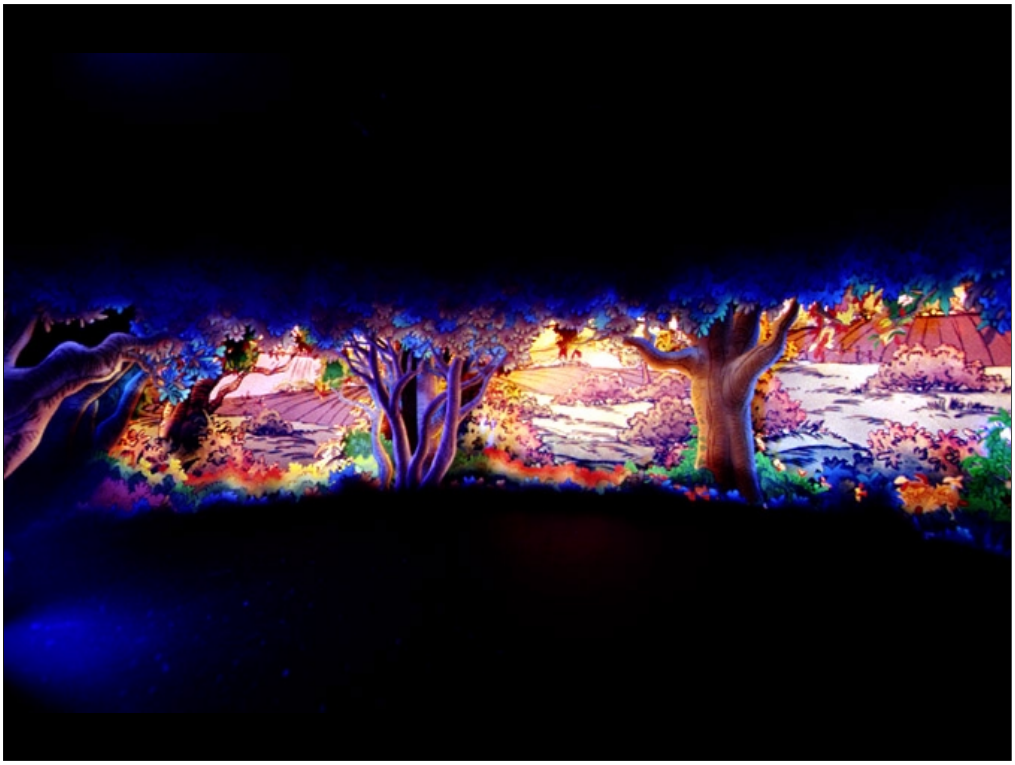
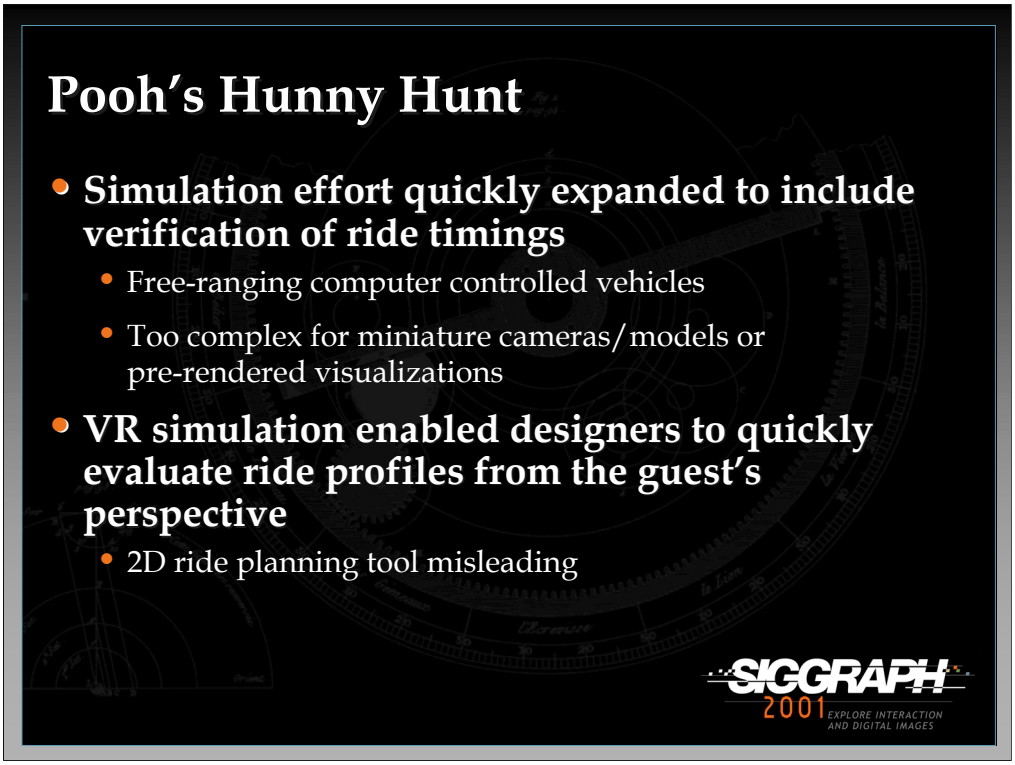




