Tracking Visual Engagement in Mixed Reality

A framework for analysing interaction with digital models

Adam Tomkins

a.tomkins@sheffield.ac.uk

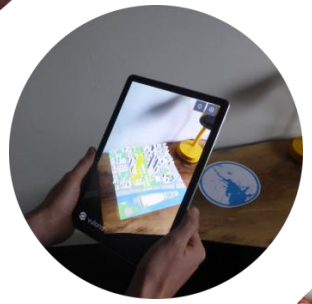
The University Of Sheffield.

adaptive urban transformation

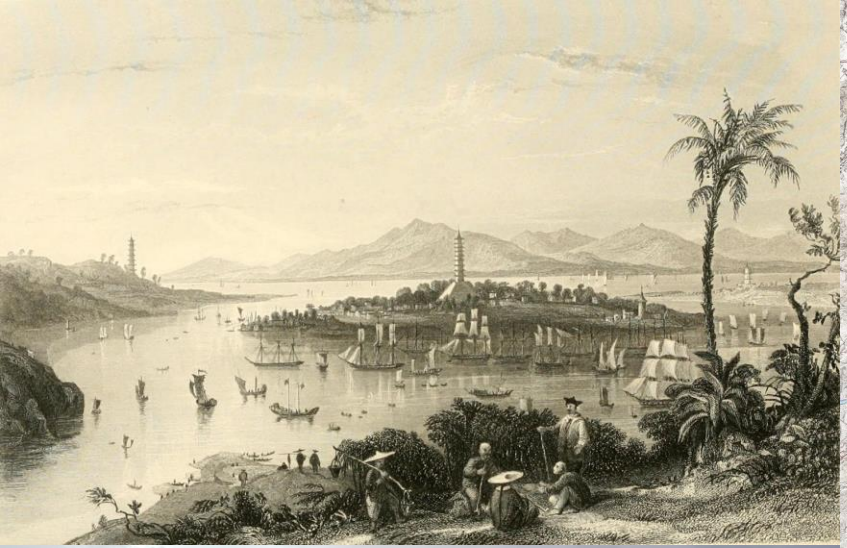
Software Sustainability Institute

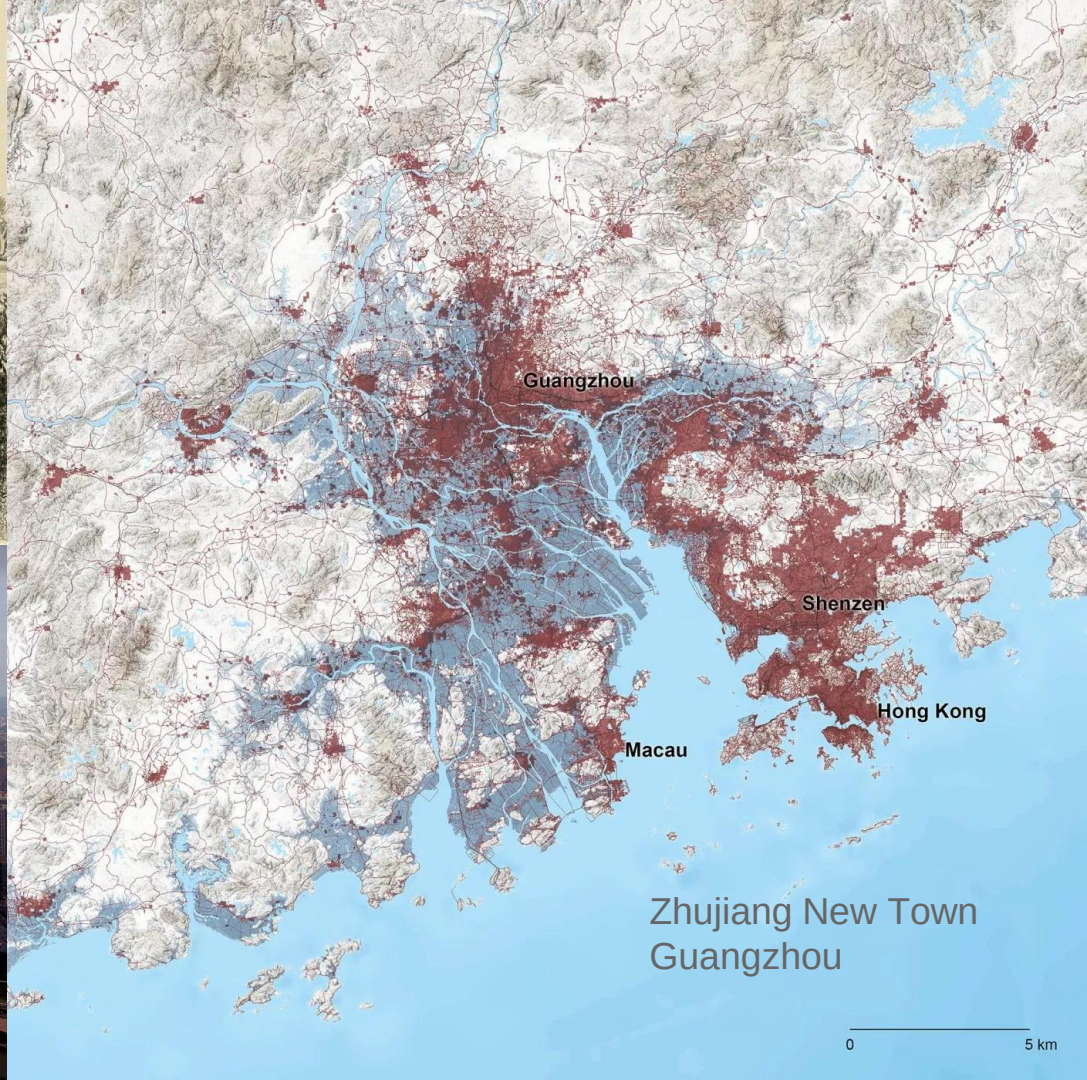
Tracking Visual Engagement in Mixed Reality

