Bristol Computer Graphics

# Mother of All Renderers Radiance in Real-Time?

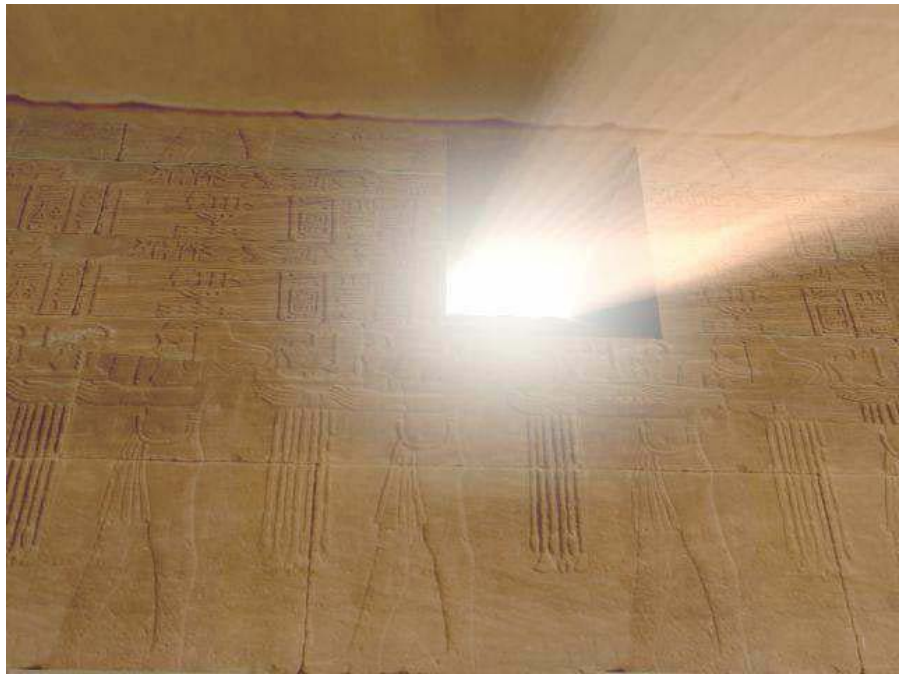
Alan Chalmers

University of Bristol

# MOAR features

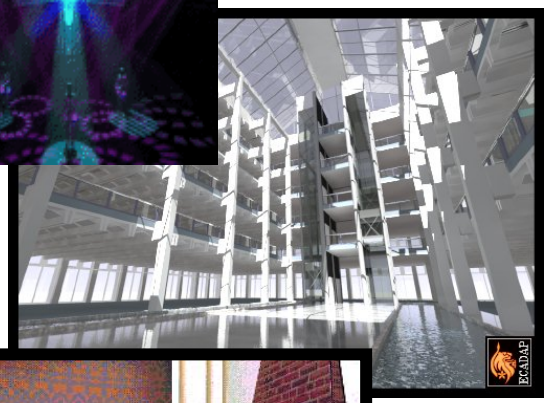
- High Fidelity Graphics
  - Physically based global illumination
    - Participating media
  - Fully dynamic scenes
  - Interactive environments
- Parallel Processing
  - Within a node
  - Between nodes
- Visual Perception
  - Selective, time constrained rendering
  - Component based approach
- Partners: Manchester, Bradford, Bournemouth, Zaragoza, Minho, BrightSide, Greg ...

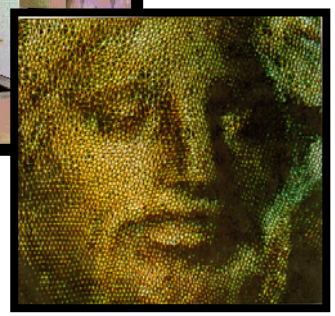
# Participating media: Dust



# The need for realism

- Computer Graphics allow virtual environments to be “constructed” on a computer in a straightforward manner
- Computer reconstructions can be easily misleading
- Realism is *essential* if we are to use these virtual environments as a representation of reality





# The need for real-time

- Computer Graphics has opened up a wide range of simulation and entertainment opportunities
- Real-time requires a minimum of 15 fps
- Real time is necessary for multi-sensory environments
- Real-time is *essential* if we are to gain the maximum benefit computer graphics has to offer

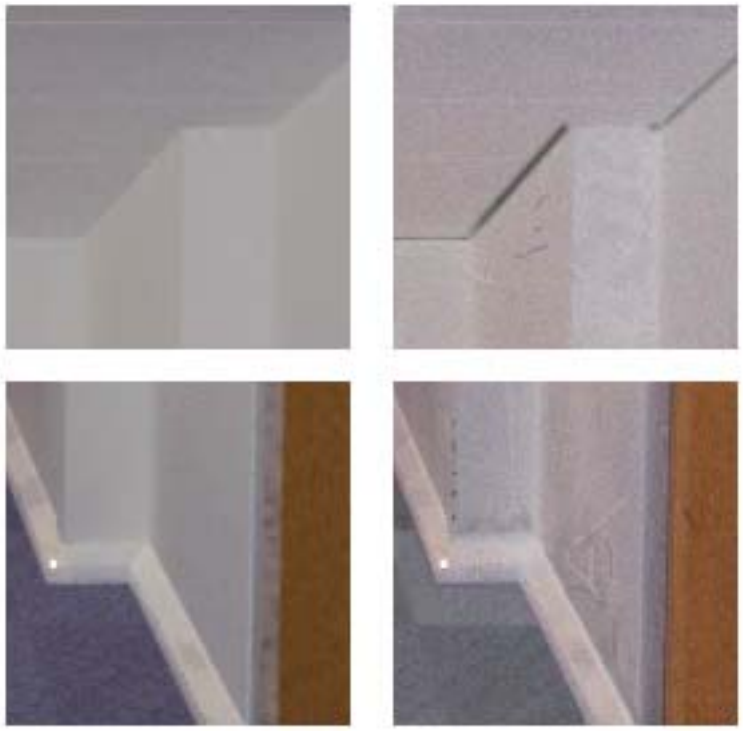
Diabolo II

Atlantis: The Lost Empire

# Realism

Believable Realism!