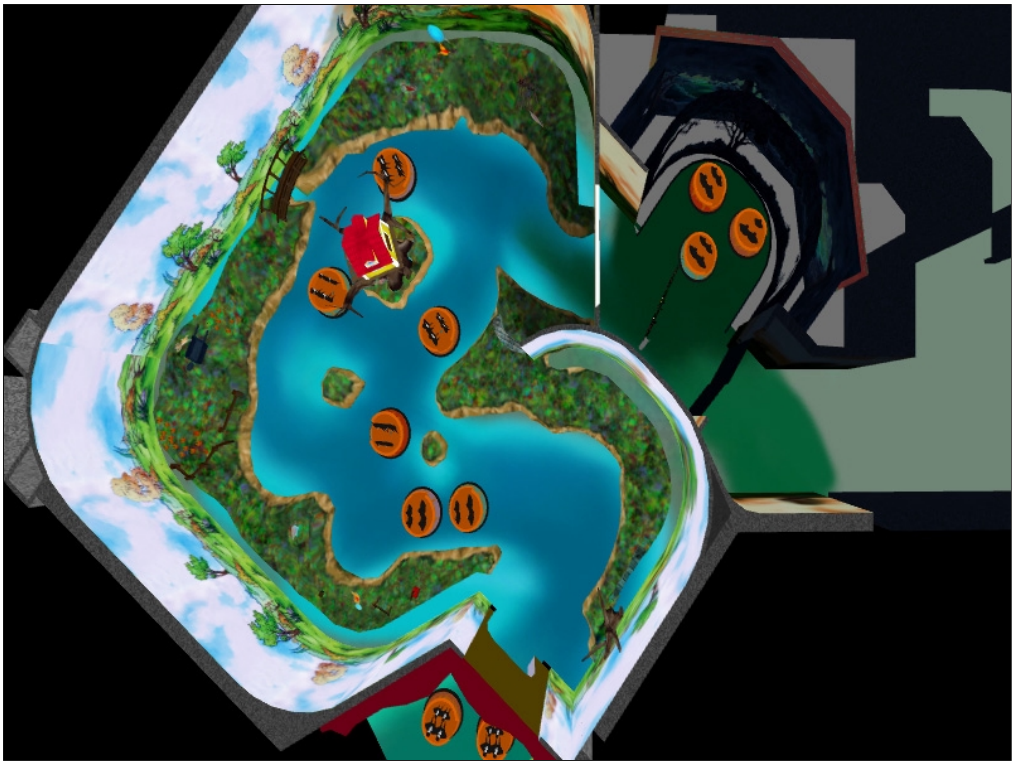
Black-lit physical model of the interior of the Tigger bounce section of Pooh's Hunny Hunt.

Virtual simulation of the Tigger bounce. Virtual cars moved up and down. Eye point could be moved to any seat in any car.



3D Hunny Hunt Model also utilized in multiple ways:

- Sightline verification used to validate reduction in number of audio-animatronic figures
- Real-time model used in planning of media development
  - Audio timing
  - Tigger bounce visuals



Overhead view of the Blustery Day and Tigger bounce sections of the Pooh's Hunny Hunt virtual model. This is a view of the VR studio's 3D simulation of the ride. The actual ride planning tool was much more iconic and represented the ride as a 2 dimensional image (plan view) with simple circles representing the ride vehicles.

Owl’s house in the Hunny Hunt physical scale model.

Owl’s house in the VR simulation.

