

The VRDC logo is positioned at the top center of the slide. It features the letters 'VRDC' in a bold, white, sans-serif font. The letters are set against a dark blue background that is shaped like a diamond or a stylized 'V'. The overall background of the slide is a vibrant red, with thin, dark blue lines forming a grid-like pattern that intersects at the center.

VRDC

Evolving Mixed Reality

Designing on the Real World

Ran Gal

Microsoft Research

Samantha Gorman

Tender Claws

Brian Schwab

Magic Leap

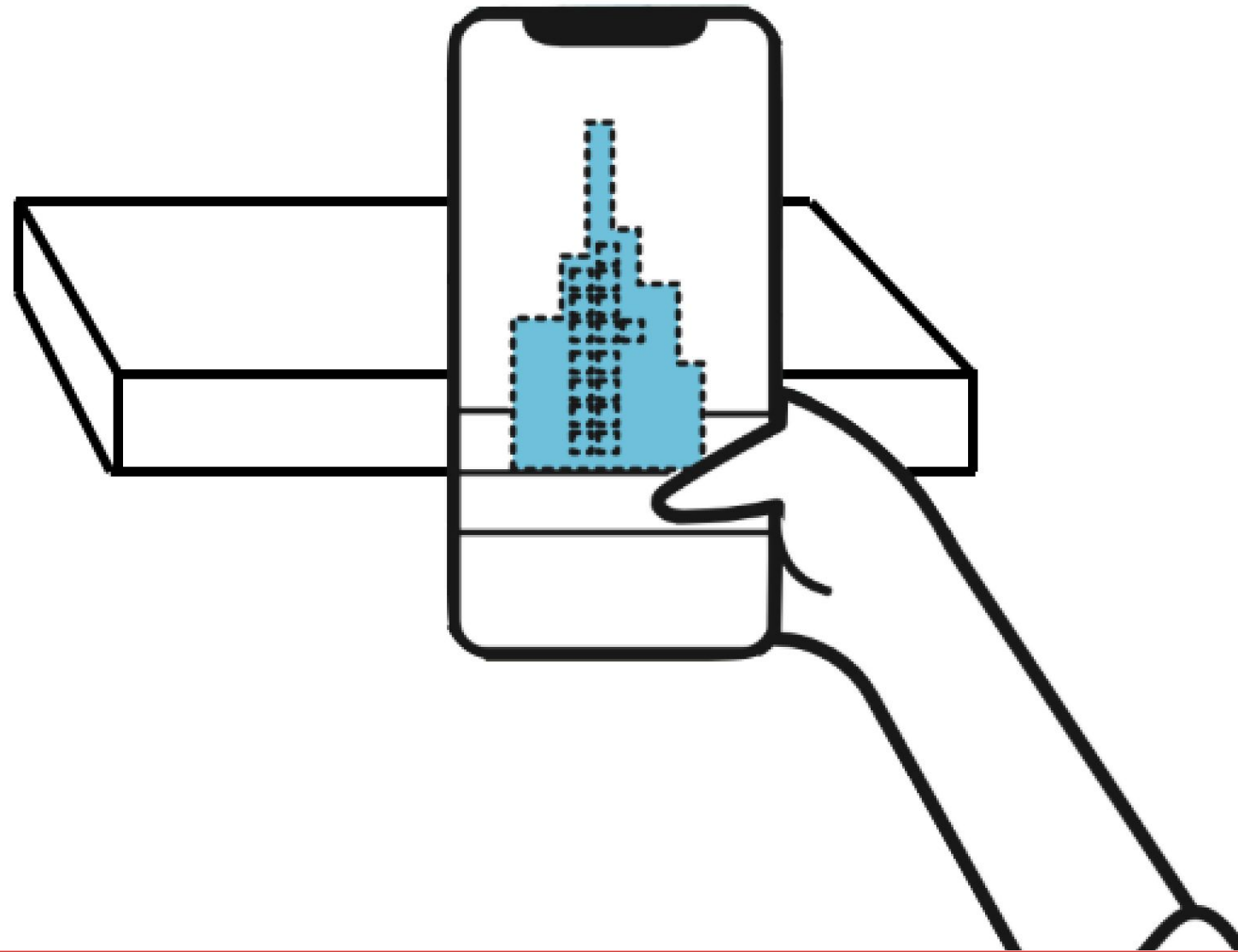
Jono Forbes

Unity

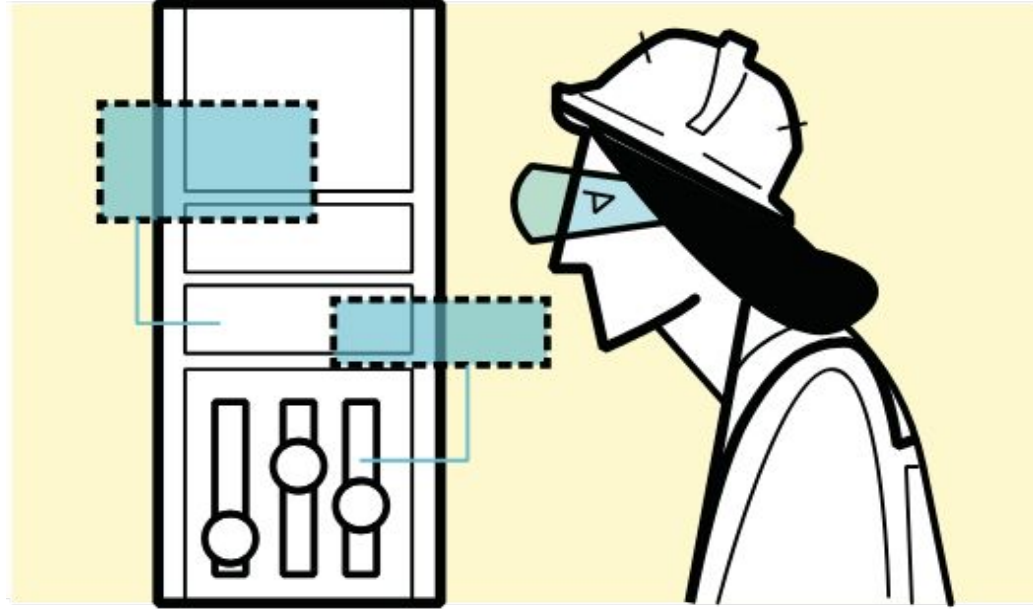
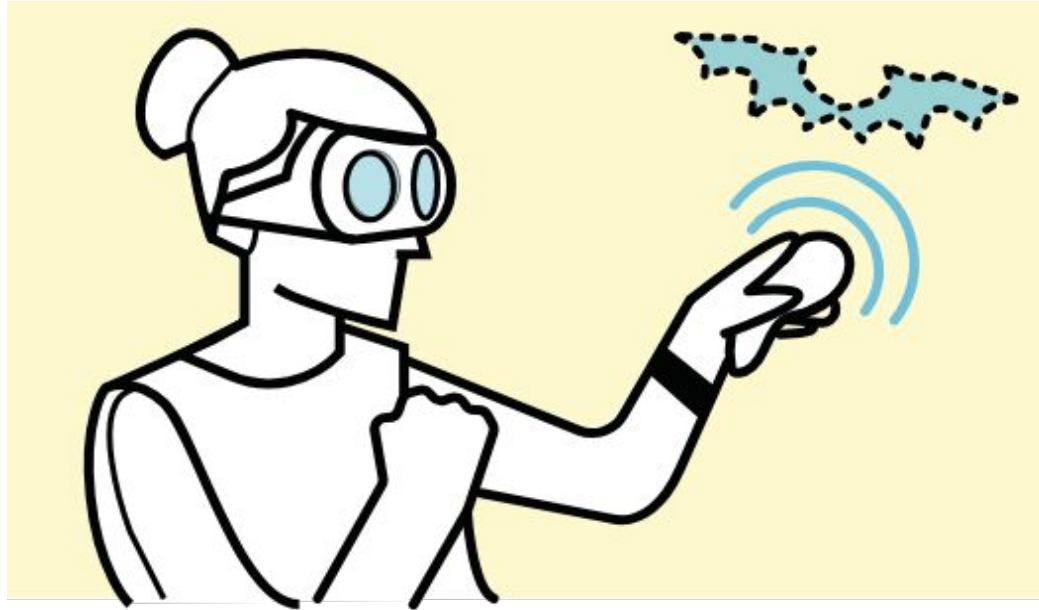
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Where We Are Today



Where We're Going



The VRDC logo features the letters 'VRDC' in a bold, white, sans-serif font. The letters are set against a dark blue background that forms a stylized, upward-pointing arrow shape. The entire logo is centered at the top of the slide.

