



ROYAL INSTITUTE  
OF TECHNOLOGY

DH2323 DGI18

# INTRODUCTION TO COMPUTER GRAPHICS AND INTERACTION

# **USER STUDIES AND PERCEPTION**

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# Evaluating Computer Graphics

- Computer graphics inherently **human-centered**
- Images, animations, behaviour
- Computer applications are used by humans
- Often the aim is create *convincing* results

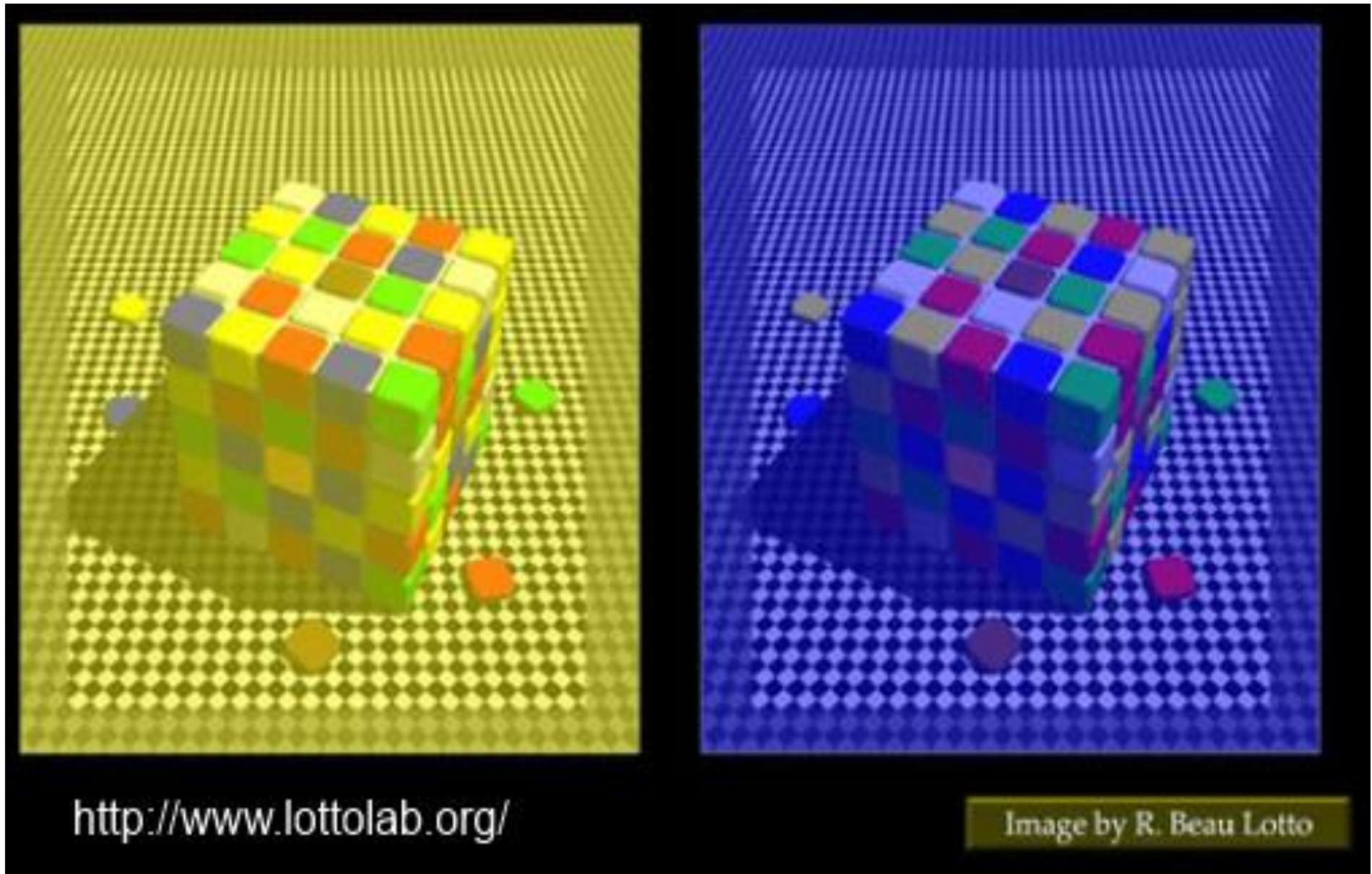
# Obvious?