Pooh's Hunny Hunt Video

Free-Ranging Vehicle
And Tigger Bounce Simulation

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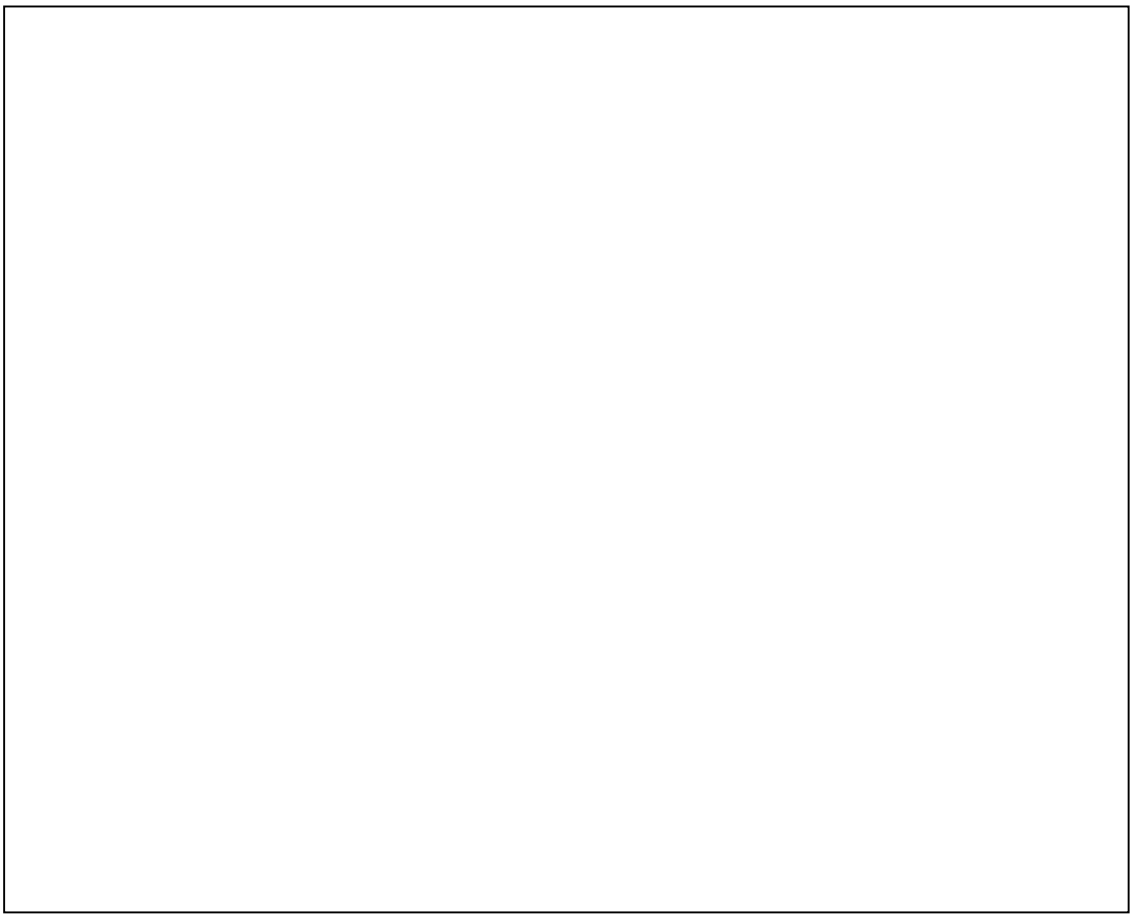

Lessons Learned

The importance of CAVEs as a display medium

- **Large number of simultaneous viewers encourages interactive design sessions**
  - Demos into Design Sessions
- **Powerful communication tool**
  - Paradise Pier pre-bid
  - Selling Hunny Hunt to Oriental Land Company
- **The importance of first person perspective for ride timing verification**
- **Externalizes discussions**

