CIS 4930-001: Introduction to Augmented and Virtual Reality

Design for AR/VR

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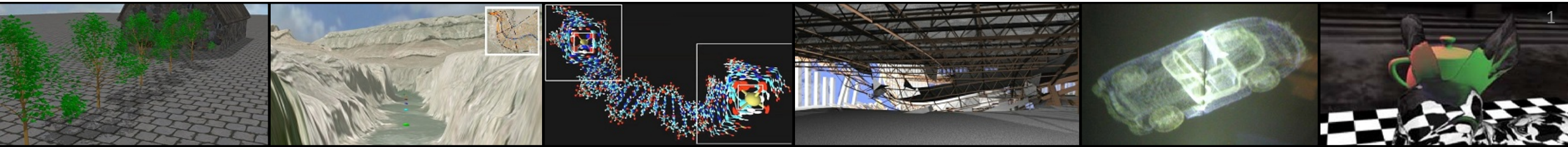
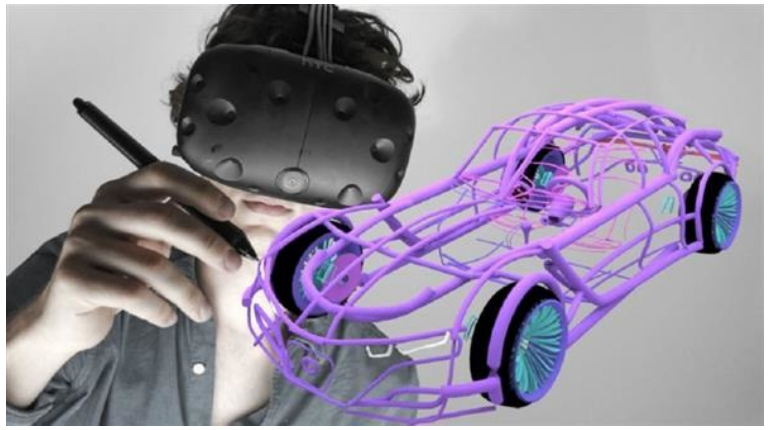


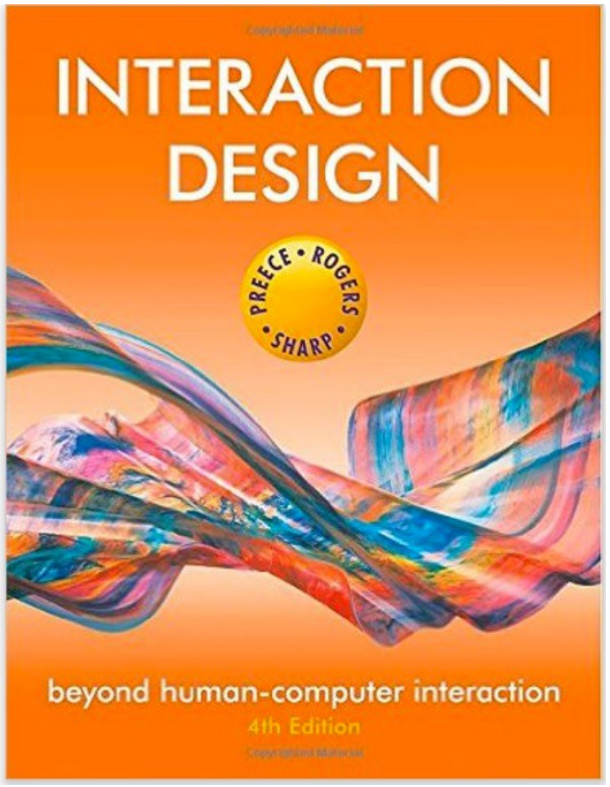
How Can we Design AR/VR experiences that meet real needs



What is Interaction Design ?

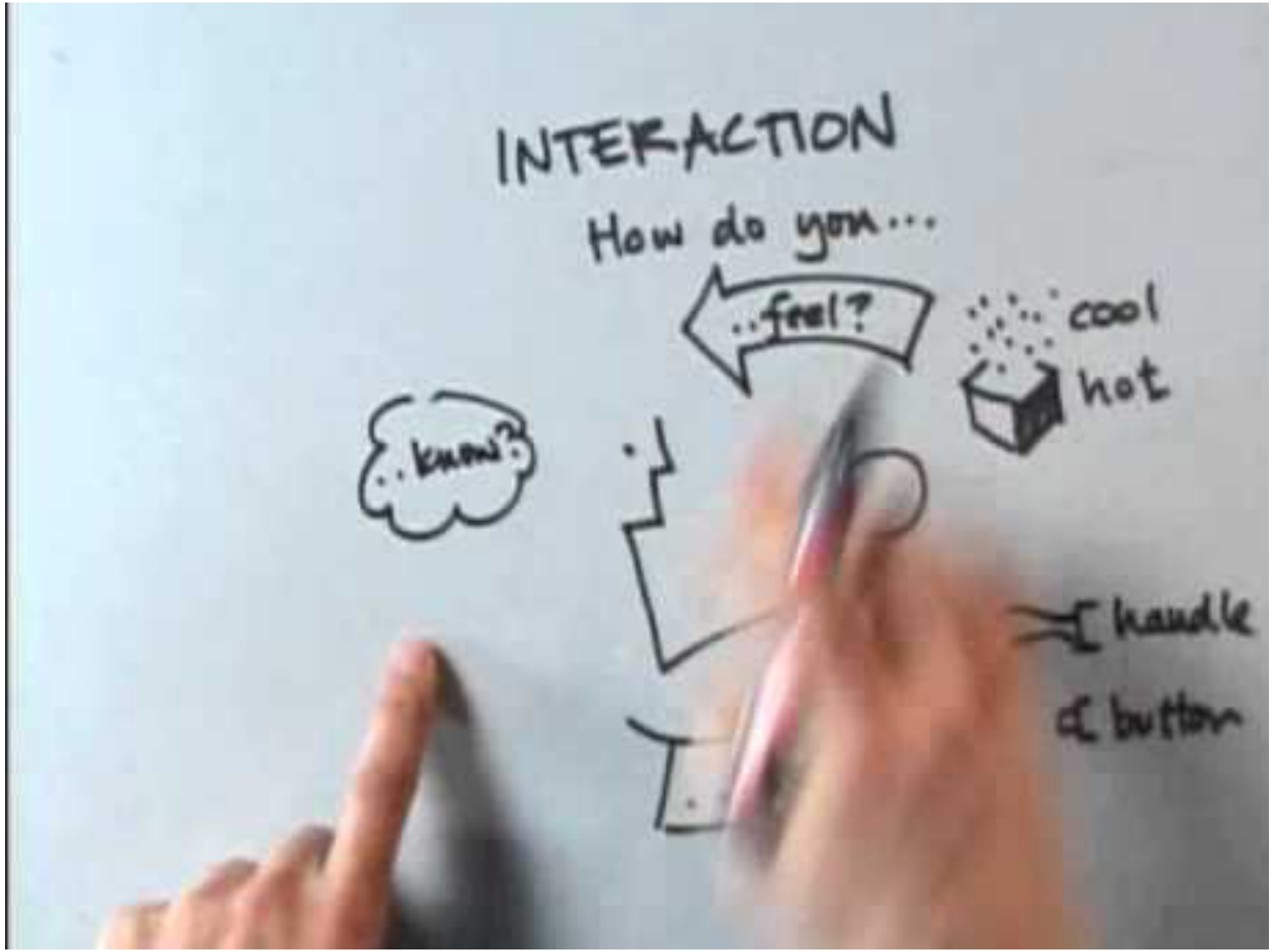
"Designing interactive products to support people in their everyday and working lives"

J. Preece, Interaction Design, 2002.



Interaction Design is the design of user experience with technology

Bill Verplank on Interaction Design



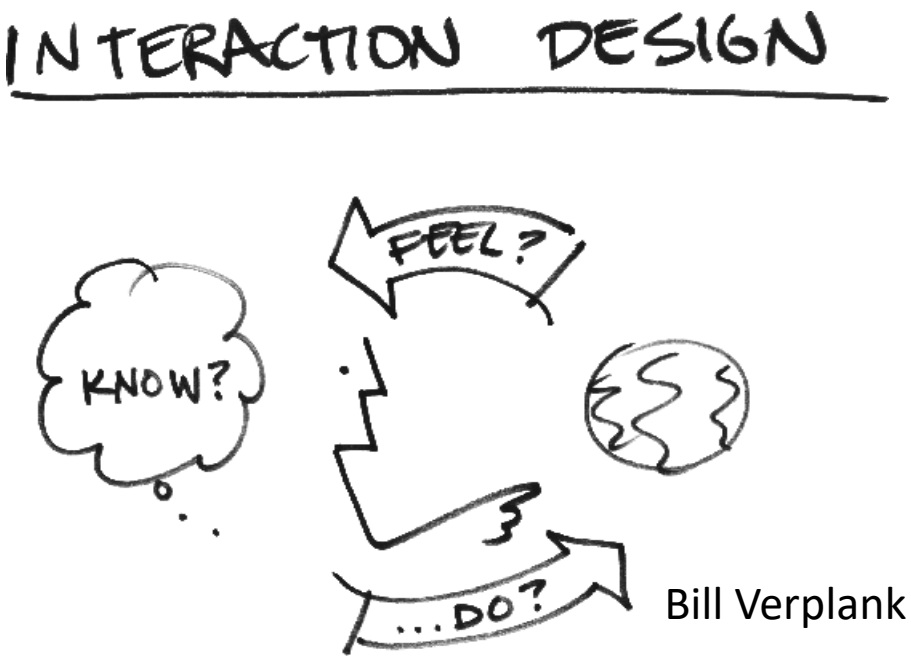
https://youtu.be/Gk6XAmALOWI

Interaction Design involves answering three questions:

What do you do? – How do you affect the world?

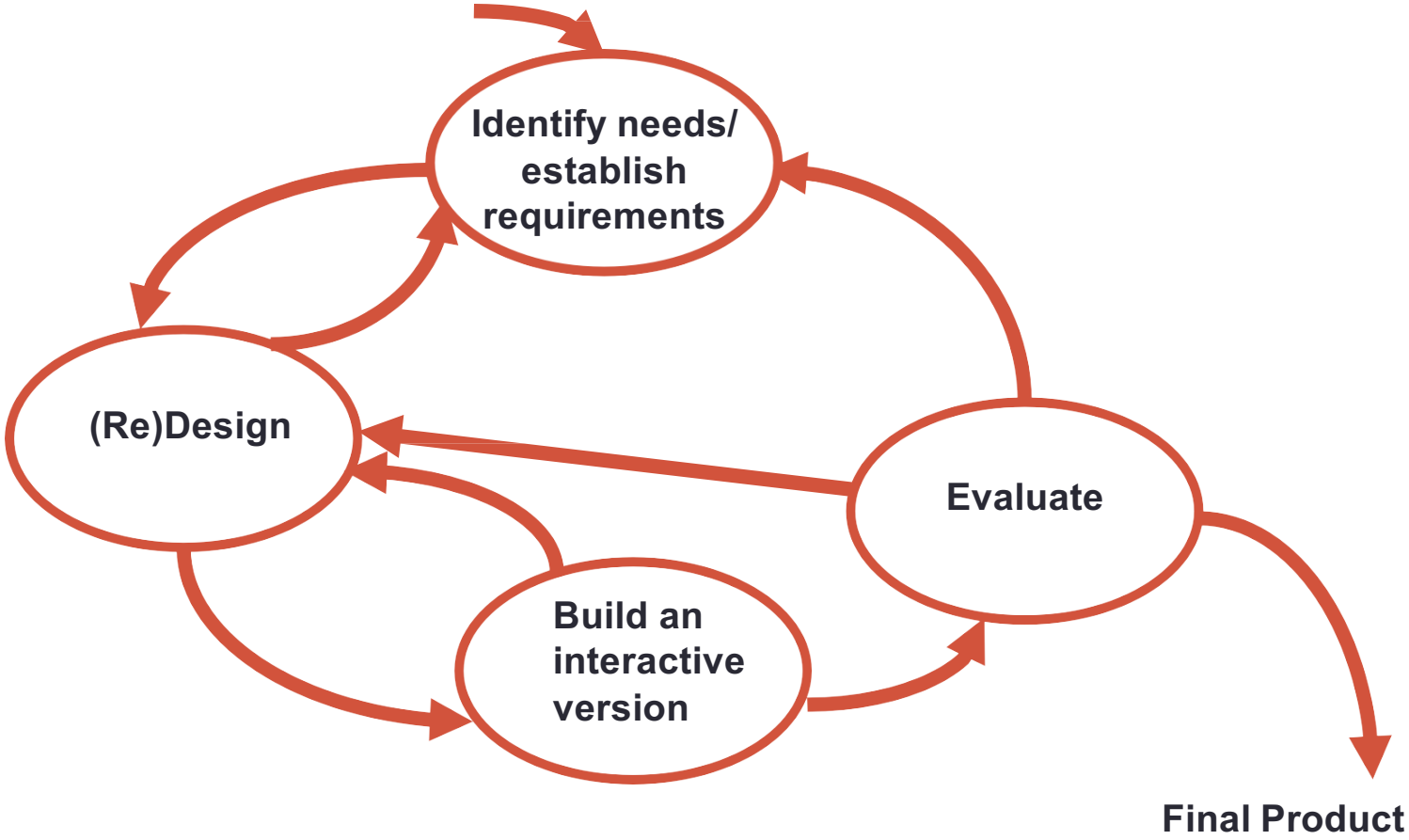
What do you feel? – What do you sense of the world?

What do you know? – What do you learn?



Bill Verplank

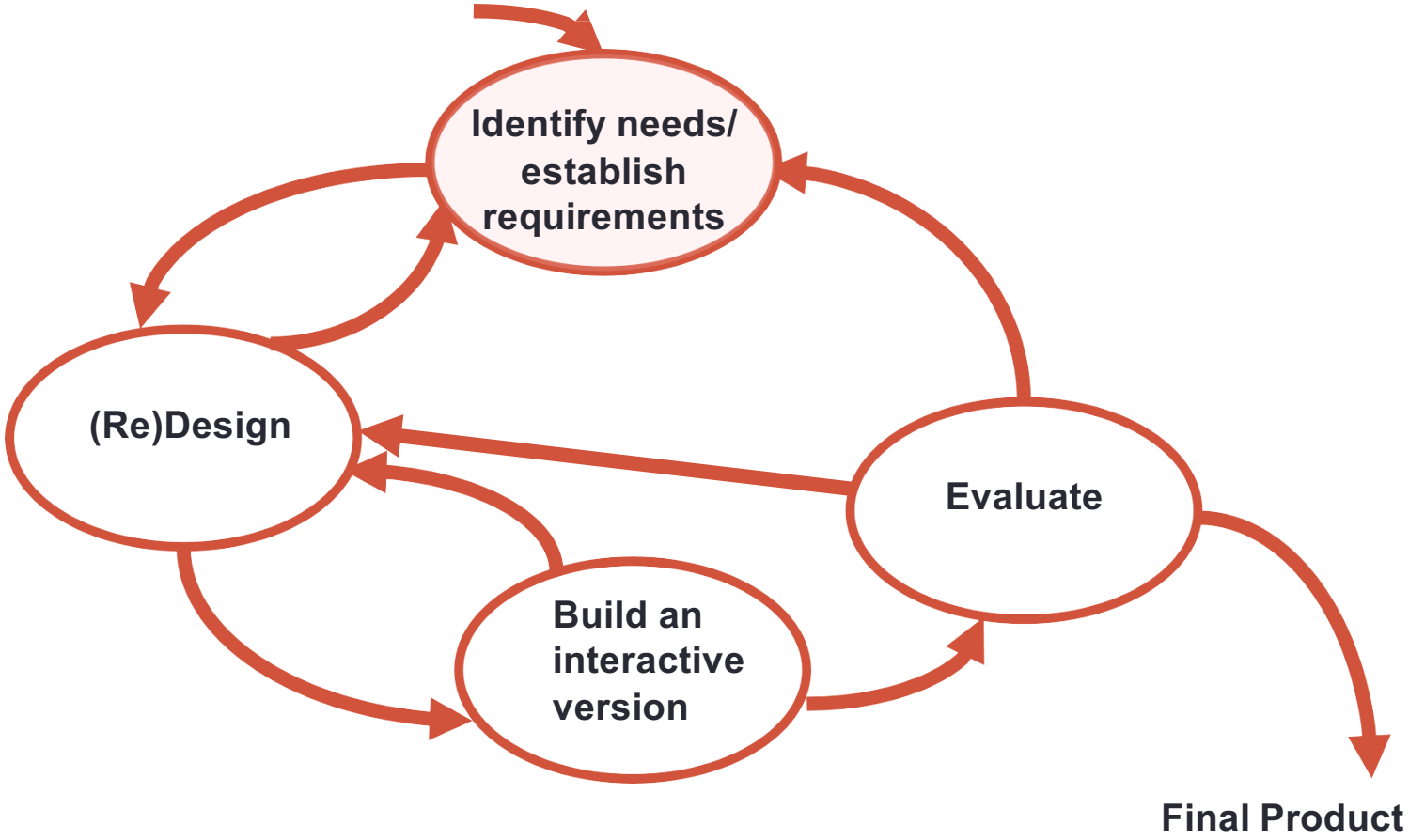
The Interaction Design Process



Develop alternative prototypes/concepts and compare them

And iterate, iterate, iterate....

NEEDS ANALYSIS



Needs Analysis Goals

1. Create a deep understanding of the user and problem space
2. Understand how AR/VR can help address the user needs

Key Questions

Who is the user?

- Different types of users

What are the user needs?

- Understand the user, look for insights

Can VR address those needs?

- VR cannot solve all problems

Who are the Users?