# Blindingly!

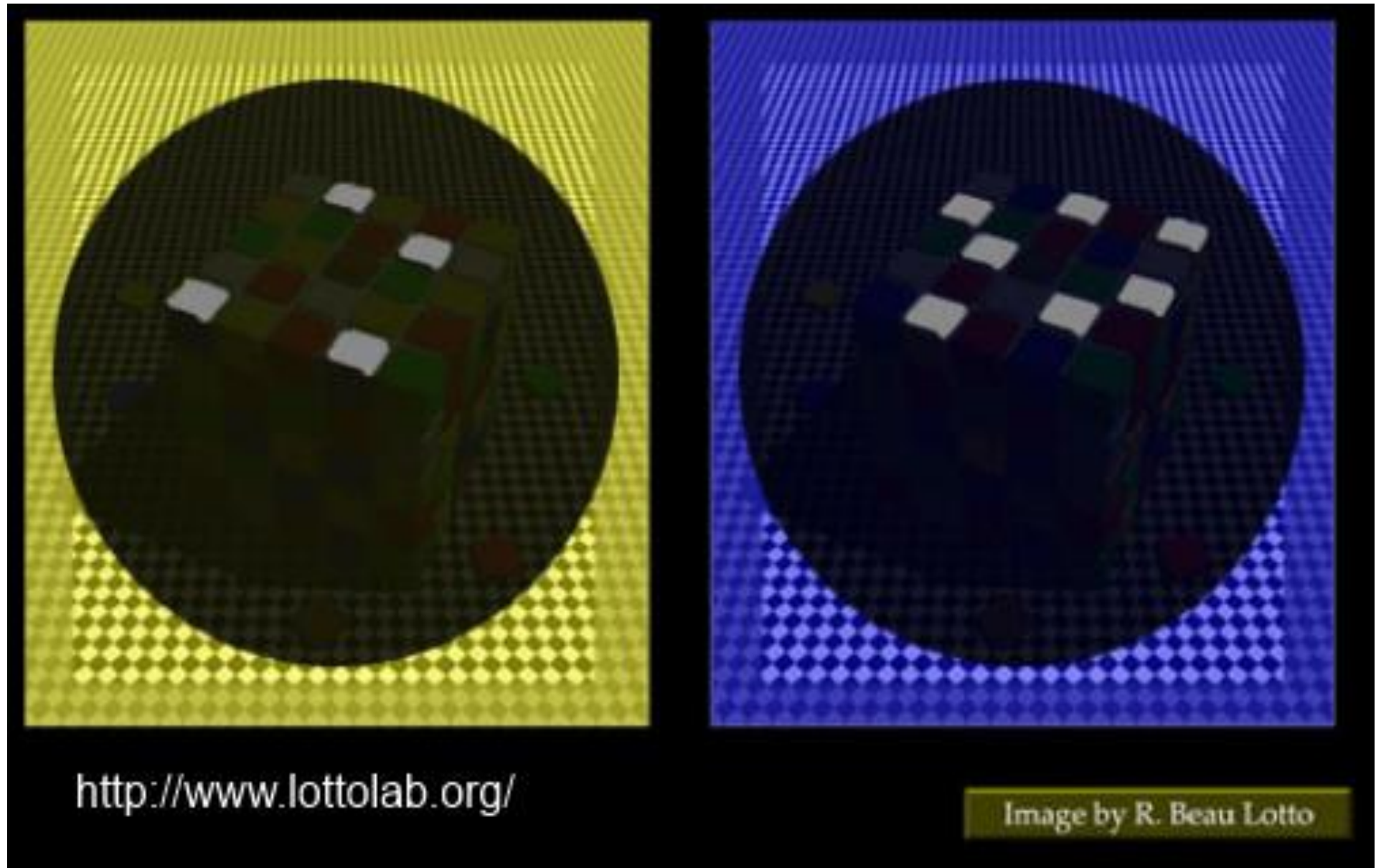
# Annoying Humans

- But it takes exceptional and continuous conscious effort to *properly* keep humans in the process
- Partly because we are human...
- In computer graphics
  - Useful to test human sensitivities to artificially created scenes, characters and behaviours

# Example



# Example





# User Studies for Evaluation

- Human experiments
- Process of evaluating or understanding a technique, tool or idea in terms of needs, preferences and abilities of humans
- Have people use your system or observe stimuli
- Evaluate what they do

# Process Overview

- Design
- Procedure
- Data analysis
- Conclusions



# Process Overview

- Design
  - *Hypothesis*: what do you want to find out?
  - Who will be the *population*?
  - How will you recruit them?
  - *Metrics*: what will be measured / recorded?