VRDC

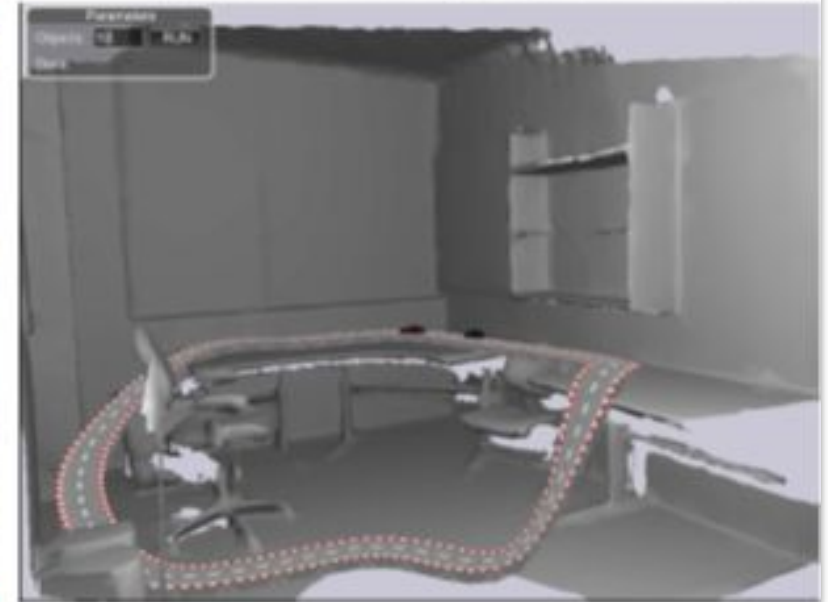
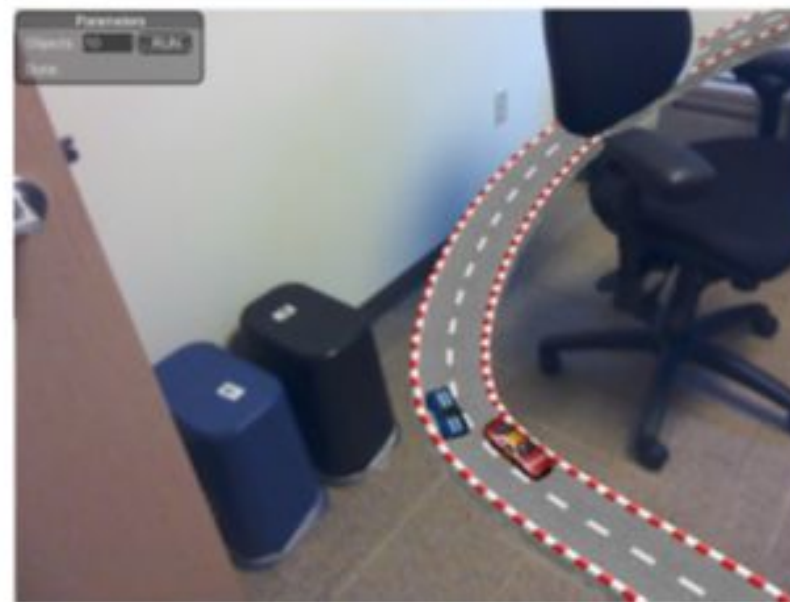
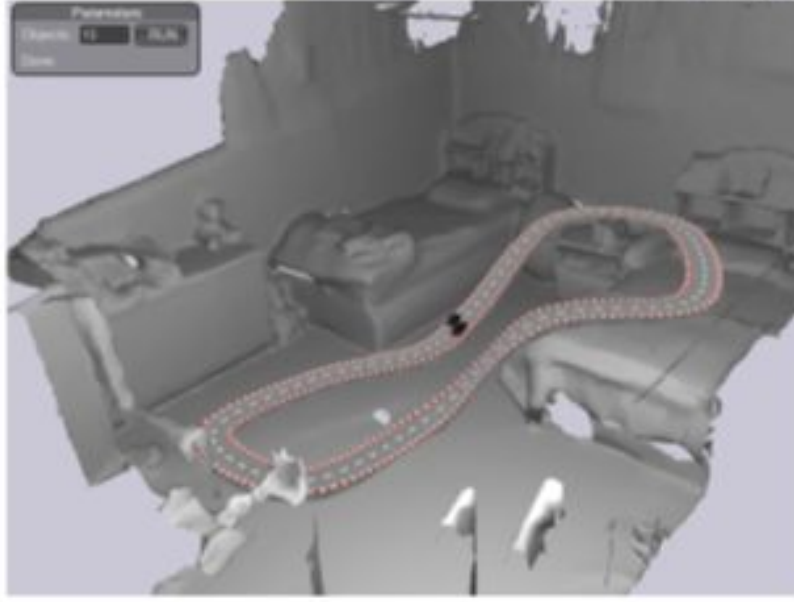
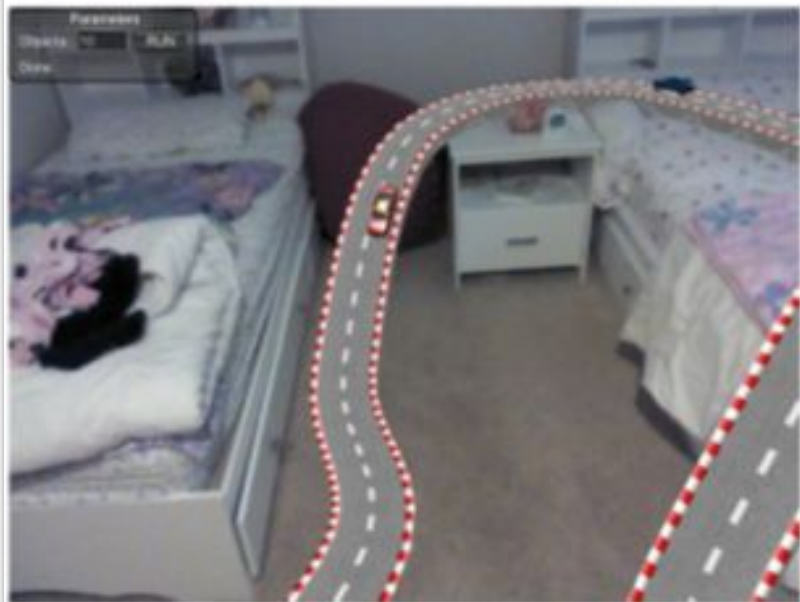
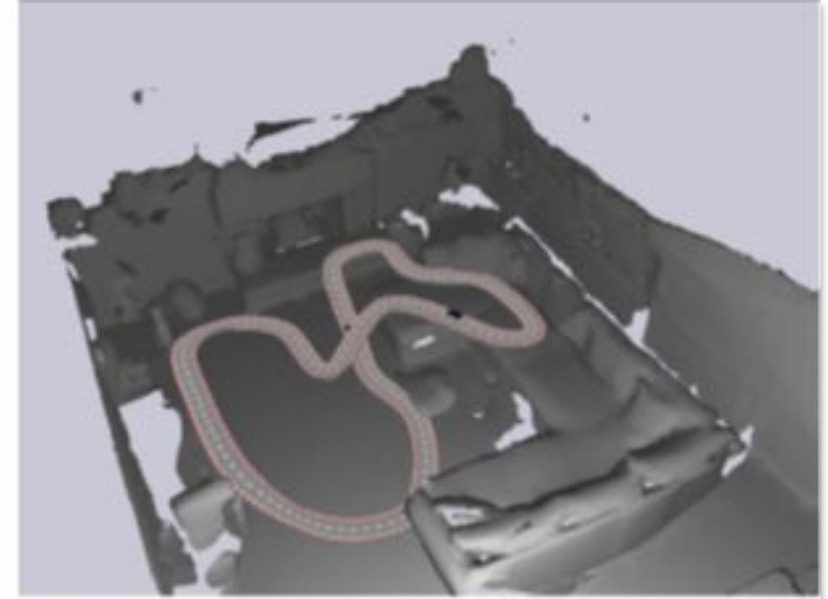
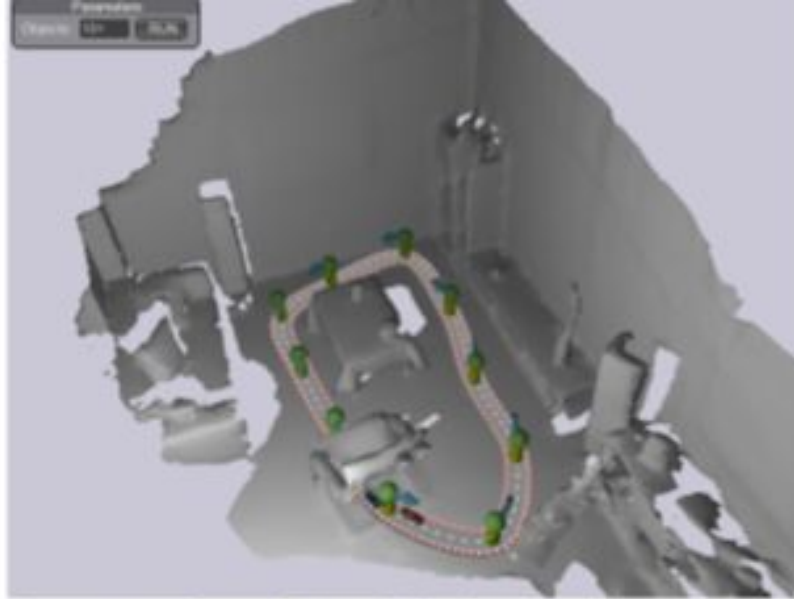
Ran Gal
Microsoft Research

A large, dark blue arrow pointing upwards, centered on the slide. It has a slight gradient and is positioned behind the bottom text.

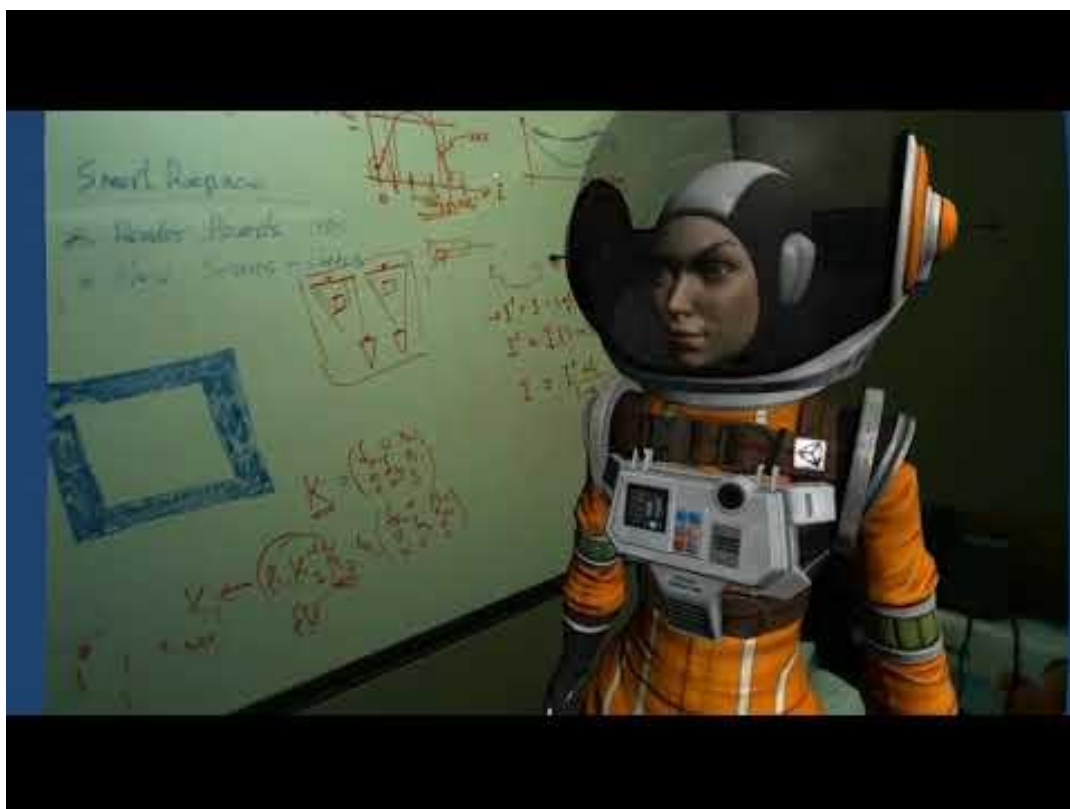
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FLARE



More Examples



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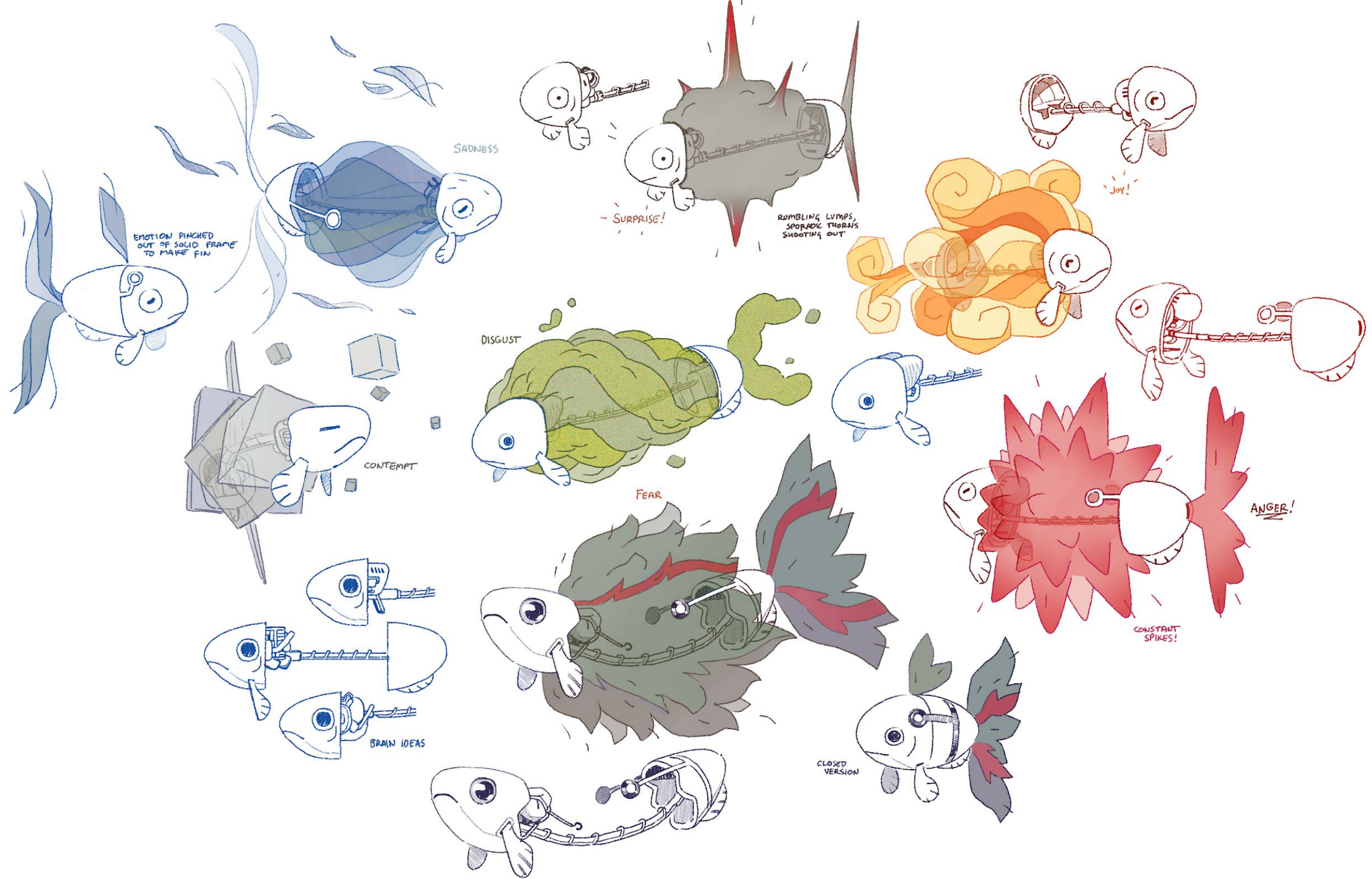
VRDC

Samantha Gorman Tender Claws

A large, dark blue, stylized letter 'A' is centered on the slide. It has a thick, blocky appearance with a slight gradient from top to bottom, being darker at the top. It is positioned between the speaker's name and the conference information.