Different types of users, must consider them all

- Primary: people regularly using the AR/VR system
- Secondary: people providing tech support/developing system
- Tertiary: people providing funding/space for AR/VR system

Methods for Identifying User Needs

Learn from people

Learn from Experts

Learn from analogous settings

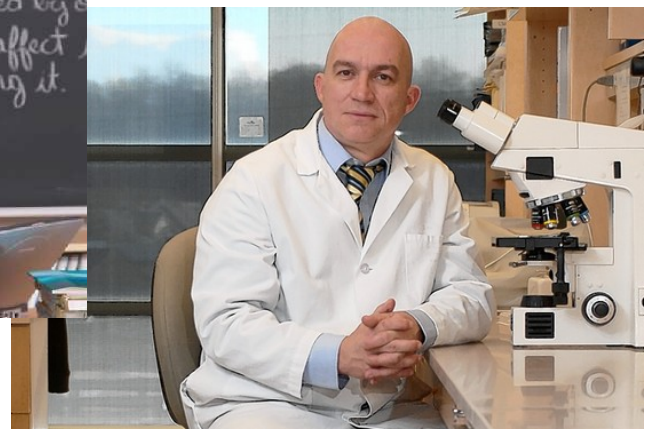
Immersive yourself in context

Learn from People

Learn from target users by:

- Questionnaires and interviewing
- Running focus groups
- Observing people performing target tasks

Learn from Experts



Experts have in-depth knowledge about topic

- Can give large amount of information in short time
- Look for existing process/problem documentation

Choose participants with domain expertise

- Expertise, radical opinion, etc.

IMMERSIVE YOURSELF IN CONTEXT

A day in the Life of.. Cultural Probes.. Role Playing..

Put yourself in the position of the user

- Role playing, a day in the life of a user, cultural probes
- Observing the problem space around you – how do you feel?

Take notes and capture your observations

Seek Inspiration in Analogous Setting

What can public libraries learn from Apple stores?

Inspiration in different context than problem space

- E.g. redesign library by going to Apple store

Think of Analogies that connect with challenge

- Similar scenarios in different places

Identifying User Needs

From understanding the user, look for needs

- Human emotional or physical necessities.
- Needs help define your design

Needs are Verbs not Nouns

- Verbs (activities and desires)
- Nouns (solutions)

Identify needs from the user traits you noted, or from contradictions between information

- disconnect between what user says and what user does

Is AR/VR the Best Solution?

Not every problem can be solved by AR/VR

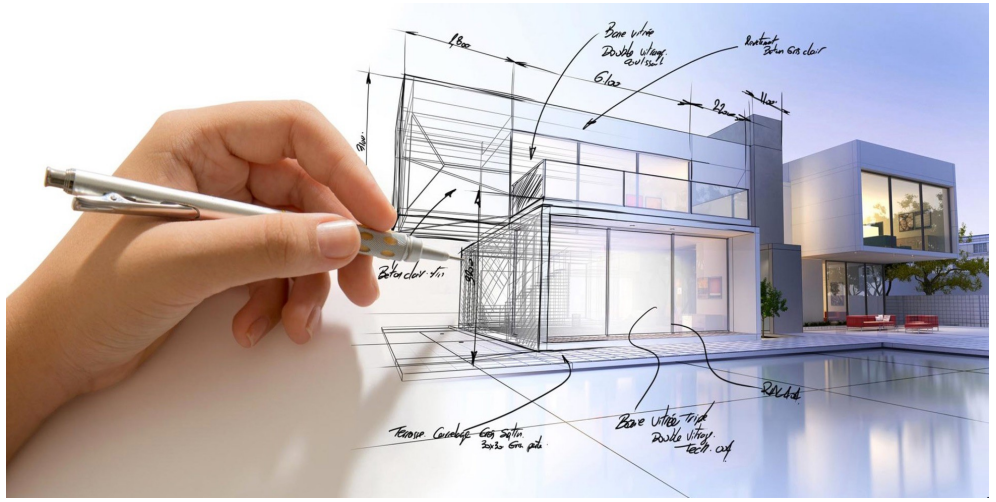
Problems Ideal for AR/VR, have:

- visual elements
- 3D spatial interaction
- physical manipulation
- procedural learning
- [AR]need for connection with real world

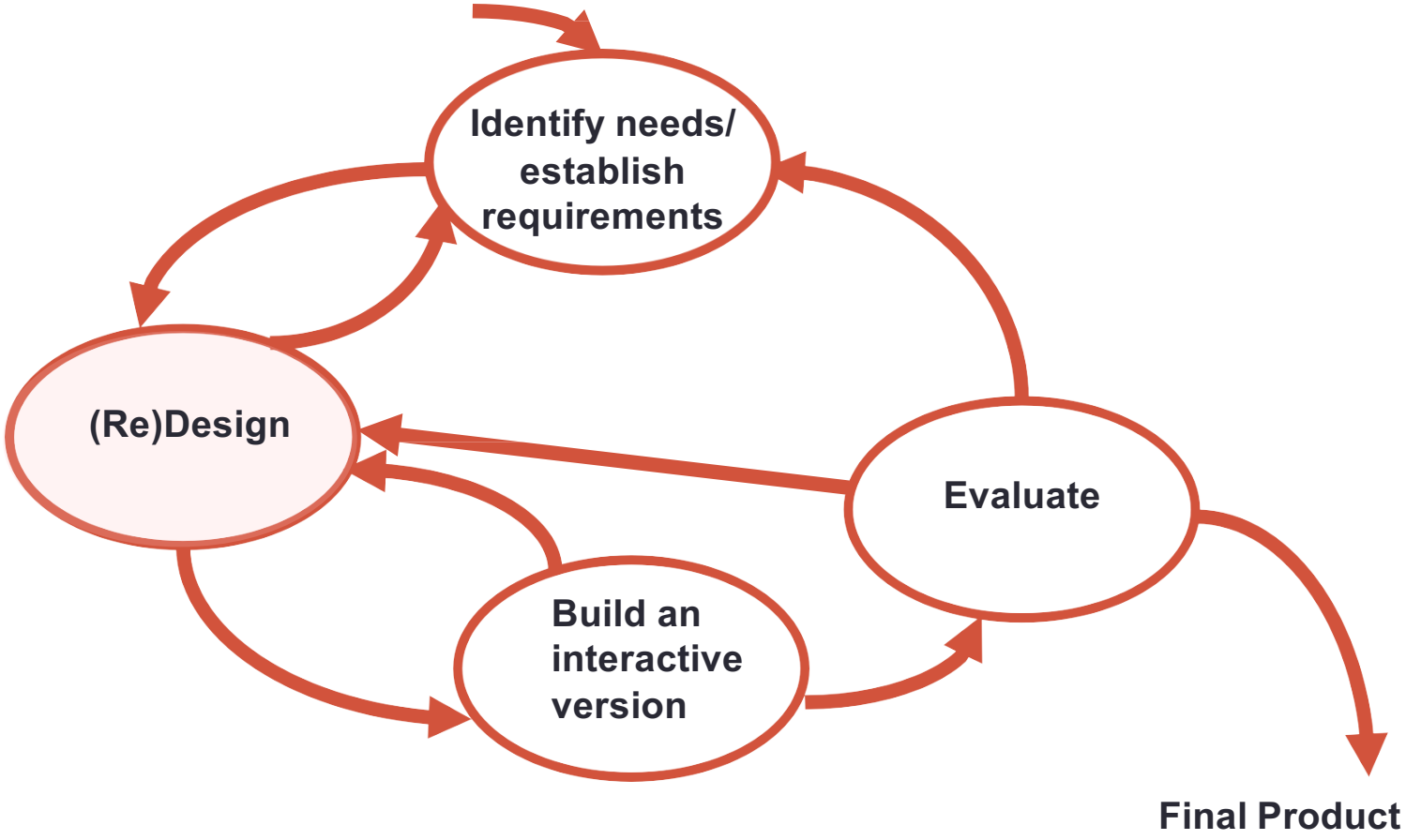
Problems Not ideal for AR/VR, have:

- heavy reading, text editing
- many non visual elements
- non spatial tasks
- need for tactile, haptic, olfaction feedback

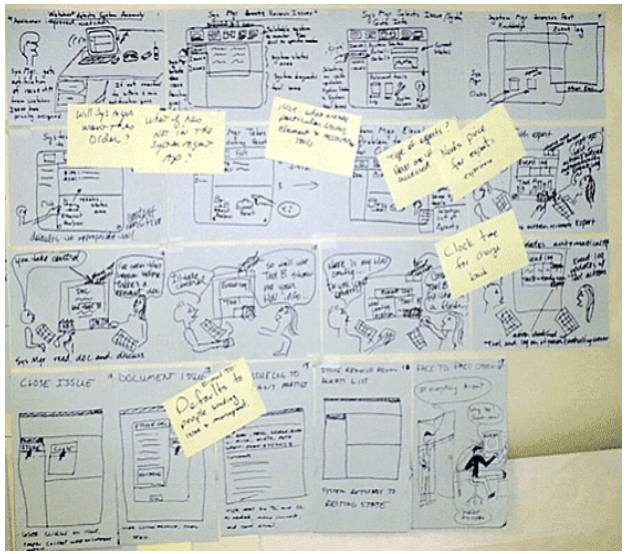
SUITABLE FOR VR OR NOT?



DESIGN


Identify needs/ establish requirements
(Re)Design
Evaluate
Build an interactive version
Final Product

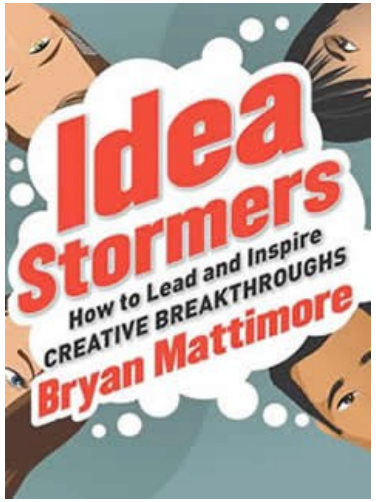
Idea Generation



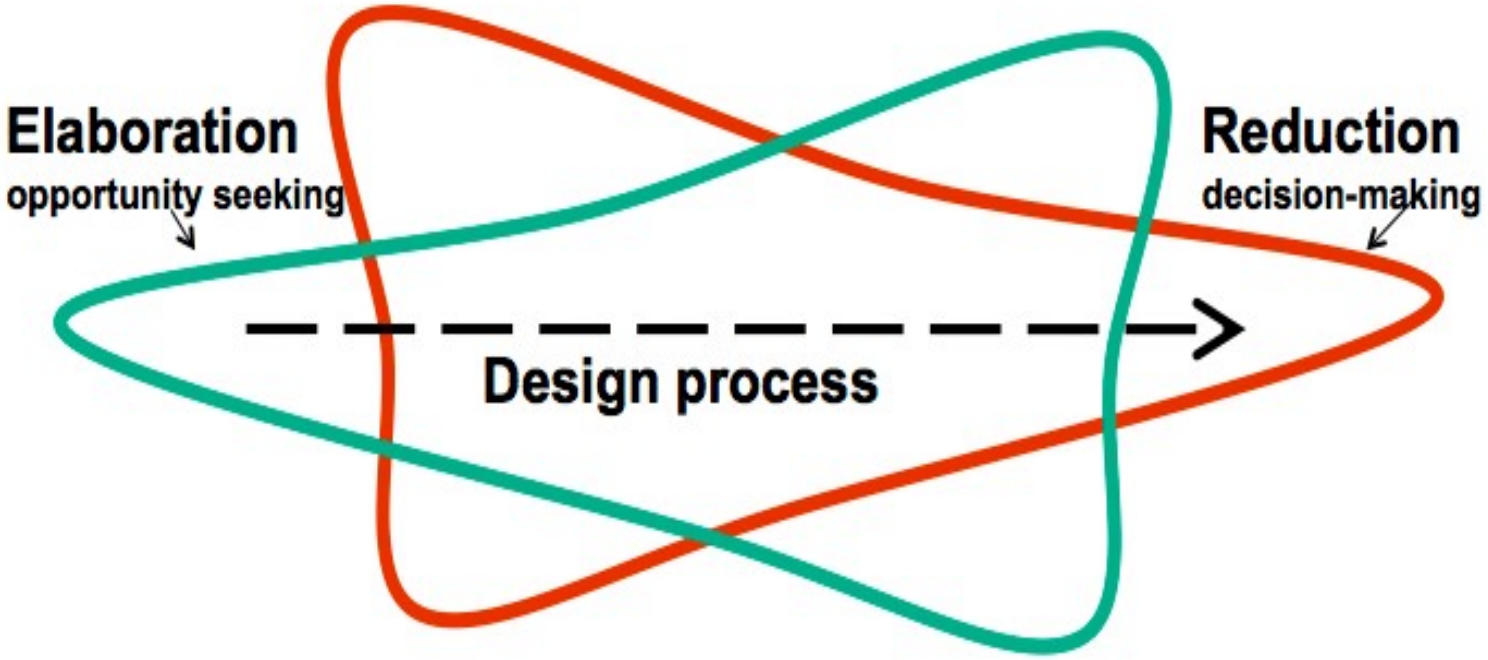
Once user need is found, solutions can be proposed

Idea generation through:

- Brainstorming
- Lateral thinking
- Ideal storming
- Formal problem solving
- Etc..



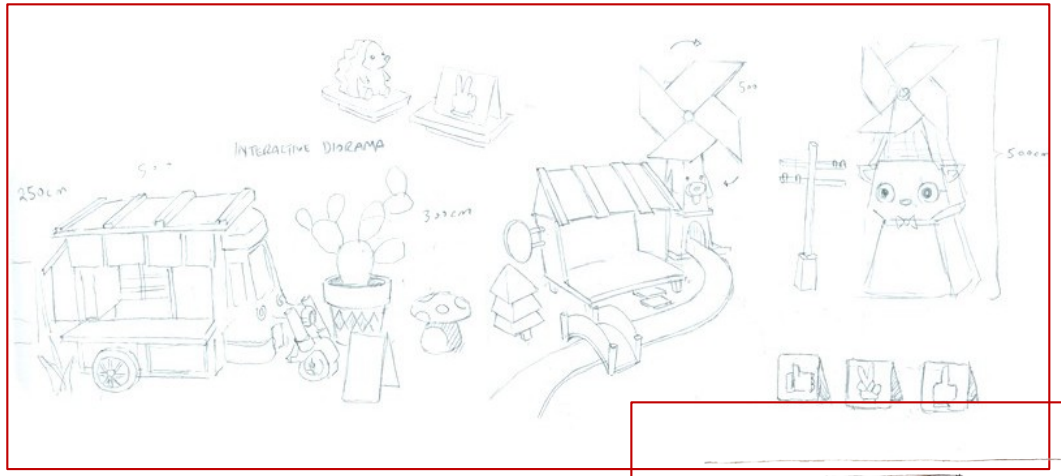
ELABORATION AND REDUCTION

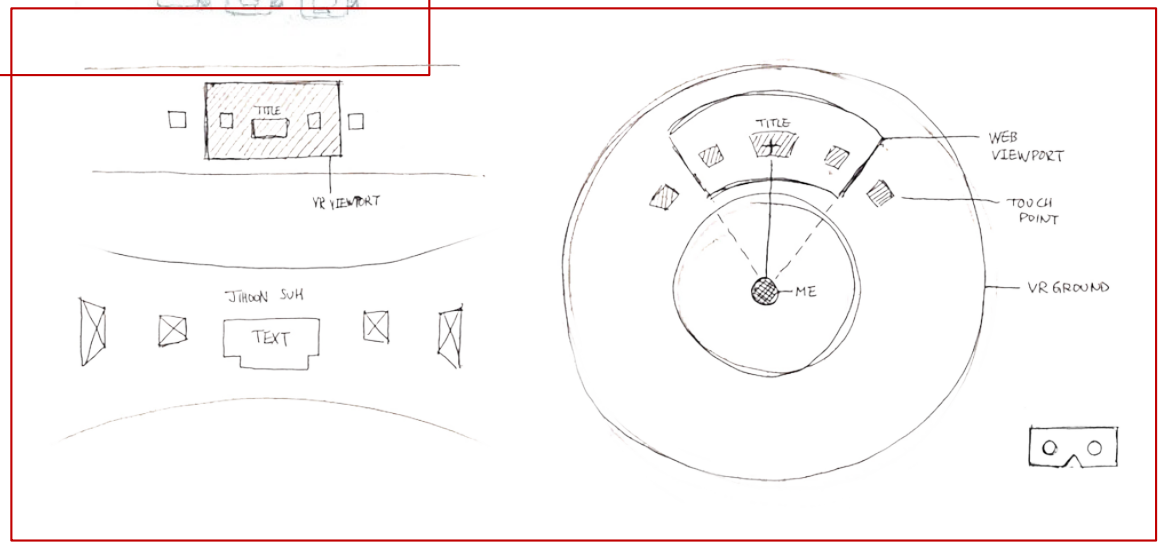


Elaborate on Ideas and Reduce to Final Design Direction

- Elaborate - generate solutions. These are the opportunities.
- Reduce - decide on the ones worth pursuing
- Repeat - elaborate and reduce again on those solutions

Interface Design Sketches



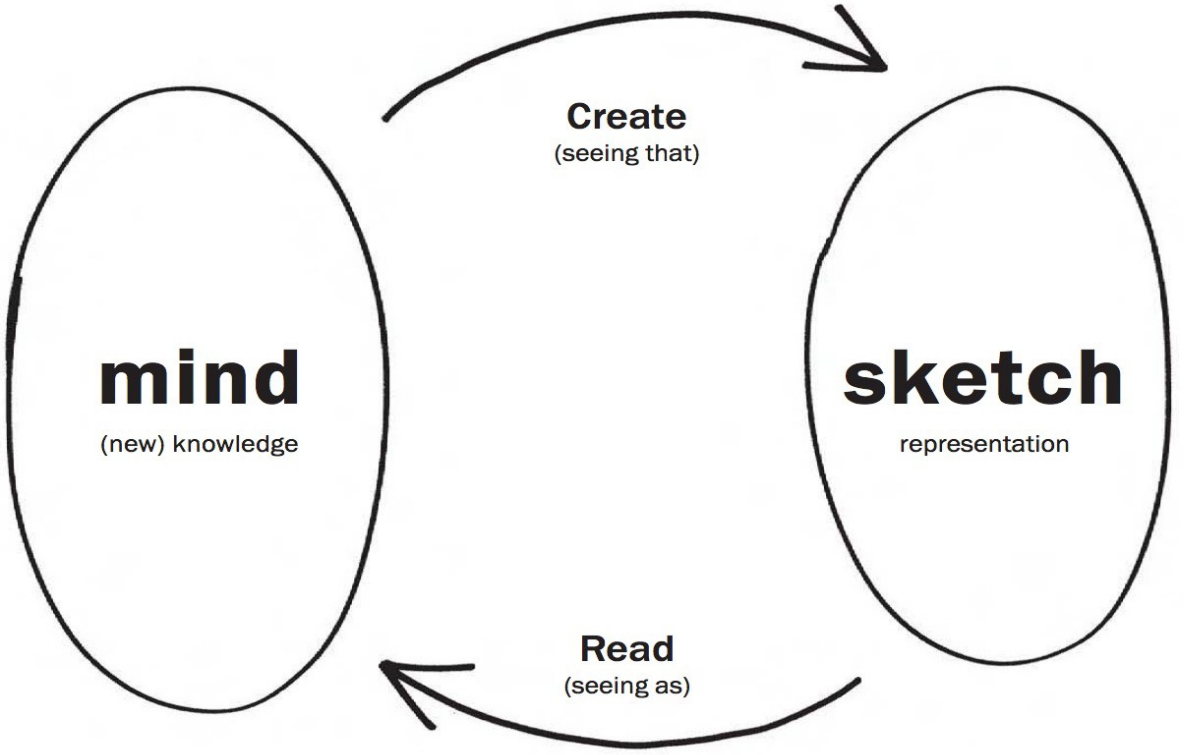


ROLE OF SKETCHING

Use sketching as way to communicate and create new ideas

"Sketching is about the activity not the result"

Bill Buxton



Why is Sketching Useful?