# Process Overview

- Design
- Procedure
  - All participants sign up for a time slot
  - *Informed consent*
  - Execute study
  - Questionnaires/debrief

# Process Overview

- Design
- Procedure
- Data analysis
  - Chance and confidence: *Significance*
  - *T-test*
  - *ANOVA*
  - F statistic, *p* values

# The Role of Chance



85% success rate: Euro 2008, World Cup 2010  
Paul the Octopus, Animal Oracle

# Controlled Experiments

- Events or actions caused by the experimenter intentionally
- Controlled: only variables being examined will change

Everything held constant except for one variable

- Control group: *normal* or *usual* state
- Repeatedly and reliably produce a specific event or situation

**Cause and effect (correlation v causation)**

# The Task

Set context through a scenario and task

- Clearly specify it
- Evaluation:
  - “A mouse is faster than a keyboard for numeric entry”
- Hypothesis:
  - “Participants using a keyboard to enter a string of numbers will take less time than participants using a mouse”

# Conditions

- Each condition changes something
- Independent variables (IV)
- In controlled experiment:
  - Two group types: *Control group* and *Experiment group(s)*
- Need to consider the ordering of conditions



# Participants

- *Within-subjects vs between-subjects*
- Within-subjects
  - *Repeated measures* design
  - Participant tested under each condition

# Participants

- *Within-subjects vs between-subjects*
- Within-subjects
- Between-subjects
  - *Independent measures*
  - Participant tested under one condition only
  - Avoid order effects, boredom; more participants needed

# Participants

- Record *relevant* participant details!
  - Gender
  - Age
  - Handedness
  - Vision
- Pay close attention to ethics/legal considerations!
- **Anonymity**
  - Data needs *to be* anonymous and participant needs to *know*

# Notes

- Power: the more participants there are, the better they sample the population
- ~20-30 participants per condition often considered a good/minimum number

# The Test Environment



# Pitfall #1

People sometimes do strange things, so  
they need to be observed

# Pitfall #2

People sometimes do strange things  
because they are being observed



## Pitfall #3

- Be very careful about the wording of questions

“About how fast were the cars going when they *smashed* into each other?”  
(Loftus & Palmer, 1974)
- **Garbage in -> garbage out**

# Pitfall #4

- Experimenter bias
- **Seeks evidence conforming to one's expectations**
- 'Cherry picking'
  - Keep/focus on the *good* data, discard/ignore *bad* data
- Unintentional
- There are *many* more  
Google: "List of cognitive biases"

# Pitfall #5

- Response bias
- **Participants may try to give you the answers they think you want**
- Conceal expectations
- Preserve anonymity
  - Data collection should be anonymous
- Add *catch trials*

# General Advice

- Always do a *pilot study*
- Smaller number of participants
- Not statistically valid
- But highlights problems with the experiment design and procedure...  
...**before** the main experiment

# A 'Live' Example

# Experiment Description

## 4 Experiment

Thirty two participants (12F, 20M) age 18 to 30, were seated in front of a computer screen. They were told that the experiment consists of three blocks and were given an instruction sheet: two photographs of the corridor and open zone were shown and they were told that the images they were about to see were derived from real photographs, but in some the character formations were real, while in others they were synthetically generated. For the first block of the experiment the participants were told to focus only on the positions of the characters. For each image displayed, participants were asked if they thought the positions of the *pawn* figure characters were real or synthetically generated. For the second block, participants were asked to look at the orientations of the characters only and judge if they were real or synthetically generated. For the

final block of the experiment, participants were asked to take both position and orientation of the characters into account and judge whether the scenes were real or synthetically generated. The reason that we presented the experiment in this order was to avoid biasing participants. If the pawn figures were viewed after the humanoid characters, this could have caused them to perceive the scenes as less realistic due to the reduced realism of the characters, which was not the effect being tested. Furthermore, the scenes with position and orientation combined were presented during the final block, to prevent participants from taking position into consideration when conducting the orientation only trial. Between each trial, a blank-screen was displayed for 5 seconds, after which the number of the next trial was displayed alerting participants.