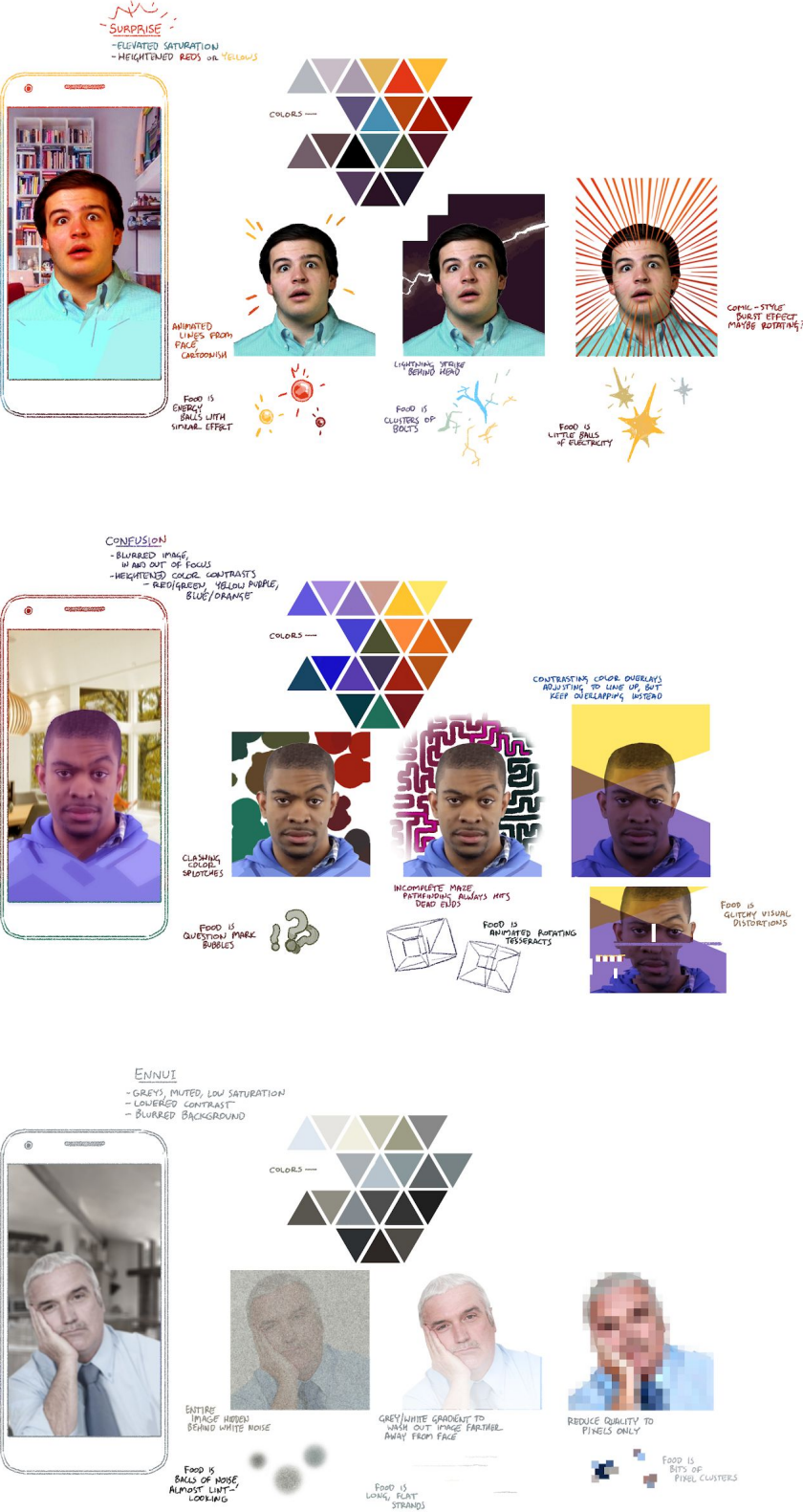
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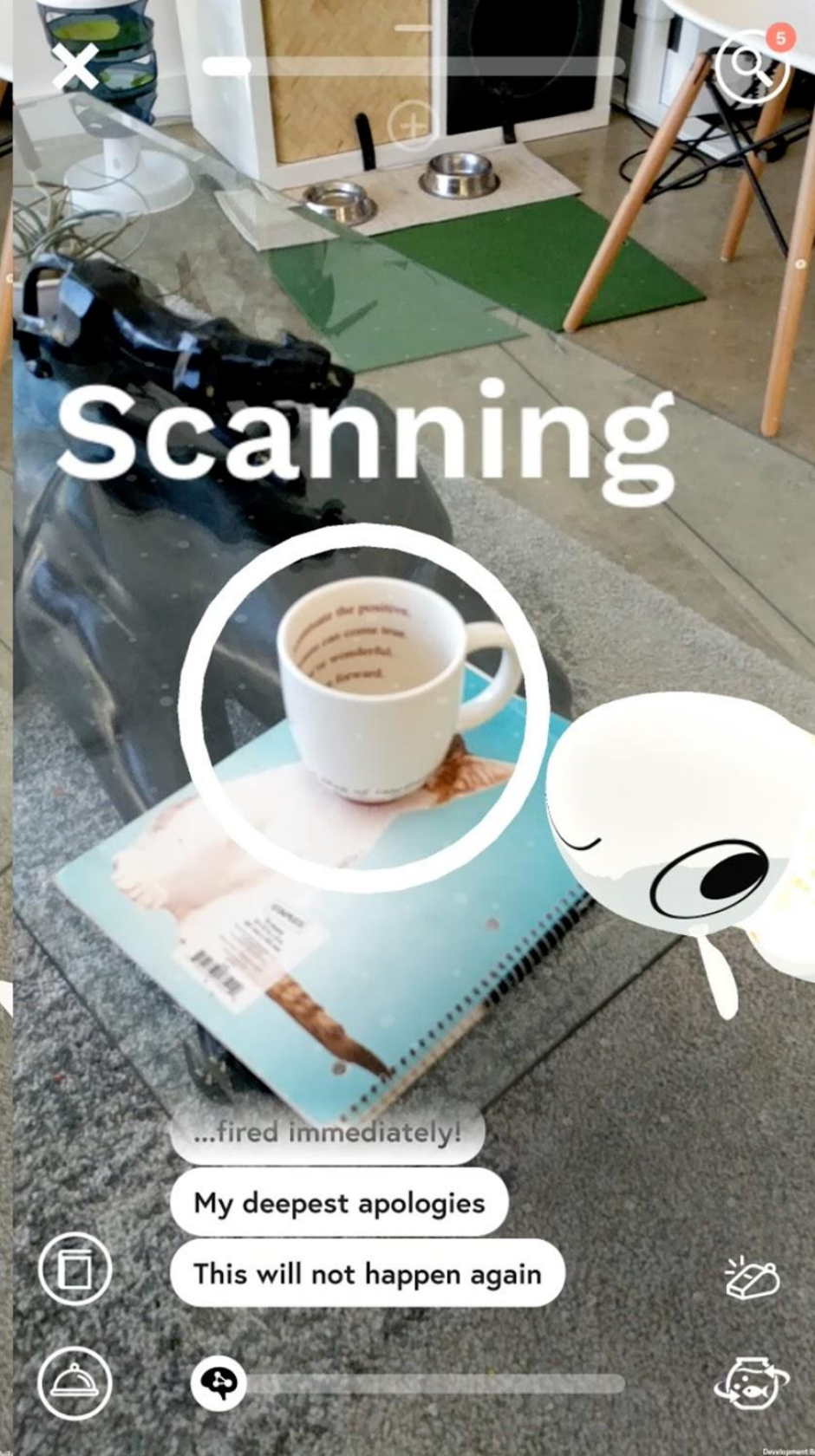
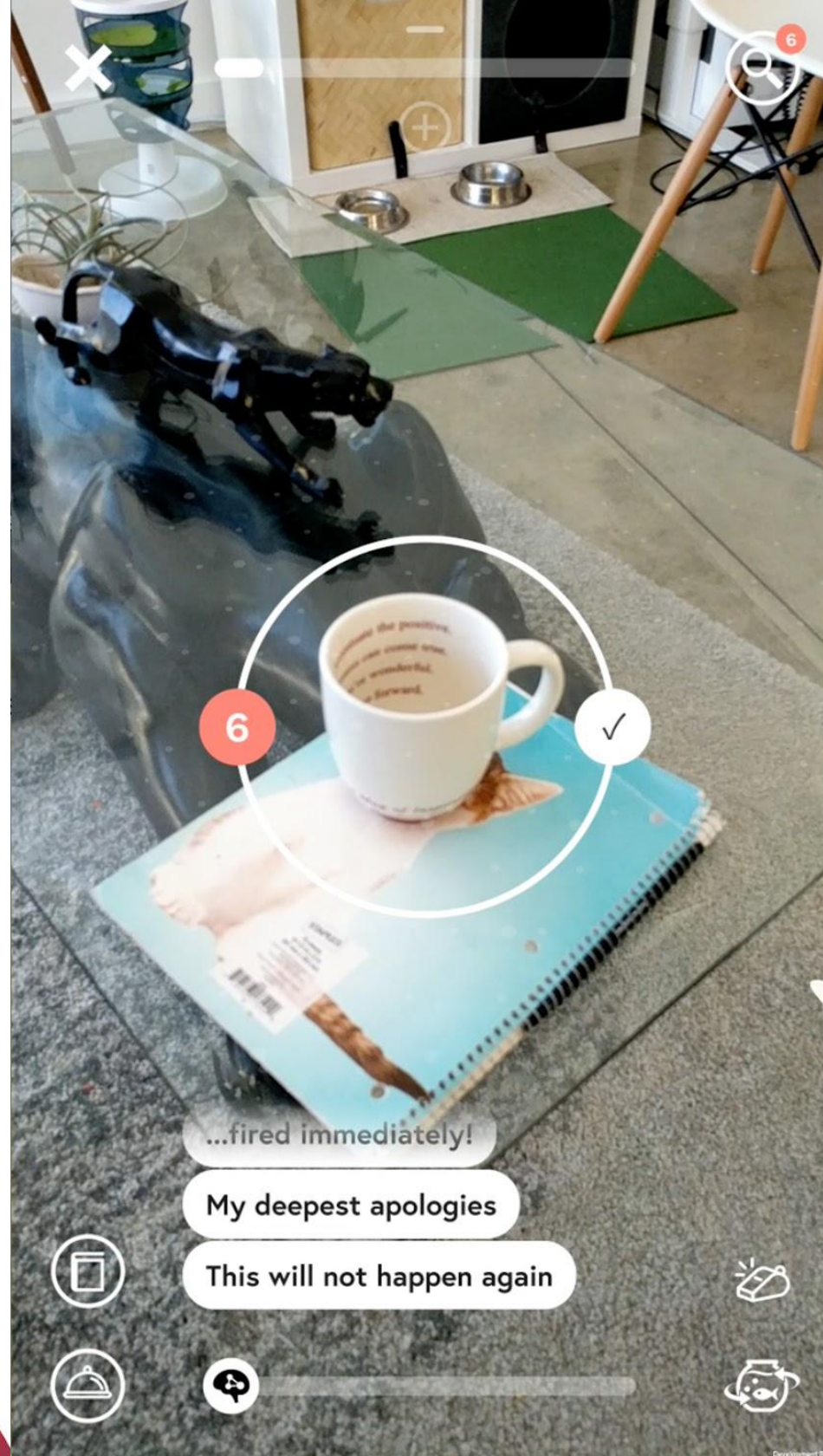






World Context Independent





OBJECT LEARNED

Cup

ADD TO INVENTORY

Meaningful Social Play



The VRDC logo features the letters "VRDC" in a bold, white, sans-serif font. The letters are set against a dark blue background that is shaped like a diamond or a stylized 'V'. The overall design is clean and modern.

