

Designing for Extended Reality

VR



Digital environments
that shut out the real world.

AR



Digital content on top
of your real world.

MR



Digital content interacts
with your real world.

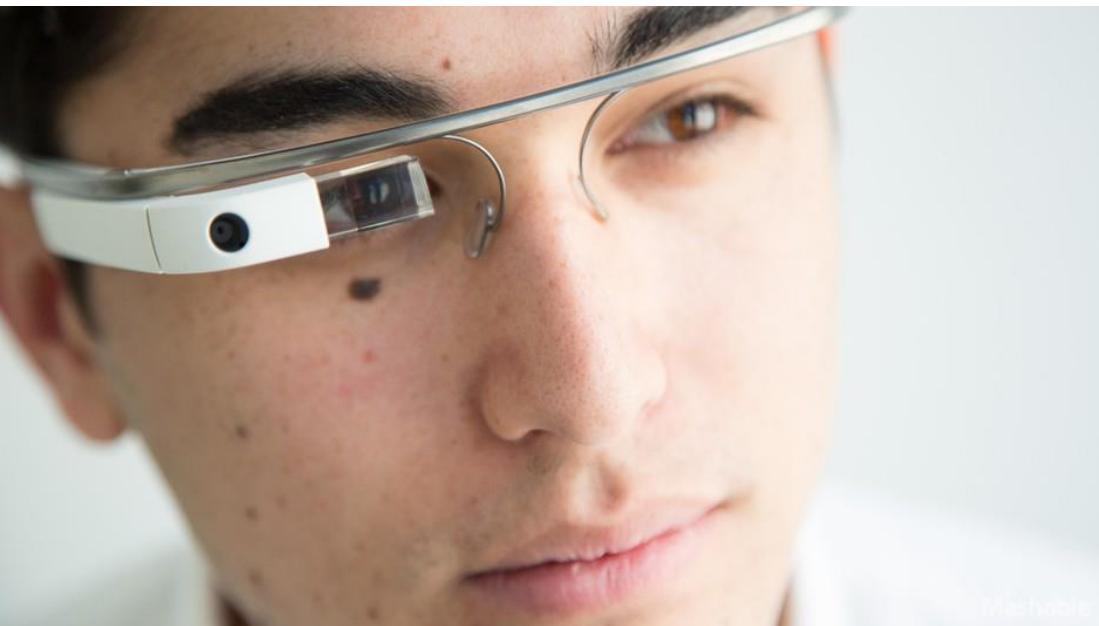
Extended Reality

*The terminologies surrounding this technology changes as the industry develops

VR



AR



MR

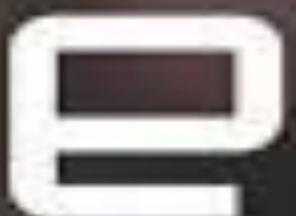


Immersive Technologies



A close-up photograph of a man with a beard and mustache wearing the Microsoft HoloLens 2 augmented reality headset. The headset has two cameras on top and a strap across the bridge of his nose. He is looking slightly to the right of the camera.

HOLO LENS 2

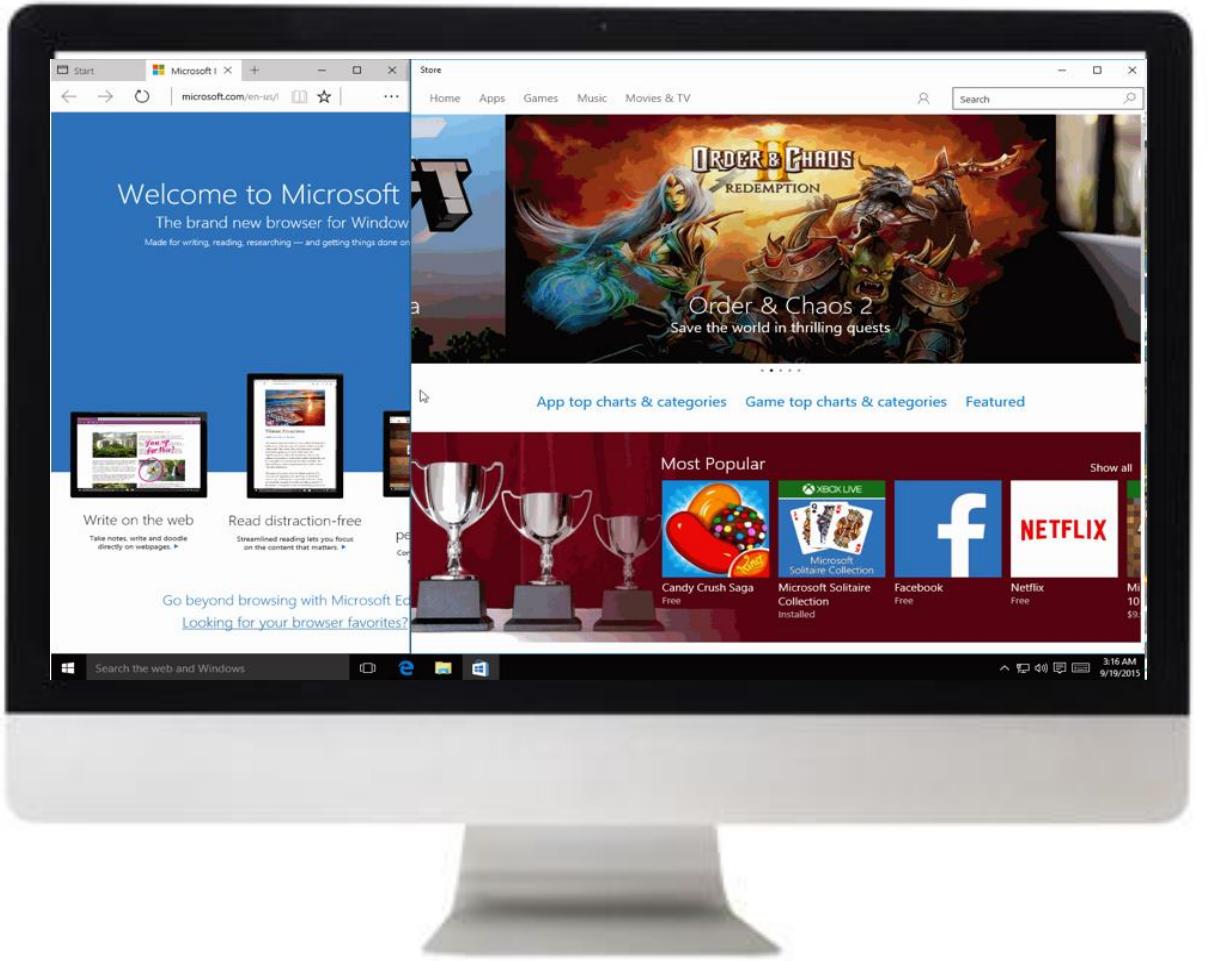


Motivation



Traditional displays have a limited amount of pixel on a 2D screen.

Motivation

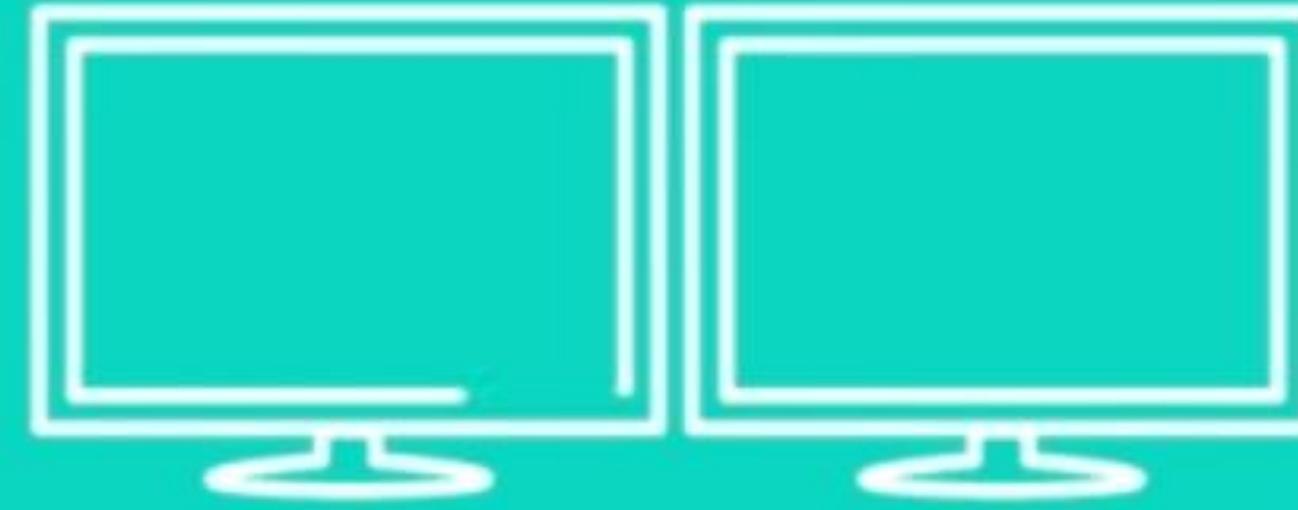


VS

With immersive technologies, we technically have "unlimited" pixels. More specifically applications can utilize a 360 degree view and z depth to place content



Motivation



**VR Interface Design Pre-
Visualisation Methods - Mike Alger**

<https://www.youtube.com/watch?v=id86HeV-Vb8>

How are we going to take the **design lessons** learned and taught over the past 50 years and **extend them** into this next wave of **immersive technology** that is on the cusp of becoming truly accessible?

- Nick Dauchot (The User Experience of Virtual Reality) 
<https://medium.com/uxxr/the-user-experience-of-virtual-reality-c464762deb8e>



Exploratory Stage

to collect bibliography related with the main topics of the research: specific applications, their characteristics, general and/or related (if there are some) usability heuristics.



Descriptive Stage

to highlight the most important characteristics of the previously collected information, in order to formalize the main concepts associated with the research.



Correlation Stage

to identify the characteristics that the usability heuristics for specific applications should have, based on traditional heuristics and case studies analysis.



Explicative Stage

to formally specify the set of the proposed heuristics, using a standard template.



Validation Stage

to check new heuristics against traditional heuristics by experiments, through heuristic evaluations performed on selected case studies, complemented by user tests.



Refinement Stage

based on the feedback from the validation stage.



Exploratory Stage

to collect bibliography related with the main topics of the research: specific applications, their characteristics, general and/or related (if there are some) usability heuristics.



Descriptive Stage

to highlight the most important characteristics of the previously collected information, in order to formalize the main concepts associated with the research.



Correlation Stage

to identify the characteristics that the usability heuristics for specific applications should have, based on traditional heuristics and case studies analysis.



Explicative Stage

to formally specify the set of the proposed heuristics, using a standard template.



Validation Stage

to check new heuristics against traditional heuristics by experiments, through heuristic evaluations performed on selected case studies, complemented by user tests.



Refinement Stage

based on the feedback from the validation stage.

Search for Related Works

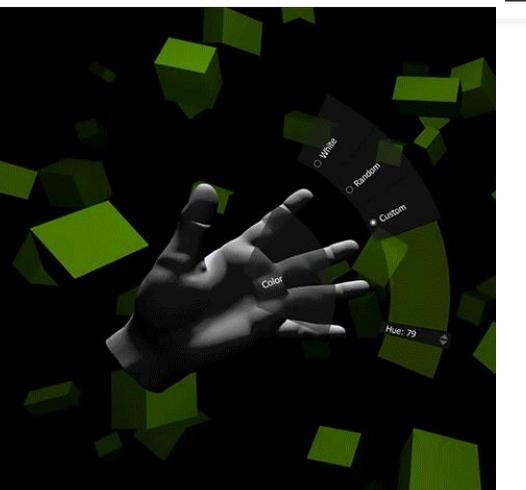


LEAP MOTION

Technology Developers Careers Blog Gallery About Store

FILTERS: ART & DESIGN EDUCATION EXPLORATIONS GAMING HARDWARE MEDICAL MUSIC ORION UNITY UNREAL

UX DESIGN VR/AR M UX XR



LM ALEX COLGAN / APRIL 13, 2015 / 0 COMMENTS

4 Design Problems for VR (And How to Solve Them)

SHARE TWEET LINKEDIN

Hand tracking and virtual reality are both emerging technologies. Combining them into a fluid and seamless experience can be a real challenge. This article explores the bleeding edge of VR design with a collection of guidelines.

As an optical motion tracking platform, the Leap Motion controller is very different from handheld controllers in many ways. It has its own unique strengths, while avoiding common weaknesses.

1. The Midas Touch

The mythological King Midas loved being able to touch everything he could see. He realized he couldn't stop. Your VR demo needs to let users to comfortably move their hands around without triggering unwanted interactions.

Gesture-based interactions should be initiated with part of casual movement. (For example, grabbing is intent.) For UI design, [Widgets](#) should be positioned to avoid accidental triggering. Dynamic visual feedback is also important. See [Interaction Design in the VR Best Practices Guidelines](#).



Sign in Get started

UX VR

/ developers

Discover Design VR Best Practices General User Experience Vision Locomotion User Input Audio User Orientation and Positional Tracking Avatars Rendering Closing Thoughts Additional Reading Develop Distribute Support Manage

Introduction to Best Practices

The VR best practices are designed to help you create great VR content. VR is awesome. VR opens a world of possibilities by creating the sensation of being entirely transported into a virtual (or real, but digitally reproduced) three-dimensional world. VR provides a visceral and immersive experience that traditional screen-based media cannot. These best practices will help you develop VR experiences that users will enjoy.

This guide contains some tips about how to make the best possible VR experiences for your users. We'll make some specific recommendations about how to make comfortable experiences; however, VR is a young medium and all developers are responsible for ensuring that their content conforms to all standards and industry best practices for safety and comfort and to keep abreast of scientific research and industry standards.

The recommendations in this guide are starting points for designing a comfortable game or application. Your application or use case may have different requirements than the best practices identified in this guide. This guide will not offer performance optimization or technical development recommendations. Information about optimizing your app can be found in the Mobile [Testing and Troubleshooting](#) and the Rift [Optimizing Your Application](#) guides.

There are still aspects of VR that haven't been studied enough to make definitive statements about how to make a comfortable experience for all users. Simply following the recommendations in this guide does not guarantee a comfortable or enjoyable experience. Iterative user testing of your content is critical. We count on you, the community of Oculus developers, to provide feedback and help us mature these VR best practices.

Safety First

If VR experiences ignore fundamental best practices, they can lead to discomfort in some people. This discomfort can be a combination of symptoms clustered around eyestrain, disorientation, and nausea. Therefore, it is important that you follow these best practices or in the alternative, solutions that you have developed to minimize discomfort.

Certain types of images are believed to be capable of triggering photosensitive seizures in a small portion of the population. The International Standards Organization has published [ISO 9241-391:2016](#) as a standard for image content to reduce the risk of photosensitive seizures. You are responsible for reviewing the standards and literature on photosensitive seizures and image safety and designing content that conforms to these standards.

Additionally, excessive use without breaks is not recommended for developers, end-users, or the device. Please review the Health and Safety Warnings at [www.oculus.com/warnings](#). We encourage you to review all of the Health and Safety Warnings as they may impact the development of your content.

Technical and Content Requirements

Not covered in this guide are the technical and content requirements that you must follow for your app to be distributed in the Oculus Store. These are detailed in the [Designing for Distribution](#) guide.

If you plan to submit an application to the Store, it is important to familiarize yourself with our Store guidelines and design toward those metrics from the beginning. Even if you do not wish to ship an app through the Oculus Store, many of those guidelines reflect what we have found to be the basis for an enjoyable, immersive experience, and we recommend thoroughly reviewing them either way.

Experiment, Experiment, Experiment

The suggestions in this guide are by no means the only mechanisms that could work for specific applications. We encourage you to experiment and try different techniques. Maybe your app will benefit from doing the opposite of some things we've suggested. The only way to know is to experiment.



Exploratory Stage

to collect bibliography related with the main topics of the research: specific applications, their characteristics, general and/or related (if there are some) usability heuristics.



Descriptive Stage

to highlight the most important characteristics of the previously collected information, in order to formalize the main concepts associated with the research.



Correlation Stage

to identify the characteristics that the usability heuristics for specific applications should have, based on traditional heuristics and case studies analysis.



Explicative Stage

to formally specify the set of the proposed heuristics, using a standard template.



Validation Stage

to check new heuristics against traditional heuristics by experiments, through heuristic evaluations performed on selected case studies, complemented by user tests.