C. Ennis, C. Peters, C. O'Sullivan: Perceptual evaluation of position and orientation context rules for pedestrian formations. *Applied Perception in Graphics and Visualization (APGV)* 2008: 75-82

# Methodology

- Consisted of 4 phases:
  - Data Collection Phase
  - Annotation Phase
  - Reconstruction Phase
  - **Modification Phase**



# Data Collection Phase

- Videos taken of 2 locations:

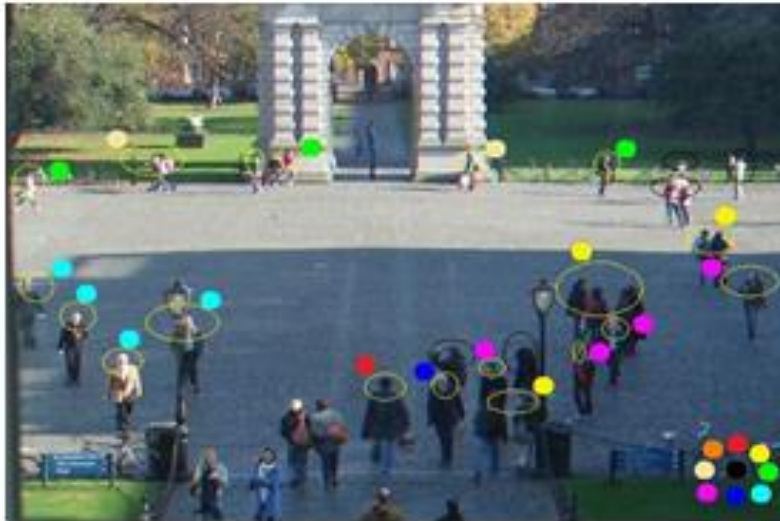


Unconstrained / Open Scene  
30 Characters



Constrained / Corridor Scene  
12 Characters

# Annotation Phase



- Still images annotated to highlight Positions, Orientations and Groupings
- Colour-coded *Dynamic* vs. *Static* groups and 8 different Orientations



# Position Rules



Still Image



Real



Random



Context:

Bounds Sensitive, Group Sensitive

# Orientation Rules



Still Image



Real



Random



Context:  
Flow Sensitive, Adjacency  
Sensitive, Group Sensitive



# Reconstruction Phase

- Creation of virtual replicas of real images that were captured and annotated

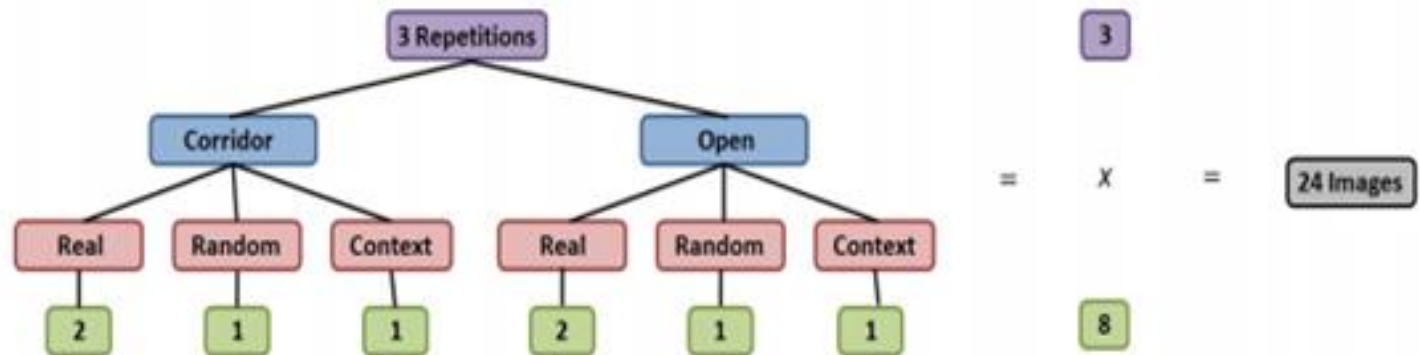


- Using image as viewport background in 3ds Max
- Tweaking Camera parameters to align model and still image

