GAMING THE LANDSCAPE

For Jenny, Kynlee, and Jonah

GAMING THE LANDSCAPE
The Potential Applicability of Game Engines for Design Representation

by
Justin Kau

Submitted in partial fulfillment for the
Masters of Landscape Architecture
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Committee Chair - Dr. Robert Ribe

Committee Advisor - Dr. Chris Enright

Committee Advisor - Dr. David Hulse

ABSTRACT

This project examines the potential applicability of Video Game Engines to the representation of landscape architectural designs. Video Game Engines present a unique and novel format for design representation in that they allow subjects to have an immersive dynamic experience navigating within a digital construct of a designed site.

This project collected visual preference data through an online survey comparing the representational formats of digitally rendered two-dimensional imagery against dynamic Game Engines simulations at distinct levels of Design Intent and Textural Detail.

This multivariate approach to survey content allows for a more robust and dynamic response analysis. While the survey responses do not indicate that Game Engines are more effective at representing design, the dynamic nature of the research framework allow the findings to illuminate interesting trends that have implications for future implementation of this technology.

Game Engine technology has recently become easily accessible, but there is little existing research on Game Engine applicability for design representation. This research is intended to explore how Game Engine technology compares in representing landscape design, and provide insight for future research.

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FIGURES

"In landscape architecture, visual representations are the primary means of communication between stakeholders in design process"

Kevin Raaphorst (et al.)
The semiotics of landscape design communication: towards a critical visual research approach in landscape architecture

1. INTRODUCTION

1.1 REPRESENTATION IN LANDSCAPE ARCHITECTURE

Mark Lindult (2008) conducted a survey of 317 landscape design firms from 14 countries. The study found that 75% of them self-identified their firm's level of computer use at intermediate or above (Lindhult 2008). As technology becomes more ubiquitous in our field it is possible that the way landscape architecture is represented may – or should – change. This project will examine one potential new tool that holds immense promise for altering the way design is represented – video game engines. Landscape design representation has a scope, history, and significance far beyond the ability of this project to adequately discuss. It is, however, important to understand current representation conventions to grasp the significant opportunities that video game engines provide.

Eckart Lange (2001) describes two types of visualization techniques for landscape architects: analog and digital. According to Lange, analog tools include: sections, sketches, perspective drawings, photomontages, and physical models, whereas digital tools consist primarily of digital 3-dimensional (3D) models and the resulting visuals generated from them (Lange 2001). Bradley Cantrell and Wes Michaels (2010) discuss the analog/digital divide by media as opposed to the drawing style. Thus, according to their summary analog representations contain "pencil (graphite), pen (ink), markers (pigment), and watercolor (pigment)" (Bradley and Michaels 2010, 2). Digital representation methods are left undefined in their analysis, implying that any method not involving one of the analog medias is therefore digital. The oversimplification of both categorizations illuminates the fact that digital tools have not radically altered landscape representational techniques.

Rather, digital tools have become supplements to the traditional tools and methods of analog representation. Fundamentally, a beautifully rendered digital 3D model with photoshop post-processing is the same representation that is created by an analog perspective drawing. The only difference between the Photoshop image and the perspective drawing is the tool which created it. Bradley and Michaels state that:

> *Knowledge of analog representation plays a vital role in understanding the application of digital tools and techniques. Tools such as Adobe Illustrator and Photoshop are born directly from analog processes and tools defined by their physical counterparts.*
> *(Bradley and Michaels 2010, 2)*

While there is nothing wrong with digital tools supplementing analog representations and materials, there are far more promising opportunities which digital tools present for landscape architects. The most potentially significant digital tool for landscape architectural representation is the body of software known as Video Game Engines.

1.2 WHAT ARE VIDEO GAME ENGINES?

Video Game Engines are tools which enable rapid prototyping and development of video games. They are generally frameworks which contain coding to handle inputs, outputs and game physics (Lewis and Jacobson 2002). More specifically “the game’s engine refers to that collection of modules of simulation code that do not directly specify the game’s behavior (game logic) or the game’s environment (level data)” (Lewis and Jacobson 2002, 28). Simply said, Game Engines are platforms which simplify the process of creating video games.

While it might seem reasonable to assume that Game Engines are useful only for building video games, they have significant potential outside the game industry. Lewis and Jacobson discuss the cooperation between computer scientists and the game industry that has enabled better understanding and exploration of advancements in graphic quality (Lewis and Jacobson 2002, 27).

Zhihan Lv et al. used “Unity 3D game engine to develop and prototype a biological network and molecular visualization application for subsequent use in research or education” (Lv et al 2013, 1).

The research-based video game Sea Hero Quest tests navigational ability and collects data from its more than 3 million users to study dementia. For every 2 minutes played, each user generates data equivelent to 5 hours in lab simulations. The scientists involved claim they have generated 12,000 years worth of dementia research to date (from Sea Hero Quest Website - see references).

Digital artists such as Rick Silva, Carl Burton, Cool 3D World, and others use Game Engines as a platform for art creation. The introduction of Virtual Reality (VR) and tools like Tilt-Brush make it possible for artists and designers to design inside digital space. In this Virtual Reality environment artists can paint in real-time immersive 3D space.

Additionally, and most significantly to this project, designers and developers have begun to use Game Engines for representing architectural designs.

There are dozens, if not hundreds, of distinct Video Game Engines. Each with unique strengths and weaknesses that make each better suited for certain tasks. Some engines arose from development of a video game and access to its engine was granted upon release of the game. The video game Doom and its associated engine is an example of this scenario (Lewis and Jacobson 2002, 28) . Other engines have been created specifically with versatility in mind and are able to do a wide variety of things with less specifically tailored elements, such as Unity 3D, RPG Maker, Three.js, and many others.

The propensity to dismiss Game Engines as only useful for game creation is an inappropriate rejection of an immensely powerful and flexible tool. Game Engines are capable of radically altering the way that design is represented and communicated, and impose minimal additional cost (time and software) to implement.

1.2 PROJECT SPECIFIC TOOLS

This project will develop landscape design simulations for a small urban site in Eugene, Oregon using the Unity 3D Video Game Engine. The Unity 3D engine is utilized in this project partly because of its significant documentation and flexibility, and partly due to software training access. It is important to note that other Game Engines (such as Unreal Engine 5, or CryEngine) could have been equally successful in meeting the needs of this project. Most investigations in this project, while specifically tested using Unity 3D, should easily transfer to many alternative Game Engines with little lost in translation.

A substantial list of additional digital tools was involved in the creation of this project, and will be explained in greater detail in the methods chapter. The digital tools (listed by significance to project completion) include: Rhino 3D, Speedtree, Cinema 4D, and Photoshop. Software plug-ins LandsDesign (for Rhino 3D), PlayMaker (for Unity 3D), V–Ray (for Rhino 3D), and MaterialStudio (for V–Ray - Rhino 3D). See the Methods Chapter for more details about digital tools.

1.3 WHY EXPLORE VIDEO GAME ENGINES FOR DESIGN REPRESENTATION?

The translation from experienced reality to representation always incurs a loss of data. There are elements of the ways in which we perceive space that are unable to adequately translate into any form of representation to date. This is a familiar fact to designers, who are perpetually struggling to represent the fullness of design intent with limited representational tools. This research will explore how Game Engines might function as an alternate form of landscape design representation that, while still incurring a translational cost, will hopefully be more capable than conventional formats at communicating design intent.

Game Engines may enable designers to facilitate more substantial interactions between digital 3D models and users. This would mean that self-navigation (discovery), time, and spatial relationships could become part of the process when users experience game engine representations. James Corner states,

> *"Just as landscape cannot spatially be reduced to a single point of view, it cannot be frozen as a single moment in time… The disclosure of meaning in a given landscape can only occur when the subject is present, moving through it, open to sensation and experience" -James Corner (Swaffield 1991, 148).*

Game Engines present an ideal representational solution to some of the issues that Corner brings up. While no representation will likely ever function as a lossless translation of reality, Game Engines offer a truly unique digital means by which designers can communicate with interest groups through dynamic 3D simulations.

1.4 WHY IS THIS PROJECT SIGNIFICANT?

This project seeks to inform two particular elements of representation within Video Game Engines. The first element is the ability of game engines to more successfully represent design intent. The project will attempt to discover how well Game Engines fare against 2D imagery, thereby measuring whether and how they are more successful or not. The research question that frames this element is as follows:

Researchable Question #1

> *Do people more frequently perceive certain urban design qualities when those qualities are represented in self-navigated digital 3D simulations, or when they are represented in digitally rendered static imagery designed to highlight the same qualities?*

Secondly, the project is concerned with the effect of altering level of textural detail in representation. How does altering the representational state – specificially ***Textural Detail*** – of vegetation and material quality impact users' perception of design? The research questions that explorres this idea is:

Researchable Question #2

> *Does the level of textural detail – principally of vegetation – influence users' preference of visualization methods, either within a format (2D or Game Engine) or between formats?*

By displaying two distinct levels of textural detail (one high detail, one low detail) this question will explore the understanding of how subjects perceive those different levels of detail. This has implications both for the appropriateness of level of detail, and for labor costs associated with simulation creation.

This research is significant because if Game Engines are better at representing design intent, then they would be further validated as a tool that should be strongly considered for mainstream acceptance into the field of landscape architecture.

For a field entirely dependent upon our ability to represent ideas and space, Video Game Engines present an alternate, novel, and potentially more effective form of representation that could prove to be momentous for landscape architecture.

The raw potential of environmental visualization continues to grow – even to accelerate. So, we look for new ways to put it to use. We experiment, sometimes with success. Most recently, the possibility of exploring complex realistic outdoor environments in real-time has arrived - and awaits our ingenious application.

Ian D. Bishop
Visualization for Participation: The Advantages of Real Time?

2. METHODS

2.1 SITE SELECTION

The project is primarily an exploration of representation, therefore every design choice in this study has been made to deliberately create the best scenario for testing the specific elements considered in this research. Due to limited time-frame and resources, the project site needed to be small and have simple base conditions. An urban site was preferred because of the complexity and difficulty in accurately representing topography and vegetation.

In response to these considerations, Kesey Square (Broadway Plaza) in downtown Eugene, Oregon was chosen as the project site for this study. To provide appropriate context for the digital model the design site was developed within the context shown in Figure 1.


Willamette St.
West Broadway
Design Site
N
100 feet

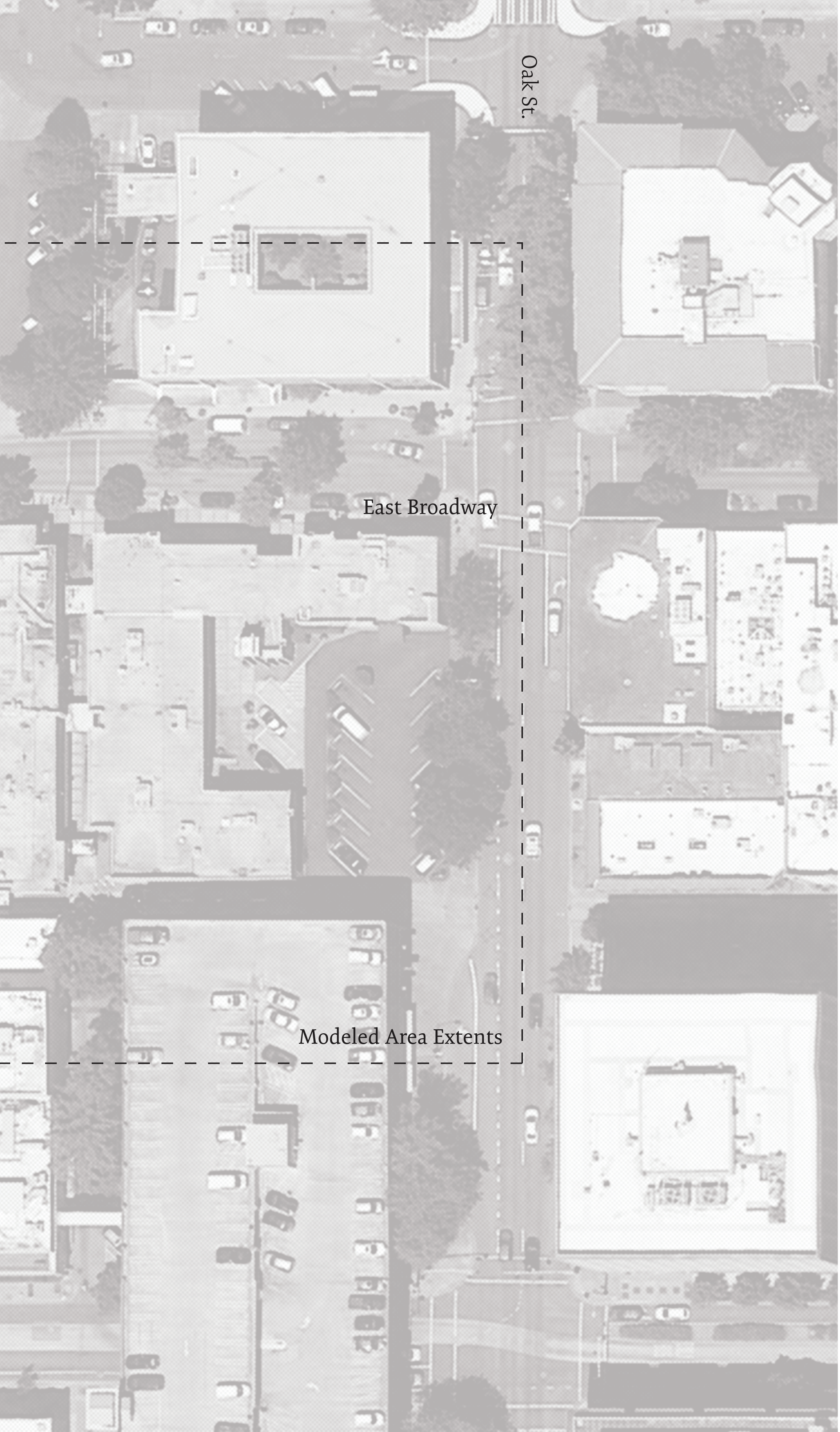


FIGURE 1:
DESIGN SITE

Kesey Square
(Broadway Plaza)
Eugene Oregon

Image source:
Google Earth Pro
2017.06.28

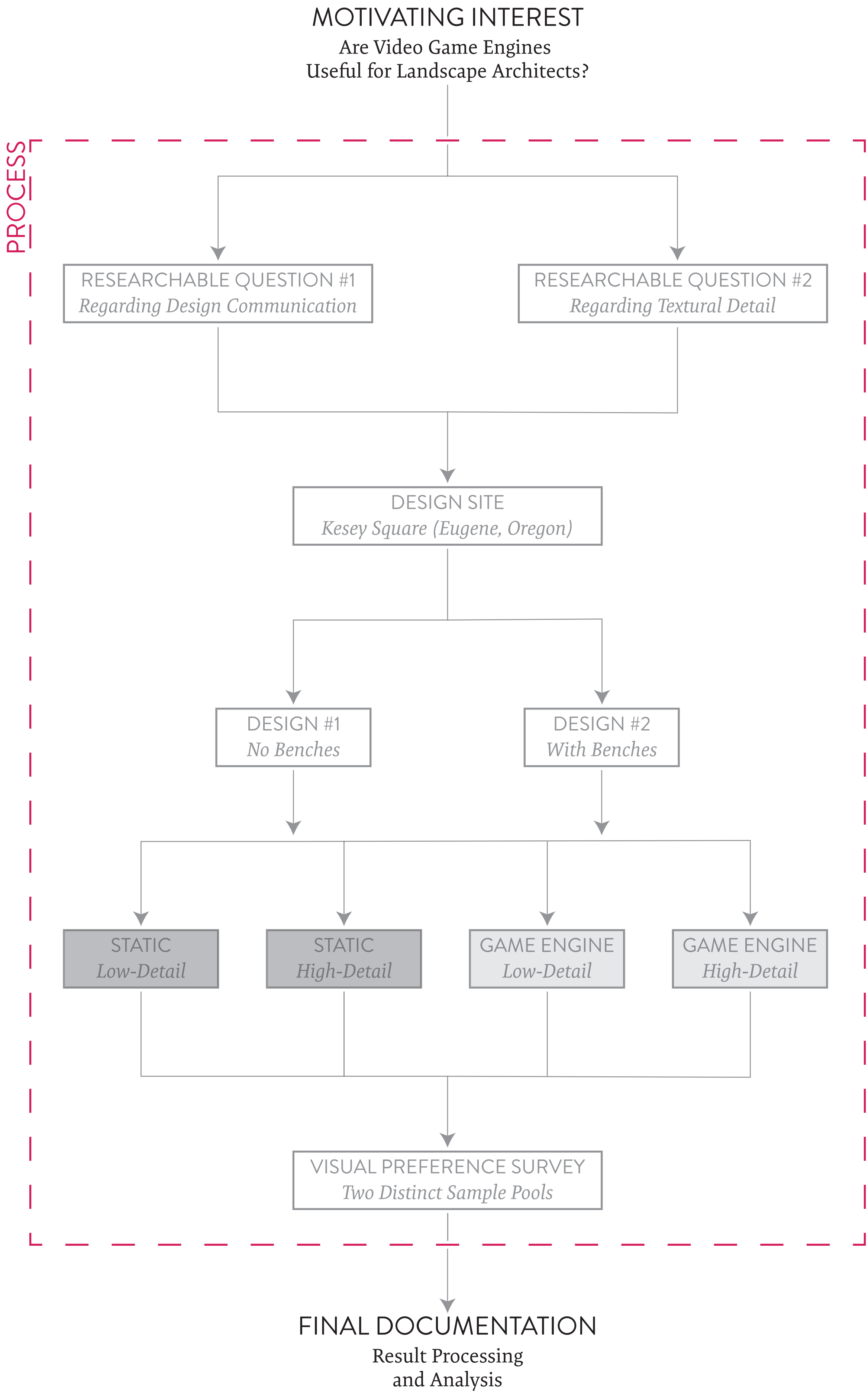

MOTIVATING INTEREST
Are Video Game Engines
Useful for Landscape Architects?
PROCESS
RESEARCHABLE QUESTION #1
Regarding Design Communication
RESEARCHABLE QUESTION #2
Regarding Textural Detail
DESIGN SITE
Kesey Square (Eugene, Oregon)
DESIGN #1
No Benches
DESIGN #2
With Benches
STATIC
Low-Detail
STATIC
High-Detail
GAME ENGINE
Low-Detail
GAME ENGINE
High-Detail
VISUAL PREFERENCE SURVEY
Two Distinct Sample Pools
FINAL DOCUMENTATION
Result Processing
and Analysis

FIGURE 2:
PROJECT METHODS DIAGRAM

2.2 OVERVIEW OF PROJECT METHODOLOGY

This project is concerned with two elements of representation. Primarily, are Game Engines better tools for landscape architects to use when communicating design? And secondly, how much does textural realism (or detail) impact that communication?

> *Do people more frequently perceive certain urban design qualities when those qualities are represented in self-navigated digital 3D simulations, or when they are represented in digitally rendered static imagery designed to highlight the same qualities?*

Researchable Question #1

> *Does the level of textural detail – principally of vegetation – influence users' preference of visualization methods, either within a format (2D or game engine) or between formats?*

Researchable Question #2

To explore the significance of these questions, a site design for Kesey Square was developed. Substantially more seating was then added to that initial design, resulting in two separate and distinct but deeply related designs (Figure 2 & 3). These two designs were then represented with different formats and textural detail (Figure 2).

There are eight representational sets in total. These eight visualizations were divided equally between two study protocols (which will be discussed further). Figure 4 shows the two designs, with the two corresponding levels of ***Textural Detail*** represented in both Game Engine simulation, and in rendered 2D image. Having distinct designs differing on one dimension enables more robust and controlled analytic potential. The significance and details of these two designs are covered in greater detail later in this chapter.