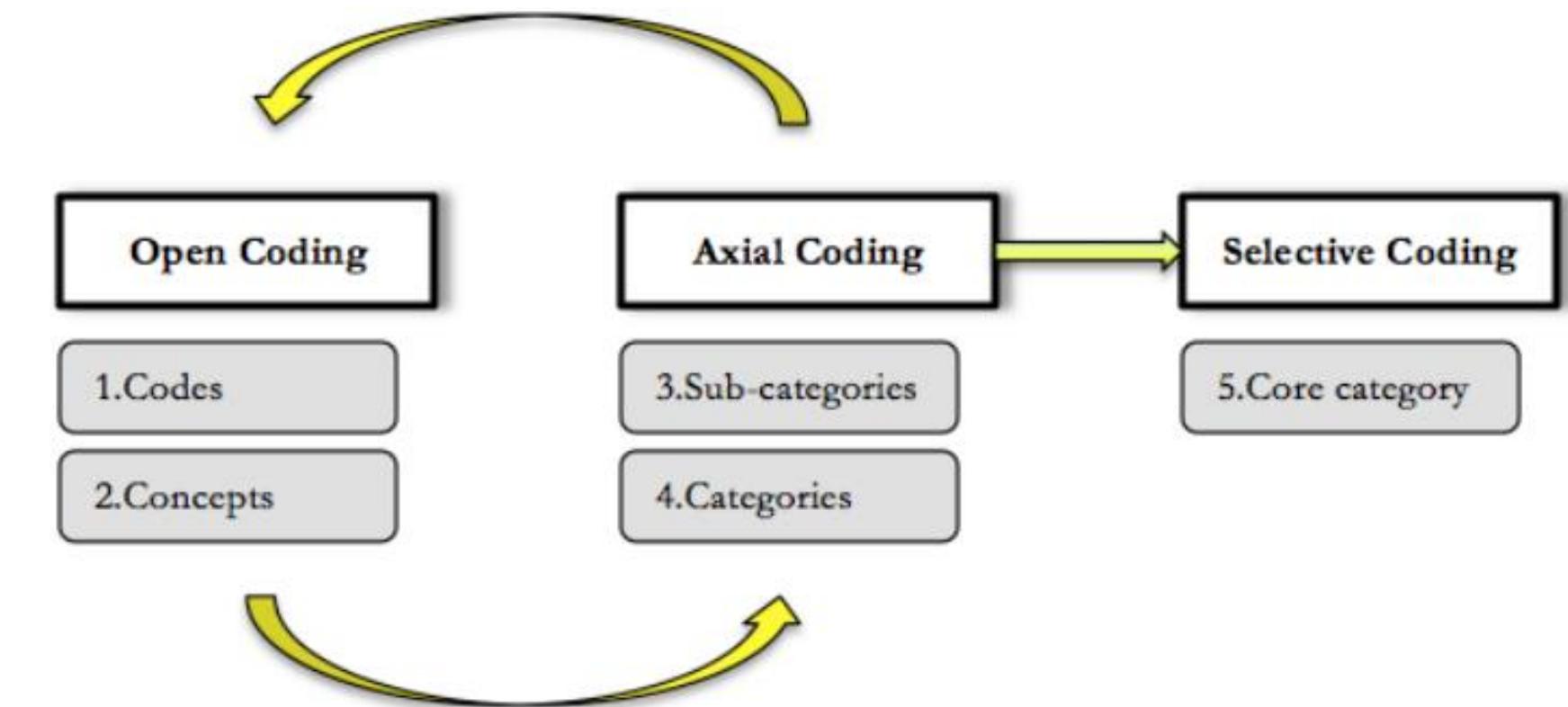
Refinement Stage

based on the feedback from the validation stage.

Descriptive Stage

Thematic Analysis

- Extract themes from our collection of resources
- Iteratively grouped, labelled, discussed and re-labelled categories and guidelines
- Extracted directly from the data through a Inductive bottom-up approach
- No prior theoretical frameworks specifically guided the framework.





Exploratory Stage

to collect bibliography related with the main topics of the research: specific applications, their characteristics, general and/or related (if there are some) usability heuristics.



Descriptive Stage

to highlight the most important characteristics of the previously collected information, in order to formalize the main concepts associated with the research.



Correlation Stage

to identify the characteristics that the usability heuristics for specific applications should have, based on traditional heuristics and case studies analysis.



Explicative Stage

to formally specify the set of the proposed heuristics, using a standard template.



Validation Stage

to check new heuristics against traditional heuristics by experiments, through heuristic evaluations performed on selected case studies, complemented by user tests.



Refinement Stage

based on the feedback from the validation stage.

How are we going to take the **design lessons** learned and taught over the past 50 years and **extend them** into this next wave of **immersive technology** that is on the cusp of becoming truly accessible?

- Nick Dauchot (The User Experience of Virtual Reality) <https://medium.com/uxxr/the-user-experience-of-virtual-reality-c464762deb8e>

Correlation Stage

Traditional Design Guidelines

NIELSEN'S TEN USABILITY HEURISTICS

- Visibility of the system's status
- Match between the system and real world
- User control and freedom
- Consistency and standards
- Error prevention
- Recognition rather than recall

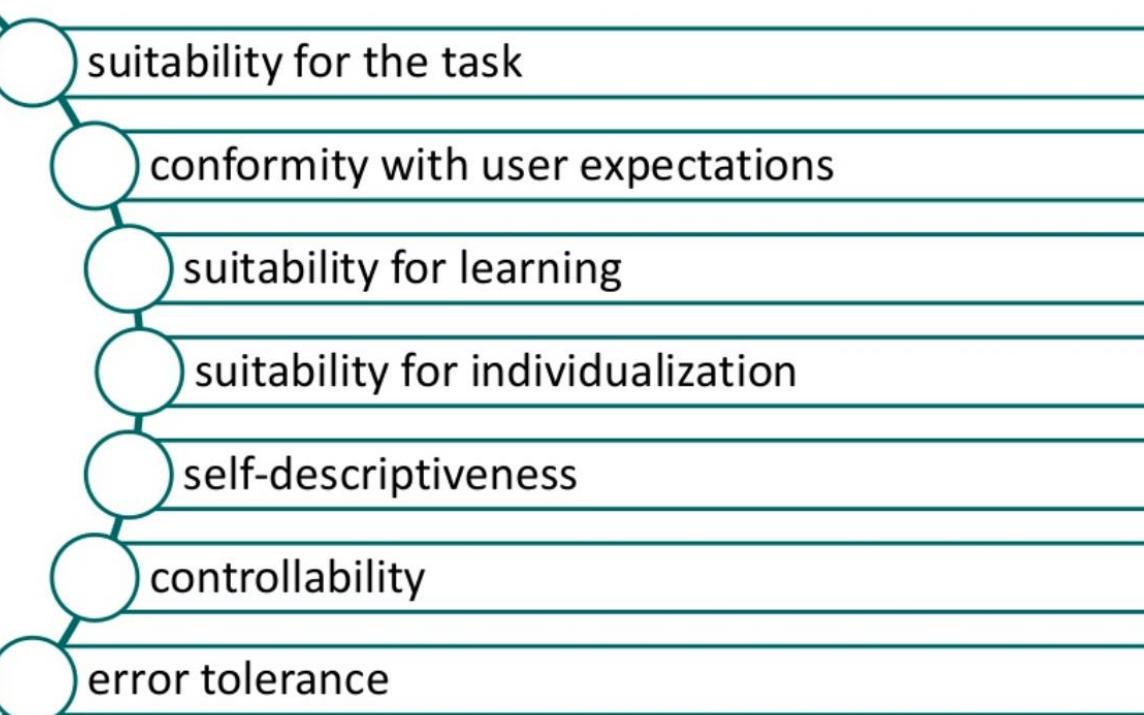
Source: <https://www.nngroup.com/articles/ten-usability-heuristics/>

- Flexibility and efficiency of use
- Aesthetics and minimalist design
- Help users recognize, diagnose and recover from error.
- Help and documentation



Applying Dialogue Principles

ISO 9241-110:2006



SHNEIDERMAN'S "EIGHT GOLDEN RULES OF INTERFACE DESIGN"

1 STRIVE FOR CONSISTENCY.
Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent commands should be employed throughout.

2 ENABLE FREQUENT USERS TO USE SHORTCUTS.
As the frequency of use increases, so do the user's desires to reduce the number of interactions and to increase the pace of interaction. Abbreviations, function keys, hidden commands, and macro facilities are very helpful to an expert user.

3 OFFER INFORMATIVE FEEDBACK.
For every operator action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial.

4 DESIGN DIALOG TO YIELD CLOSURE.
Sequences of actions should be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplishment, a sense of relief, the signal to drop contingency plans and options from their minds, and an indication that the way is clear to prepare for the next group of actions.

5 OFFER SIMPLE ERROR HANDLING.
As much as possible, design the system so the user cannot make a serious error. If an error is made, the system should be able to detect the error and offer simple, comprehensible mechanisms for handling the error.

6 PERMIT EASY REVERSAL OF ACTIONS.
This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data entry, or a complete group of actions.

7 SUPPORT INTERNAL LOCUS OF CONTROL.
Experienced operators strongly desire the sense that they are in charge of the system and that the system responds to their actions. Design the system to make users the initiators of actions rather than the responders.

8 REDUCE SHORT - TERM MEMORY LOAD.
The limitation of human information processing in short-term memory requires that displays be kept simple, multiple page displays be consolidated, window-motion frequency be reduced, and sufficient training time be allotted for codes, mnemonics, and sequences of actions.



Exploratory Stage

to collect bibliography related with the main topics of the research: specific applications, their characteristics, general and/or related (if there are some) usability heuristics.



Descriptive Stage

to highlight the most important characteristics of the previously collected information, in order to formalize the main concepts associated with the research.



Correlation Stage

to identify the characteristics that the usability heuristics for specific applications should have, based on traditional heuristics and case studies analysis.



Explicative Stage

to formally specify the set of the proposed heuristics, using a standard template.



Validation Stage

to check new heuristics against traditional heuristics by experiments, through heuristic evaluations performed on selected case studies, complemented by user tests.



Refinement Stage

based on the feedback from the validation stage.

Explicative Stage

Structure of our guidelines

- **Name**
- **Definition**
- **Explanation**
- **Additional Guidelines**
 - **Explanation**
 - **Examples**

1. Organize the spatial environment to maximize efficiency

XR is inherently spatial. Use space as an organizational tool to create an environment that is comfortable to use and minimizes the amount of conscious thinking a user has to do to accomplish his or her goals.

By using the third dimension, XR can leverage how humans interpret spatial information to free up working memory and create dynamic environments. With that said, it is easy to create uncomfortable experiences depending on how the elements are placed around the user. It is important that the environment is carefully designed to take advantage of the extra space while limiting physical movement for accomplishing a task.

Additional Guidelines

Take advantage of 3D space to spread out content.

XR provides users with a larger area for placing and interacting with content. Designers should use the additional space to avoid cluttering of objects and information. For example, the Windows Mixed Reality Home application in Figure 1 lets users place apps and content in a virtual house similar to a 2D desktop. It showcases how a 3D environment can be used to spread out content to help with organization, multitasking, and visual appeal.

Group similar objects to make them easier to find.

Placing similar objects together can use attention chaining behaviour to conceptually link application features together. This can help users find digital objects and information more efficiently and effectively.

Keep visual and physical restrictions in mind when arranging content.

When positioning content, it is important to remember that users have physical limitations and a limited field of view. Place visual elements in areas where users' can comfortably view for long periods and interactive elements in areas where interaction is relaxed.



Fig. 1. The picture is of Windows Mixed reality home. The application lets users can customize and place content throughout a 3D virtual house.

Explicative Stage

- 1. Organize the spatial environment to maximize efficiency**
- 2. Create flexible interactions and environments**
- 3. Keep users in control**
- 4. Keep it simple: do not overwhelm the user**
- 5. Design around hardware capabilities and limitations**
- 6. Prioritize user's comfort**
- 7. Build upon real world knowledge**
- 8. Provide feedback and consistency**
- 9. Use cues to help users throughout their experience**
- 10. Design for error tolerance**
- 11. Create a compelling experience**

11 User eXperience Guidelines for Designing HMD Extended Reality Applications

Organize the spatial environment to maximize efficiency

XR is inherently spatial. Use space as an organizational tool to create an environment that is comfortable to use and minimizes the amount of conscious thinking a user has to do to accomplish his or her goals.

Organize the spatial environment to maximize efficiency

XR is inherently spatial. Use space as an organizational tool to create an environment that is comfortable to use and minimizes the amount of conscious thinking a user has to do to accomplish his or her goals.

Additional Guidelines

- Take advantage of 3D space to spread out content.



Organize the spatial environment to maximize efficiency

XR is inherently spatial. Use space as an organizational tool to create an environment that is comfortable to use and minimizes the amount of conscious thinking a user has to do to accomplish his or her goals.

Additional Guidelines

- Take advantage of 3D space to spread out content.
- Group similar objects to make them easier to find.

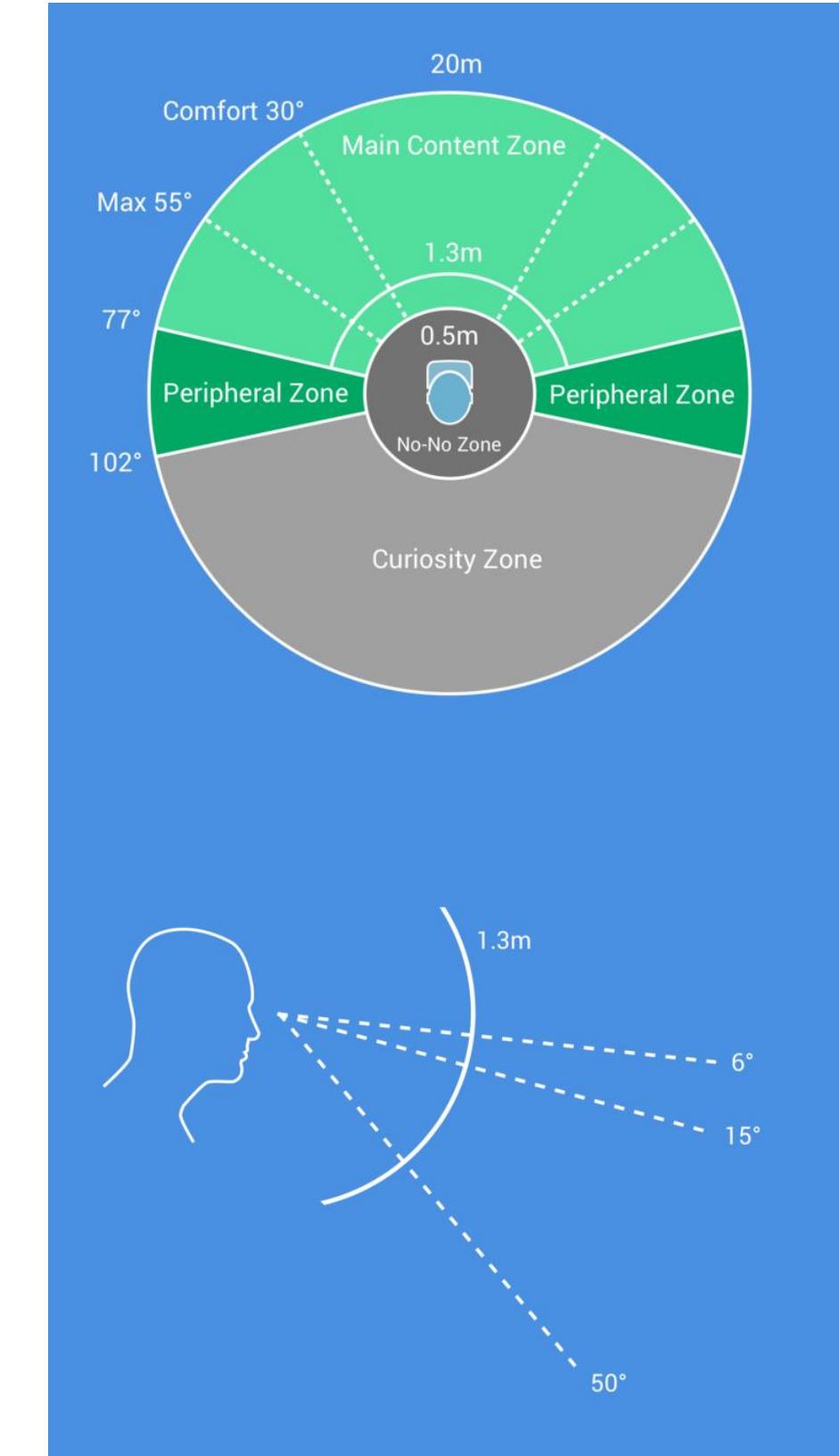


Organize the spatial environment to maximize efficiency

XR is inherently spatial. Use space as an organizational tool to create an environment that is comfortable to use and minimizes the amount of conscious thinking a user has to do to accomplish his or her goals.

Additional Guidelines

- Take advantage of 3D space to spread out content.
- Group similar objects to make them easier to find.
- Keep visual and physical restrictions in mind when arranging content.



Create flexible interactions and environments

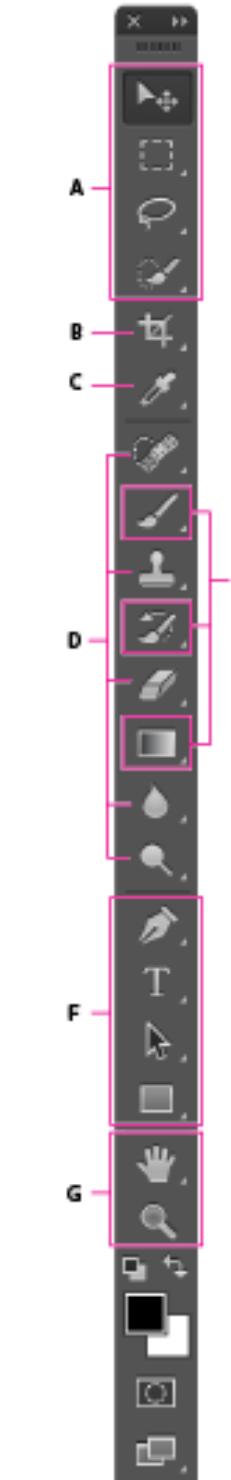
Provide users with the capability to customize the application to their personal preferences and comforts. Build in options that cater to a range of users that take into account different experience levels and physical considerations.

Create flexible interactions and environments

Provide users with the capability to customize the application to their personal preferences and comforts. Build in options that cater to a range of users that take into account different experience levels and physical considerations.

Additional Guidelines

- Build in interactions for both inexperienced and experienced users.