VRDC

Brian Schwab
Magic Leap - Interaction Lab

A large, dark blue, stylized letter 'A' logo is centered on the slide. It has a thick, blocky appearance with a slight shadow effect.

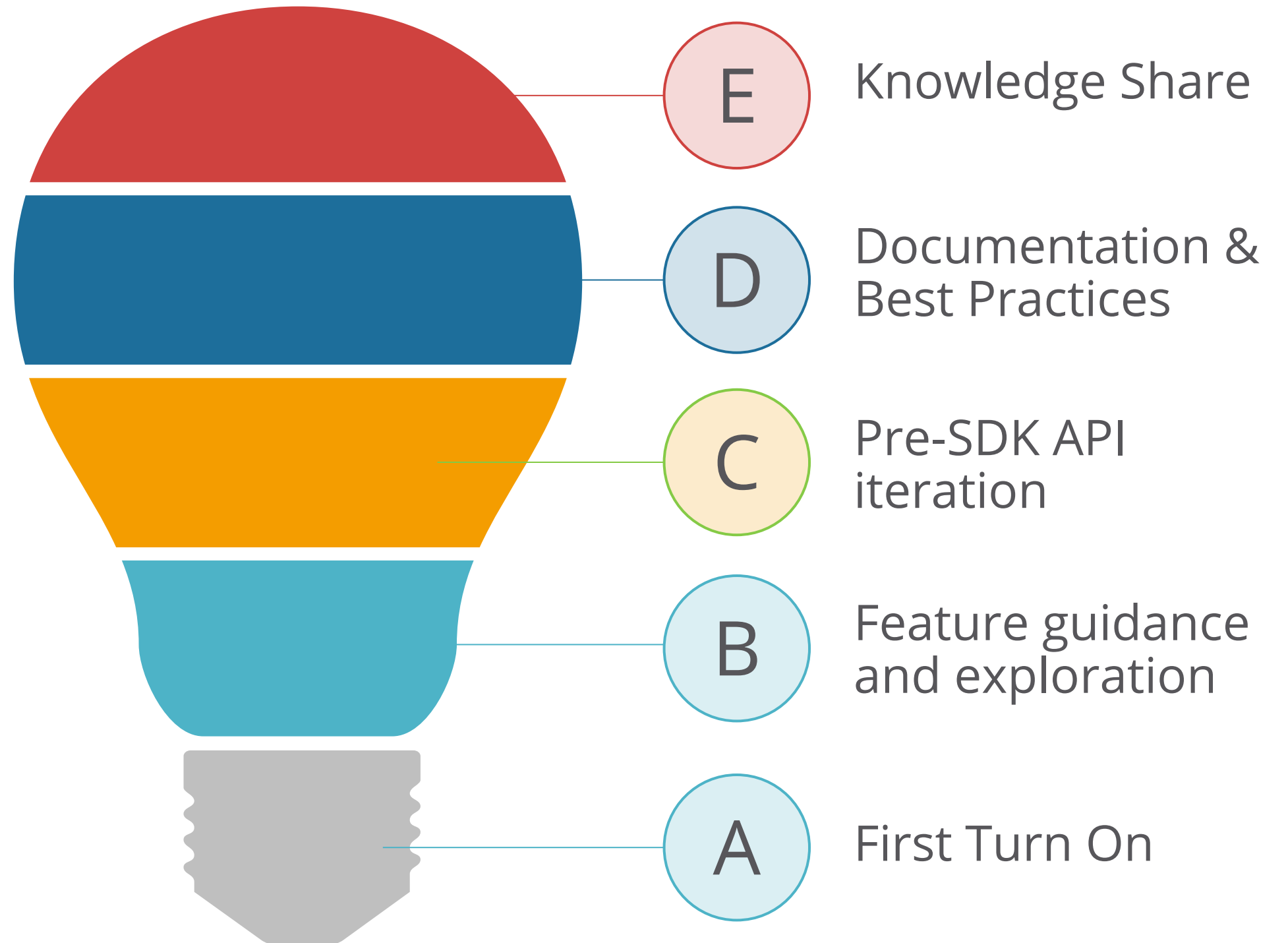
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What is the Lab?

Small team,
mostly engineers,
rapid prototypers.

Sit between
hardware/perception
and the SDK group.



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VRDC

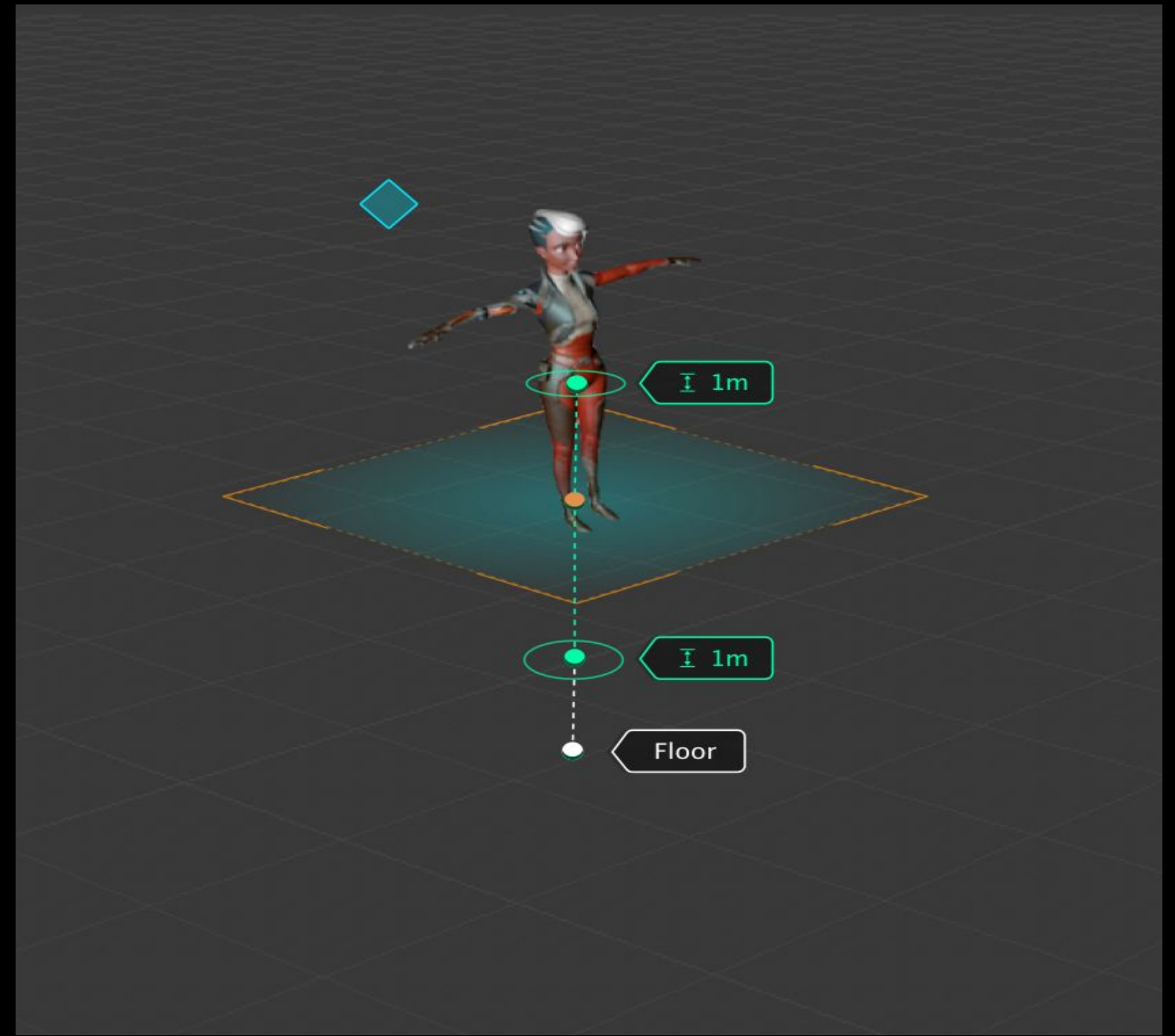
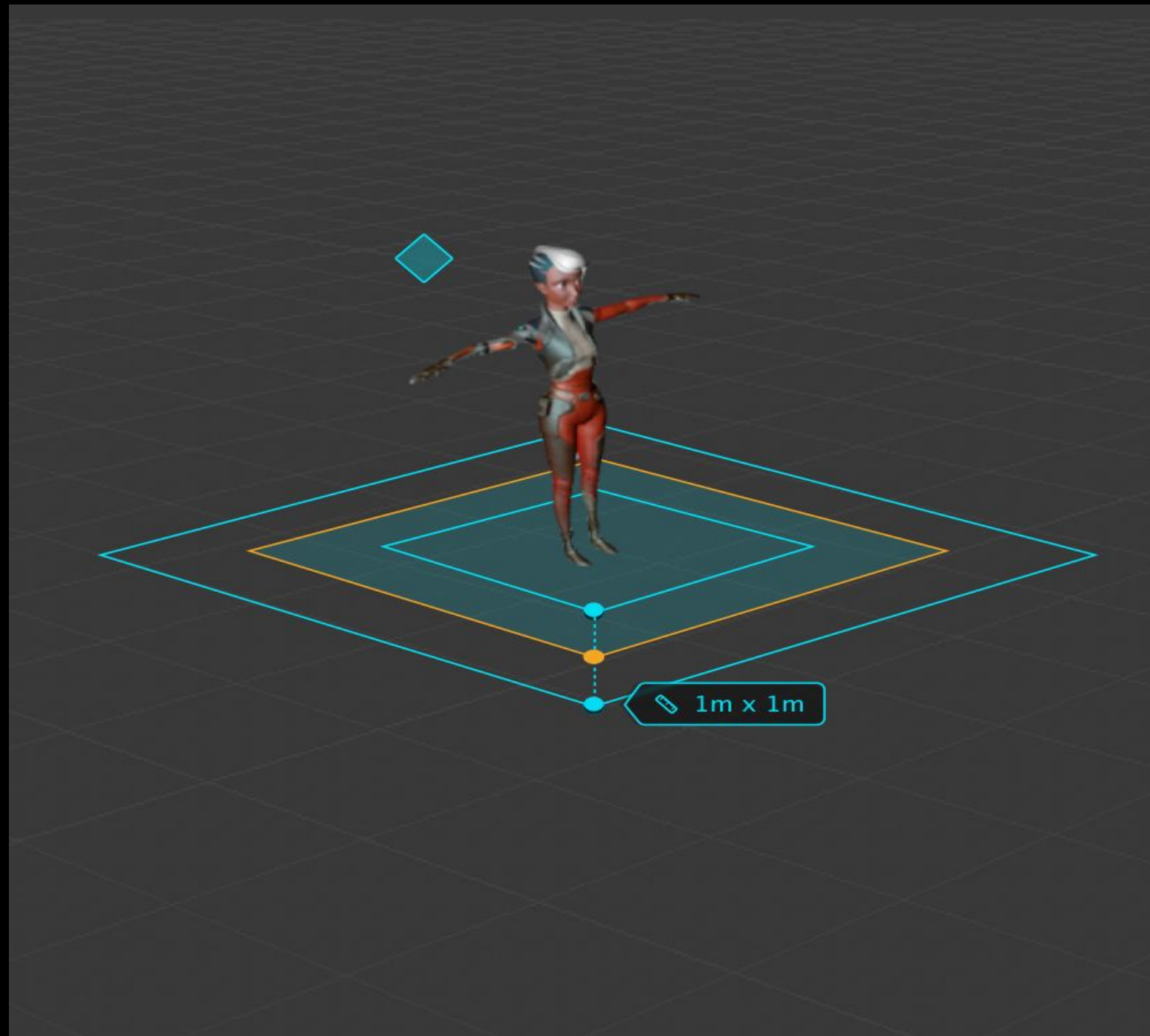
Jono Forbes Unity Labs - MARS

The Unity logo is a large, dark blue, stylized 'U' shape that is centered on the slide. It has a slight gradient and is positioned above the conference information.

