Recursive Reality

KYLE LI

- Primary focus of the class : VR (Virtual Reality)
  - ∵ NYC is focusing on it
    - ↳ Job opportunities for international students, VISA, etc.
  - ↳ ∃ several projects in & around NYC

✗ **Self Assignment :** Start learning Unity 3D
  - ↳ The class may not cover <u>how</u> to use Unity

- Upcoming Events in NYC : (in Sept 2nd week)
  Brooklyn Army Terminal 100th Anniversary
  - ↳ Showcase your VR project & get funding

- History of VR
  - ↳ Started in early 1990s → a box in which you stand & operate
  - ↳ Next in 2005 → headsets that came with computers
    (120×350 px resolution)
  - ↳ Oculus Rift launched in 2012 — DK1
    - ↳ Made dizzy ∵ h/w & s/w didn't catch up with movement
    - ↳ So, Oculus sold themselves to FB.

- Idea : create content for a platform so that they can stick around for a long time.

○ We have MOTION CAPTURE STUDIO in school.
  ↳ Check it out.

○ Check projects by NYC MEDIA LAB

○ Verizon & other companies in NYC.
  ↳ Working on 5G : transformative technology as compared to 4G
    ↳ What are its applications
    ↳ VR will have tremendous scope ∵ of streaming speeds

○ Check HTC Vive : we have it in school.

Current Limitations of VR

→ Difficult to hold

→ Connectivity issues in real-time.

→ code in several platforms, every company has a diff⁺ contents store

VR headsets don't have a focal pts. So, eyes don't know where to look.
Not for children under 13 yrs age.

The controllers are not intuitive to use

○ Interesting project : Create a VR interaction such that the learning curve is small.

○ Coming up with new VR content is critical for it to last long!

○ Current topics in discussion
  ↳ Use AI as personal assistants — companionship
      ↳ ≃ movie, HER

———— ∞ ————

§ Nicholas Fortugno: one of the best Game designers
      ↳ Used to teach at Parsons (12 yrs)

○ Frederic E. Church: painter in 1800s.
  ↳ Colopaxi: Sublime paintings

○ History Society for New York — place for Sublime paintings
  ↳ Harry Potter exhibition coming in Oct. 2018.

○ The idea of the course is to go back to basics
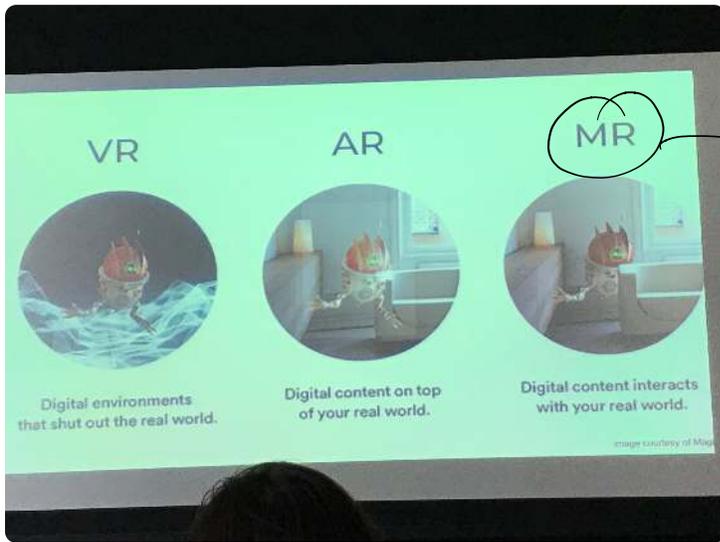   ↳ Understand nature & explore the world.
          ↳ Create VR experiences with that understanding.

○ Check out Microsoft Holo Lens, & other VR devices
      ↳ Some of them are available at TNS.
○ Check Google Cardboard

VR   AR   MR

Digital environments that shut out the real world.   Digital content on top of your real world.   Digital content interacts with your real world.

Understanding physical space (depth information). So, when things are put in space, they can be put behind other things

○ **DAYDREAM** : primary VR headset which would be used in class.

   Google

  ↳ Other headsets: Mirage Solo, Bridge, Fove, Magic Leap, Gear VR (Samsung), Oculus Go (the least), Hololens, HTC Vive

→ tracks iris (not head)
  ↳ good for eye tracking

good for eye tracking

○ Structure Sensor : 3D scanning can be done using iOS devices.

○ Graphics wise : BEST : HTC Vive
           ↳ Disadvantage : lot of cables.

○ Microsoft has created a standard for VR development.
  ↳ companies like Dell, Acer, HP, etc are using it.
  ↳ it is a separate platform, but technology wise, it is still developing.

- Magic Leap : more gestures & better customiz^n than MS Hololens.
- Leapmotion : Available open-source for downloading design files.
  ↳ *You would primarily use this for your projects*
- Holokit : NYU developed headset — only does AR. For MR, you need to code yourself

— × —

- For VR development, Windows devices are better than those of Apple.

- Take a Physical Computing class next semester → integrates very well with this course
- PERIPHERALS
  ↳ Motion detection — glove
  ↳ Myo : Gesture control — Sensor
  ↳ Makey Makey : A kit to quickly make buttons
  ↳ Dexmo F2 : Give force feedback to give a feeling of touch virtually
  ↳ Woojer : Sound feedback band
  ↳ Olorama : Scent & fragrance
  ↳ Perception Neuron : Motion tracking setup — entire body.

Perception Neuron
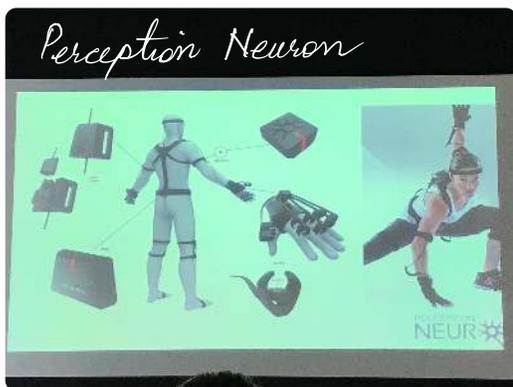
⑧ Tip : If you need anything, talk to Sven.

Homework for this week
- Look for AR & VR experiences around NYC & online
- Document the entire thing in a blog.

※ Jesper Juul.
  └ PHD in Games
  └ Analysis on community building
    for games — wrote papers.
      └ First person shooter

§ View games as <mark>dynamic systems</mark>
  └ rules, goals, game mechanics, game space, game components,
  players

what you are
doing in a game
(your interactions)

○ Game : Diner Dash
  └ By TNS faculty

Diner Dash Tips and Tricks

: Thought idea :
clicking the game
as per times.

o Magic Circle
  ↳ Idea used in Game Mechanics
      ↳ You want the player to get into the magic circle

✶ Rules of Play
  ↳ Book talks about
  fundametals of Magic Circle

o Magic Circle example : Hado

✶ Game Feel
  ↳ Book talking about
  feelings of players

→ Game references:
  SuperHot,
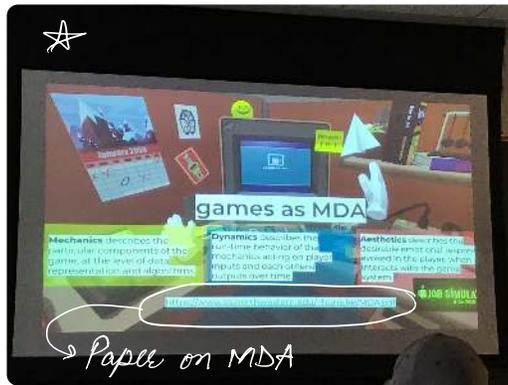 Persona5

✶ Play with Microsoft Hololens.

✶ Play Experience : Talk about the fun part of a game -only.

o Cheap assets : Chinese
Website : Taobao.com

○ New Way of looking at games : MDA Game Design

↳ M : Mechanics
↳ D : Dynamics
↳ A : Aesthetics

↳ Good way to talk about
interactive experiences
(using these terms)

↳ Paper on MDA

○ Job Simulator : Game
simulating job experience
↳ Bought by Google

Job Simulator

○ Game Experience :
example : Juicy Breakout.

example of MDA : Little Big
Planet

Juicy Breakout

NOTE ON MDA:
ONLY FOR REFENCE.
Don't let it restrict you to
make games.

○ 8I & Depth Kit : Companies working on Volumetric Scanning
↳ Realistic video capture of people :̊ Holoportation
↳ Present in NY.

↳ Kinect also does it. But, Depth Kit is better.

✷ Do tutorials on Unity.
   ↳ Learn & use it

✷ Build Sphere Contraption on Unity.