Tools Panel Overview

A Selection tools

- Move (V)*
- Rectangular Marquee (M)
- Elliptical Marquee (M)
- Single Column Marquee
- Single Row Marquee
- Lasso (L)
- Polygonal Lasso (L)
- Magnetic Lasso (L)
- Quick Selection (W)
- Magic Wand (W)

B Crop and Slice tools

- Crop (C)
- Perspective Crop (C)
- Slice (C)
- Slice Select (C)

C Measuring tools

- Eyedropper (I)
- 3D Material Eyedropper (I)
- Color Sampler (I)
- Ruler (I)
- Note (I)
- Count (I)

D Retouching tools

- Spot Healing Brush (J)
- Healing Brush (J)
- Patch (J)
- Content Aware
- Red Eye (J)
- Clone Stamp (S)
- Pattern Stamp (S)

- Eraser (E)
- Background Eraser (E)
- Magic Eraser (E)

- Path Selection (A)
- Direct Selection (A)

- Rectangle (U)
- Rounded Rectangle (U)
- Ellipse (U)
- Polygon (U)
- Line (U)
- Custom Shape (U)

G Navigation tool

- Hand (H)
- Rotate View (R)
- Zoom (Z)

- Pen (P)
- Freeform Pen (P)
- Add Anchor Point
- Delete Anchor Point
- Convert Point

- Horizontal Type (T)
- Vertical Type (T)
- Horizontal Type Mask (T)
- Vertical Type Mask (T)

* Indicates default tool

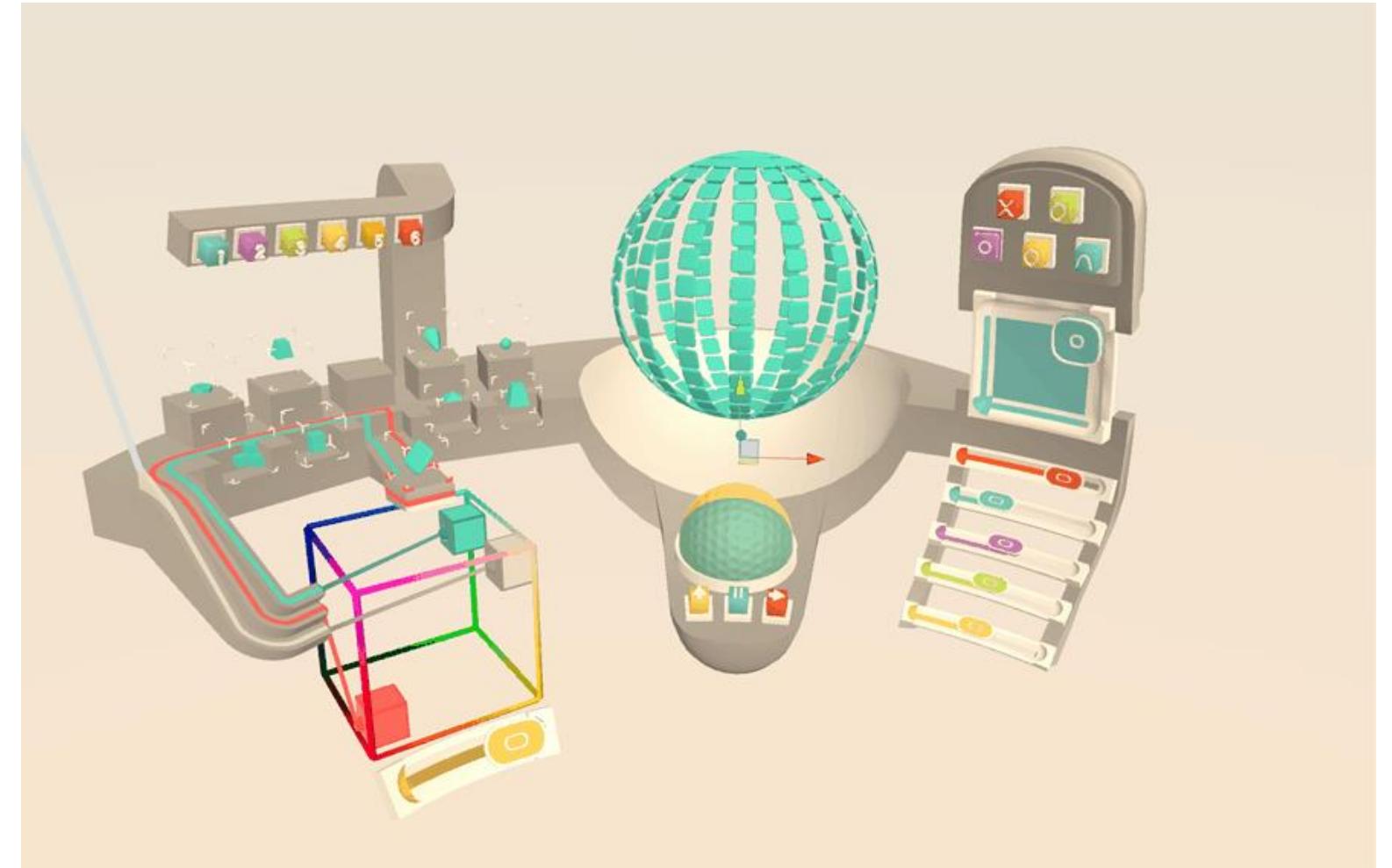
* Keyboard shortcuts appear in parenthesis

Create flexible interactions and environments

Provide users with the capability to customize the application to their personal preferences and comforts. Build in options that cater to a range of users that take into account different experience levels and physical considerations.

Additional Guidelines

- **Build in interactions for both inexperienced and experienced users.**
- **Let users shape their environment to optimize their workflow.**

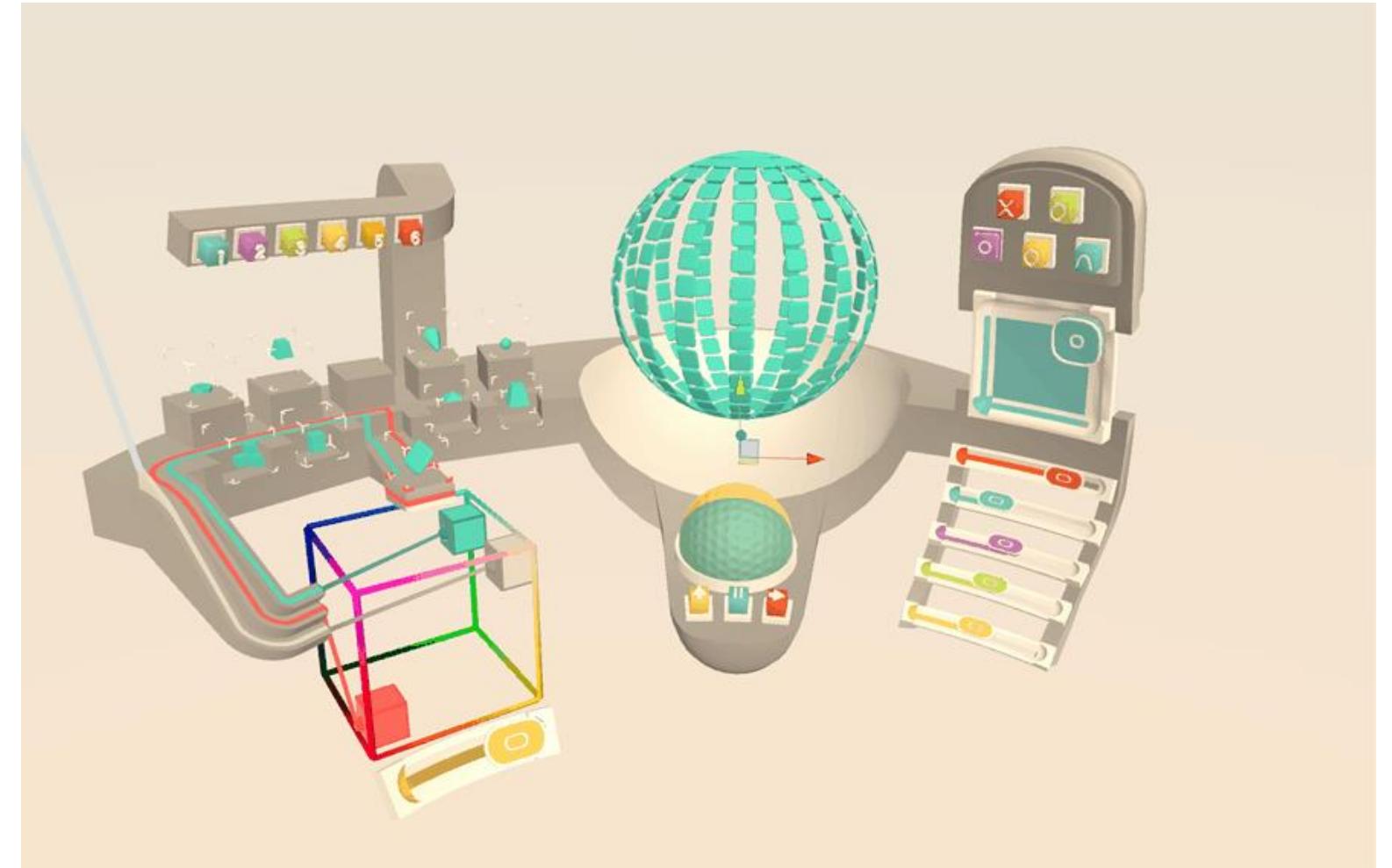


Create flexible interactions and environments

Provide users with the capability to customize the application to their personal preferences and comforts. Build in options that cater to a range of users that take into account different experience levels and physical considerations.

Additional Guidelines

- **Build in interactions for both inexperienced and experienced users.**
- **Let users shape their environment to optimize their workflow.**
- **Let users define what it means to be comfortable.**



Keep users in control

The application should act and respond in a way that gives users the sense that they are in charge of the experience.

Keep users in control

The application should act and respond in a way that gives users the sense that they are in charge of the experience.

Additional Guidelines

- Don't force actions without user's permission.

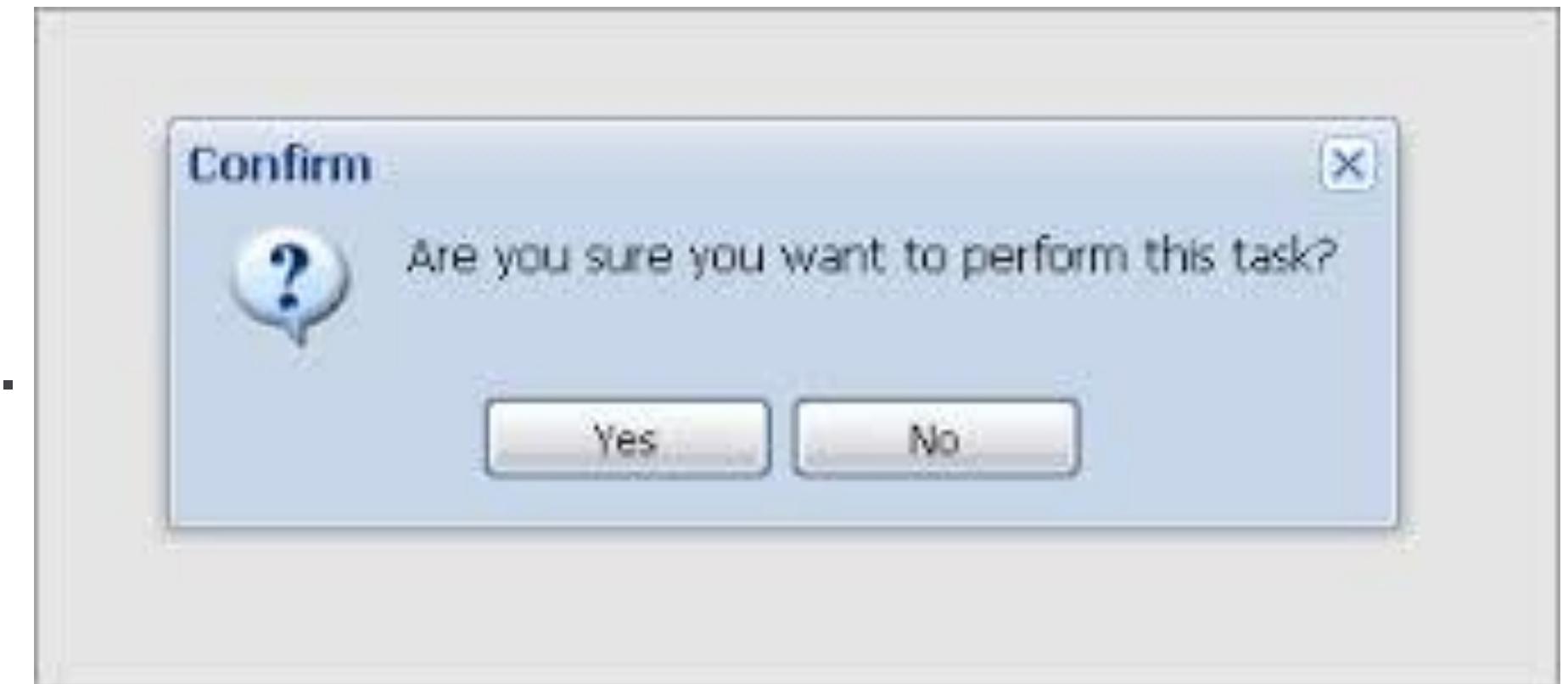


Keep users in control

The application should act and respond in a way that gives users the sense that they are in charge of the experience.

Additional Guidelines

- Don't force actions without user's permission.
- Provide exits for users to leave unwanted states.



Keep users in control

The application should act and respond in a way that gives users the sense that they are in charge of the experience.

Additional Guidelines

- Don't force actions without user's permission.
- Provide exits for users to leave unwanted states.
- The application should be “honest”.

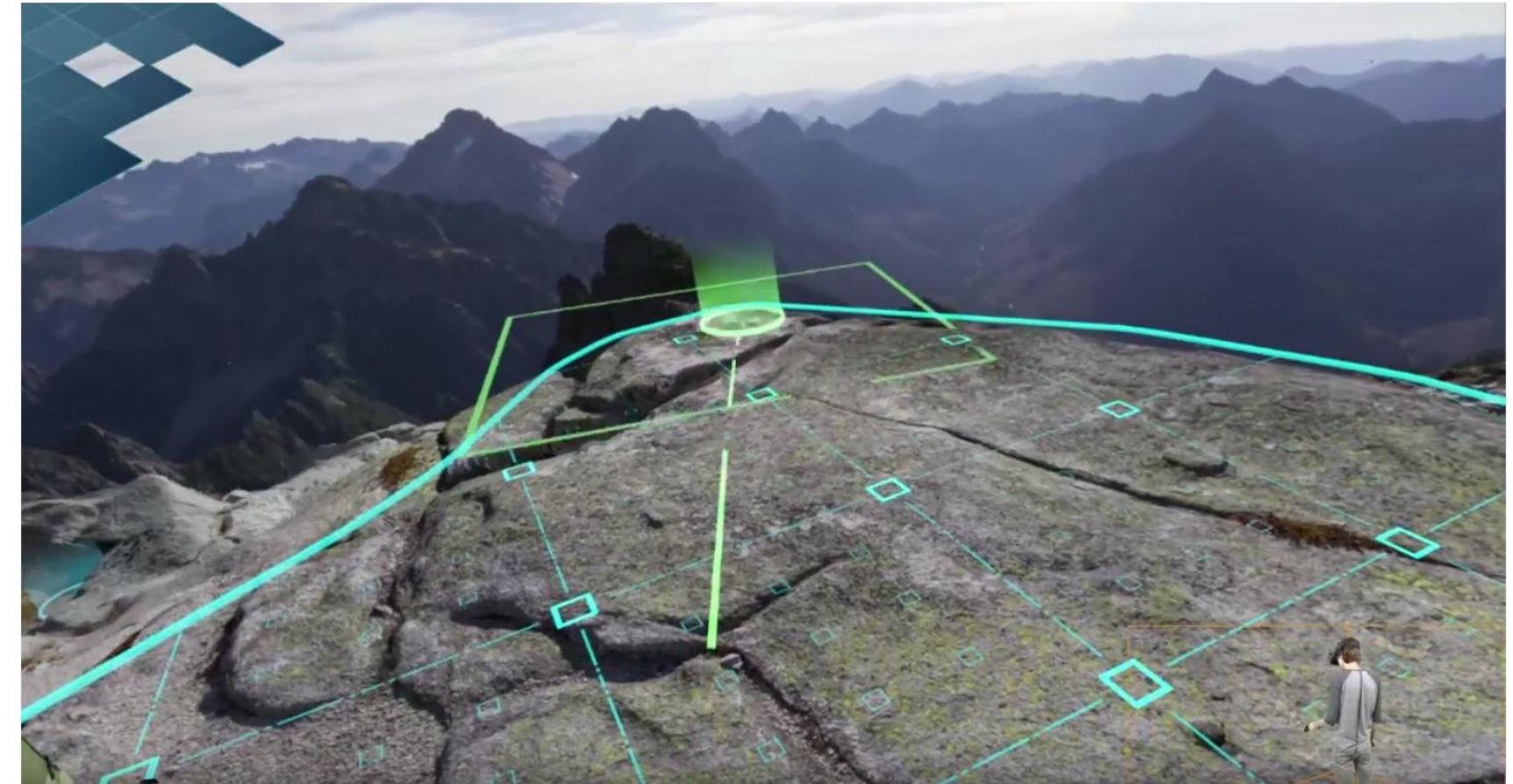


Keep users in control

The application should act and respond in a way that gives users the sense that they are in charge of the experience.

Additional Guidelines

- Don't force actions without user's permission.
- Provide exits for users to leave unwanted states.
- The application should be “honest”.
- Let users control their movements.