DESIGN 1 (WITHOUT BENCHES)

Not to Scale

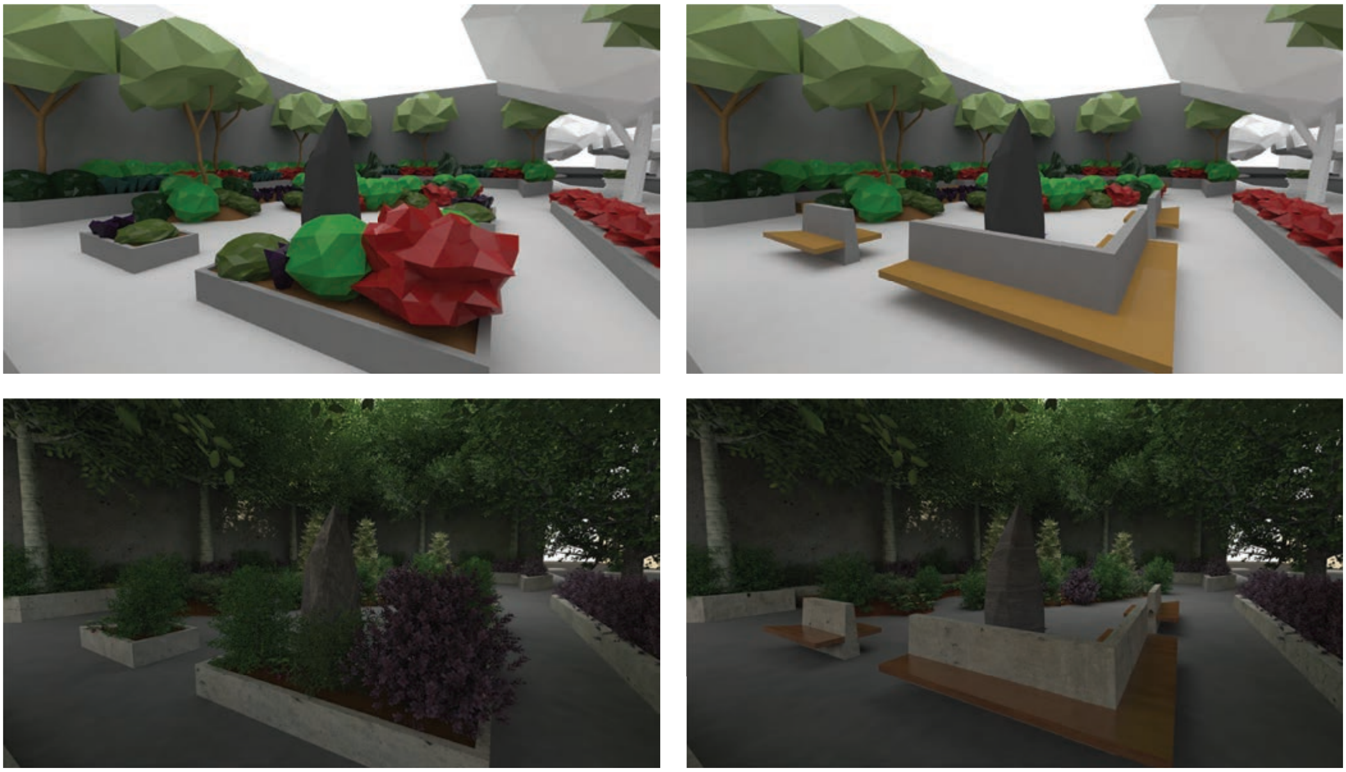
DESIGN 2 (WITH BENCHES)

FIGURE 3:
SITE DESIGN

Kesey Square
Designs 1 and 2
(Broadway Plaza)
Eugene Oregon

Not to Scale N

STATIC 2D RENDERINGS



GAME ENGINE RENDERINGS

FIGURE 4:
REPRESENTATION FORMATS

Designs 1 and 2 represented in:
Static (high and low-detail)
Dynamic (high and low-detail)

2.3 WHAT DOES DESIGN INTENT MEAN FOR THIS PROJECT?

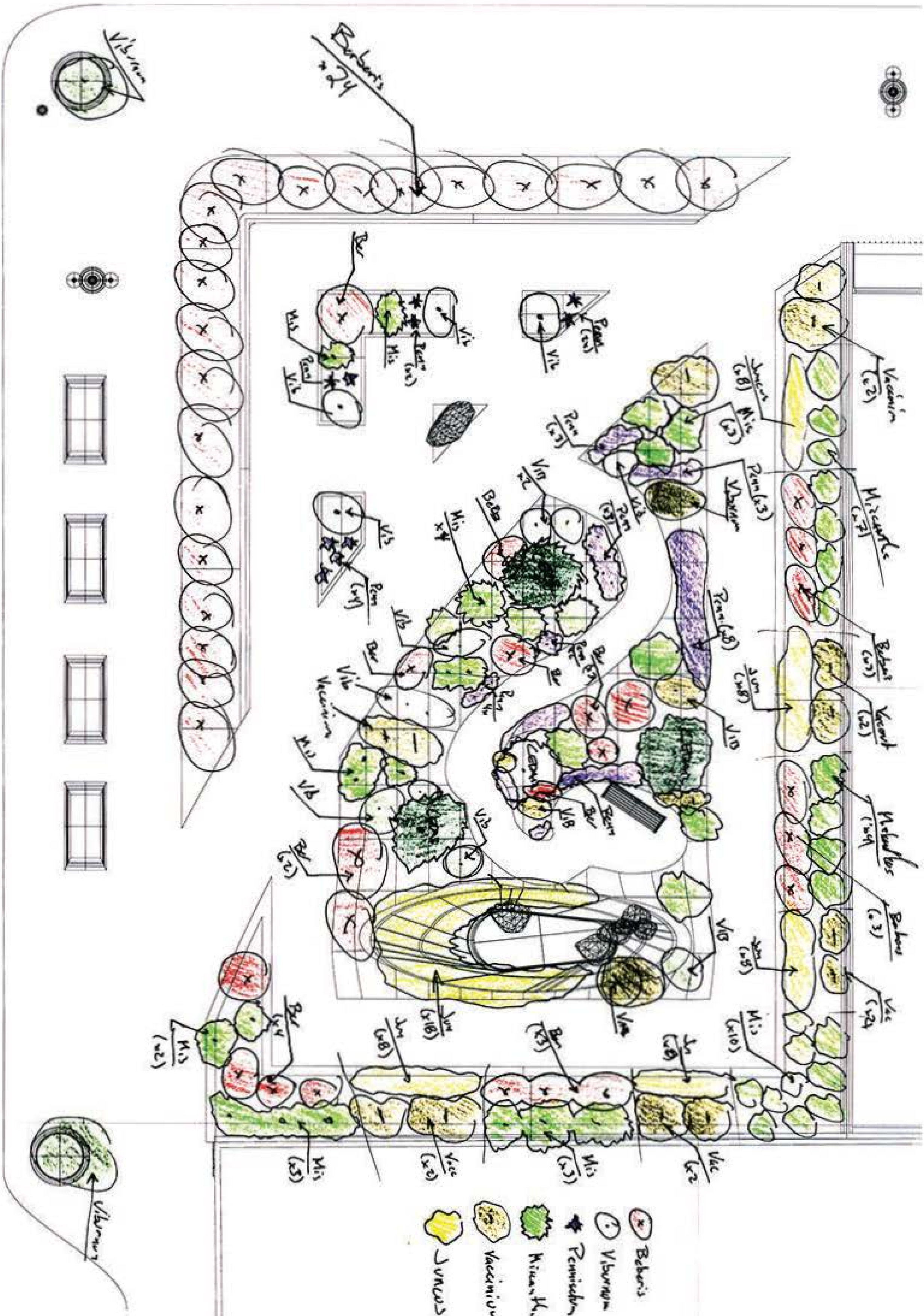
A specific measurable quality of "good seating" was introduced into the designs to enable testing of the ability to represent design intent. With "good seating" integrated into the design it becomes possible to test if subjects are more likely or able to discover and observe qualities that they feel create good seating potentials with self- guided dynamic Game Engine simulations or with static representations.

The summary significance of design intent is the introduction of a measurable quality that allows direct comparison between different forms of design representation. By having two nearly identical designs that are only altered by the addition or subtraction of seating elements, it becomes possible to gauge users' assessment of that design distinction (***Design***).

If users are more able to discover and discern the design distinction by engaging with Game Engine simulations, it can be argued that Game Engines provide a more effective means of communicating design intent than static renderings.

Additionally, the introduction of textural detail provides a vehicle for an even more robust analysis by statistically analyzing the trend between Game Engine and Static renderings (***Dynamism***) and between high detail and low detail (***Textural Detail***).

If Game Engines are more effective at communicating design intent than static renderings at both ***Textural Details*** (regardless of *preference* for detail), then the argument for game engines as a more effective tool for communicating design intent is even stronger.



N

Not to Scale

FIGURE 5:
SCHEMATIC PLANTING PLAN

All designs stayed as true to this schematic planting plan as possible to ensure uniformity across visualizations.

2.4 DESCRIPTION OF DESIGNS:

The qualities used to determine good seating are defined as follows: attractive outlook, accessible, encourages sociability, comfortable, continuity of site materiality, well lit, safe, and placed upon a dry firm foundation.

Ultimately, the question of whether the seating in Design 2 (with benches) is “good” or not is somewhat superfluous because the seating in Design 2 (with benches) is definitively better than the seating in Design 1 (without benches), which is identical to Design 2 (with benches), except that no non-feature benches exist (see Figure 3).

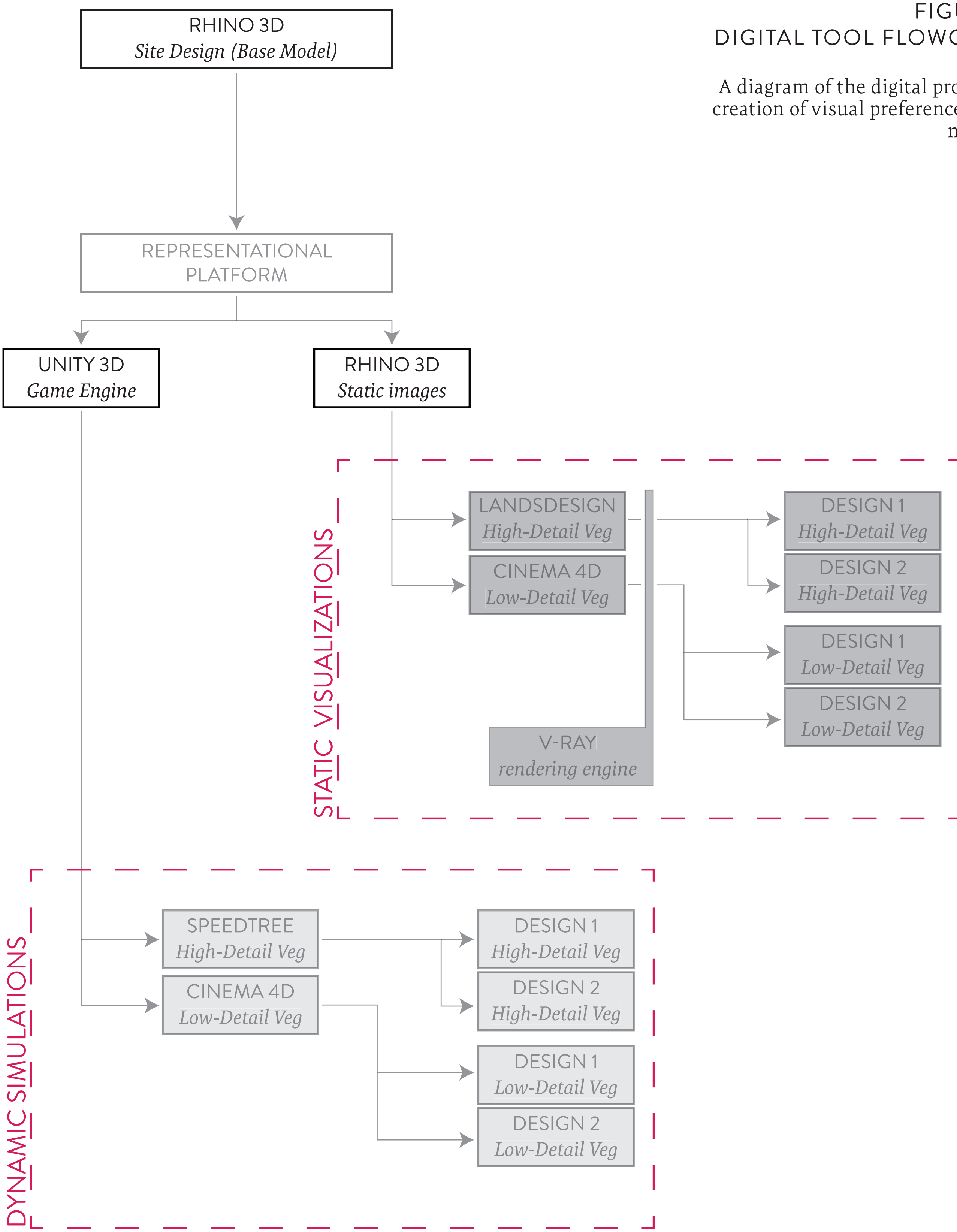
The feature-bench occurs in both designs as a navigational target for testing Game Engines against static representations irrespective of ***Design*** or ***Textural Detail***. This navigational target is deliberately difficult to access with the intent of testing how well users are able to control the self-guided dynamic simulations.

The planting design is kept as similar as possible between the two designs. A loss of plant bed area occurs when adding benches to Design 2, but the area is small and no species novel to the planting design were placed in areas which only exist in Design 1.

Figure 5 shows the schematic planting plan used for populating the scenes in both the Game Engine and 3D model. This plan shows the Design 1 (without benches) planting plan, but the only plants removed for Design 2 are the Juncus spp. in the perimeter bed, and all plants in the raised planters near the Rock Feature that are replaced by benches in Design 2.

FIGURE 6:
DIGITAL TOOL FLOWCHART

A diagram of the digital process for creation of visual preference survey material.



2.5 PROCESSES

The digital workflow for this project is large and complex (Figure 6). There were multiple digital tools utilized and many variables associated with each. To provide the greatest potential transparency to this project, the following will detail the digital workflow. The detail of description has been limited to the perceivable significance as related to the interpretation of results from preference testing.

The site and surrounding context were modeled in Rhinoceros 3D 5.0 (Rhino3D). Both iterations of design (Design 1 and 2), were created on the same base model within Rhino3D with layer designations that allowed for visibility distinction at the representational phase.

Site visits, Google aerial imagery, Google street view, and site photographs were used to scale and model the context area designated in Figure 1. Using people as scalable reference points, interpolation of object and building size was conducted to ensure the highest possible accuracy within the available resources of this project.

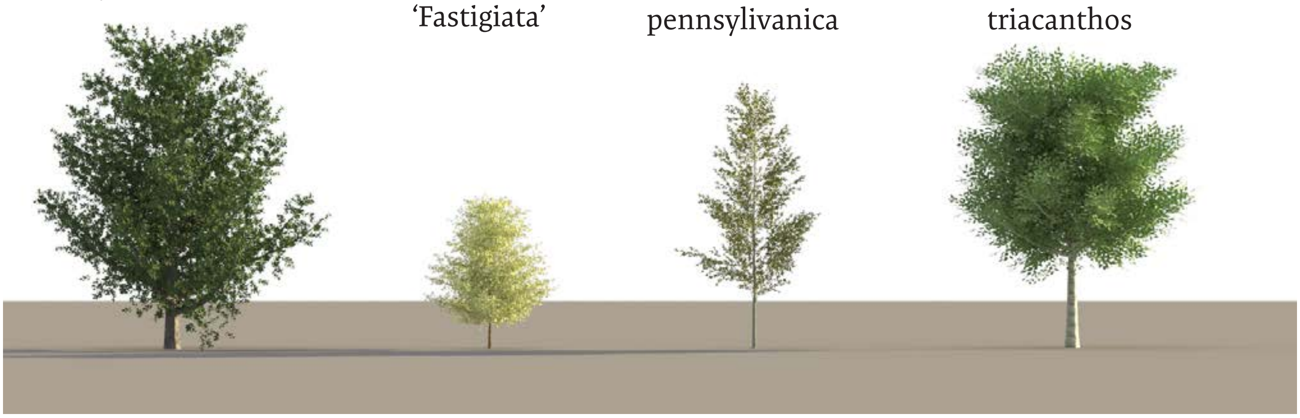
Open Street Map (OSM) data was added to the base model at an early stage to add an additional layer of accuracy and context representation. The OSM data was inserted into the Rhino3D model via the Rhino3D plug-in “Grasshopper”. The building height data associated with the OSM file was questionable (OSM is open source software), and thus ground truthing was the more trusted methodology, but the OSM data acted as a check for model accuracy, and provided a secondary source for building footprint locations.

At this point there is a bifurcation in the treatment of the base digital model for Game Engine simulation and 2D imagery rendering, but it is important to note that the base model – the “structure” upon which each representation is built – originates from the same Rhino3D source model (see Figure 6).

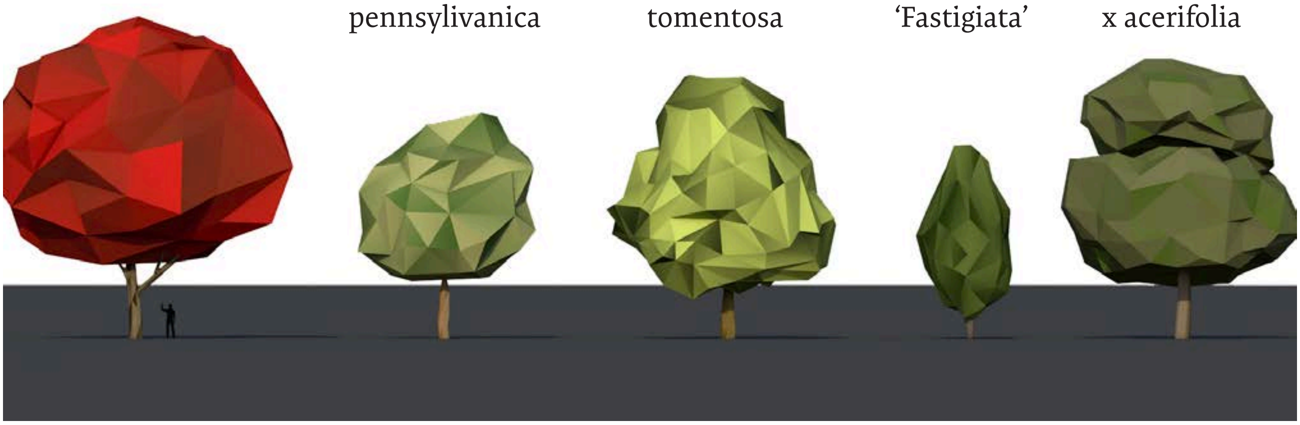
For the Game Engine simulations, the entire base model is exported as an .OBJ file from Rhino3D and imported into Unity 3D Game Engine (Unity) as an “asset”. Unity scene space models in meters, so before exporting from Rhino3D the entire model – which was drafted in feet – is converted to meters in Rhino3D thus ensuring the export and import retain correct scale.

For 2D image rendering, the base model remains in Rhino3D and is assigned digital material properties through the V-Ray Rendering Engine (V-Ray). V-Ray is a plug-in for Rhino3D that allows for the creation of more photo-realistic representations by using more advanced material shaders and light calculating processes.

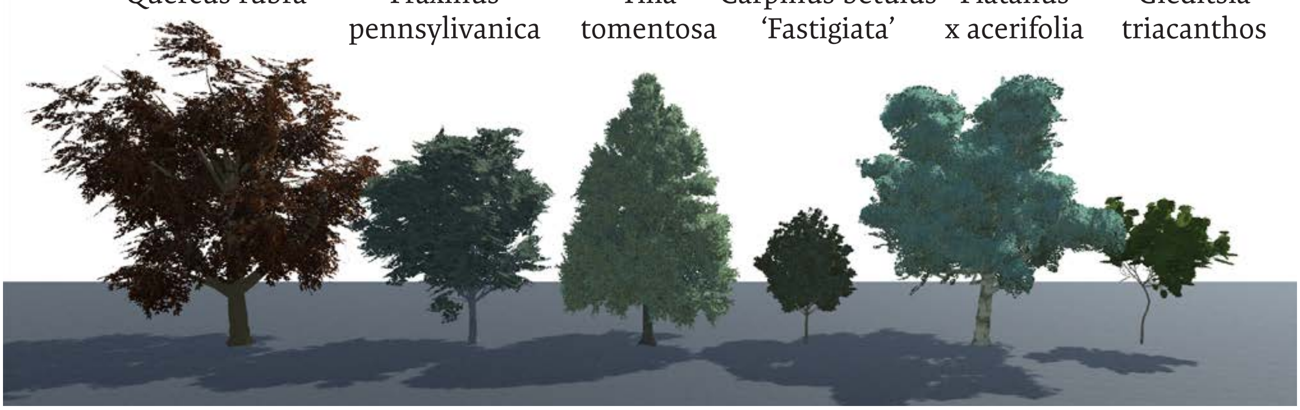
All objects in the visualizations, except vegetation are modeled in the method described above, with all content being generated in Rhino3D. All representations received the addition of vegetation (regardless of ***Textural Detail)*** as the last step before final output generation.



LANDSDESIGN VEGETATION



CINEMA VEGETATION



SPEEDTREE VEGETATION

FIGURE 7:
DIGITAL VEGETATION

The digital trees created and used for various representational sets.

2.6 DIGITAL VEGETATION OVERVIEW

The creation of accurate and realistic vegetation is a major challenge with digital tools. Their immense organic complexity, in addition to a myriad of textural and visual interactions is incredibly difficult to accurately represent with digital tools.

The difficulty of representing vegetation in game engine simulations is what prompted the research question about importance of ***Textural Detail***.