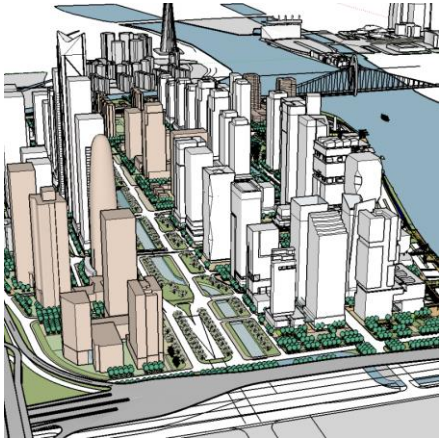
What is Mixed Reality?

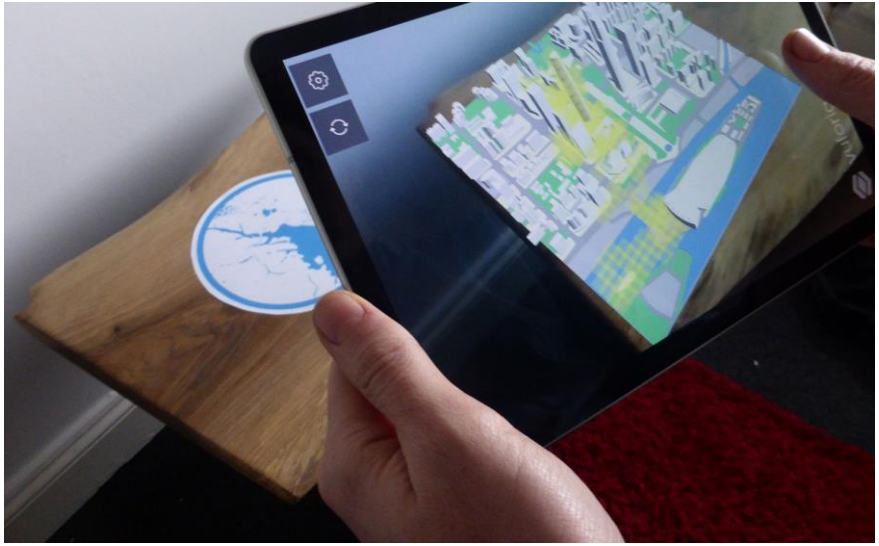


Umbrella Term
for Virtual Reality and
Augmented Reality
(also known as XR)




Guangzhou
Shenzen
Hong Kong
Macau
Zhujiang New Town
Guangzhou
0
5 km





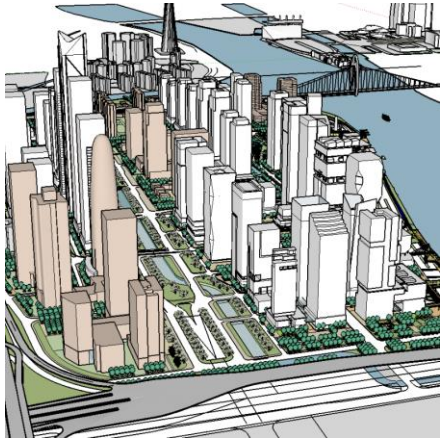
Zhujiang New Town
Guangzhou

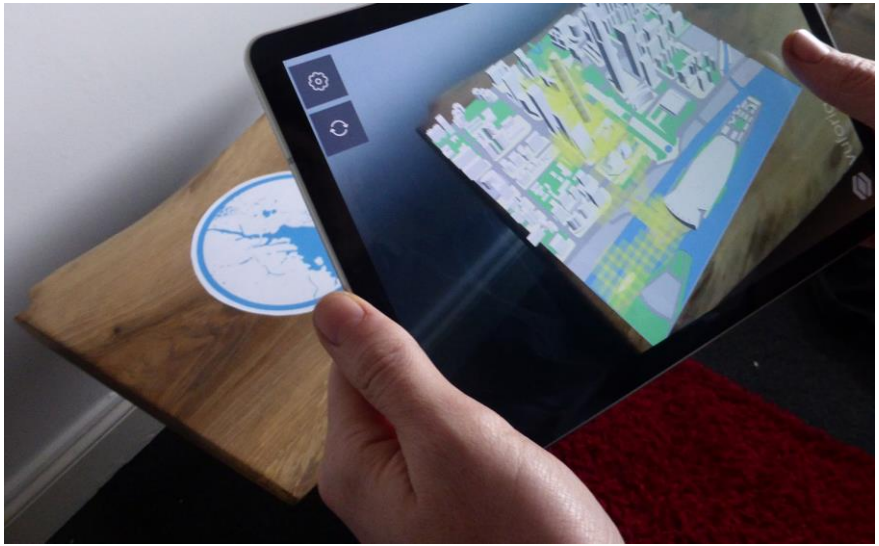
adaptive urban transformation

Visual Engagement

How do we understand how a stakeholder consumes a design?