✷ <u>Unity</u> :
   → Rigid body component : add Physics to your object
   → Add material to the object for adding behavior
      ↳ Asset section → Create → Physic material

※ Cool VR project :
Viewing sound in VR
  ↳ Experiments with Google

※ Try VR experience for
Blade Runner
  ↳ Google Cardboard & Daydream

※ When creating objects in 3D space, don't keep it still. It should have some sort of motion to depict life.

※ Change the rate of motion of Unity (play)
  ↳ Edit > Project Settings > Time
      ↳ Fixed Timestamp & Time Scale $\propto \dfrac{1}{Speed}$
        ↳ Requires good rendering power.

※ Coding – Unity
  Variable : Time.deltaTime
      ↳ proportional movement wrt time — automatically done

☆ variable : Time.time

↳ eg. use sine fns using this ∿∿

↑↓↑↓
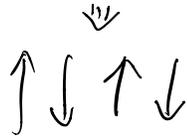
Back & forth motion achieved.

§ Matching Coding Standards

Processing

Arduino

Unity

void setup ( ){ }

void setup( ){ }

void Start( ){ }

void draw ( ){ }

void loop( ){ }

void Update( ){ }

§ Talk by Jesper Juul
↳ A master of FPSC (First Person Shooter Control) games

○ Idea of making a game fun:
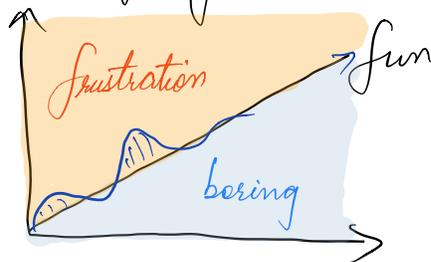
○ Game Strategies
↳ ① Walk Simulation
↳ ② Generative island & audio : Proteus
↳ ③ Blocking player goals : eg : Dys4ia , 80 Days

� When doing VR development, don't make the scene looking from just one side.
  ↳ People should be able to navigate from all angles.

✱ In VR, mostly we see content from 1st person view. So, think about closeup scenes. Take close-up pictures. Analysing a space from birds-eye view is not the best thing.

✱ Flat figures are boring. Details & curves brings exciting.
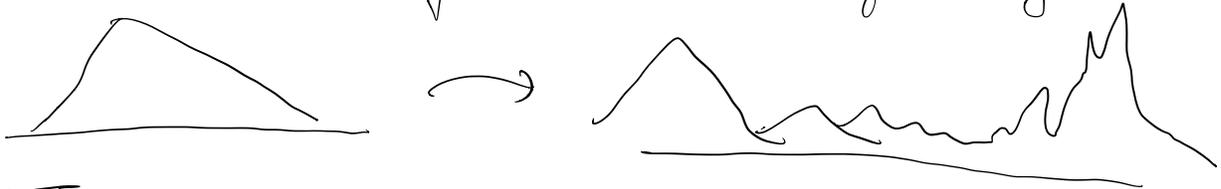
✱ Terrain is very resource intensive in Unity.
  ↳ So, build models in Maya / Cinema 4D & import it in Unity.
  ↳ Idea: Even if it is a cube, build it somewhere else.

✱ In Unity Terrain, 1 unit ≡ 1 meter
  ↳ 1 Unity Unit = 1 meter real-life

✱ For mobile platform, use 2000 units x 2000 units (2 km x 2 km). This is the max, you would use.

※ In first person control, see the height of the person.
  ↳ Default height = 1.8 units ≅ 6ft.

※ Directional light : Straight light ≡ Sunlight. ○⊏

※ File > Build Setting — export options
          ↳ Default ; PC, Mac
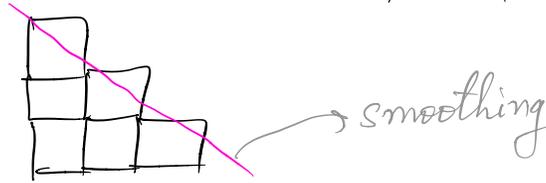
       ↳ Player Setting
           ↳ Other setting
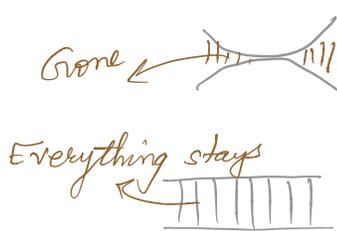
Gone ←⇔⊪⊩ ⎱ Gamma : value adjusts lightness &
                          darkness.

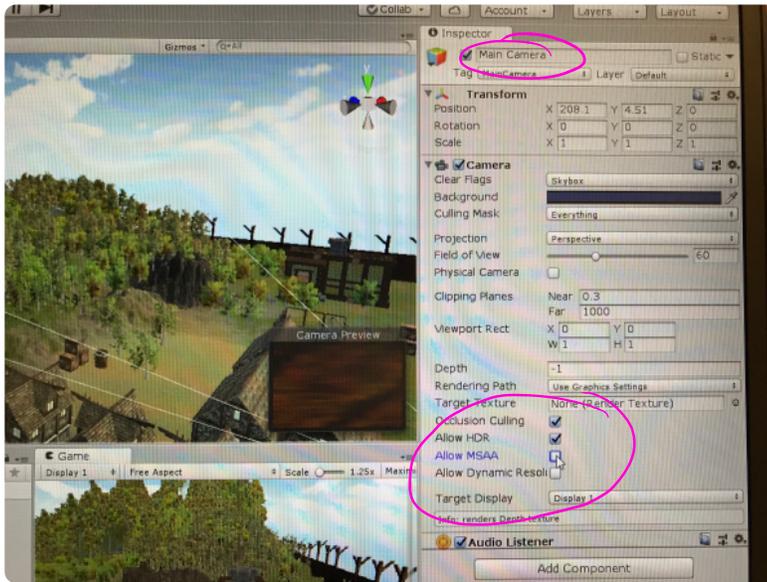Everything stays ←⊪⊪⊪ ⎰ Linear : Higher end graphics & looks
                          ↳ Use for high quality objects
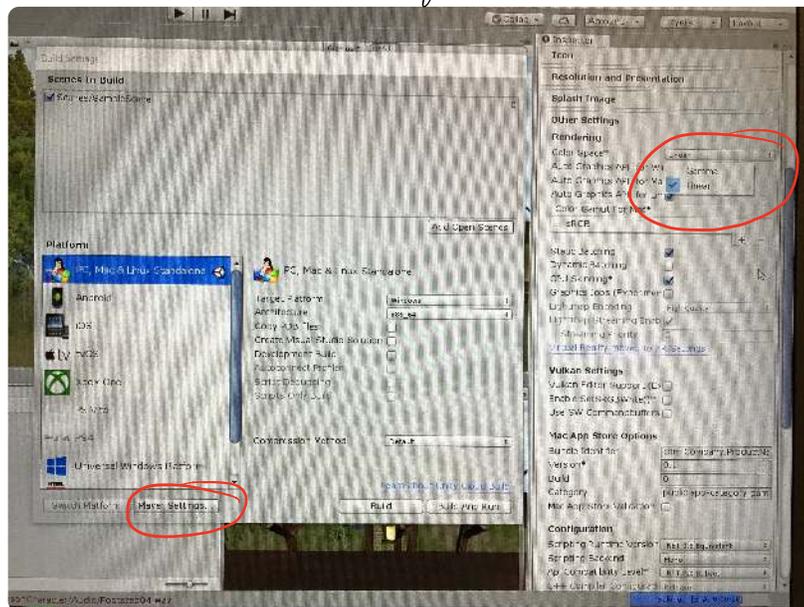
✴ Main Camera

    ↳ MSAA : Anti-Aliasing Method

        ↳ Redraws the corners of the pixel for smoothness
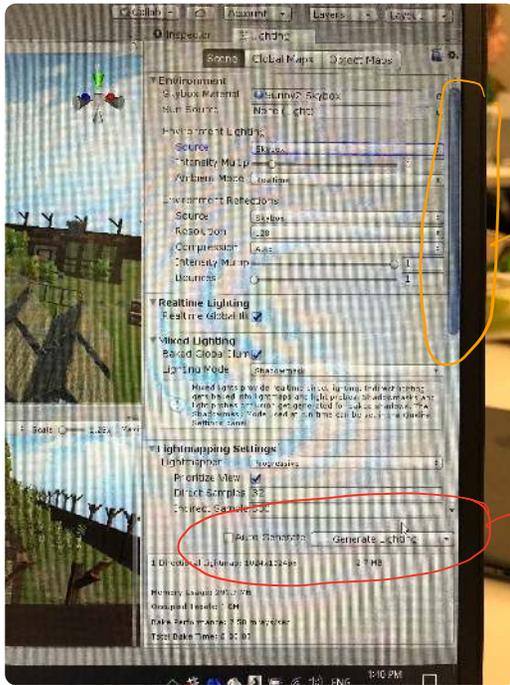

→ smoothing

    ↳ HDR : Also does anti-aliasing.