Early ideation

Think through ideas

Force you to visualize how things come together

Communicate ideas to inspire new designs

Ideal for active brainstorming

Beginning of prototyping process

VR Design Considerations

Use UI Best Practices

- Adapt know UI guidelines to VR

Use of Interface Metaphors/Affordances

- Decide best metaphor for VR application

Design for Humans

- Use Human Information Processing model

Design for Different User Groups

- Different users may have unique needs

Design for the Whole User

- Social, cultural, emotional, physical cognitive

Use UI Best Practices

General UI design principles can be applied to VR

- E.g. Shneiderman's UI guidelines

Providing interface feedback

- Mixture of reactive, instrumental and operational feedback
- Maintain spatial and temporal correspondence

Use constraints

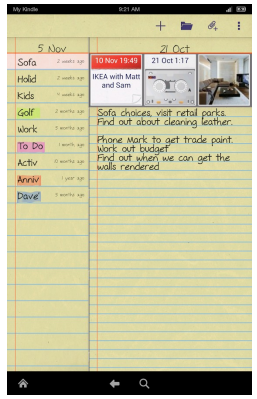
- Specify relations between variables that must be satisfied
  - E.g. physical constraints reduce freedom of movement

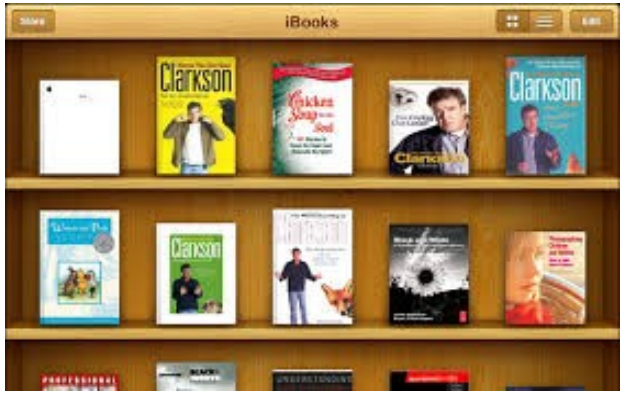
Support Two-Handed control

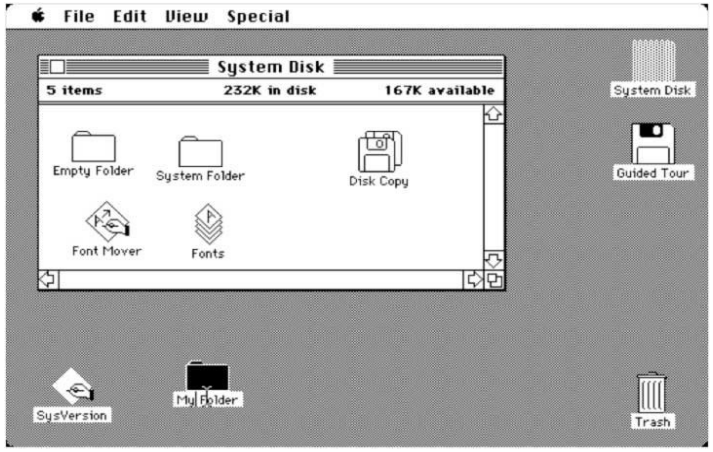
- Use Guiard's framework of bimanual manipulation
  - Dominant vs. non-dominant hands

Ben Shneiderman, Designing the User Interface: Strategies for Effective Human-Computer Interaction, 1997

Use Interface Metaphors







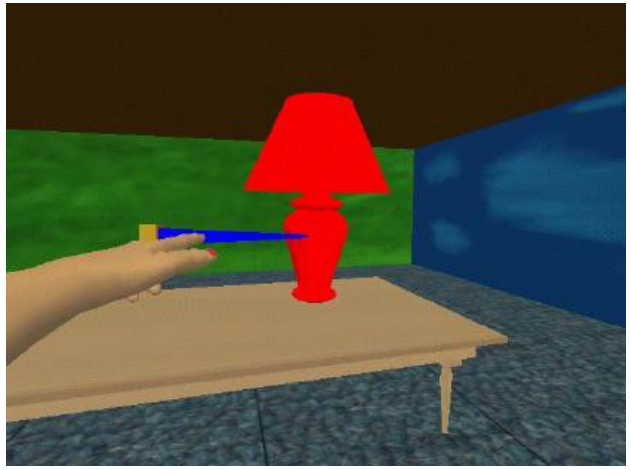
Design interface object to be similar to familiar physical object that the user knows how to use

- E.g. Desktop metaphor, spreadsheet, calculator

Benefits

- Makes learning interface easier and more accessible
- Users understand underlying conceptual model

Typical AR/VR Interface Metaphors



Direct Manipulation

- Reach out and directly grab objects

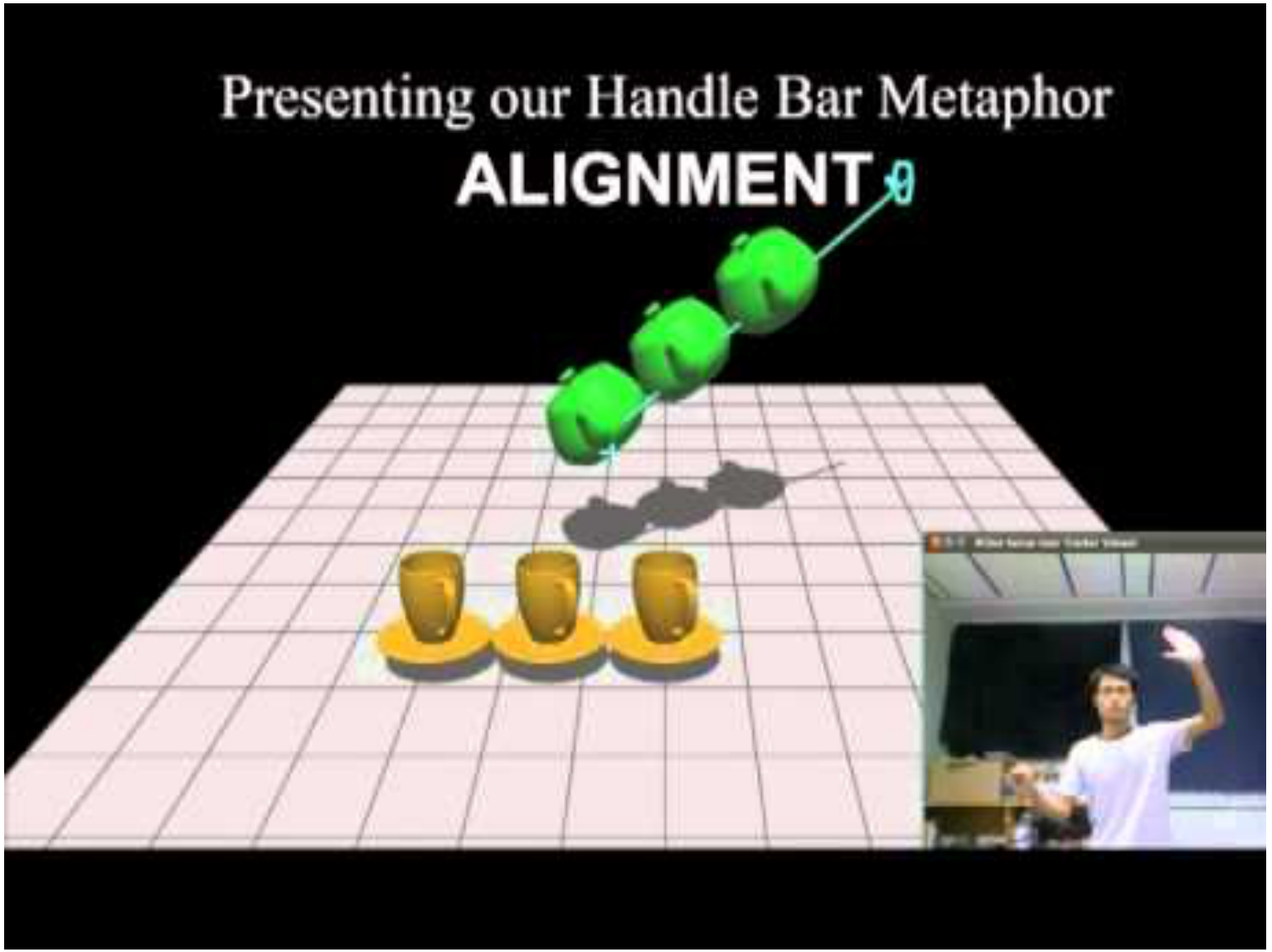
Ray Casting

- Select objects through ray from head/hand

Vehicle Movement

- Move through VR environment through vehicle movement

EXAMPLE: HANDLE BAR METAPHOR



HTTPS://YOUTU.BE/VBCP63JD3OI

How are These Used?

AFFORDANCES

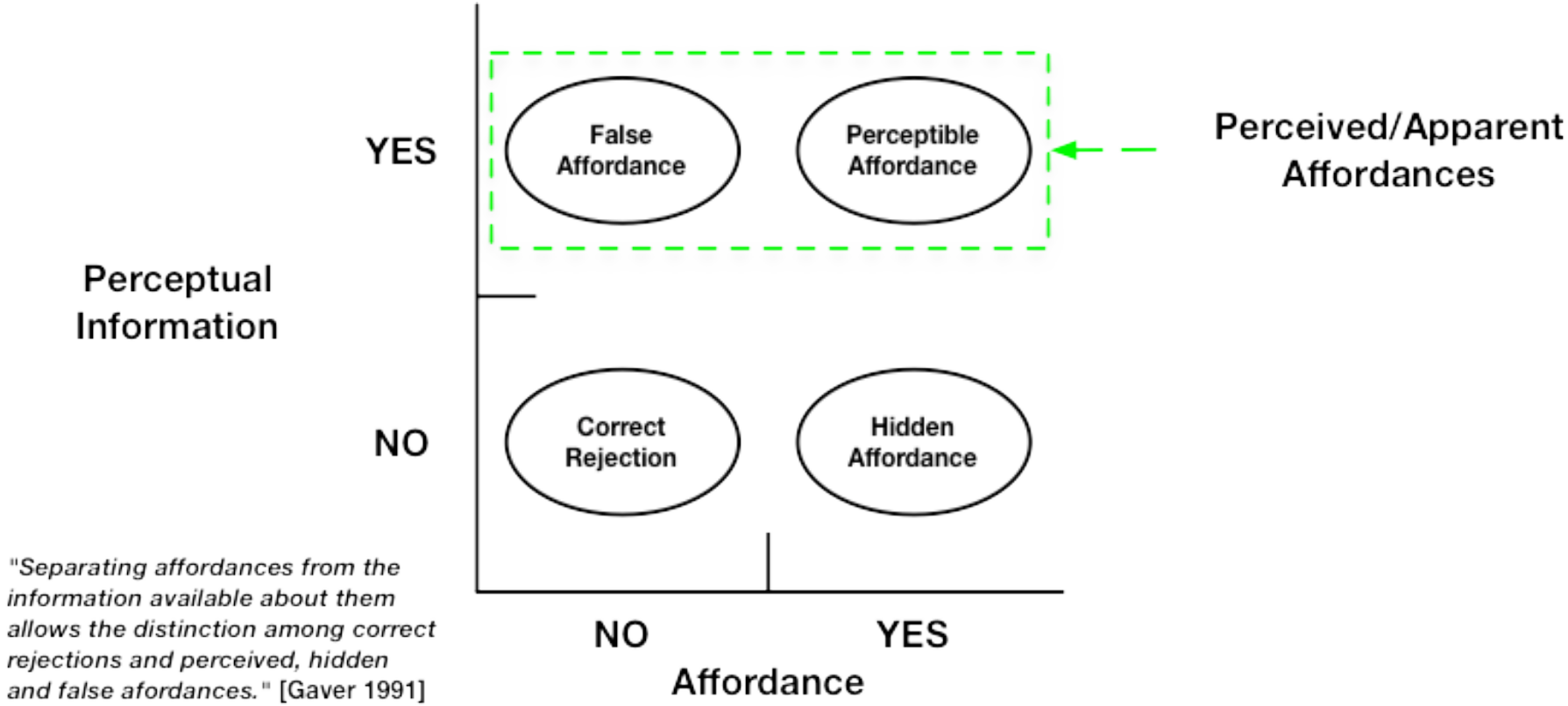
*"… the **perceived** and **actual** properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used.*

[...]

Affordances provide strong clues to the operations of things."

NORMAN, THE PSYCHOLOGY OF EVERYDAY THINGS 1988, P.9

PERCEIVED VS. ACTUAL AFFORDANCES



"Separating affordances from the information available about them allows the distinction among correct rejections and perceived, hidden and false afordances." [Gaver 1991]

Perceived affordance should match actual affordance

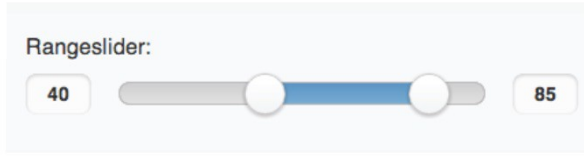
PHYSICAL VS. VIRTUAL AFFORDANCES

Physical Affordance

- Look and feel of real objects
- Shape, texture, color, weight, etc.
- Industrial Design

Virtual Affordance

- Look of virtual objects
- Copy real objects
- Interface Design



AFFORDANCES IN AR/VR

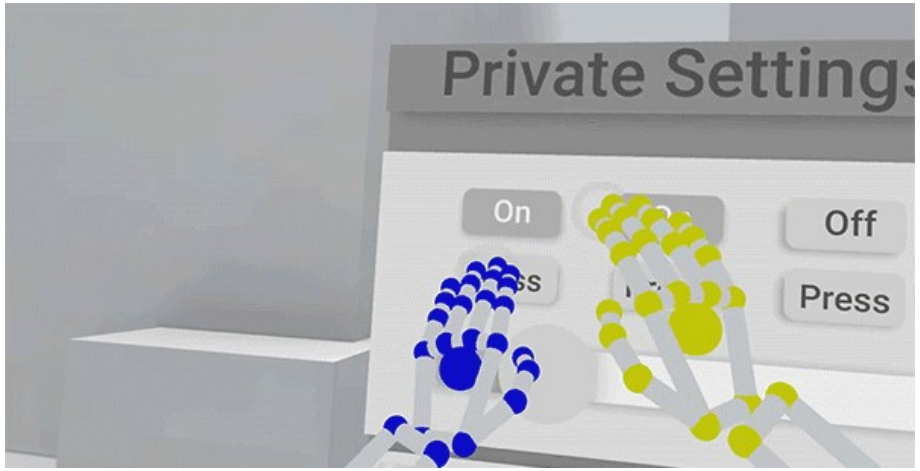
Familiar objects in Job Simulator

Object shape shows how to pick up

Design interface objects to show how they are used

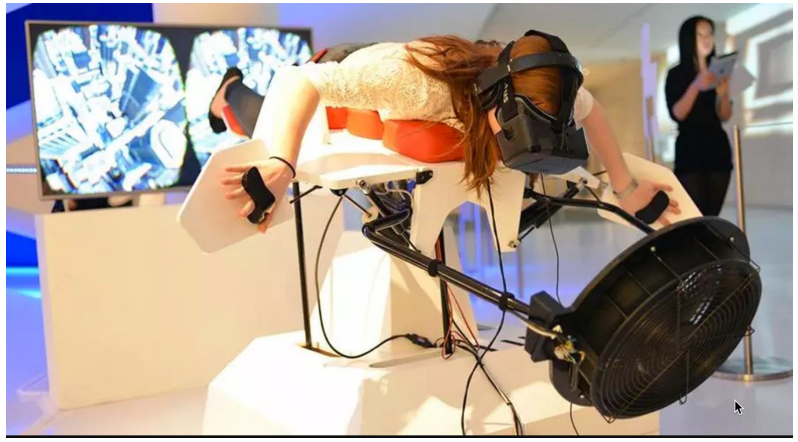
- Use visual cues to show possible affordances
- Perceived affordances should match actual affordances
- Good cognitive model - map object behavior to expected