Qualitative - Quantitative - Complementary





Interviews

Qualitative Methods

Experiential - Emotional - Individual

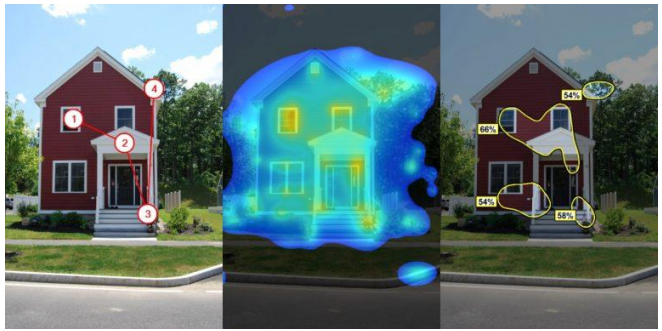
What information do follow-up interviews seek to gain?

- Quality evaluation of the design
- Emotional evocations of intervention choices
- Experience and preference
- … but memory is flawed

Eye Tracking

Quantitative Methods

Spatial - Temporal - Comparative

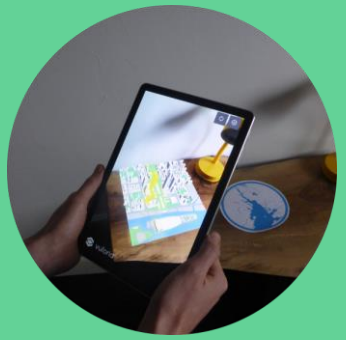


What questions does eye tracking answer?

- Where are the naturally salient areas of an image?
- How do eyes move across an image
- How do changes in an image affect participant behaviours.

Engagement in Mixed Reality

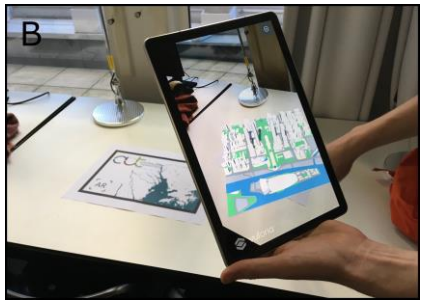
What opportunities are created by MR



Perspective Tracking

Record & Recreate Exploration

Tracking - Spatial Exploration - Multiscale



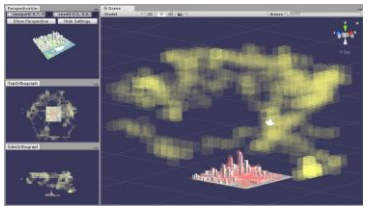
What questions does Tracking in Mixed Reality enable?

- How does a user frame the design during exploration?
- Does the the design encourage spatial exploration?
- Do features have the intended effect on a participants attention?

Perspective Tracking Framework

Passive Exploration Tracking

6 DoF Tracking - Spatial Exploration - Data Driven Inquiry



unity

Aims of the Framework

- Extend existing MR applications
- Gather non-intrusive data during participation studies.
- Provide insight and support during follow-up interviews
- Support evaluation of design decisions