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9:41



1.5 x 3.2

Min

Max

W

1.5

H

3.2

Cancel

Done

The VRDC logo features the letters "VRDC" in a bold, white, sans-serif font. The letters are positioned within a dark blue, diamond-shaped graphic that is slightly offset to the left. The background is a solid red color with a subtle pattern of thin, white diagonal lines forming a grid of squares. There are also small, white diamond shapes scattered across the background.

VRDC

Challenges of AR

A large, dark blue arrow pointing upwards, centered on the page. It has a slight gradient and is positioned below the main title.

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The VRDC logo features the letters "VRDC" in a bold, white, sans-serif font. The letters are set against a dark blue, diamond-shaped background that is slightly offset from the center. The overall background of the slide is a vibrant red-orange color, decorated with thin, dark lines forming a grid pattern and small, stylized diamond shapes in the corners.

VRDC

The Unknown Real World

A large, dark blue, stylized letter 'A' is positioned in the lower center of the slide. It has a modern, geometric design with a slight shadow effect.

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VRDC

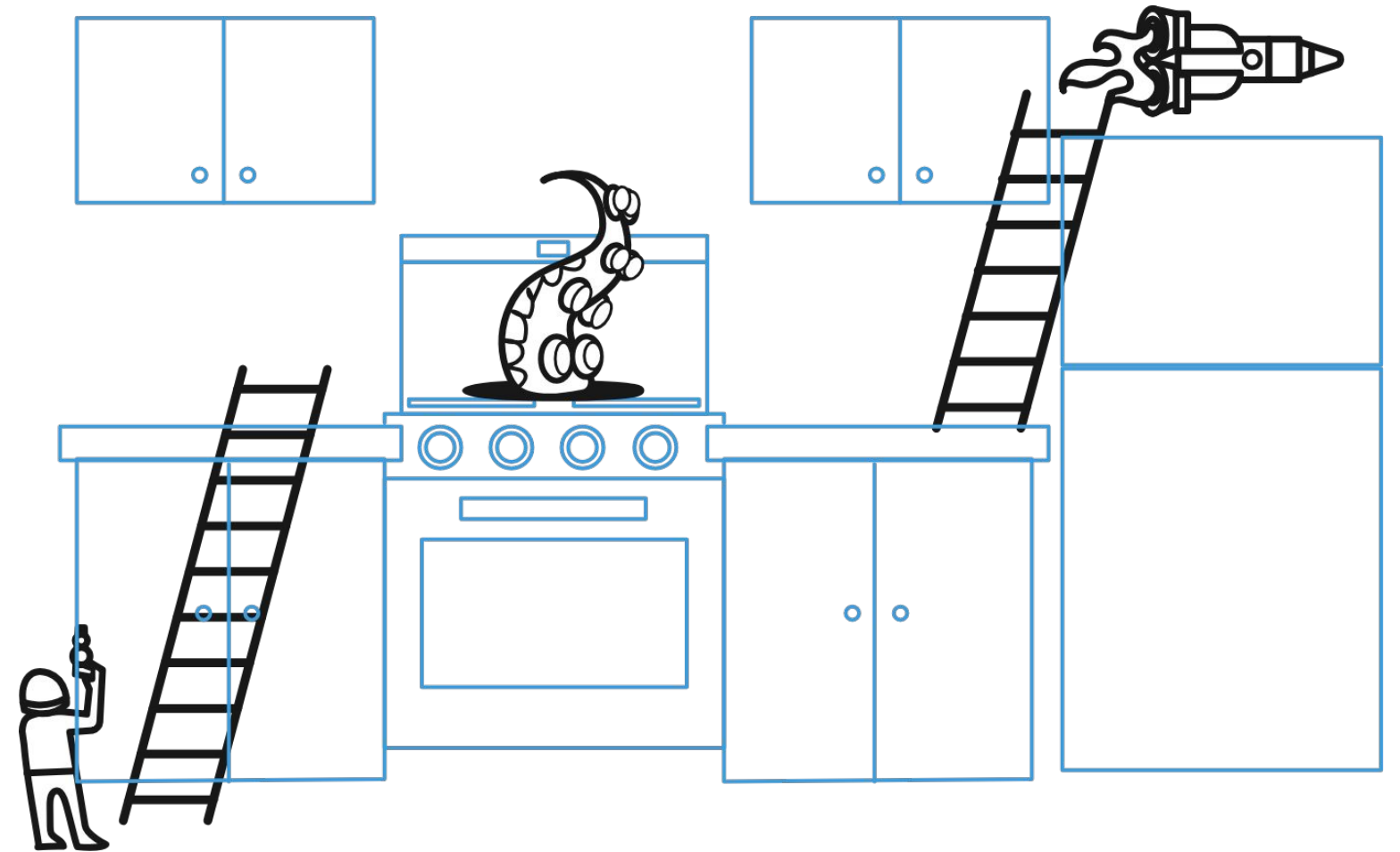
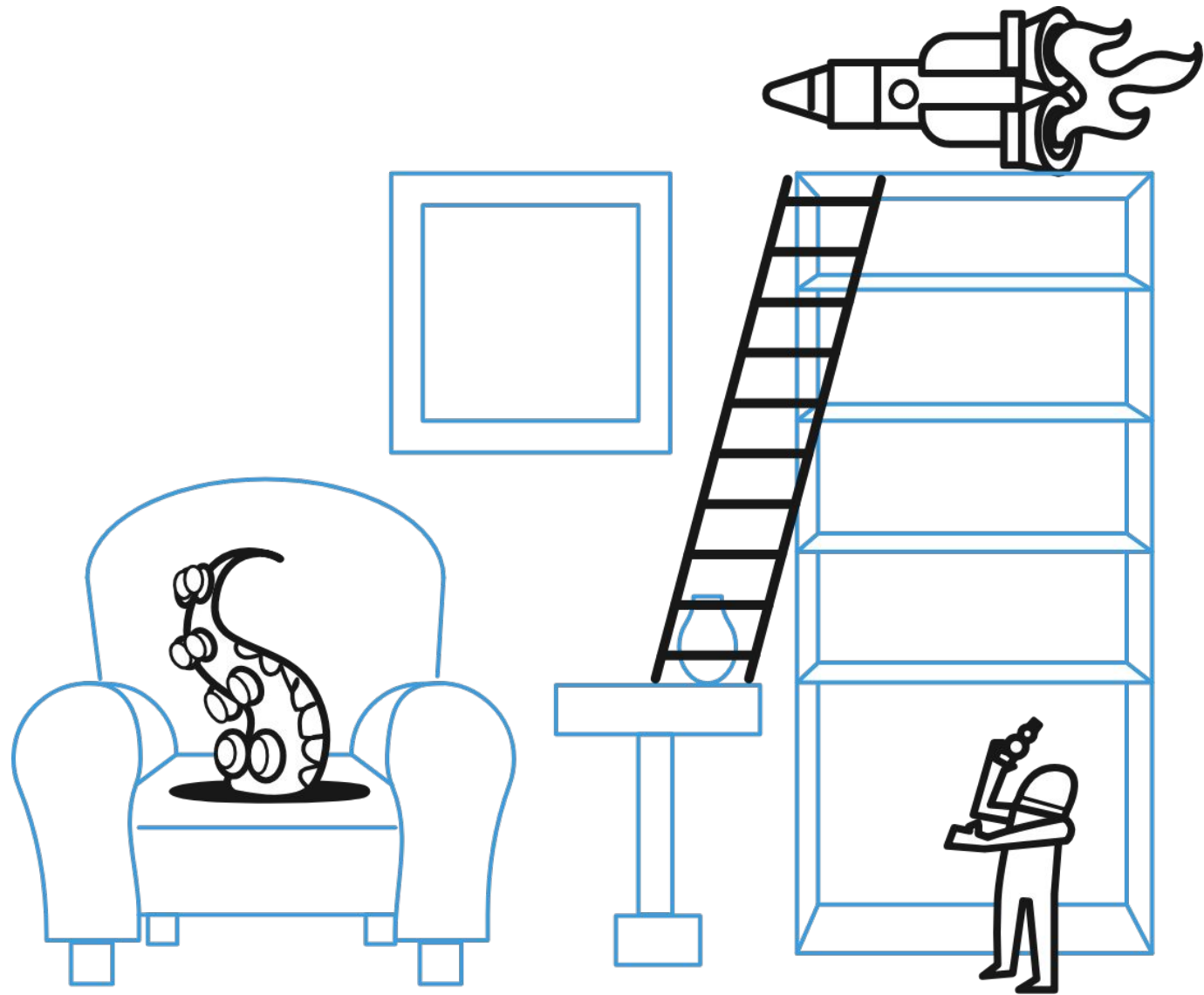
Rules, Constraints, Conditions, Fallbacks

A large, dark blue, stylized letter 'A' is centered on the slide. It has a thick, blocky appearance with a slight shadow or gradient effect, giving it a three-dimensional feel.

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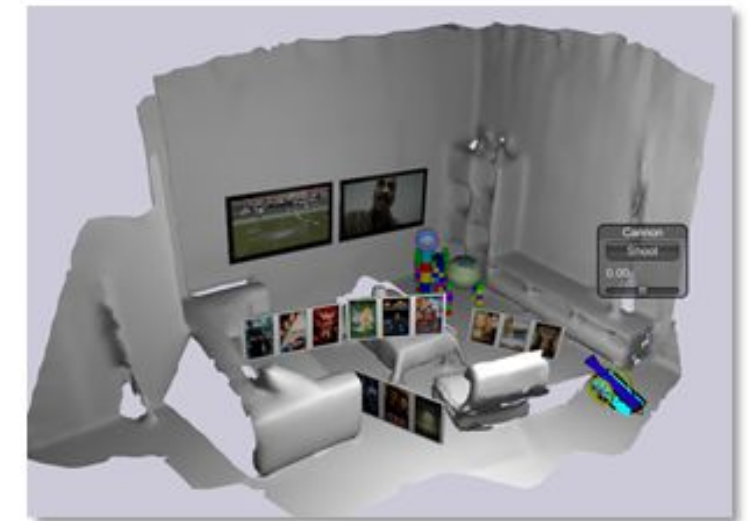
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Responsive Design



Reality is Complex

- Challenges
 - Layout consistency
 - With Other Virtual Content
 - With the Physical Environment
 - Handling Several Application in the same space
 - Handling Several Users in the same space