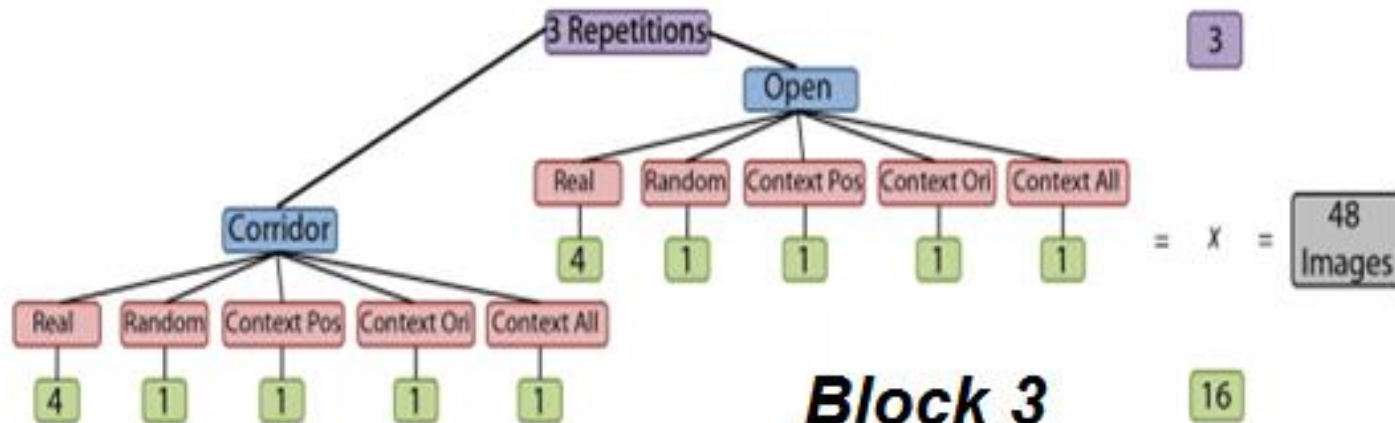
# Experiment

- 32 participants (12F 20M) aged 18 – 30
- 3 Blocks – Position, Orientation, Both
- Participants were asked whether they thought the formation was *Real* or *Synthetically Generated*
- Images displayed for 4 seconds