Perspective Tracking *Framework*

Components

Viewers

Stakeholders, Public

Models

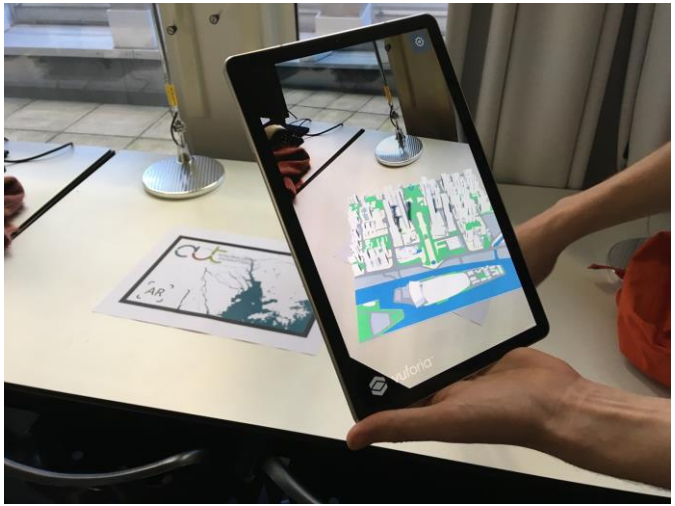
3D/2D digital models, environments

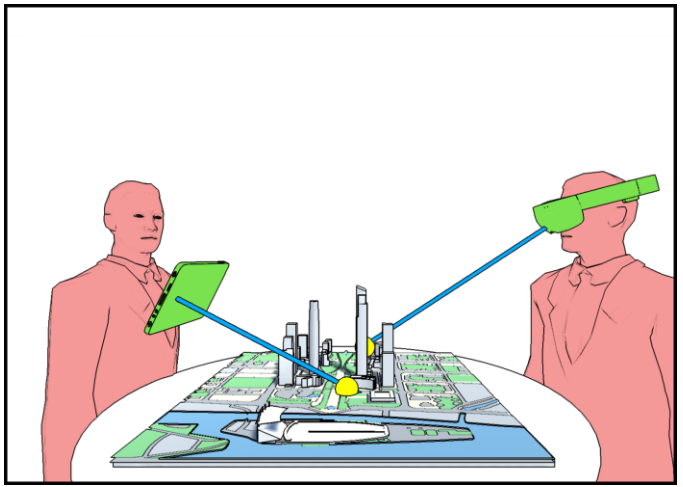
Viewports

VR Headset, Mobile Devices, AR Headsets, Desktop

Focal points

Perspectives

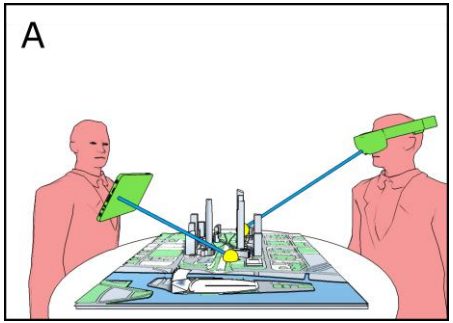




Data Collection

Capturing Simple Interactions