    ⇒ Don't use both MSAA & HDR. So, turn off
        MSAA checkbox.

✴ lighting : very complicated object ; Takes a lot of baking time.

Direct light

Indirect light
(bounce)

→ Without baking ; we only see direct
    light

→ With baking ; Direct & indirect visible
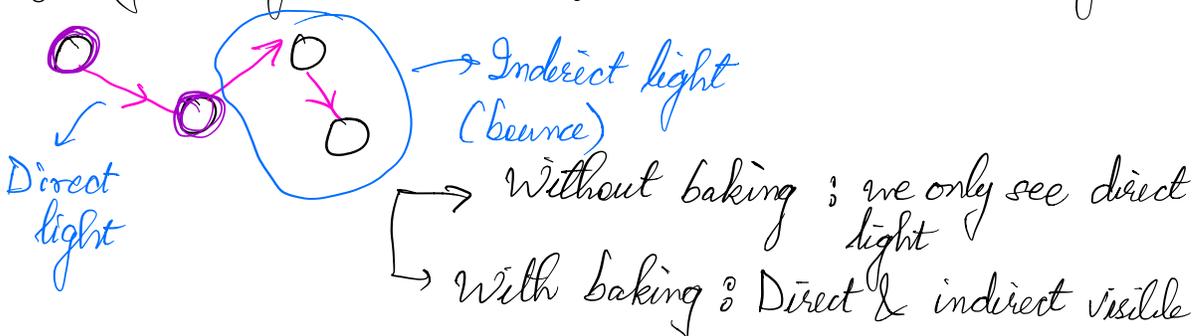
Scroll down to see FOG options.

Uncheck Auto Generate
↳ If you don't want the baking to run automatically

�֍ Edit > Project Settings > Quality
   ↳ Change the quality of render : High/Very High
   ↳ Anti - Aliasing — Dropdown — Disabled.

✗ Using Post Processing Stack Asset
   ↳ Adjust all processing at once.
   ↳ First Person Cam. > Add Component > Post Processing
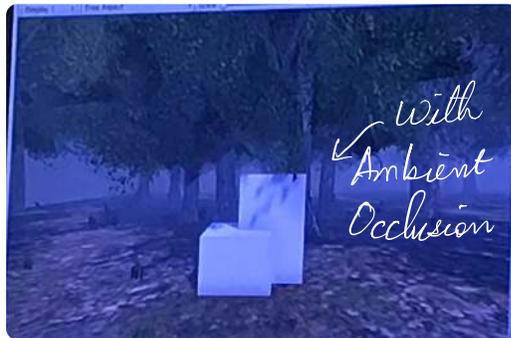   Behavior.

Not :
Main Camera
   ↳ Asset > Create > Post Processing Profile
                              (≡ XML file)
       ↳ Drag and drop this profile on the
          added component of Main Camera.
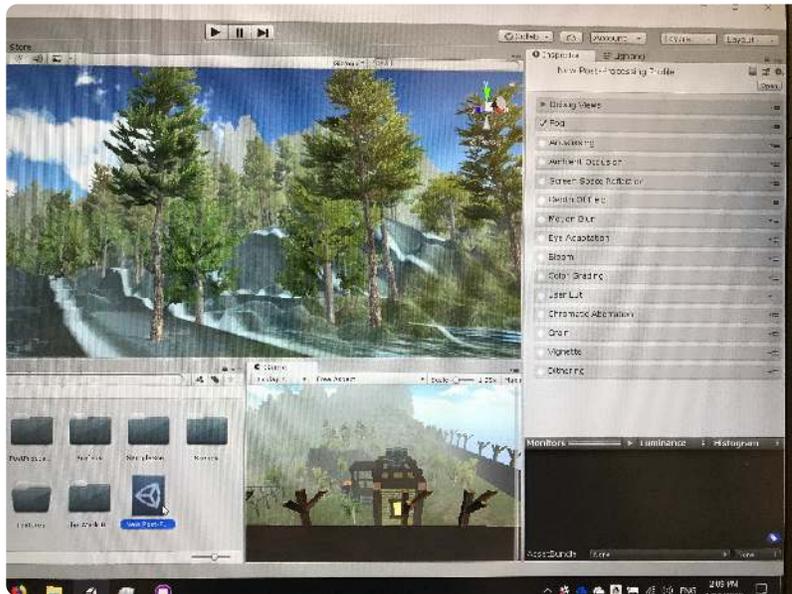
→ Anti Aliasing
  ↳ Use Temporal
Types
→ Multi Sample (MSAA)
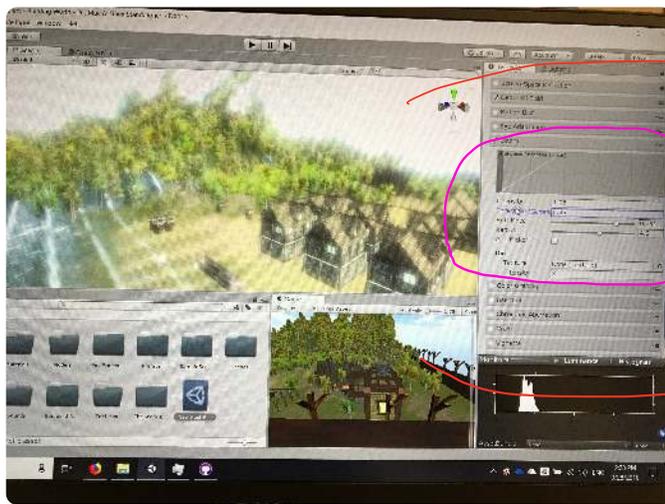Fast Approximate
    (FAAA)
Temporal (TAA)

→ Ambient Occlusion
    ↳ Emphasize anything that intersects

With
Ambient
Occlusion

→ Motion Blur
    ↳ Can be used to do the drunk effect.

→ Eye Adaptation : when you go from dark room to light,
                   our eyes adjust. Unity recreates effect.

→ Bloom : Using glow effect on a light

→ Bloom effect

→ Adjustment

→ Without bloom

→ Color grading ≡ LUMETRI COLOR : Premiere Pro.
   ↳ Tonemapper > Filmic (ACES)

✗ First Person Controller
   ↳ > First Person Character > Rendering Path > Deferred.
      ↳ If using VR, use Forward.

✷ Setup your computer for VR equipment
   ↳ Android SDK & Java (JDK)

↳ Edit > Preference > External Tools ⟶ get all SDKs.
                                   ↳ Follow installation guide
                                      for Google Cardboard &
                                      Daydream

→ Download these & link
   the SDK & JDK.

✷ Update terrain & share
   screenshots

✷ Additional lighting assets on Unity Asset Store
   ↳ Legacy Image Effects
   ↳ Legacy Cinematic Image Effects

§ Working with lighting — TURN OFF ALL LIGHTS

- ○ Starting from scratch — to see effect of lighting
  - ① Change skybox to solid color
  - ② Change color to black
  - → In lighting, turn all intensity multipliers to zero
  - → Directional light : turn off checkbox/set intensity to zero.
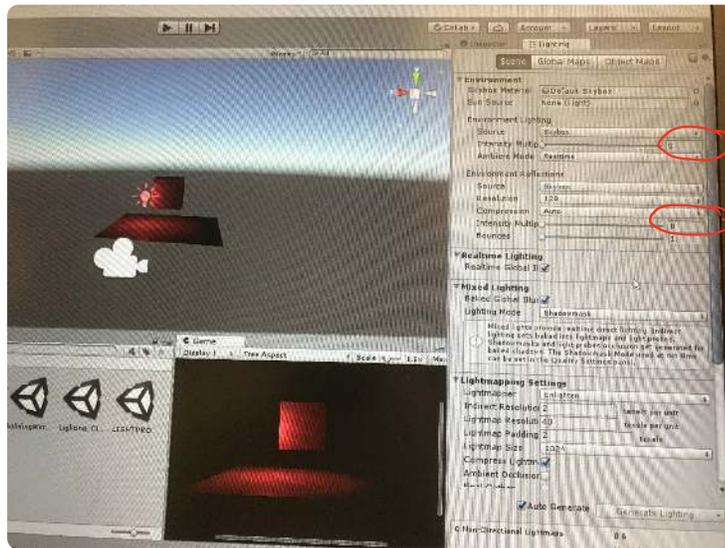
Turn intensity multiplier to zero.

