Picture Yourself

An Interactive Installation for David and Susan Coulter Welcome Center

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I. Introduction

Carnegie Mellon University's Office of Marketing & Communication and Entertainment Technology Center (ETC) have collaborated to build an exhibit, Picture Yourself, for the new David & Susan Welcome Center. Located in the newly opened Tepper Quadrangle, the Welcome Center is populated with prospective students and their families. The goal of Picture Yourself was to design a live "selfie spot" that captures the "affinity of CMU" and allows the visitors to see themselves as a part of the community of CMU.

Our team was tasked with creating an experience that showcases an innovative use of technology which is both entertaining and informational for the visitors. We believe Picture Yourself is a great opportunity to not only provide a memorable experience for the visitors but also meaningfully archive data of the CMU community. Essentially, we envisioned Picture Yourself as an interactive guestbook. Our guests will be able to leave a trace of themselves at CMU and also have something to take home to remember their visit.

In this documentation, we have summarized our semester's work from design process to technical implementation. We would like to thank Beth Wiser and Brian James from CMU Office of Marketing and Communications for their continuous support and encouragement throughout the semester. We would also like to thank Chris Klug and Ralph Vituccio, our project advisers, for guiding and pushing us towards our goal. We hope to see Picture Yourself continue to grow and be permanently installed. Thank you.

Team Picture Yourself

November 18th, 2018

II. Overview

The Office of Marketing and Communications, described Picture Yourself like below:

"Before digital cameras, there were Kodak Moments. Throughout major vacation destinations, you would find small signs marking a spot where vacationers could snap a photo with the most beautiful background capturing the place and time. Locations like this have now become known as "selfie spots." Whether the destination marks the spot or not, young people seek out the place and moment that pridefully shows the world where they've been and, in most cases, where they are at the moment. ETC students will work with CMU Marketing and Communications to build a Welcome Center exhibit at the new Tepper Building. CMU is creating an opportunity for visitors to not only show where they are, but where they could see themselves in the future. A large wall-size display becomes a customizable backdrop with scenes of CMU's

campus — both familiar locations and some that many never see. From the Mall or Walking to the Sky to the robotics high bay. From Qatar to Silicon Valley. But the vision goes further. Want to see yourself on the stage at the Tonys? Select Drama scenes. Have dreams to walk the moon with your space rover? Or maybe you just want a selfie with the Scottie dog. The large video display may be driven by a smaller kiosk with a scene selector and brief descriptions of the locations making the experience both entertaining and informational. The wall will be an additional beacon from the exterior and can be programmed for static or motion images when not in use as a photo backdrop."

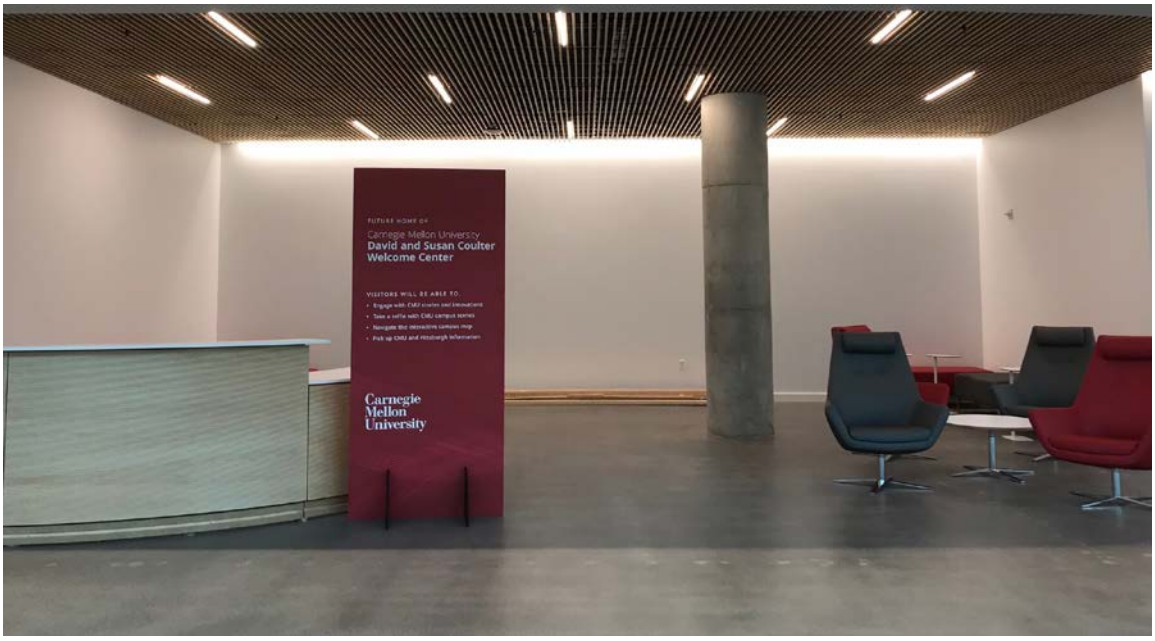


Figure 1: David and Susan Coulter Welcome Center before opening.

Beth Wiser, the Director and head of Visitor Experience of Office of Marketing and Communications, and Brian James, the Creative Director, asked our team:

- **To create a working prototype that is flexible, robust and easily customizable.**
    - Flexible: our wall display can be replaced with a video or other type of media for special events or occasions.
    - Robust: our software and any technology should be cost-efficient and easy to maintain
    - Customizable: our client can edit the content and further develop the software
- **To prepare a documentation that will help them or potential vendors understand our design process, and learn how to use and customize the software.**

Our goal was not to fully install the design but to provide viable options for layout, potential vendors for installation and estimated budget plan. We were given $150,000 as our budget but our client clearly expressed that we should aim to find an economical plan for our design.

III. Ideation & Design Research

During our first meeting, our client coined us the phrase, the "affinity of CMU"; we defined it with three core values of CMU: the diversity of students, its interdisciplinary programs, and unique traditions. Picture Yourself should highlight these aspects of our community to the visitors and inform them through engaging and meaningful interactions.

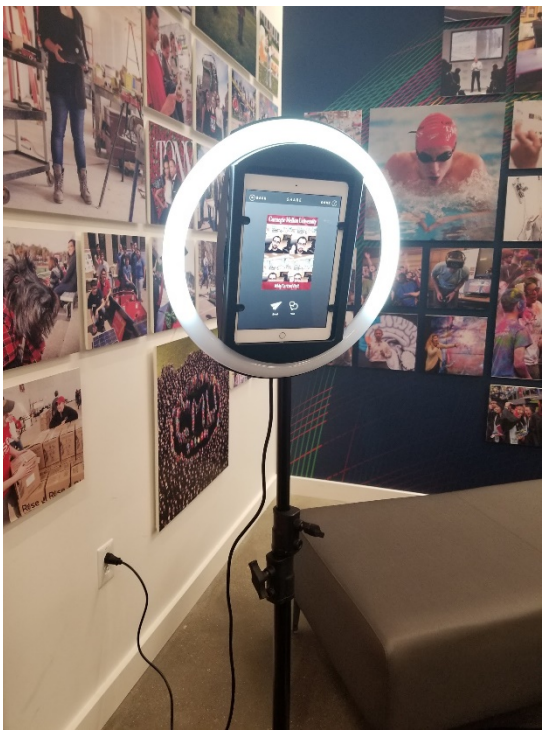


Figure 2: Simple Booth installed in Welcome Center

Our client introduced us to Simple Booth ***(Figure 2)*** as an example. Simple Booth HALO is an all-in-one photo booth that utilizes an iPad app and a lighting rig that allows for quick and easy installation with versatile and fun social features. It has been used on various CMU events, such as Carnival and the Grand Opening of Tepper Quadrangle. We realized Simple Booth already had a lot of the basic content our client wanted; it was relatively a short and easy-to-use experience for users to take a selfie, personalize it, and share it. We were impressed by its function to organize and archive pictures taken at different locations and dates.

After the meeting, our team began to discuss how to make our experience both entertaining and informational for the visitors. We wanted to incorporate some of the features of Simple Booth into our prototype. It was crucial to make the act of taking a picture of yourself in a public space more fun and perhaps more meaningful. We continued to explore past examples of interactive installations, creative uses of selfies and innovative platforms for wall display.

Cotto Share the World Pleasure Kinect Wall ***(Figure 3)*** was very similar to what our client has described. Using a video wall and Kinect, a motion sensing input device, the installation allowed visitors to see themselves placed in various cities and interact with an object, such as a floating lantern. This was a common way to use Kinect as a device for interaction in the public space. Visitors also had the choice to upload and display their own photos as their backdrops. We found this setup had a lot of potential for fun interactions and virality on social media. For example, have Scotty dog run around our guests' movements and perhaps guide them through different locations of CMU campus. However, there was a limitation in the aesthetic of keying or compositing the users and still images. We also believed such interactions could potentially be too distracting for our experience had to be both entertaining and informational.

Figure 3: *Cotto Share The World Pleasure Kinect Wall* (Bangkok International Airport, Bangkok 2012). Photograph by Sense.s Co.,Ltd.

Portrait Machine ***(Figure 4)*** is an interactive photography installation that archives and visualizes portraits taken by the visitors. Our team was inspired by its software that analyzes and organizes portraits based on similarities or differences in features such as color, composition and facial expression. We also thought the mosaic visualization of

the portraits looked modern and had potential for a meaningful story. For example, each portrait becomes a pixel or a building block to create a bigger picture, representing the community.

Figure 4: Installation view of *Portrait Machine* (CBK Amsterdam, Amsterdam 2009). Photograph by Theodore Watson

In order to deliver a polished prototype, it was important for us to focus on the content of the experience and discover the limitations of technology as soon as possible. We immediately started to conduct research on our target audience, study our space and explore potential platform to guide our design and decisions.

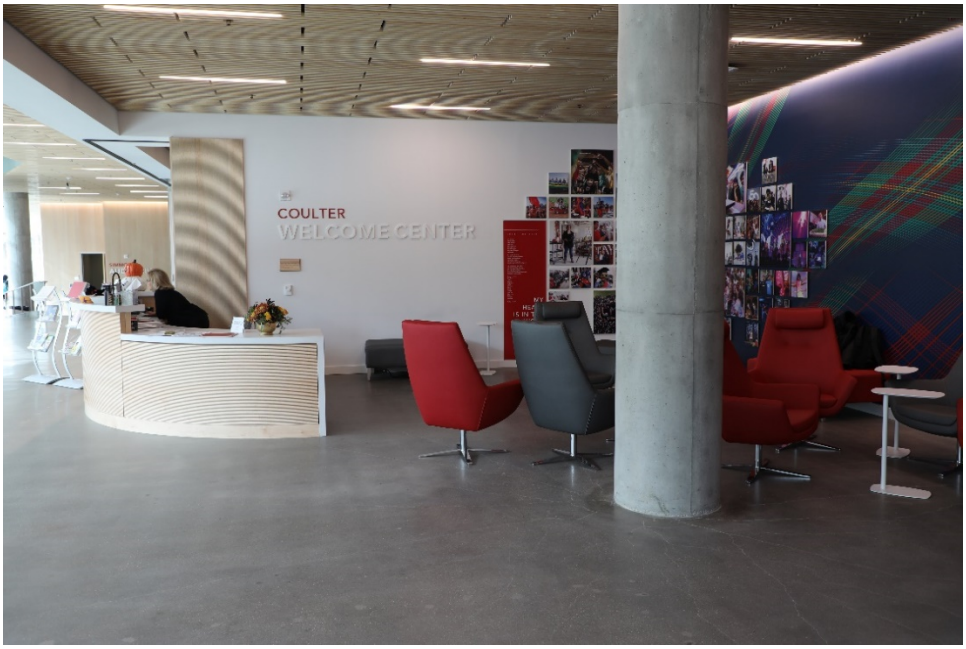


Figure 5: The David and Susan Coulter Welcome Center after opening.