Passive - Granular - Individual - Aggregate

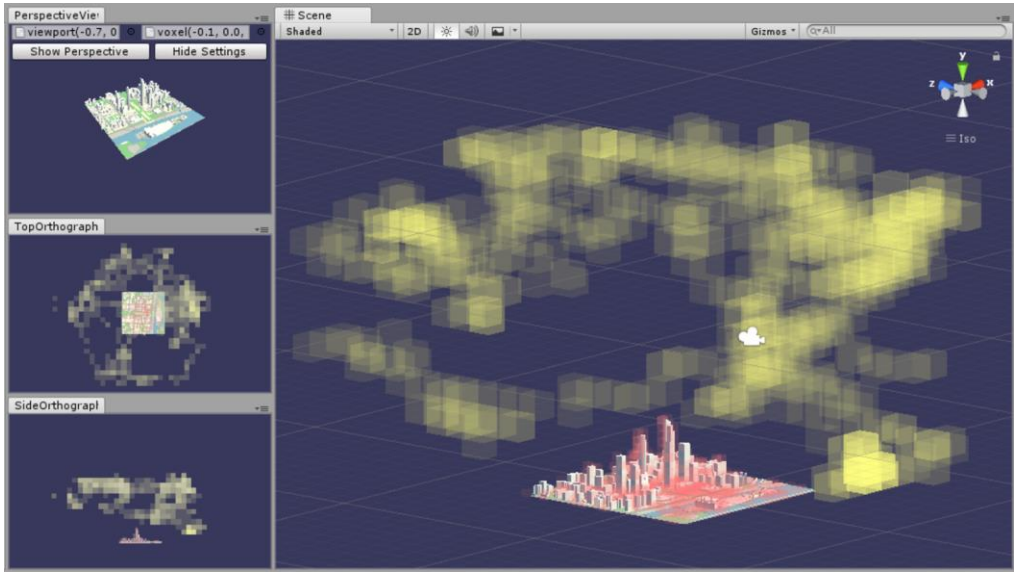


Data that the framework gathers:

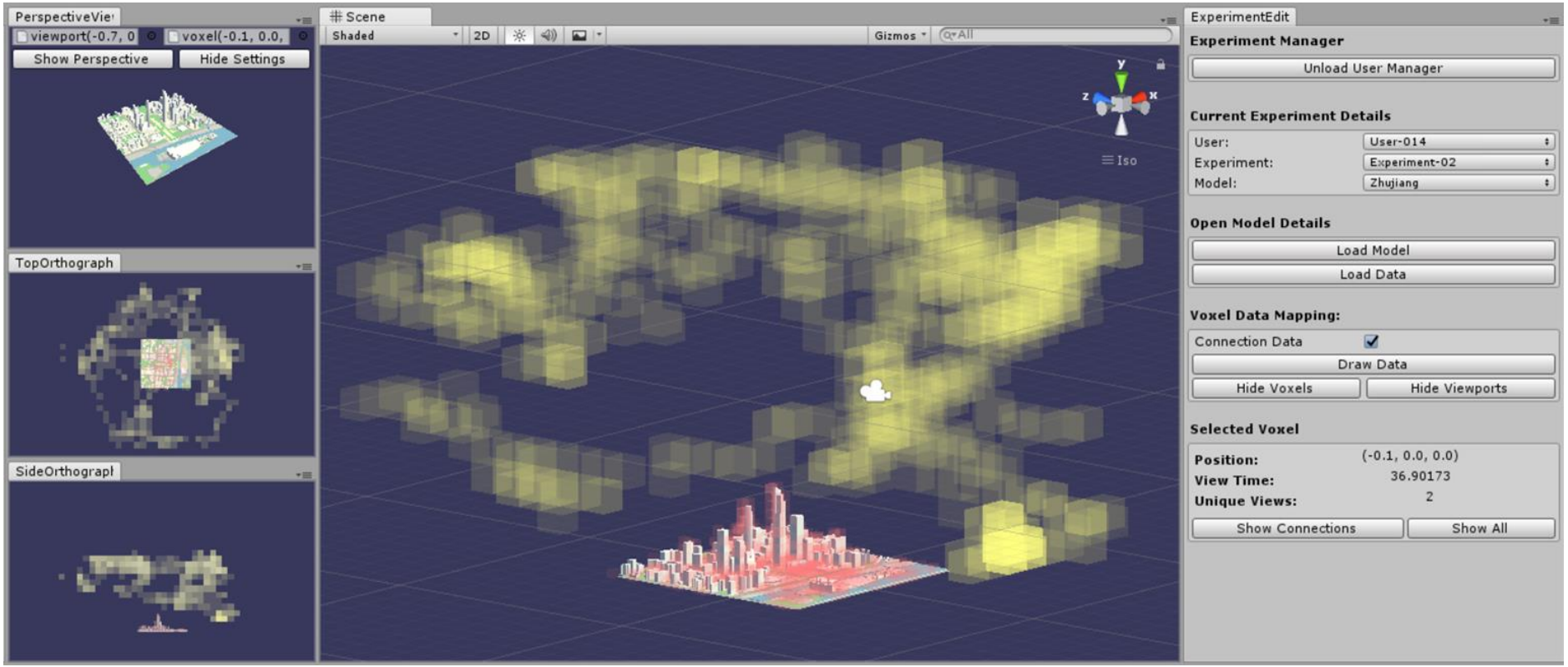
- The total time spent interacting with the model, from each vantage point.
- The total time spent focused upon each point in the proposed model
- The unique number of visits to each of point in space.
- Voxelize the data