§ Giving a torch effect

3D object with bloom & texture (not a light)

Spotlight
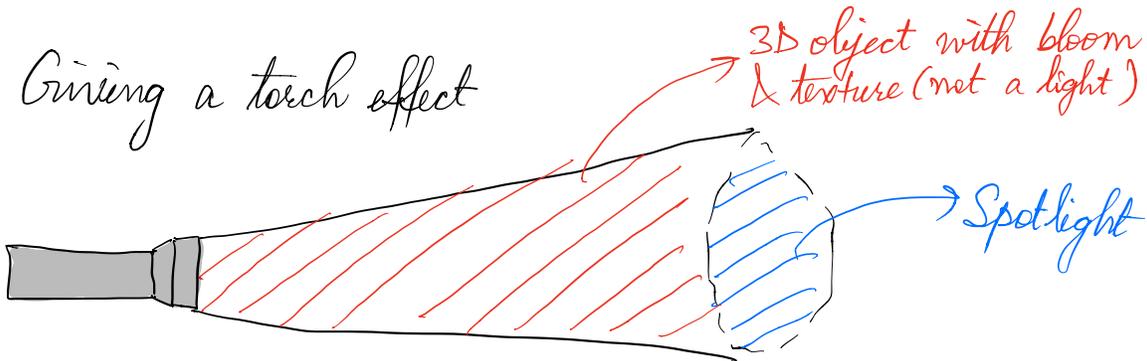
○ Lighting Mode :

↳ Realtime ──→ used for dynamic objects

↳ Mixed

↳ Baked ──→ for an object which doesn't move.
↳ eg. terrain, trees
(bake a rich light once so that
it can be reused)

Global Illumination

	Object Type	Realtime	Precomputed Realtime GI	Baked GI	
Lightmapper		None	Enlighten	Progressive/Enlighten	
Light Type		Realtime	Realtime	Baked	Mixed
Direct Light	Dynamic	Realtime	Realtime	None	Realtime/ Baked
	Static	Realtime	Realtime	Baked	Realtime/ Baked
Indirect Light	Dynamic	None	None/Light probes	None/Light probes	None/Light probes
	Static	None	Procomputed	Baked	Baked

In newer versions of Unity (2018)
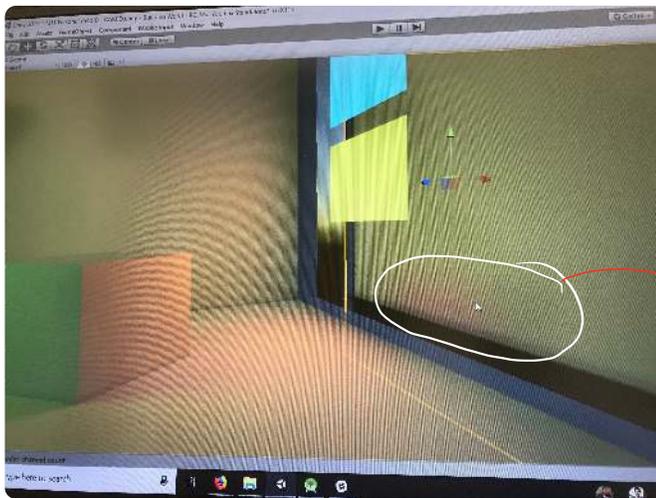
→ A baked light
basically paints the
light on the scene
to save space in
realtime.
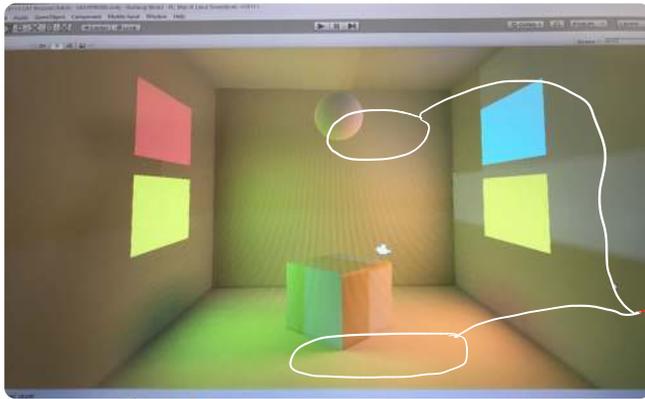
Mixed colors of lights — doesn't happen in realtime.
⇒ This light was baked.

§ Add animation
  ↳ Select object
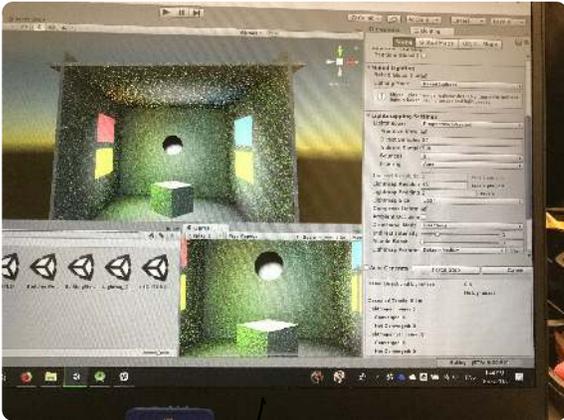   ↳ Window > Animation — Create keyframes for different properties.

⚹ Before setting lighting
  ↳ Adjust the static objects
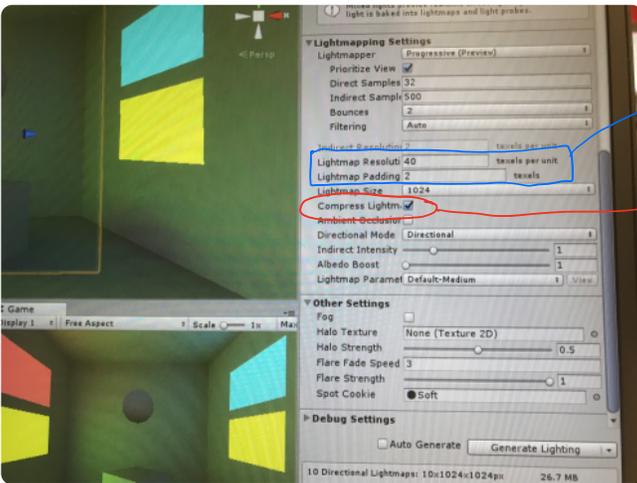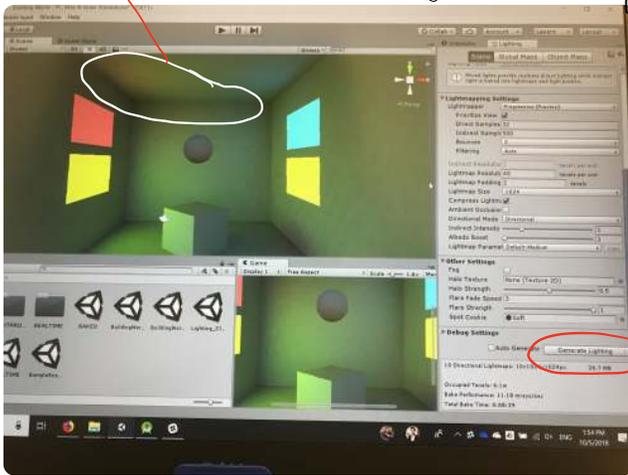   ⎰ Select object > Inspector > Static
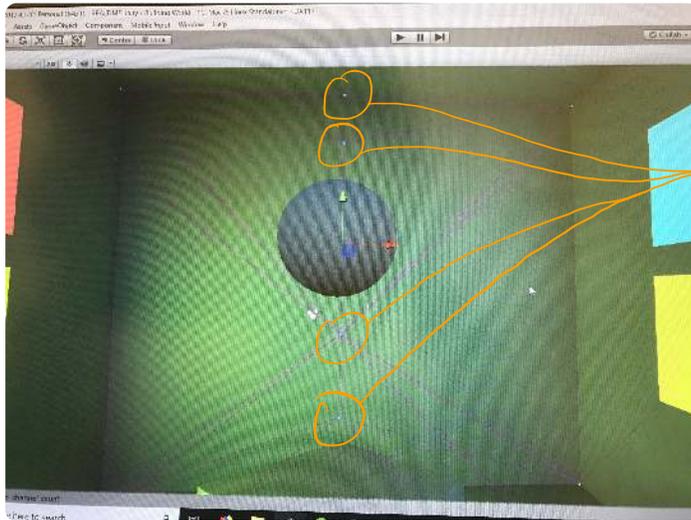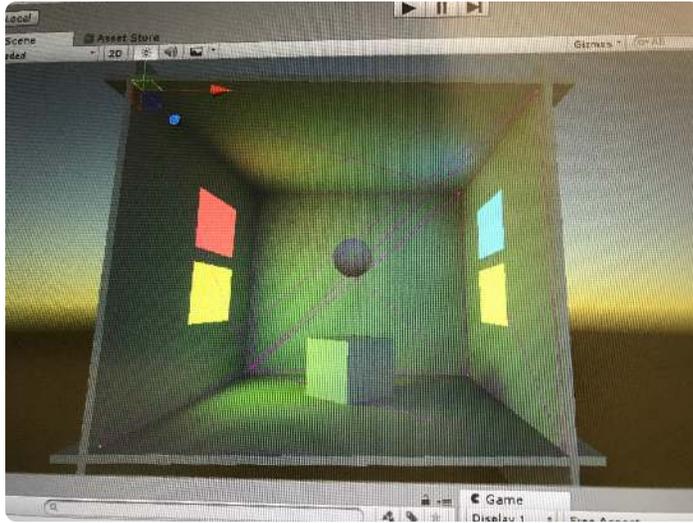   ↳ Lighting > Mixed Lighting
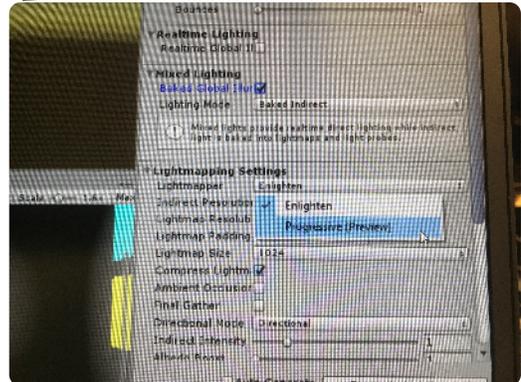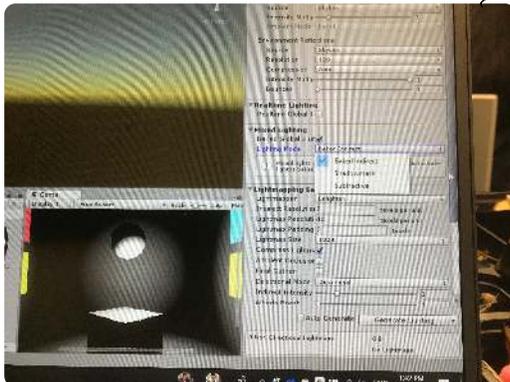
Baking light on Static Objects
↳ After clicking Generate Lighting