We visited the Welcome Center and observed the behaviors and activities of the people in the space. The Welcome Center ***(Figure 5)***, specifically the lounge behind the kiosk, is mostly populated by visitors, consisting of prospective students and their families waiting for their tours to start or asking questions at the kiosk. However, the number of visitors varied based on the schedule of campus tours and information sessions. We observed our visitors exploring the space; reading booklets from the kiosk and looking at the various information on the wall. One of the interesting note we collected from our observation and meeting with student ambassadors was that the parents, particularly the

mothers, of prospective students were usually more energetic and more actively curious about the school and tended to ask more questions during the tours.

Also, many showed interest in alumni network and CMU students' life after graduation. The visitors would ask about alumni events or job recruitment events. Current students were always around the area next to the Welcome Center, either eating and catching up with friends or looking for a quiet place to study. On average, the current students would spend 2 - 4 hours in the area. Based on our survey, currents students did not use the Welcome Center or the lounge because they believed it was meant for the visitors.

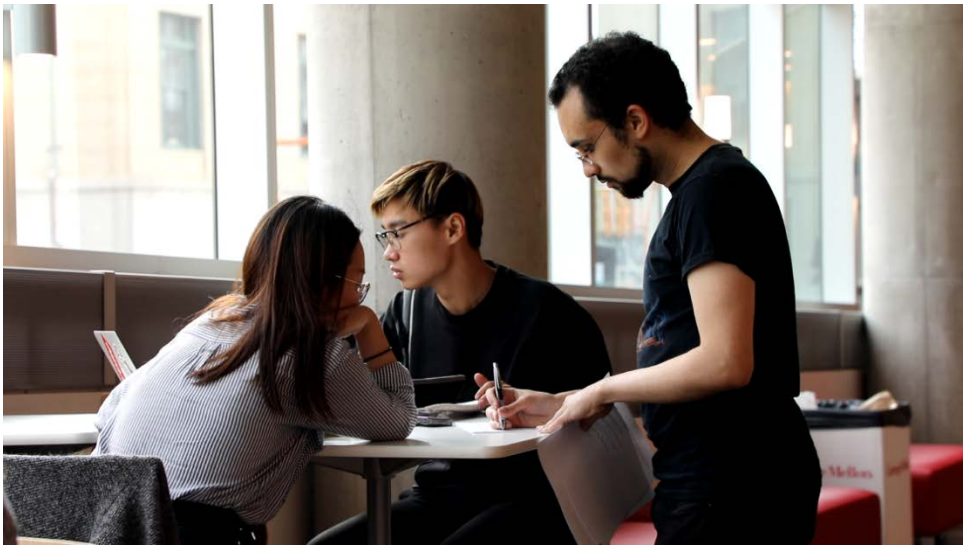


Figure 6: *Producer Matthew Floyd (right) is conducting a survey on a current student.*

We continued to conduct several visits and hangouts in the Welcome Center to collect more data on lighting, the through-put and platform tests. Using the answers from our surveys and helpful notes from the student ambassador, we started to recognize some of our user's needs and our client's goal for Picture Yourself.

Picture Yourself can be an installation that not only allows us to help them understand who we are, but also helps us to understand who they are. Similar to the design behind *Portrait Machine,* our team recognized the opportunity to collect data from the prospective students. We believed building this connection based on similarities had a lot of potential for meaningful user interactions and aesthetic visuals and experience. The mosaic visualization is also something our team wanted to incorporate into our experience and wanted to explore the potential of using selfies as pixels or nodes. For example, if our user is from South Korea, we will visualize selfies of current students and alumni who are also from South Korea. We discussed creating a dynamic typography and perhaps an image using the mosaic visualization method.

We can also learn how many students from South Korea visit Carnegie Mellon University for campus tours. We envisioned the visitors answering series of basic questions and the more they answer, the more intricate the visualization on wall display becomes. We also wanted to provide answers to the questions that are frequently asked from the visitors, such as, more information about their intended majors, fun facts or even jobs after graduation.

Going back to our definition of "affinity of CMU," we wanted to highlight each pillar in our experience:

- **Diversity of Students:** We wanted to display the vast network of CMU students from all around the world. Our users will see how many students share their ethnicity, hence not feeling alone or nervous about attending the university. This can also highlight the global impact and study-abroad programs based on the users' answers.
- **Interdisciplinary Programs:** We can provide information about each department and its history. Also, we can highlight few students or alumni who attended two different schools, for example, College of Engineering and Human-Computer Interaction Institute. Picture Yourself can be a great example of this aspect too.
- **Unique Traditions:** One aspect of the advice from the ambassadors was to dispel the myth that Carnegie Mellon University is an "asocial STEM school." Picture Yourself can display information about the unique traditions and various social events, such as Carnival and Lunar Gala.

After deciding this core content, we began to find a way to make our experience more fun and entertaining. ***(Figure 7)*** We wanted to utilize the motion sensing input device so our visitors can have a different experience from other available technology in the space. Using the tartan pattern and Scotty dog was also essential to make Picture Yourself more fitting to Carnegie Mellon University's tradition and aesthetic. We also wanted to use an iPad and Simple Booth HALO stand because it was height adjustable and had a lighting rig that can help the quality of the selfies taken in the space.

Figure 7: Initial Sketch of Picture Yourself

IV. Floor Plan & Layout

Figure 8: Installation Space at Welcome Center

We were given a specific space in the Welcome Center to design our installation on ***(Figure 8)***. The dimensions of the space were approximately **13 ft. 4 in. by 13 ft. 4 in. (160" x 160")**. However, our client warned us that using the

entire area will limit the number of chairs and table available in the lounge and possibly crowd up the area. We were told to minimize the required space for the installation and keep the lounge area more spacious for the visitors. The pillar also was a big part of our design challenge. We wanted to push ourselves to find a creative solution to make the pillar more interesting or even interactive.

We first had to decide where we should place the wall display. Picture Yourself should be very visible; our visitors should be able to see it well as they enter the building and be drawn to it easily. We believed it was best to use the wall you can see from the entrance on Forbes Avenue. ***(Figure 9)*** There were less lighting fixtures around it to meddle with the color or brightness of the display and had enough surface to create a large display.

Figure 9: Installation area and ideal wall for our wall display

We initially explored the option of using ultra short-throw projectors to create the wall display. Around the corner, there is a Touch Screen TV displayed as an interactive map of the Carnegie Mellon University's Campus. Projectors could show variety and possibly more flexible option in terms of installation and aesthetic. *(This particular decision will be further discussed in budget plan).* Having a large and immersive wall display could be a "wow-factor" of our installation and we wanted to create it without committing too much of our budget on it.

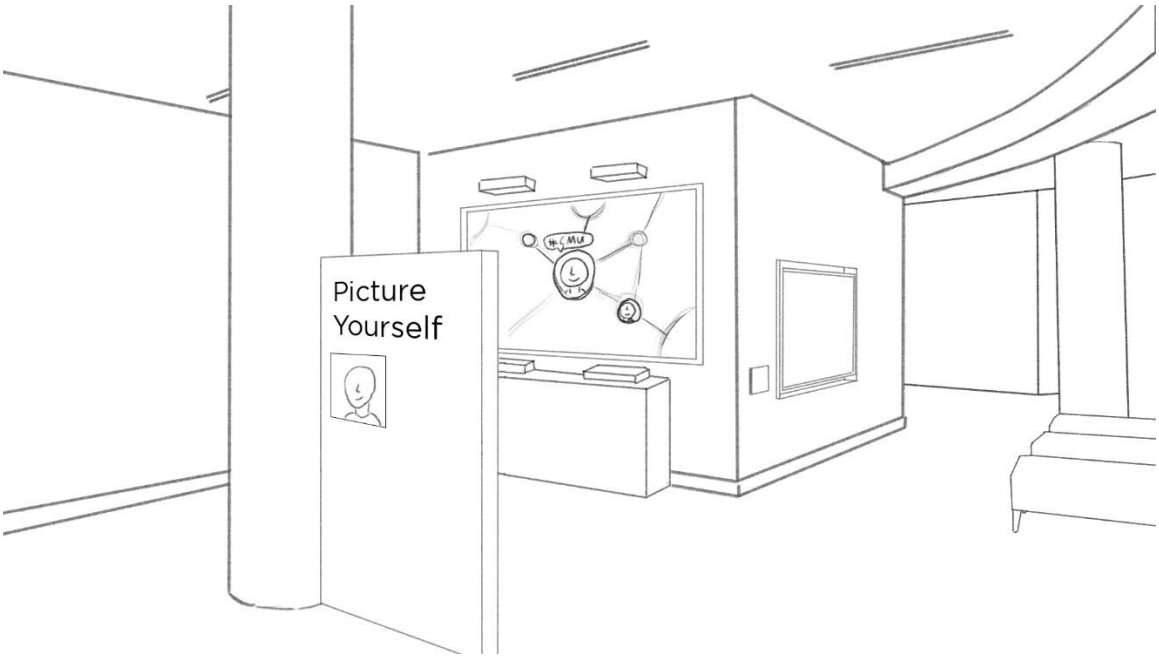


Figure 10: Sketch of Picture Yourself

Figure 10 shows a layout of our installation using four ultra-short throw projectors. By using Edge-Blending software, we can combine four projections into **a 107.5" wall display**. In order to enhance the brightness and color of our projection, we wanted to design a picture frame around the projection with an ambient light rejecting material on the panel. The frame will also have a place to attach the motion sensing input device. Our software will be installed in a computer that will live in a small furniture or a cabinet, locked. The same furniture will be used to station the bottom two projectors; Ideally, the furniture should protect the projectors and the computer and work as a barricade that tells the users to not approach the wall display any further. All the projectors will be connected to the computer and the installers should place all the wires behind the wall.

We wanted to give the pillar more purpose and perhaps hide its bareness by building a 3' by 6' panel next to it. On one side of the panel, we will print the instructions on how to use our installation and warnings on inappropriate photos and behavior**.** In front of the panel, about 5' apart, we will place Simple Booth and have our application downloaded. **Ideally, we would hire vendors to fabricate the frame, the panel and the furniture with cohesive design, color and material.**

After researching various models of projectors, we found **Optoma EH320UST** as our ideal choice. It was relatively cheaper than other similar models and seemed to have a lot of vendors available in Pittsburgh. Based on the distance calculator available online, we created a rough blueprint of the space. The projectors should be placed about 14" away from the wall and as mentioned before, we will utilize four projections to create a bigger display.

Each projection should be **54" by 40.5"** with various overlapping edges. We have attached a PDF document named **"NvEdgeBlending_v3"** along with our documentation that guides you through the process of edge blending. The computer will have the necessary graphics card to bridge four projectors and run the software. This will setup the four projections to display the correct resolution and size that fits in the frame.