Interface


B


PerspectiveVie
viewport(-0.7, 0
voxel(-0.1, 0.0,
Show Perspective
Hide Settings
TopOrthograph
SideOrthograpl
Scene
Shaded
2D
Gizmos
Iso

Data Interface



Data Exploitation

Answering Complex Questions

Intention - Design - Experience

Questions the framework enables

- Do our design intentions match up with user experience?
- Are there areas that encourage exploration, or areas that are overlooked?
- What are the *naturally salient perspectives* that we facilitate?

Salient Perspectives

Naturally framed features

Individual - Spatial - Experiential

Carl Steinitz - PhD Thesis (1967)

Salient Perspectives

Naturally framed features

Individual - Spatial - Experiential

Feature Focused

Viewport Focused

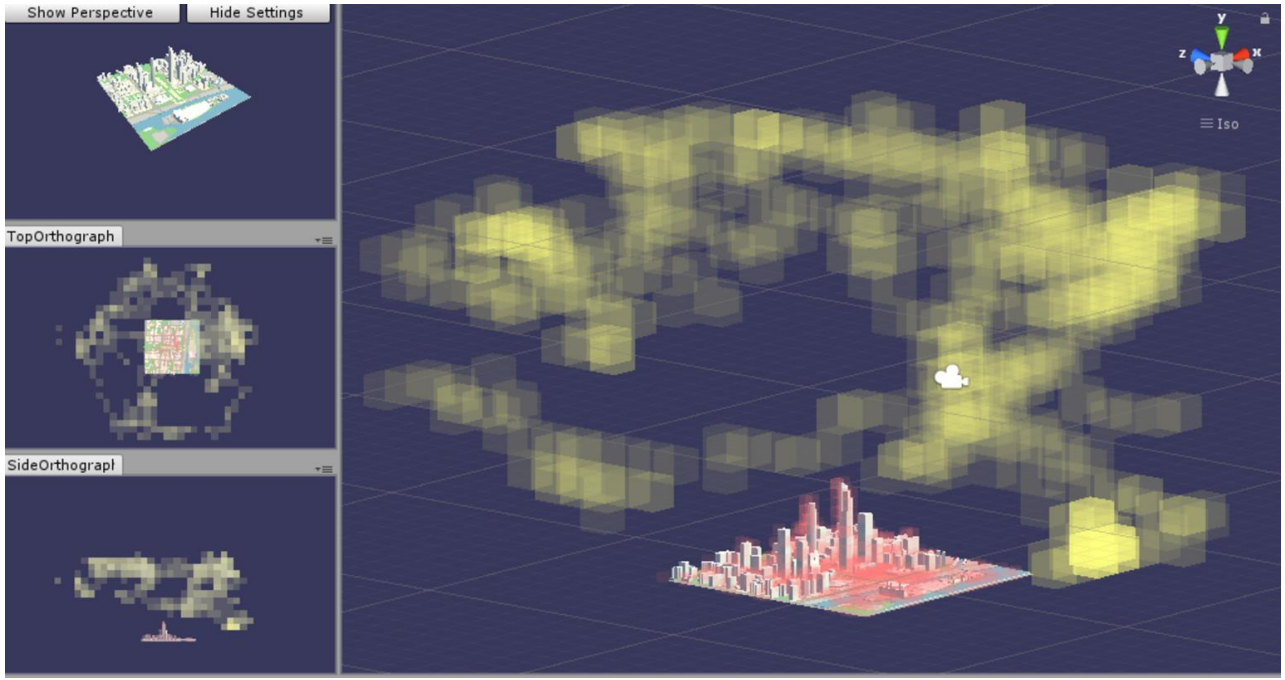
Keyhole Views

Attentional Views

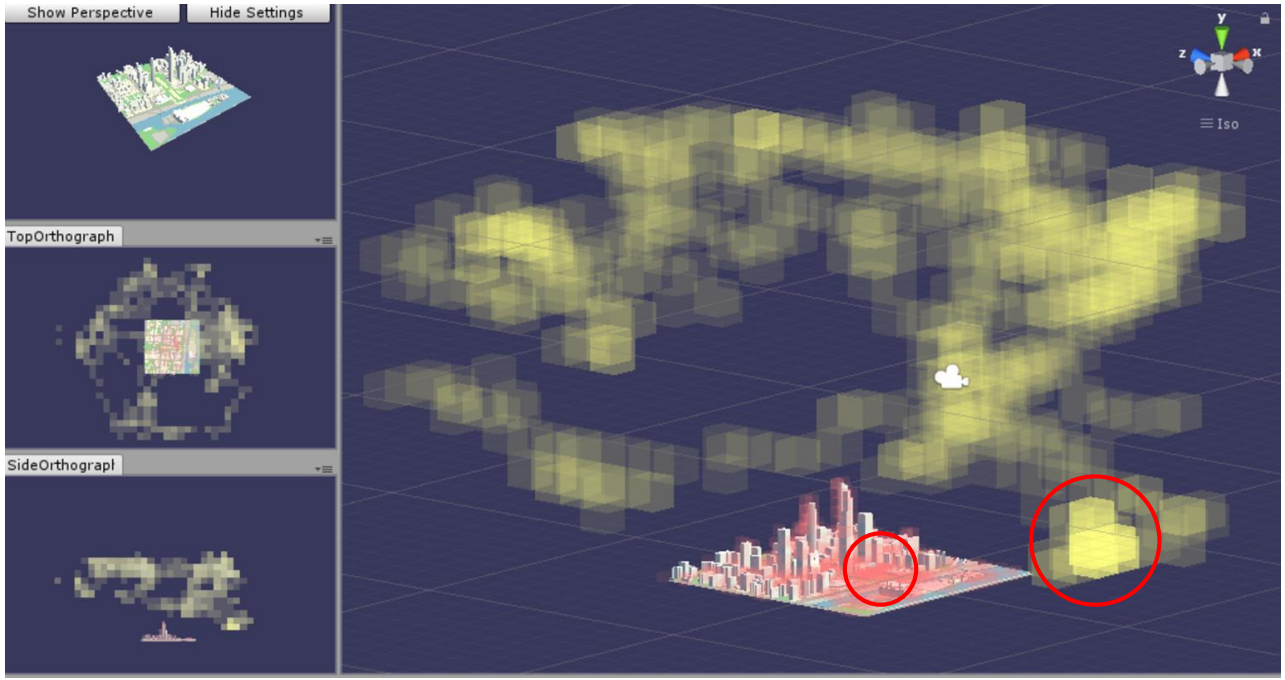
How do we understand Engagement?