A mix of lights

Keep a ratio of
1:10. 2:40 is
good.

Compress lighting
↳ Tick to NOT
render full resol^n

§ Using Light Probe Group → Uniformly add multiple light

    ↳ Put it where the light is changing.

each dot stores the light info on build. So, we can use this info on objects.

    ↳ Select a dot & press ctrl+D to duplicate the dot & make add^mal dots.

Adjust the position of the light probe. Wherever you place the probe, it will take-in information.

○ Light probe ≡ Data logger.

    ↳ So, if you want a particular color to be highlighted add more light probe points from that source.

o Lighting — set importance
  ↳ Select the light > Inspector > Render mode

Auto   Important   Not Important
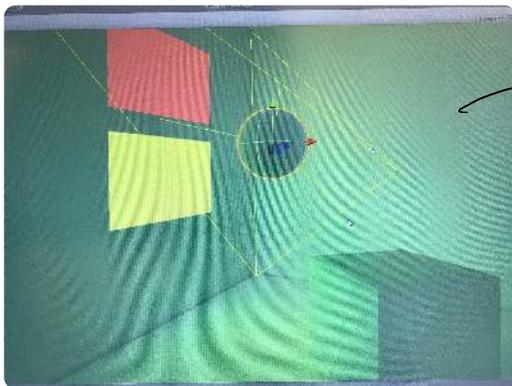   ↓   ↓
         Pixel lighting   Vertex lighting
         (More detail)   ↓
                            Uses very less
     [Don't have   computing resources
      more than   (takes only vertex
      4 imp. lights   info. for lighting.)
      in 1 scene]

✳ Mid Term : Build a world using whatever you
  have learned. ⟶ Oct 26.
    ↳ focus on aesthetics
    ↳ Interactions → after mid-term.
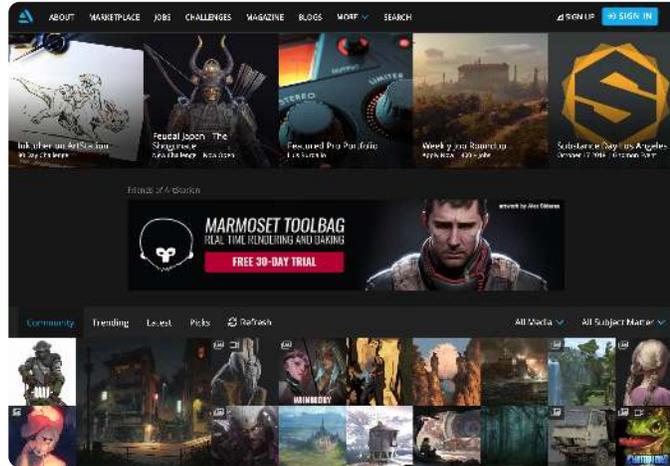   ↳ It should work in VR.

→ Once baking completes, you
  can move the object & see which
  probe points are affecting the
  object on that position.
  This scene is mostly green. So,
  add more points on red regions &
  bake again.

§ Workspace to check trends for inspiration
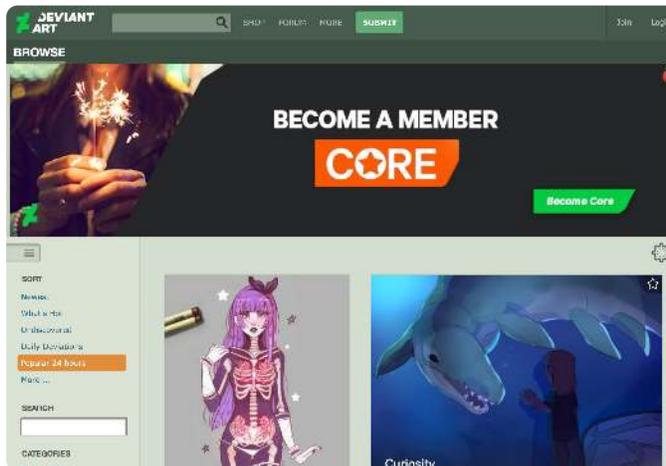
① Art Station
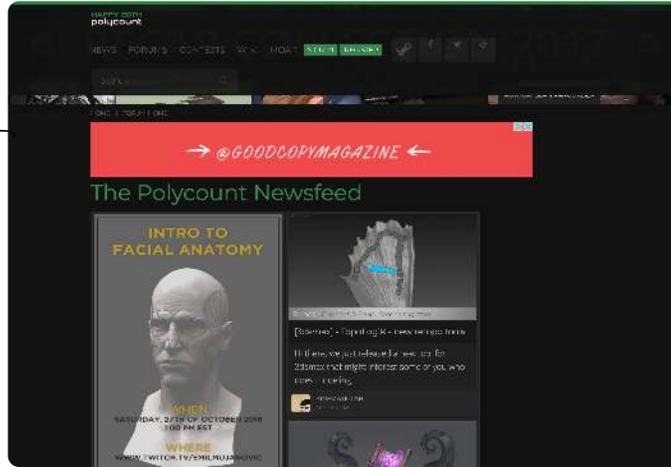

② Pinterest
(creative
environments)

③ Behance

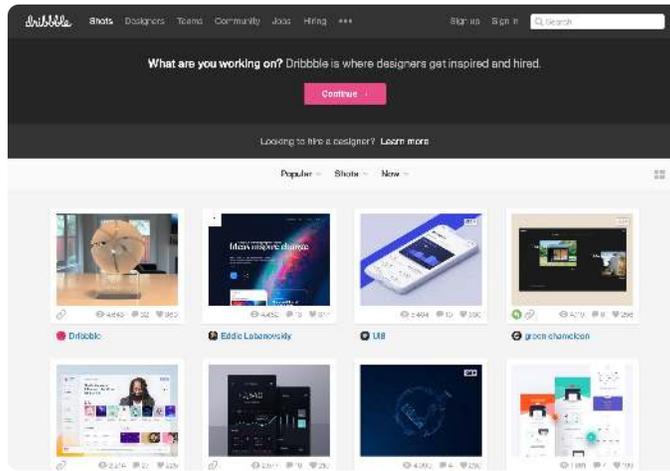④ Deviant Art

⑤ Polycount

Supportive
community
to create assets
& get feedback
on work

⑥ FB page : The Tenthousand Hours → Join it
⑦ Guild wars

⑧ Dribble

⑨ Pixiv

Japanese
style
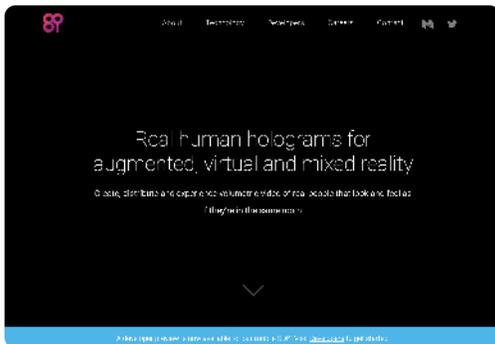
§ How to create assets — Techniques

ↆ Photorealistic – taking pictures & building a 3D environment through it

↓

Photogeometry

○ Structure Sensors : do scanning through iPhone

✳ Companies working in Photogeometry in NYC.