EXAMPLES OF AFFORDANCES IN AR/VR



Virtual buttons can be pushed

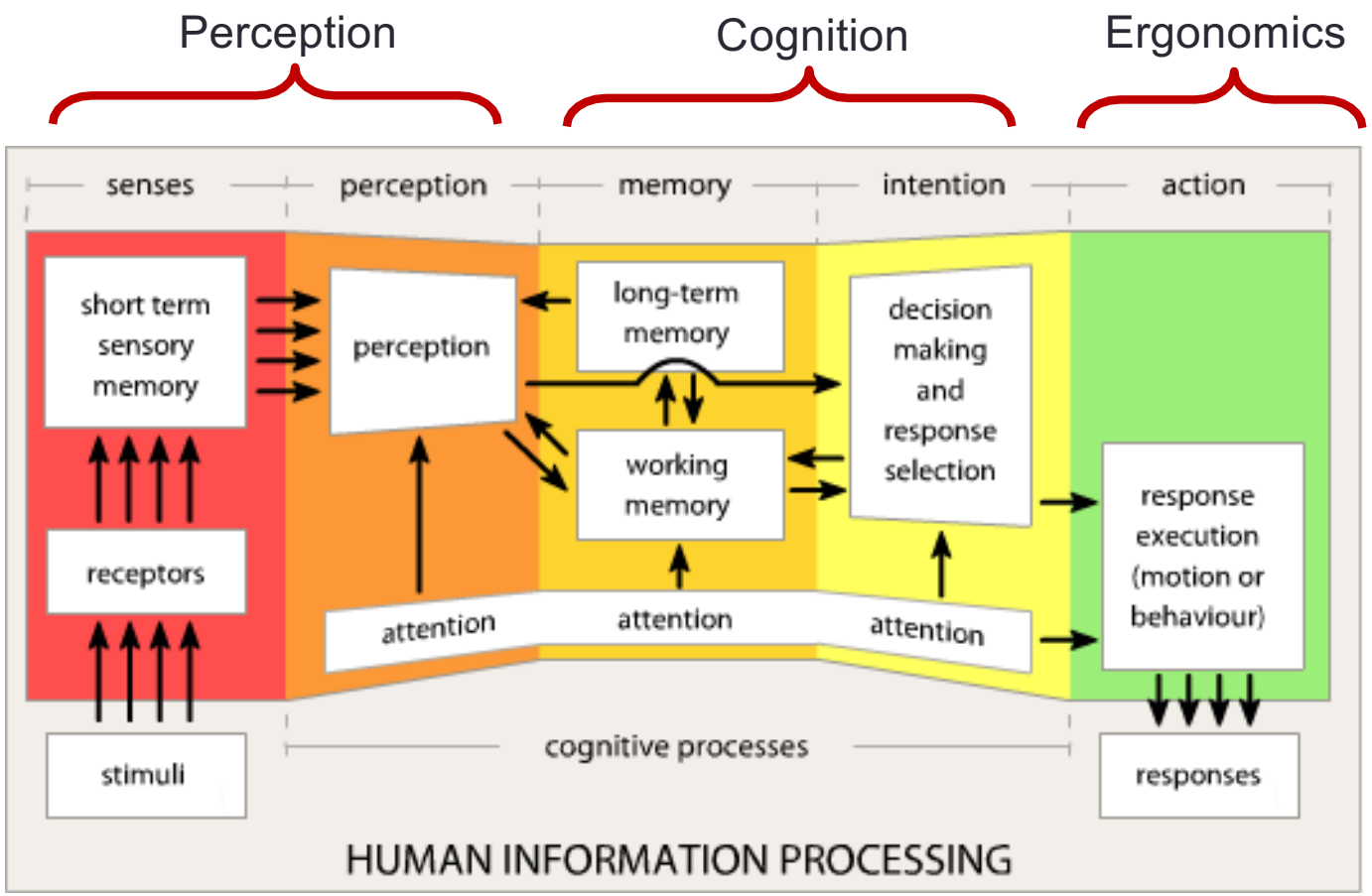
Virtual doors can be walked through



Flying like a bird in Birdly

Virtual objects can be picked up

HUMAN INFORMATION PROCESSING



High level staged model from Wickens and Carswell (1997)

- Relates perception, cognition, and physical ergonomics

Design for Perception

Need to understand perception to design AR/VR

Visual perception

- Many types of visual cues (stereo, oculomotor, etc.)

Auditory system

- Binaural cues, vestibular cues

Somatosensory

- Haptic, tactile, kinesthetic, proprioceptive cues

Chemical Sensing System

- Taste and smell

Design for Cognition

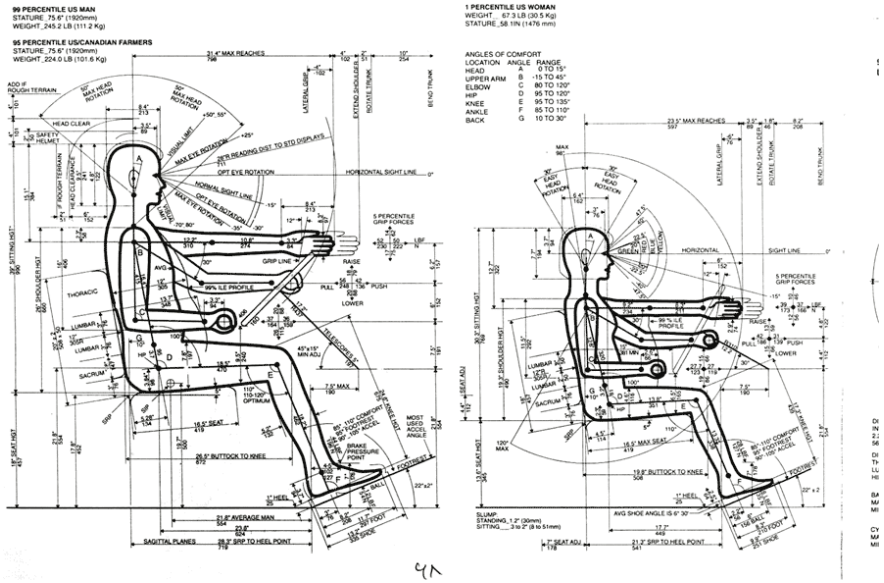
Design for Working and Long term memory

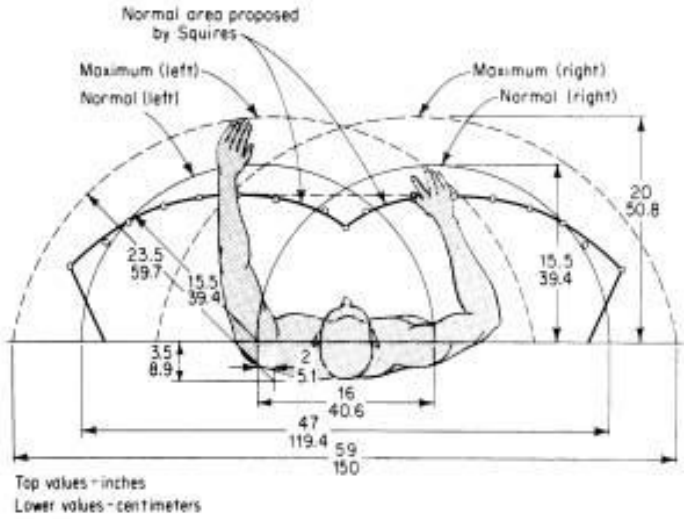
- Working memory
  - Short term storage, Limited storage (~5-9 items)
- Long term memory
  - Memory recall trigger by associative cues

Situational Awareness

- Model of current state of user's environment
  - Used for wayfinding, object interaction, spatial awareness, etc..
- Provide cognitive cues to help with situational awareness
  - Landmarks, procedural cues, map knowledge
  - Support both ego-centric and exo-centric views

DEISGN FOR PHYSICAL ERGONOMICS





Design for the human motion range

- Consider human comfort and natural posture

Design for hand input

- Coarse and fine scale motions, gripping and grasping
- Avoid "Gorilla arm syndrome" from holding arm pose

Designing for Different User Groups

Design for Difference Ages

- Children require different interface design than adults
- Older uses have different needs than younger

Prior Experience with VR systems

- Familiar with HMDs, VR input devices

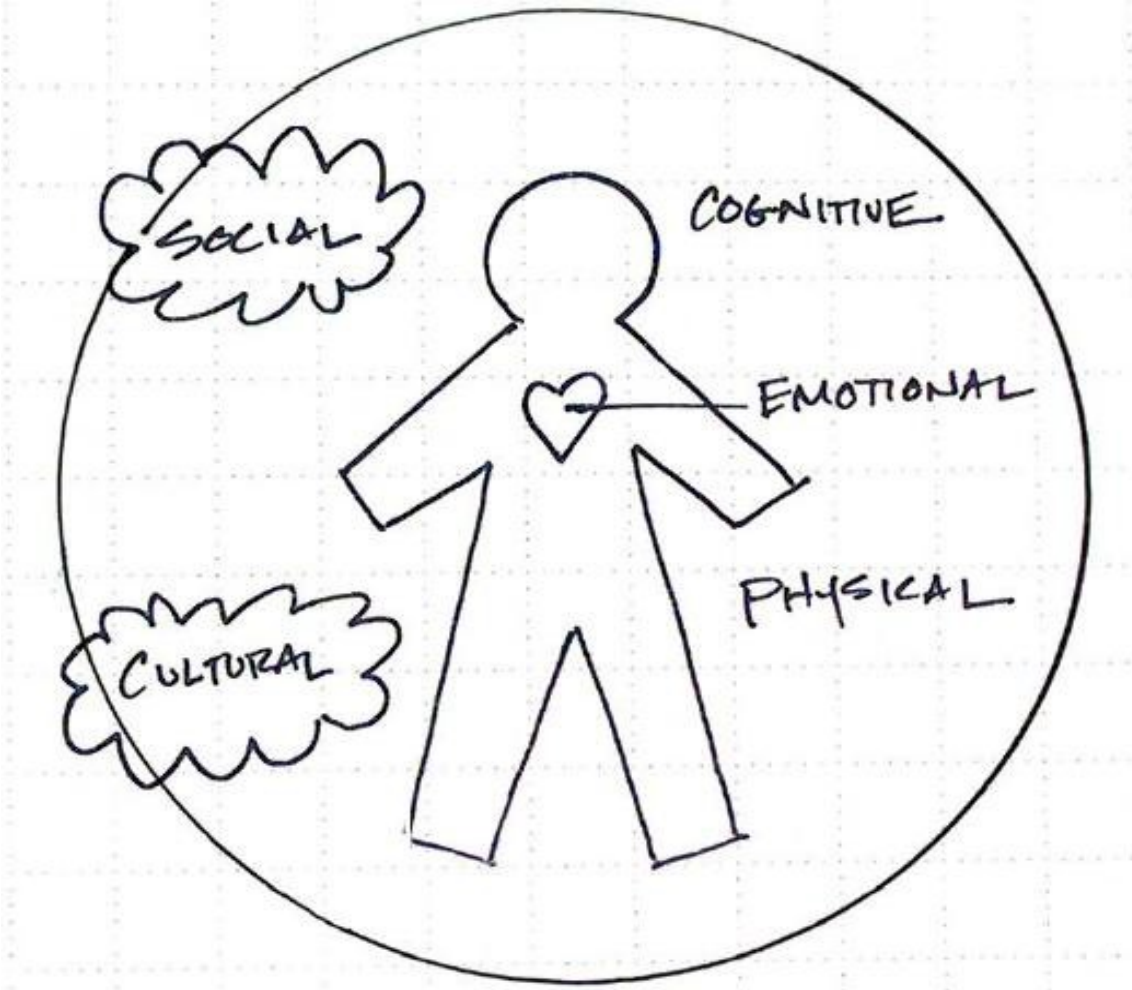
People with Different Physical Characteristics

- Height and arm reach, handedness

Perceptual, Cognitive and Motor Abilities

- Color perception varies between people
- Spatial ability, cognitive or motor disabilities

CONSIDER THE WHOLE USER NEEDS



Whole User Needs

Social
- Don't make your user look stupid

Cultural
- Follow local cultural norms

Physical
- Can the user physically use the interface?

Would you wear this HMD?

Cognitive
- Can the user understand how the interface works?

Emotional
- Make the user feel good and in control

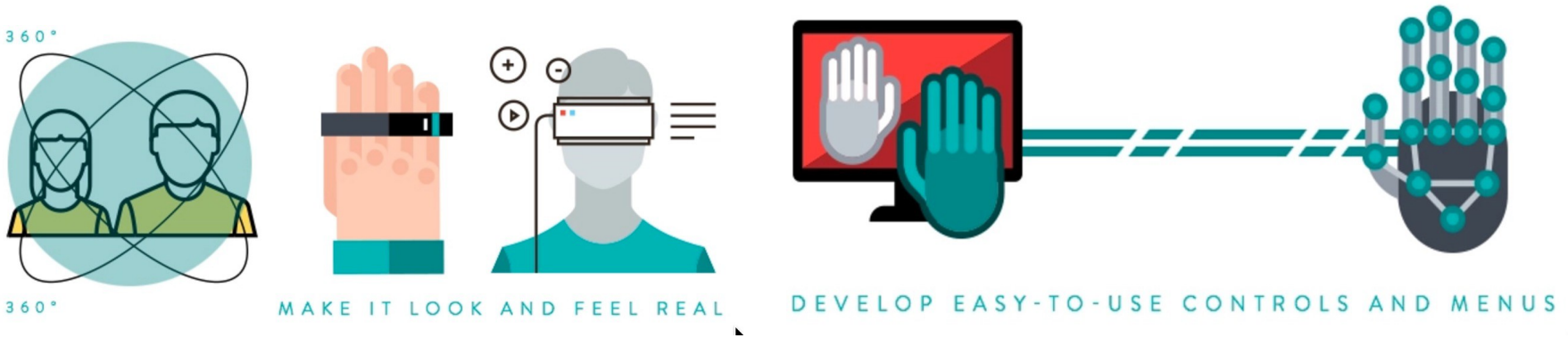
UX Guidelines for VR

The Four Cores of UX Design for VR

- Make interface Interactive and Reactive
- Design for Comfort and Ease
- Use usable Text and Image Scale
- Include position audio and 3D sound

https://www.dtelepathy.com/blog/philosophy/ux-guide-designing-virtual-reality-experiences

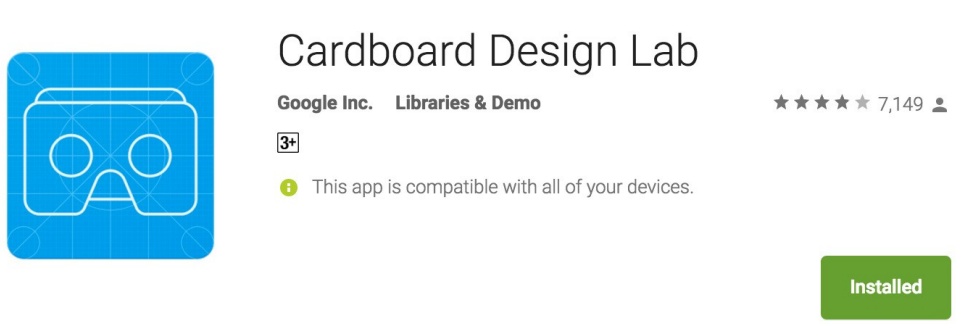
UX Challenges

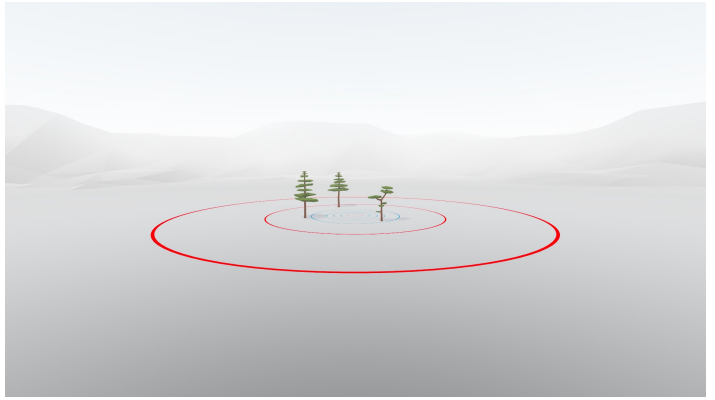


Problems to be Addressed

- Keep the user safe
- Make it look and feel real
- Make sure users don't get simulation sickness
- Develop easy-to-use controls and menus

Cardboard Design Lab



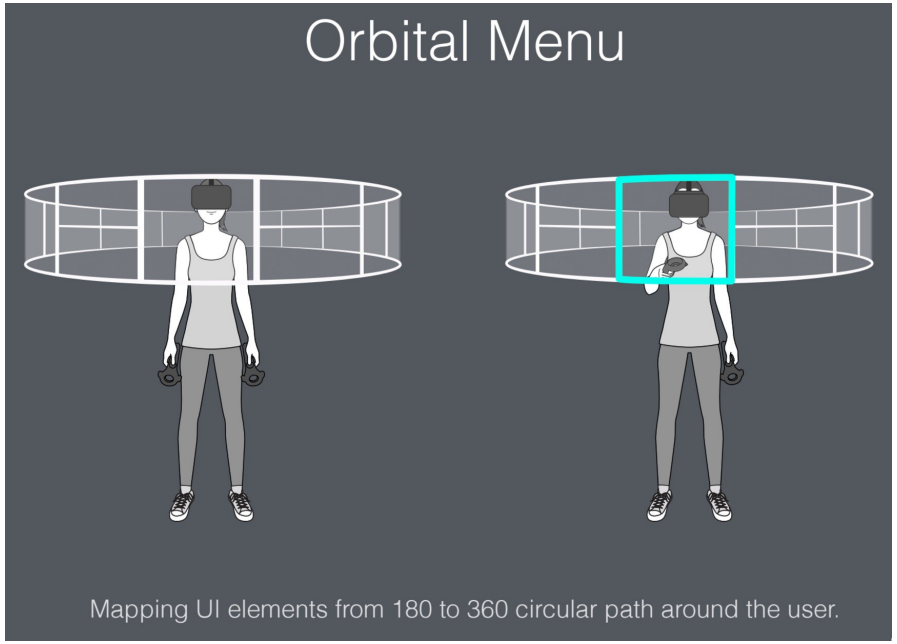


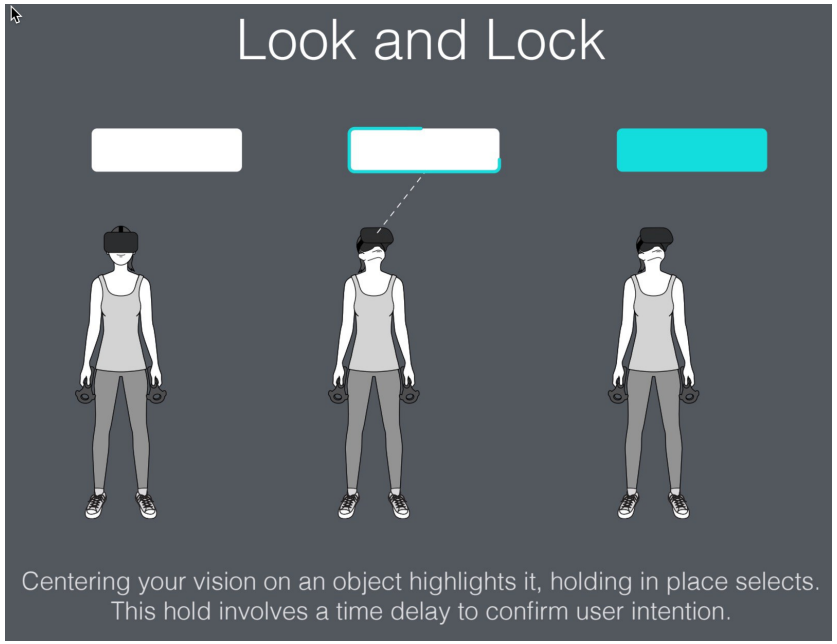
Mobile VR App providing examples of best practice VR designs and user interaction (iOS, Play app stores)

Demo: Cardboard Design Lab

https://youtu.be/2Uf-ru2Ndvc

VR Human Interface Guidelines





Interface design website - http://vrhig.com/

Set of VR interface design best practices

Design Guidelines (from 3D UI book)

Design for comfortable poses

Design for relatively short sessions and encourage breaks

Use constraints, use and invent magical techniques

Consider real world tools and practices as a source of inspiration for 3D user interface design

Consider designing 3D techniques using principles from 2D interaction

Consider using physical props and passive feedback, particularly in highly specialized tasks

Ensure temporal and spatial compliance between feedback dimensions

More VR Design Guidelines

Use real-world cues when appropriate.