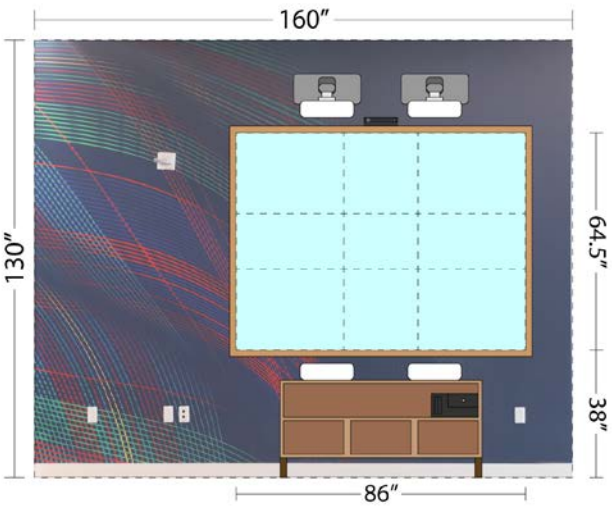


Figure 11: Possible Layout of Installation using Ultra-Short Throw Projectors (4:3)

As shown in ***Figure 11***, we propose using **a 4:3 display or aspect ratio, 86" by 64.5",** in order to achieve a taller wall display. However, because most common aspect ratio is 16:9, other media, such as videos, will play with letterboxed format due to the frame around the display. ***(Figure 12)*** If this is not ideal, we can choose to use the 16:9 aspect ratio and fabricate the frame in the **16:9 aspect ratio dimensions, 86" by 49".** The budget plan for this layout is shown on **Table A in Budget Outline.**

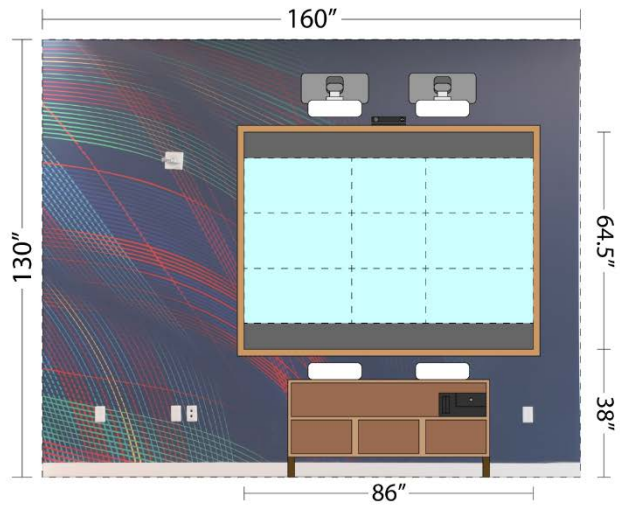


Figure 12: Possible Layout of Installation using Ultra-Short Throw Projects (16:9)

The footprint should be printed or marked on the floor to show the center point of the interaction area. ***(Figure 13)*** It will also work as an ideal spot to stand in front of the projection. Our initial goal was to allow the visitors to interact with the display through their movements. In order to help our visitors even more, marking the boundaries of the interaction space would guide our visitors understand how much space they have to interact with the wall display. However, our team has continued to struggle with using Kinect to track our guests' head movement; our experience did not feel fun and sometimes frustrating due to the tracking issue. Since we could not find a viable solution to the issue in our development, we began to prepare possible alternatives to Kinect, or any motion sensing input device.

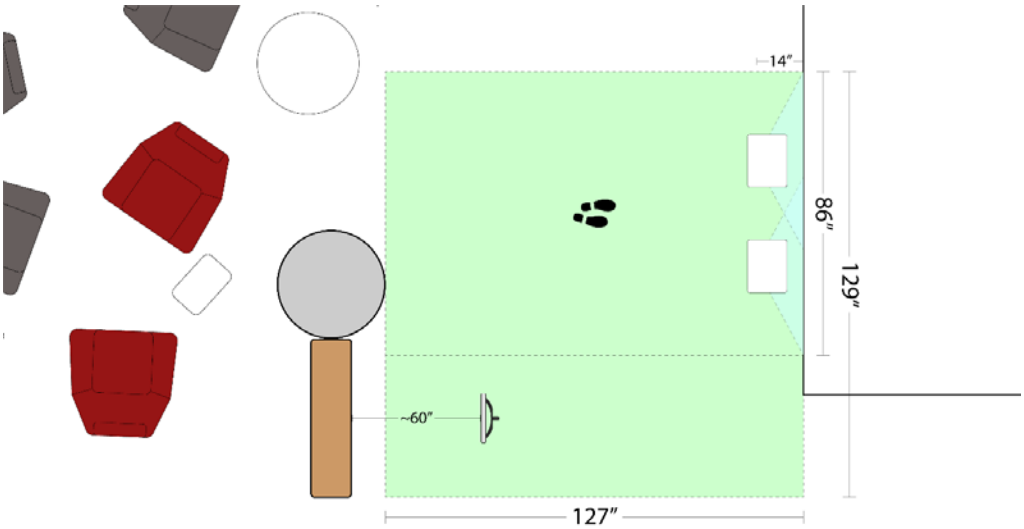


Figure 13: Top-Down View of the Installation Space

Optoma also has interactive projectors, **EH320USTi**, that could work as an alternative to the motion sensing input device. It could allow our visitors to use their fingers or hands to interact with the wall display physically. Our interaction area becomes much smaller, freeing up more space for the lounge. We can also use a different model of Simple Booth HALO to be installed on the wall. ***(Figure 14)*** Visitors can choose to write on their selfies or decorate with stickers, hashtags and so on. The method of navigation, point-and-drag, becomes much more comprehensive and easy-to-use. In this case, it would be ideal to only use two projectors, because the interaction would now require our users to be close to the wall display. The bottom two projectors would be at risk of getting damaged or moved by our users approaching the wall display.

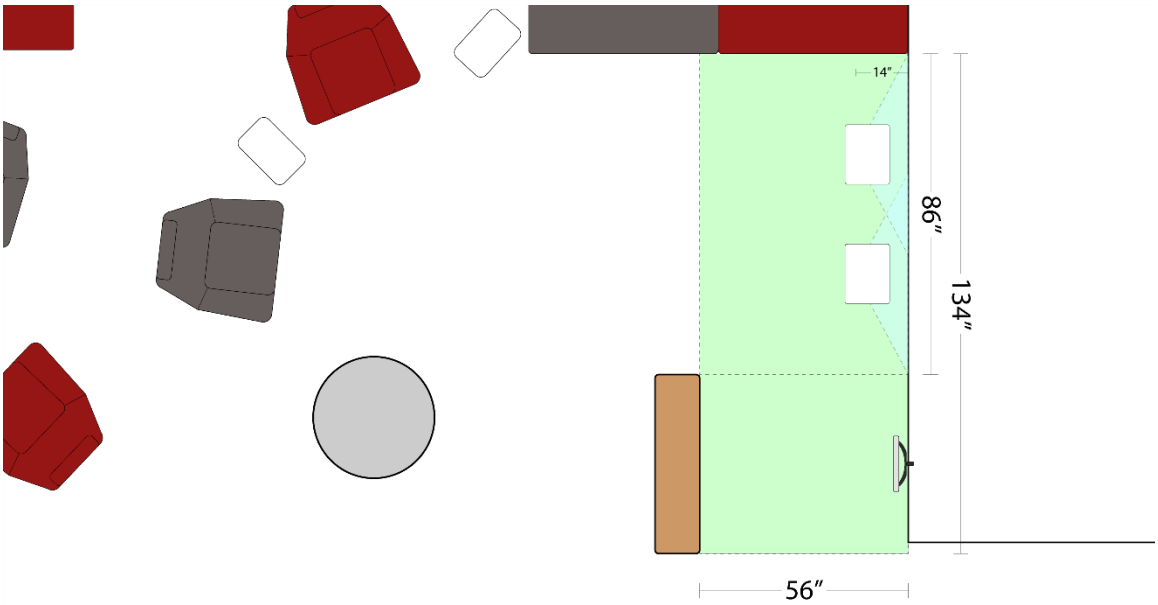


Figure 14: Alternative Setup with Interactive Projectors

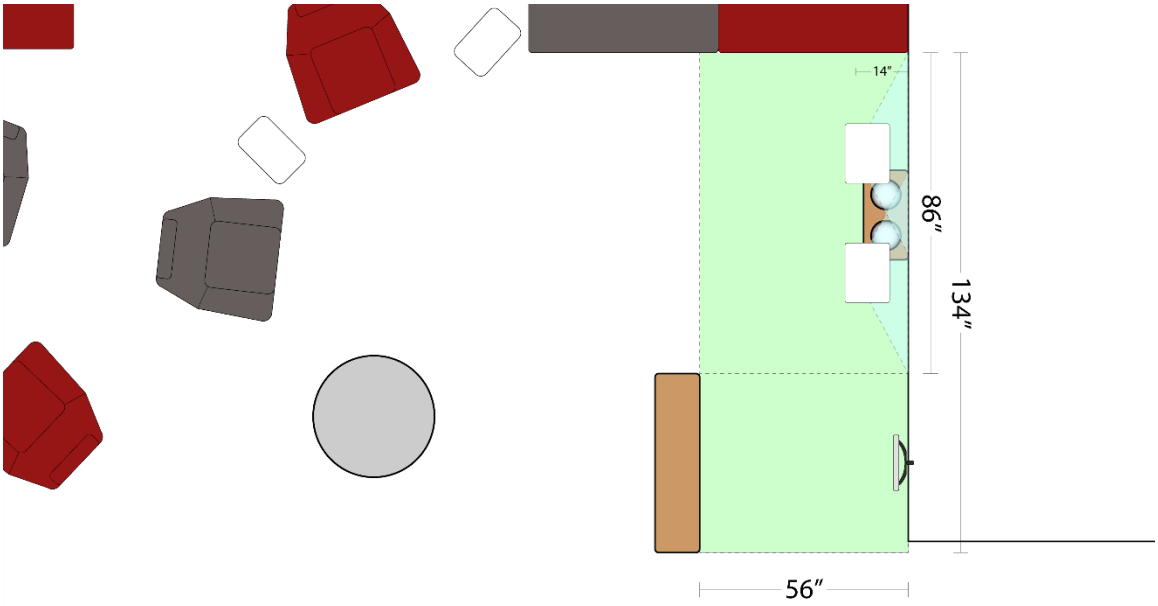


Figure 15: Alternative Setup with Trackball

We also imagined using a Trackball or other platform that has physical objects to interact with to navigate. ***(Figure 15)*** A creative use of these type of physical interaction could display an innovative use of technology but it also requires fabrication and design, which can possibly cost a lot.

Both layouts that have Simple Booth HALO installed on the wall could possibly limit the flexibility of the camera adjustment. We have to make sure our installation meets the ADA standards of forward and side reach for the users on wheelchairs. ***(Figure 16)*** The wall display, the furniture or trackball, and the panel would all be positioned based on these standards. However, because we were not able to test out these particular setups, it is not a safe assumption for the layout to work without testing.

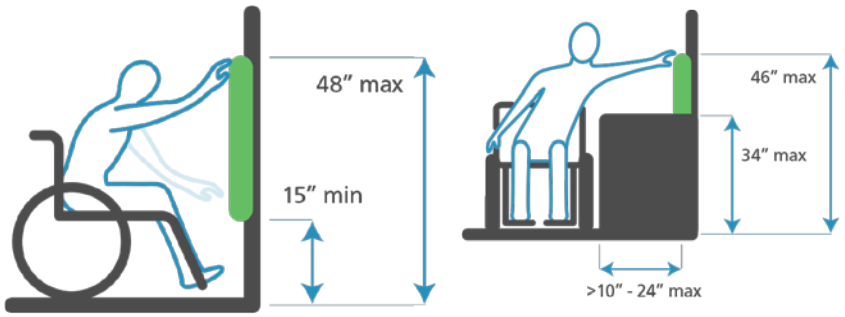


Figure 16: ADA Standards for Kiosks

V. Budget Outline

There are still different opinions about using projectors or TVs for our wall display. We believe projectors are better option in terms of price and flexibility. Because we imagined our wall display to be immersive, we wanted our wall display to be as big as possible. However, we realized this could take up a lot of space and also cost a lot in terms of installation. Using multi-panel TV Screen to make a wall display a common and safe option to create a digital signage. The proposed budget plands are based on prices available online, our client has to consider paying more for installation and perhaps fabrication fee.