8I Studio : NYC.

Depth kit : NYC

✳ NYC Media Lab is building a VR & AR Lab
ↆ Brooklyn Navy Yard → Building 22.

§ Asset Tools

1. Tilt Brush
   ↳ Works with Oculus Rift

○ Shader : A script in Unity — you can control how many details you want

2. Z brush ⟶ 3D model
3. pyxel edit → 2D based
4. mageca voxel → quick char. building
5. 3D coat → realistic textures
6. Cinema 4D → create own shapes
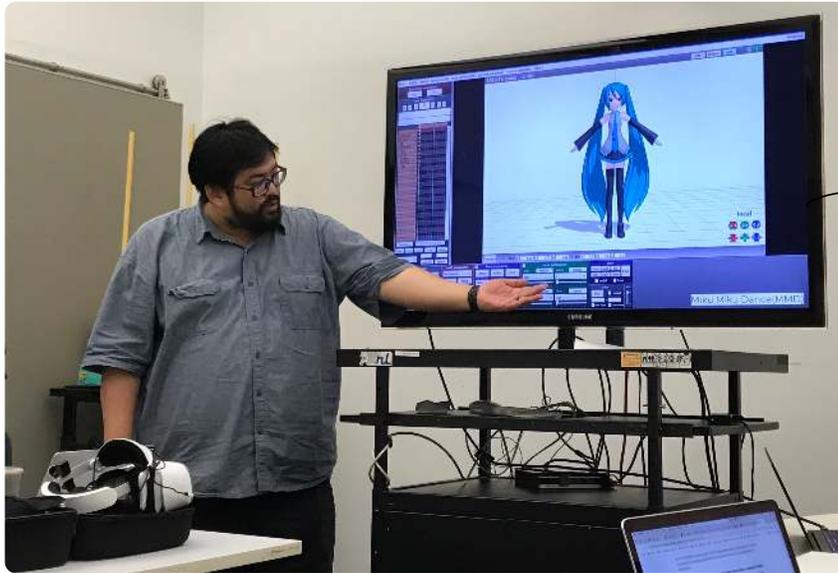7. Meduim → 3D model in Oculus Rift
8. Blender
9. Milkshape → take models from games & put in other games — file format conversion
10. Metasegoia → good for low polygon

✳ Retopology : process to reduce the faces (polygons) from 10 M faces to 10 K (say).

✱ Miku Miku Dance (MMD)
    ↳ Make characters animate & dance to Music.

→ Japanese
  design
  community

✱ Create 2.5D models ⟶ LIVE 2D
    ↳ Put characters in a format & export to create
      fake 2.5D.

✷ Unity Chan

→ Download
from Asset Store
↓
Get a 3D model
with all expressions

✷ 3D Kitbashing — Modular arrangement
⌐ Building PARTS of a 3D model & get them to
create a final piece.

→ Using scrap
to create sth
meaningful

✷ Adobe Mixamo & Fuse

✳ Autodesk Character Generator

≡ Adobe Fuse
(better: online)

✳ Clip studio : Japanese version of Unity

✳ Bowl Roll → MMD Community Blog → for inspiration

────✂────
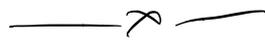
◌ Open Hogwarts → a project which is an open
community for creating Hogwarts.

✳ Setup the platform on Oculus Go with the
Prototype of Mid-Term project.

§ <u>Managing resources</u> ——→ for mobile platform

↳ Asset store : <mark>Resource Checker</mark> ——→ import in project

    ↳ It shows all the <u>assets</u> being used in the project

      ↳ Check their sizes, go to Photoshop, trim it & import the reduced file (512 kb) in Unity

      ↳ Sometimes texture sizes are of 32 bit. If they don't have an alpha channel, reduce it to 16 bit.

→ Window > Rendering > <mark>Occlusion Culling</mark>

    ↳ Select all > Bake

    ↳ Idea : Bakes only the scene that is visible — not the entire scene.

→ To reduce the size further, go to the respective object & click on "STATIC" in Inspector. After doing that to all static objects, use Occlusion Culling. The compression would be better.

static
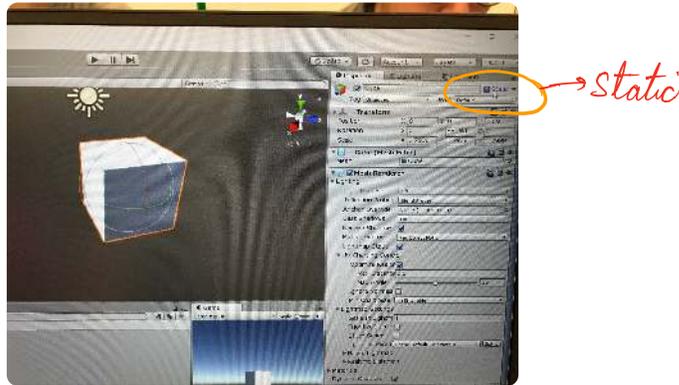
→ Bake as many lights as you can — don't run them in real-time.

→ In the game view, go to stats & see the vertices
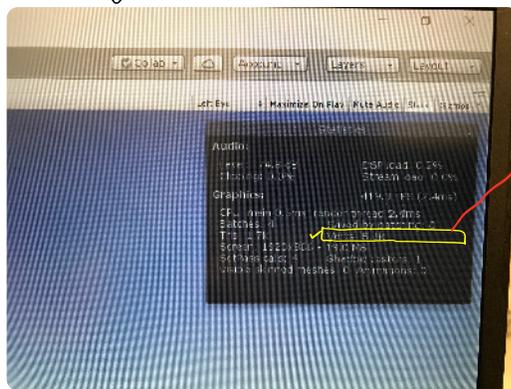
↳ For mobile,

200 K — 3 M Vertices

↳ That's the optimal range for vertices

↳ Best : < 1 M vertices

→ For Oculus Go

↳ ∃ special settings on their website to further optimize the scene

↳ When doing game design, don't show the entire screen at once — this will reduce what needs to be rendered
↳ ⇒ less no. of vertices.
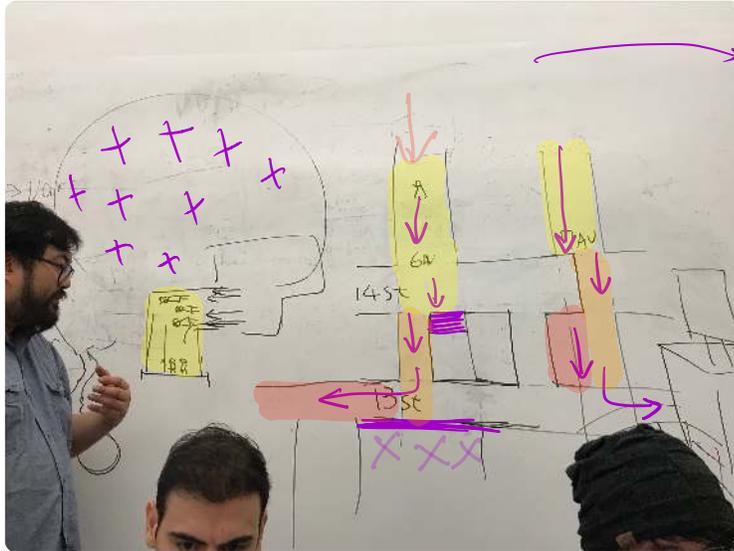
Add turns to the view so that the entire view is not visible

✳ Make a 2-3 sentence pitch
↳ Handover your world to anyone by saying this pitch

§ Thinking <u>about languages to use</u> :

As you get in your 2nd year, focus on one-skill & build on it.
Also, learn the tools which are used in the industry :

① openFrameworks — not used in an industry

② Cinder — alternative to openFrameworks & used by the industry

③ Processing — very limiting & not used in an industry. It is very slow to work on heavy tasks.