In an effort to provide a less challenging alternative to photo- or "hyper-" realistic vegetation this project is exploring the potential of the Low Poly* style as a means for design representation. The process of creating and representing abstracted Low Poly elements is much simpler. If this process proves equally effective it would significantly reduce the labor costs associated with the utilization of game engine simulations for landscape architects. Low Poly and low textural detail are used synonymously throughout this document.

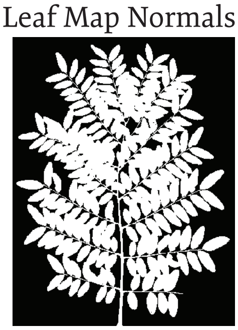
Figure 7 shows the three types of vegetation generated for the project. All of the Cinema and Speedtree vegetation were constructed specifically for this project, whereas the LandsDesign vegetation was placed into the model as pre-fabricated elements.

**Low-Poly : A stylistic distinction in digital constructs. The name is a reference to the low polygon count of the abstracted forms. Polygon count is an important part of the digital rendering process (in both static and dynamic formats) and is part of the determination of physics computation for light calculations. In general, lower polygon count contributes to faster digital processing time.*

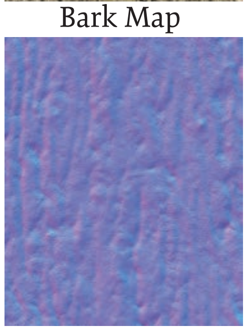
Leaf Map

Leaf Map Normals

Bark Map



Leaf Map Alpha



Bark Map Normals

Polygons - Tree
branches: 13,055 tris
caps: 177 tris
leaf meshes: 1,930 tris
TOTAL: 15,102

FIGURE 8:
SPEEDTREE VEGETATION

A *Gleditsia triacanthos* as modeled in Speedtree.

2.7 SPEEDTREE VEGETATION

To create the vegetation for the high detail Game Engine simulation a third-party software called Speedtree was utilized (Figure 8). Photographs of actual plant species bark and leaves were manipulated to generate digital material that could be applied to the plant models. Photographs of the plant species were also used for generating realistic forms of plants within the Speedtree modeling program.

The textures generated for tree materials go through several processes before they can be applied to tree models. For the leaf materials, a single leaf image is developed (in Photoshop) into a larger branch/leaf structure. This conglomeration - called a leaf map - enables the appearance of more leaves on a tree with fewer computed polygons. The leaf map is saved as an image file with an alpha channel associated to enable transparency through the leaf plane where no leaves are drawn. Additionally, a normal map is generated for each leaf map and bark texture. The normal maps give the appearance of depth once the material is applied to the digital object.

Polygon count is always a consideration when working in Game Engines, and so great care was taken to balance form and function in generating realistic vegetation. Polygon count was limited as much as possible and generally averaged about 15,000 polygons per completed SpeedTree plant model (see Figure 8).

2.8 LOW POLYGON COUNT VEGETATION

For the creation of low detail vegetation Cinema4D, a different 3D modeling program was used. While the content could potentially have been created with Rhino3D, there are many reasons that this process was more effective in Cinema4D.

For this workflow photographs of the desired plant species were placed into the model space of Cinema4D as a reference, then 3D objects were manipulated to generate the approximation of form for each species.

The vegetation models were then exported from Cinema4D to Unity as .FBX files and to Rhino3D as .OBJ objects (see Figure 6). The file type used determines what information is conveyed, and how it is transported. These separate file types were necessary to retain the most information capable within each destination software.

Within each representational platform (Unity and Rhino3D) materials were created and assigned to these Low Poly vegetation models. This different material creation results in a slight distinction (color and texture) between the Game Engine Low Poly plants and the Static 2D Low Poly plants, even though they originated from the same source files.

2.9 LANDSDESIGN VEGETATION

The final mode of vegetation generation is for the high detail Static renderings, which was generated using a third-party software plug-in within Rhino3D called LandsDesign. LandsDesign has a large content library of 3D vegetation models that can be dropped into a model and are supported by V-Ray.

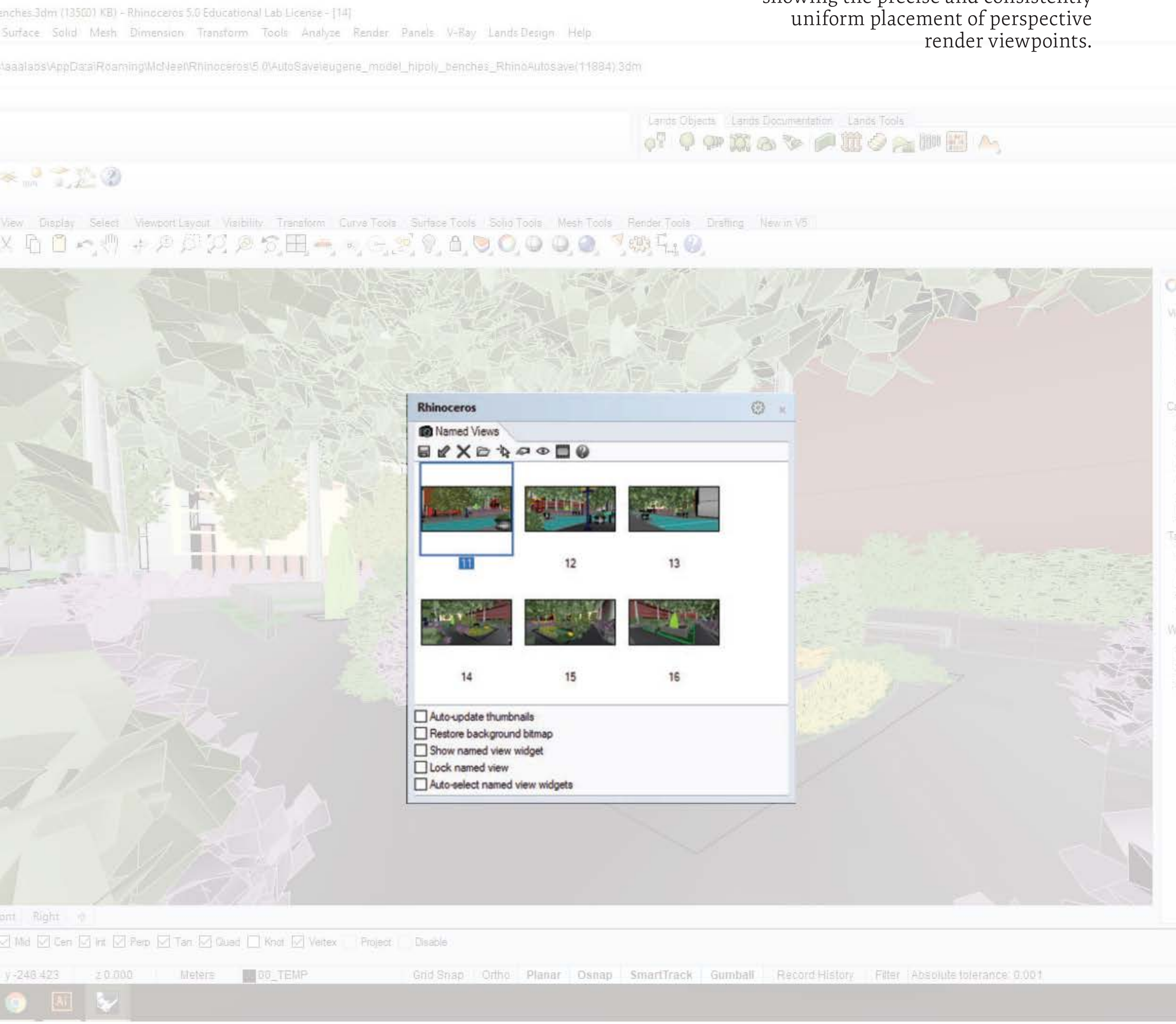
This was the least labor-intensive method of vegetation representation, but due to the limits of the LandsDesign plant library, also the least accurate.

Several desired plant species did not exist in the LandsDesign content library so substitutive species (which had the closest appearance to the desired plant form and texture) were utilized as surrogates.

This was an unfortunate concession of using LandsDesign, but one which project constraints demanded. This concession is offset by the idea that form and texture are the key considerations, and therefore the LandsDesign vegetation models are appropriately similar to the other vegetation models which were defined by form, texture, and desired plant characteristics such as height, diameter, and crown shape.

FIGURE 9:
NAMED VIEWS IN RHINO3D

The digital workspace of Rhino3D, showing the precise and consistently uniform placement of perspective render viewpoints.



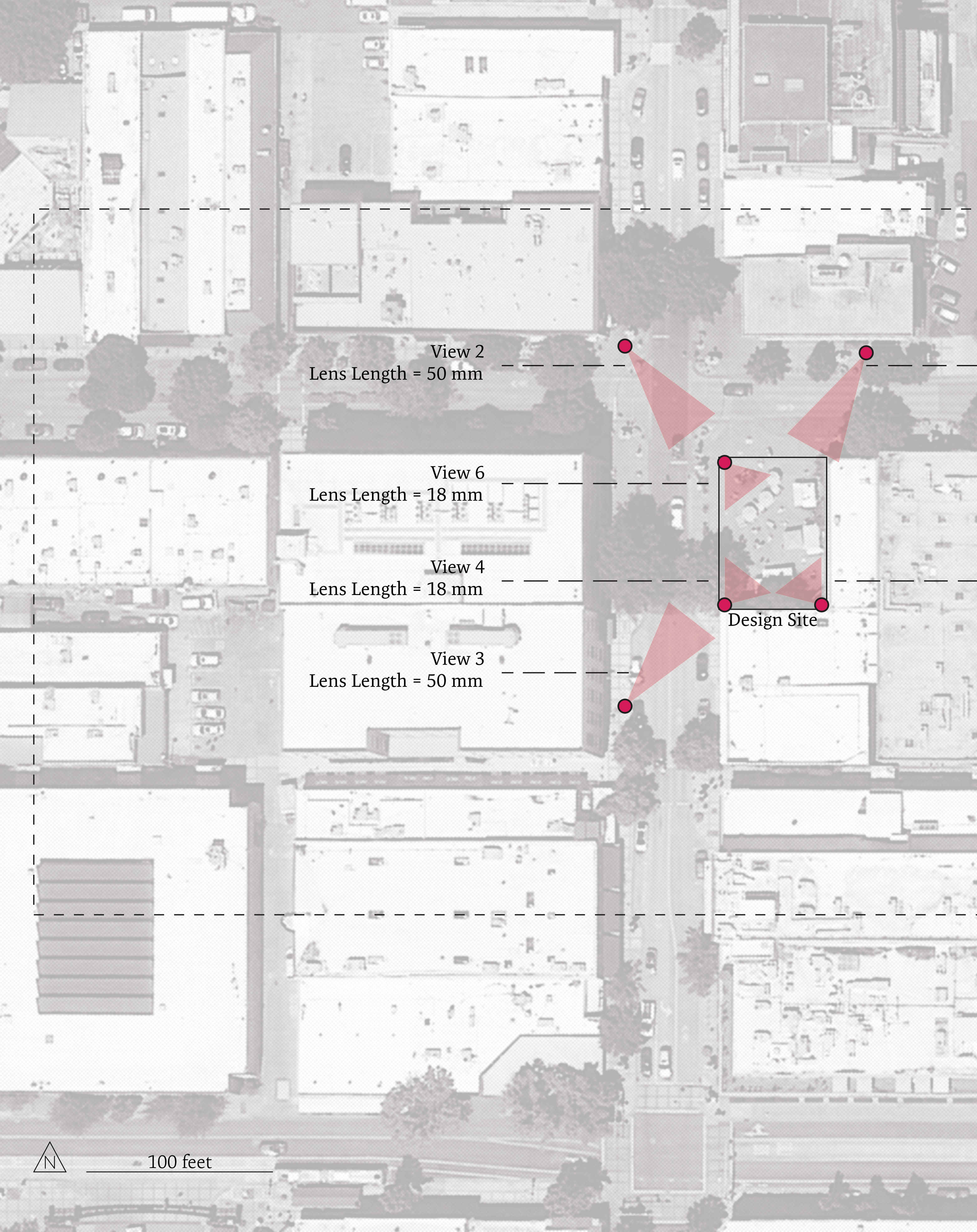
2.10 STATIC IMAGE CAMERA SETUP

Six scenes for each static visualization set were established within Rhino3D by creating “Named Views” for generating static renderings. This enabled repeatable and consistent camera position, Field of View (FOV), and rotation across all Static renderings (***Design*** and ***Textural Detail***).

These “Named Views” (Figure 9) were set up to create a sense of the site context and were positioned so that seating opportunities or lack thereof are visible in the static rendered images. While the seating is displayed when possible, it is not the focal point of any scene. Rather, the scenes are deliberately positioned so that the seating is on the periphery of the scene to increase ability to test communication of design intent. As an example, View #5 (Figure 11E) is positioned so that the benches along the eastern wall are visible only on the outside perimeter of the image.

This indirect exposure to the distinctions between ***Design*** can then be used as a metric for evaluating interpretation of Design Intent (i.e. did people more frequently observe the benches in static renderings or dynamic simulations).

A full set of these “Named Views” (shown in plan view in Figure 10) are presented as the rendered Static 2D images on the next pages (Figure 11A-11F). To see all visualization products see appendix C1-C17.


View 2
Lens Length = 50 mm
View 6
Lens Length = 18 mm
View 4
Lens Length = 18 mm
Design Site
View 3
Lens Length = 50 mm
N
100 feet