A. Ultra-Short Throw Projectors + Kinect

Item	Model	Price	#	Total
Projectors	Optoma Technology EH320UST 4000-Lumen Full HD Ultra-Short Throw DLP Projectors	$1,599	4	$6,396.00
Mounts	Optoma Technology Dual Stud Ultra-Short Throw Projector Wall Mount	$279	4	$1,116.00
Projector Lamps	Optoma Technology 260W Lamp for EH320UST Projectors	$59	4	$236.00
Technology	• Dell Precision Workstation T3620 Mini Tower + NVIDIA Quadro P2000	$1035.73	1	$1035.73
	• 10.5" iPad Pro 64GB	$639.00	1	$639.00
	• Xbox One Kinect Sensor	$99.99	1	$99.99
Extra	Ambient Light Rejecting Projector Screen Material (4:3 | 86x115 | 143-in | Rolled)	$174.95	1	$174.95
Vendors	Clear Story Creative Design Consultation	$2,000	1	$2,000.00+
			Total:	**$11,707.67+**

B. Interactive Ultra-Short Throw Projectors + Simple Booth

Item	Model	Price	#	Total
Projectors	Optoma Technology EH320USTi 4000-Lumen Full HD Ultra-Short Throw DLP Projectors	$1,899	4	$7,596.00
Mounts	Optoma Technology Dual Stud Ultra-Short Throw Projector Wall Mount	$279	4	$1,116.00
Projector Lamps	Optoma Technology 260W Lamp for EH320UST Projectors	$59	4	$236.00
Technology	• Dell Precision Workstation T3620 Mini Tower + NVIDIA Quadro P2000	$1035.73	1	$1035.73
	• 10.5" iPad Pro 64GB	$639.00	1	$639.00
	• Simple Booth Install Kit	$3200.00	1	$3200.00
Extra	Ambient Light Rejecting Projector Screen Material (4:3 | 86x115 | 143-in | Rolled)	$174.95	1	$174.95
Vendors	Clear Story Creative Design Consultation	$2,000	1	$2,000.00+
			Total:	**$15,997.68+**

C. TV Wall Display + Kinect (Ideal)

Item	Model	Price	#	Total
TV	Samsung UH55F-E Bezel Width of 1.7mm	$3,899	6	$23,394.00
Mounts	Installation Fee	$?	1	$?
Technology	• Dell Precision Workstation T3620 Mini Tower	$699.00	1	$1035.73
	• 10.5" iPad Pro 64GB	$639.00	1	$639.00
	• Simple Booth Install Kit	$3200.00	1	$3200.00
	• Xbox One Kinect Sensor	$99.99	1	$99.99
			Total:	**$28,368.72+**

D. TV Wall Display + Kinect (Minimum)

Item	Model	Price	#	Total
TV	NEC 98"Ultra High Definition Professional Display	$12,799	1	$12,799.00
Mounts	Wall Mount Kit	$141	1	$141.00
Technology	• Dell Precision Workstation T3620 Mini Tower	$699.00	1	$1035.73
	• 10.5" iPad Pro 64GB	$639.00	1	$639.00
	• Simple Booth Install Kit	$3200.00	1	$3200.00
	• Xbox One Kinect Sensor	$99.99	1	$99.99
			Total:	**$17,577.99+**

- The dimensions of TV are smaller than the proposed dimensions of the projection. Also the aspect ratio is 16:9 not 4:3.
- **Plan C** is a full wall display created with 55" monitors. The cost of the installation may change based on the installation fee.
- A simple setup, **Plan D**, only requires a single monitor, but ideally requires installation service.

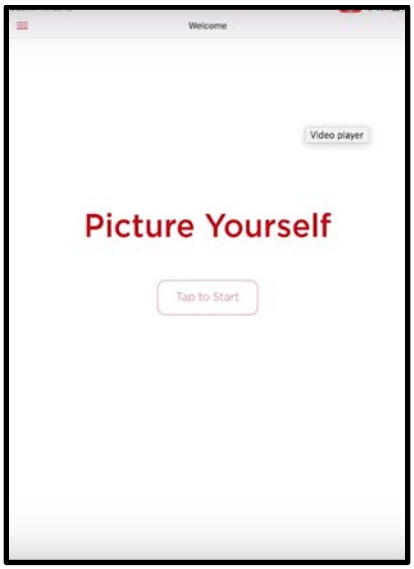
VI. User Journey

A. Guest sees the passive screen on the wall

The guest can be anyone from a prospective student on one of the tours to a current student spending time in the Tepper Building. There will be a passive screen (seen above) on the display wall (with nodes placed in a Unity 3D scene) that will zoom in and out depending on the guest's position to it. It, along with the decorative background board next to the pillar, are designed to get the guests' attention.

B. Guest is directed to the iPad if he/she wants to start

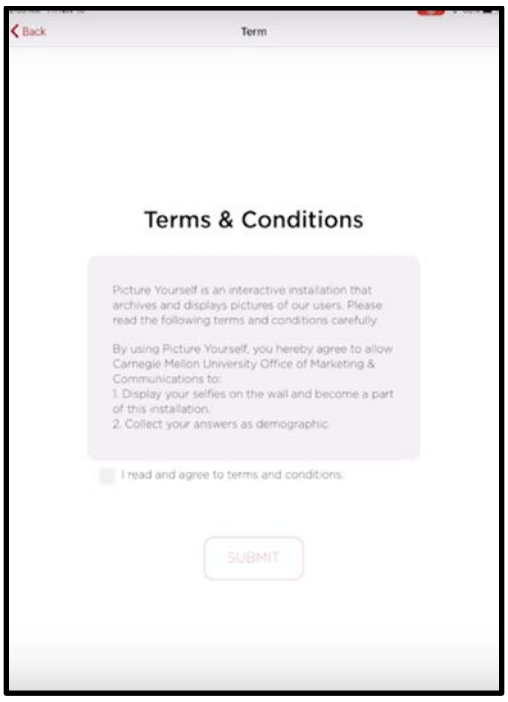
If the guest shows hesitation, this is where a student ambassador or member of CMU stationed at the Welcome Center desk can gently let them know that they can touch the iPad if they want to try the installation out.



The home screen of the iPad is seen above.

C. On the iPad, guest agrees to Terms & Conditions

The first interaction the guest undergoes is agreeing to the Terms & Conditions of the installation:



This page will cover issues such as privacy concerns and the requirement of taking appropriate photos. Some of this information will also be written on the background board.

D. On the iPad, guest can choose to take their photo

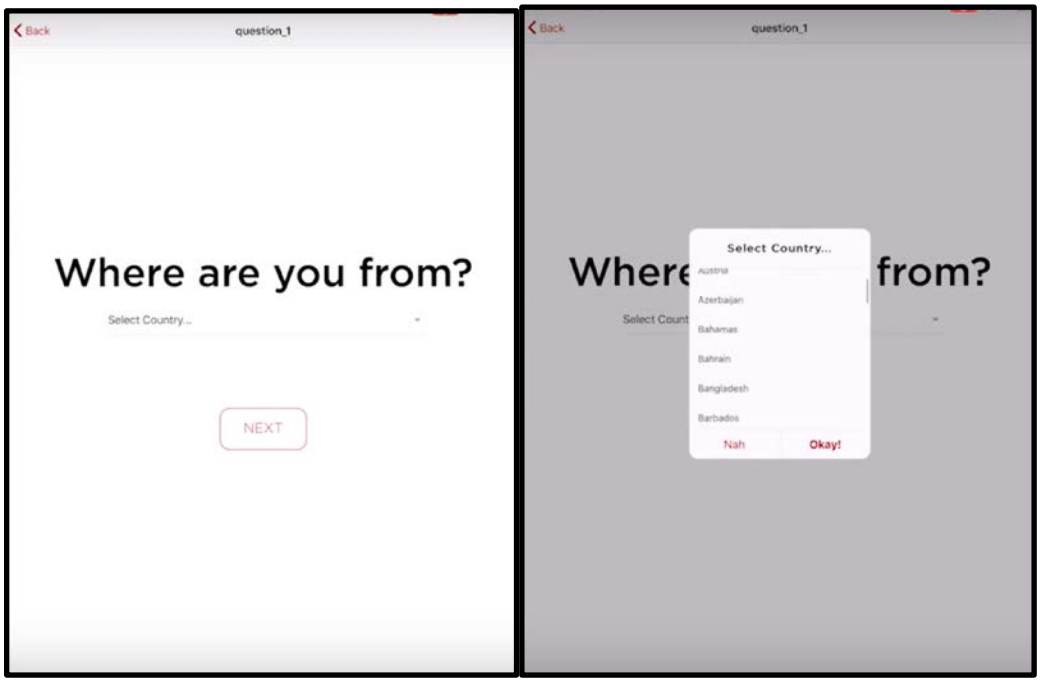
Once the guest has agreed to the terms, they now have the opportunity to take their photo. It is possible to implement the use of props (such as a stuffed Scotty dog or a Tartan), stationed at the Welcome Center desk that guests can use if they would like. Preliminary playtesting results (an example of a guest during playtesting is shown below) show that the guests who want to take selfies like to be as creative as possible with them.

E. On iPad, guest can retake photo if he/she is not happy with the photo

The guest will get the chance to retake their photo if they are not happy with it, using the "Try Again" button (seen below). If they like the photo, they can click the "Submit" button to continue forward with the experience.

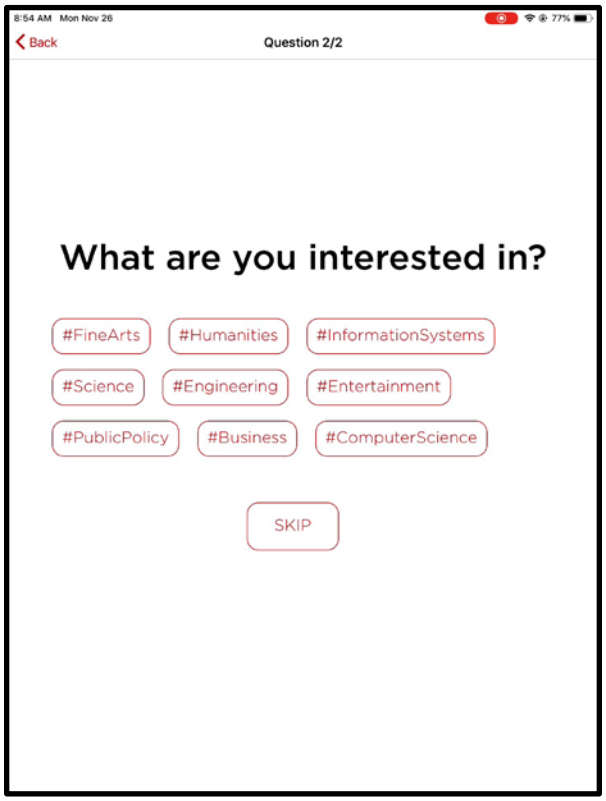
F. On the iPad, guest is asked the question "Where are you from?"

Moving forward, the guest is asked the question "Where are you from?" and may choose from a selection of countries (seen below):



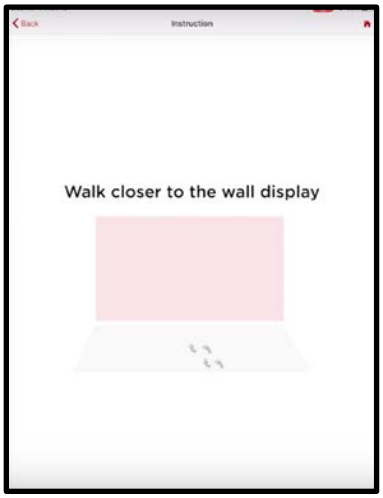
G. Guest can answer more questions ("What discipline are you interested in?" + additional content)

The guest can now answer more questions. One question ("What are you interested in?") has been programmed to go along with the prototype, but the types of questions that can be asked as additional content, especially with regards to specificity, are endless.