Keep it simple: do not overwhelm the user

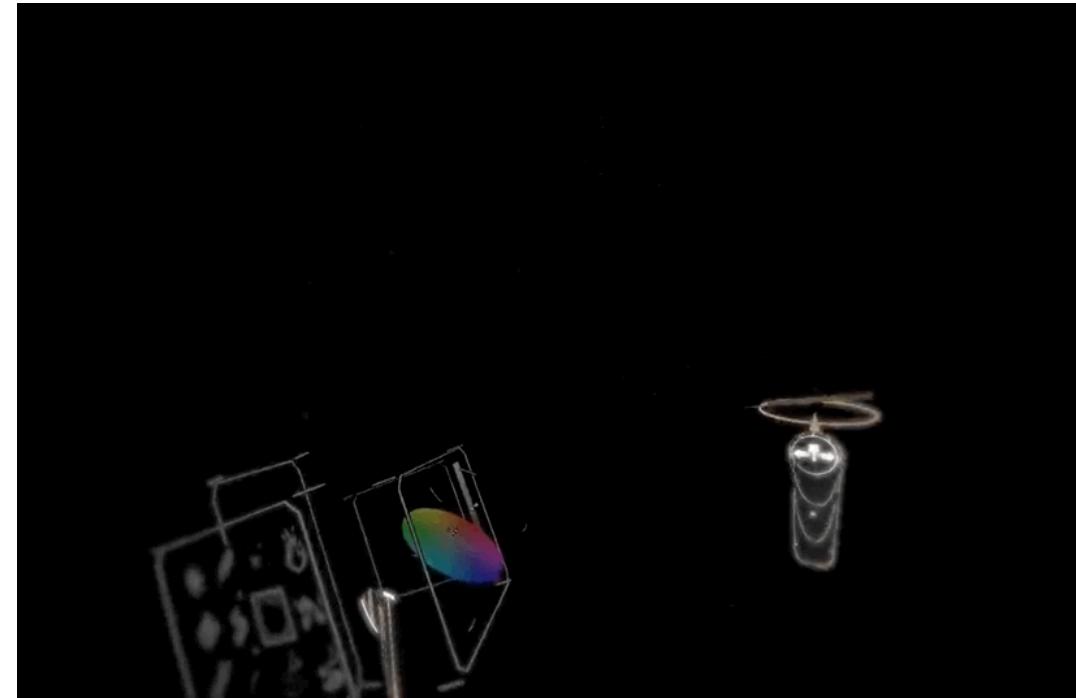
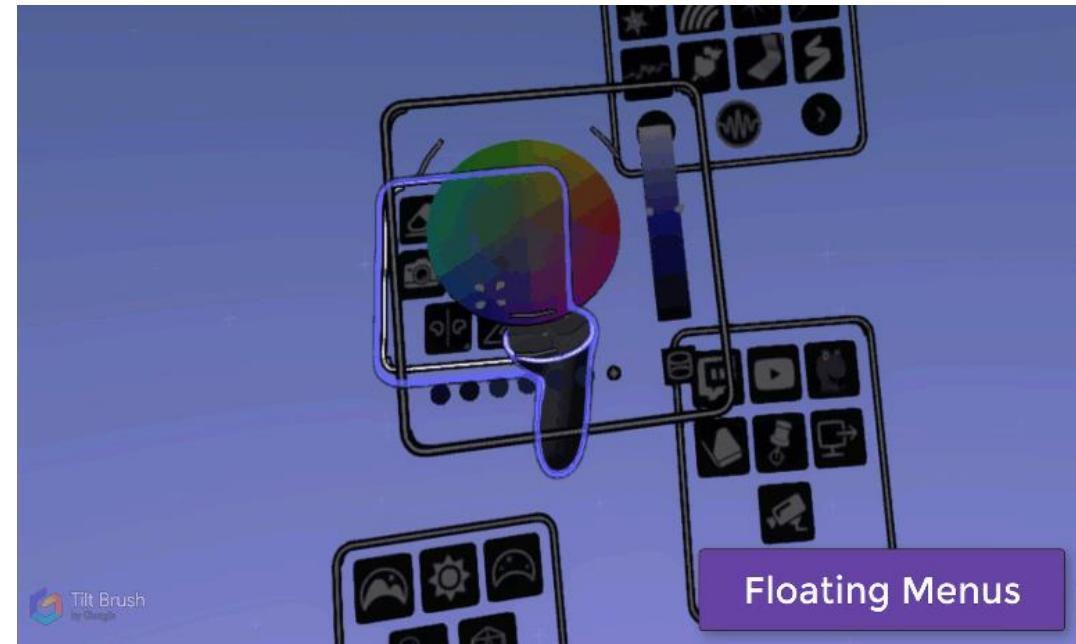
The more there is, the less the user remembers. Create simple and relevant elements in an environment that do not distract the user from what is important.

Keep it simple: do not overwhelm the user

The more there is, the less the user remembers. Create simple and relevant elements in an environment that do not distract the user from what is important.

Additional Guidelines

- Keep tools and information ready, but not distracting.

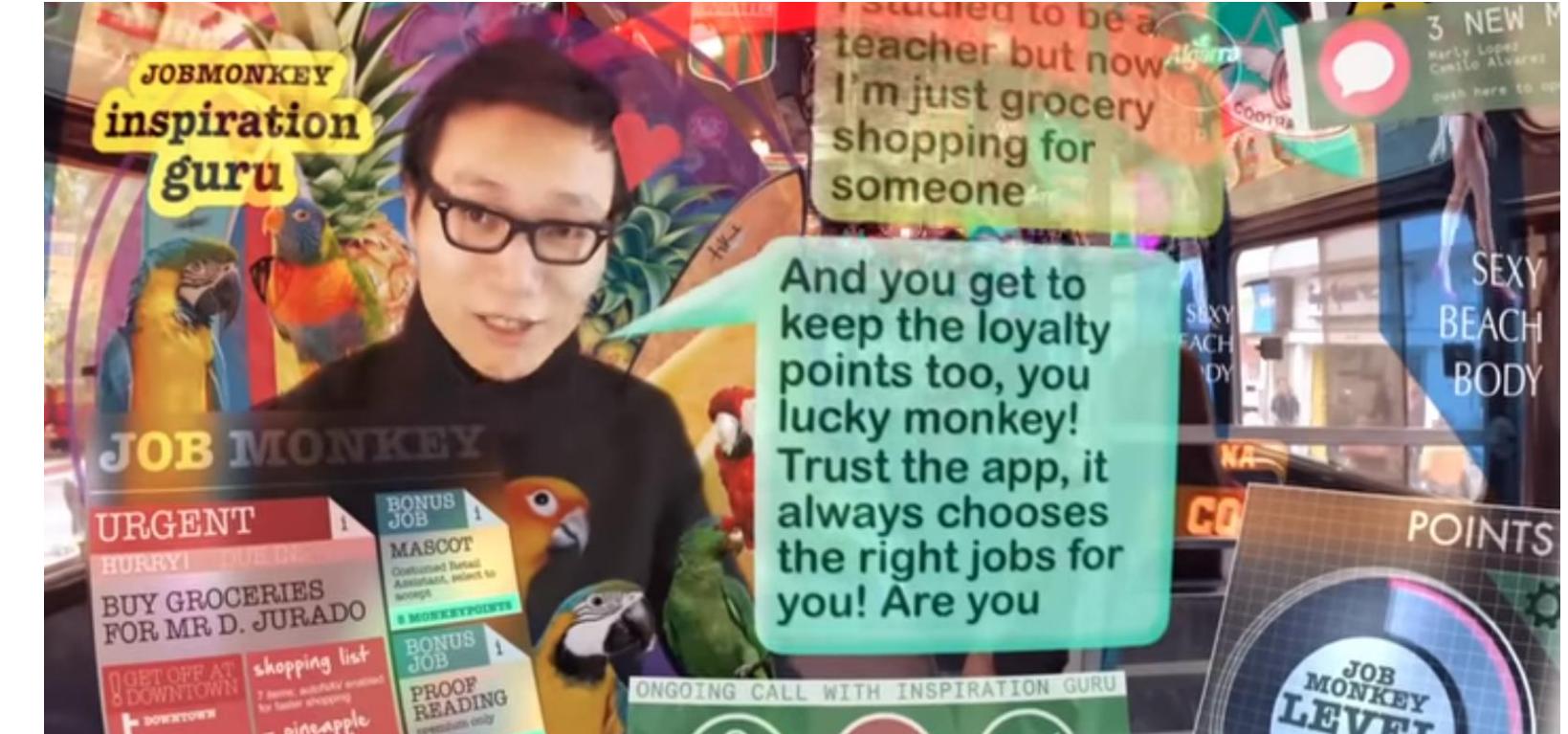


Keep it simple: do not overwhelm the user

The more there is, the less the user remembers. Create simple and relevant elements in an environment that do not distract the user from what is important.

Additional Guidelines

- Keep tools and information ready, but not distracting.
- Don't obscure the user's vision with virtual elements.



Design around hardware capabilities and limitations

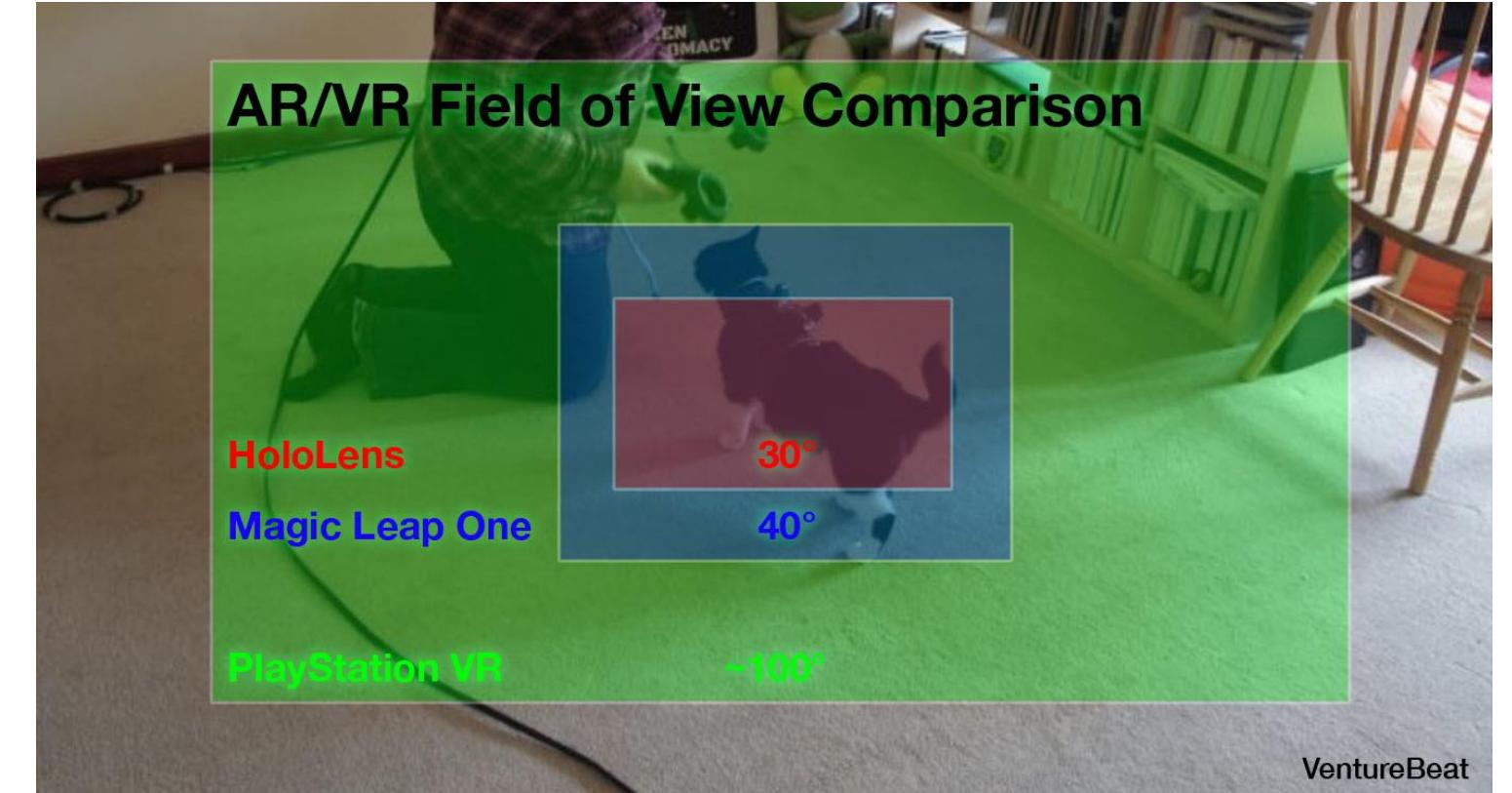
The way users interact and explore the environment will be greatly dependent on the system they are using.
Always keep the capabilities of the hardware in mind when crafting XR experiences.

Design around hardware capabilities and limitations

The way users interact and explore the environment will be greatly dependent on the system they are using. Always keep the capabilities of the hardware in mind when crafting XR experiences.

Additional Guidelines

- Sensitive to the capabilities of the hardware.

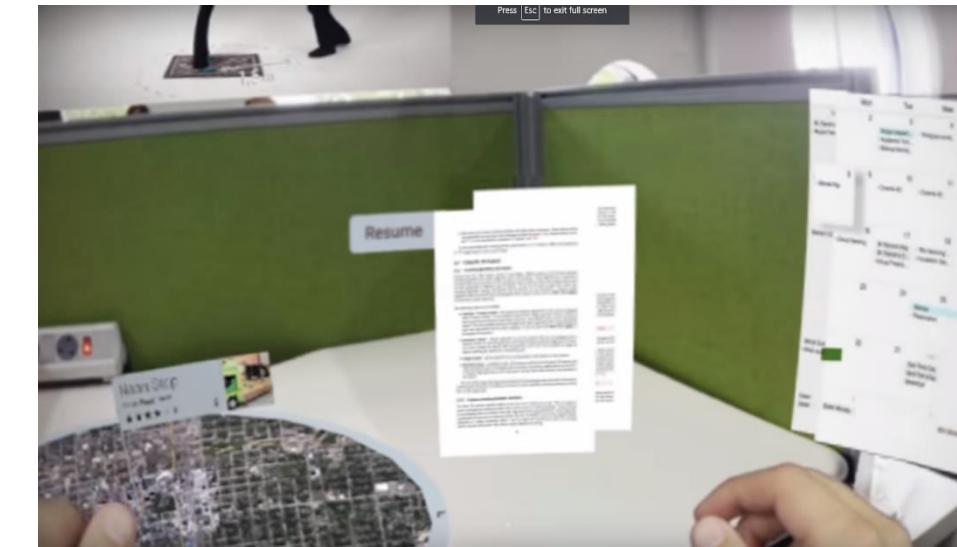


Design around hardware capabilities and limitations

The way users interact and explore the environment will be greatly dependent on the system they are using. Always keep the capabilities of the hardware in mind when crafting XR experiences.

Additional Guidelines

- Sensitive to the capabilities of the hardware.
- Use the Strengths of the Medium.



Prioritize user's comfort

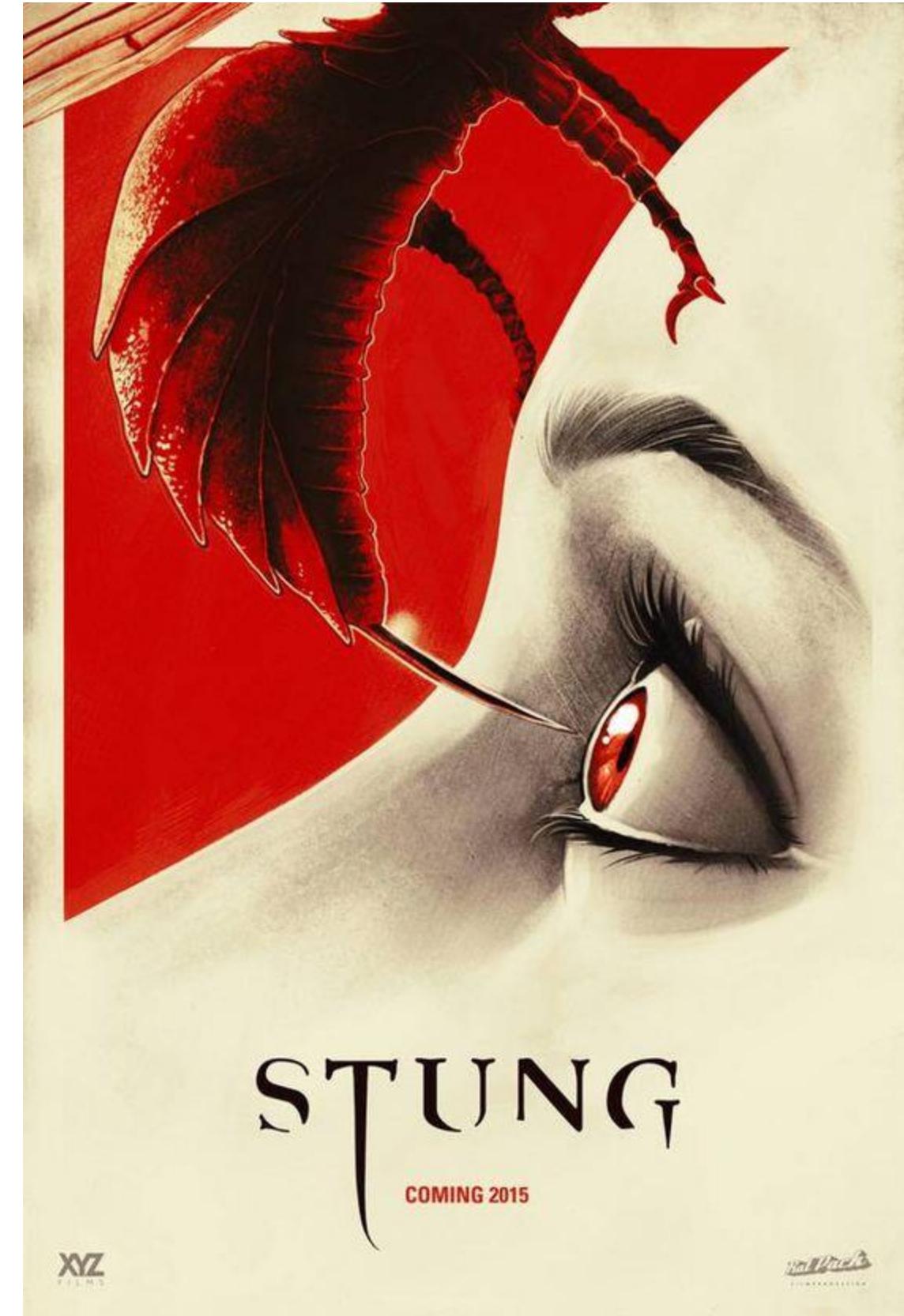
The XR application should keep the user safe by taking extra precautions to maintain the physical, physiological, and environmental comforts for the user throughout the experience.

Prioritize user's comfort

The XR application should keep the user safe by taking extra precautions to maintain the physical, physiological, and environmental comforts for the user throughout the experience.

Additional Guidelines

- Respect users personal space.



Prioritize user's comfort

The XR application should keep the user safe by taking extra precautions to maintain the physical, physiological, and environmental comforts for the user throughout the experience.

Additional Guidelines

- Respect users personal space.
- Physiological considerations.