If there is a horizon line, keep it steady

Be careful about mixing 2D GUI and 3D

Avoid rapid movement, it makes people sick

Avoid rapid or abrupt transitions to the world space

Keep the density of information and objects on screen low

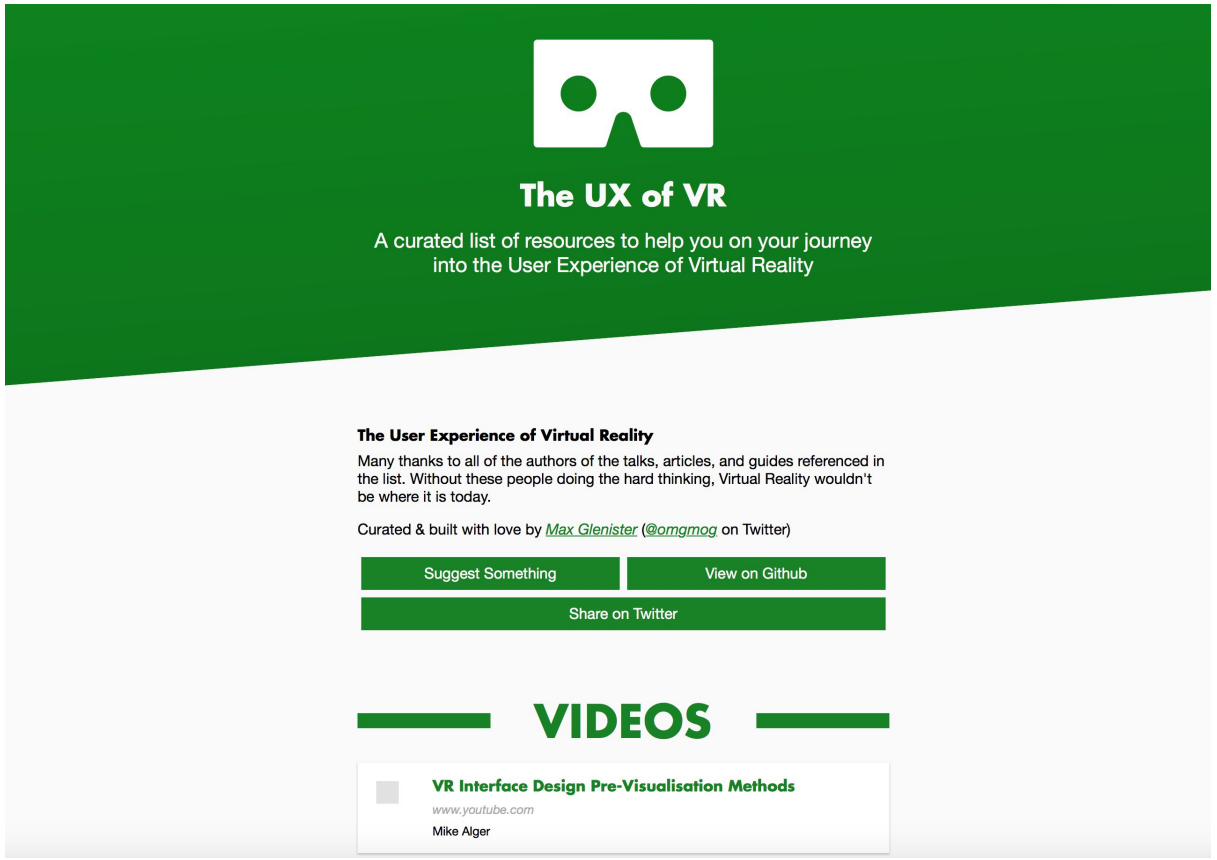
Do not require the user to move their head or body too much

From https://www.wired.com/2015/04/how-to-design-for-virtual-reality/

UX OF VR WEBSITE

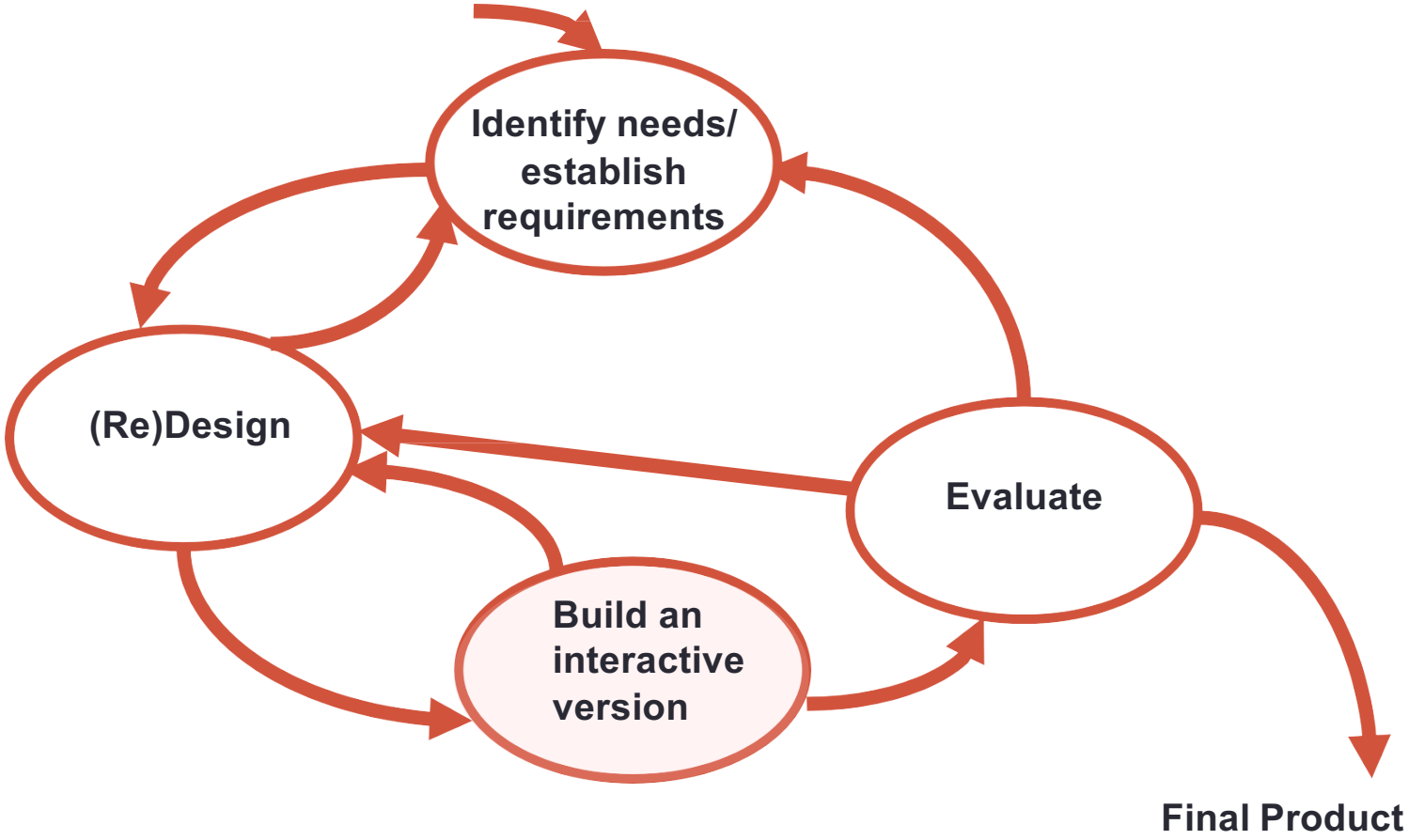
Many examples of great design ideas

Videos, books, articles, slides, code, etc..



HTTP://WWW.UXOFVR.COM

PROTOTYPING



Why Prototype?

Quick visual design

Capture key interactions

Focus on user experience

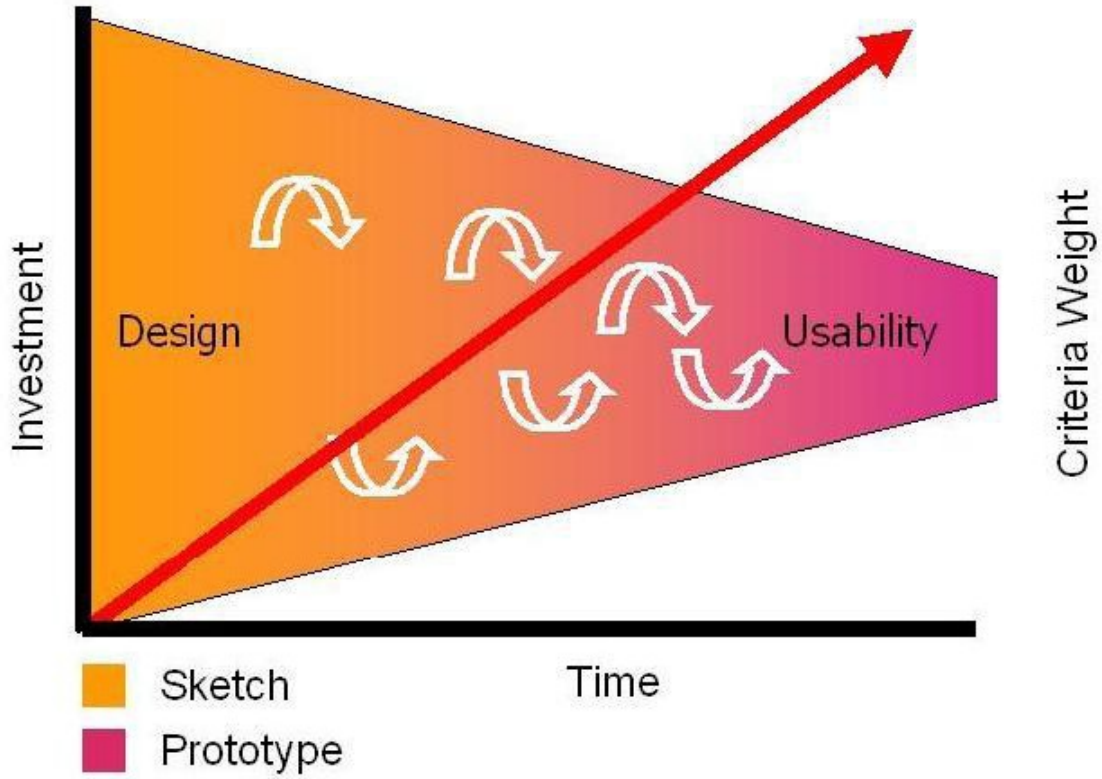
Communicate design ideas

“Learn by doing/experiencing”

FROM SKETCHES TO PROTOTYPES

Sketches: early ideation stages of design

Prototypes: capturing /detailing the actual design



Sketch vs. Prototype

Sketch	Prototype
Invite	Attend
Suggest	Describe
Explore	Refine
Question	Answer
Propose	Test
Provoke	Resolve
Tentative, non committal	Specific Depiction

The primary differences are in the intent

From Sketches to Prototypes

Early design

Brainstorm different ideas and representations	Multitude of sketches
Choose a representation	Sketch variations and details
Rough out interface style	Sketch *or* low fidelity prototypes
Task centered walkthrough and redesign	Low to medium fidelity prototypes
Fine tune interface, screen design	
Heuristic evaluation and redesign	
Usability testing and redesign	High fidelity prototypes
Limited field testing	
Alpha/Beta tests	Working systems

Late design

Typical Development Steps

Sketching

Storyboards

UI Mockups

Interaction Flows

Video Prototypes

Interactive Prototypes

Final Native Application

Increased Fidelity & Interactivity

Typical Prototyping Tools

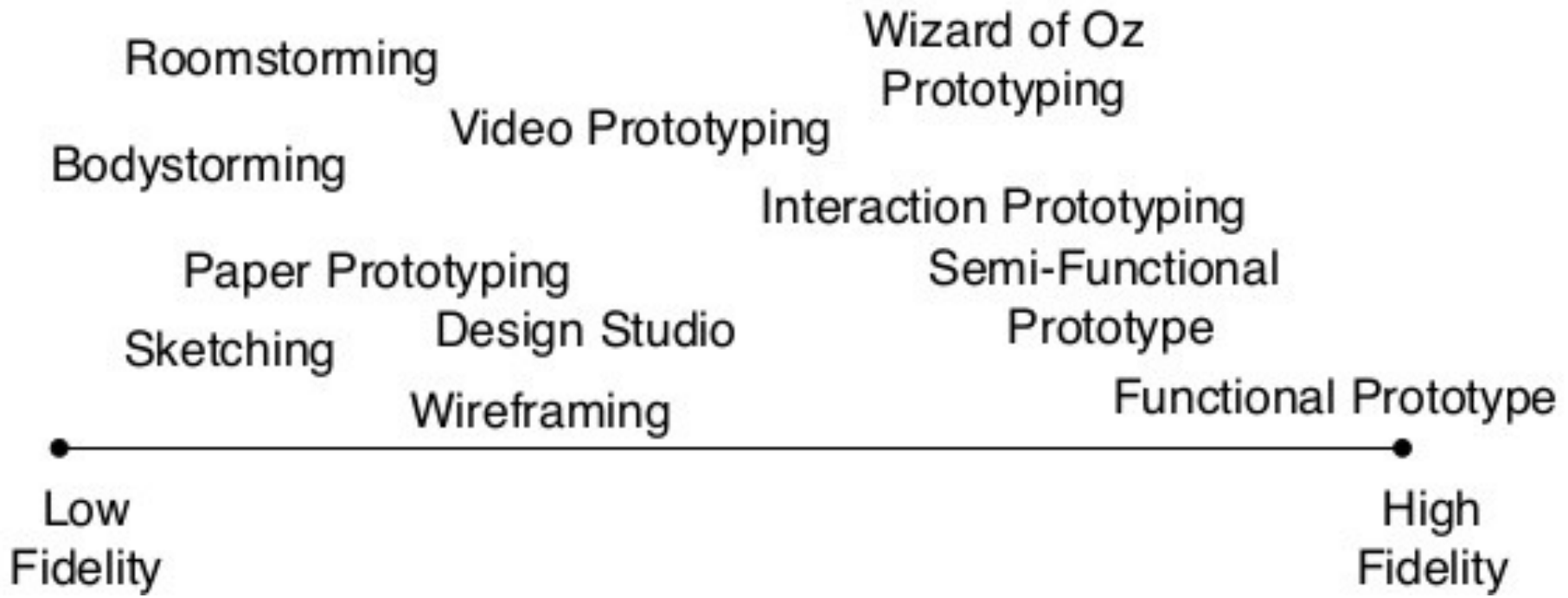
Static/Low fidelity

- Sketching
- User interface templates
- Storyboards/Application flows

Interactive/High fidelity

- Wireframing tools
- Mobile prototyping
- Native Coding

Design/Prototyping Tools



ADVANTAGES/DISADVANTAGES

Prototype	Advantages	Disadvantages
Low-fidelity	• low developmental cost • evaluate multiple design concepts	• limited error checking • navigational and flow limitations
High-fidelity	• fully interactive • look and feel of final product • clearly defines navigational scheme	• more expensive to develop • time consuming to build • developers are reluctant to change something they have crafted for hours