FLARE

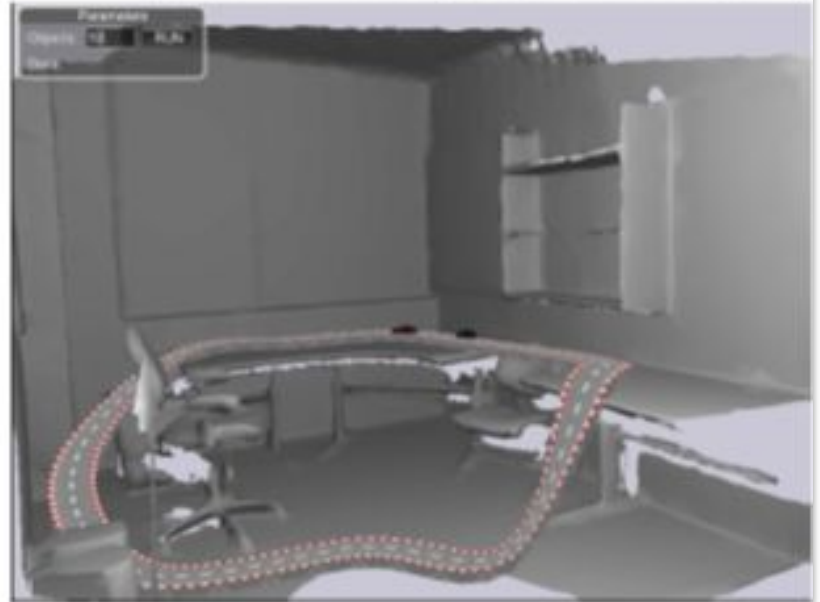
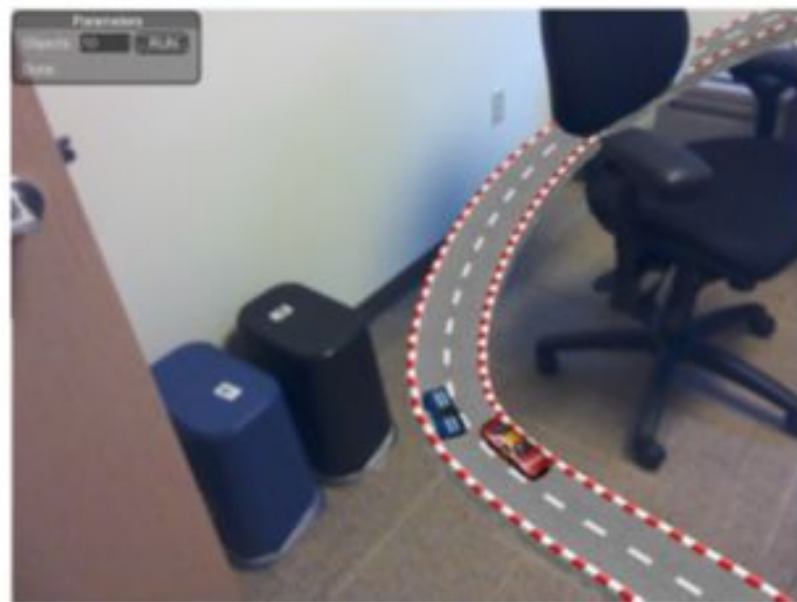
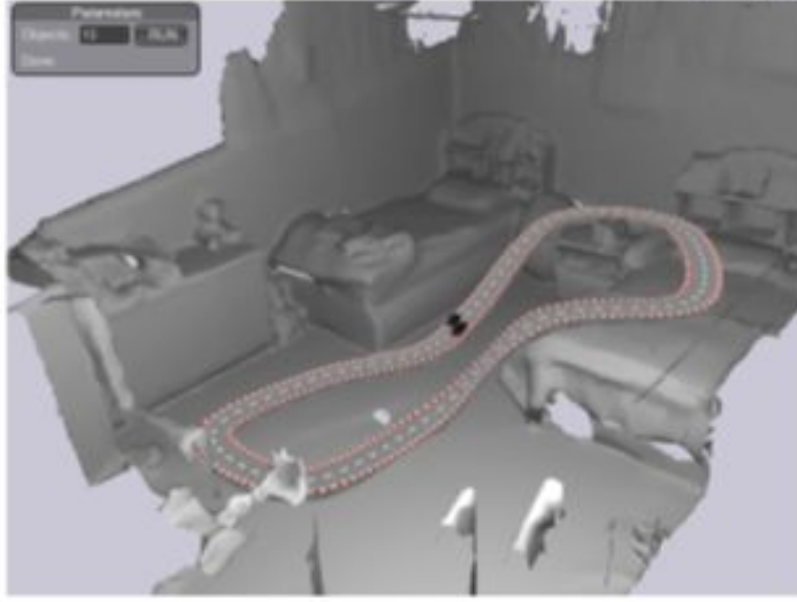
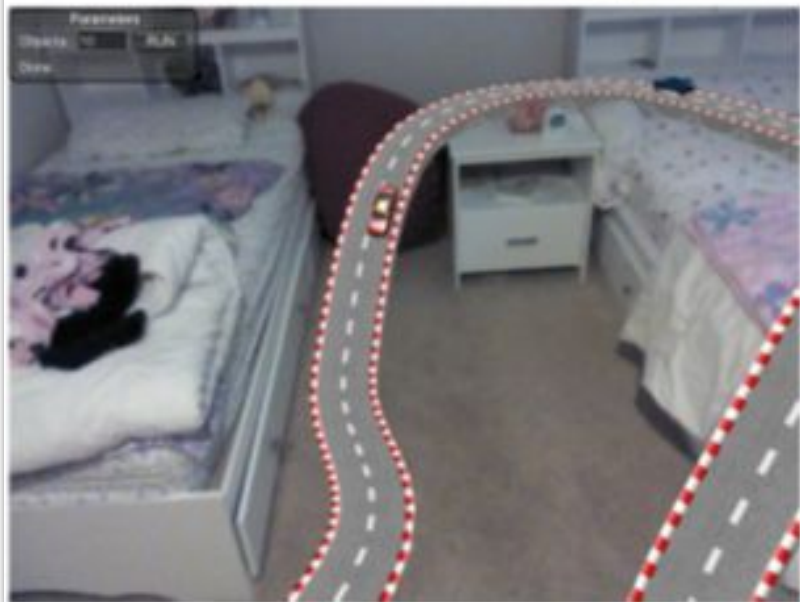
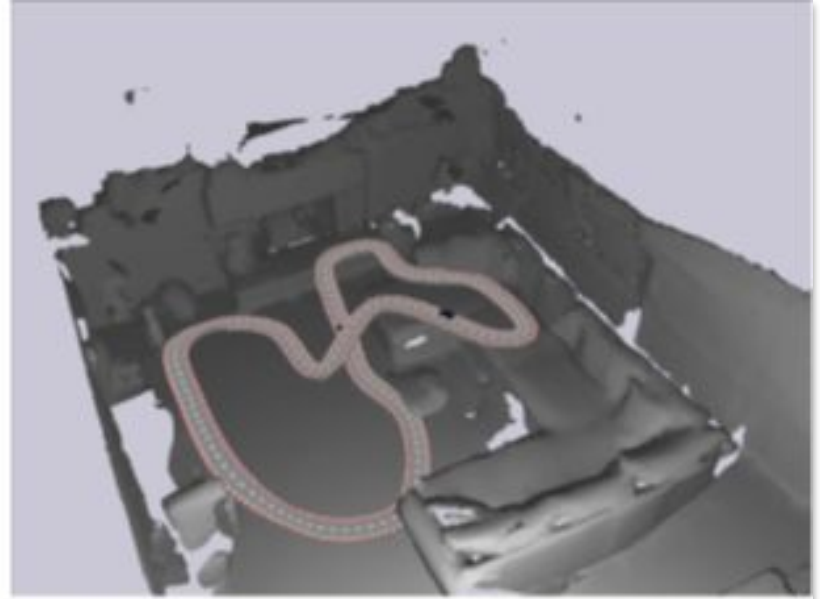
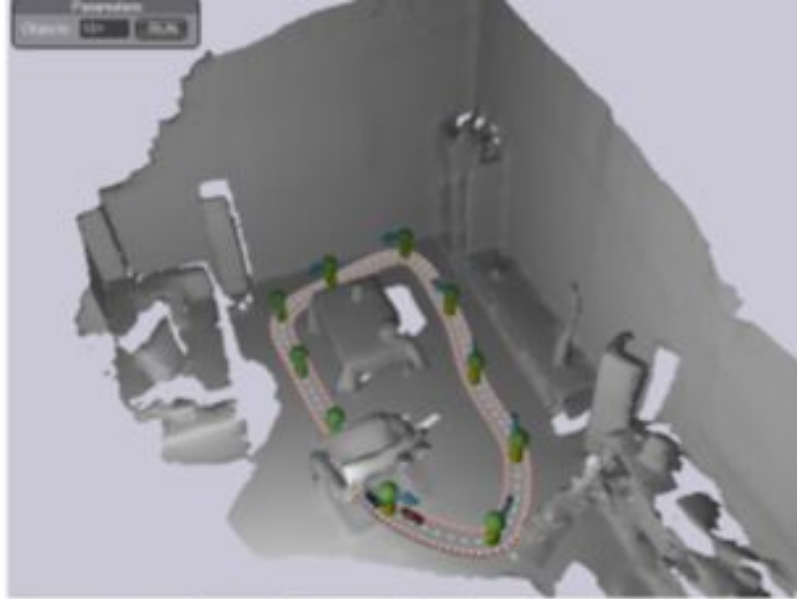
- **Use Declarative Rules**
 - Constraining Elements Properties using Cost Functions
- **Solve as a constraint satisfaction problem**
 - Solution's quality depends on allocated cycles



Race Track



Race Track



Graceful Adaptation



MARS

- Real World Objects
- Conditions
- Rules
- Fallbacks



The “generic” AR rules pipeline

- Sensing - depth, RGB, IR, motion, acceleration, audio, lighting, etc.
- Analysis
 - Room structure, Hole filling, Detection and Classification.
 - More semantic information leads to more intelligent layouts.
- Layout the experience in the current environment
- Apply the Experience’s logic
- Continue sensing and responding to environmental events
 - Allowing for Graceful Adaptation

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VRDC

Machine Learning

The GDC logo is a large, stylized letter 'A' composed of two overlapping triangles. The left triangle is dark blue and the right triangle is a lighter blue. The 'A' is centered in the lower half of the slide.

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VRDC

User Input & Intent

A large, dark blue arrow points upwards from the bottom of the slide towards the center. It has a slight gradient and is positioned centrally.

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VRDC

Going Procedural

A large, dark blue, stylized letter 'A' is centered on the slide. It has a thick, blocky appearance with a slight gradient, giving it a three-dimensional feel. It is positioned in the lower half of the slide, above the footer text.

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VRDC

Tools & Workflows

A large, dark blue arrow pointing upwards, centered on the page. The arrow has a slight gradient and is composed of two main triangular sections meeting at a point at the top.