# Scruffy textures

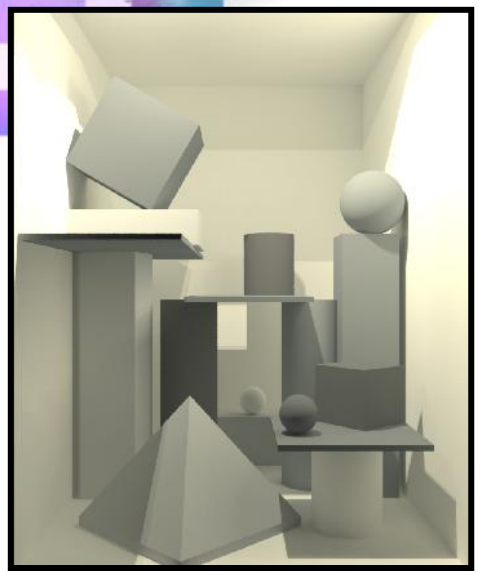


# Quantifying reality

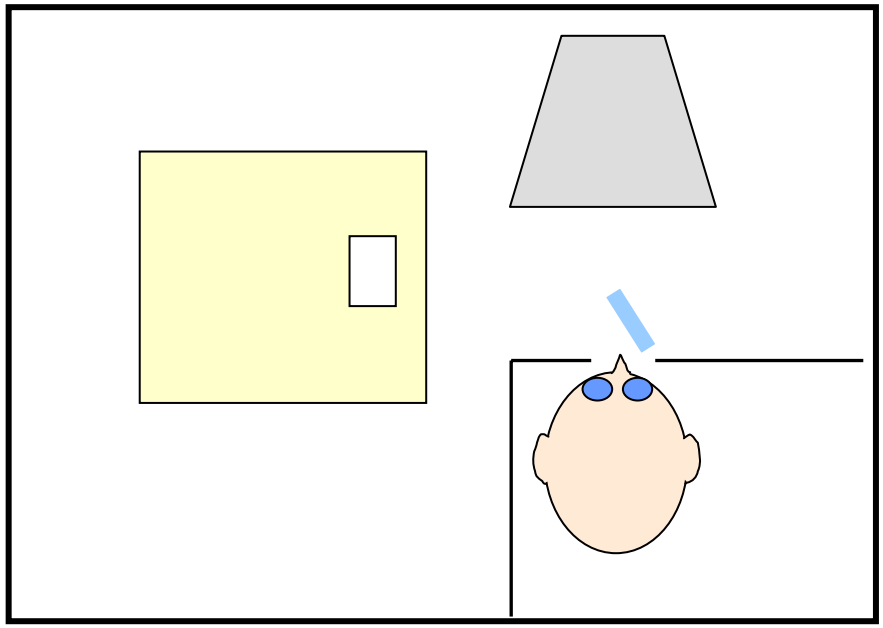
# Quantifiable Realism

Ann McNamara / Timo Kunkel

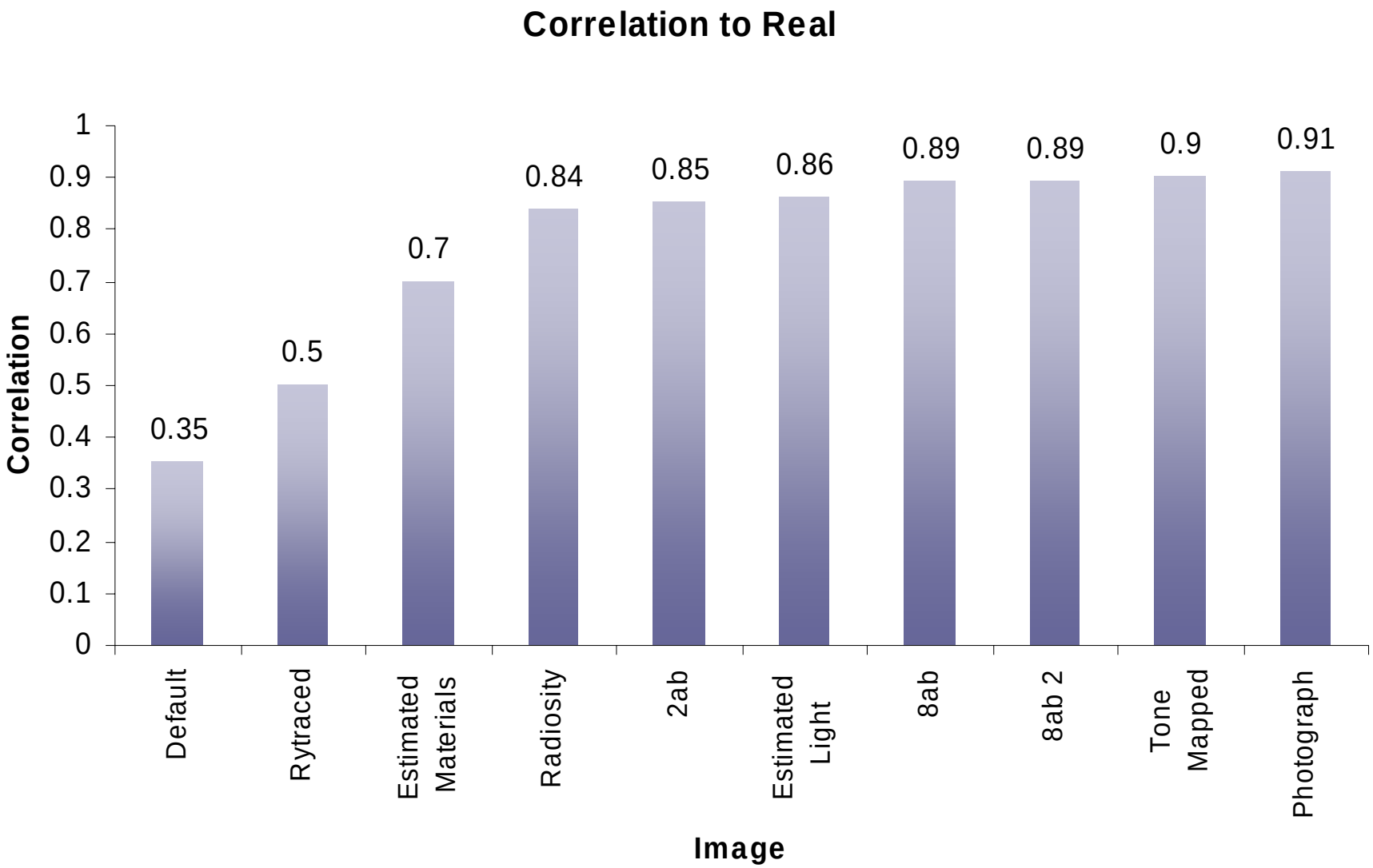
Photo of
Real Scene



Rendered



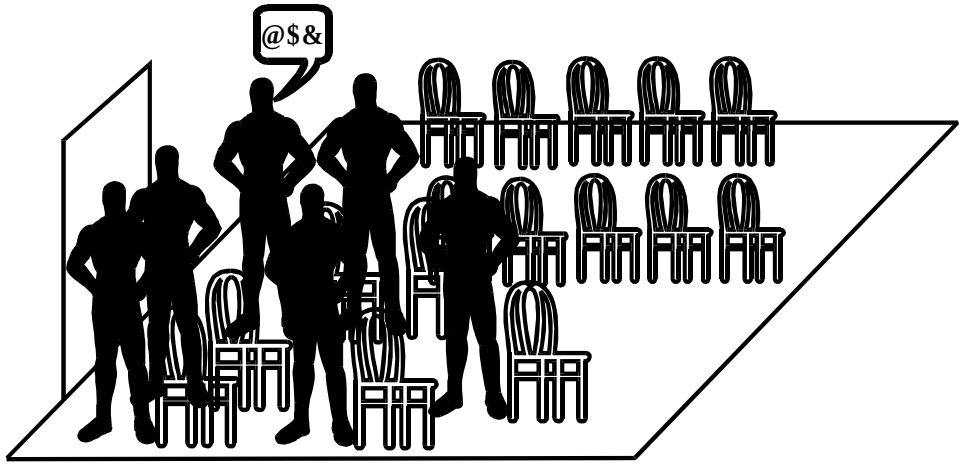
# Perceptual Match



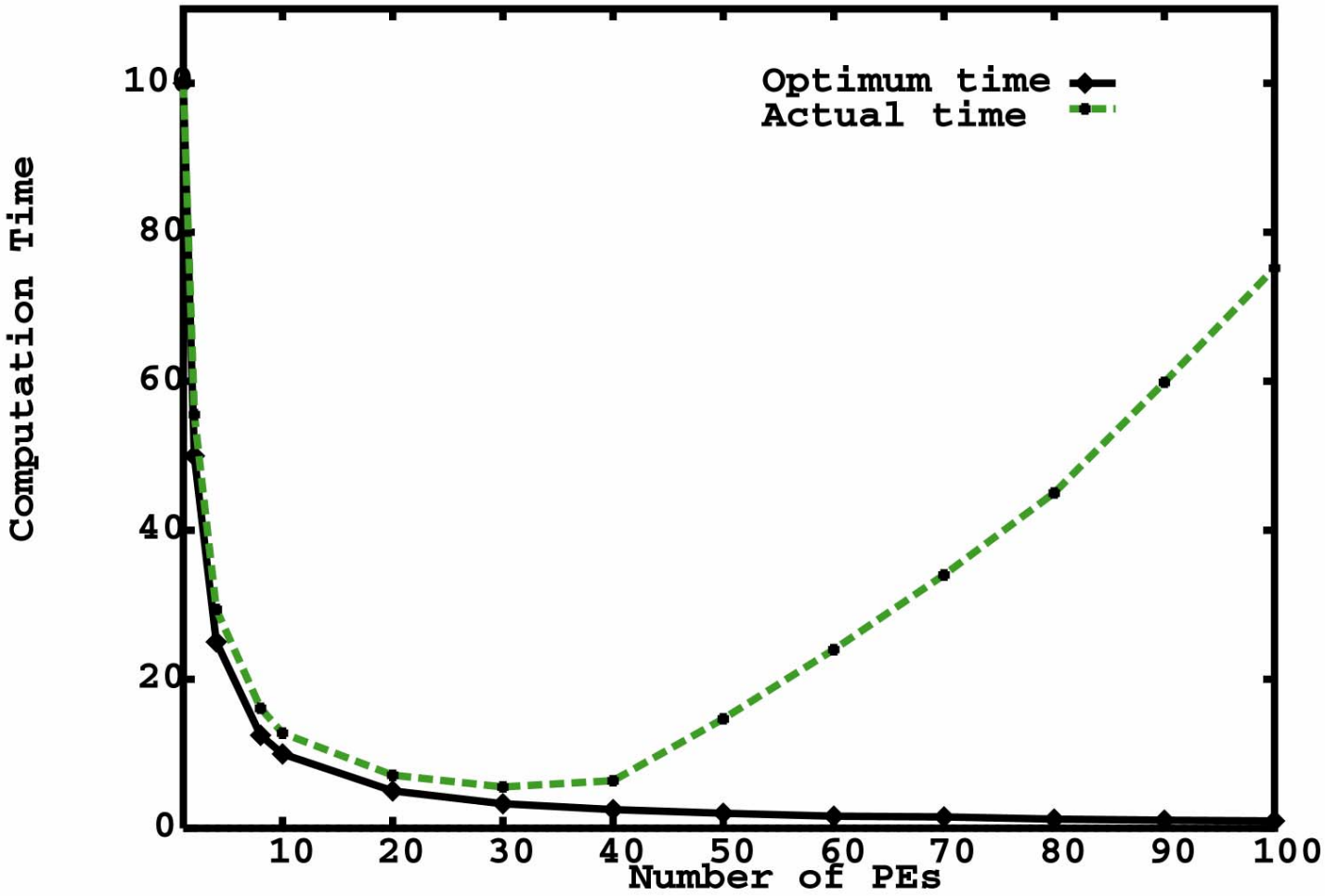
# Parallel Rendering

"*Parallel processing is like a dog's walking on its hind legs. It is not done well, but you are surprised to find it done at all*'
Steve Fiddes (apologies to Samuel Johnson)]

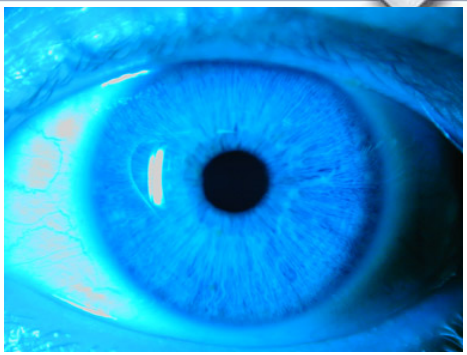
- Co-operation
- Dependencies
- Scalability
- Control



# Solution times



# Human Visual System



- *Good but not perfect!*

Flaws in the human visual system:

- Change Blindness
- Inattentional Blindness

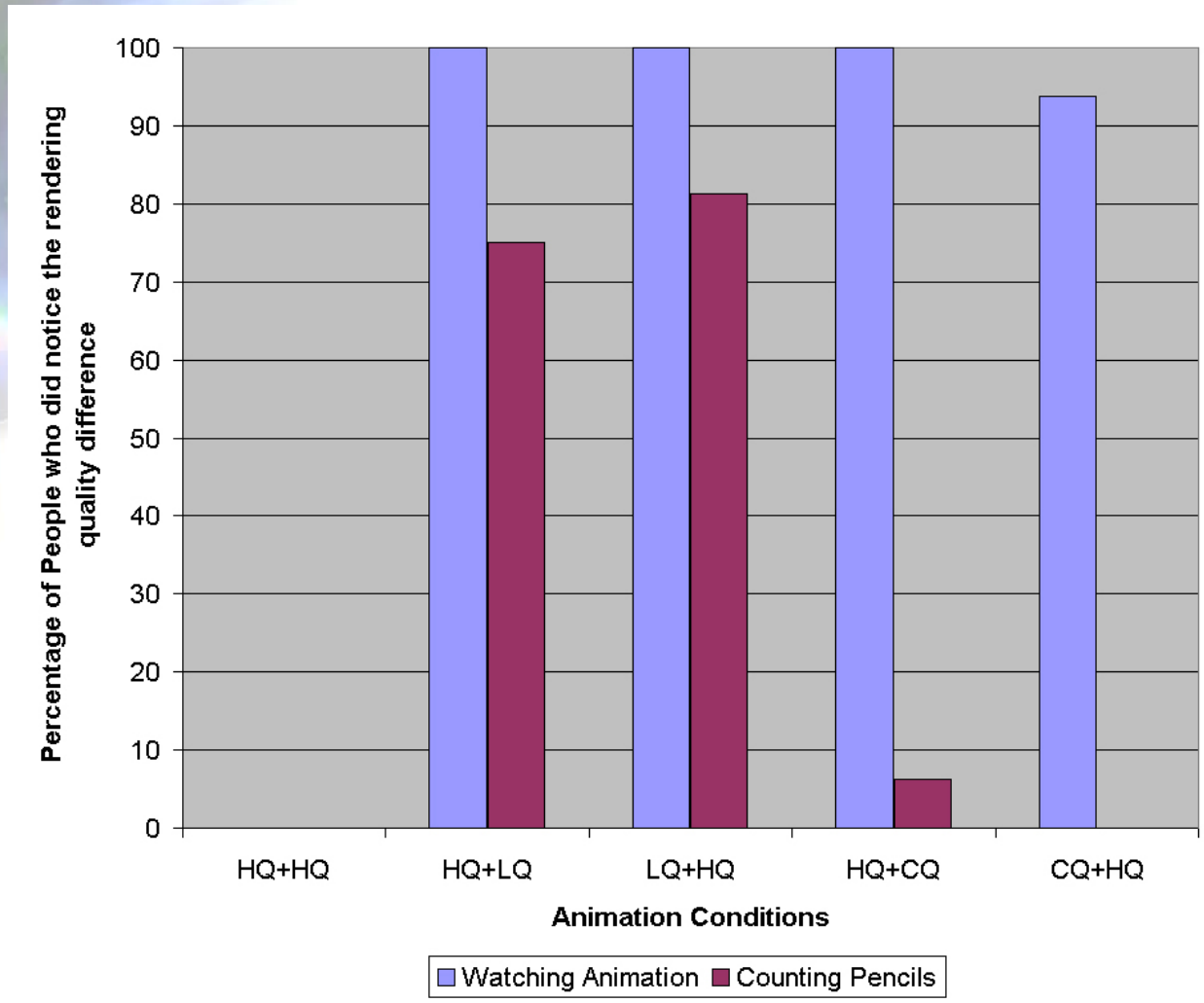
Avoid wasting computational time

# Animations

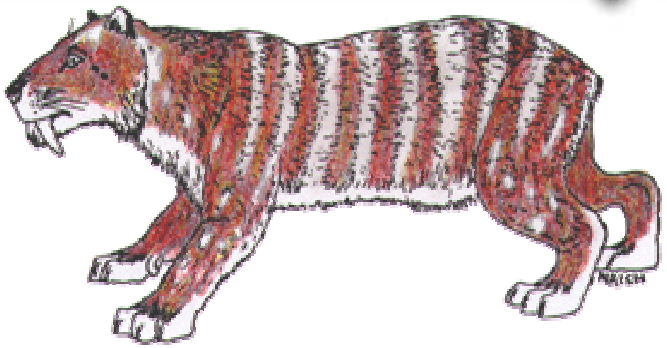
# High Quality vs Low Quality

# Inattentional Blindness Results

Kirsten Cater

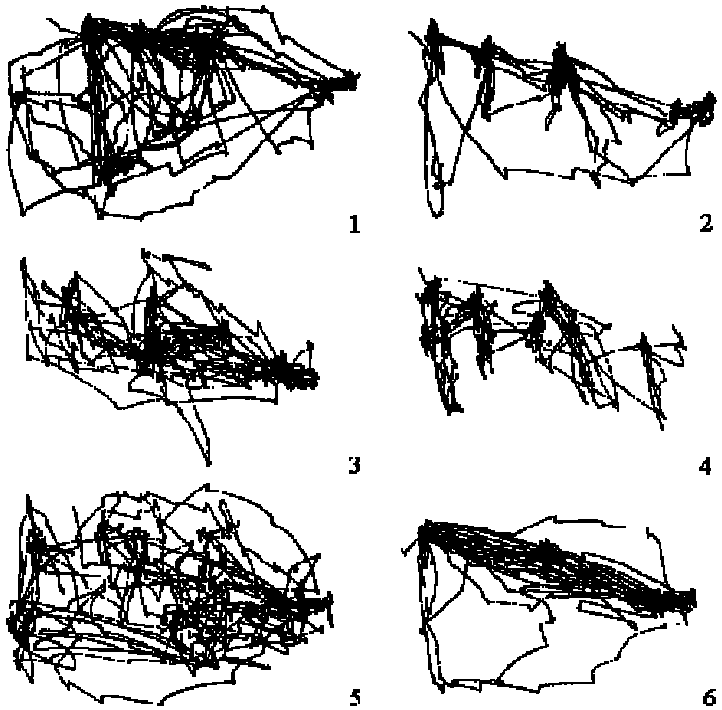


# Visual Attention



- Bottom-up
  - Stimulus driven
    - movement in bush, red apple in green tree etc
  - *Saliency maps*
- Top-down
  - Directed by voluntary control
    - looking for street signs, targets in computer game
  - *Task maps*

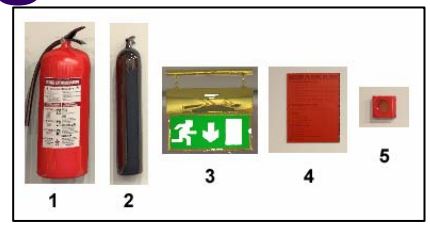
# Top-Down



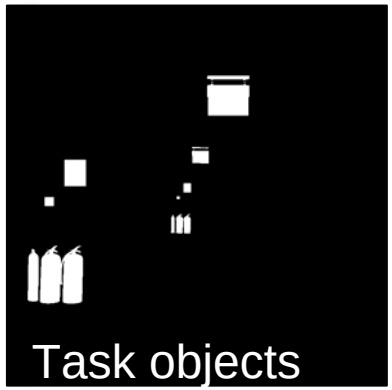

1. Free viewing, 2. Judge their ages, 3. Guess what they had been doing before the unexpected visitor's arrival, 4. Remember the clothes worn by the people, 5. Remember the position of the people and objects in the room & 6. Estimate how long the unexpected visitor had been away from the family [Yarbus 1967].

# Importance Maps

Veronica Sundstedt




- Selective guidance
  - Uses a combination of saliency and a measure of task relevance to direct the rendering computation
- Selective rendering
  - Corresponds to the traditional rendering computation
  - Computational resources are focused on parts of the image which are deemed more important by the selective guidance