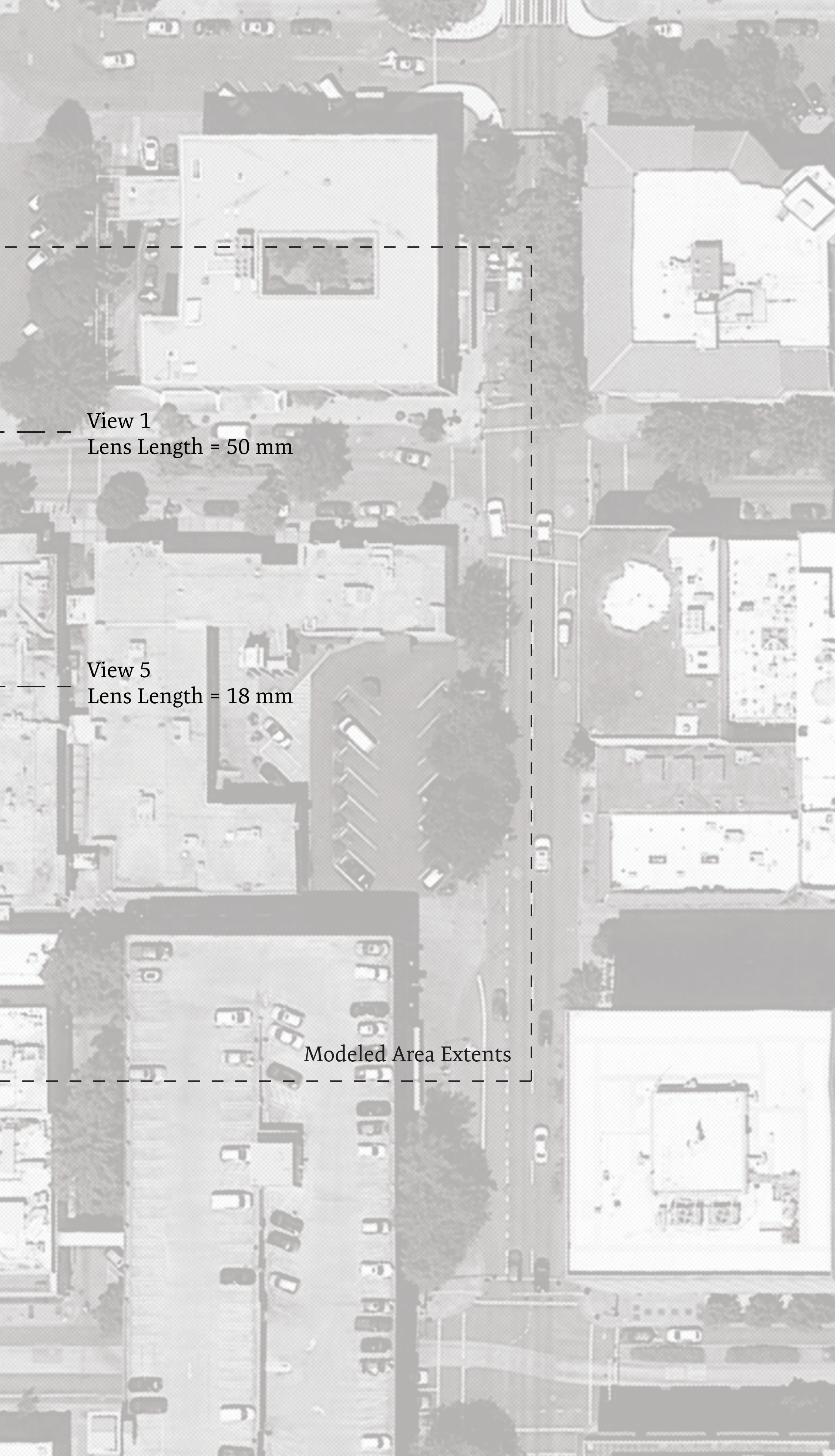


FIGURE 10:
STATIC RENDERING
NAMED VIEWS

Image source:
Google Earth Pro
2017.06.28

FIGURE 11A:
STATIC RENDERING
DESIGN 2 - VIEW 1

Rhino3D Base
LandsDesign Vegetation
VRay Rendered Static Output

FIGURE 11B:
STATIC RENDERING
DESIGN 2 - VIEW 2

Rhino3D Base
LandsDesign Vegetation
VRay Rendered Static Output

FIGURE 11C:
STATIC RENDERING
DESIGN 2 - VIEW 3

Rhino3D Base
LandsDesign Vegetation
VRay Rendered Static Output

FIGURE 11D:
STATIC RENDERING
DESIGN 2 - VIEW 4

Rhino3D Base
LandsDesign Vegetation
VRay Rendered Static Output

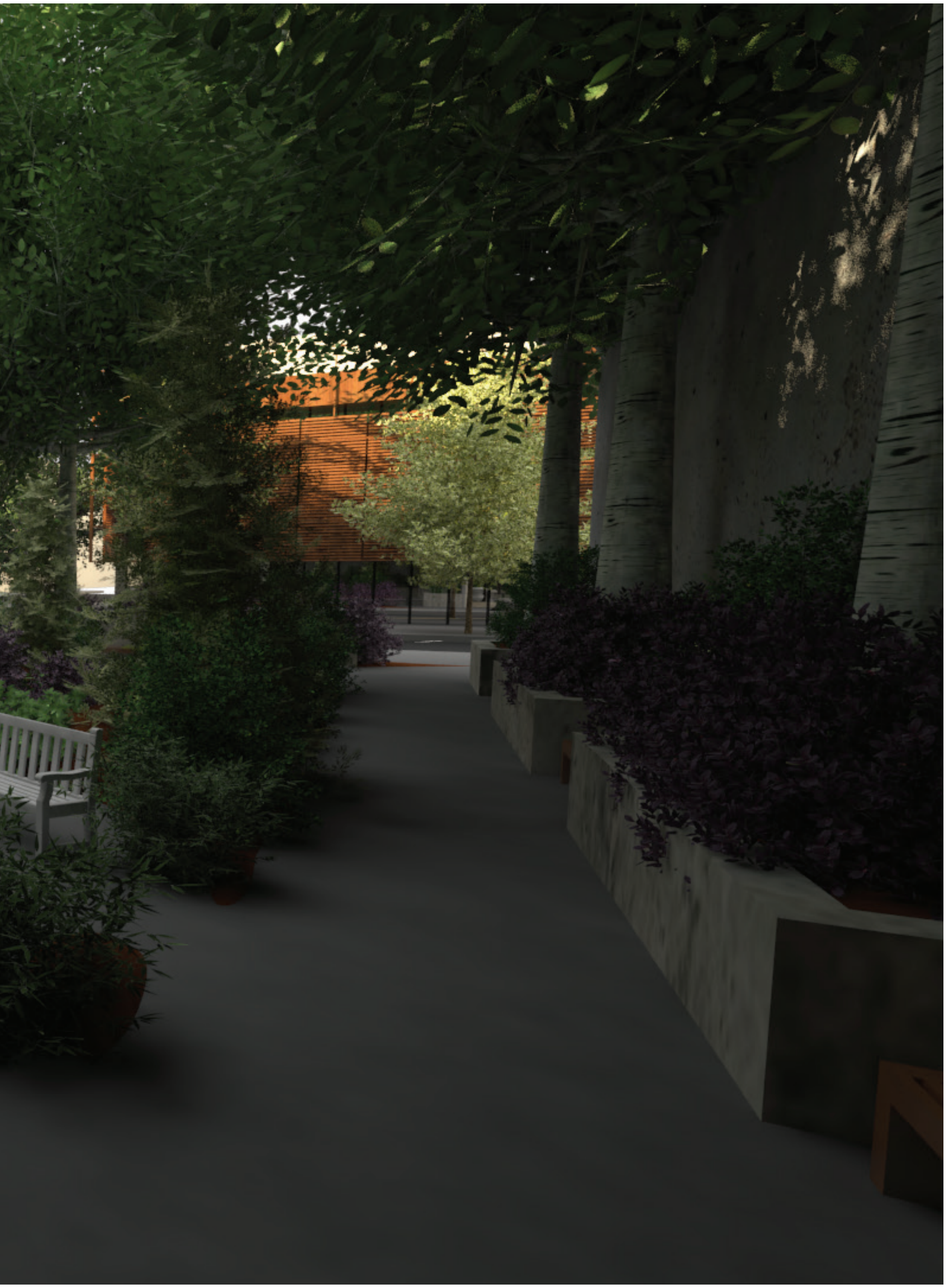


FIGURE 11E:
STATIC RENDERING
DESIGN 2 - VIEW 5

Rhino3D Base
LandsDesign Vegetation
VRay Rendered Static Output

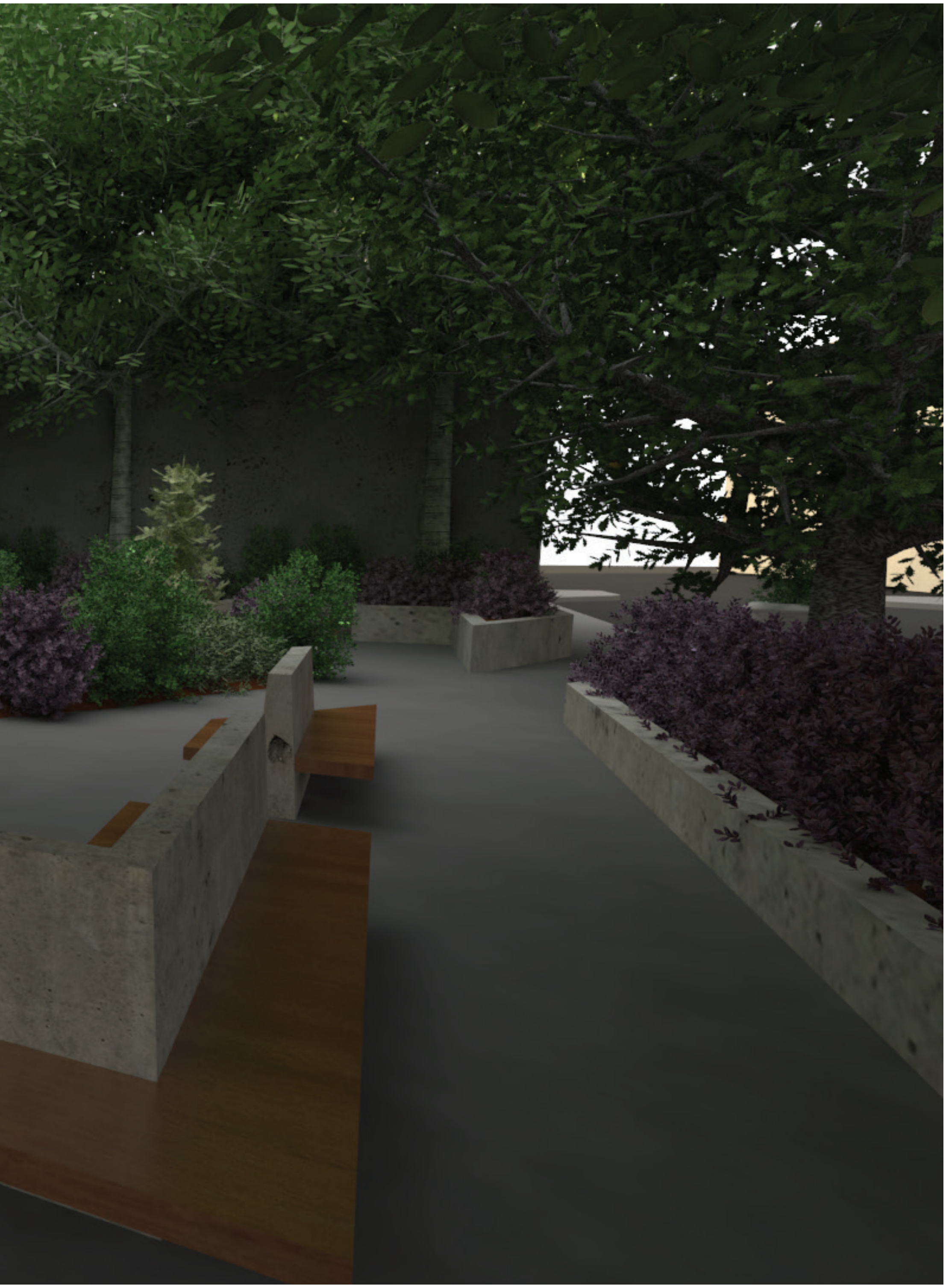


FIGURE 11F:
STATIC RENDERING
DESIGN 2 - VIEW 6

Rhino3D Base
LandsDesign Vegetation
VRay Rendered Static Output

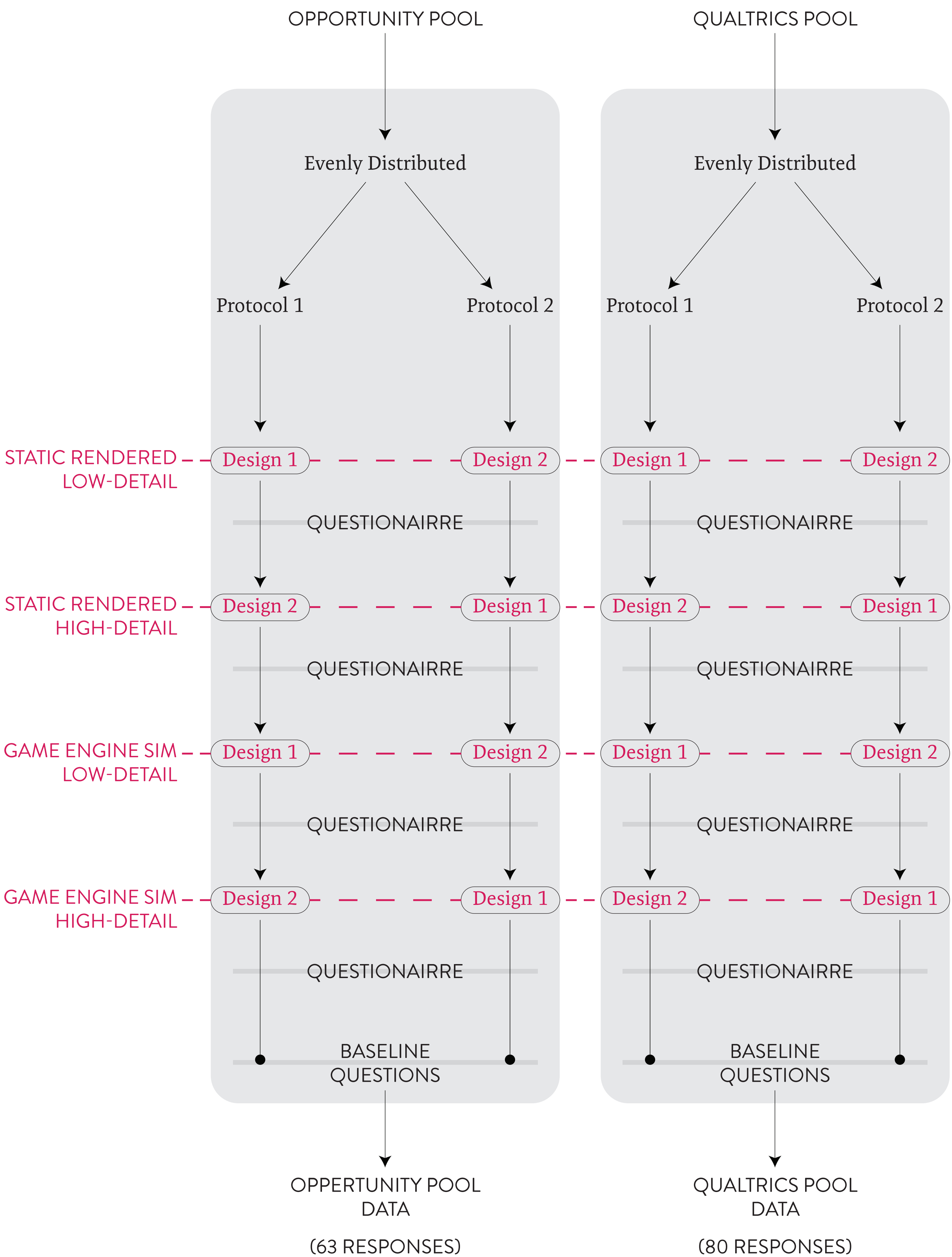

OPPORTUNITY POOL
QUALTRICS POOL
Evenly Distributed
Evenly Distributed
Protocol 1
Protocol 2
Protocol 1
Protocol 2
STATIC RENDERED LOW-DETAIL
Design 1
Design 2
Design 1
Design 2
QUESTIONAIRRE
QUESTIONAIRRE
STATIC RENDERED HIGH-DETAIL
Design 2
Design 1
Design 2
Design 1
QUESTIONAIRRE
QUESTIONAIRRE
GAME ENGINE SIM LOW-DETAIL
Design 1
Design 2
Design 1
Design 2
QUESTIONAIRRE
QUESTIONAIRRE
GAME ENGINE SIM HIGH-DETAIL
Design 2
Design 1
Design 2
Design 1
QUESTIONAIRRE
QUESTIONAIRRE
BASELINE QUESTIONS
BASELINE QUESTIONS
OPPERTUNITY POOL DATA
(63 RESPONSES)
QUALTRICS POOL DATA
(80 RESPONSES)

FIGURE 12:
SURVEY PROTOCOL & SUBJECT POOLS

Two distinct surveys with identical content were used to observe any differences between the Opportunity Pool and the Qualtrics Pool.

2.11 STUDY METHODS AND PROTOCOLS

Visual preference was used to contrast self-guided dynamic Game Engine simulations against static two-dimensional imagery (Bishop and Leahy 1989). Participants engaged the preference study through the online survey hosting tool Qualtrics. There were two distinct study subject pools, one that was generated through local advertisement and social media called the "Opportunity" pool, and another called the "Qualtrics" pool which was recruited by Qualtrics and which was provided financial incentive for participation. Users, regardless of subject pool, were evenly directed into one of two protocols as described in the flowchart (Figure 12).

The two distinct protocols vary the order of ***Design*** and ***Textural Detail*** of the representations to reduce biases. Additionally, to further minimize bias, the dynamic simulations are always shown after viewing static visualizations.

The study varies three elements across the representations:

- *Designs* – benches or without benches
- *Dynamisms* – Game Engine Simulation or Static 2D
- *Textural Detail* – High and low

Each study participant viewed only half of the study content regardless of pool or Protocol. The order of visualizations proceeds from Low-Detail Static, High-Detail Static, Low-Detail Game, to High-Detail Game, with the order of Design alternating on each subsequent visualization.

The systematic stratification of these study protocols reduced recency bias and minimized the degree to which respondents might detect the experimental variability.

After viewing each visualization participants were presented with a questionnaire analyzing their visual preference and their ability to ascertain the location and frequency of seating opportunities (design intent), those questions are listed on the next pages.

Demographics were recorded with a set of questions called "baseline questions".

Each participant answered “preference questions” between each visualization and "baseline questions" once at the termination of the study (Questions listed on the next page).

PREFERENCE QUESTIONS:
asked after each visualization

1. **Beauty:** How beautiful do you find the vegetation and planting design of the place you just experienced?

Rank from 1-10

2. **Ease of Navigation:** How easy was it for you to grasp this simulated place's layout so you could easily discover what it looks like and <u>notice nice places to sit down?</u>

Rank from 1-10

3. **Degree of Realism:** How easy was it for you to grasp this simulated place's appearance so you could easily get a good sense of what it would feel and look like if it were actually built?

Rank from 1-10

4. **Return Visits:** How much would you want to come back and visit this place more than once to enjoy its beauty?

Rank from 1-10

BASELINE QUESTIONS:
asked once at end of survey

1. What is your age?

a) 18-23 b) 24-29
c) 30-40 d) 40+ e) Prefer not to say

2. What is your gender?

a) Man b) Woman c) Other d) Prefer not to say

3. Would you consider yourself a "gamer"?

a) Yes b) No c) I don't know d) Prefer not to say

4. Do you have formal training in a design profession?

a) Yes b) No c) I don't know d) Prefer not to say

5. Have you ever visited Broadway Plaza (Kesey Square) in downtown Eugene Oregon?

a) Yes b) No c) I don't know d) Prefer not to say

GAMING THE LANDSCAPE

Please participate in this research study exploring the potential use of video game engines as tools for design representation.

ALTERNATIVE DESIGNS FOR EUGENE'S KESEY SQUARE PRESENTED IN AN INTERACTIVE VIDEO-GAME FORMAT

more info at:
GAMINGTHELANDSCAPE.COM

FIGURE 13:
PROMOTIONAL FLYER

Example of the promotional flyer that was printed (8.5x11 in.) and distributed for Opportunity sample recruitment.

2.12 RECRUITMENT METHODS - OPPORTUNITY SAMPLE

The Opportunity Sample was recruited through online postings, flyer-distribution, and word-of-mouth. Many of these respondents are individuals who knew of the project prior to taking the survey, and many of them are designers currently associated with the University of Oregon Landscape Architecture program.

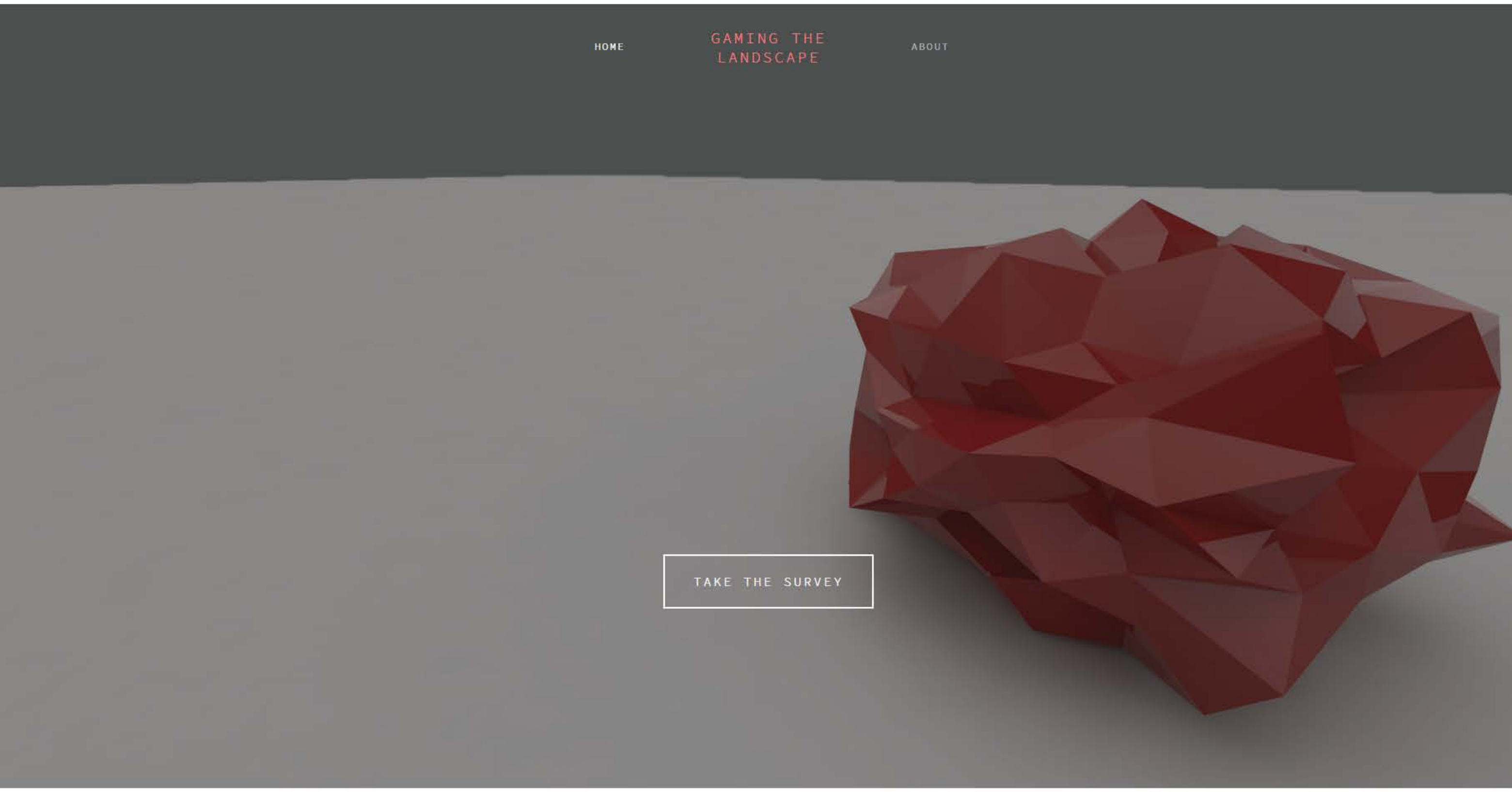
Flyers (Figure 13) were distributed throughout Lawrence Hall (College of Design) University of Oregon, the EMU at UO, and coffee shops near the University of Oregon. Digital versions of the flyer were posted to the online platforms of Instagram and Facebook, with friends and family spreading the word to others asking for participation. Additional recruiting was done in person to several UO landscape studio groups, and the employees of Cameron McCarthy Landscape Architecture.

Note that the advertising flyer (Figure 13) advertises the URL Gamingthelandscape.com. This was the solution to the complex survey link required to access the online survey, and will be discussed further.

There were 63 responses to the opportunity sample survey, but 11 of those contained no response data. There were no indications of invalid data or untrustworthy data, and no additional responses were discarded (see Section 2.14).

FIGURE 14:
GAMINGTHELANDSCAPE.COM SPLASH PAGE

The home screen of Gamingthelandscape.com, which study participants see as they begin the study.



2.13 GAMING THE LANDSCAPE SPLASH PAGE

When Opportunity Sample participants engaged with the study they were directed to the domain "Gamingthelandscape.com" (Figure 14). This domain was purchased, then setup with Squarespace (website building service) to provide an easy and memorable domain name that would act as a jumping off point to the survey protocol for Opportunity Sample participants.

This may seem like an unnecessary step, but the URL link which Qualtrics provides to access the online survey is a random string of characters that would be an additional hurdle (in remembering and taking the effort to enter) to get subjects to participate in the study.

https://oregon.qualtrics.com/jfe/form/SV_9HwlanB0LncBw2N
or
Gamingthelandscape.com

By using a simple and catchy domain name the intent was to create a website that would be easy to access and appealing to explore. Once at the site, users are clearly directed to the study protocol by clicking a highly visible button.

This additional step was only intended to ease access to the survey and garner more participation. It in no way contributed to the data collected or study outcomes and or results.

2.14 RECRUITMENT METHODS - QUALTRICS SAMPLE

The Qualtrics Sample was recruited by Qualtrics for a fee. This sample was designed to meet certain demographic and population parameters which in theory would provide a widely representative sample group of urban residents throughout the United States.

Qualtrics collected more than 320 responses, and of those, 126 of were of appropriate quality for data analysis. This initial sorting was done by Qualtrics and was mainly based on the size of respondents home city (>50,000 residents), and a timeframe determined by the mean of an test group sample. Qualtrics determined that the mean completion time of initial respondents was 5 minute. To reduce invalid responses a speed check of one-third this mean time (1 minute and 40 seconds) was added and any response below this benchmark was not counted in the 126 appropriate responses.

Of those 126 responses and additional 46 were discarded due to questionable validity. The two factors implemented to cull potentially invalid data, were "gibberish responses" and completion time.

"Gibberish responses" were identified as any response that had more than 14 scores of the same value for the 16 preference questions (ie many "gibberish responses" rated all 16 preference questions with values of 10, making no distinction for beauty, navigation, or realism between ***Dynamism***, ***Textural Detail***, or ***Design***). This determination was made because of the large discrepancies between visualization sets, which implies there should be some preference between the sets, even if it is a minor one.

The completion time was further investigated, and increased from the 100 seconds (1 min. 40 secs.) that Qualtrics had set to 210 seconds (3 mins. 30 secs.). This time was derived by taking the survey myself. As the author of each question, and the creator of all survey content I was more familiar with the survey then it would be possible for any respondent to be. As I took the survey myself I read every question and response word-by-word, but did not spend any time looking at images (which would allow leeway for any participants who read more quickly than I). At the game engine stage of the survey where an external link must load before any visualization exploration can occur I waited for the two separate links to load, but did not spend any time exploring the models. This survey test clocked at ~200 seconds. To allow variability in internet speeds and read times, but retaining a desire to have individuals actually spend time experiencing the simulations a time of 210 seconds was set as a baseline completion and any response of lesser time was discarded.