# Experiment 1: Pos and Ori



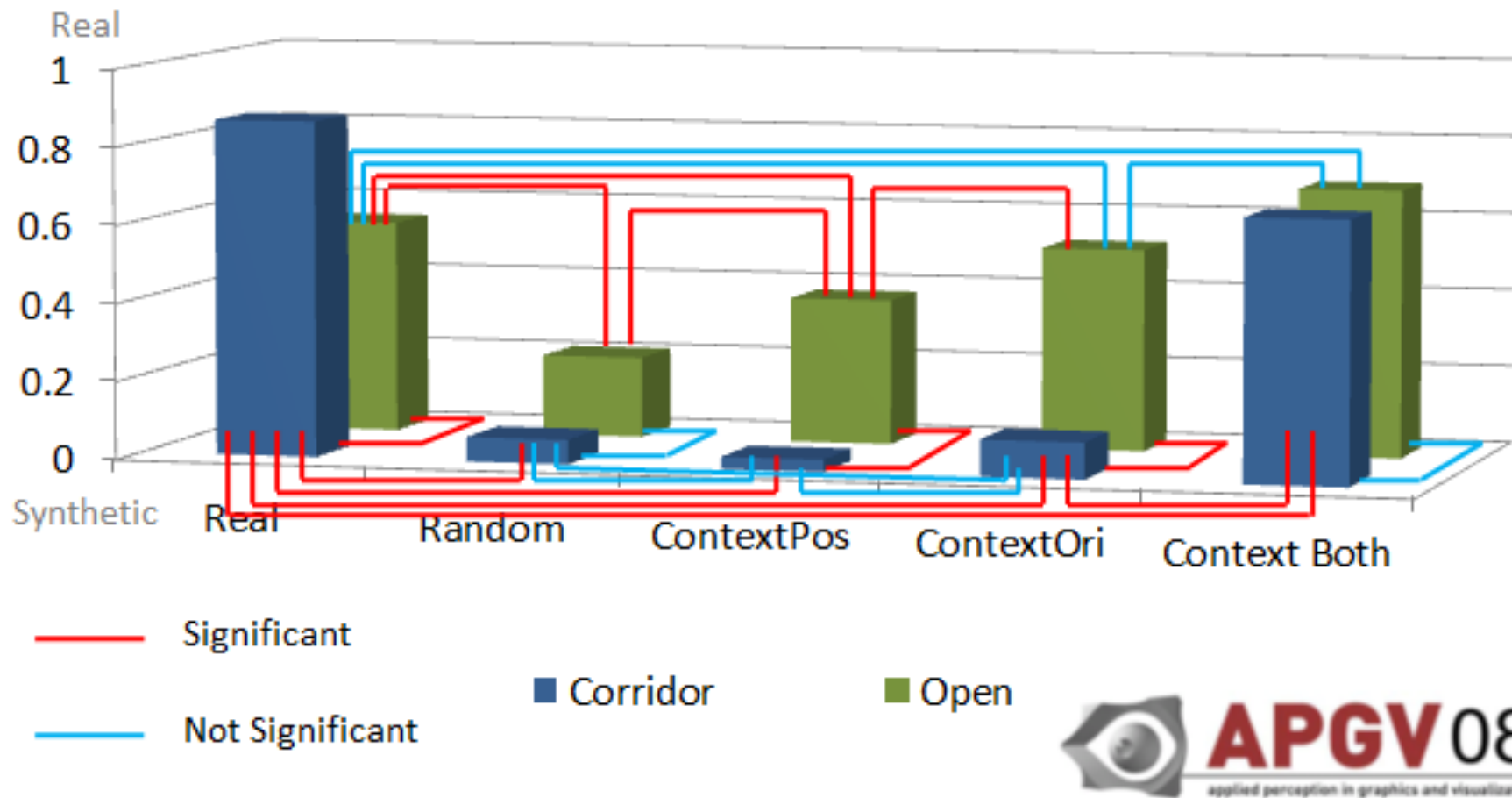
**Block 1 and 2**



**Block 3**



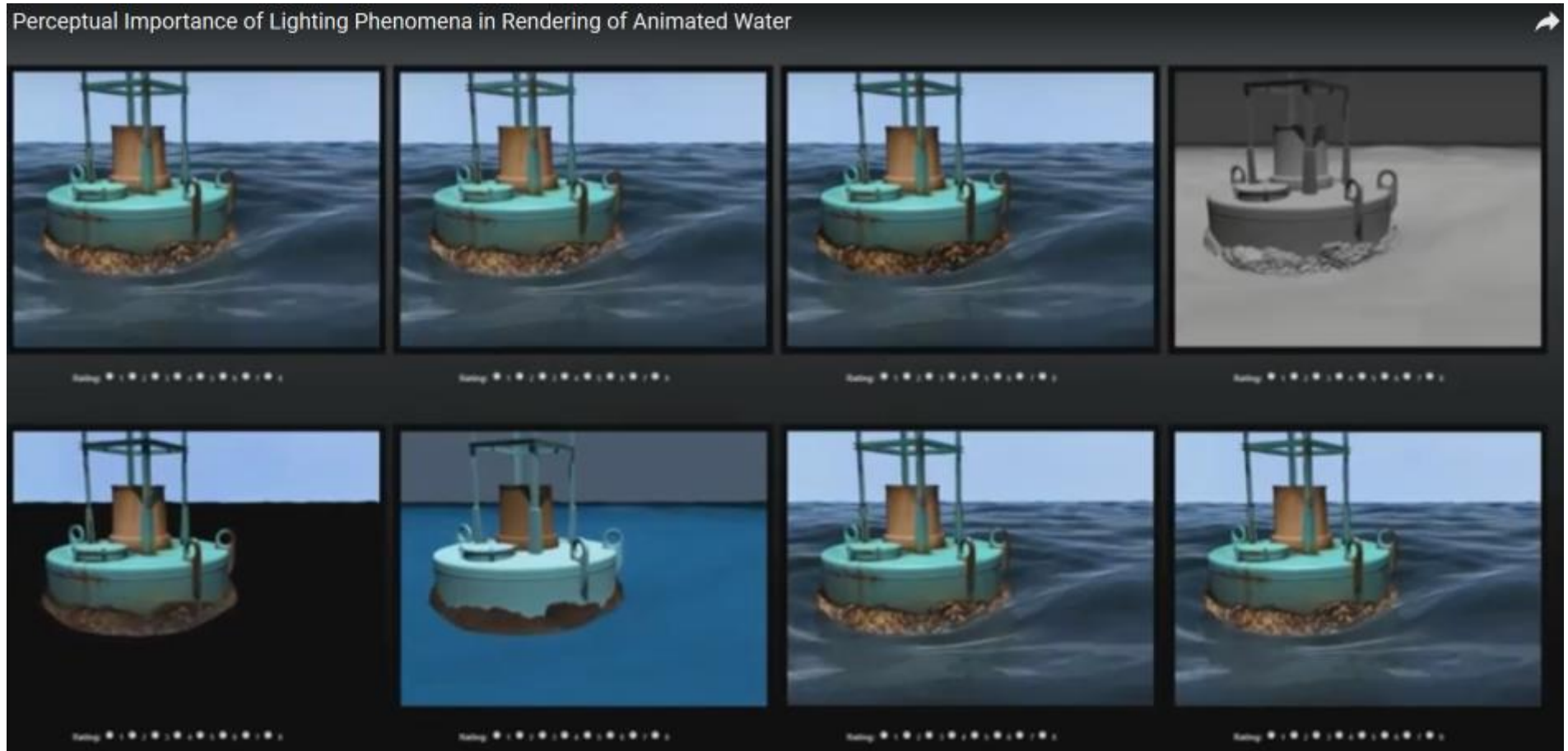
# Position and Orientation



# Perception and graphics

- Determine human sensitivities
  - Reduce level of detail in parts of the scene that are not salient
- Drive algorithms in real-time
  - Eye-gaze and detection
  - *Concealing Rendering Simplifications Using Gaze Contingent Depth of Field*, Tim Lindeberg, 2016
  - Project's page:  
<http://www.csc.kth.se/~chpeters/projects.html>

# Another Example



<https://www.youtube.com/watch?v=3mBJRjs9LpU>