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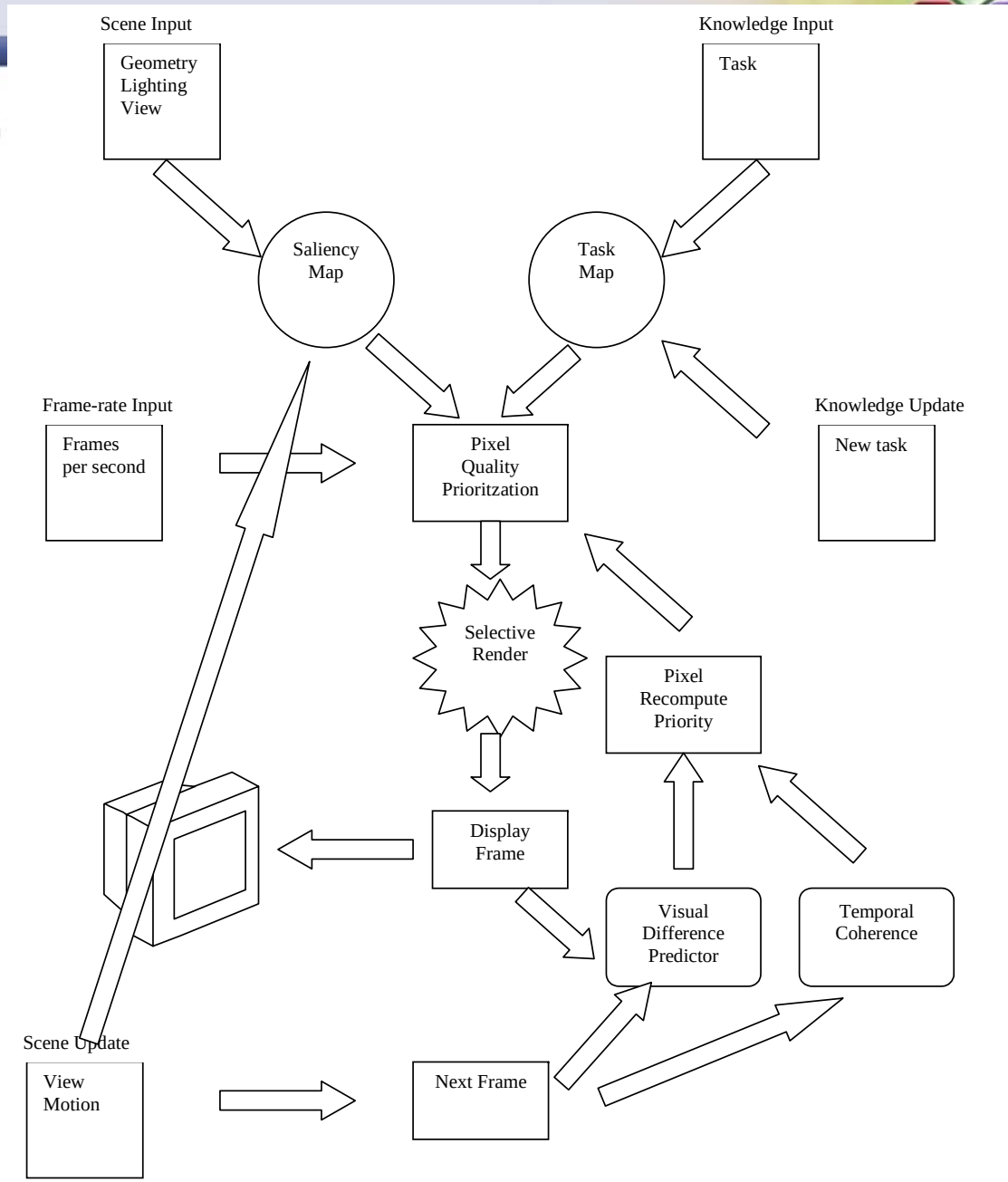
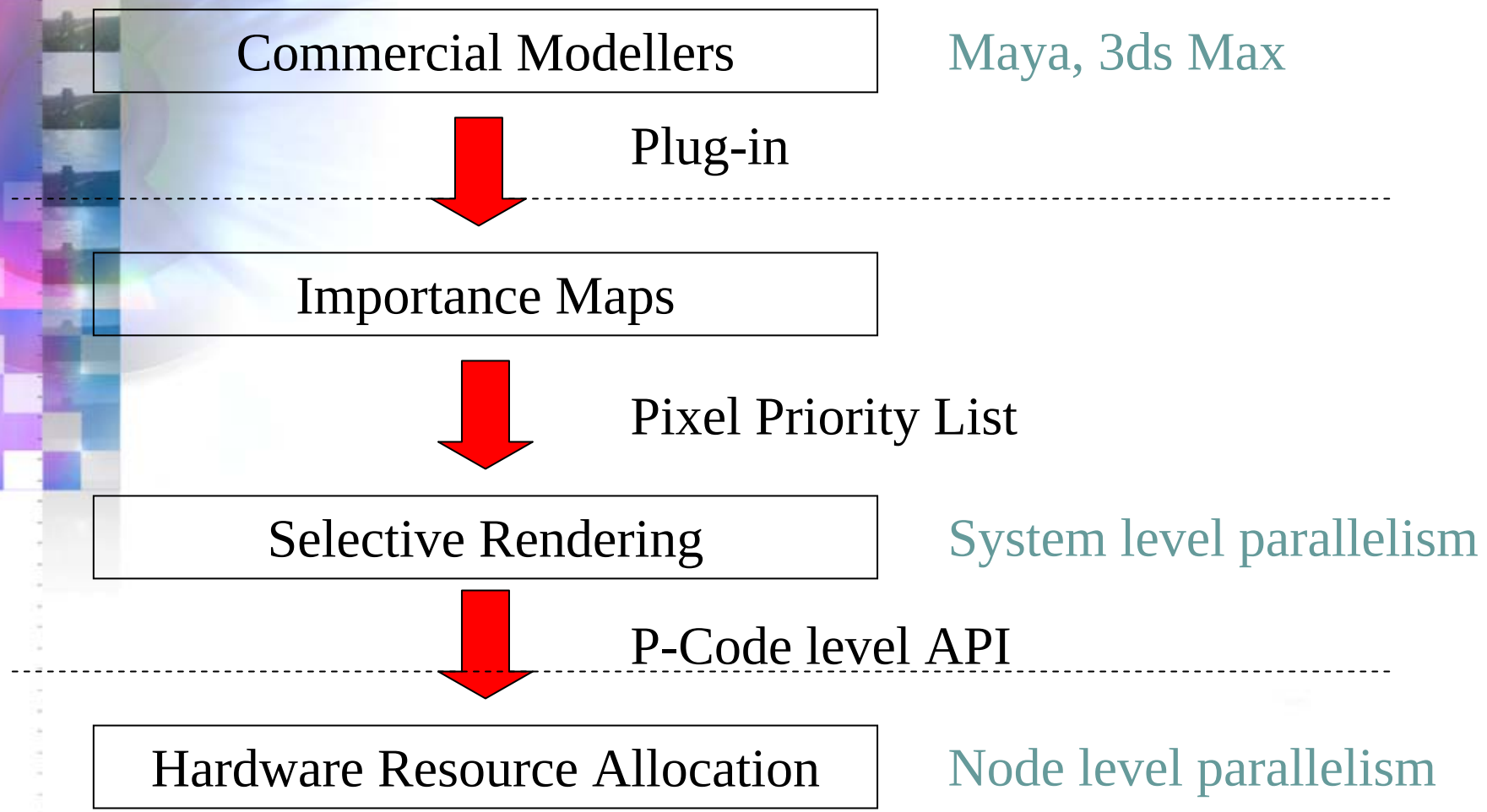
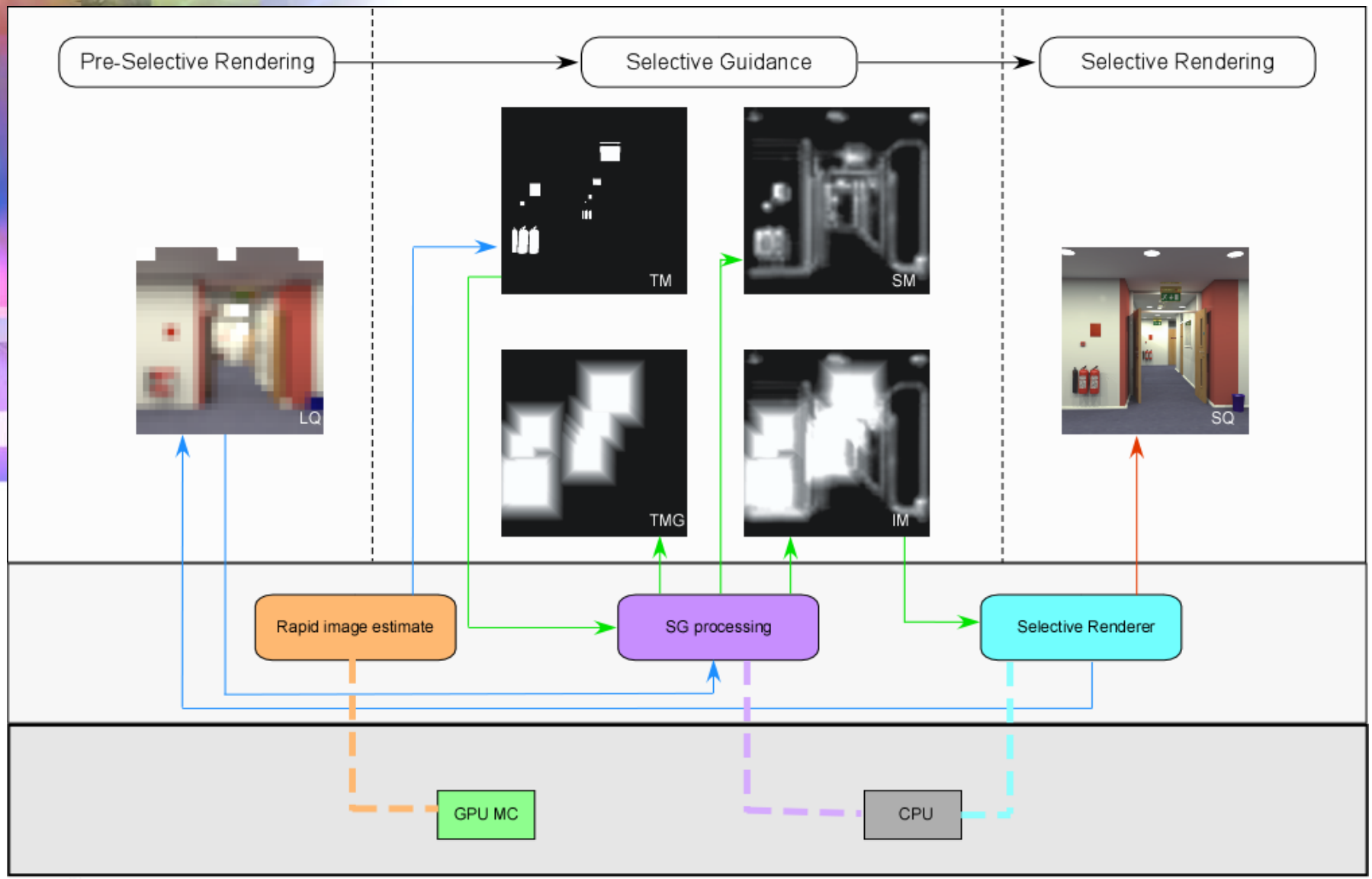
# Perceptual Rendering Framework