When implementing the two criteria onto the 126 responses from Qualtrics 40 responses are determined to be "gibberish responses" and an overlapping 46 are culled due to insufficient time spent in the survey. Which is to say the 40 "gibberish responses" are further validated as invalid data by the fact that they are below the reasonable time benchmark. The additional 6 responses that were not "gibberish responses", but were under the time benchmark also had questionable response trends that indicated lack of appropriate care in responding to preference questions.

2.15 DEMOGRAPHIC DIFFERENCE BETWEEN SAMPLES

The Opportunity sample was comprised of a fairly homogenous age range that was slightly skewed toward younger individuals (See Figure 16). Only 25% of the study population was over 40 years of age. Conversely, 58% of the Qualtrics sample was over 40 years of age.

The two sample pools had different gender response rates, with the Opportunity pool identifying as 56% woman, and 44% man. The Qualtrics pool identified as 75% woman, 24% man, and 1% other.

It would have seemed that being a "Gamer" would have been a big factor in the response scores, but 31% of the Opportunity sample, and 25% of the Qualtrics sample identified as "Gamers". This surprisingly small demographic discrepancy (given the age distinction) likely had an only a minimal impact on results.

The amount of formal design training is a significant distinction between sample populations, with 63% of Opportunity sample respondents identifying as having received formal design training, and only 9% of the Qualtrics respondents identifying as designers.

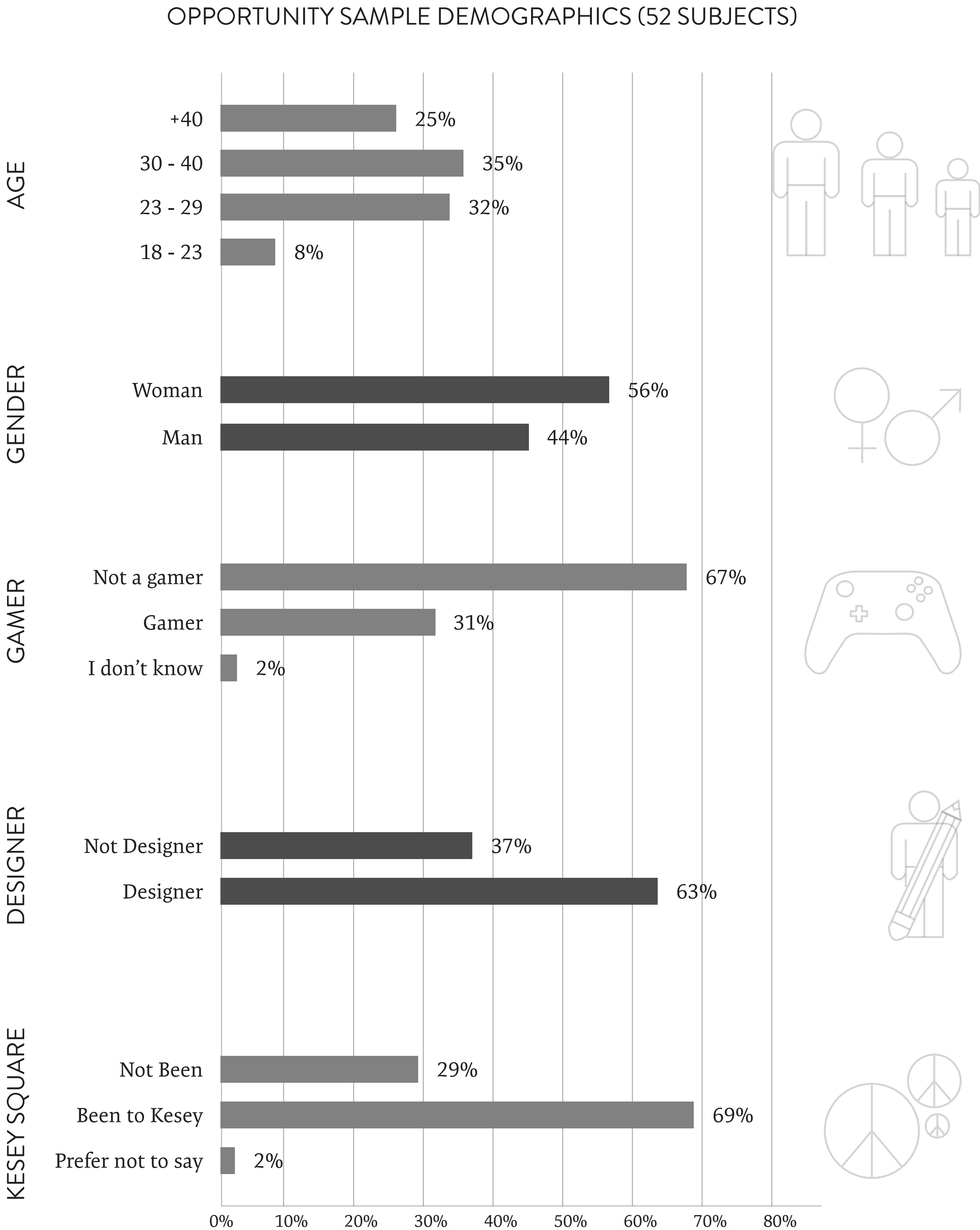
Another very large distinction between the sample populations is the number of respondent who have visited the design site in person. Opportunity sample respondents indicated that 69% of them have visited Kesey Square, while only 8% of Qualtrics respondents have been to the design site.

It would seem that given these discrepancies between demographic pools there should be some traceable trend in the response scores correlating to these differences.

FIGURE 15: (NEXT PAGE)
SURVEY DEMOGRAPHICS

Survey demographics by baseline question, separated by study pool.

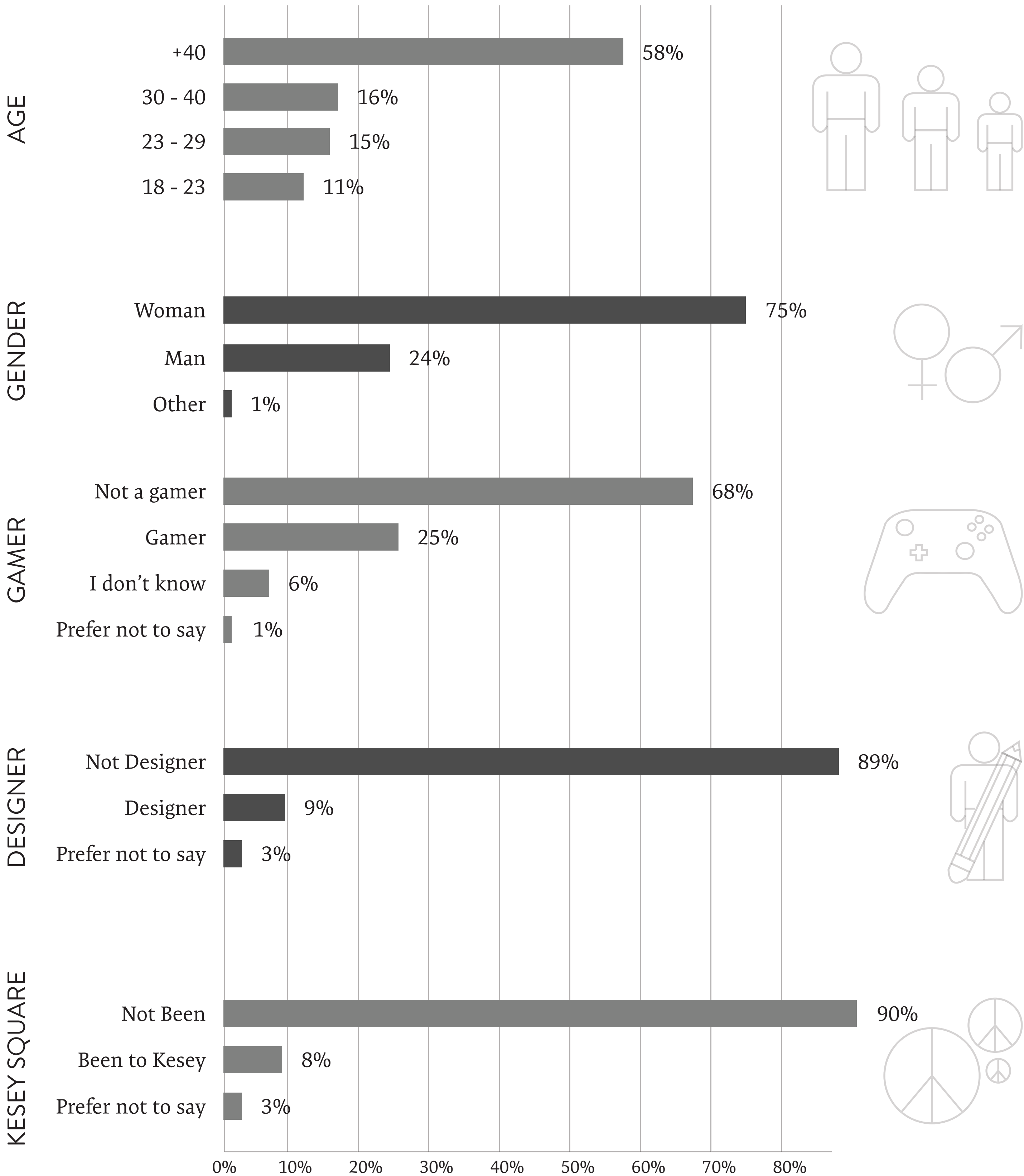
While it is possible that some trend may be occurring in the data, the calculations that were performed to analyze the results show no significant corollary. Given that multivariate approach, and my limited proficiency with statistical techniques, it is possible there are relationships occurring between demographic trends and preference scores that do not show up in these analyses.



OPPORTUNITY SAMPLE DEMOGRAPHICS (52 SUBJECTS)
AGE
+40
25%
30 - 40
35%
23 - 29
32%
18 - 23
8%
GENDER
Woman
56%
Man
44%
GAMER
Not a gamer
67%
Gamer
31%
I don’t know
2%
DESIGNER
Not Designer
37%
Designer
63%
KESEY SQUARE
Not Been
29%
Been to Kesey
69%
Prefer not to say
2%
0%
10%
20%
30%
40%
50%
60%
70%
80%

QUALTRICS SAMPLE DEMOGRAPHICS (80 SUBJECTS)

FIGURE 15



"The possibilities of employing empirical methods to develop and apply aesthetic assessments are not limited by the weaknesses of any particular method. Instead, the qualities and relationships which might be researched are tremendously varied, as are the approaches to such research. "

Robert Ribe
On the possibility of quantifying scenic beauty—A response

3. RESULTS

3.1 SUMMARY OF RESULTS

The goal of this project was to explore video game engines as an alternative tool for representing design. The project's investigatory process and survey response results indicate that game engines are an exceptionally viable tool for representing design.

According to study results Video Game Engine simulations are a comparable communication device to static imagery (Figure 17). And while study results do not decisively show Game Engines to be superior to static representations, Game Engines do receive comparable preference ratings in most cases (Figure 17).

Unfortunately, results do not indicate that Game Engines are better at communicating design intent. Rather, results do indicate that Game Engines and static representations are fairly comparable across the tested aesthetic preferences. The follow chapter will unpack the visual preference study in an attempt to answer the specific research questions as well as the over-arching question of the applicability of Game Engines in design representation.

FIGURE 16:
OPPORTUNITY RESULTS SAMPLE SUMMARY

The averaged results of both sample populations tabulated by ***Design*** and format (***Textural Detail*** & ***Dynamism***). Scores given on a 1-10 sliding scale.

OPPORTUNITY SAMPLE - 52 PARTICIPANTS

	LOW DETAIL STATIC RENDERING		HIGH DETAIL STATIC RENDERING		LOW DETAIL GAME ENGINE SIM.		HIGH DETAIL GAME ENGINE SIM.	
	No Bench	Bench	No Bench	Bench	No Bench	Bench	No Bench	Bench
BEAUTY	5.85	5.62	7.77	7.54	*4.80*	5.15	**7.96**	6.76
NAVIGATION	6.16	6.48	6.85	6.92	*5.64*	6.62	**7.42**	6.32
REALISM	5.52	5.23	**8.50**	8.15	*4.76*	5.77	8.08	6.96
RETURN VISITS	5.58	5.16	6.96	6.85	*5.12*	5.27	**7.27**	6.24

Bold = cells shaded dark grey; italics = cells shaded light grey.

QUALTRICS SAMPLE - 80 PARTICIPANTS

	LOW DETAIL STATIC RENDERING		HIGH DETAIL STATIC RENDERING		LOW DETAIL GAME ENGINE SIM.		HIGH DETAIL GAME ENGINE SIM.	
	No Bench	Bench	No Bench	Bench	No Bench	Bench	No Bench	Bench
BEAUTY	6.97	6.93	**7.81**	7.59	6.16	*5.88*	7.09	6.81
NAVIGATION	7.32	7.17	**8.21**	7.92	5.97	*5.95*	6.12	6.51
REALISM	5.73	5.79	**8.65**	8.38	*5.32*	5.58	6.70	6.84
RETURN VISITS	6.12	5.95	**7.47**	7.09	*4.88*	5.12	6.14	6.12

Bold = cells shaded dark grey; italics = cells shaded light grey.

AVERAGE PREFERENCE SCORES (RANKED 1-10)

HIGHEST CATEGORY SCORE (ROW)

LOWEST CATEGORY SCORE (ROW)

3.2 RESULT OVERVIEW

The response preference scores (valued from 1-10) from both sample groups are averaged and tabulated in Figure 16. The highest and lowest scores for each category; Beauty, Navigation, Realism, and Return Visits have been highlighted to visualize key differences. This figure shows the entirety of the averaged data, which from this point forward will be condensed by removing the ***Design*** element of the study (by averaging the "Bench" and "No Bench" scores within each ***Textural Detail*** and ***Dynamism***)

It took significant effort throughout this project to establish two distinct designs to create a platform for evaluating the communication of design intent. Upon analysis of the data, no clear trend is apparent between the two designs. Ideally there would have been a significant increase in navigational preference for Design 2 (with benches). Additionally, it was hoped that there would be a significant increase in all ratings for dynamic simulations over static simulations in terms of navigational preference, with the ***Design*** (Bench or No Bench) as a secondary support, but the data does not confirm to these hypotheses.

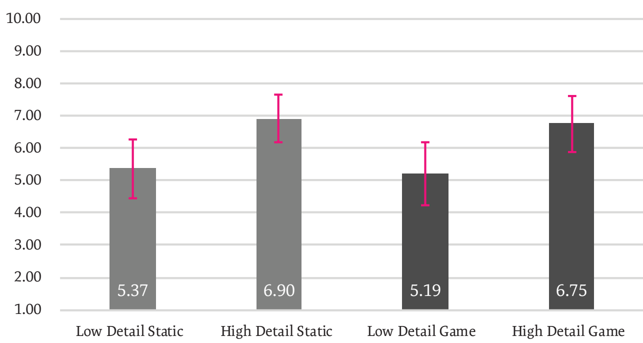
The High-Detail Game Engine "No Bench" (Design 1) scored the highest average in every questions except Realism in the Opportunity sample. The Qualtrics sample, conversely, found the High-Detail Static "No Bench" (Design 1) to be the most preferred (Figure 16).

These, and further disparities will be analyzed in depth in an attempt to unpack the various implications of these results.

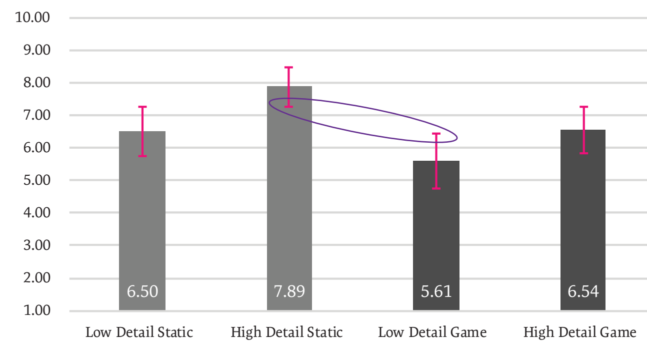
FIGURE 17:
AVERAGE SCORES ACROSS ALL FOUR PREFERENCE CATEGORIES

The amalgamated averages across all four preference categories by format. Designs 1 & 2 averaged within each visualization format. Scores given on a 1-10 sliding scale.

AVERAGE TOTALS - OPPORTUNITY SAMPLE



AVERAGE TOTALS - QUALTRICS SAMPLE



Statistically Significant Difference

Error Bar (95% Confidence Interval)

1.00 - 10.00 Ranked Preference (1 lowest - 10 highest)

3.2 RESULT PROCESSING

A useful breakdown of response data was discovered by removing the ***Design*** ("Bench" or "No Bench") element of test conditions and subsequently comparing the two remain criteria (***Textural Detail***, and ***Dynamism***) across all preference categories (Beauty, Navigation, Realism, and Return Visits).

This is a less robust analysis than the survey protocol might have allowed for (could have tested results of Design 1 against Design 2 at each of the preference categories), but given the lack of evidence that Game Engines proved better at communicating design intent this method provided a more useful framework for communicating the significant findings.

All graphs shown in Figures 17-20 include error bars showing the 95% confidence interval for each graphed data point. This was calculated by finding the standard deviation for each value and using the excel function "=Confidence(alpha, standard_dev, size)" to generate 95% confidence levels. Those confidence intervals were then applied to the bar graphs as fixed error values above and below each point on the graphs. Henceforth, any discrepancy in which the error bars of one graph column do not overlap the error bars of another, is said to be statistically significant. (See table - appendix D.)

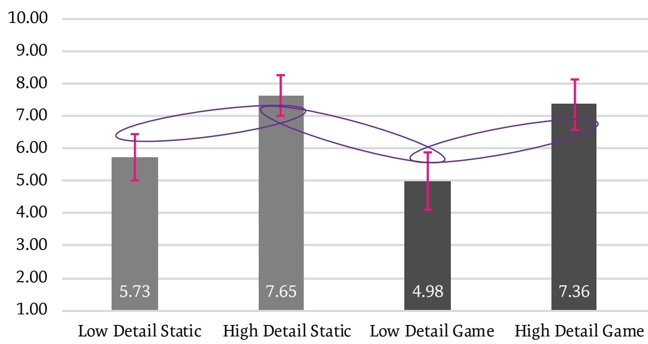
Figure 17 shows the combined average scores across all four preference categories displayed by ***Dynamism*** and ***Textural Detail***.

The only statistically significant finding when comparing the averages of all four preference categories in Figure 17 is the distinction between the High Detail Static and the Low Detail Game (highlighted). This indicates that across all kinds of perceptions High Detail and Static experiences combined to increase ratings and vice versa.

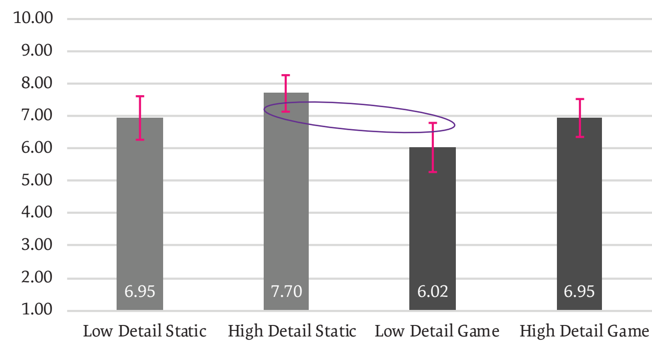
FIGURE 18:
BEAUTY RESULTS SUMMARY

The sample average Beauty and Return Visit results graphed by ***Textural Detail*** and ***Dynamism***.

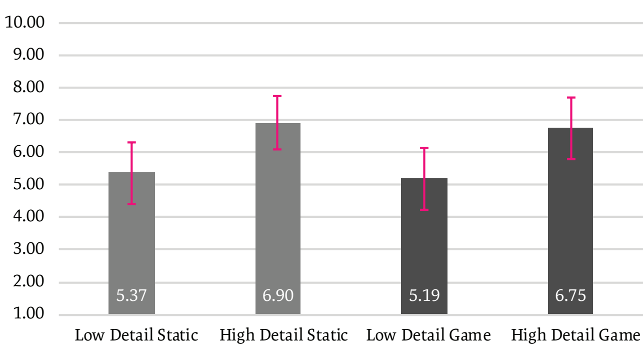
AVERAGE BEAUTY - OPPORTUNITY SAMPLE



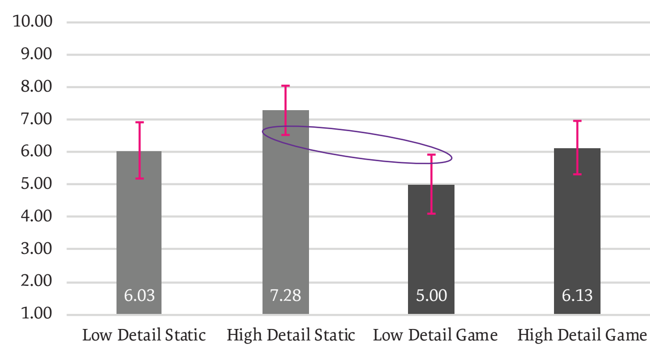
AVERAGE BEAUTY - QUALTRICS SAMPLE



AVERAGE RETURN - OPPORTUNITY SAMPLE



AVERAGE RETURN - QUALTRICS SAMPLE



Statistically Significant Difference

Error Bar (95% Confidence Interval)

1.00 - 10.00 Ranked Preference (1 lowest - 10 highest)

1. **Beauty:** How beautiful do you find the vegetation and planting design of the place you just experienced?