With regards to "What are you interested in?" the iPad will display different hashtags of potential interests. For now, guests can choose one.

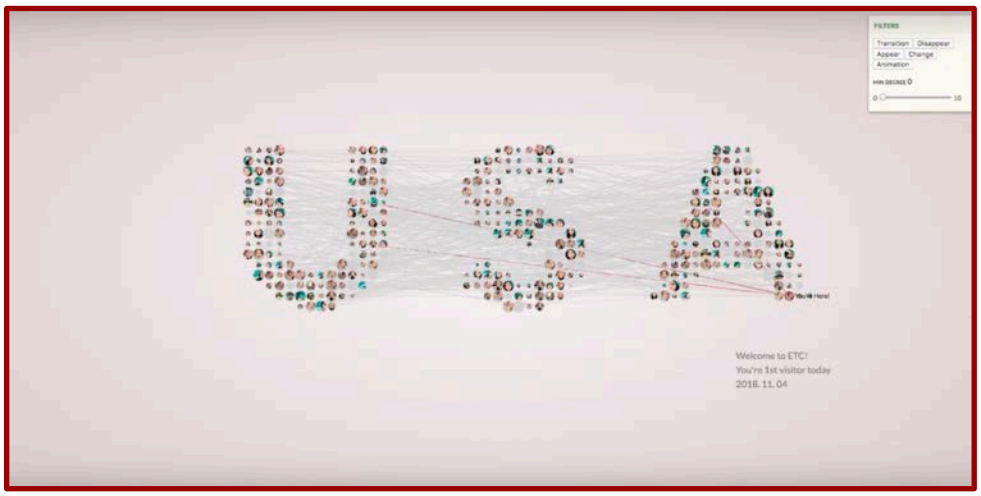
H. Guest is now directed to the wall to interact with the display



From here, there is direction on the iPad screen (left), instructing the guest to walk closer to the wall display. There will be markers (such as lines or footprints) on the floor so that guests know where they should stand and in what area they can move around in. At this point, the wall will be a visualization of randomized nodes (below) that will respond to guest movement, but has yet to include the guest's photo:

I. Guest's photo pops up on the display / guest can see their mosaic

After a short delay, the submitted photo will pop up onto the wall display for the guest to see, and then, after a short animation of the nodes, will join the associated mosaic with other similar guests. The display will also direct the guest (using red lines) to where their specific photo is in the mosaic.



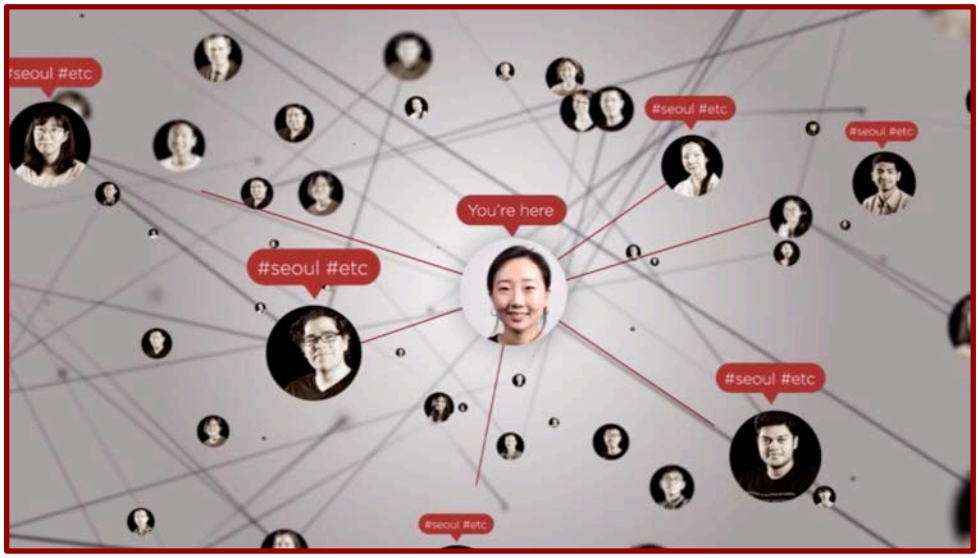
In this example, the main guest inputted "United States" as their country, so a mosaic with "USA" typography has popped with all other American students. The mosaic for "Where are you from?" will display first.

J. Guest can use the motion input sensing device to zoom towards/away from their photo by stepping forward/back in the designated area

Within the lines on the floor that designate the area in which the guest can move, the guest can move forward and backward, which (utilizing the motion sensor) zooms the wall display in and out (picture of the wall display shown below). The guest will, ideally, feel like navigating in a 3D space. Our prototype used Kinect, but that can be altered in future development.

K. By zooming in on photos, the guest will be able to see available information about these photos (and people).

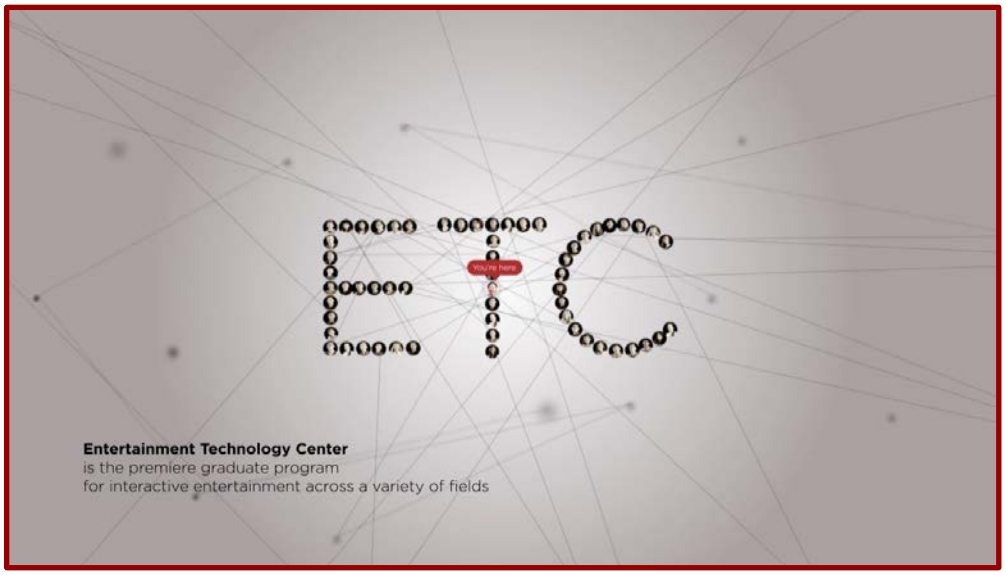
If the guest zooms in close enough to the adjacent photos, available information about these other guests will be displayed, such as exactly where they are from, as well as tags to their answers to other questions. (The example below is from our promotional video and thereby has yet to be programmed, but showcases what this step may look like in future development)



The red lines that indicate where the guest is in the mosaic will also connect them to other students, but particularly the featured alumni in the mosaic (i.e. the test faces displayed in the above photo, upon completion, would be possibly Jeff Goldblum or Leslie Odom Jr.)

L. After a set amount of time, the mosaic will shift to the next answered question.

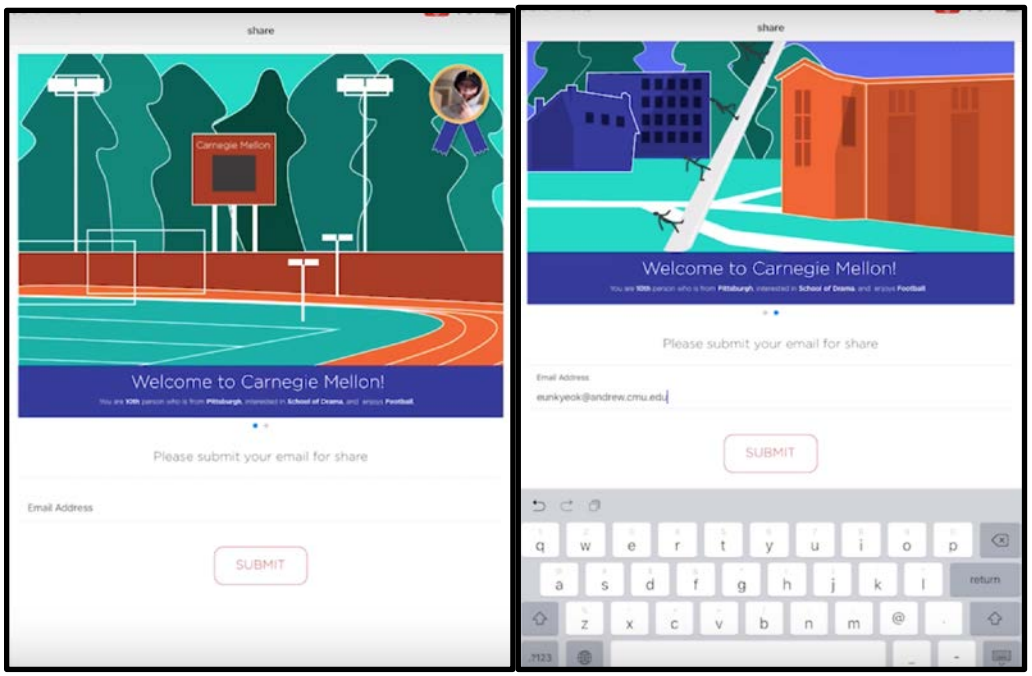
After a set amount of time, the mosaic will change from "Where are you from?" to the next question answered. In this case, "What are you interested in?" is the next question answered, so the mosaic will shift to a typographical image of the corresponding CMU department to the interest chosen (i.e. guests who selected "Entertainment" will get ETC, as it corresponds to CMU's department for entertainment technology).



For this question, a short text box will explain the connection between the chosen interest and the displayed department.

M. When the guest is done, he/she can share his/her photo via email

When the guest is done with the wall display, he/she can return to the iPad screen, where he/she can input their email address to share the photo taken (below). Additionally, there will be a series of customizable, CMU-based backgrounds that he/she can place their photo in. Our prototype uses illustrations of CMU backgrounds for this purpose, but in the future, we suggest using actual photos of campus. The guest's email **is not** saved so as to adhere to any privacy concerns.

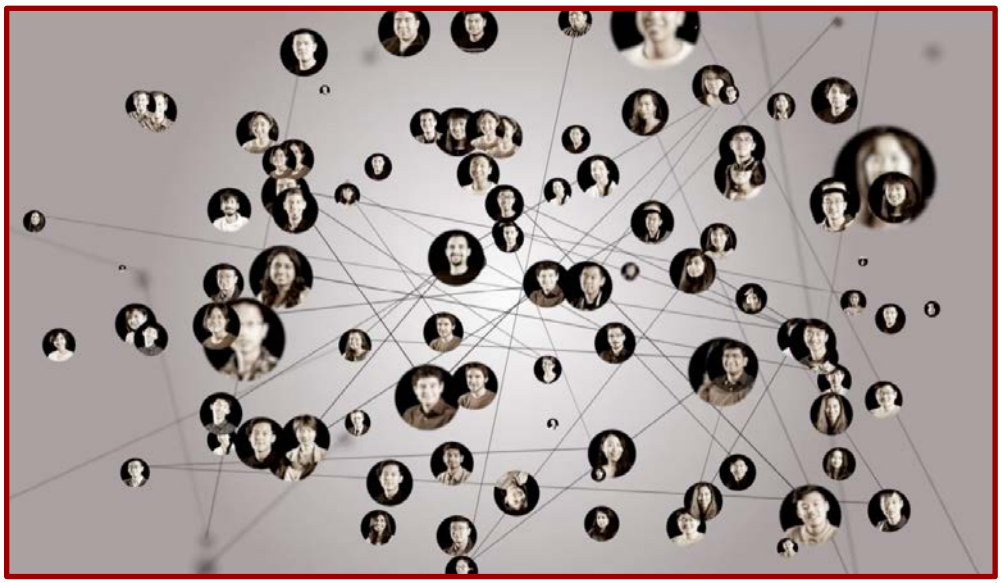


N. Guest is told "thank you for participating"

The final screen thanks the guest for participating (the corresponding email received from Picture Yourself will also say the same thing). The email

0. After a set amount of time, the display resets to passive screen mode

After a short amount of time, the wall display will reset back to its passive screen, inviting future guests to interact with the installation. This passive will continue displaying random animations, or possibly the letters "CMU."