Layers : Processing ——————
Java — — — — —
C# ～～～～～
Assembly ～～～
Machine o o o o o o o o

5 layers
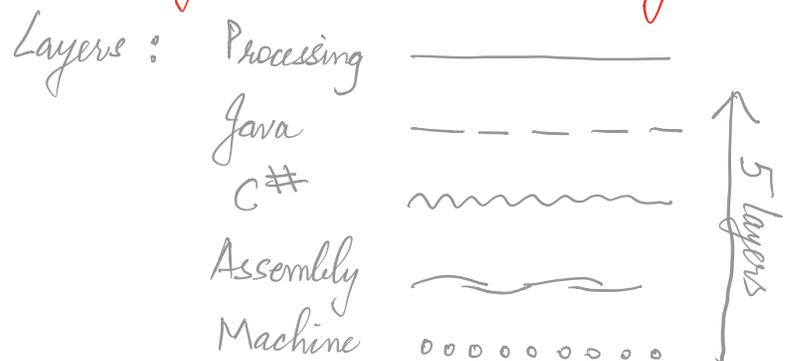
④ JavaScript — very useful as it is used in the industry. However, JS is not a visual language. It's great for connecting things together .

⭐ <u>Comments on Elevator Pitch</u>

When you create an Elevator Pitch, think about what you want others to feel after seeing the project.

✦ Zach Grage
  ↳ Indie Game Developer
  ↳ Fishing games

○ Play Crafting
  ↳ A community teaching game design, mobile dvpt.
  ↳ Award event at TNS in Dec 2018.

○ News:
  Nintendo is working with a local NYC company to implement their controllers in the school curriculum.

✳ Assignment for the week after Thanksgiving
① Research on the assigned topic (eg: shaders)
② Understand its use for 2 weeks (Nov 3rd & 4th wk)
③ Give a 30 min present" explaining the topic & its use to the class

§ Research topics to explore

Ⓐ Designing your own controller
    ↳ Human Interface Device (HID)
○ Idea : create a device which the computer understands & add"nal driver is not required

○ You can also use sound to trigger controls on the controller
    ↳ eg : AR Guns

✳ Phone Phreaking
    ↳ Use sound to trigger calling
    ↳ Used in the 80s.

- Makey-Makey
  - Devices which can detect v. low levels of resistance on the body & use that to create actions
- Using Adafruit components to create an HID controller
- Arduino Pro Micro can be used as an HID controller
  - Needs an additional bluetooth module
- Nintendo Labo Keyboard — great pComp device.

[Youtube : First Look at Nintendo Labo]

→ Using IR camera to trigger actions

- Japan's culture — newspapers include carboard based projects which inspires kids to make stuff. So, they are familiar with making stuff with cardboard.

(B) Non-HID

- Leap Motion Products —— used for hand tracking
  - ≡ Kinect
  - They have program logic system built for Unity
  - Connect with PC through USB
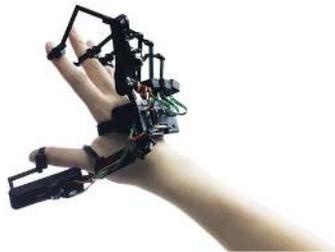 - Good company to work for — friendly, interested in product improvement

○ Manus VR
   ↳ $900

○ Myo — Gesture Control Armband

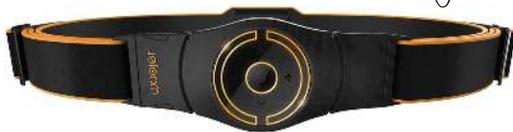→ Tracks the arm muscles when we grab something

○ Dexmo F2 : Mimic touching in VR

○ Smart Gloves by Dane Hu
   ↳ TNS Alumni

○ Woojer — a belt to give music f/b.

→ Now, making a full suit

○ Japan — an algorithm that generates characters when you input diff^t barcodes — blasted in Japan

- Apple's focus: creating a living room technology
- Microsoft → FDA approved

  AR in surgery – project on the back of a person's back —— doctors can analyze & do surgery

(C) NAV MESH (NPC) → (VR Samples)
  - ↳ Defining the area of the map in Unity to be the most expensive to go
    - ↳ eg. in patrolling, the object should move in the key area
  - ↳ AI follows a path
  - → Michael worked on it in 5-in-5
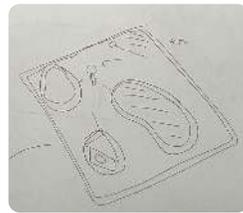
(D) Verbial Command → v. robust pipeline
  - ↳ Google, IBM Watson
  - ↳ Create interaction with voice
  - ↳ Limitation: connection speed dependency
    - ↳ 5G will solve it —— latency will have a guaranteed value & it would be 100x faster
  - → eg: train Watson to detect Harry Potter spells
    - ↳ done by Kyle
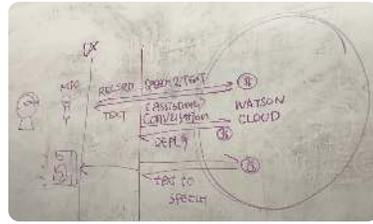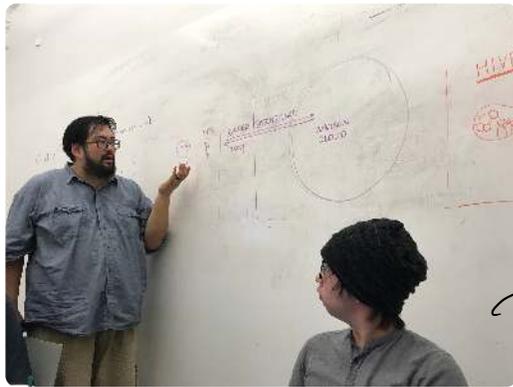
Create a conversation
through Text to Speech
(eg. what happens in
a voice call)

- Watson cloud — expensive service
  - 1 yr free for developers
  - First 400 interactions free

- Watch : Watson Unity SDK : Series on YouTube

— ⋊ —

✗ TRICK : Use your TNS alias to create multiple accounts
       & extend software licenses — get 2 licenses

— ⋊ —

- Gamers like to sit & play — think about that when
  creating games/interactions for that audience.

§ INTERACTIONS BASED ON GAZE

o New renderer feature have come on Oculus Go.
  ↳ Add a few lines in the code to give a better rendering.