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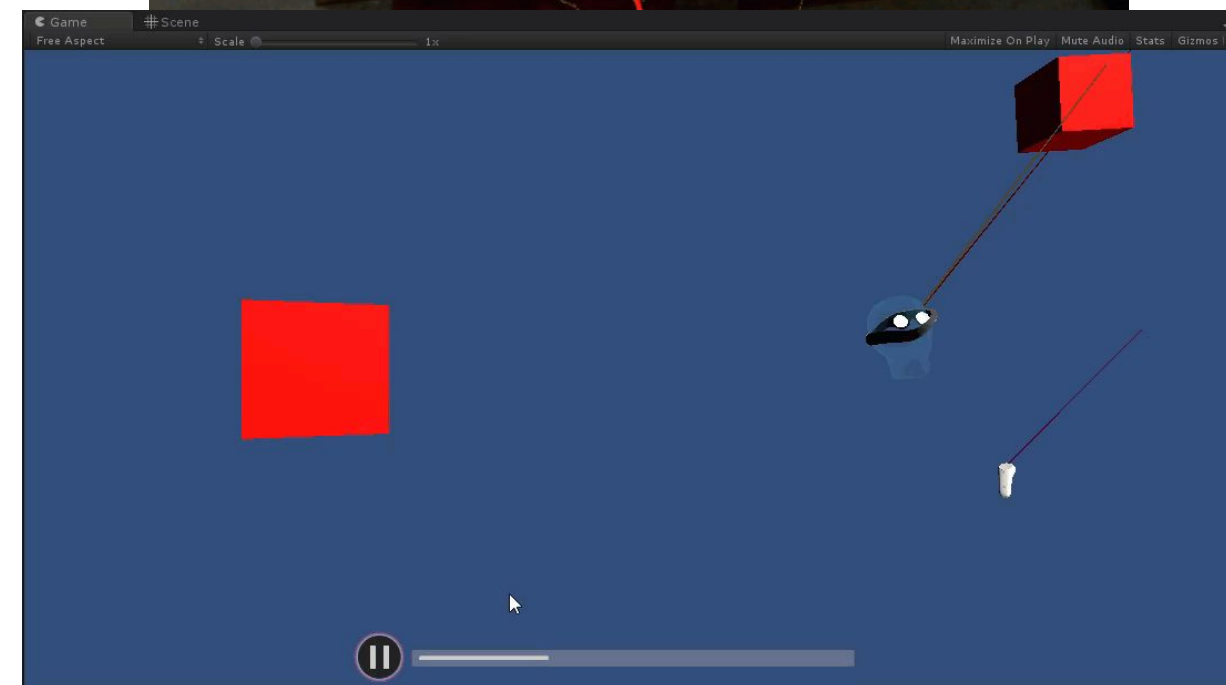
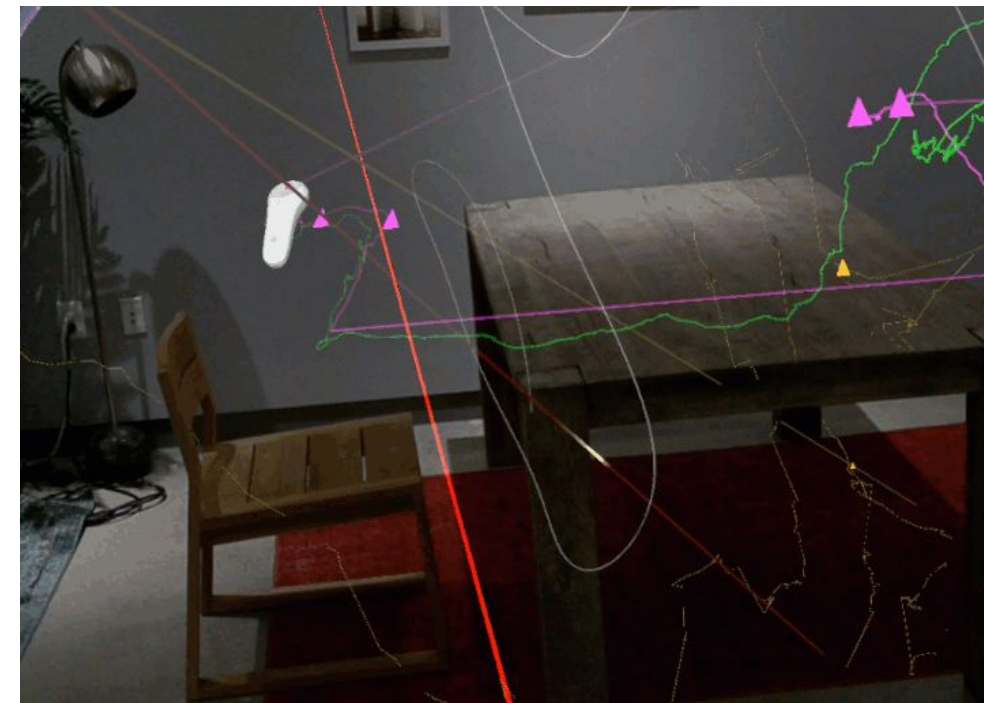
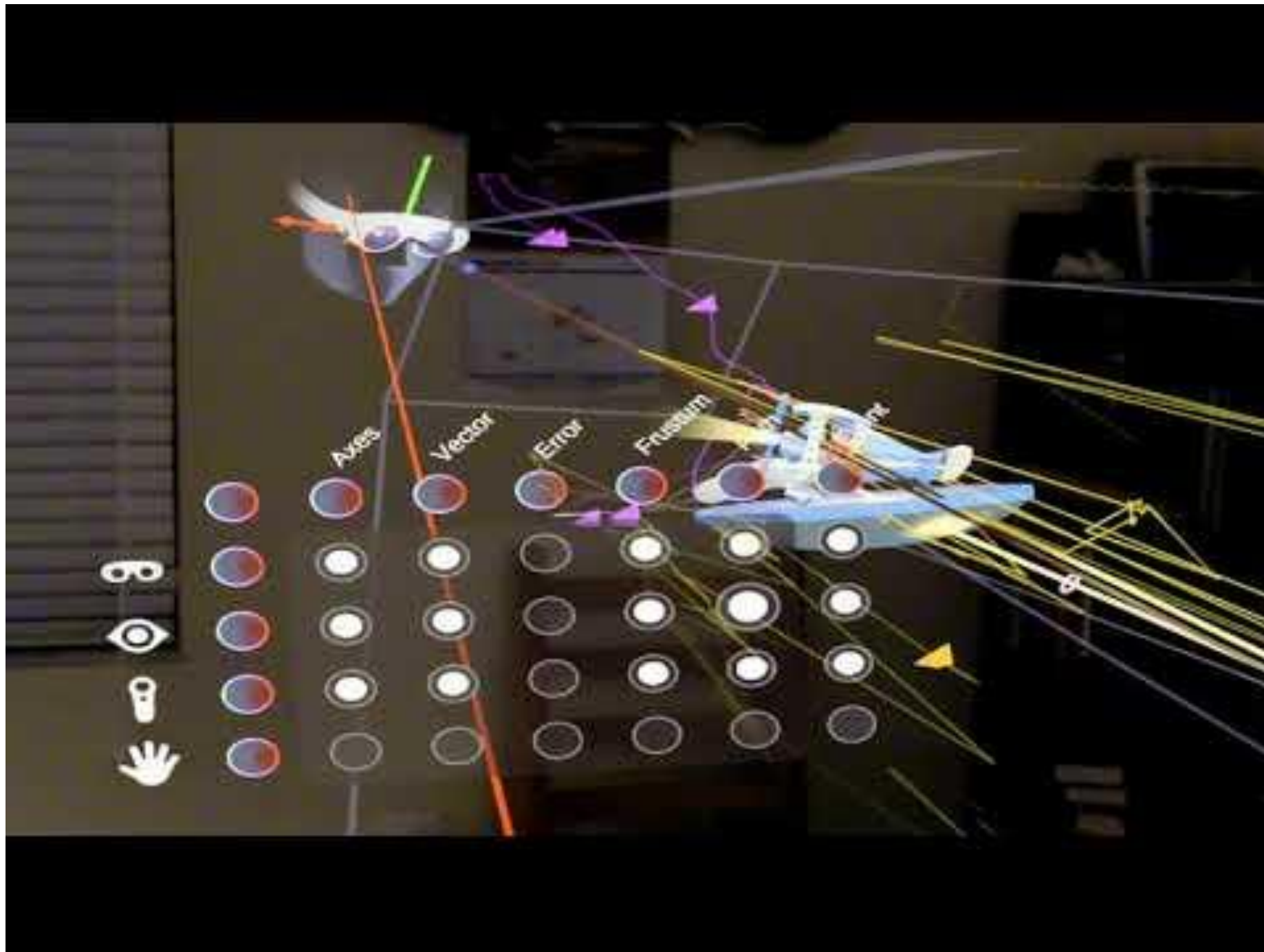
Simulation



In Editor Debugging



In Experience Debugging



The VRDC logo features the letters "VRDC" in a bold, white, sans-serif font. The letters are set against a dark blue background that is shaped like a downward-pointing triangle. This triangle is positioned within a larger red field that is bisected by two thin, dark blue diagonal lines forming an 'X' shape. In the top-left corner of the red field, there is a small cluster of three white squares of varying sizes. In the top-right corner, there is a small white diamond shape.

XR Ecosystem

A large, dark blue chevron pointing upwards is centered in the lower half of the image. It is composed of two large triangles meeting at their bases. The chevron is set against the same red background with diagonal lines as the rest of the slide.

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Many Moving Targets

A Name	Surfaces	Hit Tests	Meshi...	Markers	Relocaliz...	Camera Pose	Faces	Controller Tr...	3D Markers	Object Reco...	Light Estima...	Eye Tracking	Body Tracking	Hand Tracki...	Hand Pose	Object Seg...
ARKit	Yes	Yes		Yes	Yes	Yes	Yes		Yes	Partial	Yes					
ARCore	Yes	Yes		Partial	Yes	Yes	Yes				Partial					
Tango (defunct)			Yes		Yes	Yes					Yes					
Hololens		Yes	Yes		Yes	Yes								Yes	Yes	
Magic Leap	Yes	Yes	Yes	Yes	Yes	Yes		Yes				Yes		Yes	Yes	
6d.ai			Yes		Yes											
HTC Vive Pro	Yes	Yes	Yes		Yes	Yes		Yes								
Windows MR						Yes		Yes								
Mirage Solo						Yes		Yes								
HTC Vive						Yes		Yes								
Oculus Quest						Yes		Yes								
Oculus Rift						Yes		Yes								
Oculus Go								Yes								
Vuforia						Yes			Yes		Yes					
Placernote					Yes											
Selerio									Yes	Yes						Yes
ULsee							Yes									
Visage							Yes									
Google Mobile Vision							Partial			Yes						
Apple Vision							Partial			Yes						
Wrnch.ai													Yes	Yes		
Leap Motion														Yes	Yes	
OpenCV	Partial		Yes	Yes		Partial							Yes	Yes		
dlib			Yes													Yes
Resonai			Yes							Yes						

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VRDC

Other Applications

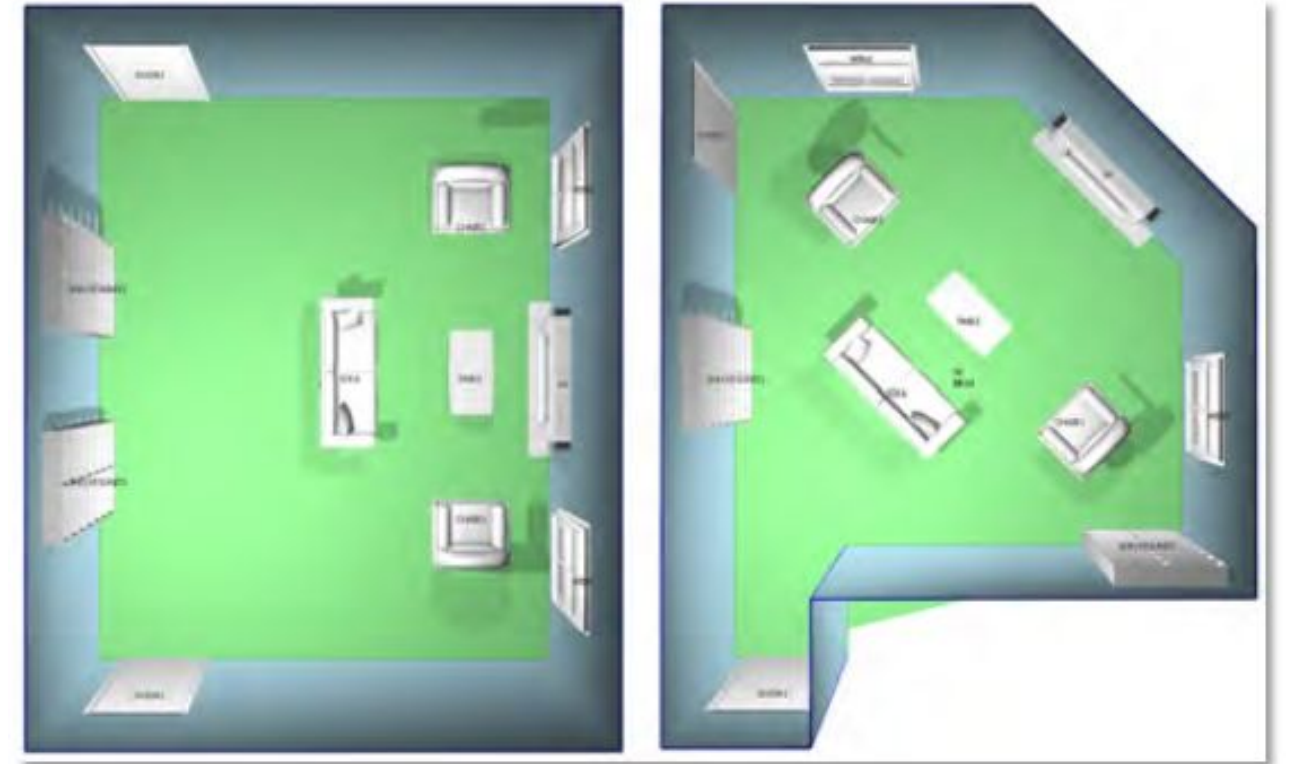
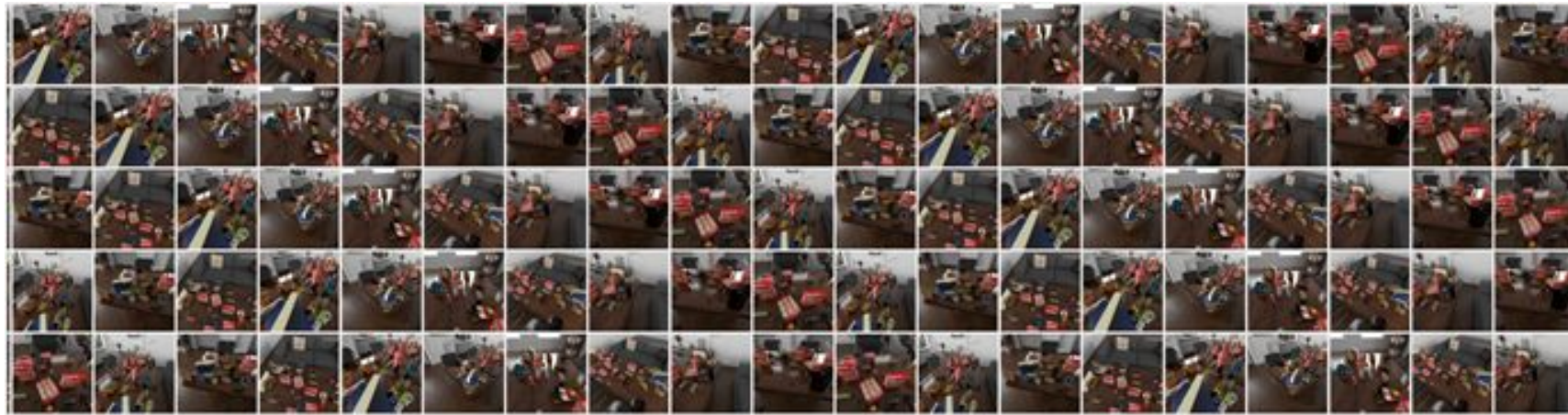
A large, stylized logo consisting of a dark blue upward-pointing triangle with a white 'V' shape cut out of its center. This logo is positioned at the bottom center of the slide, above the conference text.