VII. Customization

A. More Questions

We have implemented two questions as part of the prototype - "Where are you from?" and "What discipline are you interested in?" We believe that implementing a social question like "What extracurricular activity are you interested in?" would be valuable in showing CMU as more than only its academics. ***Figure 17*** is an example of such an extracurricular activity.

Figure 17: *Buggy races at CMU (https://www.cmu.edu/news/stories/archives/2017/april/spring-carnival-advisory.html)*

More specific questions can be asked, such as "What city are you from?" (see design example below) or "What sport are you interested in?"

Additionally, we think that implementing more "fun" questions such as "What is your favorite color?" or "What is your favorite restaurant in Pittsburgh" can add more color for guests that choose to spend more time in the experience. Future developers can patch into our code and replace the text needed to implement these new questions.

B. More Background Images

The background images used in the "Share" portion of the experience are also customizable. There is a lot of room to have fun with this; for example, specific backgrounds can be cued up for certain guests (i.e. students interested in Drama can have the Purnell building pop up as an automatic background for their photo).

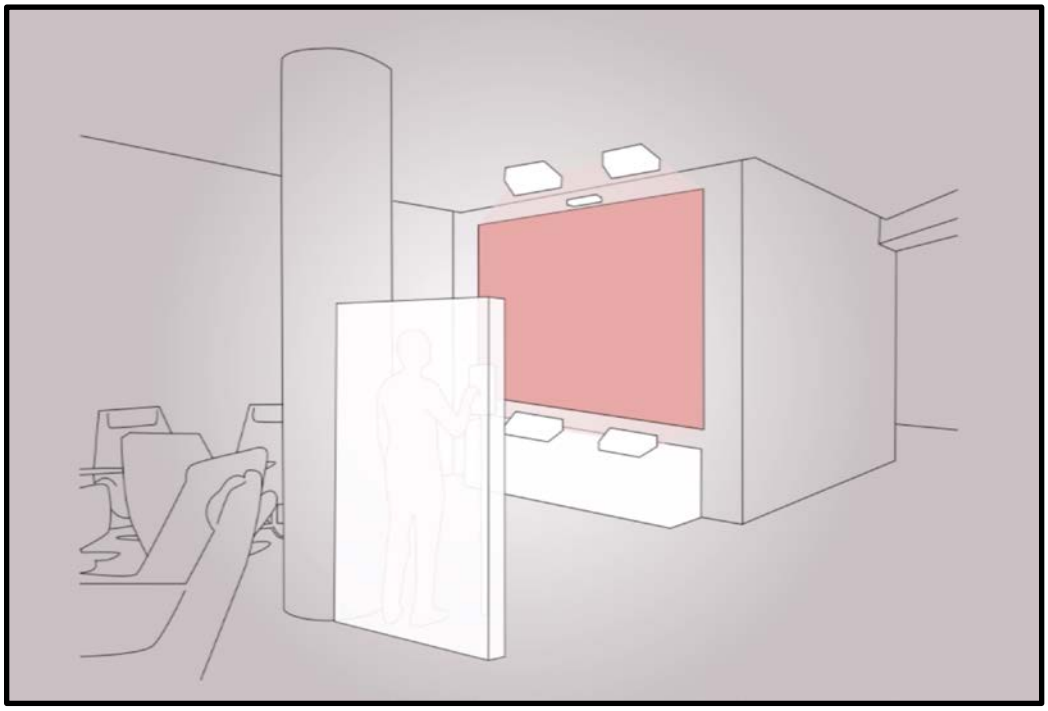


Figure 18: *Sketch of the live space with decorative board*

Additionally, the actual decorative board (***Figure 18***) can be customized with different colors or different CMU embellishments if needed. An idea we had was to implement a green screen on the front side of the board, so that visitors can place digital images of CMU's campus into their photos after they first take them (***Figure 19***).

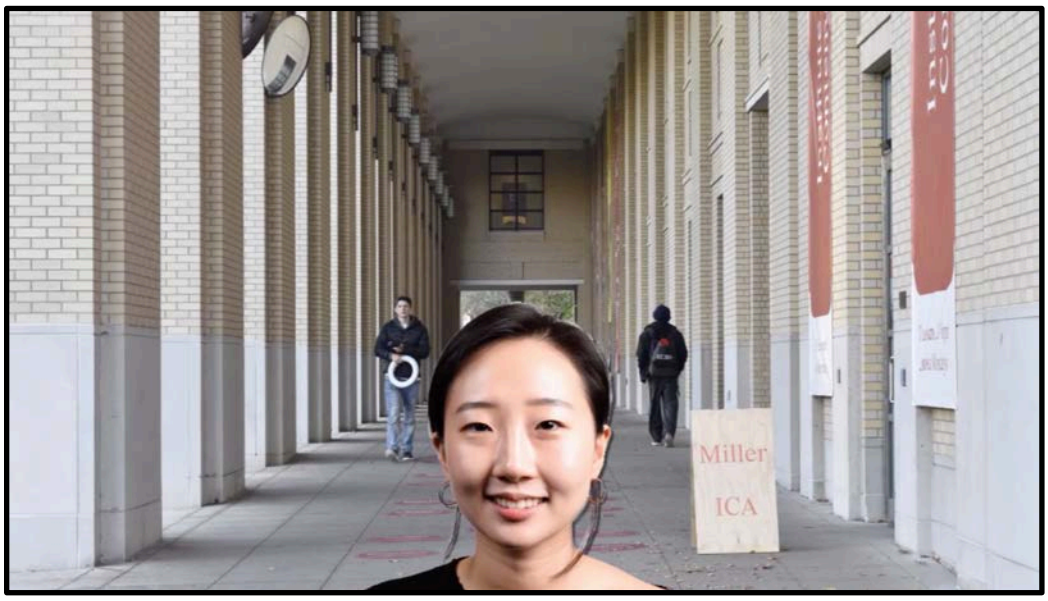


Figure 19: *An example of photo of a visitor placing themselves against the background of CMU campus*

C. Additional Content

The wall display is designed so that, at certain alumni events or events/showcases for specific departments, future developers can patch informational videos, advertisements, event photos, etc. into the display for the specific event on display.

D. Technical Alternatives to Kinect

We are aware that Kinect, already at the end of its production lifespan, is very sensitive and can be glitchy. Therefore, it's worth pointing out potential alternatives to Kinect if it begins to cause problems. These were discussed a bit under Floor Plan & Layout (and more details to some of these alternatives can be found in our Technical Development section):

- **Interactive Projectors**: A simple solution would be to allow users to step up directly to the wall and interact with their photo and the display simply by touch. We would use projection sensors so that the current technology is still compatible with the interaction.
- **Interactive stand (i.e. trackball)**: Another solution would be to have a stand engineered. This could be a stand that the iPad sits on, but it also could be placed directly next to the iPad stand (example floorplan seen in ***Figure 15***) that guests could interact with immediately after the iPad interaction. Then, trackballs (***Figure 20***) could be machined into this stand, with electric wiring running from these into the screen. This allows guests to zoom in and out of the display from this stand, without moving, although the presence of more wire presents its own challenges.

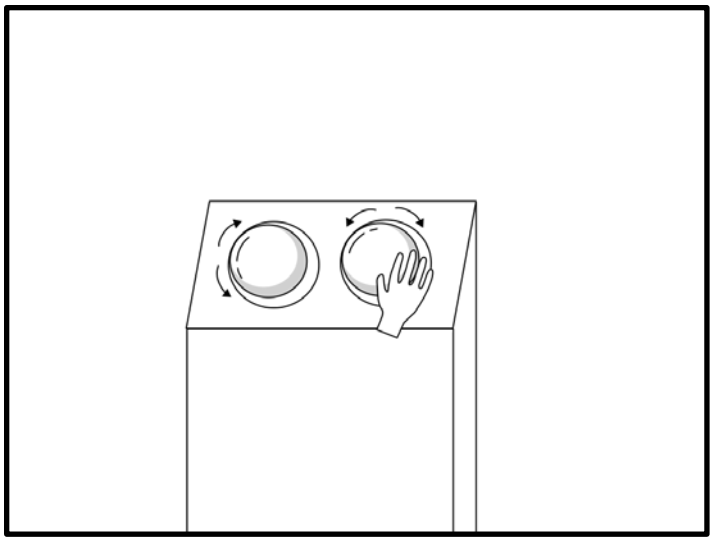


Figure 20: *An example "trackball" stand*

E. Meaningful Layering

We think it would be interesting for some of the guest information to get layered into multiple mosaics. For example, a guest could be looking at the mosaic that corresponds to "Where are you from?", but within this mosaic, there are different color codes or backdrops that correspond to the "What discipline are you

interested in?" question. So, a guest would see all of the people similar to him/her based on country, but would also get to play around with different combinations and see which guests *from* that country also selected similar disciplines. The scope and number of these meaningful combinations will depend on the questions that are asked.

There is also room to group photos in the mosaic based on the number of these similarities. So, for example, a guest could be placed closest to photos of those who share not only the same home country, but the same interests, same favorite colors, etc. This creates meaningful groups within the mosaic, and would give guests an even greater purpose when they zoom in and out of the display.

VIII. Troubleshooting (Content & Live Space)

A. Privacy

Privacy is a major concern for this installation. We want guests to be able to learn about CMU and each other from past experiences, but we don't want guests to feel forced in terms of displaying their information.

If guests seem like they are uncomfortable displaying their images, a solution is to allow for the use of avatars for some guests - they could choose pictures of dogs or certain locations around CMU instead of taking their photos. This would allow them to interact with the wall display without displaying themselves.

Additionally, the terms and conditions will hopefully lay out the steps that guests can take in the experience - guests are not required to share any information that they do not want to.

B. Inappropriate Photos

Inappropriate photos will be removed from the display. A possible way around this is to program the iPad with facial recognition software so that *only* a picture of a face will get taken. Another way is to have whomever is stationed at the Welcome Center desk monitor the photos being taken.

A good solution is also to have a delay in terms of which photos are archived into the mosaics for future guests to see. For example, say that a guest takes and share their photo, but it will not be added into the full display for another 24 hours. Therefore, there could be a designated time of day when a Welcome Center ambassador checks the photos taken over the past 24 hours and immediately removes any inappropriate photos before they are added to the wall display.

C. Lighting

Lighting is a concern due to the open windows nearby the installation and the bright nature of the area in which the exhibit is located. The current projector is using 4,000 lumens, which, in preliminary testing, has looked ok. But this could indeed change during summer months or longer days when the sun is higher and brighter in the sky. It is possible that projectors with higher lumens may need to be used.

We have also researched methods in which to lower the contrast, so that the lighting around the area feels less harsh. A possible way around this is to use diffuse gels for the lights directly above the installation.

Picture Yourself Technical Development Guideline

Technical Guide Table of Contents

Intro

This technical documentation is about what the picture yourself project is. How to implement it based on the prototype we made. And how to solve technical problems when installed in the real space.