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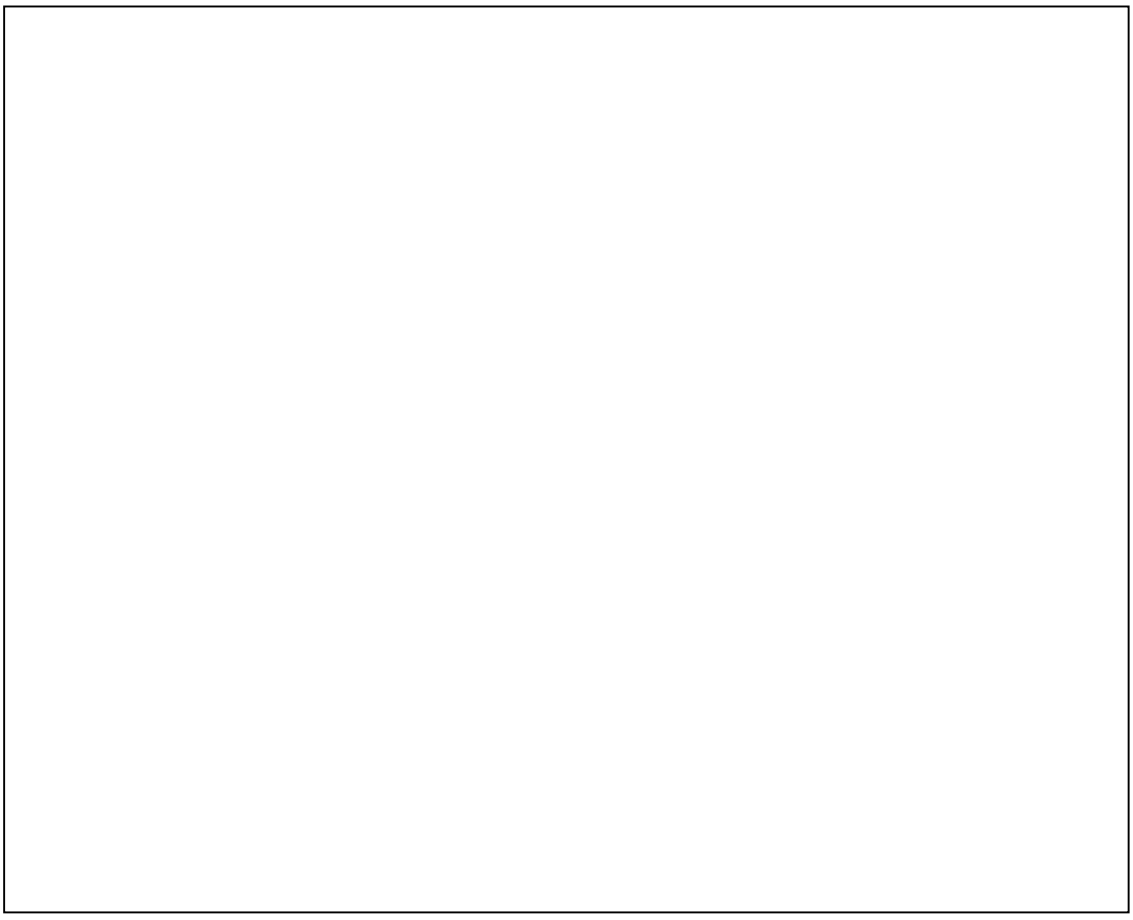
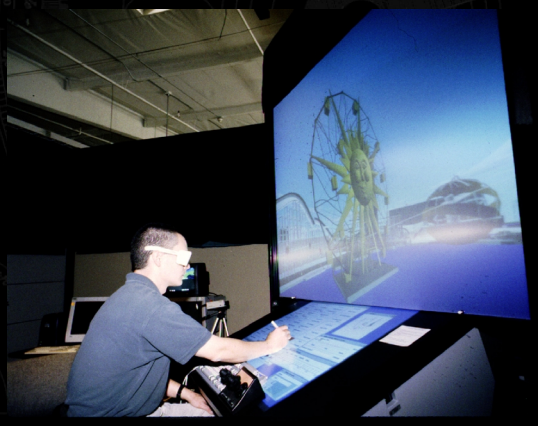


Future Directions

DIRECT: Disney's Interactive Real-time Environment Construction Tools



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DIRECT

- **Hardware**
  - Rear-projection desktop with pen-based input
  - Large FOV stereo projection screen for immersive viewing
  - 6 DoF tracking for head-tracked stereo and direct manipulation
  - Flexible device layer for incorporating joysticks, buttons, and other physical controls