# Platform Independent Parallelism



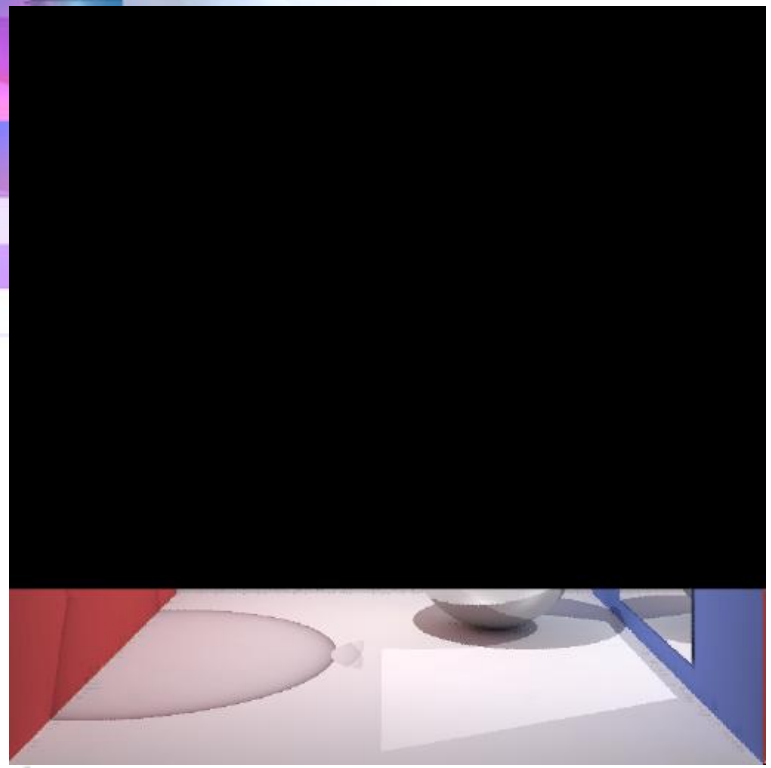
# Visual attention



# Selective Rendering

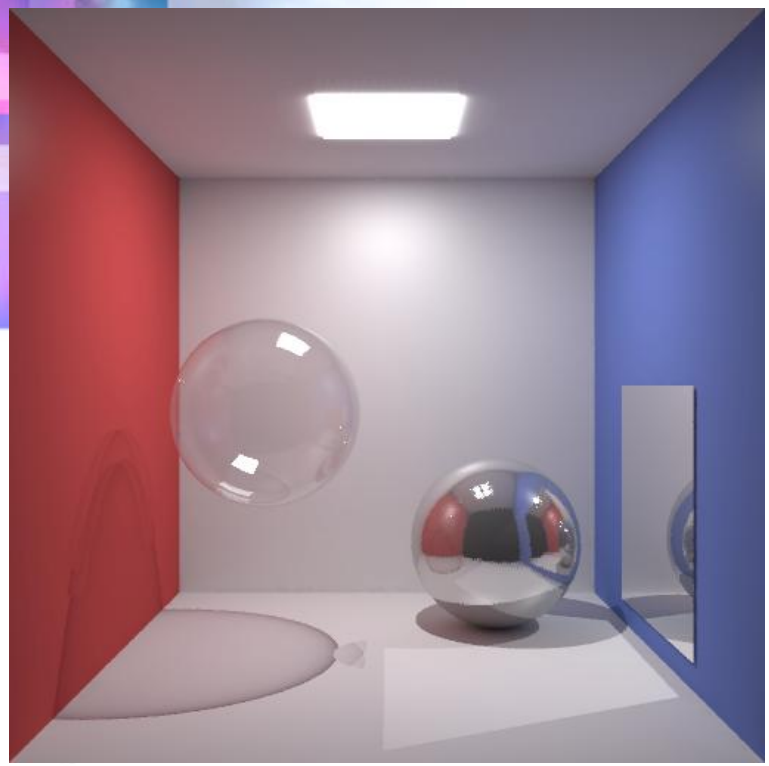
Kurt Debattista

- 10 sec budget
  - traditional versus visual attention



# Flexible computation

- Good approximation in minimum time



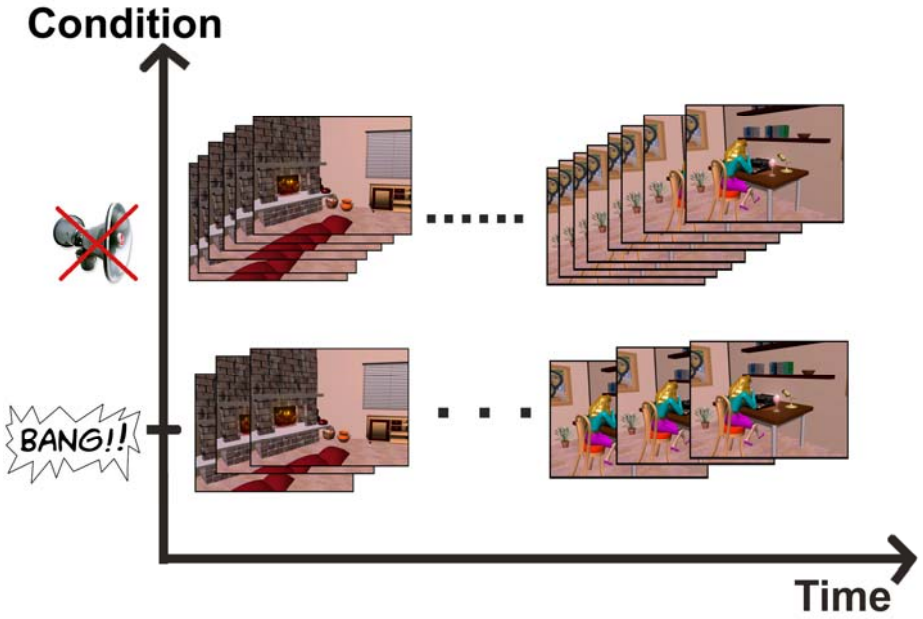
# Multi-Modal Perception

Julie Mastoropoulou

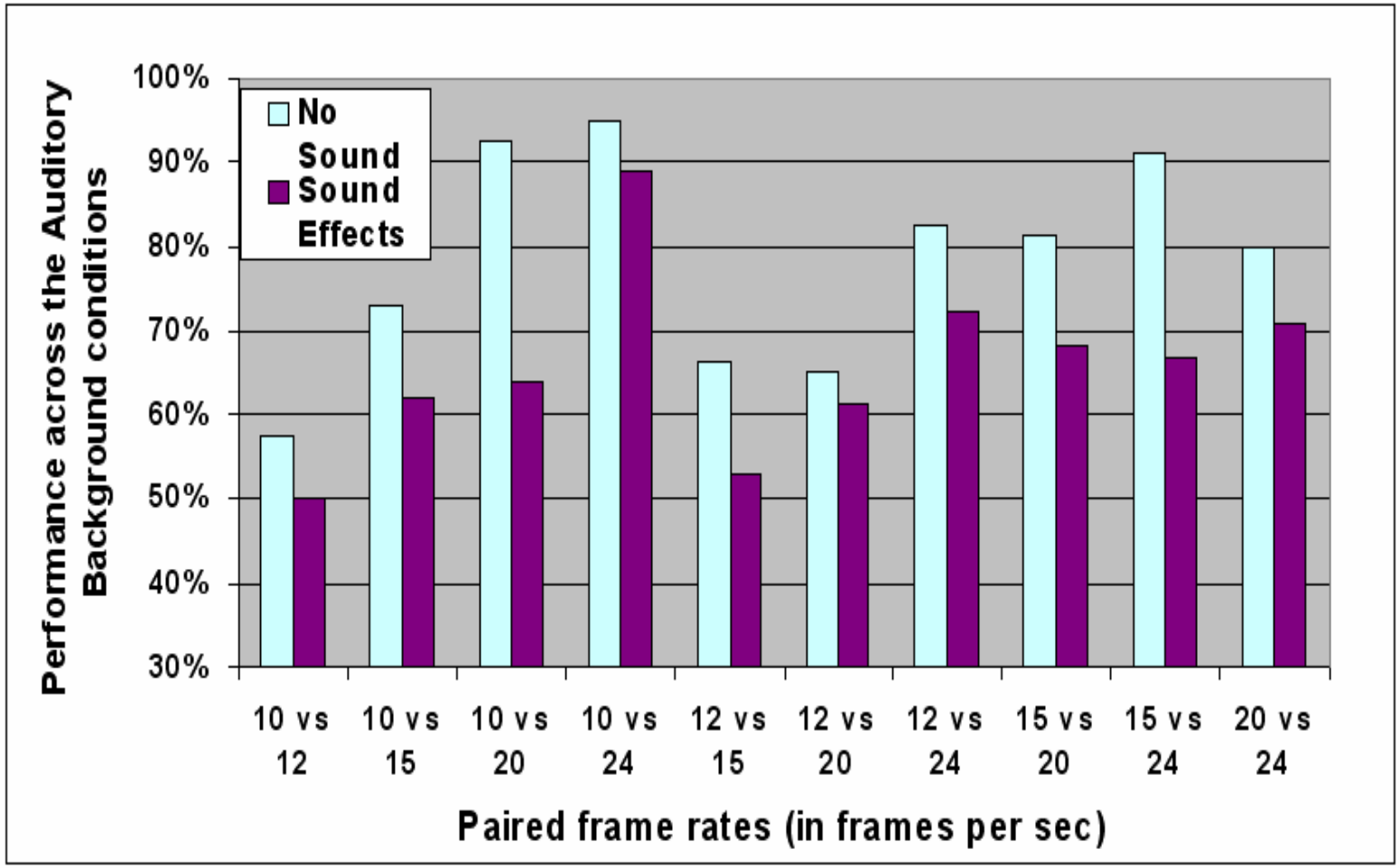
- Not possible to achieve very realistic graphics in real-time. Interactive environments require a minimum frame-rate e.g. 15fps