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Other Applications



Other Applications



Other Applications



Much more to uncover

- Layers of apps, content, styles
- Permissions
- Privacy & Ethics
- ...

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VRDC

Thank You!

Time for Questions?

A large, dark blue chevron pointing upwards, centered on the slide, serving as a background for the footer text.

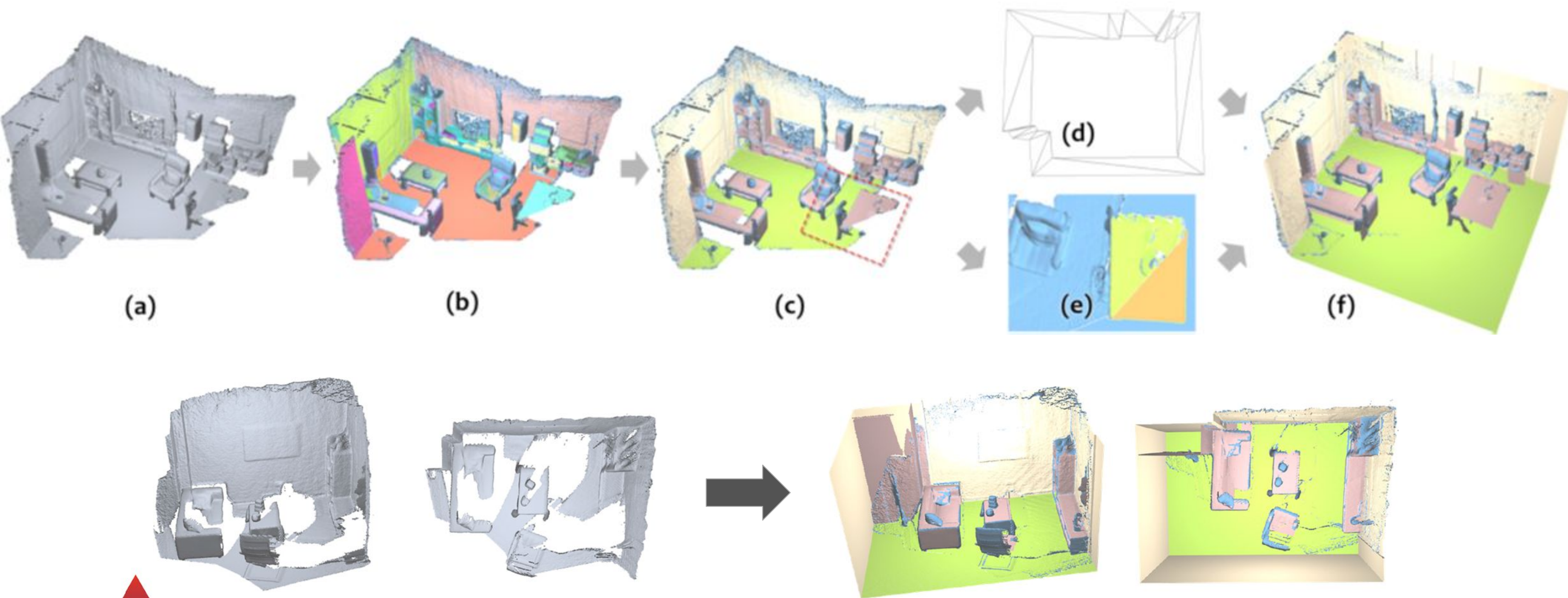
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Additional Slides



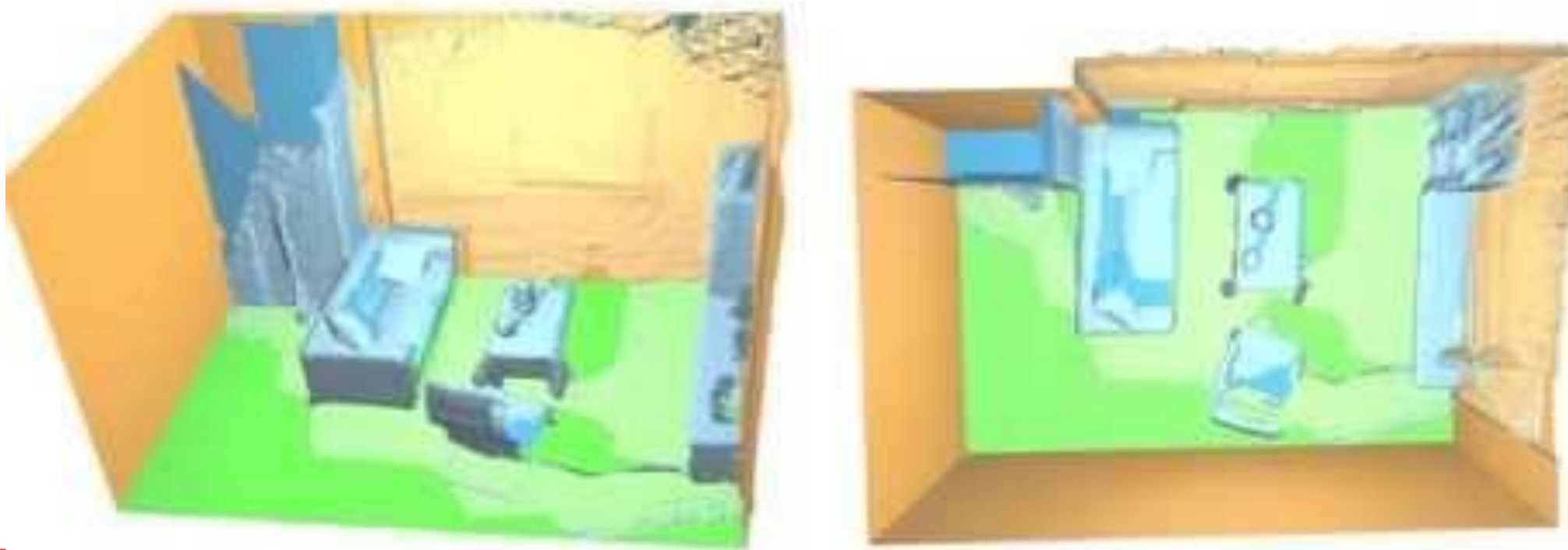
Contour and Surface Completion



Contour and Surface Completion

Example 1: Living Room

Room after completion



Layout Design for AR Applications

- A designer specifies the layout of the application

- Elements

- 3D Object -
 - Type, Orientation, Scale.
 - Frustum
 - Orientation, Field of view, Clipping Planes.

- Rules

- Algebraic notation
 - A library of predefined routines
 - Comparison and Boolean operators.
 - $\text{cost}(\text{OR}(a, b)) = \min(\text{cost}(a), \text{cost}(b))$,
 - $\text{cost}(\text{AND}(a, b)) = \text{cost}(a) + \text{cost}(b)$.

Predefined Routines:

- Distance / Angles
- BB / Geometry Intersection
- Line of Sight
- Inside/Outside Frustum
- Material Properties (Color, Texture)
- Relative Positioning

$$\text{cost}(a < b) = \begin{cases} 0 & a < b \\ (a - b)^2 & a \geq b \end{cases}$$

$$\text{cost}(s) := \sum_i w_i \cdot r_i(\hat{s}_i)$$

```

// 'F' is the user's frustum.
Screen1:=Object3 ( [28 18 10], VERTICAL, OptPos );    // A screen on the wall

// 4 media objects.
O1:=Object3 ( [10 10 10], HORIZONTAL, OptPos );
O2:=Object3 ( [10 10 10], HORIZONTAL, OptPos );
O3:=Object3 ( [10 10 10], HORIZONTAL, OptPos );
O4:=Object3 ( [10 10 10], HORIZONTAL, OptPos );

Assert ( LocalZ ( FloorFrame.Frame, Screen1.Frame.Position ) < 50 );    // Prevent the hanged screen to
// be too high above the floor

// Bring Screen1 to the center of view (as much as possible)
Assert ( Dot ( Normalize(Screen1.Frame.Position-F.Frame.Position), F.Frame.Axis3) = 1 );

// Screen1 IS inside the frustum
Assert ( Inside ( F, Screen1.Frame.Position) );

// Screen1 is not occluded from the point of view of the user.
Assert ( Visible ( F.Frame.Position, Screen1.Frame.Position) = 0 );

// The 4 media objects are INSIDE the frustum.
Assert ( Inside ( F, O1.Frame.Position) );
Assert ( Inside ( F, O2.Frame.Position) );
Assert ( Inside ( F, O3.Frame.Position) );
Assert ( Inside ( F, O4.Frame.Position) );

// They are all visible to the user.
Assert ( Visible ( F.Frame.Position, O1.Frame.Position) = 0 );
Assert ( Visible ( F.Frame.Position, O2.Frame.Position) = 0 );
Assert ( Visible ( F.Frame.Position, O3.Frame.Position) = 0 );
Assert ( Visible ( F.Frame.Position, O4.Frame.Position) = 0 );

// Limits to the distance of media objects from the user.
Assert ( Distance (F.Frame.Position, O1.Frame.Position) > 50 &&
Distance (F.Frame.Position, O1.Frame.Position) < 450
);
// Make all the objects lie at the same distance from the user.
// (The user position is represented by the frustum 'F'.
Assert ( Distance ( F.Frame.Position, O1.Frame.Position) =
Distance ( F.Frame.Position, O2.Frame.Position)
);
Assert (
Distance (F.Frame.Position, O1.Frame.Position) =
Distance (F.Frame.Position, O3.Frame.Position)
);

```