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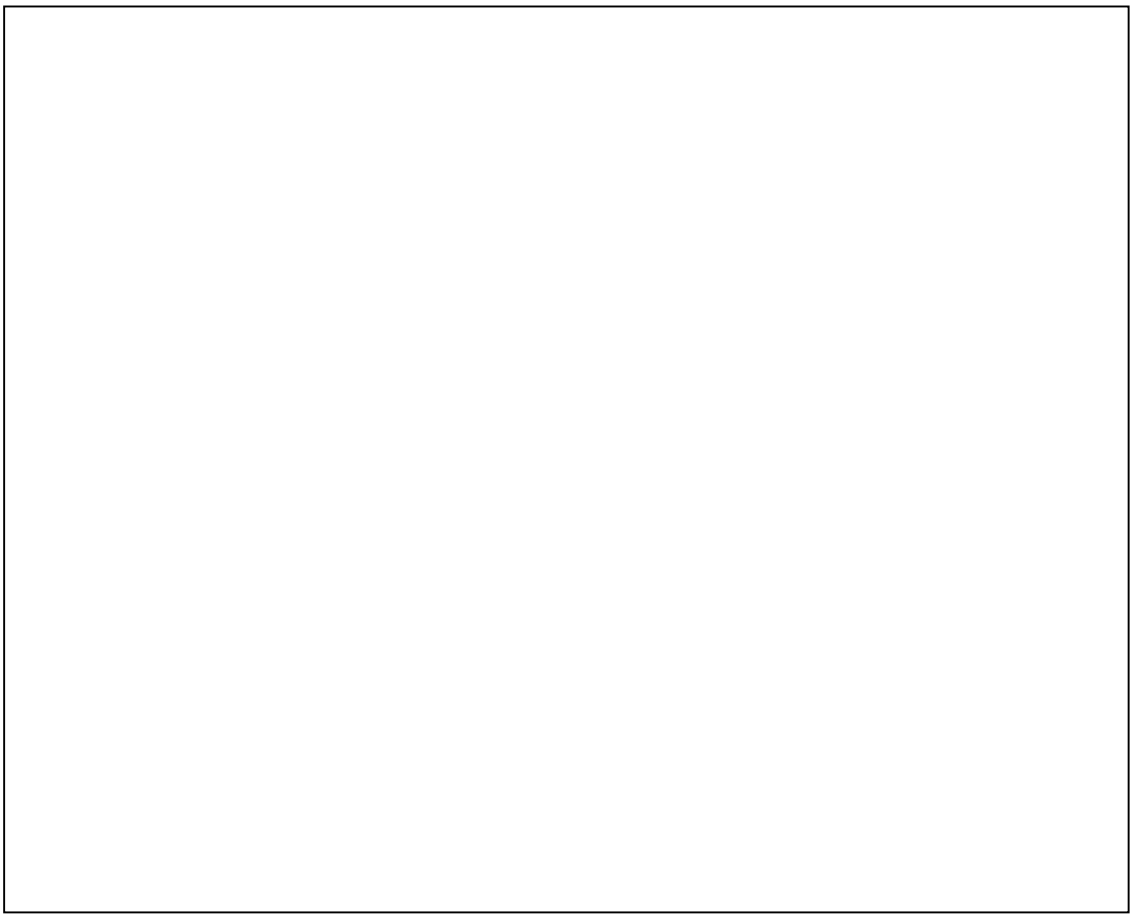

DIRECT

- **Features**
  - Intuitive direct manipulation interface for placing and sizing of 3D objects
  - Late-binding scripting layer for flexible control of dynamic simulations
  - Powerful tools for 3D curve editing and camera control

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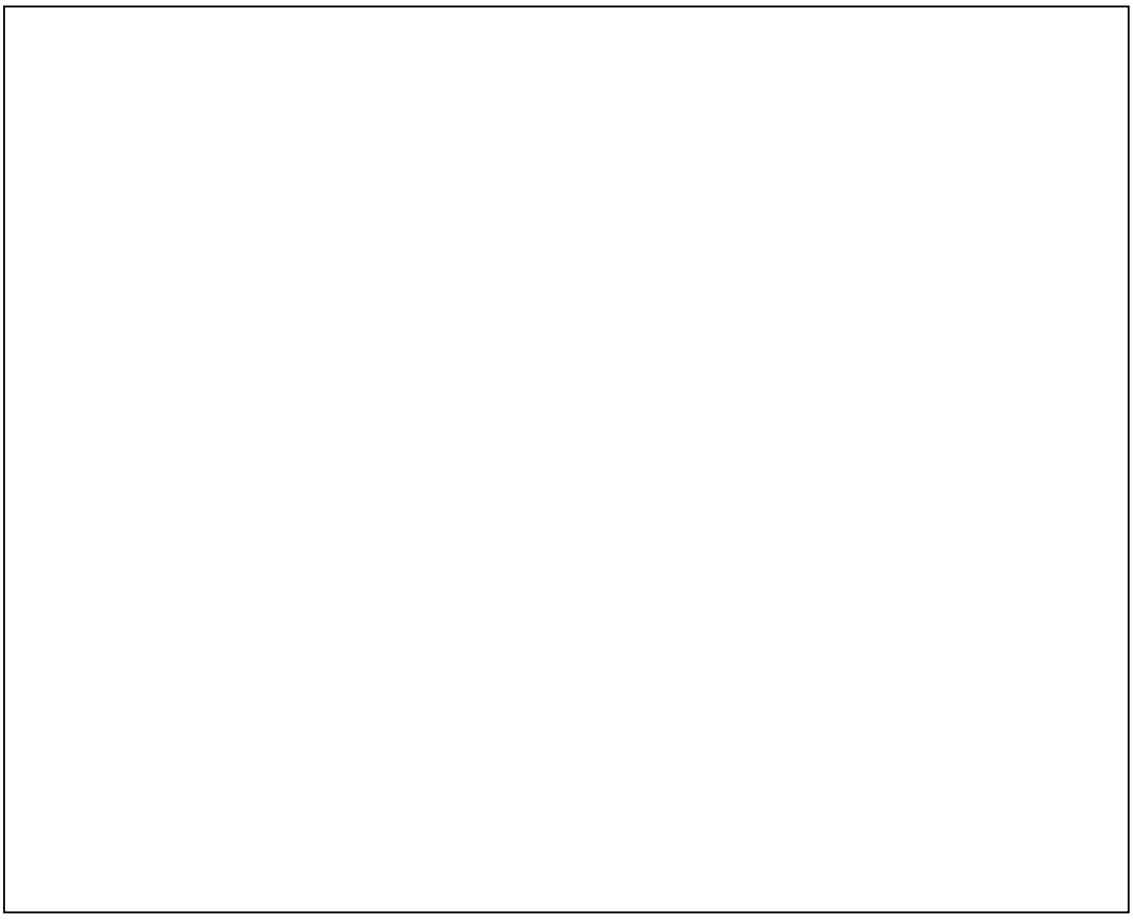