- If we can affect the user's perception of frame rate, then we can render/display less frames per sec without any perceptual difference to the user.
- This would also have major implications to the video compression standards, regarding the control of quality/bit-rate across the audiovisual frames.

# Experiment

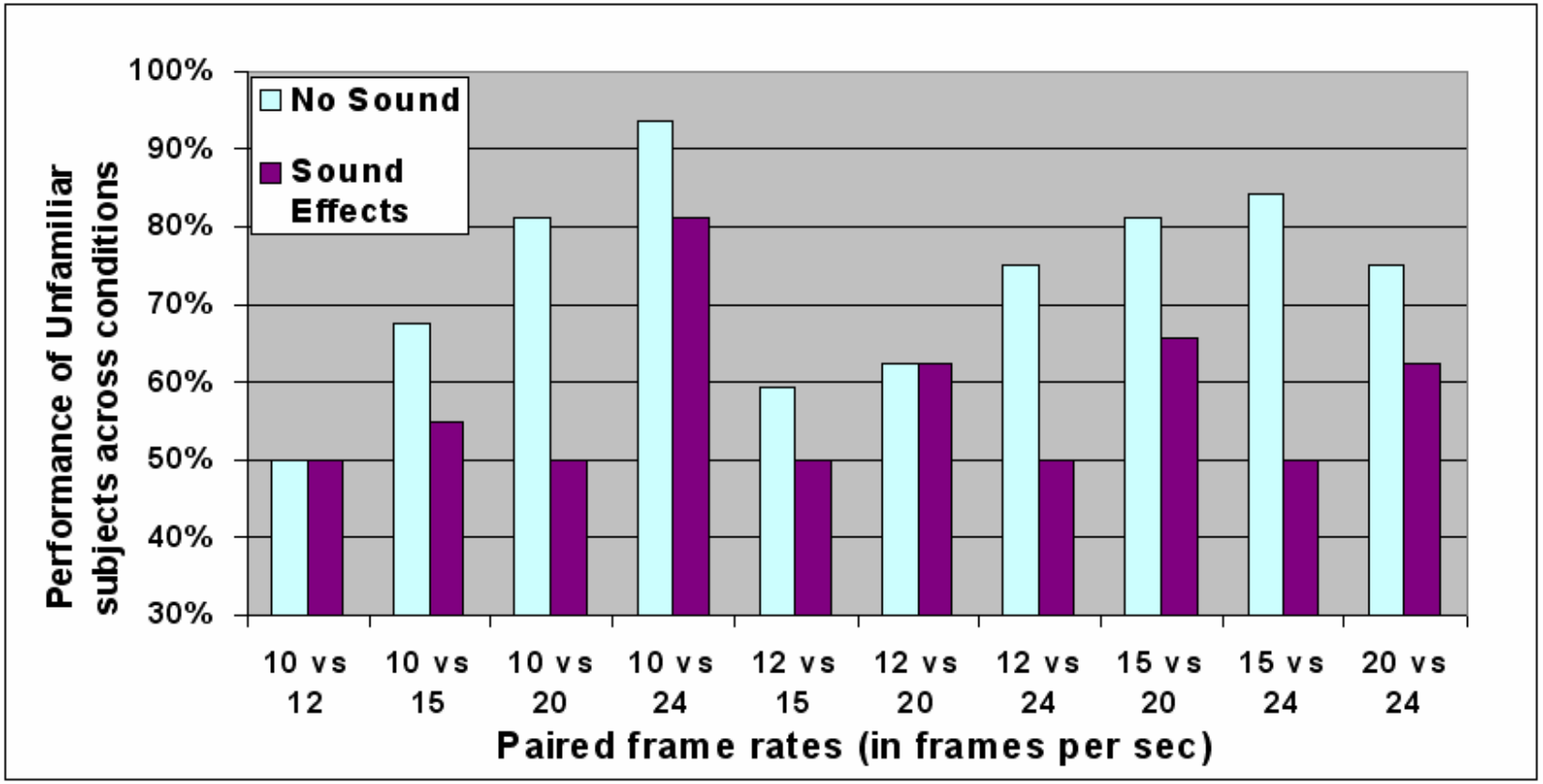
- Design
  - independent samples utilized
- Participants
  - 40 students in 4 groups
- Dependent Variable
  - perceived motion smoothness (i.e. frame rate)
- Independent Variable
  - sound effect/silence