4. **Return Visits:** How much would you want to come back and visit this place more than once to enjoy its beauty?

3.3 AVERAGE PLANTING BEAUTY

Figure 18 shows the average scores (ranked 1-10) of both sample pools' responses to Preference Questions #1 regarding Beauty, and #4 regarding Return Visits.

Return Visits is a secondary question set up to load on the perception of aesthetic beauty by study participants. The desire to return to the simulated site, and the wording of the question should significantly derive from an individual's perception of aesthetic beauty. The scores of Return Visits (labeled "Return" in Figure 18) are therefore included in this discussion of perceived beauty.

The average Beauty responses in Figure 18 indicate little significant difference between static and dynamic visualizations (different ***Dynamisms***) at similar ***Textural Detail***. Said differently, within a ***Textural Detail*** (High- or Low-Detail) there is no significant difference between ***Dynamisms*** (Game Engine or static).

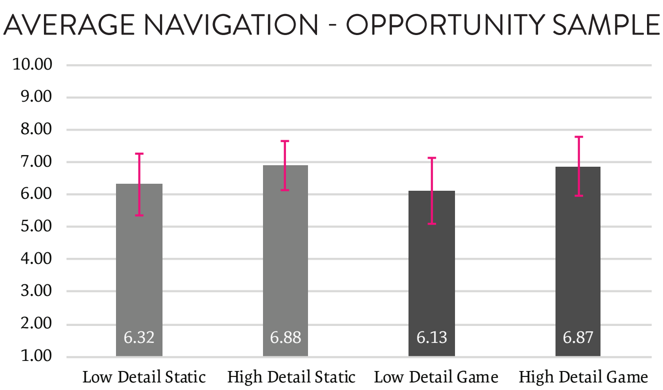
There is, by contrast, statistical significance between different levels of ***Textural Detail***. Figure 18 shows that average Beauty scores for the Opportunity sample were significantly higher for High-Detail Static, and High-Detail Game than their respective Low-Detail counterparts. And while the values are not statistically significant in the Opportunity Return scores, the same trend of between ***Textural Detail*** persists.

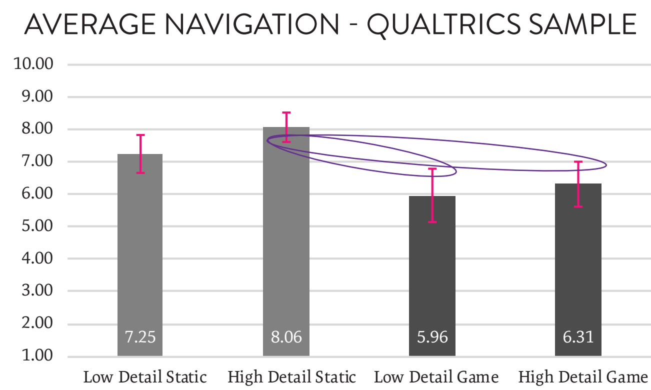
Therefore, the data suggest that users' perception of Beauty (and their parallel desire to return to that beautiful place), is strongly effected by the level of ***Textural Detail*** within a visualization, but is not significantly effected by the ***Dynamism*** of that visualization.

The greatest gain in average Beauty came from the combined effects of Static Representations and High-Detail textures.

FIGURE 19:
NAVIGATION RESULTS SUMMARY

The sample average Navigation results graphed by ***Textural Detail*** and ***Dynamism***.





Statistically Significant Difference

Error Bar (95% Confidence Interval)

1.00 - 10.00 Ranked Preference (1 lowest - 10 highest)

2. **Ease of Navigation:** How easy was it for you to grasp this simulated place's layout so you could easily discover what it looks like and <u>notice nice places to sit down?</u>

3.4 AVERAGE NAVIGATION SCORES

Figure 19 shows the average Navigation scores graphed by ***Textural Detail*** and ***Dynamism***. The only statistically significant distinction in either1 samples' Navigations scores is between High-Detail Static and both High- and Low-Detail Game in the Qualtrics responses (see highlight Figure 19).

The lack of significant distinction implies that Opportunity sample participants found static visualizations to be equally navigable as the dynamic (***Dynamism***) regardless of ***Textural Detail***. The equal navigability is not a surprising result given the large percentage of trained designers in the population, who - in theory - should be very good at interpreting spaces from various viewpoints and perspectives.

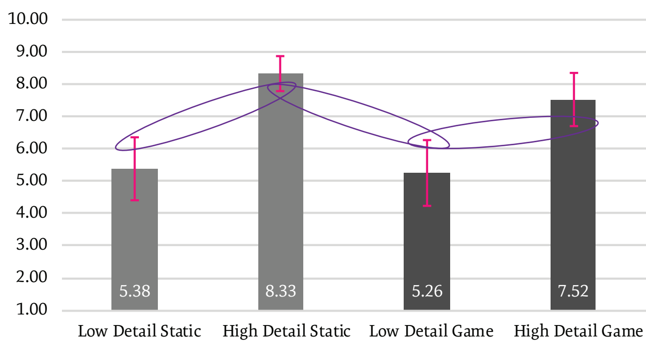
What is surprising is the statistically significant difference between ***Dynamisms*** in the Qualtrics sample. The hypothesis of this preference test was that non-designers would find self-guided dynamic simulations easier to interpret in regards to navigational qualities, but the Qualtrics response data shows the opposite.

One possible explanation for these results is that the older demographic may have experienced more difficulty understanding and using the navigation controls in dynamic simulations. Another possibility is that because they were participating for a reward (See Appendix A), they may have been less patient with the latency issues that occurred as a result of hosting the dynamic simulations online. It seems likely that these scores are the results of demographics, or they may be an indicator of flaws in experiment design.

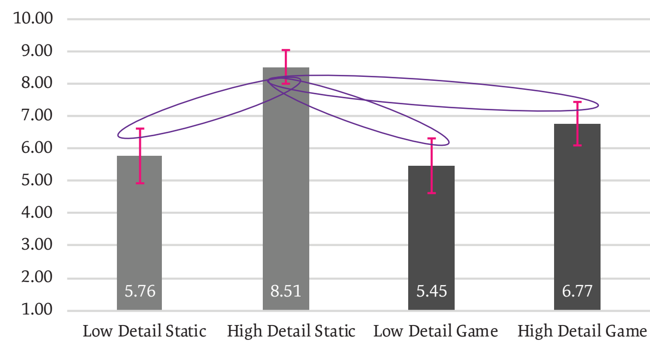
FIGURE 20:
REALISM RESULTS SUMMARY

The sample average Realism results graphed by ***Textural Detail*** and ***Dynamism***.

AVERAGE REALISM - OPPORTUNITY SAMPLE



AVERAGE REALISM - QUALTRICS SAMPLE



Statistically Significant Difference

Error Bar (95% Confidence Interval)

1.00 - 10.00 Ranked Preference (1 lowest - 10 highest)

3. **Degree of Realism:** How easy was it for you to grasp this simulated place's appearance so you could easily get a good sense of what it would feel and look like if it were actually built?

3.5 AVERAGE REALISM SCORES

Figure 20 shows the average Realism scores (ranked 1-10) for both samples graphed by ***Textural Detail*** and ***Dynamism***. Similar to the results for Beauty and Return Visits, there is again statistically significance difference between ***Textural Detail***, but less frequently a significant distinction between ***Dynamism*** of the same ***Textural Detail*** (with High-Detail Game and High-Detail Static in Qualtrics sample as an outlier).

The Realism scores, like the scores for Beauty and Return Visit, indicate a strong (and generally significant) preference for High-Detail ***Textural Detail***. But with the Qualtrics High-Detail Game aside, there is no significant difference between scores of similar ***Textural Detail***.

As vegetation was the primary distinction between visualizations of differing Textural Detail, this general preference toward High-Detail is an expected result. It is expected because elements of lower textural detail are deliberately abstract representations of form and structure, and would therefore be expected to appear less realistic.

One possible reason for the Qualtrics sample's low averaged Realism score for the High Detail Game is the way the subjects interacted with the simulations. The task of navigating through the simulation with a keyboard and mouse may have contributed to a feeling of non-realistic experience, whereas this may not have been the case for the younger Opportunity demographic.

3.6 RESEARCH QUESTION RESULTS

In resolution of the study results it is appropriate to return back to the original research questions. The first researchable question asks if game engines are better at communicating design intent:

Researchable Question #1

> *Do people more frequently perceive certain urban design qualities when those qualities are represented in self-navigated digital 3D simulations, or when they are represented in digitally rendered static imagery designed to highlight the same qualities?*

In a word, no. The results indicate that Game Engine simulations are a comparable tool for representing design intent, but not more. In many cases the average results for Game Engine simulations are very closely aligned with static representations, which seems to indicate that they are generally an equivalent tool in the categories that this project explored.

Since there is little literature exploring the nuanced details of representation with Game Engines, it feels like a win for Game Engines to say that they are essentially as good as the industry standard for design representation. And although it is disappointing that they did not perform better, this project hopefully lays a strong foundation for further exploration that may target unique features and strengths of Game Engine representations.

It is possible that utilizing Virtual Reality (VR) technology, which would replace much of the task of navigational control with more intuitive body gestures and motions, may improve Game Engine preference scores. It seems plausible that if the cognitive interference from the task of navigation control is removed dynamic simulations would become more natural and would potentially prove to better communicate design qualities than Static Images.

Researchable Question #2

The second research question was in regard to the significance of textural detail in perception of visualizations:

> *Does the level of textural detail – principally of vegetation – influence users' preference of visualization methods, either within a format (2D or game engine) or between formats?*

The results of this question are mixed. There is a definite trend toward High-Detail textures being preferred in visualizations, but in referring back to Figures 16 & 17, it is clear that how much ***Textural Detail*** matters depends on the context.

The only statistically significant difference in the Qualtrics sample responses are in relation to the High-Detail Static visualizations. Furthermore, in each criteria of the Qualtrics data there is some other format (***Textural Detail***, or ***Dynamism***) that is significantly less preferred to the High-Detail Static visualizations. This seems to indicate a general and strong preference for the High-Detail Static visualization.

In Beauty and Realism scores (Figures 18 and 20), the Opportunity Sample preferred (with statistical significance) High-Detail texture to Low-Detail texture irrespective of ***Dynamism***.

Conversely, the Qualtrics sample never showed significant distinction between ***Textural Detail*** of Game Engine simulations in any category, and only shows distinction between ***Textural Detail*** of static visualizations in the Realism category (Figure 20). While the Opportunity sample only shows statistical distinction between ***Textural Detail*** in Beauty and Realism, but not in Return or Navigation scores (Figures 18 and 19).

Data seems to indicate that those with formal design training (the Opportunity Sample) are generally less sensitive to detail, whereas the non-designers of the Qualtrics Sample are more strongly effected by ***Textural Detail***. And both sample groups appear to more strongly prefer the Static High Detail representations in all the tested visual preference categories.

So in answer to the question of does ***Textural Detail*** influence users' preference, it seems that the answer is, it depends. The use of ***Textural Detail*** appears to be more nuanced and complex then this project is capable of deciphering.

The tectonic shifts happening in the media and content world are gain to irreversibly reshape how companies and consumers create, display, view and consume content.

Vineet Kaul
Changing Paradigms of Media Landscape in the Digital Age

4. DISCUSSION

4.1 DISCUSSION

After extensive research into the implementation of design representation with Video Game Engines, it is my conclusion that Game Engines are an incredibly powerful, viable, and useful form of representation for landscape design.

There is, unquestionably, a moderate learning curve in utilizing game engines, but their use is not an unrealistic proposition given the wide array and extent of software that designers must generally learn and use throughout their education and professional career. The hurdle of utilizing game engine simulations is significantly lessened by the increasing use of 3D modeling software in design. The vast majority of time spent developing the visualizations for this project was generating the base model in Rhino3D.

Due to the nature of game engines, and the mechanics of how they interface with 3D objects, importing a complete 3D modeled design and then using the game engine to allow a scaled exploration of the space by adding a First-Person Controller* requires very little time and very little training. Once understood, the process of going from a working 3D model to an explorable dynamic simulation takes only a few minutes.

Footnote: **First-Person Controller : The body of code (pre-constructed in Unity3D) that relates some input, usually a keystroke, into an action such as a movement of a camera. This is essentially the simplest element of dynamic interaction within Game Engine simulations.*

The process of constructing quick dynamic simulations for form-studies was vastly more informative to the design process in general than was expected when setting out on this project.

There were several occasions when, after spending significant time and effort modelling a design in 3D, importing that design into the Game Engine would immediately reveal things about it that had previously been unapparent. This seemed most typically to be the case regarding scale and spatial relationships, where buildings (in a discarded design scheme) felt too close together, or stormwater planters (in another alternate scheme) felt to deep or too narrow.

This was surprising because after spending hours measuring distances and heights in constructing the digital 3D model, it took only minutes to discover previously overlooked elements of the design. Not only is this surprising because of what was learned in the simple jump from 3D model to Game Engine, but also for the false security placed in 3D models within design. Which is to say that the fact that the issues of scale and spatial relationship were surprising means that those issues were believed to be better understood (because of the construction of a 3D model) than they truly were.

So, not only are Game Engines a powerful and viable tool for design representation, but they are also a novel iteration of the design process that further informs good design thinking and development!

4.2 THE CHALLENGES

Lest any reader think the process too simple, it should be made clear that anything beyond constructing a simple form-study simulation quickly becomes very complex and time consuming.

As is implied from this project, adding accurate and diverse vegetation – regardless of level of textural realism – increases time and difficulty significantly. Additionally, anything that begins to fully leverage the real advantages and power of game engines (like toggling elements on/off, animating moving elements such as water, or even programming interactions like the ability to move site elements around a design) quickly necessitates at least a basic understanding of some form of code (Unity3D can be coded with either Javascript or Csharp). While there are visual scripting tools that ease this process, once programing game elements starts occurring, Game Engines become an entirely different sort of tool than anything landscape designers will have likely experienced or employed.

4.3 OVERVIEW

Game Engines are powerful and useful tools, and they deserve a place in the toolkit of landscape architecture software. The research indicates that even at a very simple level, Game Engines are on roughly par with current representation tools.

These results seem especially promising given the simplistic nature of these test simulations, and the vast untapped potentials that remain to be explored with Video Game Engines. Some examples of those potentials are: interactivity, virtual reality (VR), and augmented reality (AR).

Game Engines are not a replacement for the many other forms of representation currently in use. Each representation tool has strengths and weaknesses, and Game Engines are no different. Game Engines are an intensive and time consuming process (like any digital tool), and they will not be appropriate for every project.

Rather then replacing other formats as the only means of representing design, Game Engines should augment other renderings as an alternative communicative tool. This will hopefully become even more clear with further research and use as Game Engines find their place as a highly valuable tool in the very wide and diverse field of landscape architecture.

From the experience of this project Game Engines seem to be incredibly useful for:

- Enabling a more thorough and vigorous design process
- Enabling a "Dynamic" experience of site design
- Producing countless possible perspectives of a key site element or feature (as opposed to 3D renderings which require setting up certain "views").
- Demonstrating the contextual scale of design interventions
- Providing a better sense of the "journey" through a landscape
- Allowing for interactivity (i.e. changing design "on the fly")
- Creating VR & AR representations

Game engines offer the potential to fill a unique and significant role in designers' toolkits. They are comparable in communication efficacy to industry standard Static 2D representations in most regards, and they offer nearly unlimited potential for informing and representing design, being limited by the skills and abilities of the designer rather than the software.

The extent to which, throughout the duration of this project, Game Engines have felt like a tool which is perfectly suited to the field of landscape architecture cannot be overstated.

4.4 GAME ENGINES AS SIMULATION TOOLS

The mixed results of the visual preference testing indicate that self-guided dynamic simulations have potential strengths, but also some significant obstacles to overcome.

Since the survey was administered via an online tool, direct observation of participants was generally not possible. On the few occasions that observation of participants did occur there was a recurring trend that is worth noting in regards to Game Engine's potential as a representational tool.

The use of First-Person Controller navigation seemed to be a common, significant, and recurring difficulty. This difficulty was expected to a degree, and the implementation of a tutorial (which occurred at the beginning of the simulations) was meant to combat this. However, even with the control tutorial in place, those participants who were observed often had some degree of difficulty in successfully navigating through the simulation.

It was hypothesized that non-designers would find the dynamic simulations as a more understandable vehicle for design representation, but the data indicates the opposite (given that the Qualtrics pool identified as predominantly "Non-Designers" and looking at their subsequent preference values).

There are many factors that could have contributed to this lower preference, but it seems likely that controller difficulty was a major obstacle for Qualtrics participants, particularly when considering the low number of "Gamers" and the higher mean age of the subjects.

It seems that the logical next step for this research would be to conduct a similar experiment with a different control interface to see how that would impact results. In regards to Game Engines as tools for representation in professional context, exploring different control techniques seems paramount to ensuring a good client experience with the simulations.

The use of Virtual Reality (VR) is one potentially good solution. If participants are able to navigate the designs in VR there may be less navigational obstacles to overcome (or the obstacles may just be different, and quite possibly not any better).

Another potential solution to the navigational difficulties is to have a dynamic Game Engine visualization that is not self-directed, but is rather directed by the designer or a pre-trained curator. This idea is postulated by Adrian Herwig and Philip Paar (Herwig and Paar 2002, 3-6), and they take the idea beyond simply an individual navigating through a simulation. In their proposal the "Chauffeur" actively manipulates the simulation throughout the visualization process, tailoring it to user wishes throughout.

These or other solutions may potentially remove the navigational difficulty while still allowing the flexibility that Game Engine simulations provide. It seems that to fully benefit from the potentials of dynamic Game Engine simulations it is necessary to overcome navigational difficulties and ensure that users can engage with the visualization while not incurring distractions from, or be hindered by, the navigational controls.

4.5 FURTHER RESEARCH

To date, there is little exploration of the applicability of Game Engines in design representation. Therefore, the possible avenues of continued exploration are vast.

The idea of suspended disbelief, and how much time it takes before participants feel able to "believe" the digitally constructed simulation they experience could be a very important topic in utilizing game engines for design representation.

Game Engines are quickly becoming ubiquitous with Virtual Reality (VR). In fact, it is hard to talk about dynamic simulations without VR coming into the conversation. This study was unable to delve into VR because of the use of the web-hosted survey, but VR could contribute immensely to the immersion, believability, understanding, and spatial scale of dynamic simulations. It could additionally reduce navigational control issues as discussed. VR is a huge topic that invites significant and varied research, and would further the Game Engine conversation substantially.

It is possible that the results of this study may be significantly different if the survey were conducted with the same content, but in a controlled and supervised setting. The user interface and delay from internet hosting (latency) are big obstacles to fully engaging with dynamic interactions, and it is quite possible that difficultly negatively skewed responses against Game Engines. I expect that results would have been more favorable to Game Engines if the study were conducted again with small groups who received training prior to exploring dynamic simulations.

Ultimately, it seems that dynamic simulations are going to become standardized tools in design representation. Architectural software tools like Revit, V-Ray, and even Rhino3D, have developed methods for generating spherical panoramic renderings and V-Ray has recently announced a Beta trial for Unreal Game Engine.

In many regards landscape architecture lags behind other design fields in technology and workflow. This realm of dynamic simulations seems so relevant and applicable to what landscape design is all about that it would be a shame if landscape architects weren't involved in the conversation. Vegetation in digital representation is an area that still requires significant research and more advanced computational power to fully resolve, which means it is an area that has a large potential gap for landscape architects to fill.

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APPENDIX A

RECRUITMENT QUALTRICS RESPONDENTS:

Recruitment of respondents Qualtrics' language:

> The Qualtrics sample will come from traditional, actively managed market research panels developed by third party vendors. As an online market research sample aggregator, Qualtrics maintains the highest quality by using Grand Mean certified sample partners. To exclude duplication and ensure validity, Qualtrics checks every IP address and uses a sophisticated digital fingerprinting technology. In addition, every strategic panel partner uses deduplication technology to provide the most reliable results and retain the integrity of the survey data.
>
> Qualtrics' panel partners randomly select respondents for surveys where respondents are highly likely to qualify. Certain exclusions take place including category exclusions, participation frequency and so on. Each sample from the panel base is proportioned to the general population and then randomized before the survey is deployed. The population surveyed will meet the requirements of the specific survey as defined by Justin Kau and Dr. Ribe.
>
> The 'opt-in for market research' process requires respondents to submit an initial registration form requesting to participate in market research studies. Potential respondents build their profile from a standardized list of questions. The panel providers then use these profiles to select participants that would best fit a study's specifications. All of Qualtrics' panels have a double opt-in requirement. Those who do not reconfirm will not be contacted to participate in a survey.