Lessons Learned

- **The importance of in-the-world tools**
  - Object placement/control tools
  - Curve editing for camera/object paths
  - Animation controls
- **Need to better span the space of display devices!**
  - Tools which work from desktop to CAVE

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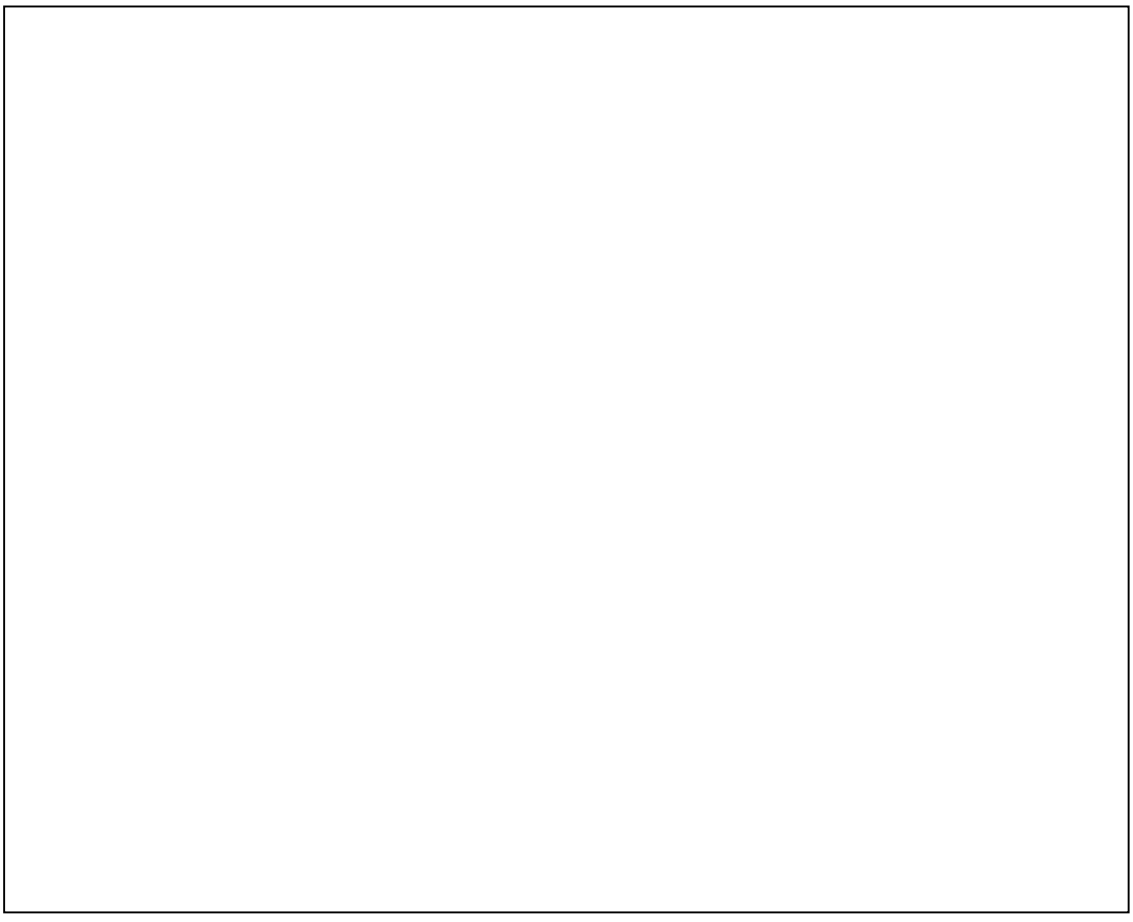