VR Prototyping Tools

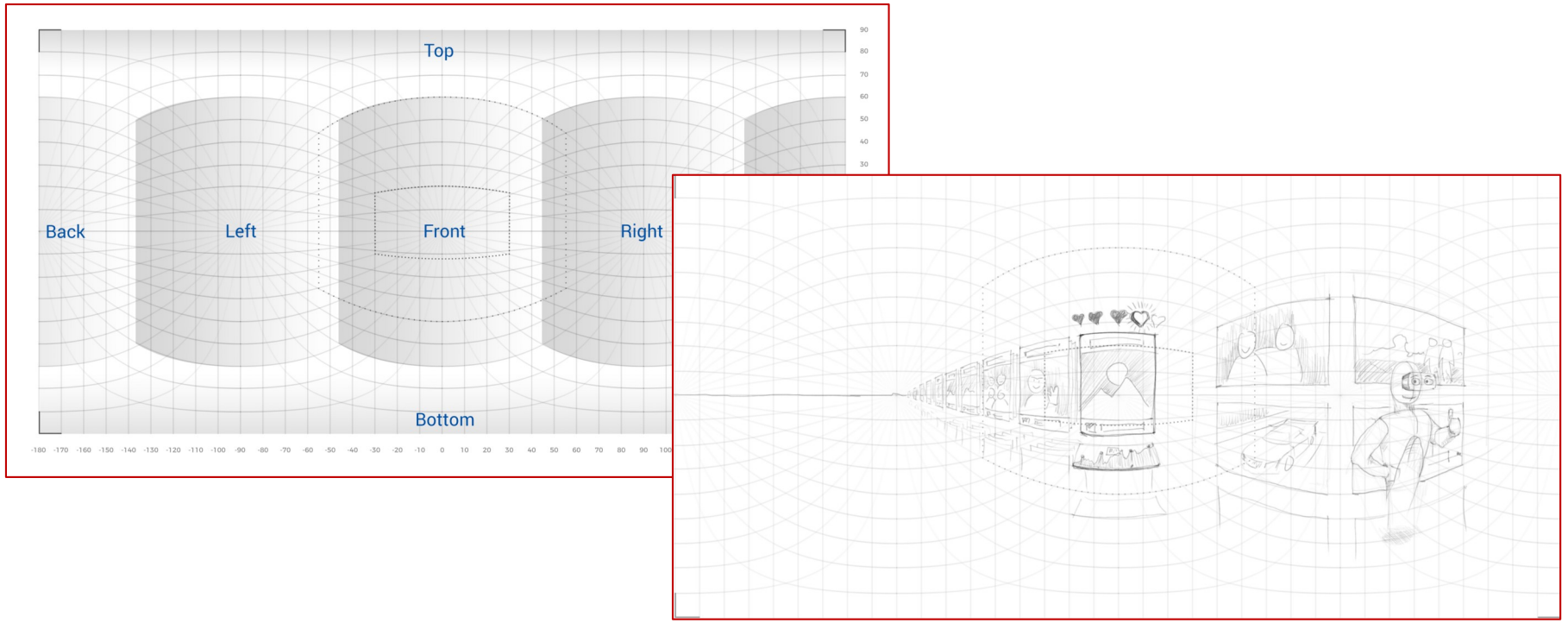
Low Fidelity

- Sketched Paper Interfaces – pen/paper, non-interactive
- Onride Photoshop tool – digital, non-interactive
- InstaVR – 360 web based tool, simple interactivity
- SketchBox – create VR interface inside VR

High Fidelity

- Entiti – template based VR with visual programming
- A-Frame – web based VR tool using HTML
- EditorVR – Unity wrapper inside VR
- Unity/Unreal Game Engine – programming needed

SKETCHING VR INTERFACES



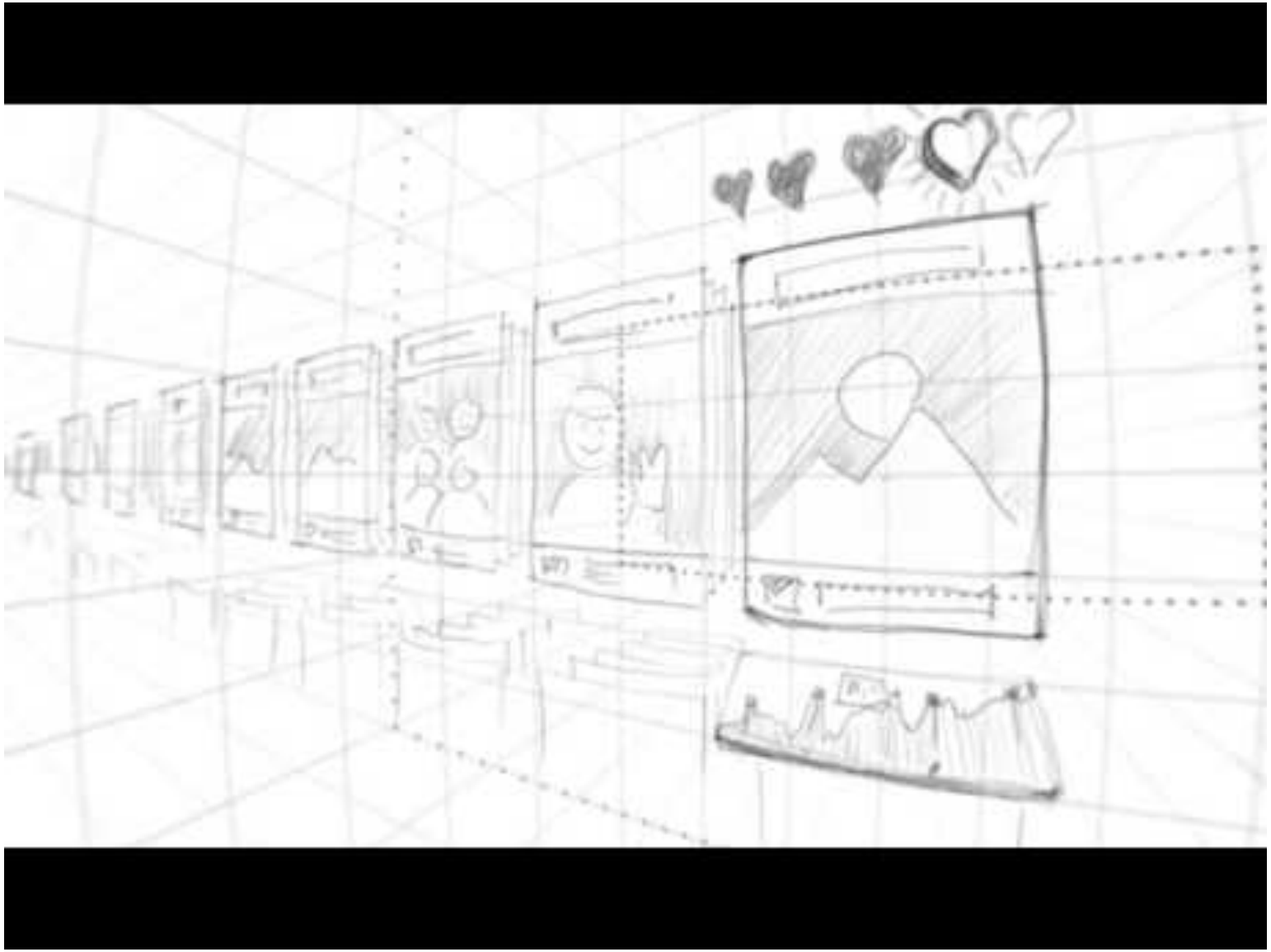
Download 360 panorama template grid

Draw interface ideas into grid

Scan into 360 photo viewer for VR HMD

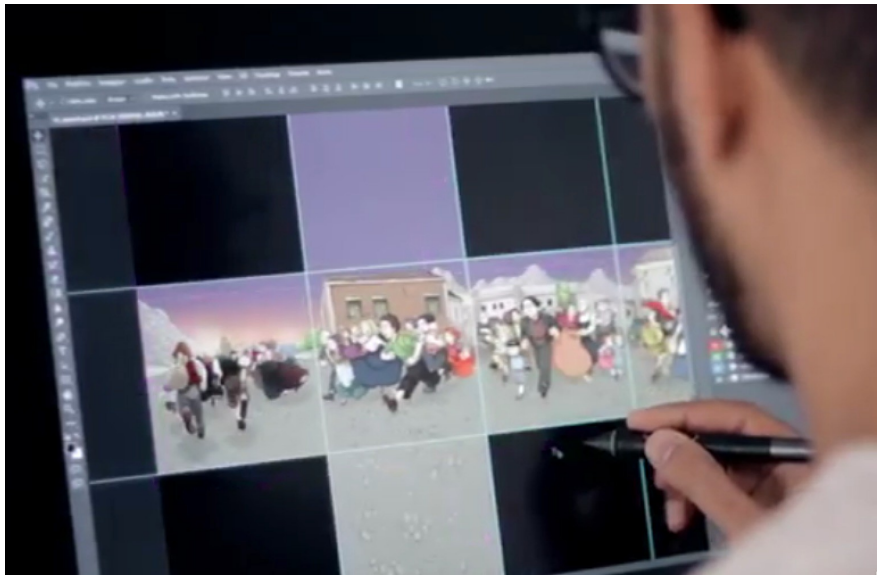
SEE HTTPS://VIRTUALREALITYPOP.COM/VR-SKETCHES-56599F99B357

Example Sketched VR Interface



https://youtu.be/BmMh6-jPWOc

ONIRIDE - 360° Art Plugin for Photoshop



Draw 360 panorama's directly in Photoshop

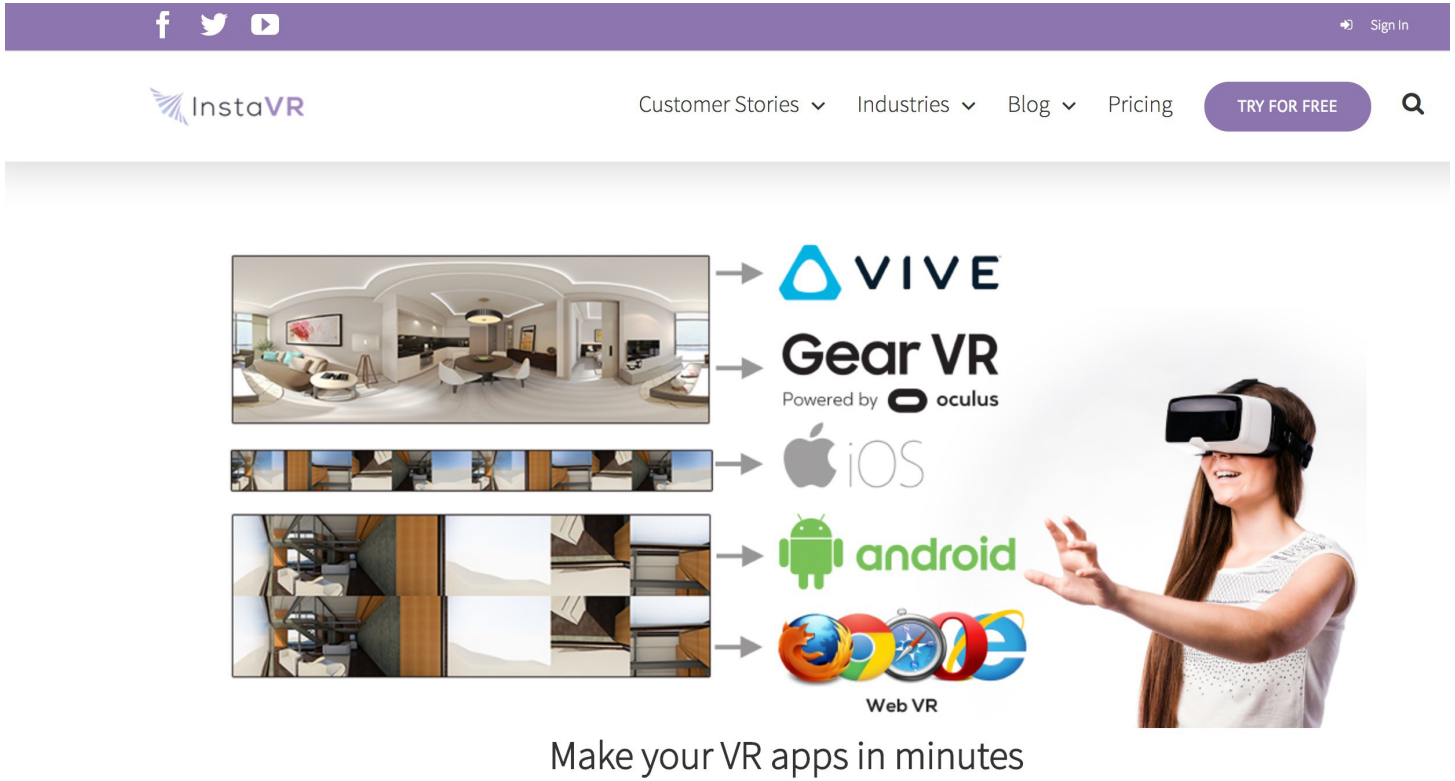
Preview in Photoshop, export to VR

See http://www.oniride.com/360art

OniRide Demo

https://youtu.be/1P1EfGizal0

INSTAVR



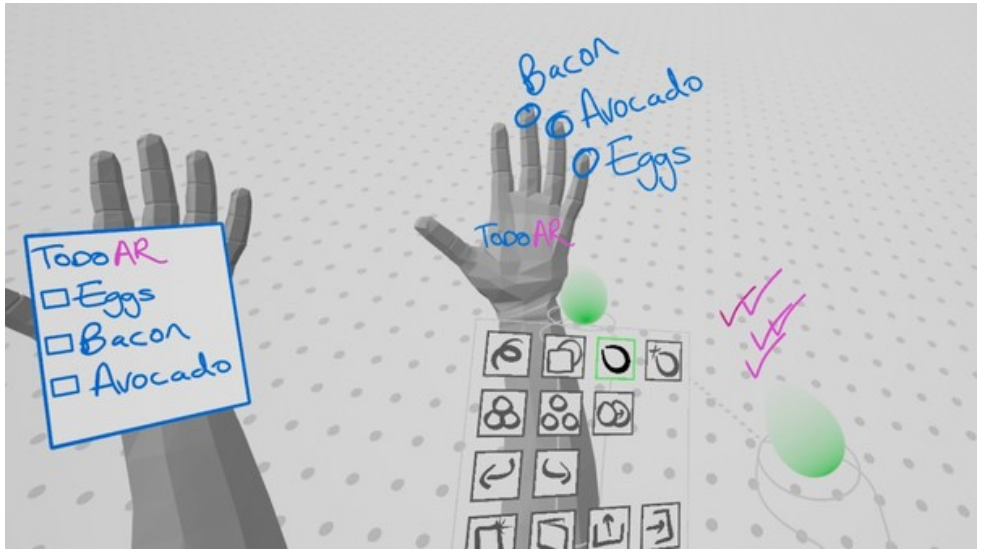
Free, fast panorama VR, deploy to multi platforms

HTTP://WWW.INSTAVR.CO/

Demo - Using InstaVR

https://youtu.be/M2C8vDL0YeA

SKETCHBOX



VR design tool - create VR interface inside VR

- Support for HTC Vive, Oculus Rift

Easy to use VR sketching tool

Available from SteamVR

SEE HTTPS://WWW.SKETCHBOXVR.COM/

Sketchbox Demo

https://youtu.be/gWfgewGzaEI

ENTITI

Stand alone application for VR/AR authoring (Windows, Mac)

Works with Entiti mobile application (Android, iOS)

Delivers multiple VR experiences – 360 and 3D scenes

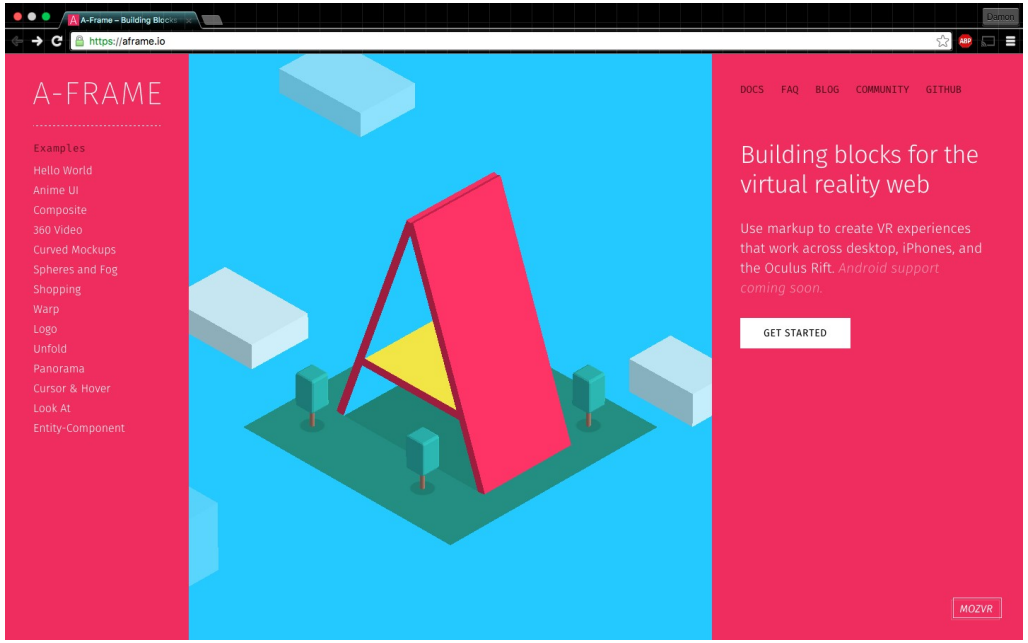
Template based VR, Visual programming for behaviors