Prioritize user's comfort

The XR application should keep the user safe by taking extra precautions to maintain the physical, physiological, and environmental comforts for the user throughout the experience.

Additional Guidelines

- Respect users personal space.
- Physiological considerations.
- Environment comfort.



Prioritize user's comfort

The XR application should keep the user safe by taking extra precautions to maintain the physical, physiological, and environmental comforts for the user throughout the experience.

Additional Guidelines

- Respect users personal space.
- Physiological considerations.
- Environment comfort.
- Limit the use of physically draining interactions.



Build upon real world knowledge

Help users to understand how to use the application by designing the interactions, objects, and environments around existing knowledge of the real world.

Build upon real world knowledge

Help users to understand how to use the application by designing the interactions, objects, and environments around existing knowledge of the real world.

Additional Guidelines

- Use real-life inspiration to create affordances in objects



Build upon real world knowledge

Help users to understand how to use the application by designing the interactions, objects, and environments around existing knowledge of the real world.

Additional Guidelines

- Use real-life inspiration to create affordances in objects
- Pair actions with outcomes that users expect.



Build upon real world knowledge

Help users to understand how to use the application by designing the interactions, objects, and environments around existing knowledge of the real world.

Additional Guidelines

- Use real-life inspiration to create affordances in objects
- Pair actions with outcomes that users expect.
- Consider the use of 3D (volumetric) representation.



Build upon real world knowledge

Help users to understand how to use the application by designing the interactions, objects, and environments around existing knowledge of the real world.

Additional Guidelines

- Use real-life inspiration to create affordances in objects
- Pair actions with outcomes that users expect.
- Consider the use of 3D (volumetric) representation.
- Be cautious of simplified interactions.



Provide feedback and consistency

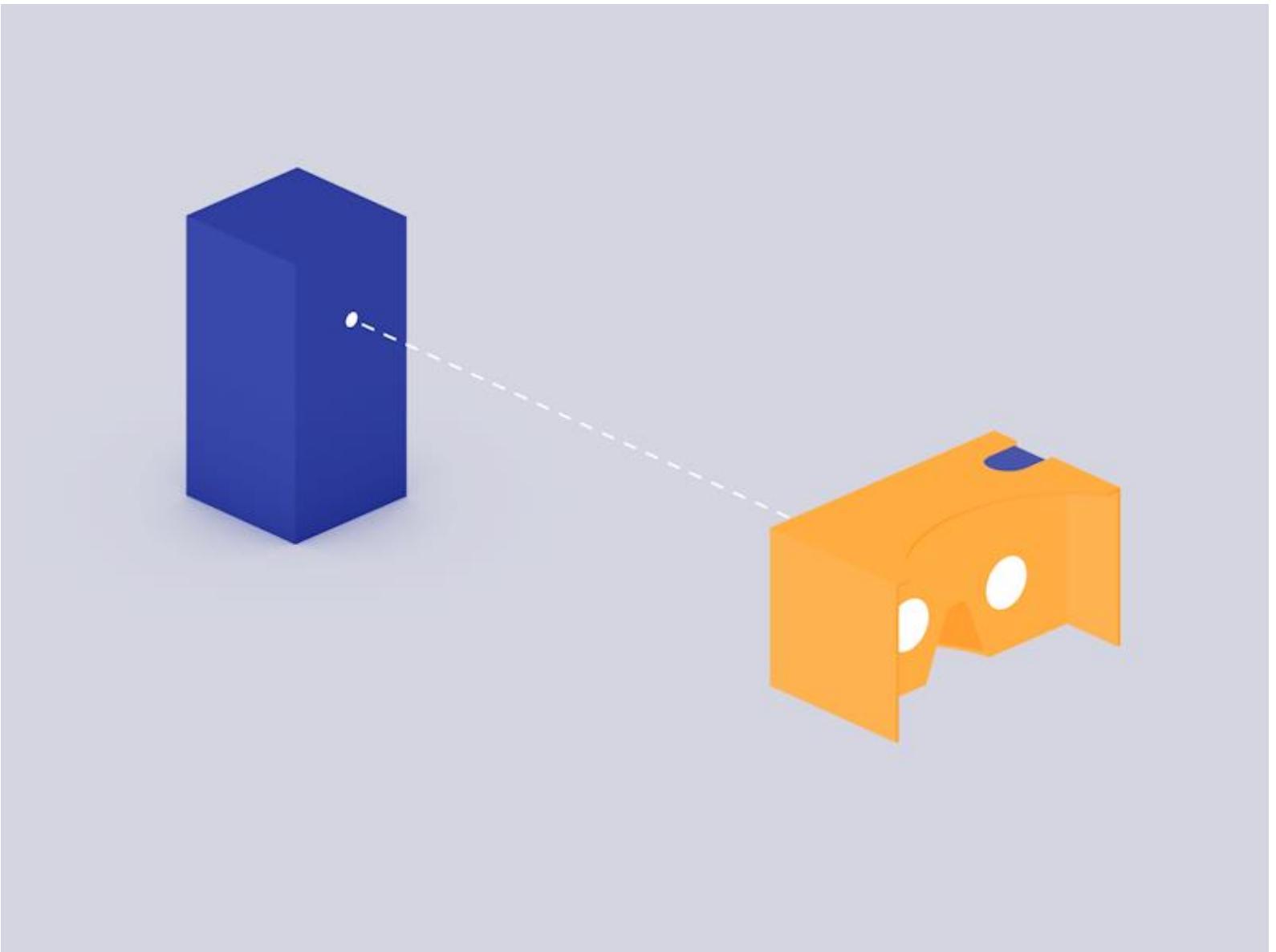
Use feedback to generalize perception of events and interactions. Additionally, feedback should be consistent such that users can build an understanding of what they can and cannot do within the application.

Provide feedback and consistency

Use feedback to generalize perception of events and interactions. Additionally, feedback should be consistent such that users can build an understanding of what they can and cannot do within the application.

Additional Guidelines

- Use feedback to standardize interactions states.

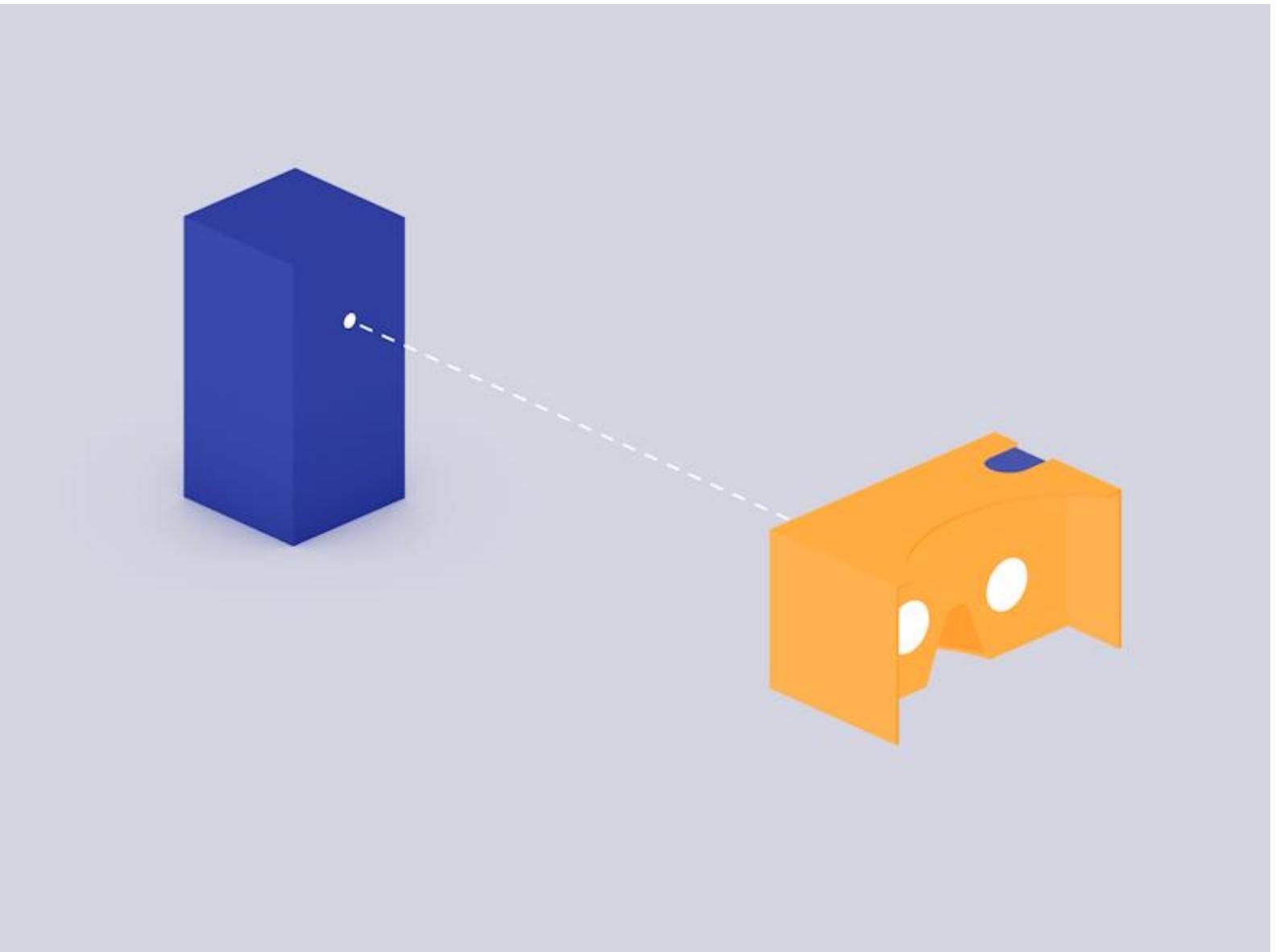


Provide feedback and consistency

Use feedback to generalize perception of events and interactions. Additionally, feedback should be consistent such that users can build an understanding of what they can and cannot do within the application.

Additional Guidelines

- Use feedback to standardize interactions states.
- Use feedback to help recognizes errors and unwanted states.

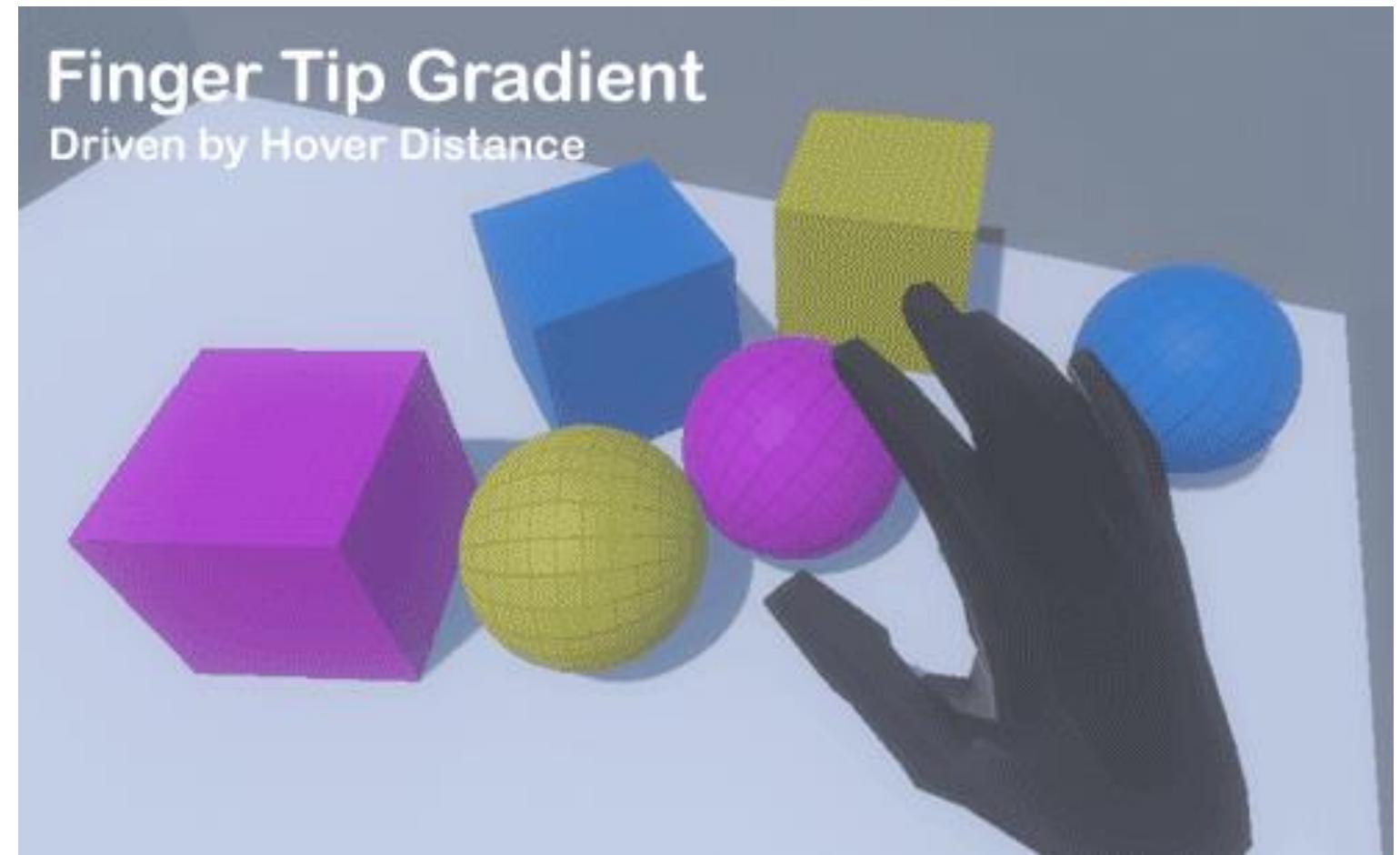


Provide feedback and consistency

Use feedback to generalize perception of events and interactions. Additionally, feedback should be consistent such that users can build an understanding of what they can and cannot do within the application.

Additional Guidelines

- Use feedback to standardize interactions states.
- Use feedback to help recognizes errors and unwanted states.
- Design for dynamic exploration: let the user explore the environment and understand it through feedback.



Use cues to help users throughout their experience

Create signifying cues to help users to get started, provide additional information, guide user's attention, and simplify choice within the application.

Use cues to help users throughout their experience

Create signifying cues to help users to get started, provide additional information, guide user's attention, and simplify choice within the application.

Additional Guidelines

- **Use attention directors to help users discover what they can do and where they should go**

Use cues to help users throughout their experience

Create signifying cues to help users to get started, provide additional information, guide user's attention, and simplify choice within the application.

Additional Guidelines

- Use attention directors to help users discover what they can do and where they should go

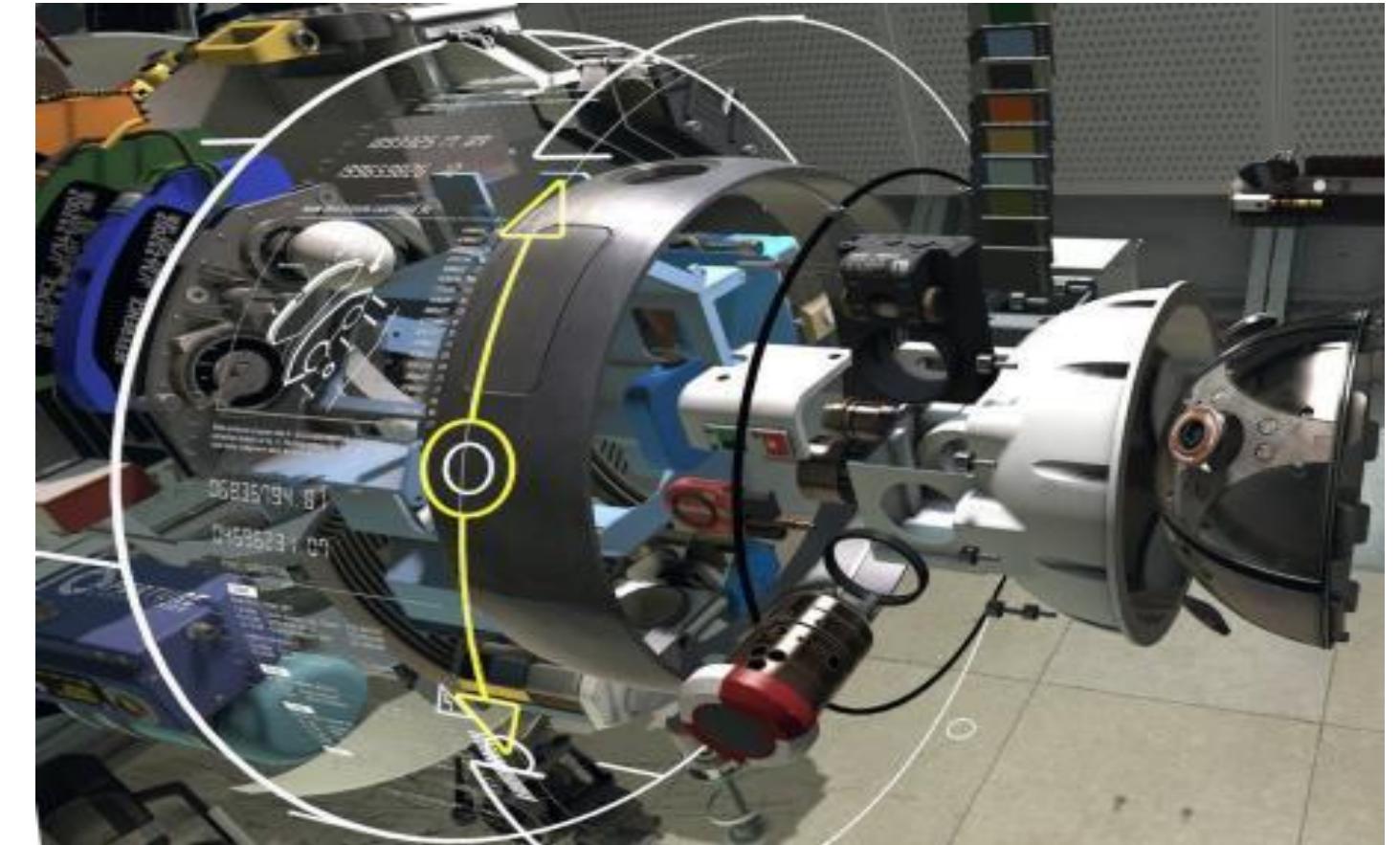


Use cues to help users throughout their experience

Create signifying cues to help users to get started, provide additional information, guide user's attention, and simplify choice within the application.