RECRUITMENT QUALTRICS RESPONDENTS (CONT'D):

Invitation of respondents Qualtrics' language:

> Potential respondents are sent an email invitation informing them that the survey is for research purposes only, how long the survey is expected to take and what incentives are available. Members may unsubscribe at any time. To avoid self-selection bias, the survey invitation does not include specific details about the contents of the survey.

Incentives/rewards to respondents Qualtric's language:

> Qualtrics respondents receive an incentive based on the length of the survey, their specific panelist profile and target acquisition difficulty. The specific types of rewards vary, and may include cash, airline miles, gift cards, redeemable points, sweepstakes entrance and vouchers.

Privacy of respondents Qualtric's language:

> As an aggregator of panels, Qualtrics provides the privacy policy of each panel provider upon request. Qualtrics ensures that every panel we associate with adheres to all state, regional, and federal laws. Our partners are members of ESOMAR, CASRO and other national organizations.
>
> Qualtrics' database does not hold sensitive or confidential panelist information, however we do hold all survey responses in our data centers. Our data centers utilize many security measures. Qualtrics' database access is restricted and requires authorization. All computer equipment (servers, SANs, switches, routers, etc.) is

RECRUITMENT QUALTRICS RESPONDENTS (CONT'D):

Privacy of respondents Qualtric's language (cont'd):

> redundant and is located in secure, environmentally controlled data centers with 24/7 monitoring. Web traffic does not directly access the database and database requests are reversed proxy via an application server to the database. All information is secured via industry standard firewalls and stringent IT security policies and procedures. We utilize industry standard web application firewalls and DDOS protection. Also, single sign- on two-factor authentication is available to customers as an option for managing panel users. Qualtrics also leverages panel partners who are meticulous in their multiple levels of security that include: redundant data centers, secure servers, encryption which includes one-way encryption, numeric IDs, secure .NET platforms, security clearance, industry standard firewalls, 24/7 monitoring of data centers, confidentiality agreements, and physical, electronic, and managerial procedures.

APPENDIX B

ALTERNATIVELY PROCESSED RESULTS

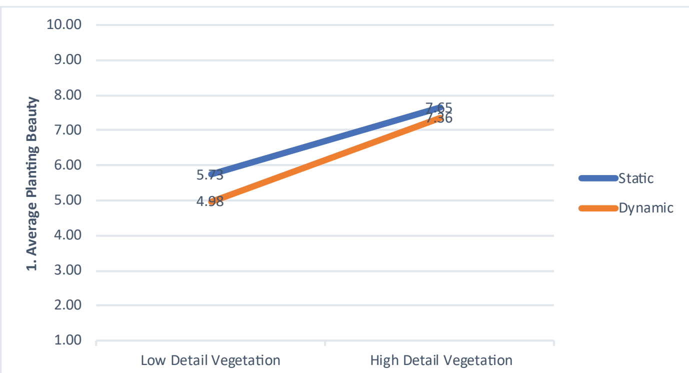
The following pages contain the survey response data as it was initially processed. This information displayed is valid and correct, but the method of analysis show in the body of the project was determined to be more effective for communicating the important elements of the findings. These alternatively processed results are included purely as supplemental information.

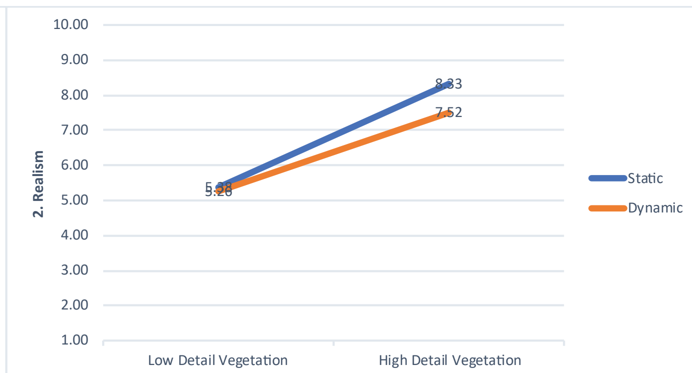
NB: No Bench HP: High Detail (poly)
B: Bench LP: Low Detail (poly)

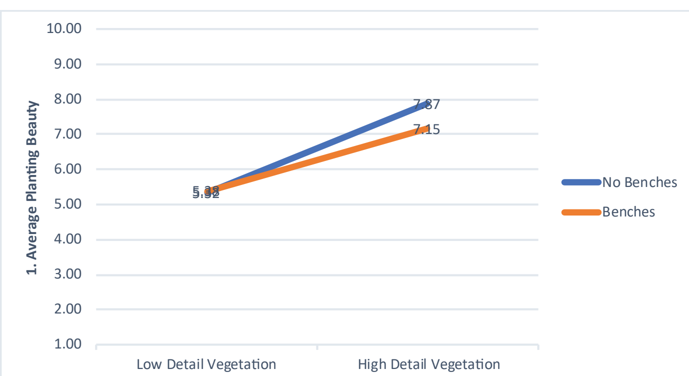
OPPORTUNITY SAMPLE

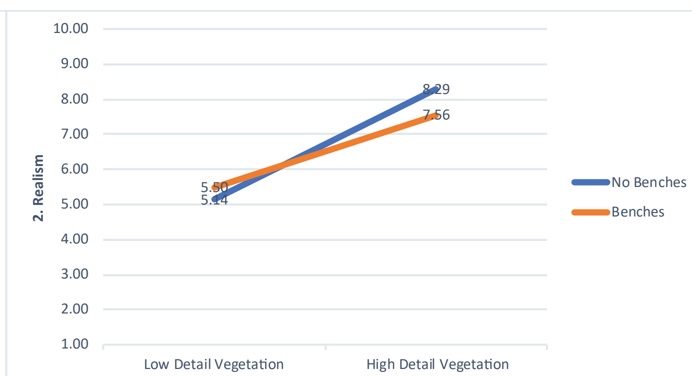
AVERAGE PLANTING BEAUTY / AVERAGE REALISM

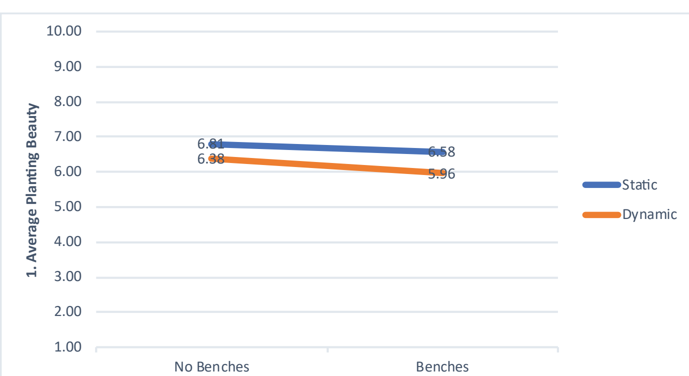
LP Static	HP Static	LP Game	HP Game		LP Static	HP Static	LP Game	HP Game
5.73	7.65	4.98	7.36	Across all Designs (B/NB)	5.38	8.33	5.26	7.52
LP - NB	HP - NB	LP - B	HP - B		LP - NB	HP - NB	LP - B	HP - B
5.32	7.87	5.38	7.15	Across all Dynamisms	5.14	8.29	5.50	7.56
NB - Static	B - Static	NB - Game	B - Game		NB - Static	B - Static	NB - Game	B - Game
6.81	6.58	6.38	5.96	Across all Textural Detail	7.01	6.69	6.42	6.36

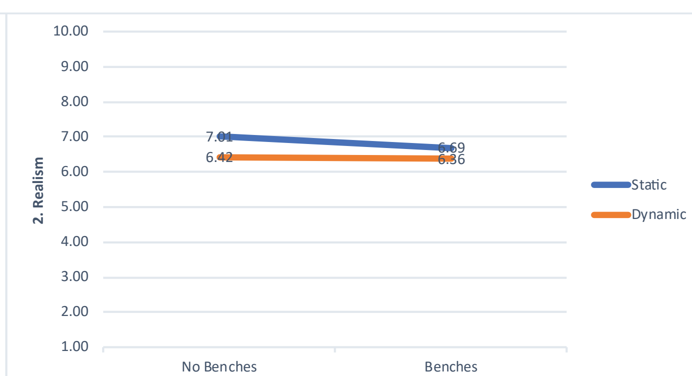






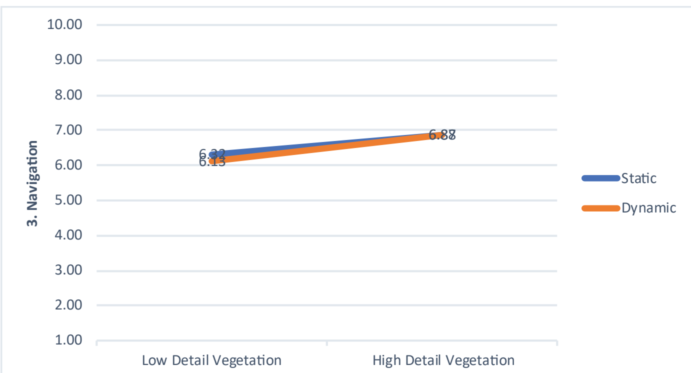


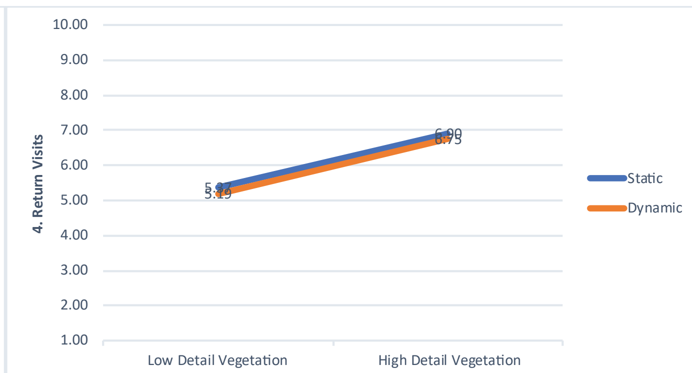


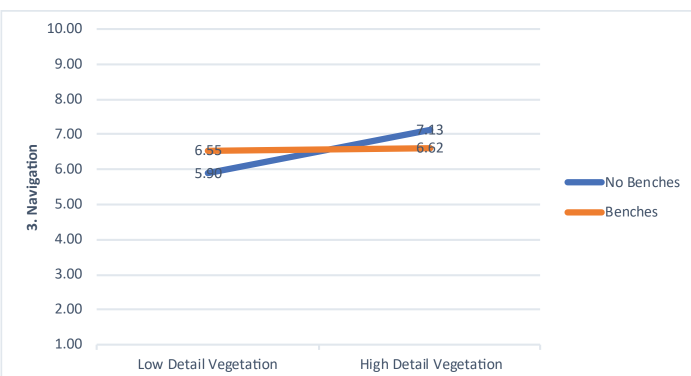


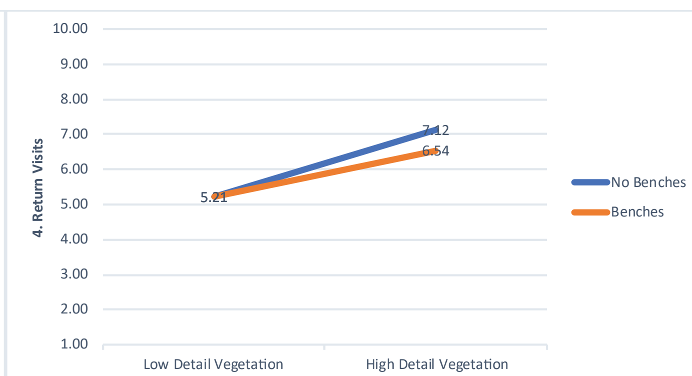
OPPORTUNITY SAMPLE

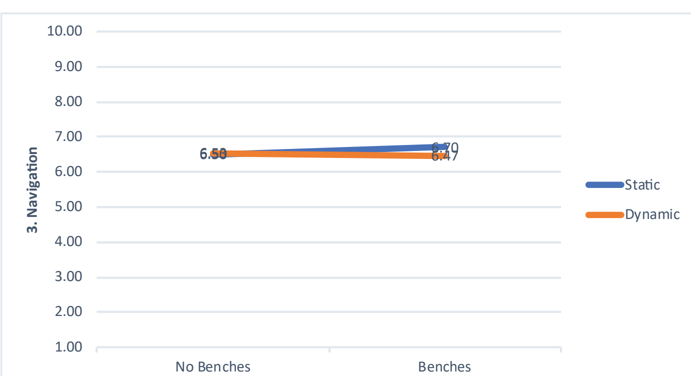
AVERAGE NAVIGATION					AVERAGE RETURN VISITS			
LP Static	HP Static	LP Game	HP Game		LP Static	HP Static	LP Game	HP Game
6.32	6.88	6.13	6.87	Across all Designs (B/NB)	5.37	6.90	5.19	6.75
LP - NB	HP - NB	LP - B	HP - B		LP - NB	HP - NB	LP - B	HP - B
5.90	7.13	6.55	6.62	Across all Dynamisms	5.21	7.12	5.21	6.54
NB - Static	B - Static	NB - Game	B - Game		NB - Static	B - Static	NB - Game	B - Game
6.50	6.70	6.53	6.47	Across all Textural Detail	6.27	6.00	6.19	5.75

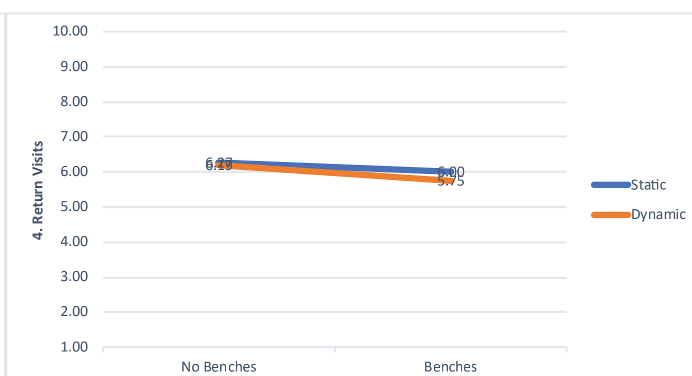












NB: No Bench   HP: High Detail (poly)
B: Bench   LP: Low Detail (poly)

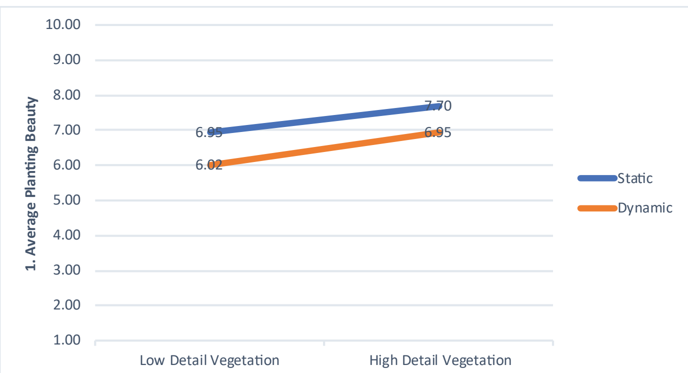
QUALTRICS SAMPLE

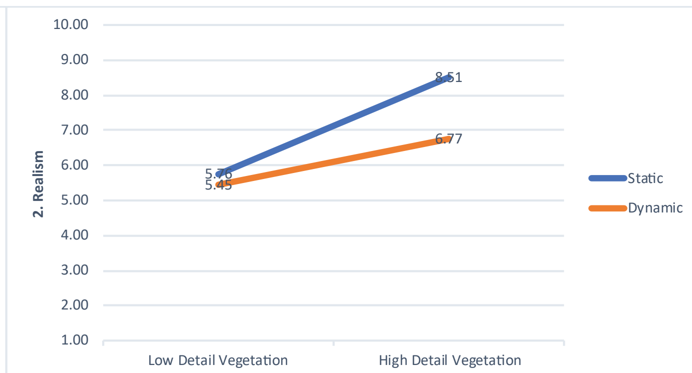
AVERAGE PLANTING BEAUTY

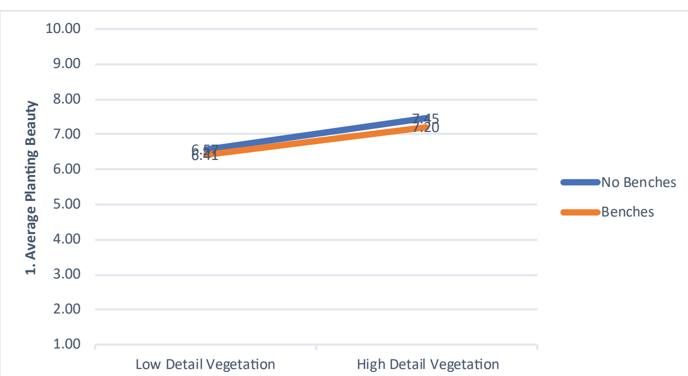
	LP Static	HP Static	LP Game	HP Game
Across all Designs (B/NB)	6.95	7.70	6.02	6.95
	LP - NB	HP - NB	LP - B	HP - B
Across all Dynamisms	6.57	7.45	6.41	7.20
	NB - Static	B - Static	NB - Game	B - Game
Across all Textural Detail	7.39	7.26	6.63	6.35

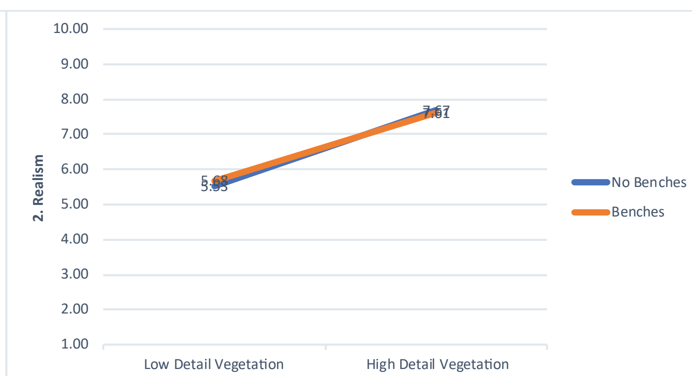
AVERAGE REALISM

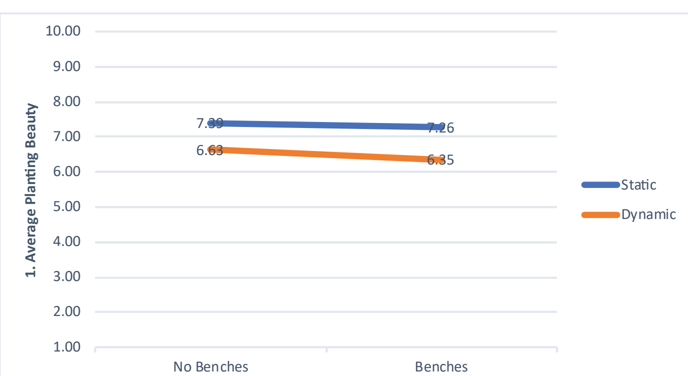
	LP Static	HP Static	LP Game	HP Game
Across all Designs (B/NB)	5.76	8.51	5.45	6.77
	LP - NB	HP - NB	LP - B	HP - B
Across all Dynamisms	5.53	7.67	5.68	7.61
	NB - Static	B - Static	NB - Game	B - Game
Across all Textural Detail	7.19	7.08	6.01	6.21