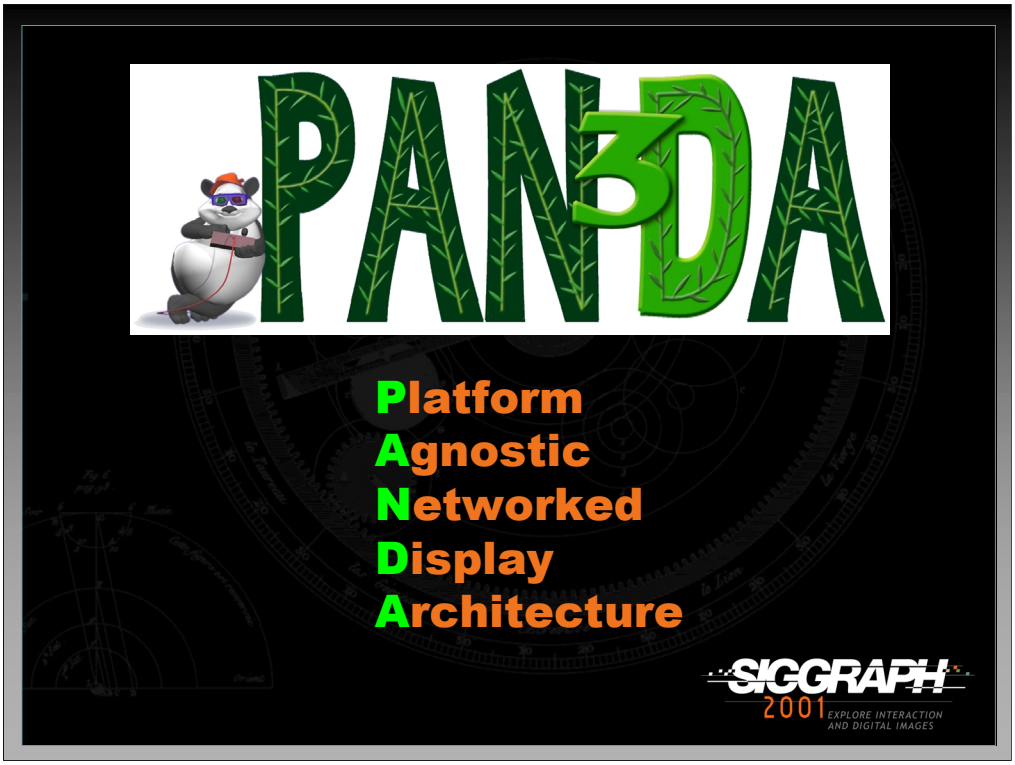

DIRECT is built on top of PANDA3D, a fourth generation **open-source** VR software system developed by the VR Studio. PANDA 3D:

- Provides real-time 3D rendering
- Incorporates powerful tools for rapid prototyping based on DIRECT and Python
- Is platform agnostic (will run on multiple platforms…. Windows, Linux, IRIX, etc….)

Visit http://www.panda3d.org for more details

Lessons Learned

- **The importance of late-binding languages**
  - Interactive scripting layer (based upon Scheme/Squeak/Python) on top of high-performance C++ layer
    - Rapid implementation/iteration of dynamic environments
    - On-the-fly GUI building critical for flexible simulation control
- **Impossible to predict what designer needs**