Additional Guidelines

- Use attention directors to help users discover what they can do and where they should go
- Simplify choice.

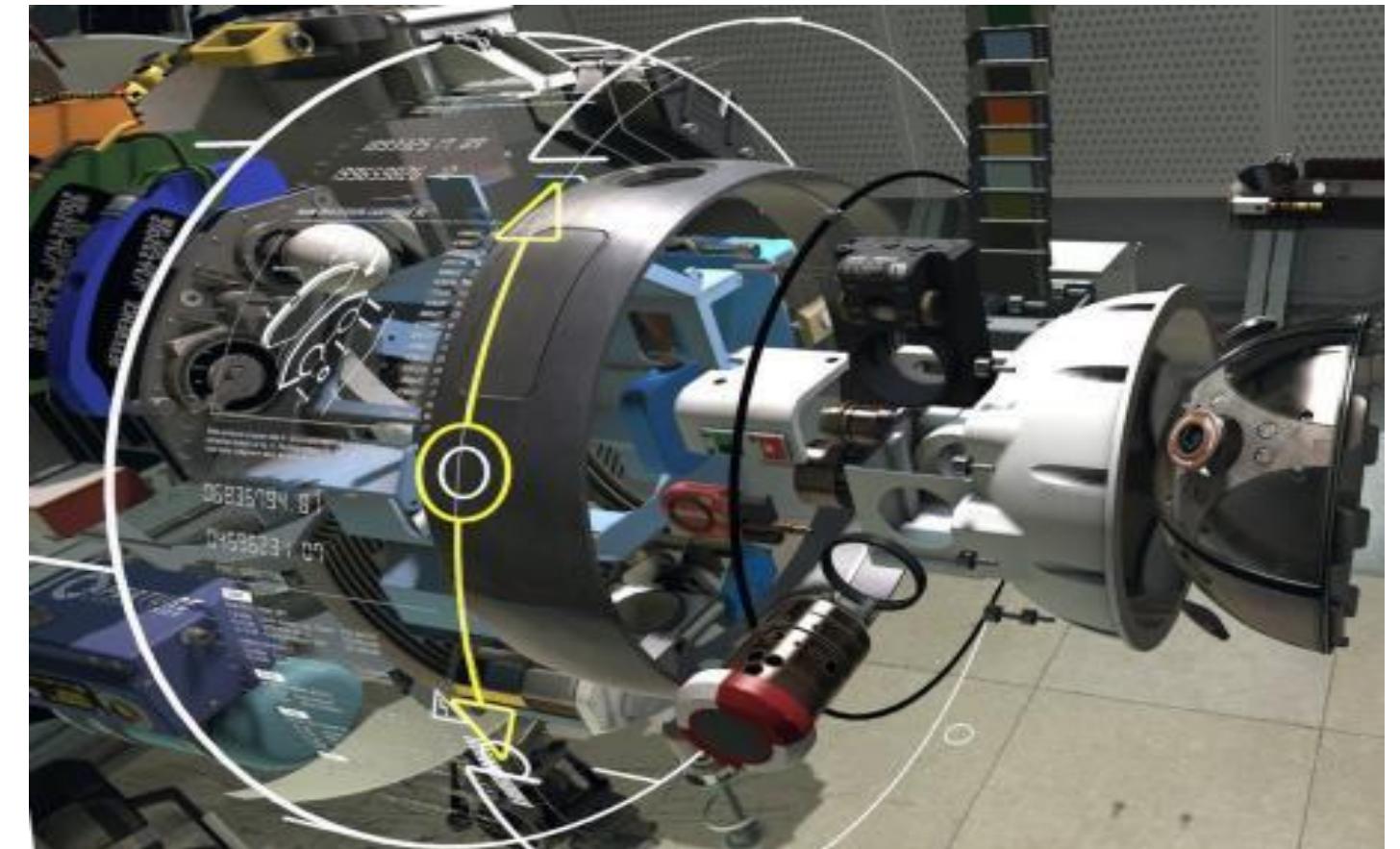


Use cues to help users throughout their experience

Create signifying cues to help users to get started, provide additional information, guide user's attention, and simplify choice within the application.

Additional Guidelines

- Use attention directors to help users discover what they can do and where they should go
- Simplify choice.
- Don't overload the user's senses with notifications.

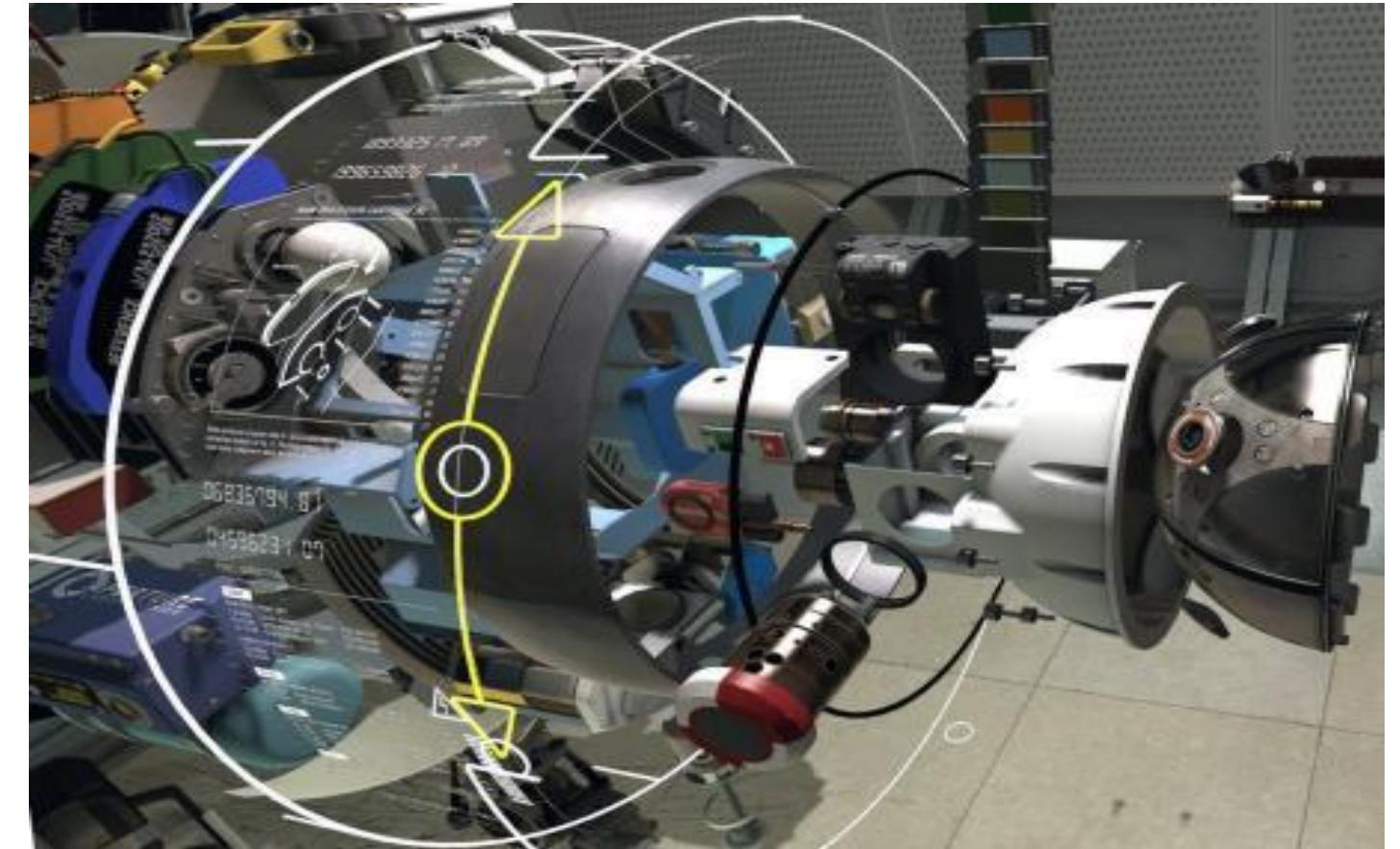


Use cues to help users throughout their experience

Create signifying cues to help users to get started, provide additional information, guide user's attention, and simplify choice within the application.

Additional Guidelines

- Use attention directors to help users discover what they can do and where they should go
- Simplify choice.
- Don't overload the user's senses with notifications.
- Use cues to integrate help and tutorials in the experience.

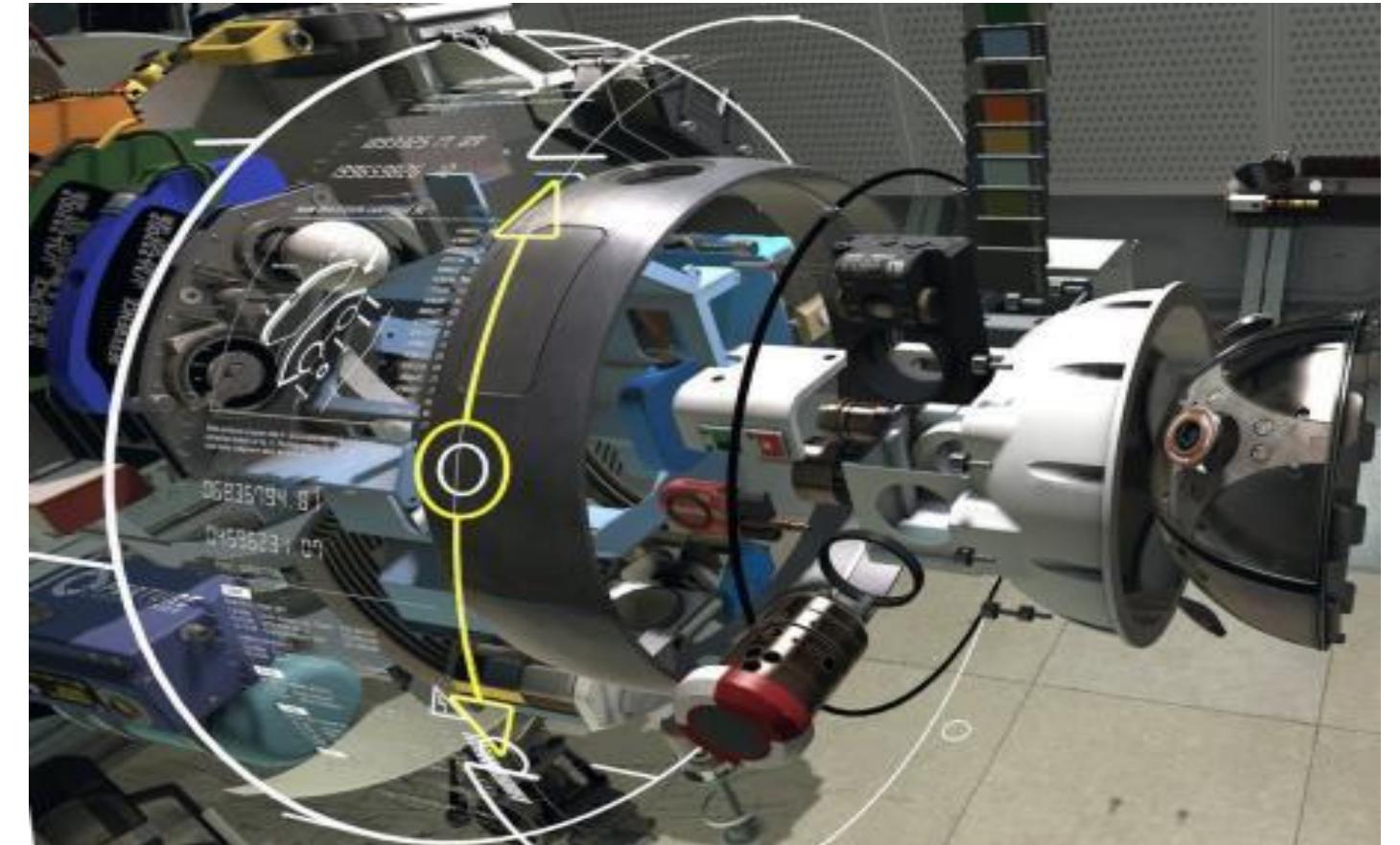


Use cues to help users throughout their experience

Create signifying cues to help users to get started, provide additional information, guide user's attention, and simplify choice within the application.

Additional Guidelines

- Use attention directors to help users discover what they can do and where they should go
- Simplify choice.
- Don't overload the user's senses with notifications.
- Use cues to integrate help and tutorials in the experience.
- Inform the users of actions that may result in errors.

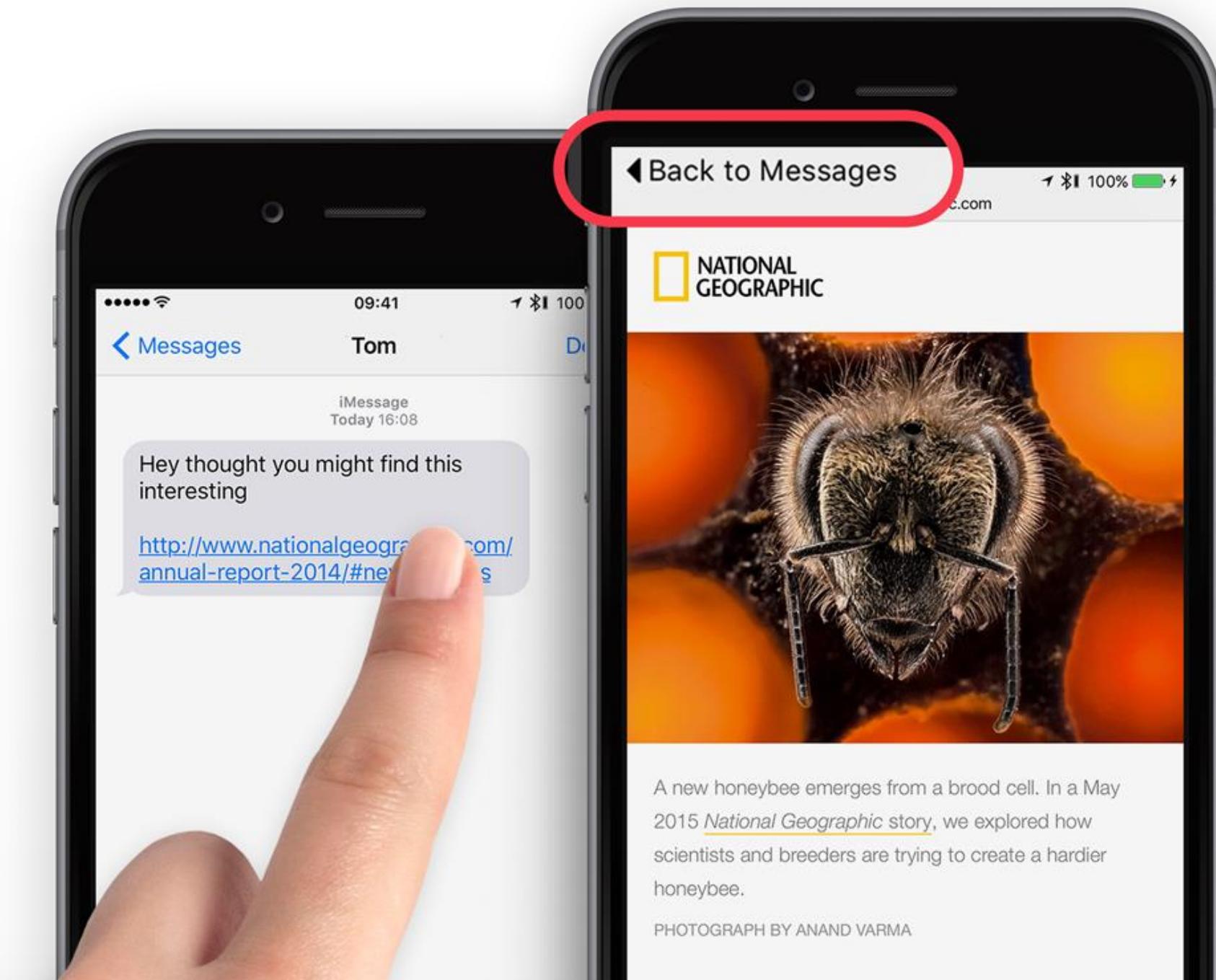


Design for error tolerance

As much as possible, allow actions to be reversible and set up protections around potential mistakes made by users. This will help relieve user's anxiety and promote exploration of the application.

Additional Guidelines

- Permit easy reversal of actions.



A new honeybee emerges from a brood cell. In a May 2015 [National Geographic story](#), we explored how scientists and breeders are trying to create a hardier honeybee.