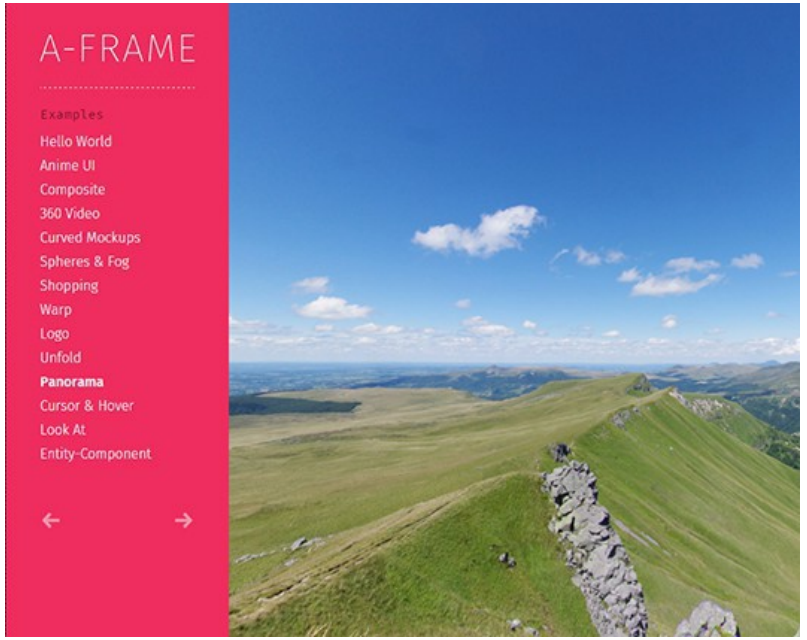
HTTPS://WWW.WAKINGAPP.COM/

ENTITI OVERVIEW

HTTPS://YOUTU.BE/TMOAFRM4GVY

A-FRAME





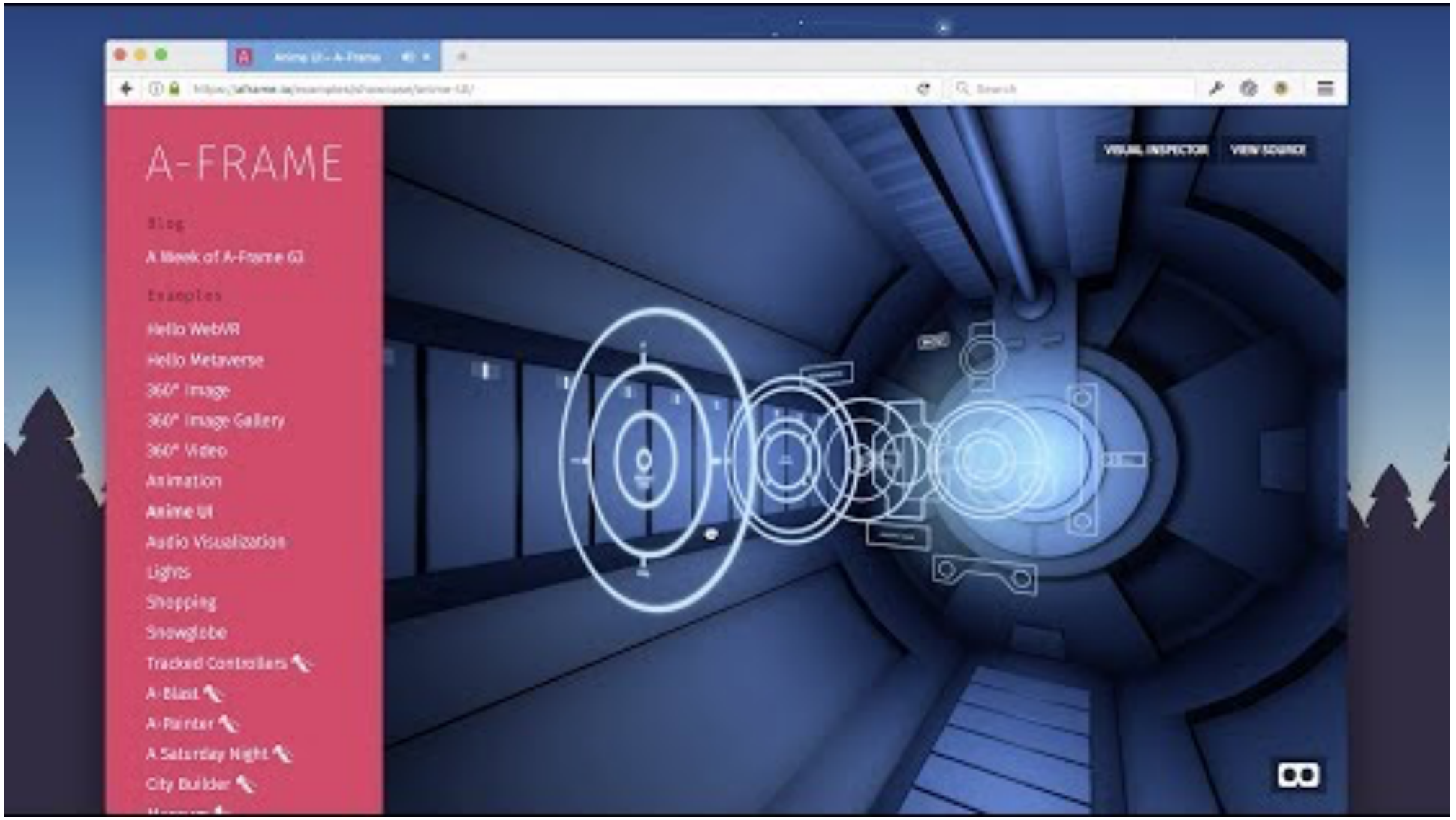
Web based VR framework

Make WebVR with HTML and Entity-Component

Works on Vive, Rift, Daydream, GearVR, desktop

SEE HTTPS://AFRAME.IO/

A-Frame Demo



https://youtu.be/1MskH9uQOyQ

UNITY EDITORVR

Edit Unity VR scenes inside VR

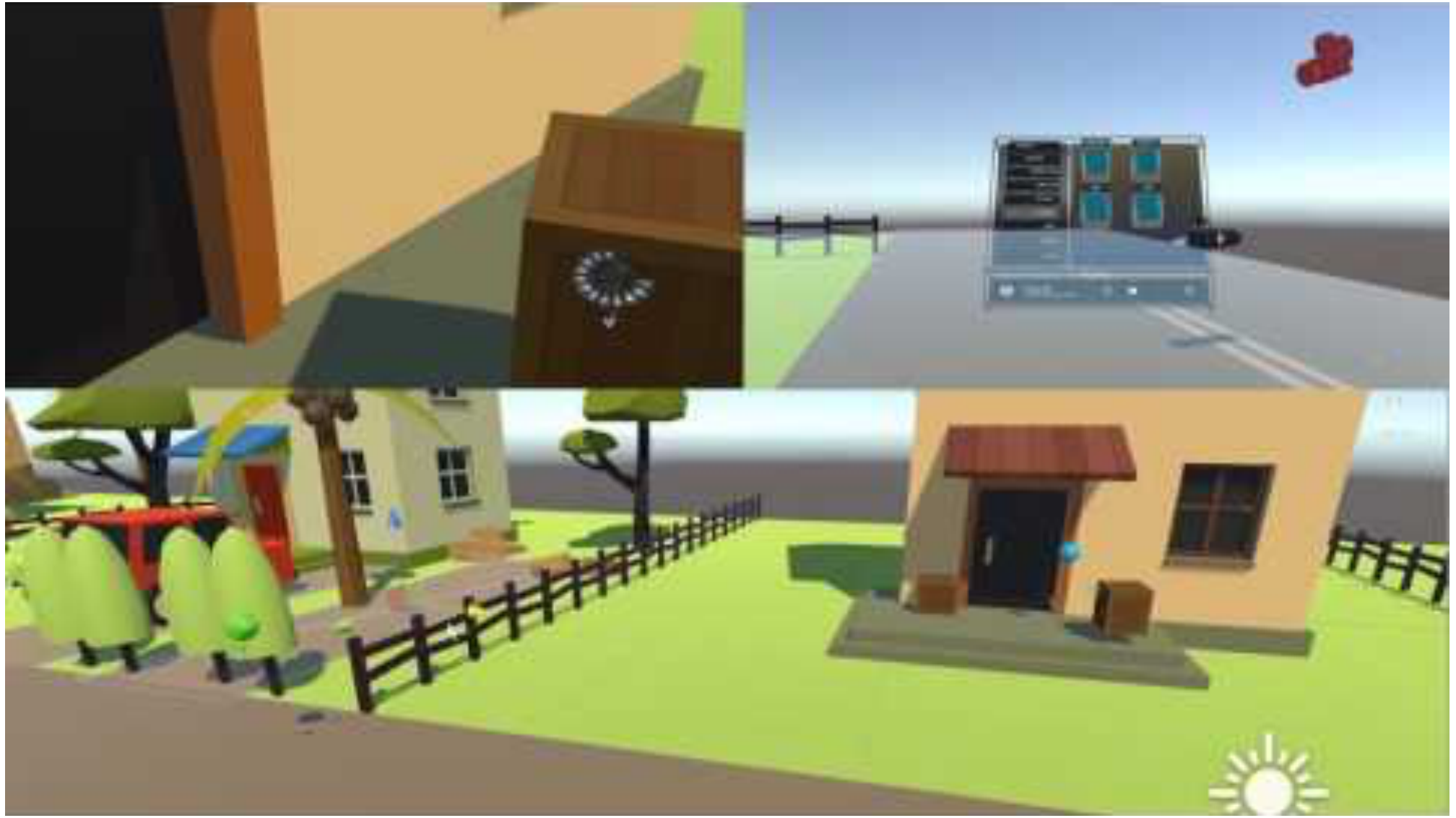
3D user interface on top of Unity

- 2 handed interface using HTC Vive

Support for multi-user input

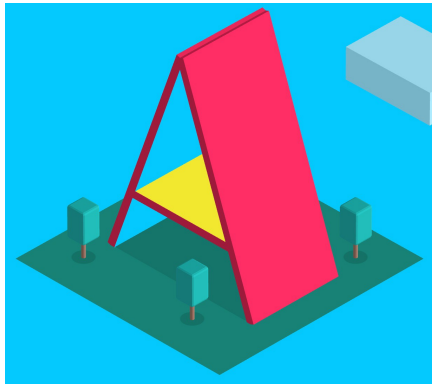
AVAILABLE FROM HTTPS://GITHUB.COM/UNITY-TECHNOLOGIES/EDITORVR

Demo: Unity EditorVR



https://youtu.be/ILe2atyofqM

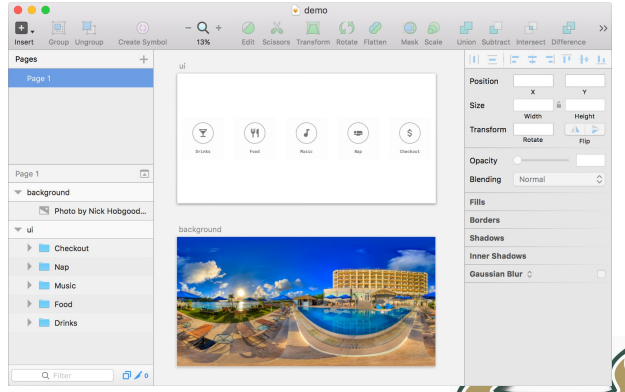
More Prototyping Tools



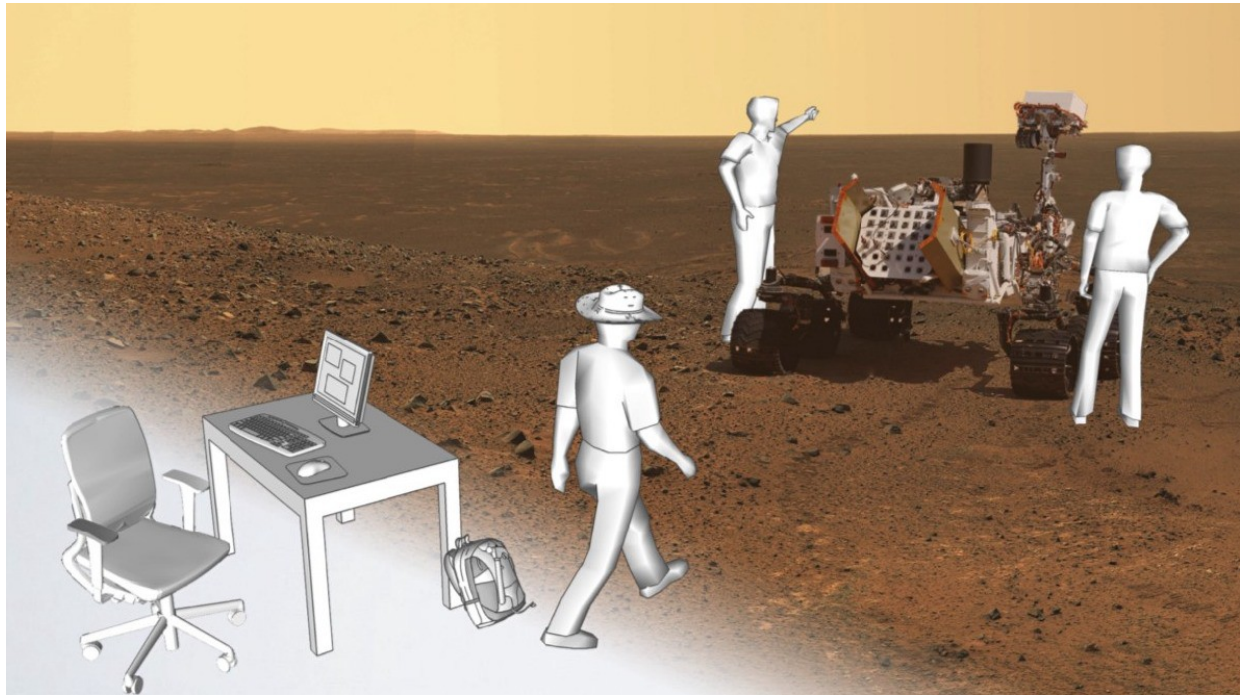
List of 24 prototyping tools

- Tools for prototyping 3D VR experiences
- Tools for prototyping 360 degree experiences
- Web based Tools for 3D prototyping
- 3D modeling tools in VR