- Who shall read:
    - Developers and designers who are in charge of implementing this project
    - Staffs who will install it
- What you will get:
    - What platform you should use
    - Data flow of the project
    - Detailed implementing guide for each application

Data Flow

Our data includes pictures taken on iPad, and answers of prepared questions.

- Pictures are taken on iPad
- When user click “submit”, Picture is sent to Amazon S3 to store
    - API:
```
Storage.put(id + fileName, buffer, {
  contentType: "image/jpeg"
})
```
    - Return: result JSON {

        key: file name

    }
- File name is sent to data server, data server adds a record of the picture in database, generates an ID
    - API: http://ec2-34-228-225-161.compute-1.amazonaws.com:8080/PictureYourself/picture?photo={result[“key”]}
    - Return: pictureResponse JSON {

        id: ID of the record in database

    }
- User answers question “Where are you from?” on iPad
- Answer is sent to data server; data server updates the record with the ID
    - API: http://ec2-34-228-225-161.compute-1.amazonaws.com:8080/PictureYourself/question?country={answer}&id={pictureResponse[“id”]}

- Return: countryResponse JSON {

  ok: 1

  }

- User answers question “What are you interest in?” on iPad
- Answer is sent to data server; data server updates the record with the ID
  - API: http://ec2-34-228-225-161.compute-1.amazonaws.com:8080/PictureYourself/question?interest={answer}&id={pictureResponse[“id”]}
  - Return: interestResponse JSON {

    ok: 1

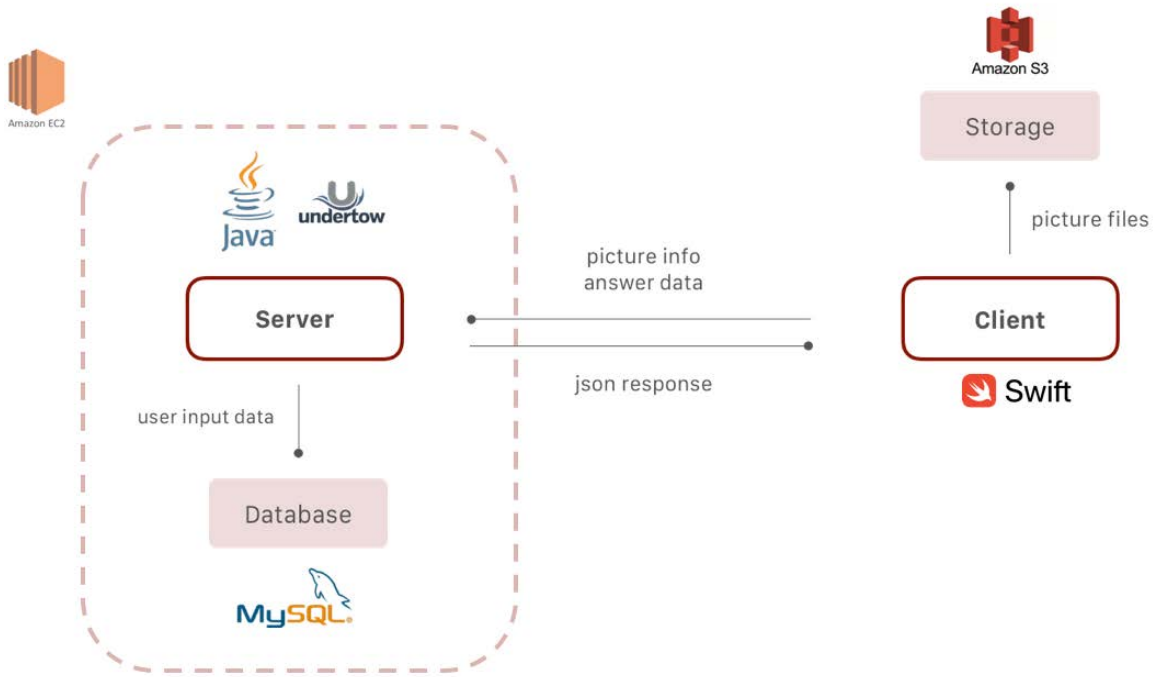
    }
- Data server send the answers to wall display app via WebSocket
  - Send: {

    country: {country},
    interest: {interest}

    }
- Wall display app fetch most related pictures from the data server
  - API: http://ec2-34-228-225-161.compute-1.amazonaws.com:8080/PictureYourself/match?country={country}&interest={interest}
  - Return match JSON list: {

    {
    id: {id},
    photo: {file name},
    country: {country},
    interest: {interest}
    }

    }
- Most related pictures are displayed on the wall

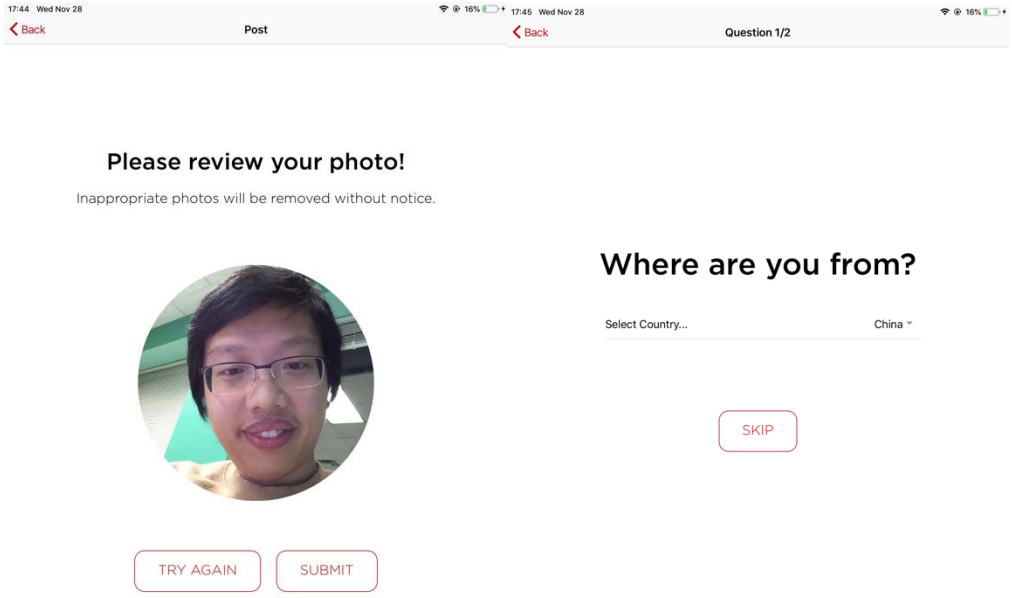

Amazon EC2
Amazon S3
Storage
picture files
Java
undertow
Server
picture info
answer data
Client
Swift
json response
user input data
Database
MySQL

Applications

The whole picture yourself system is composed of 4 parts: wall display app, selfie app, Kinect broadcast server and data server.

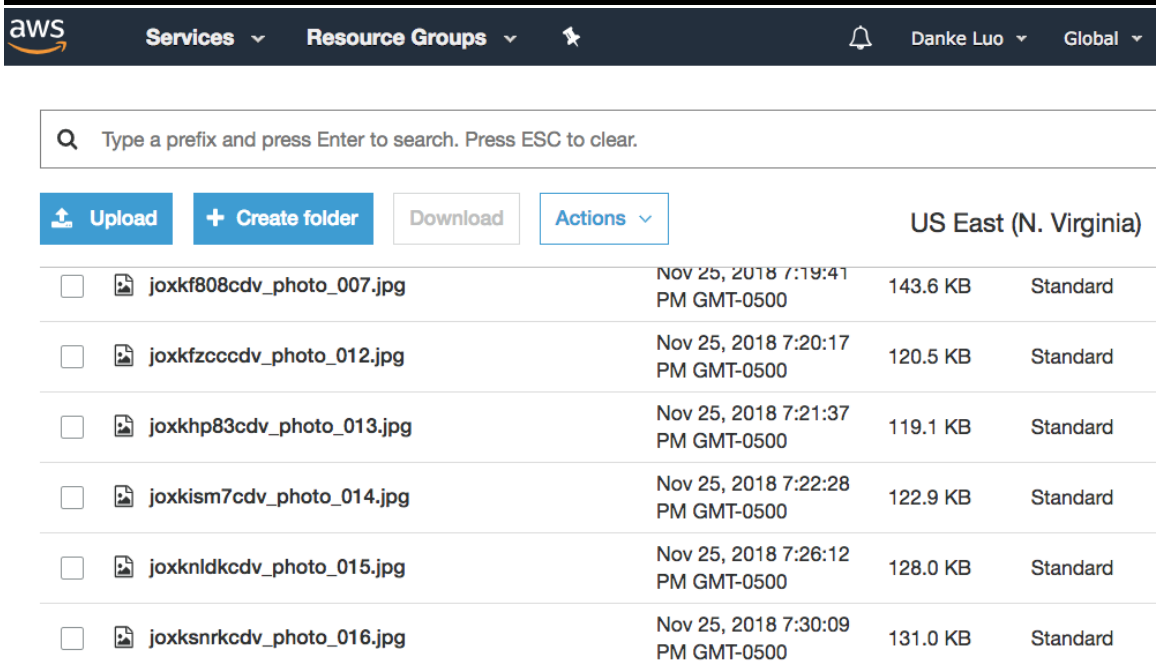
- Wall display app: The app that showcases all the pictures that is related to the current user. This app will be shown on the wall display running in full screen mode. In our prototype, we use 2D JavaScript plugin sigma to implement the nodes of pictures. In the final product, we suggest using 3D platform like Unity.

- Selfie app: The app that takes user photo, accepts user information input and shares the photo. This app will run on the iPad in the selfie spot. In our prototype, we use Ionic as our framework. In the final product, we suggest using iOS native API to develop the app.



- Intel RealSense Unity Wrapper: This plugin provides depth information to Unity wall display app.
- Data server: The server to host the database and send user information to wall display app. The server runs on Amazon EC2 and uses Amazon S3 as storage for user pictures. In our prototype, we use Undertow as web service framework and MySQL as database.

```
mysql> select * from users order by id desc limit 10;
+------+--------------------------+--------------------+-----------------+
| id   | photo                    | country            | interest        |
+------+--------------------------+--------------------+-----------------+
| 1102 | jp1rctg7cdv_photo_042.jpg | China              | NULL            |
| 1101 | jp1r8wmjcdv_photo_041.jpg | China              | NULL            |
| 1100 | jp1r8ug7cdv_photo_041.jpg | default            | NULL            |
| 1099 | jp1qnbs3cdv_photo_040.jpg | China              | Engineering     |
| 1098 | jp1no38bcdv_photo_039.jpg | China              | ComputerScience |
| 1097 | jp1ewektcdv_photo_008.jpg | Korea, Republic of | Entertainment   |
| 1096 | jp1eter0cdv_photo_007.jpg | Korea, Republic of | ComputerScience |
| 1095 | joyjnp6ncdv_photo_038.jpg |                    | FineArts        |
| 1094 | joyjb2szcdv_photo_037.jpg | Korea, Republic of | Entertainment   |
| 1093 | joyjajd6cdv_photo_036.jpg | Korea, Republic of | Entertainment   |
+------+--------------------------+--------------------+-----------------+
10 rows in set (0.00 sec)
```



- Picture resolution: 960 × 1280 pixels (iPad default)

Platforms

These are potential platforms that could be used for the final product: Unity, iOS native API, Intel RealSense, Trackball, Undertow, MySQL, Amazon EC2, Amazon S3.