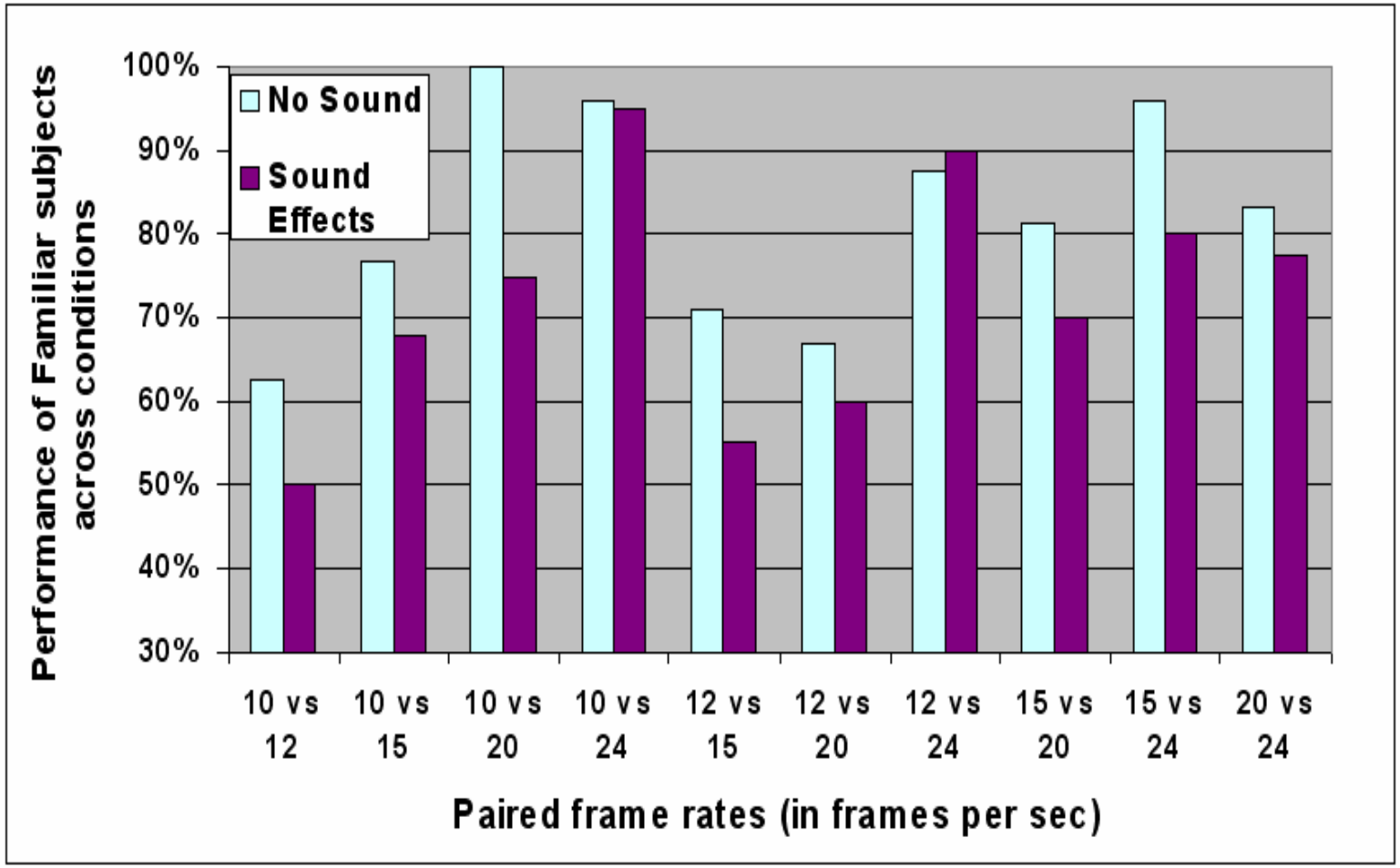
# Results Silence/Sound Effect



# Results for Unfamiliar Subjects



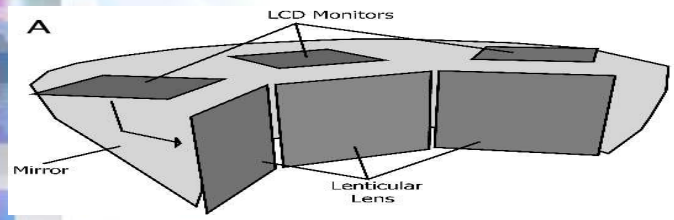
# Results for Familiar Subjects



# Graphics and Motion

Gavin Ellis

- Exploiting cross-modal interference between the human's visual and vestibular system




# Selective Rendering with Motion

| Animation | % HQ | Time (min) | Per Frame Saving |
|---|---|---|---|
| HQ | 100% | 775 | 0% |
| SQ | 65% | 615 | 20% |
| CSQ | 60% | 600 | 20% |

# MOAR Applications

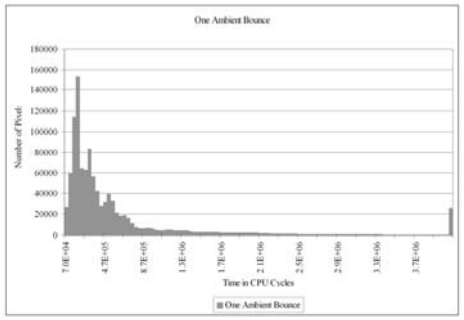
- High-Fidelity Applications
  - Simulations
    - Driving, flight
  - Archaeology
  - Architecture
  - Games

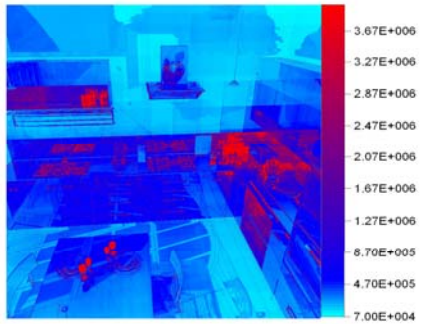
# SharpEye

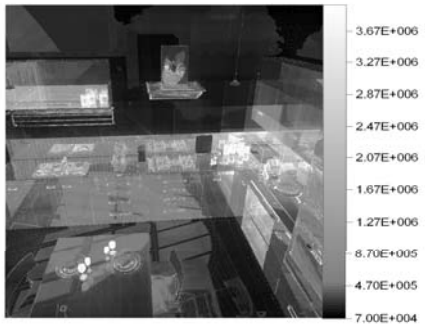
- Renderer
  - Ray tracing based
  - Spectral
  - Photon mapping
  - HDR – glint and glare
- Efficient dynamic scenes
  - Spatial and temporal coherence
- Cost Prediction
  - Quotes to clients
  - Time constrained
- Multi-Sensory Rendering
  - Audio
  - Motion

# Cost Prediction

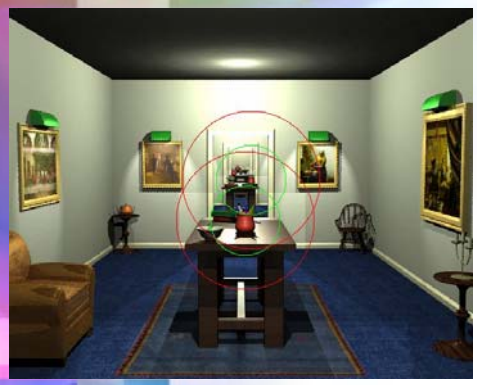
- Profiling rays used to determine simple and complex pixels
- Used to approximate total computational effort



# Realism in Real-Time



SharpEye

Task scheduling

Importance Map

Visual perception

Model reduction

Data management

Quality level

**Perceived Realism in Real-Time**

# Summary

## *It's all about Perceived Realism!*

- High fidelity computer graphics in real time

  - ➔ innovation
- Possibilities for multi-sensor, multi-user experiences
  - ➔ **Mother of All Renderers**

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