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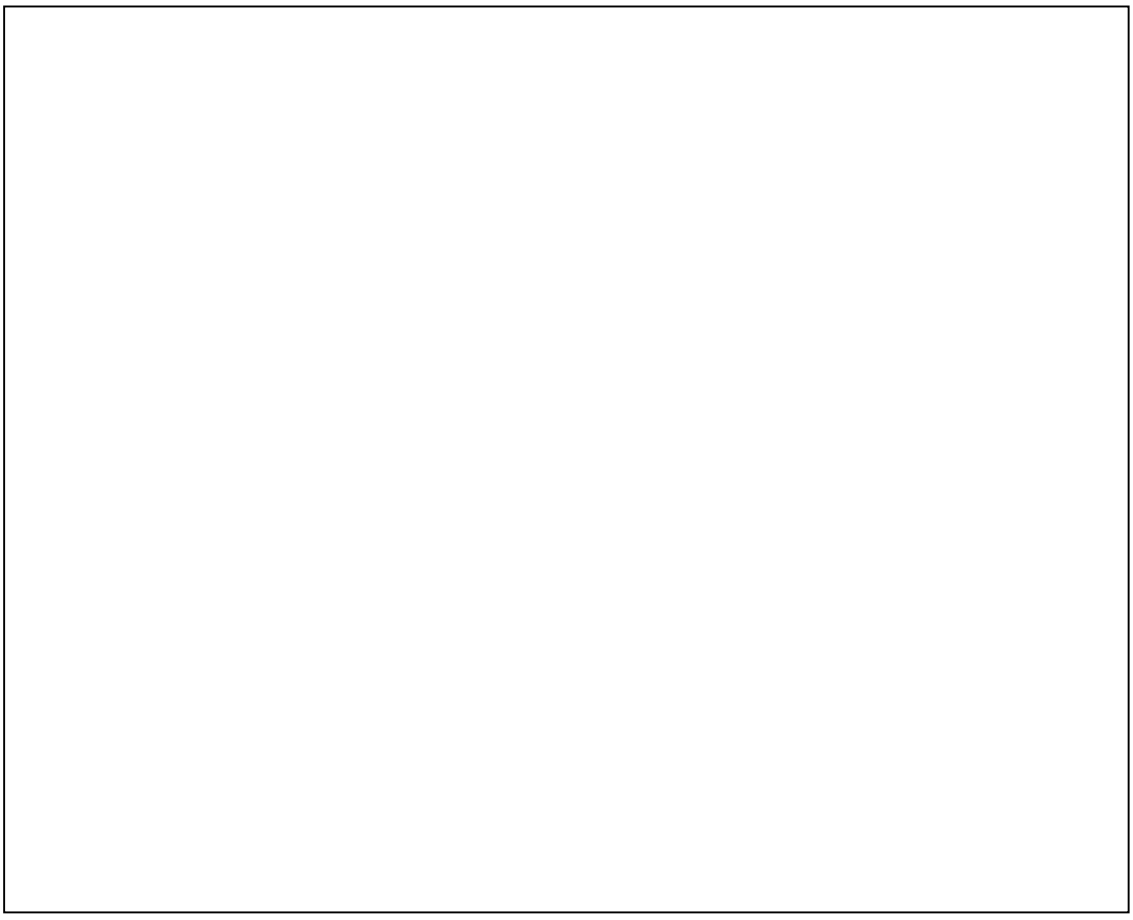

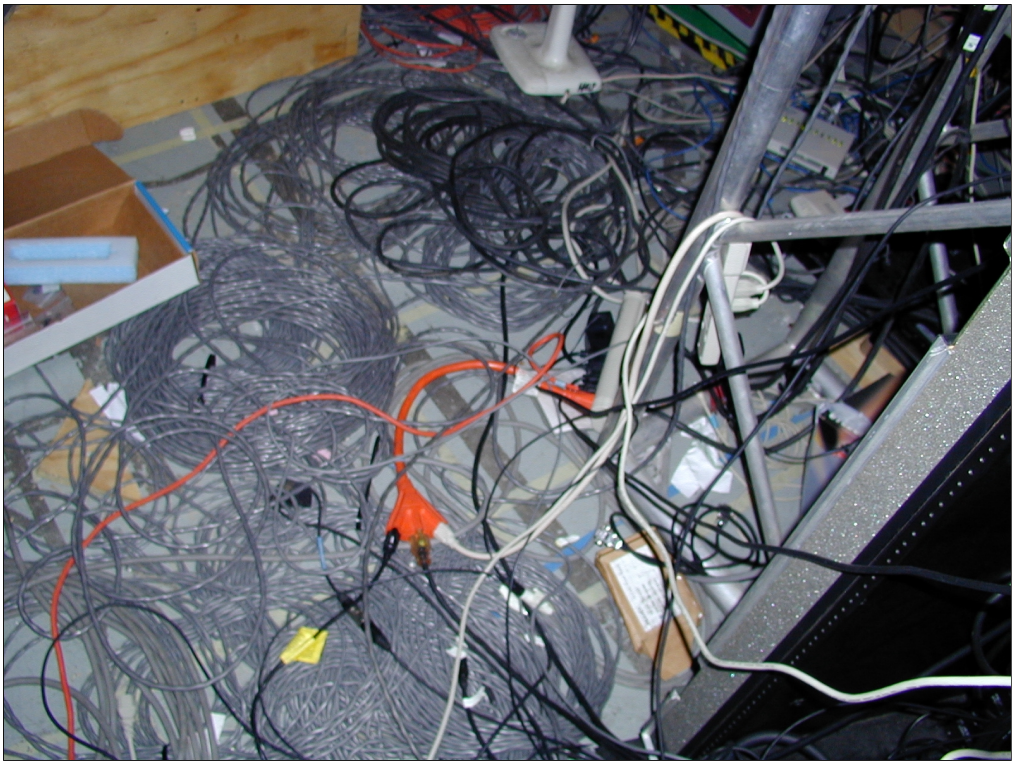

The true challenge in VR research!