See http://bit.ly/2wx3i6H

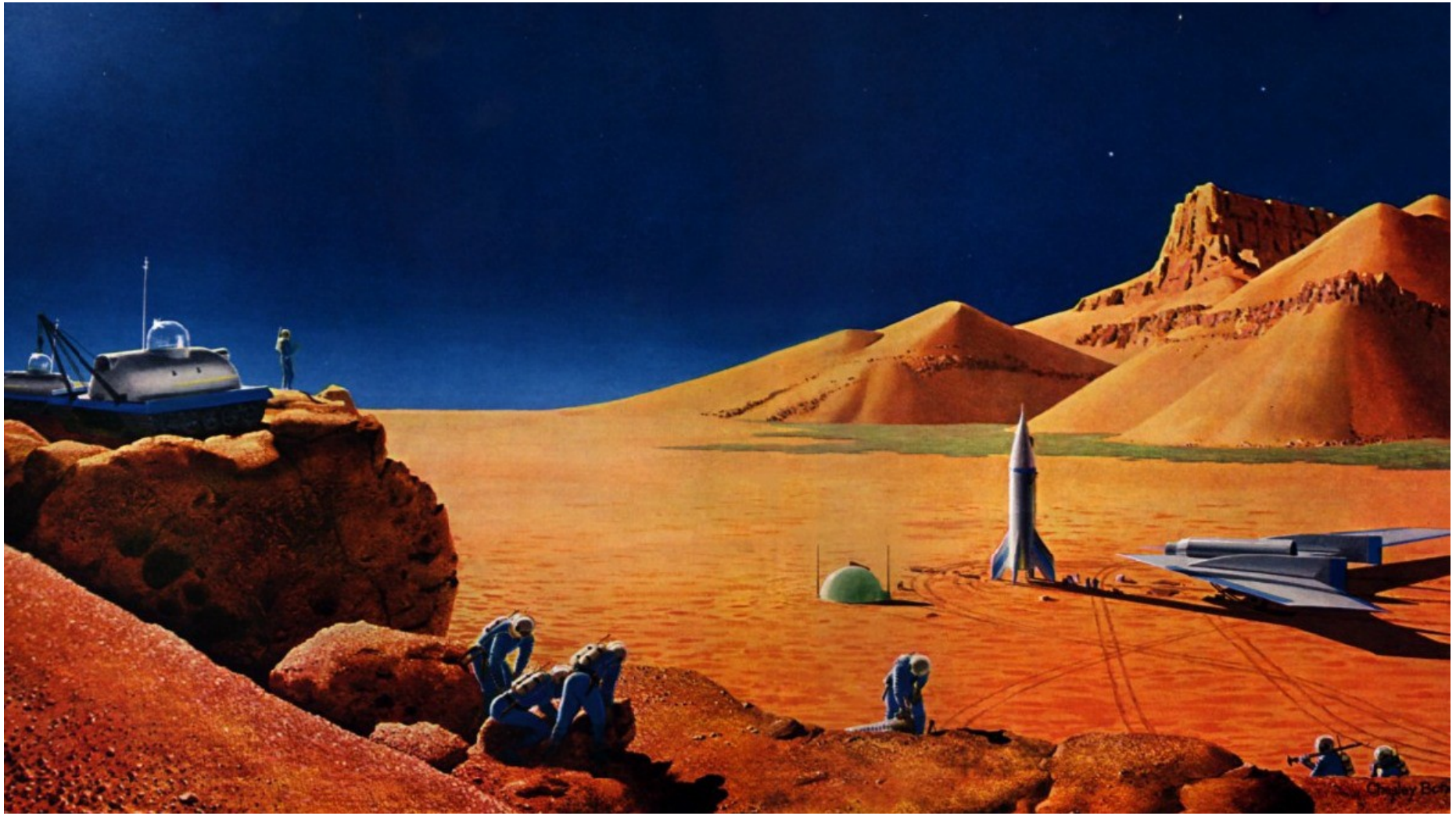


EXAMPLE: CONCEPT TO DEMO



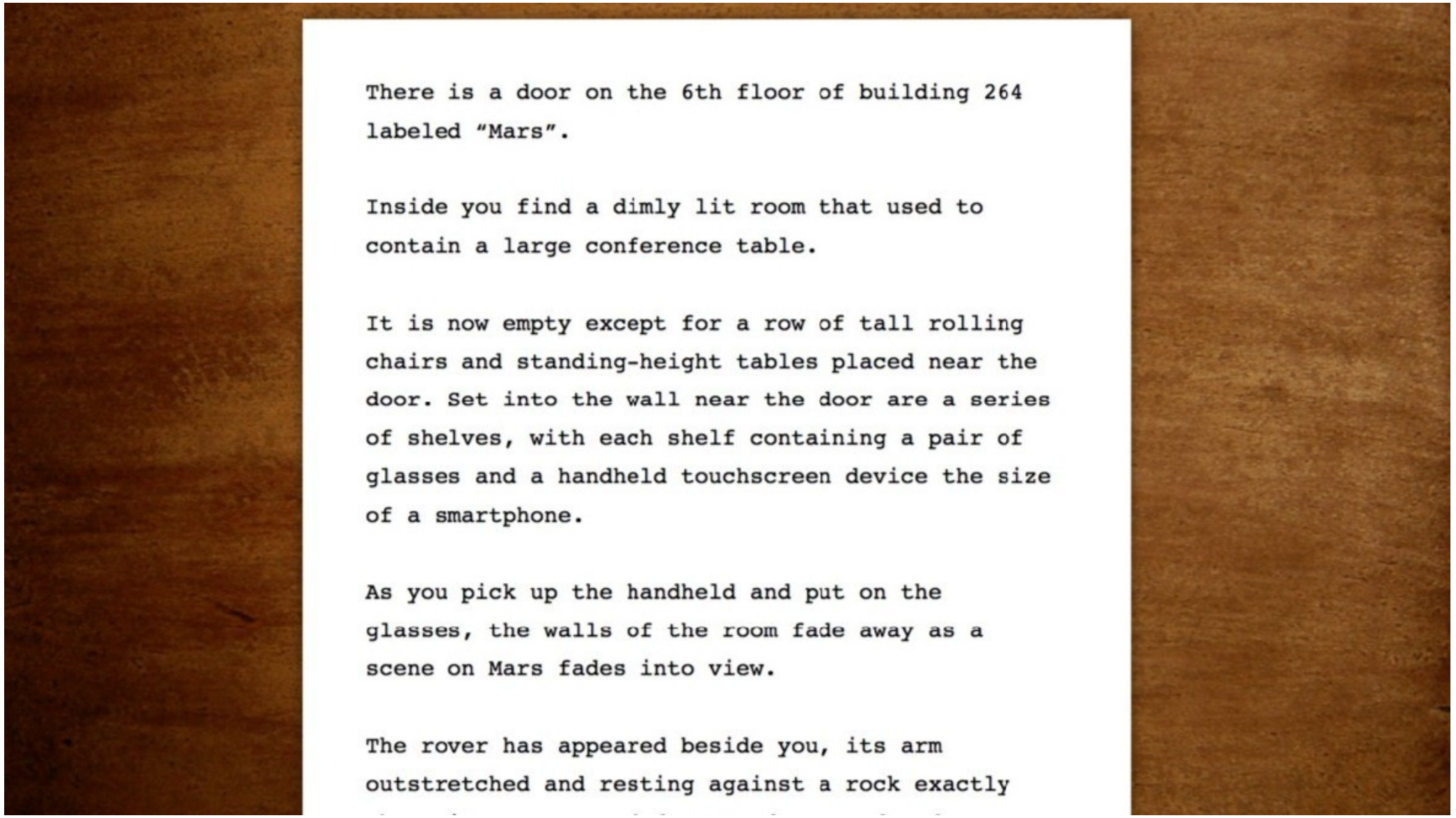
NASA Hololens AR/VR Concept Demo

- **Vision**: Work on Mars from your office
- Story and sketches based on vision
- Led to working Demo



CHESLEY BONESTELL (1940S)

HOLOLENS STORY



There is a door on the 6th floor of building 264 labeled “Mars”.

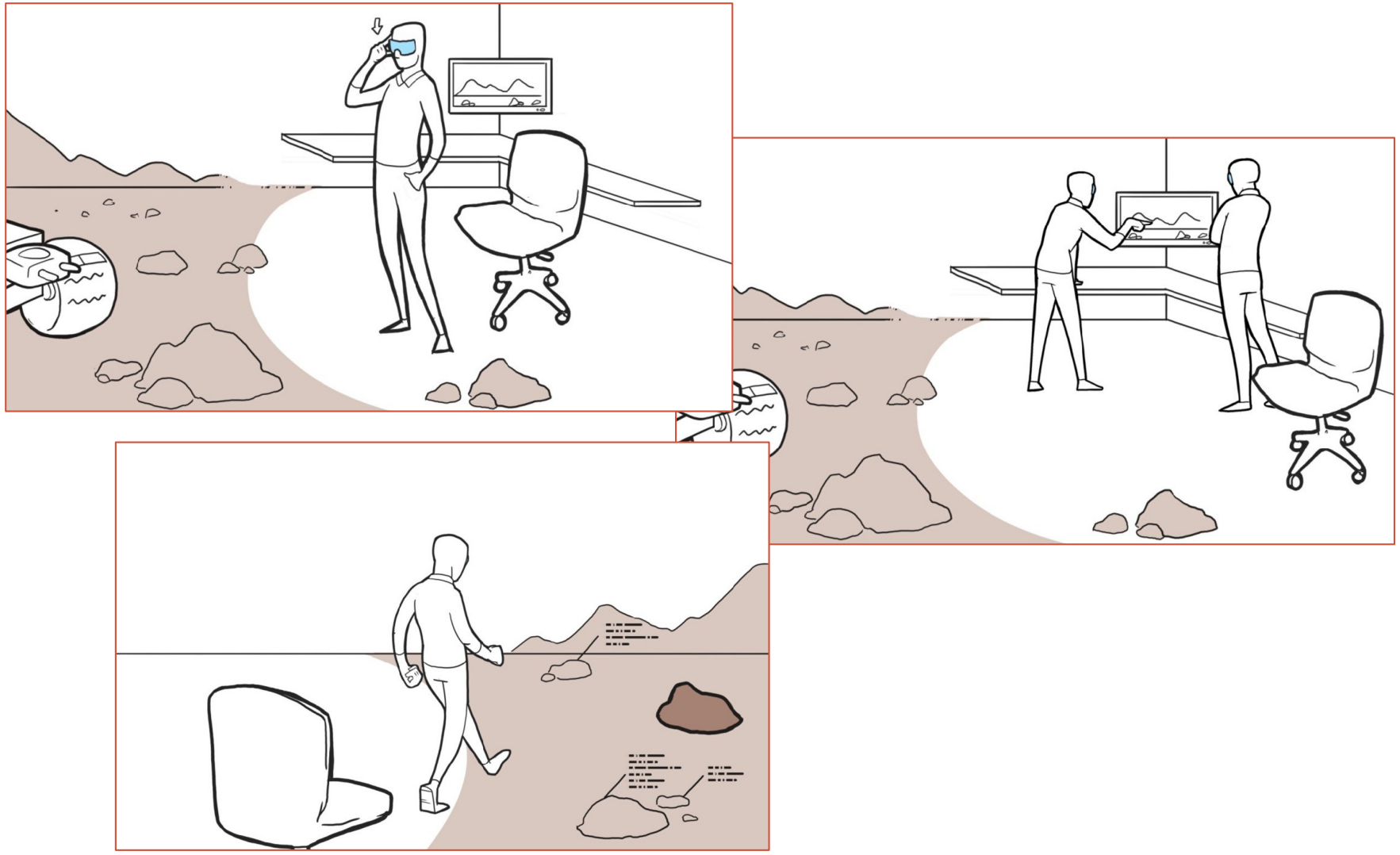
Inside you find a dimly lit room that used to contain a large conference table.

It is now empty except for a row of tall rolling chairs and standing-height tables placed near the door. Set into the wall near the door are a series of shelves, with each shelf containing a pair of glasses and a handheld touchscreen device the size of a smartphone.

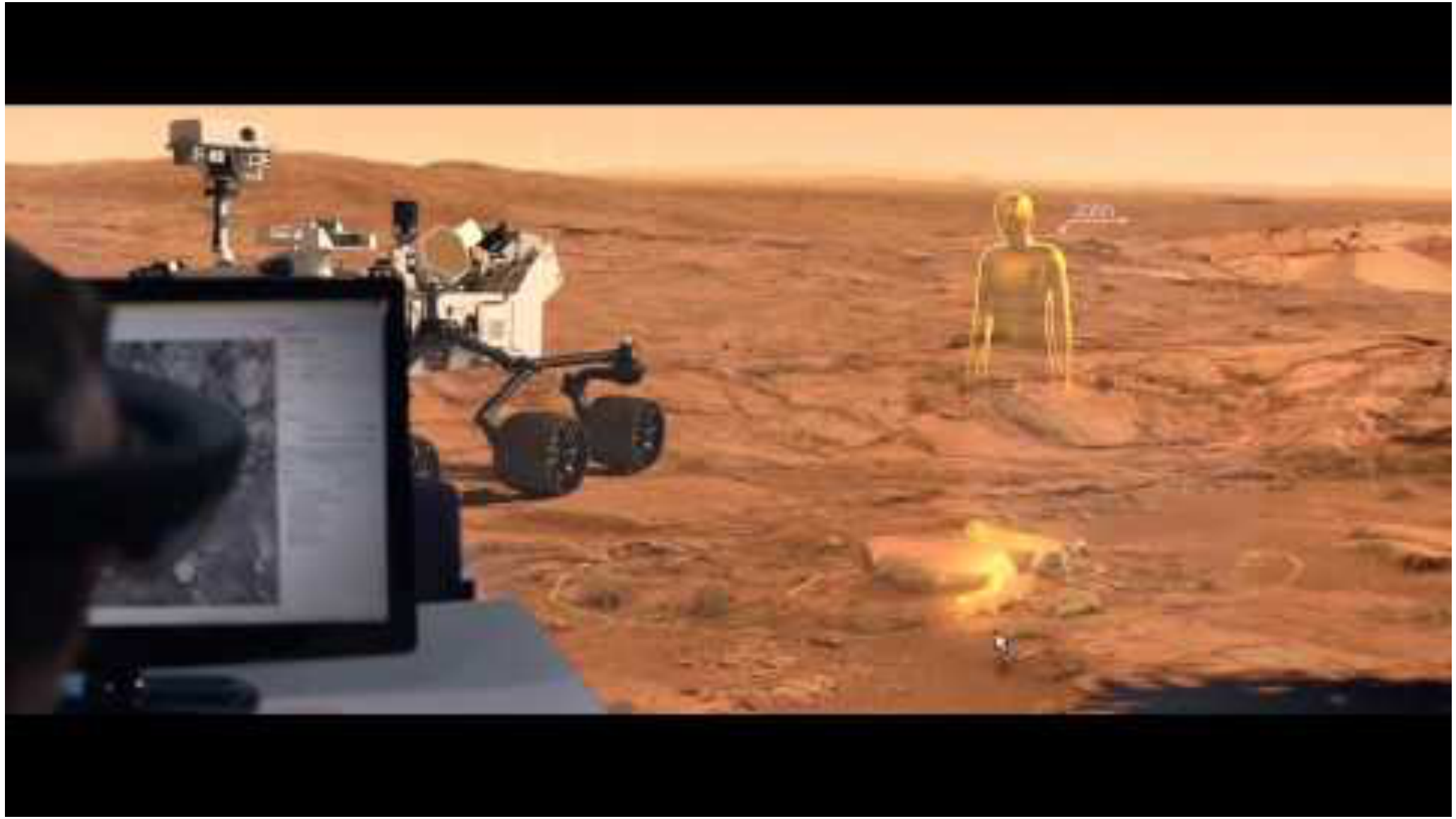
As you pick up the handheld and put on the glasses, the walls of the room fade away as a scene on Mars fades into view.

The rover has appeared beside you, its arm outstretched and resting against a rock exactly

HoloLens Concept Sketches

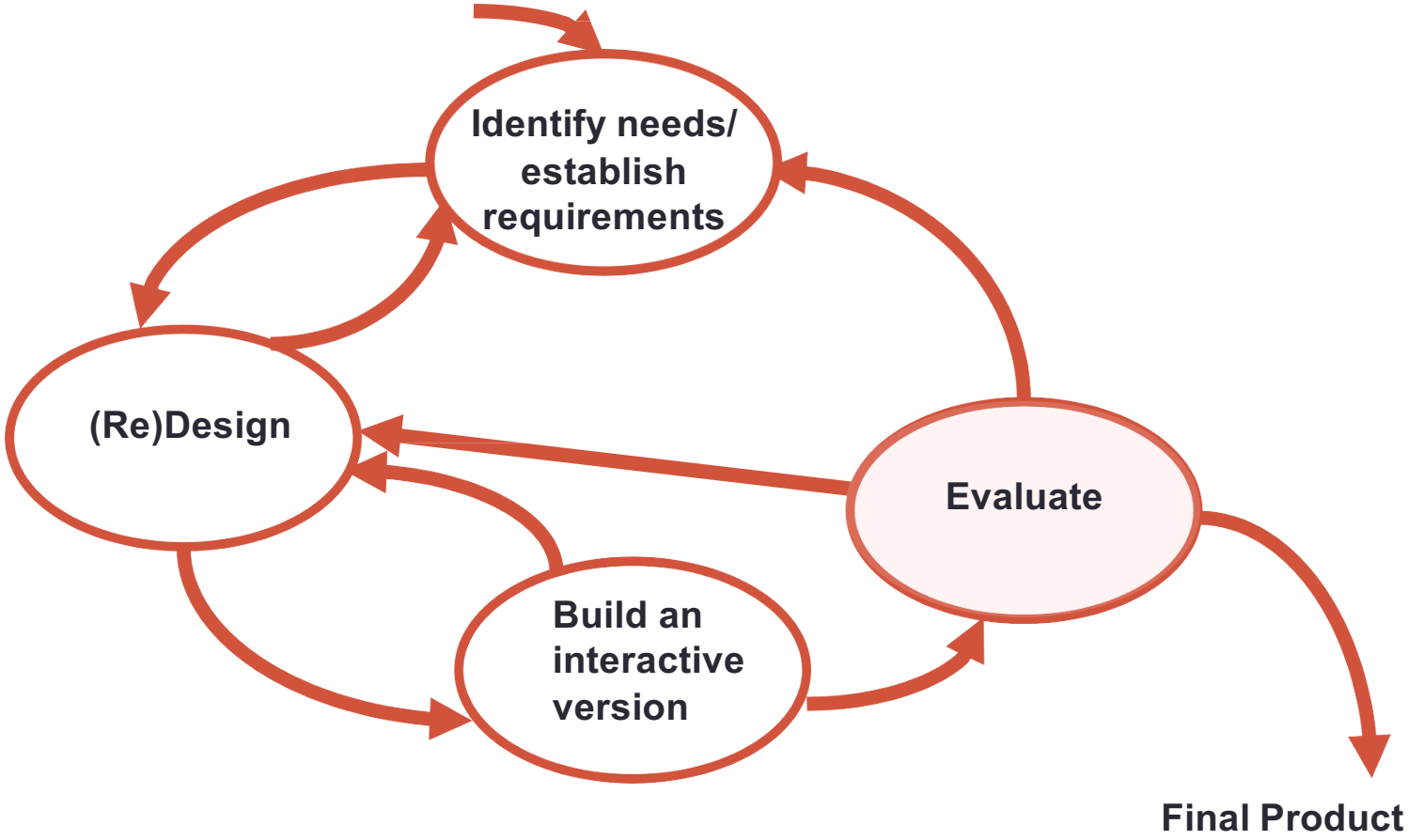


Final NASA HoloLens OnSight Demo



https://youtu.be/DXT-ynvI3Lg

EVALUATION


Identify needs/ establish requirements
(Re)Design
Evaluate
Build an interactive version
Final Product

What is evaluation?

Evaluation is concerned with **gathering data** about the **usability** of a **design** or **product** by a *specified group of users for a particular activity within a specified environment or work context*

WHEN TO EVALUATE?

Once the product has been developed

- pros : rapid development, small evaluation cost
- cons : rectifying problems

During design and development

- pros : find and rectify problems early
- cons : higher evaluation cost, longer development

Four Evaluation Paradigms

'quick and dirty'

usability testing (including lab studies)

field studies

predictive evaluation

Quick and Dirty

Informal feedback from users or consultants to confirm that their ideas are in-line with users' needs and are liked.

Quick & dirty evaluations are done any time.

Emphasis is on fast input to the design process rather than carefully documented findings.

USABILITY TESTING

Recording typical users' performance on typical tasks in controlled settings.

As the users perform tasks they are watched & recorded on video & their inputs are logged.

User data is used to calculate performance times, errors & help determine system usability

User satisfaction questionnaires & interviews are used to elicit users' opinions.

LABORATORY-BASED STUDIES

Controlled, instrumented environment

- can be used for evaluating the design, or system
- are carried out in an interruption-free usability lab
- can accurately record some work situations
- some studies are only possible in a lab environment
- some tasks can be adequately performed in a lab
- useful for comparing different designs in a controlled context

Field/Ethnographic Studies

Field studies are done in natural settings

The aim is to understand what users do naturally and how technology impacts them.

In product design field studies can be used to:

- identify opportunities for new technology
- determine design requirements
- decide how to introduce new technology
- evaluate technology in use.

Predictive Evaluation

Experts apply their knowledge of typical users, often guided by heuristics, to predict usability problems.

Can involve theoretically based models.

A key feature of predictive evaluation is that users need not be present

Relatively quick and inexpensive

Characteristics of Approaches

	Quick and dirty	Usability testing	Field studies	Predictive
Users	anyone	do task	natural	not involved
Location	anywhere	controlled	natural	anywhere
When	prototype	prototype	early	prototype
Data	qualitative	quantitative	qualitative	problems
Feedback	observations	measures & errors	descriptions	problems
Type	ad-hoc	applied	naturalistic	expert

Evaluation Approaches and Methods

Method	Quick and Dirty	Usability testing	Field studies	Predictive
Observing	x	x	x	
Asking users	x	x	x	
Asking experts			x	x
Testing		x		
Modeling				x

DECIDE: A FRAMEWORK TO GUIDE EVALUATION

Determine the *goals* the evaluation addresses.

Explore the specific *questions* to be answered.

Choose the *evaluation paradigm and techniques* to answer the questions.

Identify the *practical issues*.

Decide how to deal with the *ethical issues*.

Evaluate, interpret and present the *data*.