# Another Example

## Perceptual Importance of Lighting Phenomena in Rendering of Animated Water

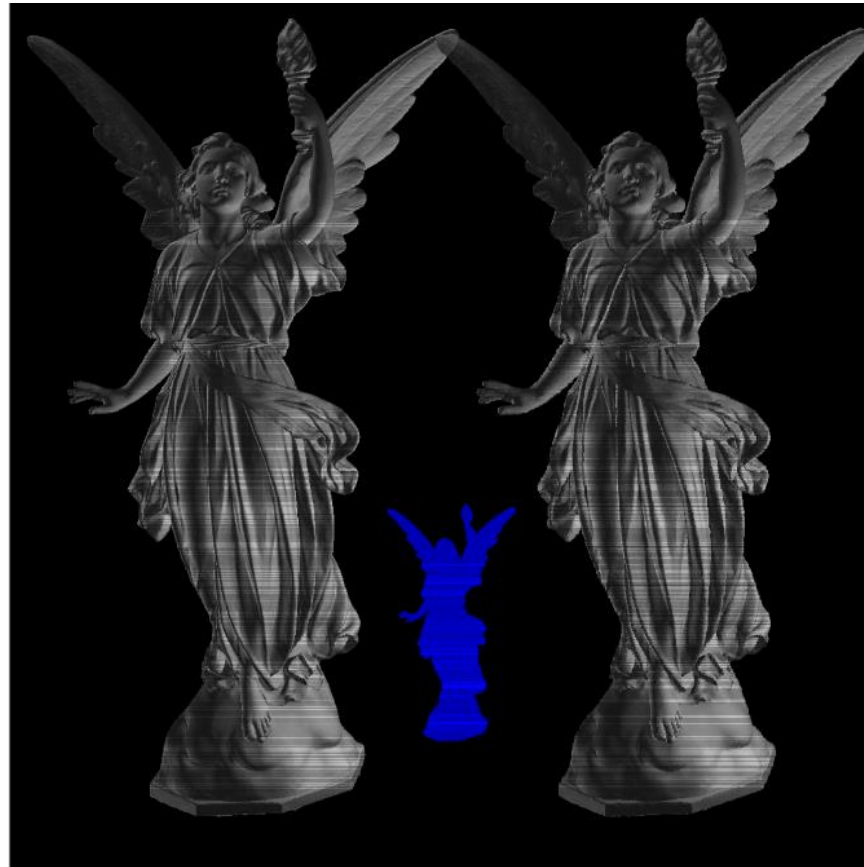
Micah Bojrab, Michel Abdul-Massih, Bedrich Benes  
Purdue University

ACM Transactions on Applied Perception

# An Overview

- Perceptually Driven Interactive Rendering  
David Luebke and Benjamin Hallen

<https://www.cs.virginia.edu/~luebke/publications/pdf/perceptual.ir.pdf>



# In Your Project

- Report on a *potential* perceptual experiment related to your project
- A good example is available here:  
<http://proceduralclouds.blogspot.se/>