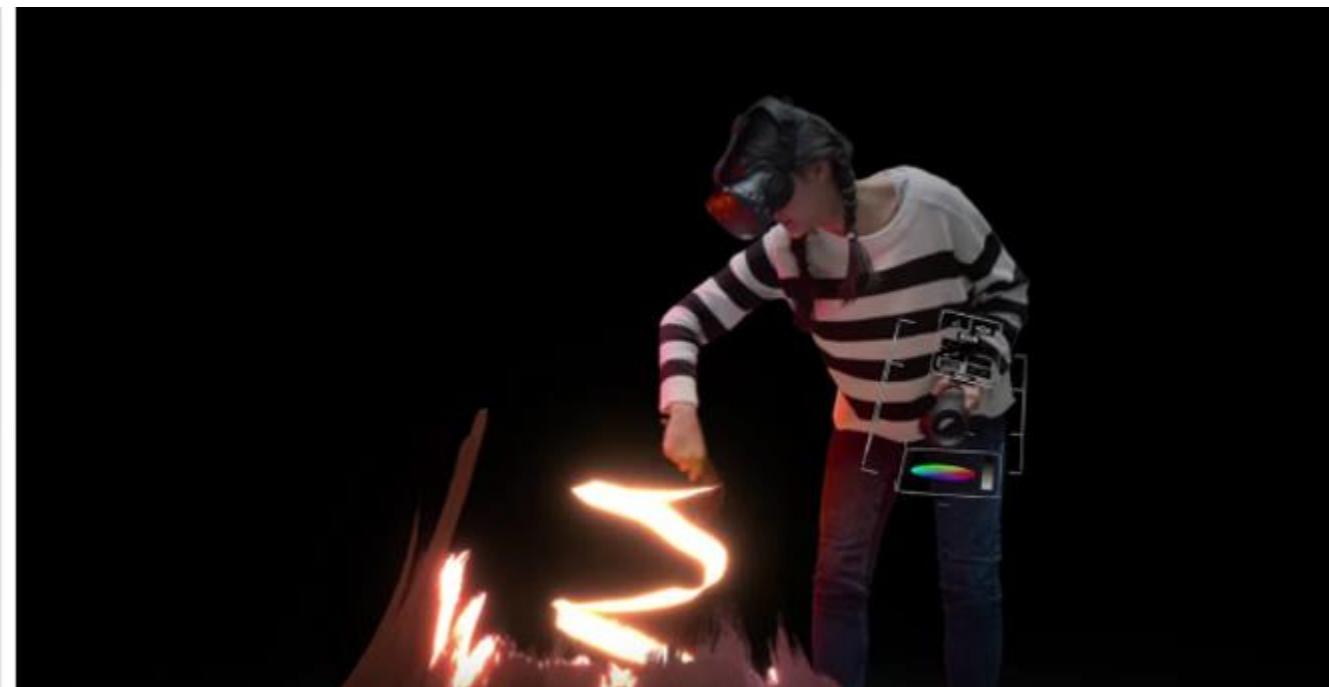
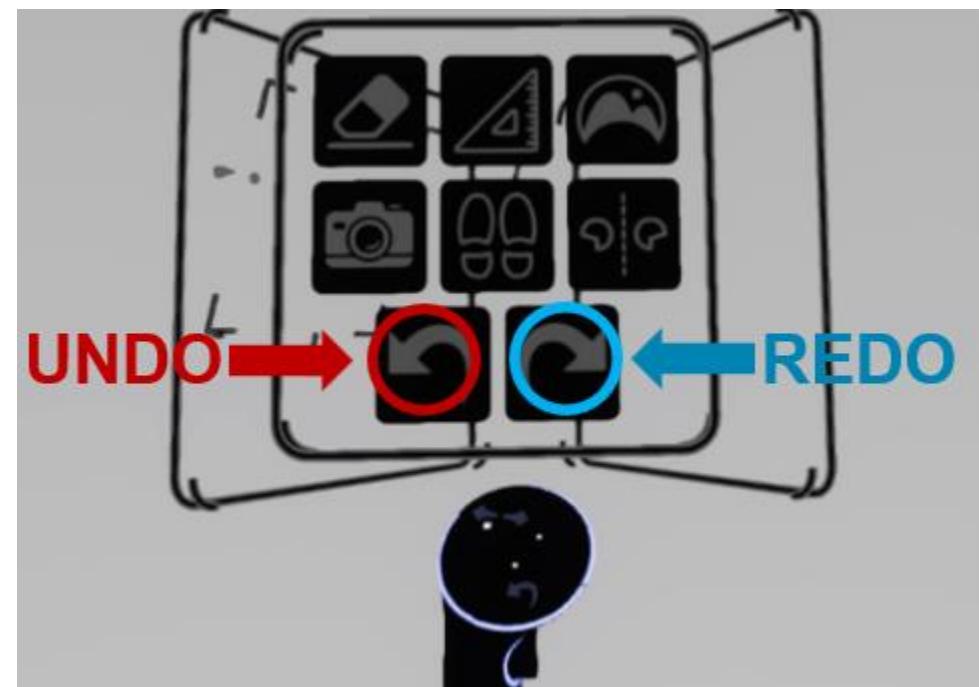
PHOTOGRAPH BY ANAND VARMA

Design for error tolerance

As much as possible, allow actions to be reversible and set up protections around potential mistakes made by users. This will help relieve user's anxiety and promote exploration of the application.

Additional Guidelines

- Permit easy reversal of actions.



Create a compelling experience

XR allows users to be immersed in the virtual environment. Enhance their senses through visuals, audio, and narrative elements that captivate them in the experience.

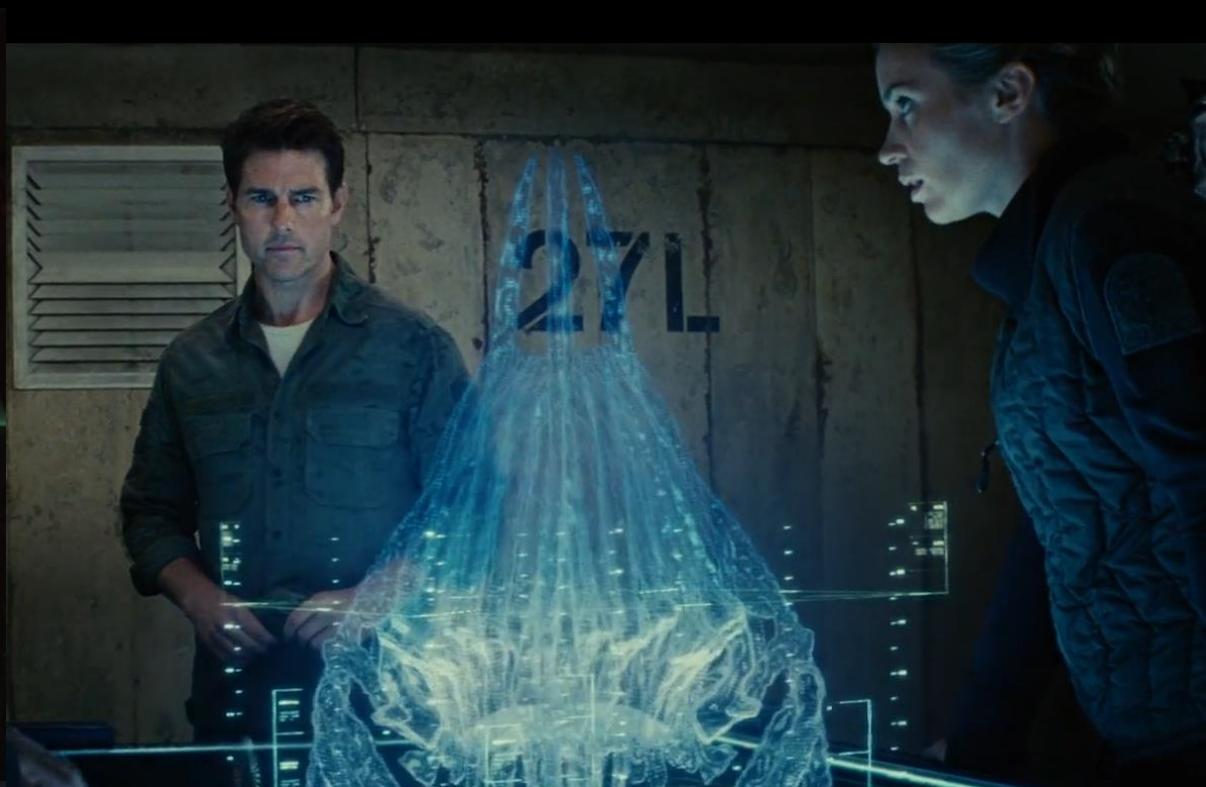
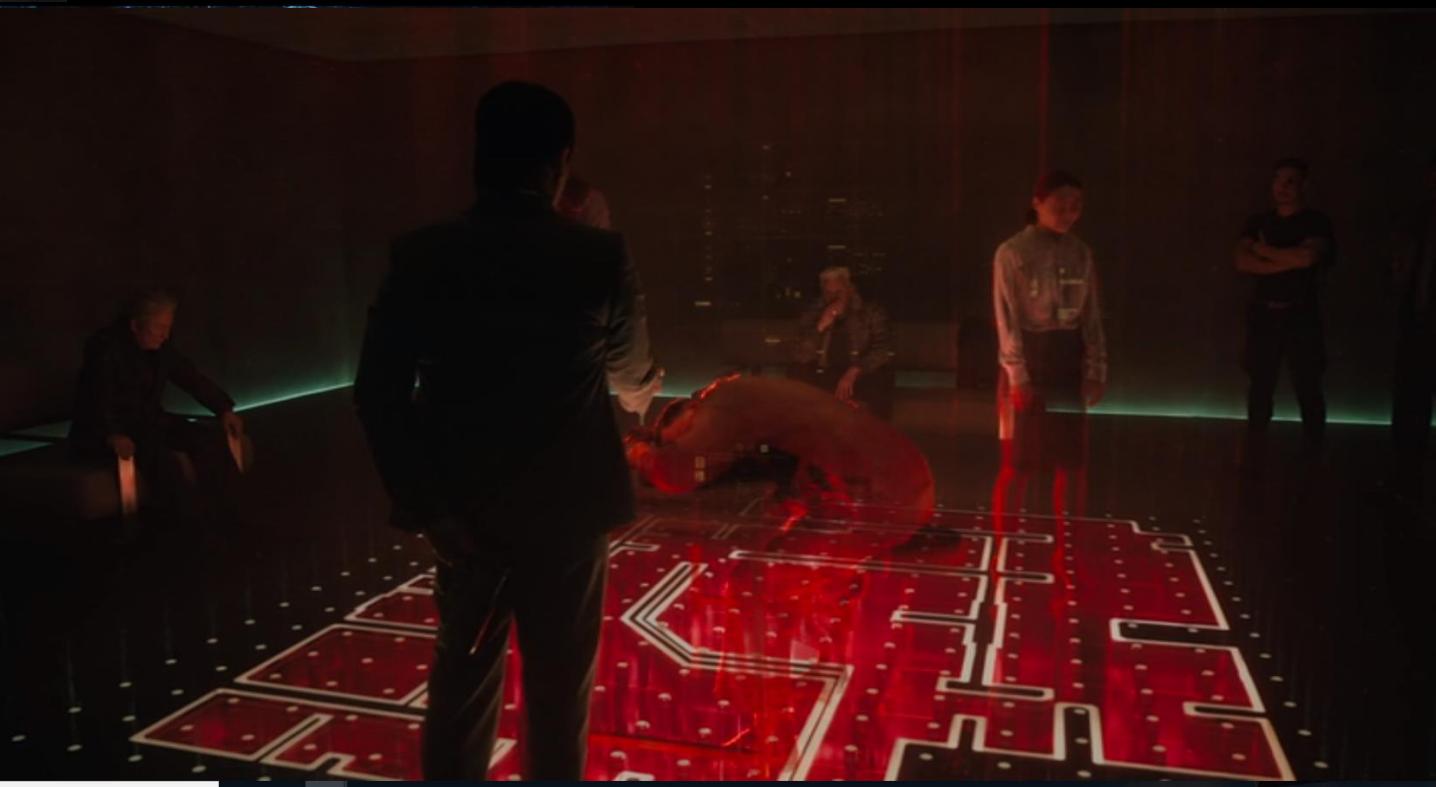
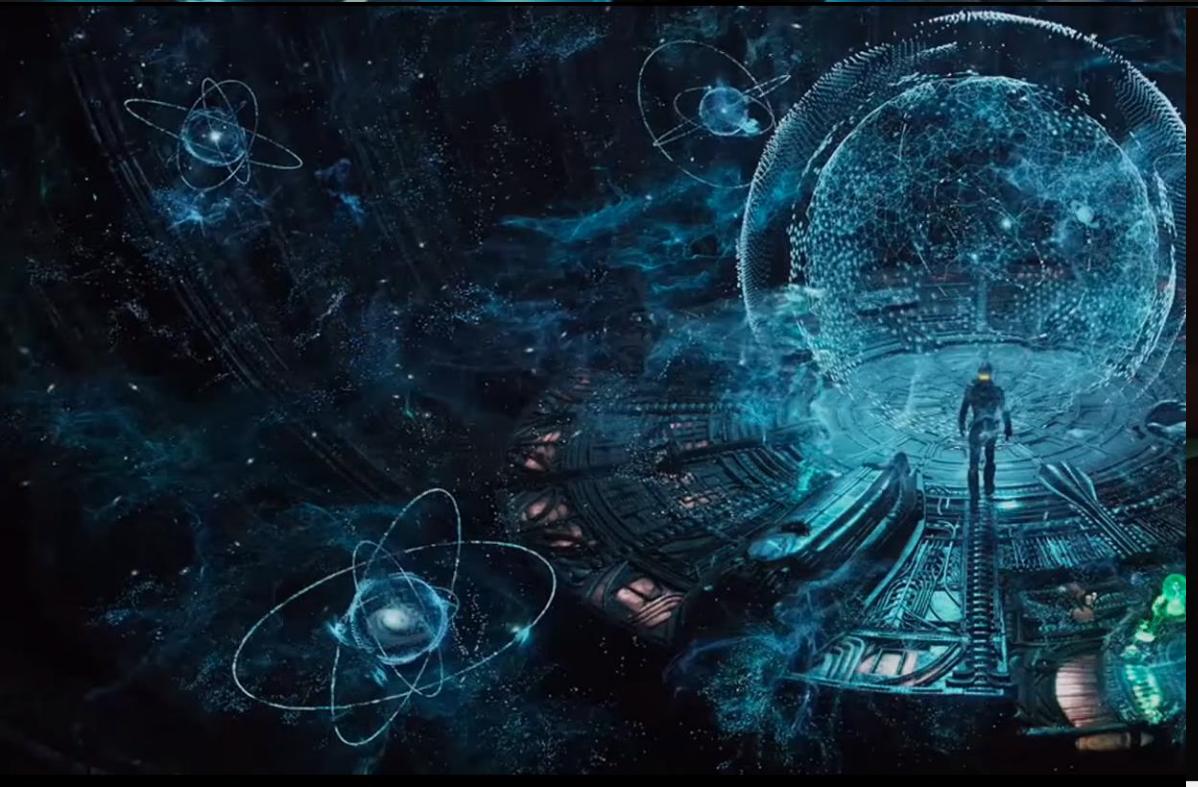
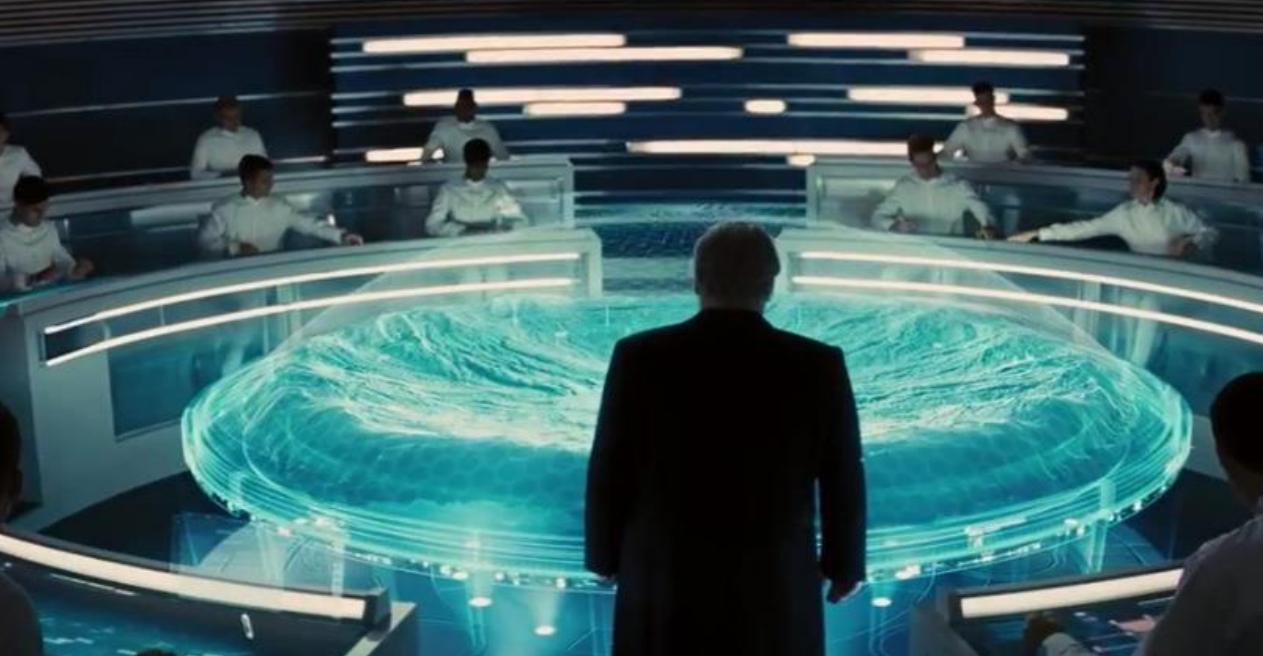
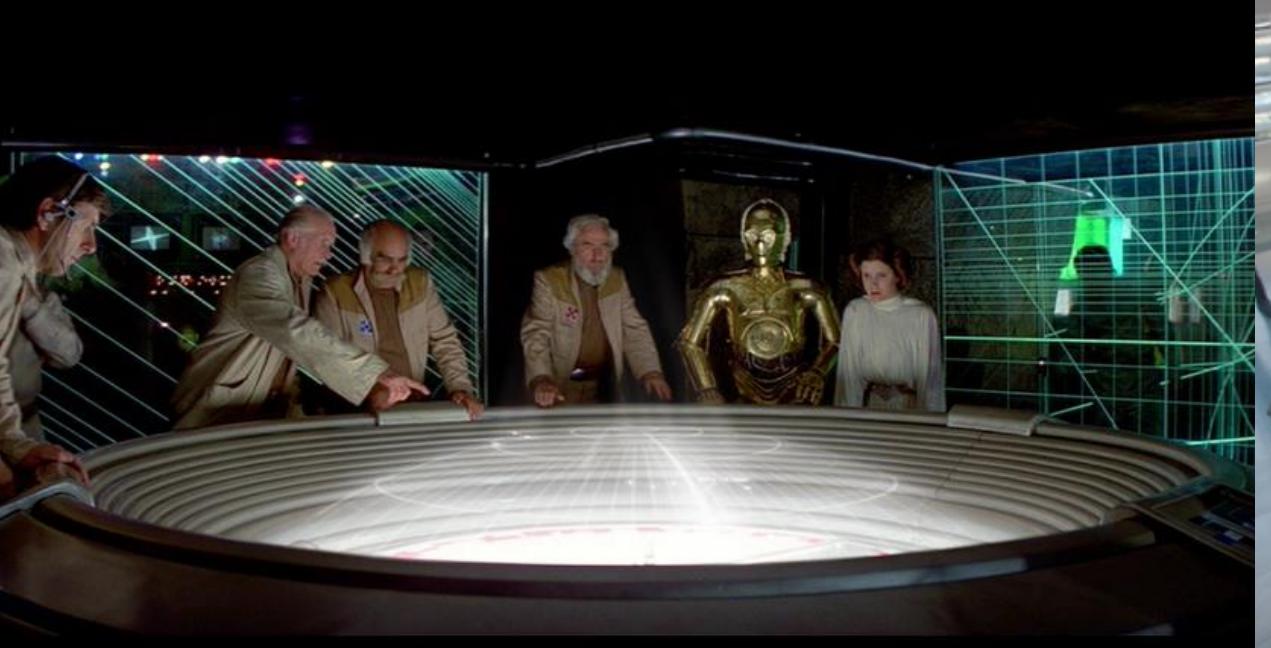
Additional Guidelines