✗ Using Gaze in Unity

Methods

RAYCASTING (≡ SONAR)   EVENT

↳ Setup a listener to listen the aggresiveness of your player/object

↳ Know the intersection with an object — trigger event

o Setup Event (Delegate)
↓
Action
↓
listener
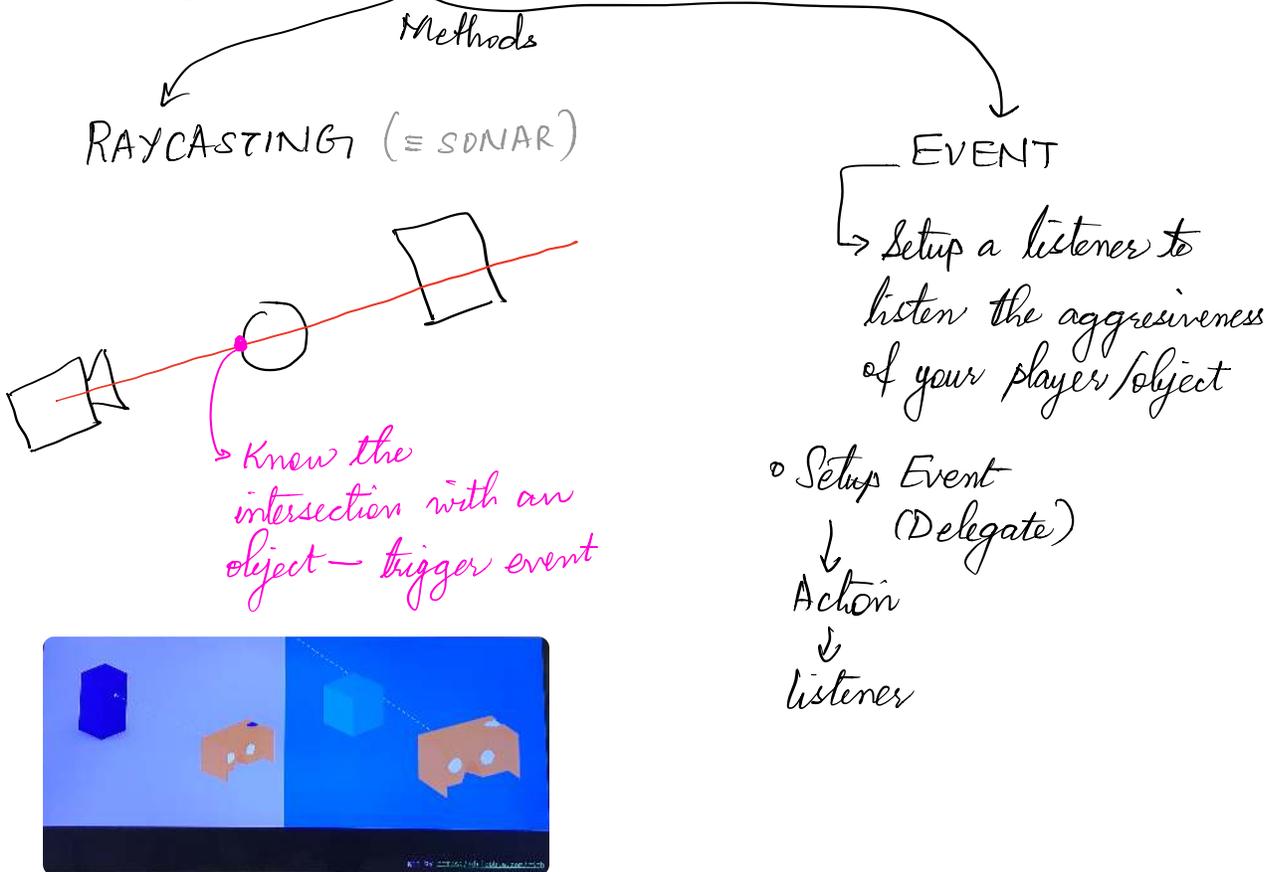
o Polling → writing everything in the Update ( ) { } f^n.

○ <mark>Doing Raycasting on Unity</mark>

Check Asset Store > Unity Projects > VR Samples

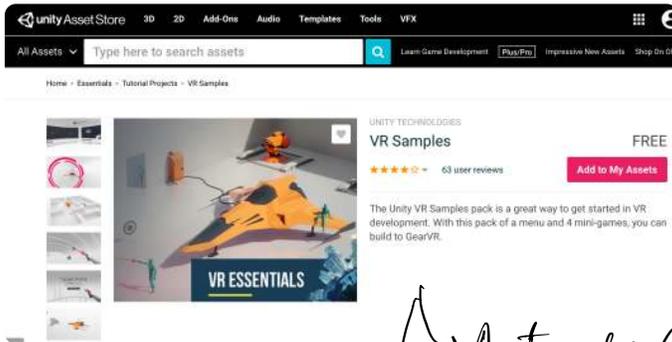It has most of the settings already done.

→ Automatically focuses on the target region.

→ A spherical view of the menu
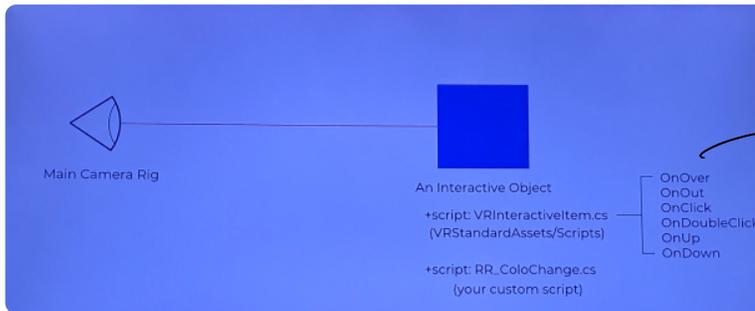
→ Scripts present in Unity Std Assets

OnUp ≡ Key Pressed

OnDown ≡ Key Released

○ <mark>Use the Std. package shared by Kyle.</mark>

→ Use the prefabs & customize it as needed.

→ Sphere — ChangeColors

↳ We can add sound on the object ∵ it doesn't destroy itself

→ Script (RR_ColorChange) : OnEnable, OnDisable

↳ Using events & listeners

↳ Sphere-Fire

    ↳ It has particle system inside it. So, the object needs to be linked with the (particles)

          ↳ GameObject of the entire particle system

    → + =   → add action

        − =   → remove action

    → void onEnable & void onDisable are built-in functions .

    ↳ " using Unity Engine "

        ↳ Adding this to the script will make Unity understand Particle Systems

○ Shortcut to comment / uncomment on C# :

    ↳ Comment : Ctrl + K + c

    ↳ Uncomment : Ctrl + K + u

○ In a game, ∃ several particle systems. So, it gets confusing.

    ↳ So, don't use sound sys. on a particle.

        ↓

        Create an empty gameObject & use it as a sound source.

○ RR-Explosion

    ↳ Var Michael Bay → explosion particle effects

- If sth is private & you want to see it in the inspector window, add [SerializeField] before it.

- For multiple explosion, play with diff^t volume levels for better effects.

- With using Events & listeners, if-else statements are not needed anymore.

§ DIFFERENT PROJECT PRESENTATIONS

✗ Ke Ding & Nick's team

○ DIMM : Distance Independent Millimeters
   ↳ Creating a UI that's readable
      ○ Character in Unity : Default height : 1.6
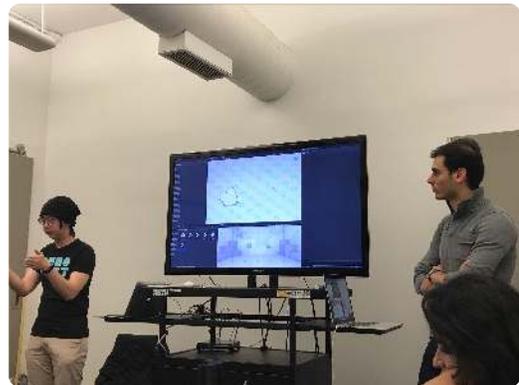   ○ UI Canvas : set the scale to 0.001
      ○ When we import an image inside unity, change its property from "Default" to "Sprite".
         Then, in the UI element, drag & drop this img in the "Source Image" section.

○ Dot Matrix System
   ↳ Create a reference sys. in Unity

○ Using Mixamo

— Uploading to Mixamo
 FBX : Doesn't work well in
      Mixamo.
      ↓
 Export character as OBJ to be
 used in Mixamo .

— Downloading from Mixamo
 ↳ Always FBX (for Unity)
         ↓
     Import FBX in C4D
   (you can tweak it there &
     export it again as FBX)

 FBX : Stores materials
 OBJ : Doesn't store
         materials

Then, import it in Unity — using animation window
                          (making transition)

○ Using Z brush — a sculpting tool
○ Good 3D software to use : Element

�✗ Echo, Ashveta & David : Spacial Sound

→ Good software for Spacial sound

Audio : Handled through audio source & audio listener

✗ Ayo, Yashwanth, (+5 others) : Blind Flying Game
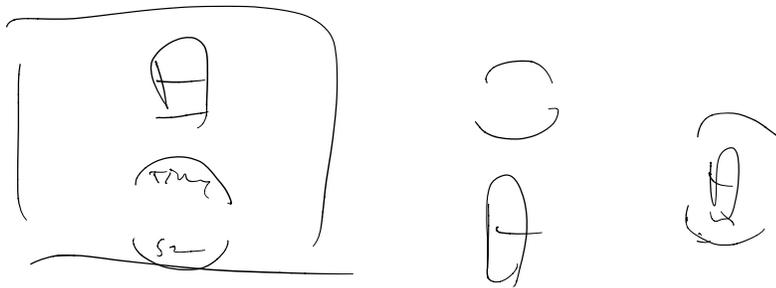

↳ Using Osc Simpl

— ✂ —

○ Comments on my final project

⚝ Sam:
  ① Document the process well. That will help explain the concept.
  ② Great explanation of the physical prototype
  ③ Test the HUD by placing it in different locations wrt the medicine

④ The interface & the HUD lags with head movement. Improve that.

✱ <u>Kyle</u> :

① Add an animation next to the ring + enzyme such that when the medicine passes through, the animation blocks the enzyme. That will create a better feedback to the player.

② The interface starts very quickly in the beginning but the pace normalizes afterwards.

END OF COURSE