Dissecting Spatial Perception Maps

Understanding visual engagement

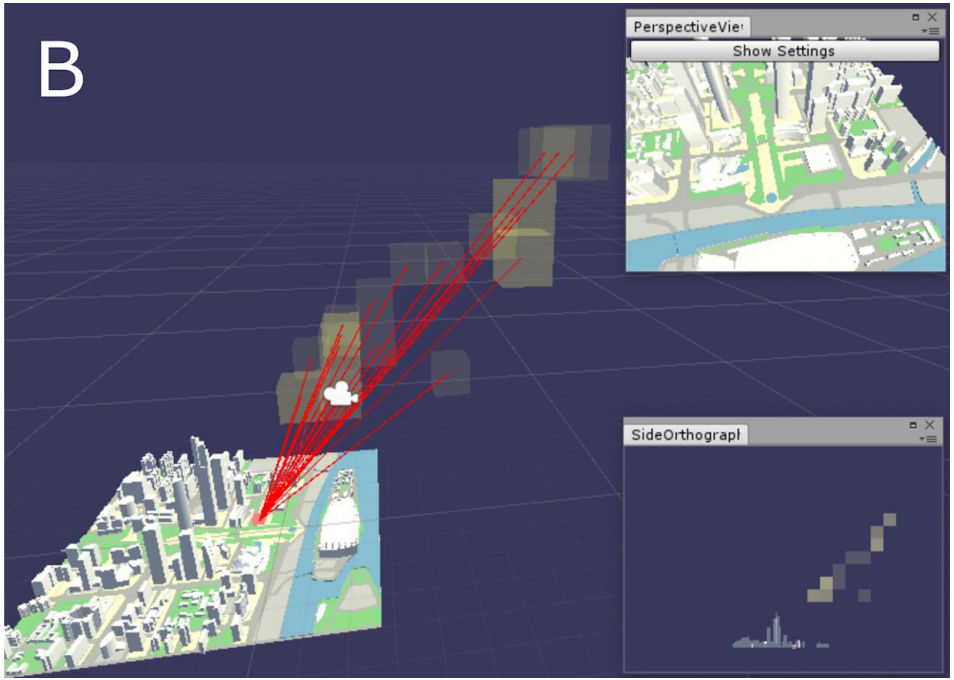


Understanding visual engagement

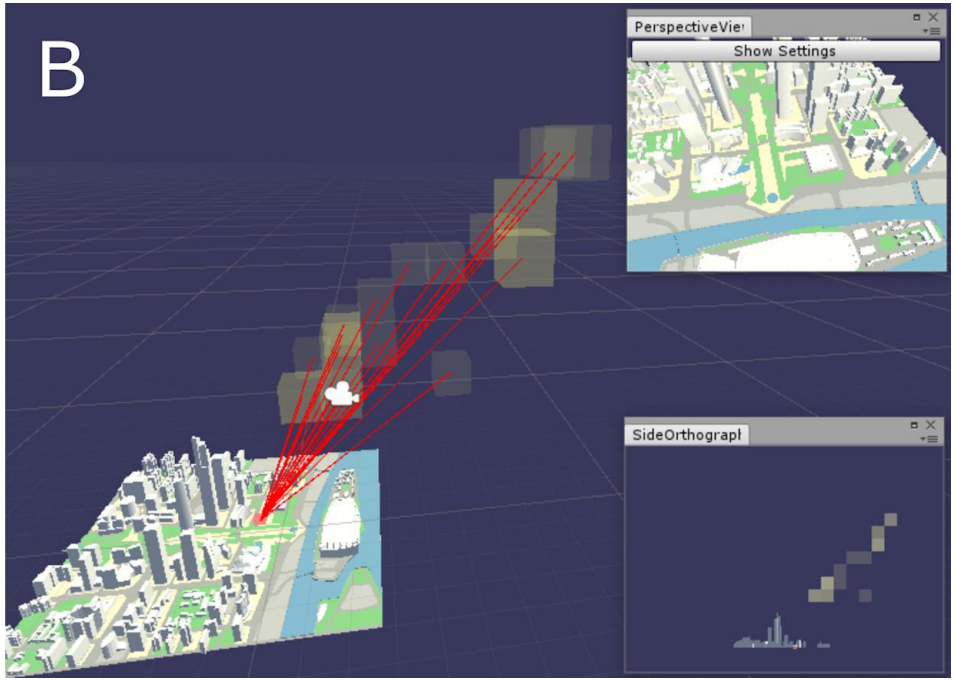


Dissecting Spatial Perception Maps

How do users interact with features



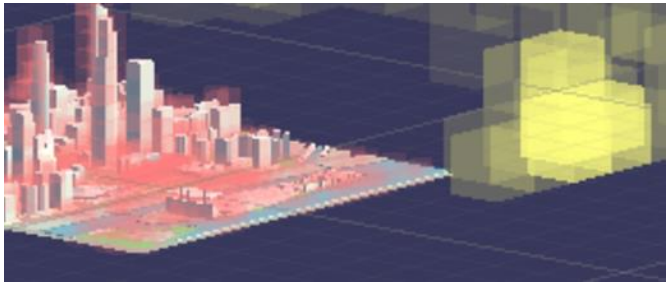
Dissecting Spatial Perception Maps

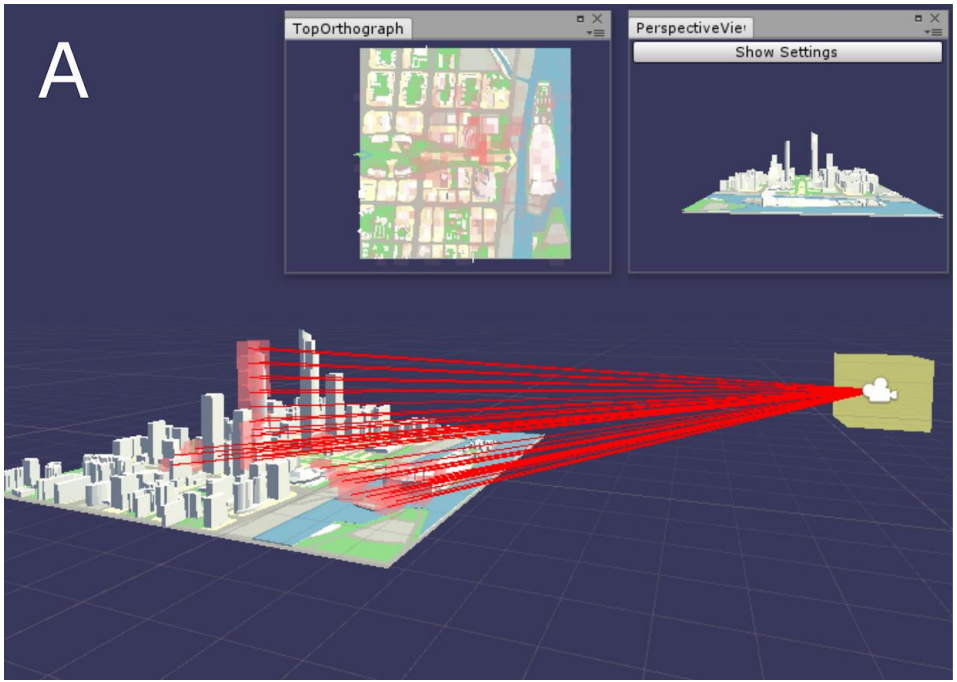


Guangzhou Library
Zhujiang New Town, Guangzhou

Dissecting Spatial Perception Maps

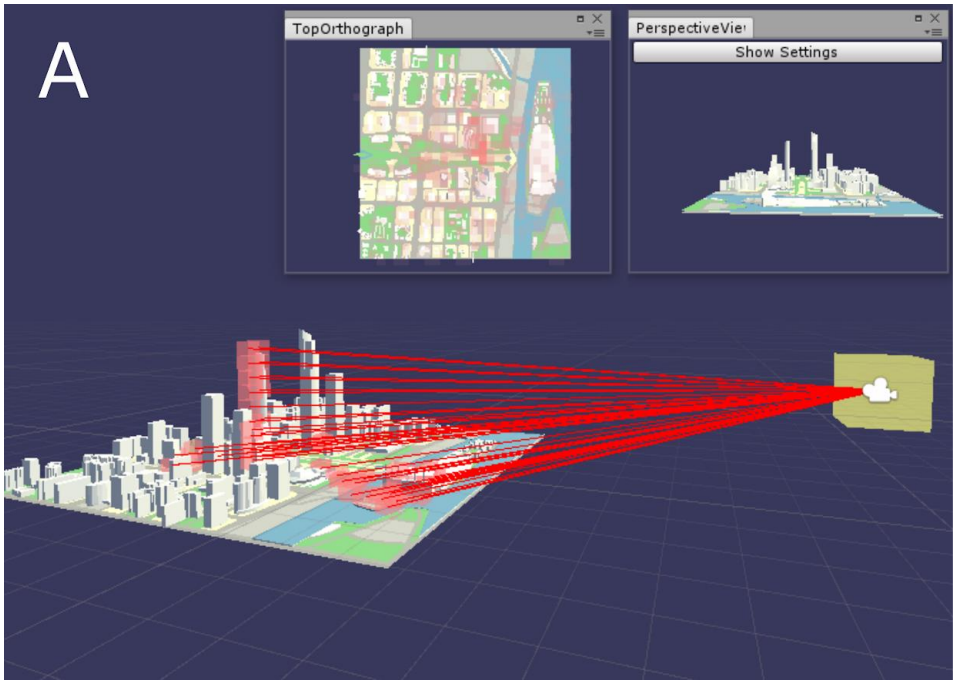
What do users look at