- Unity: This is our app that shown on wall display. It has 3D scene to show depth of picture nodes. It also has many post-effects, so you can blur surrounding nodes and focus on the nodes in the middle.
    - Pros:
        - It has a 3D space to showcase pictures, which gives a more immersive experience.
        - It provides functionalities like camera movement.
        - It provides goroutines to make animation easier to implement.
        - It has a built-in plugin for Intel RealSense integration.
    - Cons:
        - It doesn't have an existing library like sigma to handle picture layout and animations. You have to build it from the ground.
    - Conclusion:
        - Unity is a powerful tool for building 3D applications. Compared to other platforms it has an easy-to-use integrated developing environment and using C# as script, which is very convenient for front-end developers.
- iOS native API: This is the app running on iPad to take user photos, collect information and share the photo. The programming language for development would be Swift.
    - Pros:
        - iOS native API can access native functions like camera and share freely. It is easy to add features like filters.
        - Any developers that has mobile development experience can build this app easily.
    - Cons:
        - Some front-end developers might not be familiar with Swift, need some learning time.
    - Conclusion:
        - iOS native API is default for building iPad applications. It is a very mature platform, choosing it would be no risk.
- Intel RealSense: Intel RealSense is used to detect body movement. It has a depth camera to detect the position and the depth of user without the need for the user to carry any devices. Through Unity plugin RealSense can get user's coordinates and move the

nodes on wall display accordingly to user's movement. The graph will zoom in or out when user get closer or further. It will also navigate to left nodes when user move left, vice versa.

  - Pros:
    - Since the product will be shown in public space, using RealSense have a benefit of no need for the user to wear or carry other devices. You don't need to worry about devices being stolen or battery dying.
    - No other devices needed also means it is much easier for user to learn how to use it. All the user needs to do is moving his body around and the graph will change accordingly.
    - Since Unity has a plugin for RealSense, getting coordinate in a 3D space would be very simple.
  - Cons:
    - Using coordinates to control the position of nodes has a disadvantage: if you want to see the upper part of the nodes, you have to jump, which isn't an ideal interaction. The solution is to use a trackball when user get close to the wall. He can use trackball to scroll the canvas instead of RealSense.
  - Conclusion:
    - RealSense is good for detecting depth of user. Moving the graph precisely is better to handle with a trackball.

- Trackball: A physical trackball is placed close to the wall. User can use it to scroll the canvas precisely. It is composed of a frame with 2 balls on top of it. The left ball will zoom in or out the scene, and the right ball will scroll in 4 directions (up, down, left, right).
  - Pros:
    - It acts like a mouse. Thus, it can scroll the canvas smoothly.
    - It also supports click function if you want to.
    - It is very intuitive to use. Users know how to use it when they see it.
  - Cons:
    - Since it is a physical device, it may break in some time period.
  - Conclusion:
    - Combining RealSense and trackball, users can control the canvas using both their body and hand.
- Undertow: This is a Java web services framework for handling HTTP requests. It separates the server into many small servlets to handle different requests. We also use its WebSocket support to send user information update to clients.
  - Pros:
    - Undertow is lightweight and thus very fast.

        - It supports WebSocket.
        - It handles HTTP requests in different servlets. Thus, the codes are well organized.
    - Cons:
        - It is a Java library, so it needs to compile very time you change some codes.
    - Conclusion:
        - Undertow has all the benefits of Java. Using Java to access MySQL database is fast and easy.
- MySQL: MySQL is a popular relational database. It is easy to use because of its powerful query language.
    - Pros:
        - It is well supported in Java.
        - Installation and configuration are easy.
        - SQL are easy to write and widely used.
    - Cons:
        - Since it is a structured database, the schema of tables should be determined in the beginning.
    - Conclusion:
        - MySQL is so popular and easy to use. It is the go-to choice when you need database.
- Amazon EC2: Amazon EC2 is our platform to host the server and database.
    - Pros:
        - You can access the server wherever you are.
        - No need to worry about server failure.
        - If the database gets too large, it is easy to implement Spark on cloud.
    - Cons:
        - Costs some money.
    - Conclusion:
        - Hosting server on Amazon EC2 eliminates the need of a physical machine. It can save you some time.
- Amazon S3: Amazon S3 is our storage system for storing user photos.
    - Pros:

        - It is highly expandable when the space is full
        - S3 handles backup for you
        - It has easy-to-use API across multiple language and platform, including Unity
    - Cons:
        - Costs money.
    - Conclusion:
        - Amazon S3 enables the ability to expand the storage without buying many SSDs. It's fast and convenient.

Implementation Guide

This section will talk about details of how each part of the system should be implemented.

- Wall display app (Unity):
    - Picture nodes:
        - Sprite Renderer: The Sprite Renderer component is used to render each picture node. https://docs.unity3d.com/Manual/class-SpriteRenderer.html
        - WWW.texture: Returns a Texture that shows a jpg URL link, set it to renderer's material. https://docs.unity3d.com/ScriptReference/WWW-texture.html
        - Sprite Mask: It is used to mask the sprite renderer into a circle node. https://docs.unity3d.com/Manual/class-SpriteMask.html
    - Relation lines:
        - Line Render: The Line Renderer component takes an array of two points (coordinate of 2 nodes) and draw a line between them. https://docs.unity3d.com/Manual/class-LineRenderer.html
    - Node position:
        - Normal Mode: The nodes are randomly placed in the 3D scene, set x, y, z to a random number in a range.
        - Typography Mode: Make a config file of 26 letters. Each letter composed of a bunch of coordinates of nodes that can form a letter in a 3D space. Get an array of coordinates based on user's answer. Put picture nodes on these coordinates.
    - Animation:
        - Coroutine: Unity's coroutine let you do animation easily by code. Generate a coroutine for each node, move the node towards the target position each frame by adding an offset to the coordinate. https://docs.unity3d.com/Manual/Coroutines.html

- Camera:
  - Using Unity's default camera, set it looking to front towards z axis. https://docs.unity3d.com/Manual/class-Camera.html
- User info:
  - User tag: Each picture node can have a UI panel to put user answers on it. Show it when the node is close to camera.
  - User info panel: Add a Canvas on the scene and put UI element on it. Show the panel when user click the trackball. https://docs.unity3d.com/Manual/UICanvas.html
- Socket connection:
  - UnityWebRequest: Using UnityWebRequest to send GET request to our web server. https://docs.unity3d.com/Manual/UnityWebRequest.html
  - Simple Web Sockets for Unity WebGL: This is a plugin to use WebSocket connections via JavaScript in Unity. Use it to connect to our web server via WebSocket. https://assetstore.unity.com/packages/essentials/tutorial-projects/simple-web-sockets-for-unity-webgl-38367

- Native app (Swift):
  - AWS Amplify CLI:
    - Using Amplify CLI to create an iOS application and set up backend.
    - Tutorial: https://aws-amplify.github.io/docs/ios/start
  - S3 API:
    - Using it to upload pictures to Amazon S3 bucket.
    - Tutorial: https://aws-amplify.github.io/docs/ios/storage
  - Building UI:
    - Build App UI using XCode.
    - https://developer.apple.com/library/archive/referencelibrary/GettingStarted/DevelopiOSAppsSwift/BuildABasicUI.html
  - Taking picture:
    - https://developer.apple.com/documentation/avfoundation/cameras_and_media_capture/capturing_still_and_live_photos
  - Questions:

        - Send answers to server using URL Loading System.
        - https://developer.apple.com/documentation/foundation/url_loading_system
    - Share by email:
        - https://developer.apple.com/documentation/messageui/mfmailcomposeviewcontroller

- RealSense interaction: Unity use a plugin to communicate with RealSense device. https://github.com/IntelRealSense/librealsense/tree/master/wrappers/unity
    - User height calibration: Calibrate the position of the camera when user takes a photo. Make sure it is in the center of the nodes.
    - Multiple users detected: Choose the user in the center of the scene as the main user.
    - Depth: Add a RealSense device to the scene. The device will stream the depth and position data to Unity.
- Trackball interaction: Trackball can be used like a mouse. Here is one example: https://www.kensington.com/p/products/control/trackballs/Expert-Mouse-Wireless-Trackball/
    - Scroll: In Unity you can get the mouse position and change camera position based on mouse position.
    - Click: In Unity you can listen to mouse click event and show user info panel when user click.
- Data server:
    - Undertow:
        - Maven-shade-plugin: Pack the project into a single jar file.
        - PictureServlet: After iPad app upload a picture to S3 bucket, it will send the filename to server. Server will add a record to users table. SQL: insert into users (photo) values (?)
          Return: id
        - QuestionServlet: Handles user answer questions on iPad. It will update the record with the id.
          SQL: update users set country = ?, interest = ? where id = ?
        - MatchServlet: Get all the picture info with corresponding country and interest.
          SQL: select photo, id, country, interest from users where country = ? or interest = ?
          Return: Picture list
        - WebSocketConnectionCallback: Notify the Unity app that user has taken photo and answer questions on iPad.
    - MySQL: User Table:

Field	Type	Null	Key	Default	Extra
id	int(11)	NO	PRI	NULL	auto_increment
photo	varchar(255)	YES		NULL	
country	varchar(100)	YES		NULL	
interest	varchar(100)	YES		NULL	

Install Guide

This section will introduce how to publish the system and install it in real location.

- Unity app:
    - Unity can package the project to a .exe file.
    - Connect a PC to the wall screen
    - Run the .exe file in full screen mode.
- iPad app:
    - Install the app on iPad using XCode.
    - https://codewithchris.com/deploy-your-app-on-an-iphone/
- Intel RealSense:
    - Connect RealSense device to the wall PC.
    - Put RealSense camera above wall screen.
- Trackball:
    - Connect Trackball to the wall PC.
    - Place a table in front of the wall in the center and put the trackball on top of it.
- Data server:
    - Undertow:
        - Execute “mvn clean package” in the root folder to build the project
        - Execute “nohup java -jar target/picyou.jar &” to run the server in the background
    - MySQL:

```
create table users (
    id int not null AUTO_INCREMENT,
    photo varchar(255) not null,
    country varchar(100),
    interest varchar(100),
    primary key (id)
);
```

- Amazon S3:
  - The S3 bucket will generate automatically when you set up your aws Amplify.
  - Tutorial: https://aws-amplify.github.io/docs/ios/start

Technical Trouble Shooting

This section will describe how to recover when app is crashed, or server is down.

- Unity app:
  - Crashed: Rerun the Unity .exe file.
  - Not working properly: Exit the app using Alt+F4, rerun the .exe file.
- iPad app:
  - Can't install the app: Check the settings and trust the developer.
  - Exit immediately: Delete the app and reinstall it through XCode.
  - Can't run on iPad: Update XCode and iOS both to latest version and try again.
- RealSense:
  - Can't be detected in Unity: Install the RealSense driver on PC first, get the Unity plugin from assets store.
  - Doesn't light up: Check power cable and data cable are all connected to PC.
- Trackball:
  - Doesn't track: Reinstall driver and test its mouse function on the PC first.
- Data server:
  - Crashed:
    - Find the process id of the server by executing "lsof -ti :8080"
    - Executing "kill" + process id
    - Rerun the server by executing "nohup java -jar target/picyou.jar &"

X. Conclusion

We have spent a lot of time developing the prototype and data sharing / informational display aspect of the exhibit. The prototype is not as complete as we would like it to be: our use of Kinect led to sensitivity problems, and there is a lot of room for customization, including the aesthetics of the data visualization, the specifics of the information being displayed on the wall, and how to best incorporate alumni into the experience. Nonetheless, we believe that our prototype showcases our concept very well and what it can be upon completion. It will be up to future developers to decide on the questions still up in the air for us. But Picture Yourself has the potential to connect people of the CMU community around the world, and provide fellowship across time.

We hope that whomever picks up this project is as passionate about the creativity of it as we were, and we hope that Picture Yourself evolves beyond our time with it. We believe that with the right amount of polish and care with regards to installation, Picture Yourself can become a permanent experience at CMU. Thank you.