- Make the experience appealing
- Use audio to enhance the experience
- Consider using narrative elements to drive interaction
- Make a complete experience

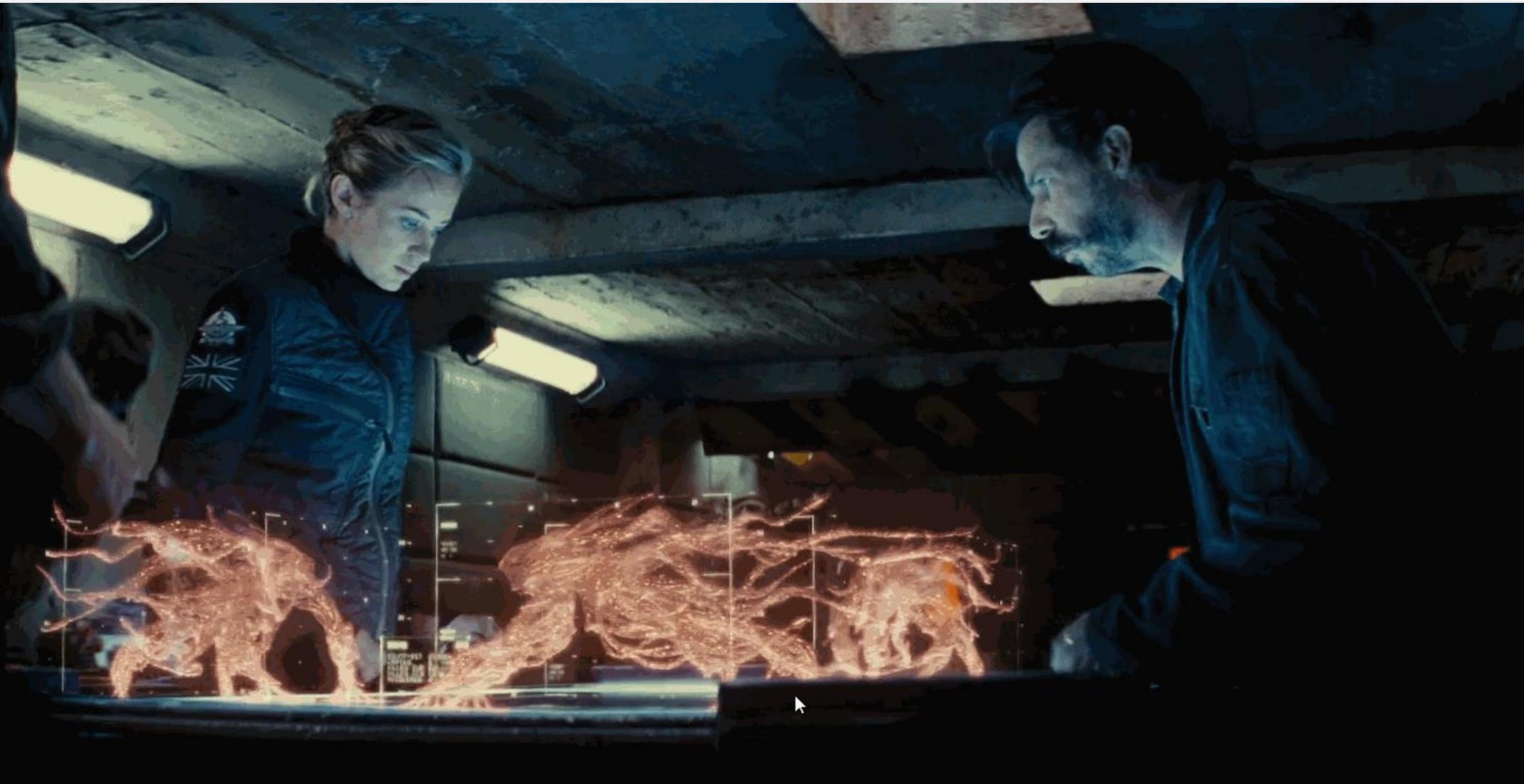


Explicative Stage

- 1. Organize the spatial environment to maximize efficiency**
- 2. Create flexible interactions and environments**
- 3. Keep users in control**
- 4. Keep it simple: do not overwhelm the user**
- 5. Design around hardware capabilities and limitations**
- 6. Prioritize user's comfort**
- 7. Build upon real world knowledge**
- 8. Provide feedback and consistency**
- 9. Use cues to help users throughout their experience**
- 10. Design for error tolerance**
- 11. Create a compelling experience**



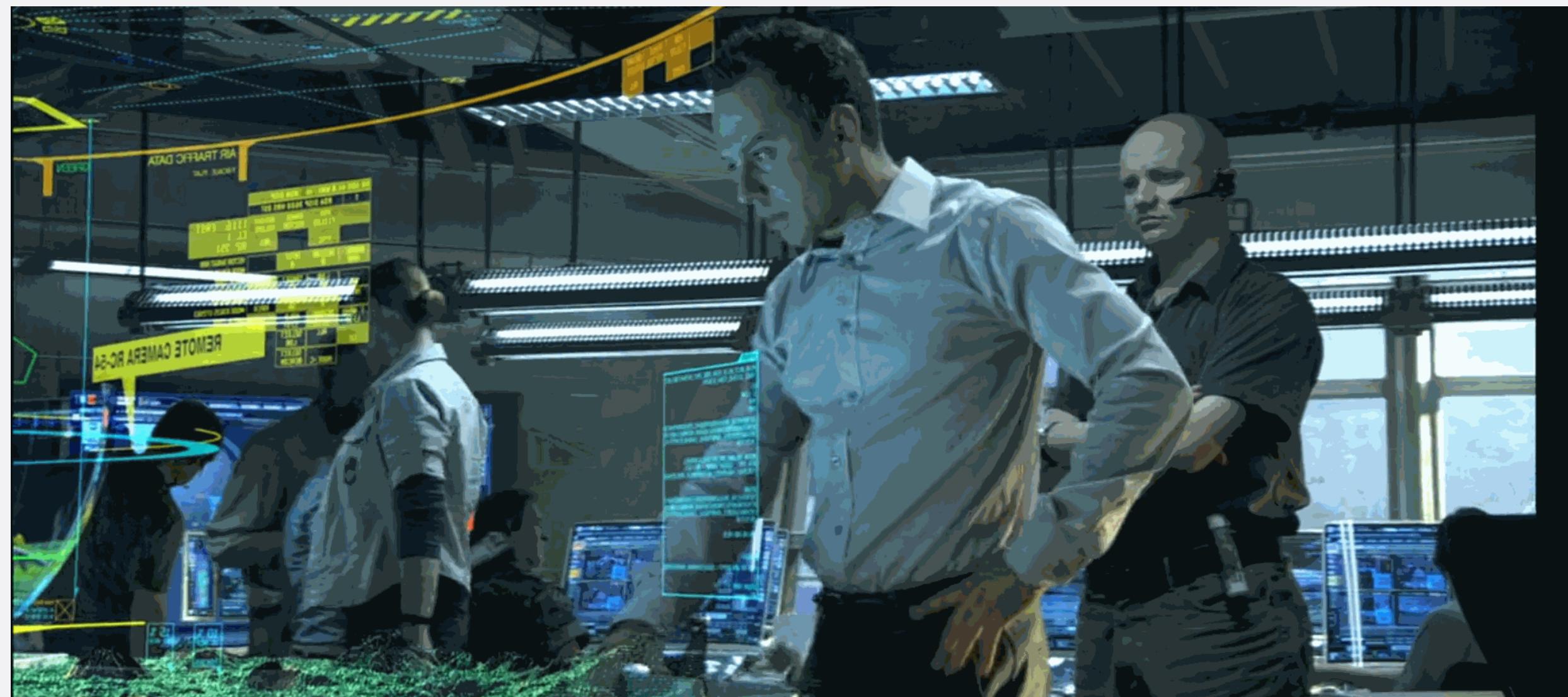
Edge of Tomorrow



Notes

- Touch table system
- Everything is done through the touch screen
- Holograms are constantly spinning
- This shows off holograms to everyone surrounding the display

Avatar



Notes

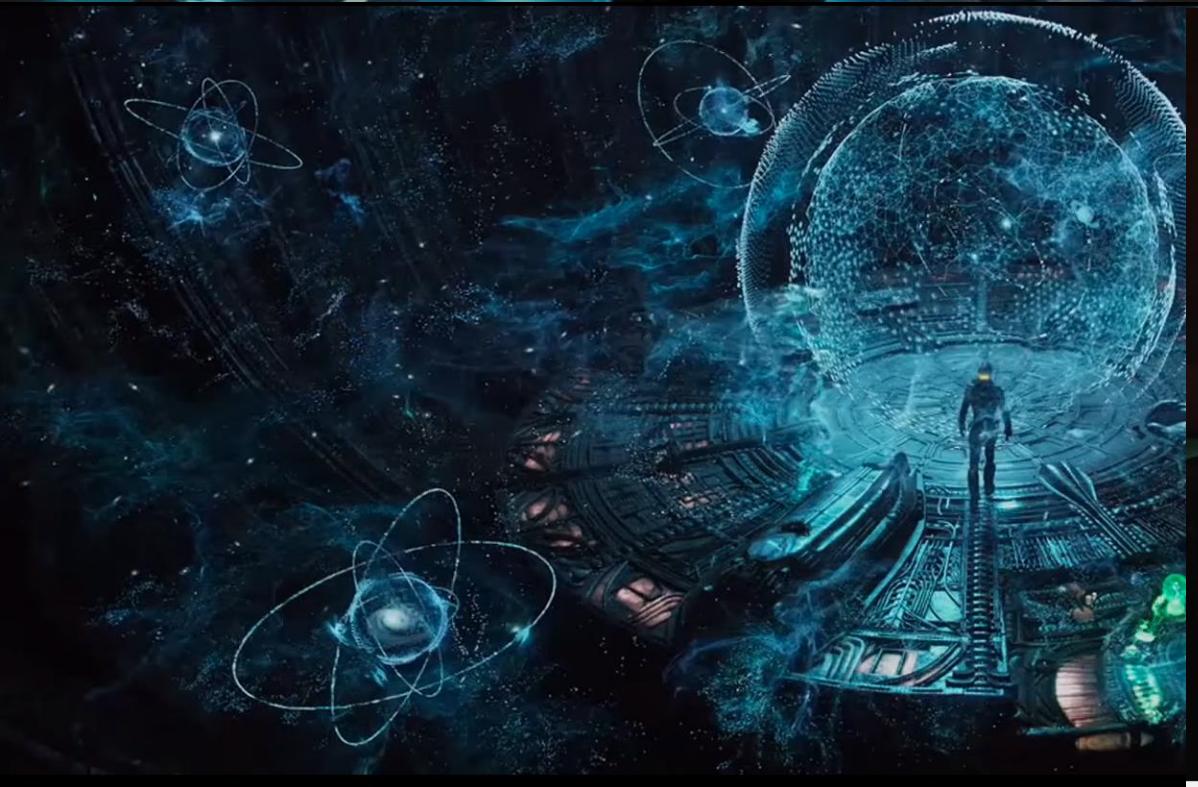
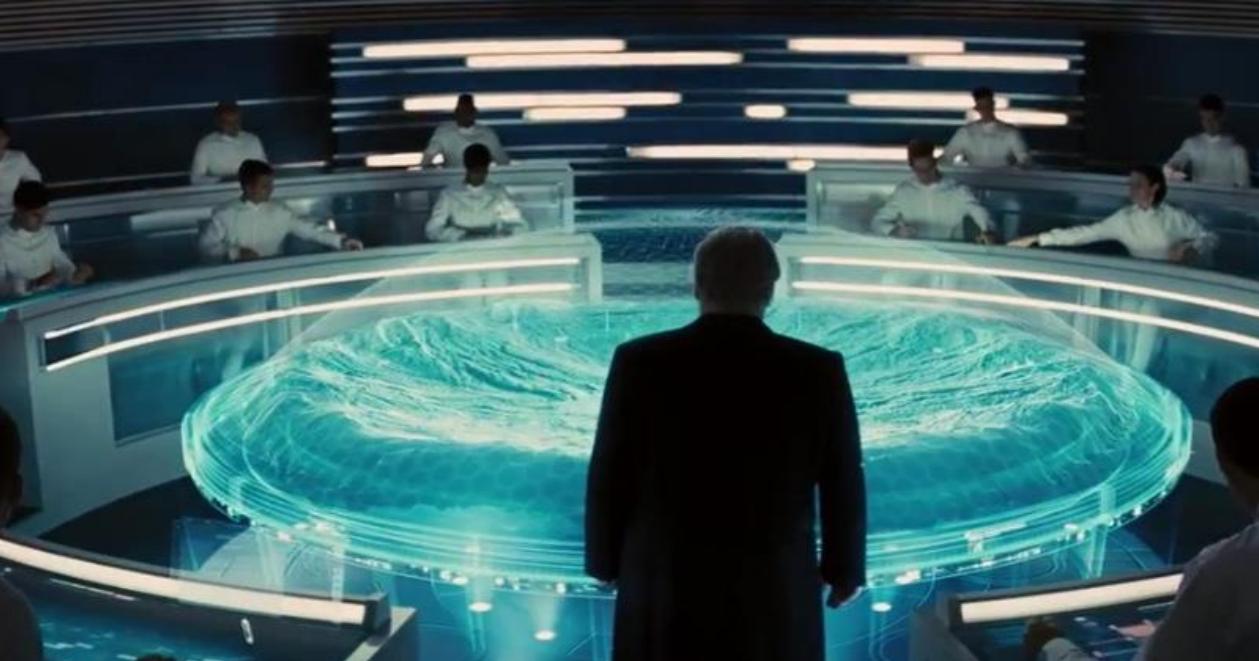
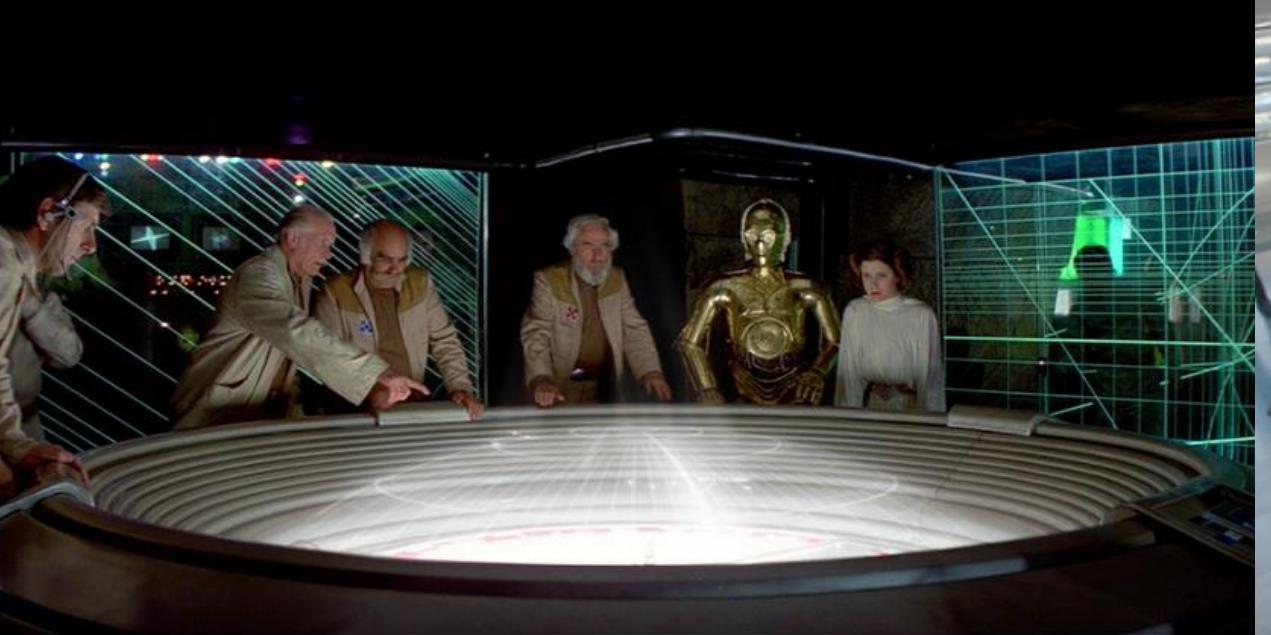
- Physical Dial and small touch screen to interact with the system
- Cannot interact with the holograms itself
- Cluttered system holograms
- Menus are not made for viewing at multiple angles

The Hunger Games



Notes

- **Holograms are used through the entire system**
- **Tasks are distributed among different members of the center**
- **Personal and collaborative holographic display interact with each other**
- **For the most part, users can only interact with one side of the collaborative hologram**



Questions?