from each point in space?



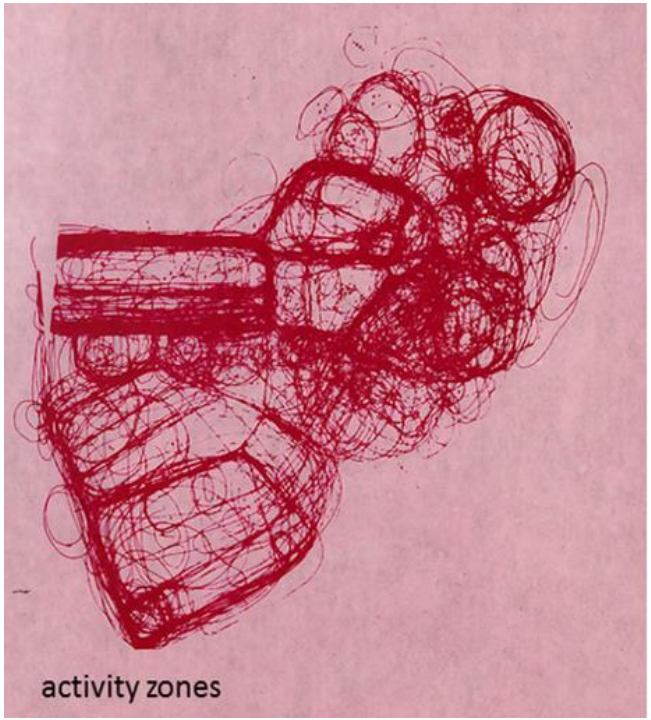


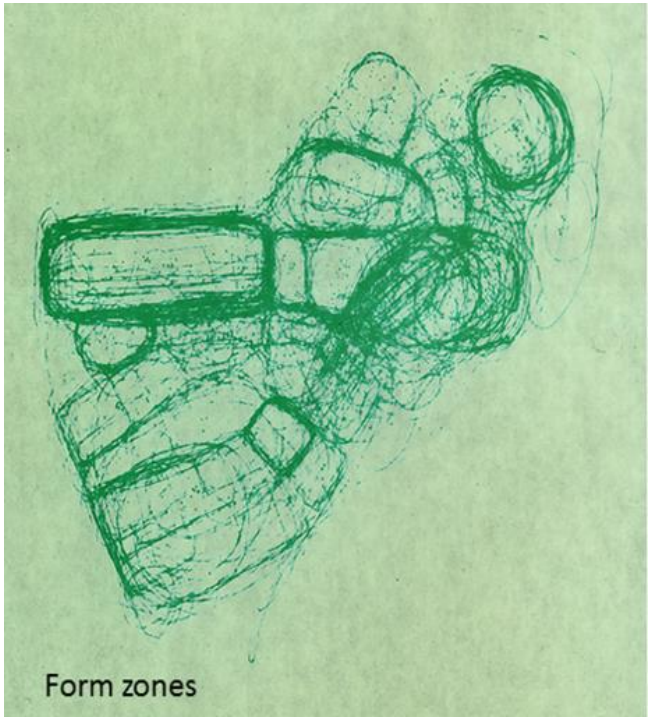
Dissecting Spatial Perception Maps

What do users look at from each point in space?



Detecting Complex Behaviours





Carl Steinitz - PhD Thesis (1967)

Where do we see this being used?

Stakeholder Participation Workshops

- Support Quantitative Design Evaluations
- Comparative studies
  - Between Designs
  - Between User groups

Mixed Reality can bring
a tighter integration of
design, intention and experience