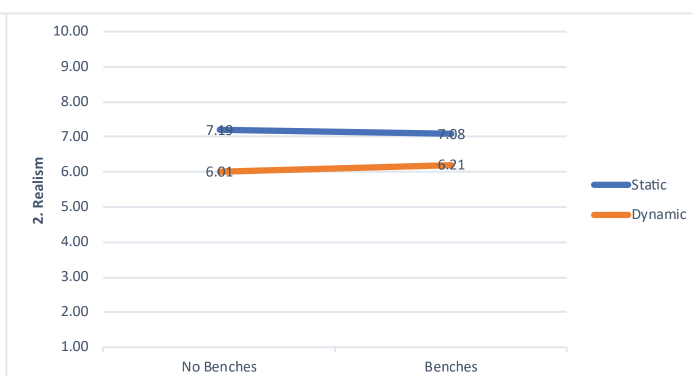










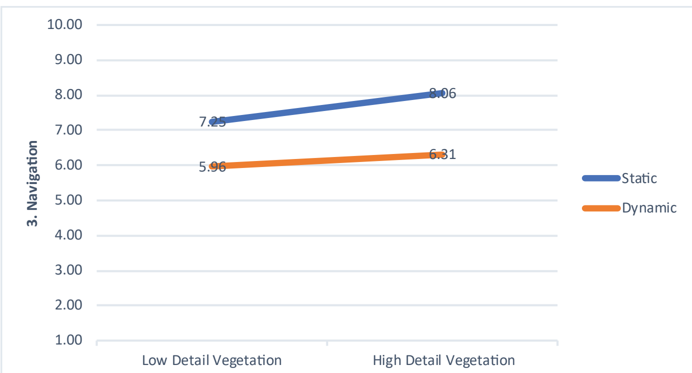


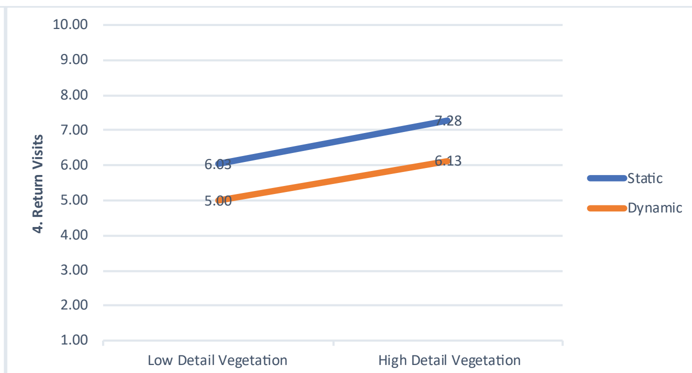
AVERAGE NAVIGATION

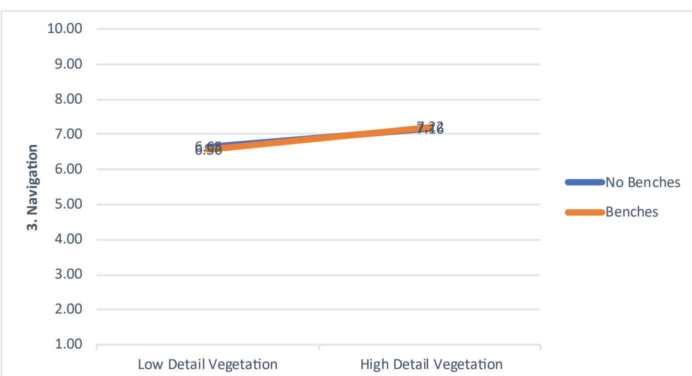
Across all Designs (B/NB)	LP Static	HP Static	LP Game	HP Game
	7.25	8.06	5.96	6.31
Across all Dynamisms	LP - NB	HP - NB	LP - B	HP - B
	6.65	7.16	6.56	7.22
Across all Textural Detail	NB - Static	B - Static	NB - Game	B - Game
	7.77	7.54	6.04	6.23

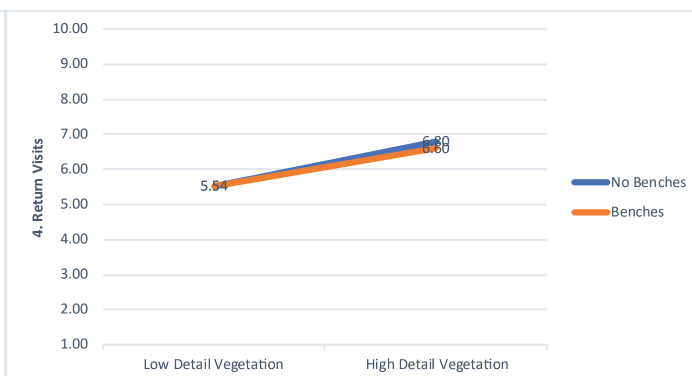
AVERAGE RETURN VISITS

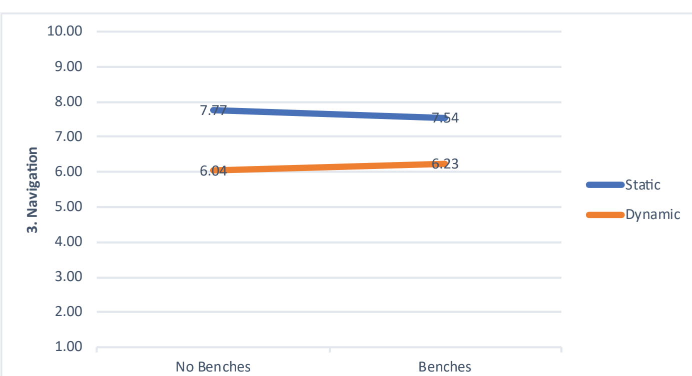
Across all Designs (B/NB)	LP Static	HP Static	LP Game	HP Game
	6.03	7.28	5.00	6.13
Across all Dynamisms	LP - NB	HP - NB	LP - B	HP - B
	5.54	6.80	5.54	6.60
Across all Textural Detail	NB - Static	B - Static	NB - Game	B - Game
	6.79	6.52	5.51	5.62

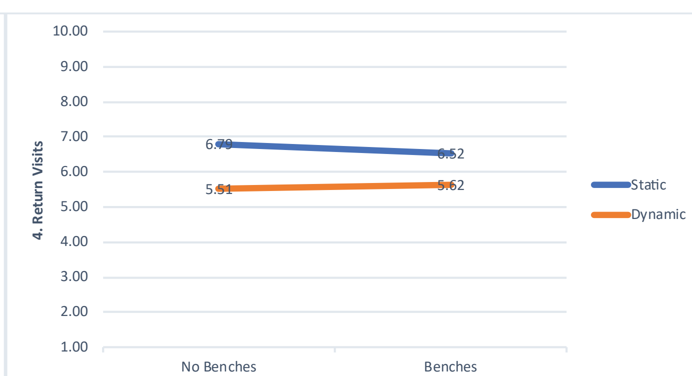












APPENDIX C

ALL VISUALIZATION SETS AT NAMED VIEWS

The following pages contain all the visualization sets (all ***Design***, ***Dynamism***, and ***Textural Detail***) that were used for the visual preference survey. The digitally rendered static images are show as native image files, just as they were for visualizations. The Game Engine Simulations were captured with screenshots directly from the dynamic simulation in the appropriate locations to correspond with the static image views. No individual participating in the survey saw static screenshot extractions from the Game Engine simulation, these images are purely for documentation within this project summary.

Any discrepancy (such as camera focal length (FOV)) is a by-product of the fact that these images are extracted as screenshots from dynamic simulations and should not be taken to reflect any information about the project or processes differently than as described in the documentation.

DYNAMIC
DESIGN 1
LOW DETAIL

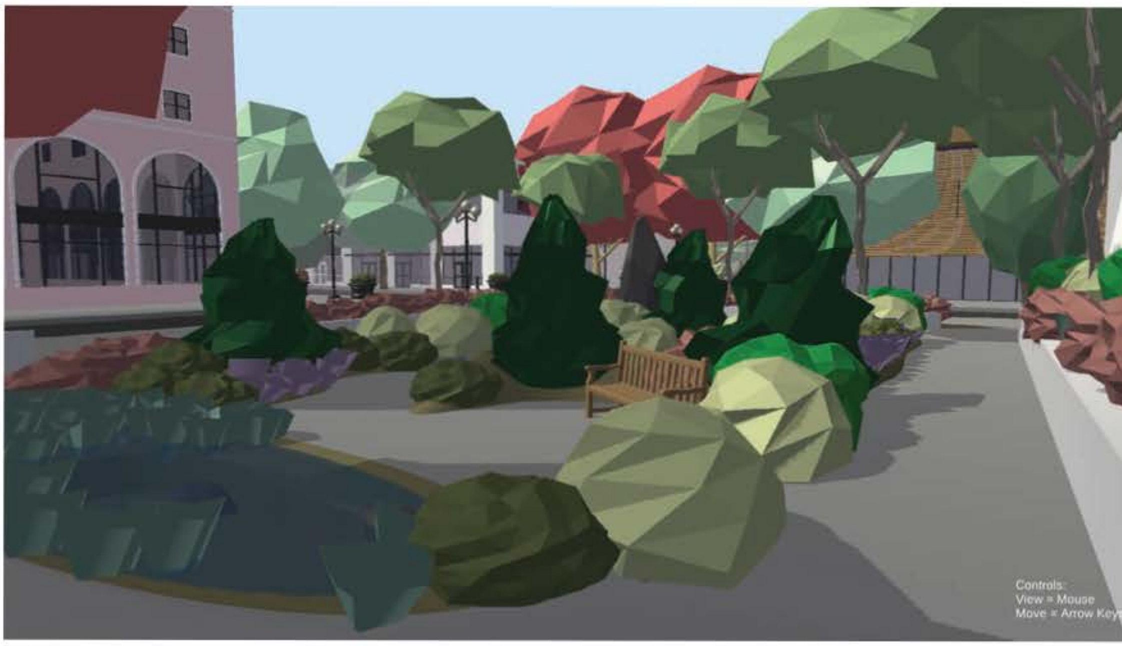
View #1

View #2

View #3

View #4

View #5



View #6

DYNAMIC DESIGN 2 LOW DETAIL

View #1

View #2

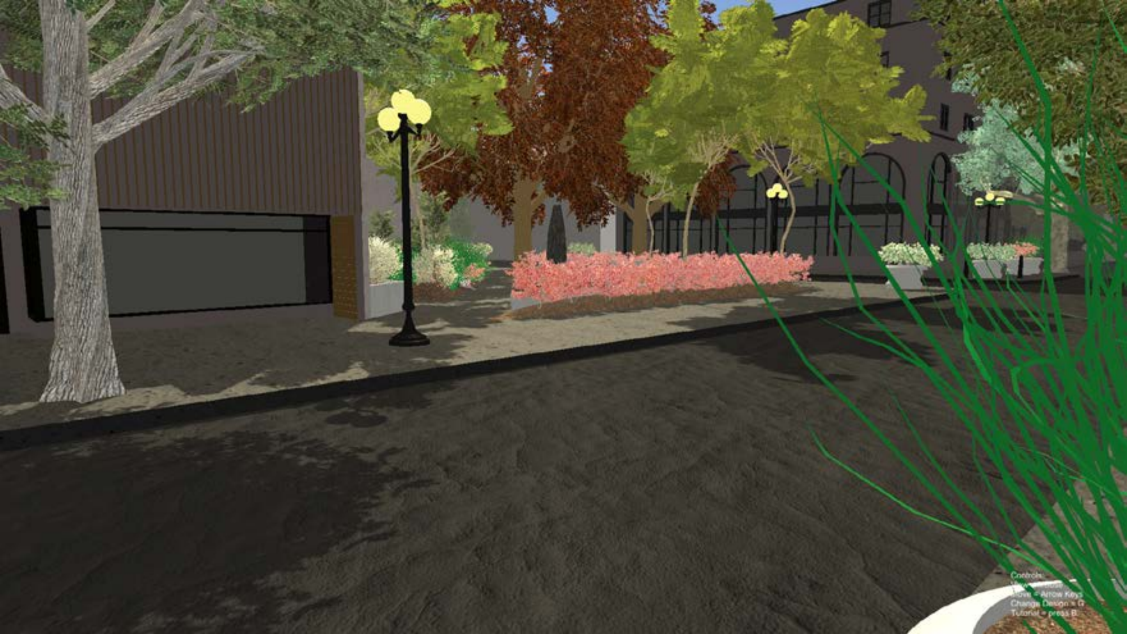
View #3

View #4

View #5

View #6

DYNAMIC
DESIGN 1
HIGH DETAIL



View #1

View #2

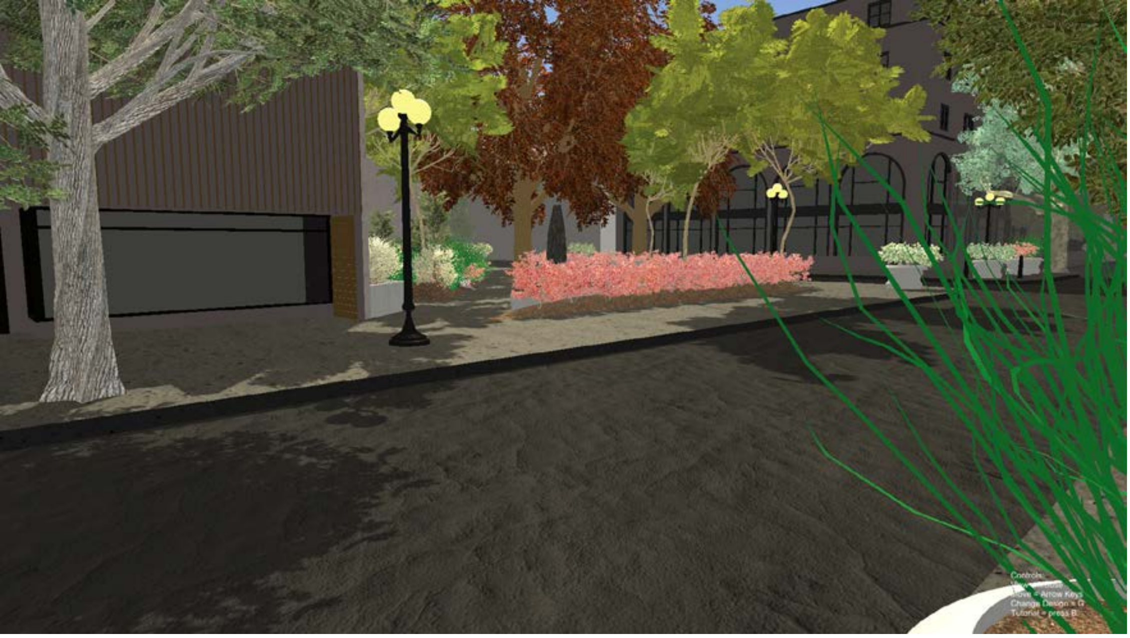
View #3

View #4

View #5

View #6

DYNAMIC DESIGN 2 HIGH DETAIL



View #1

View #2

View #3

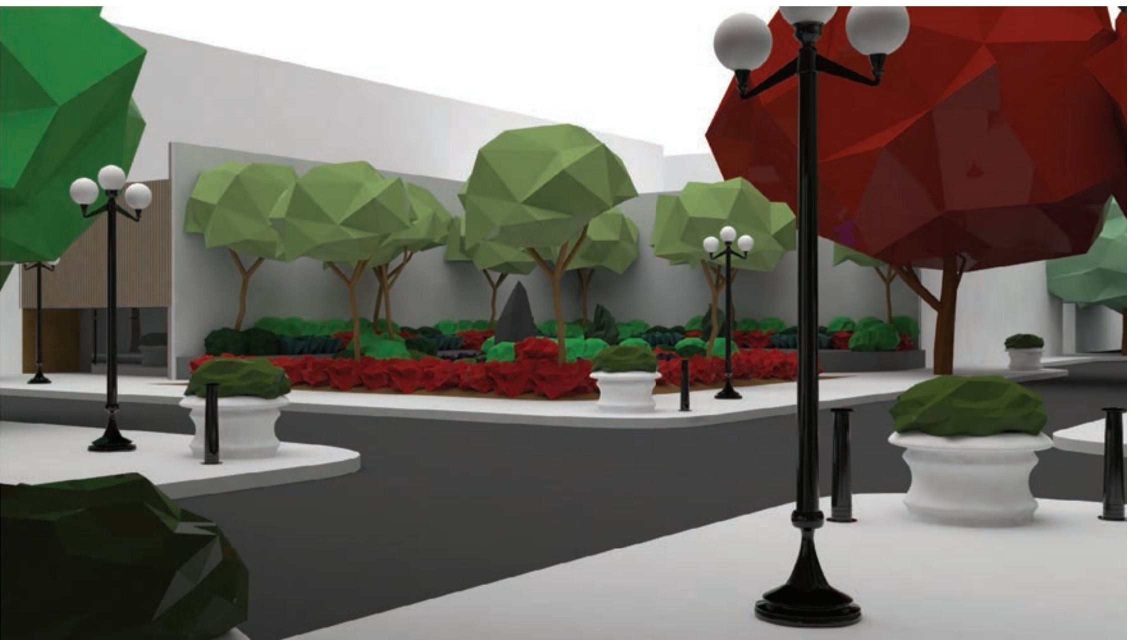
View #4

View #5

View #6

STATIC
DESIGN 1
LOW DETAIL

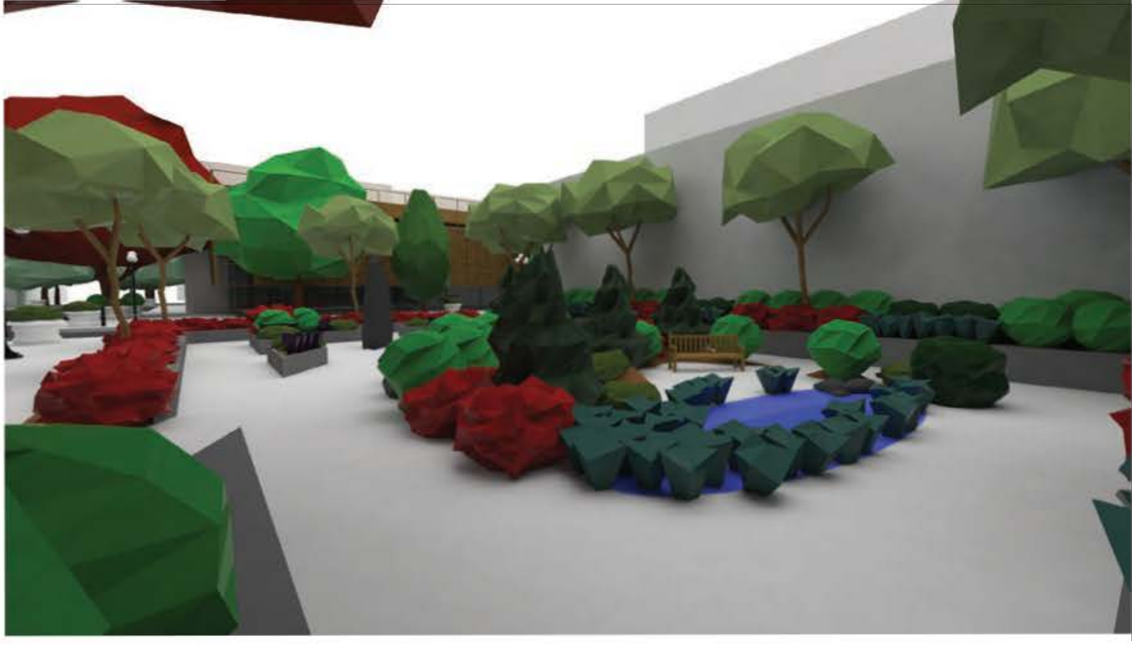
View #1



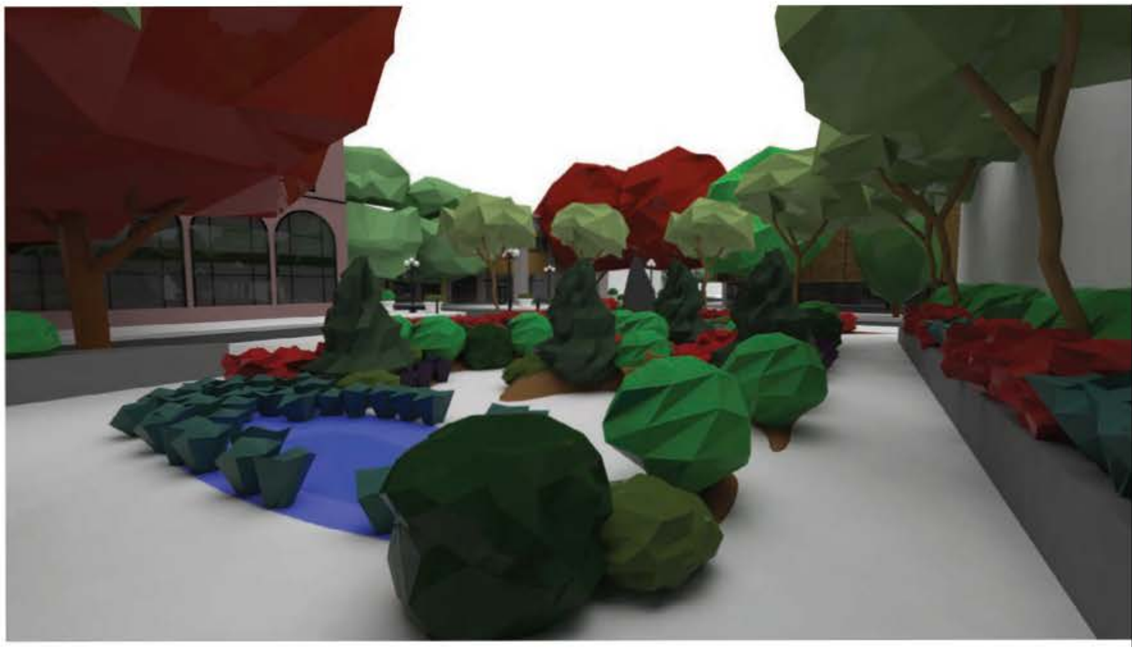
View #2

View #3

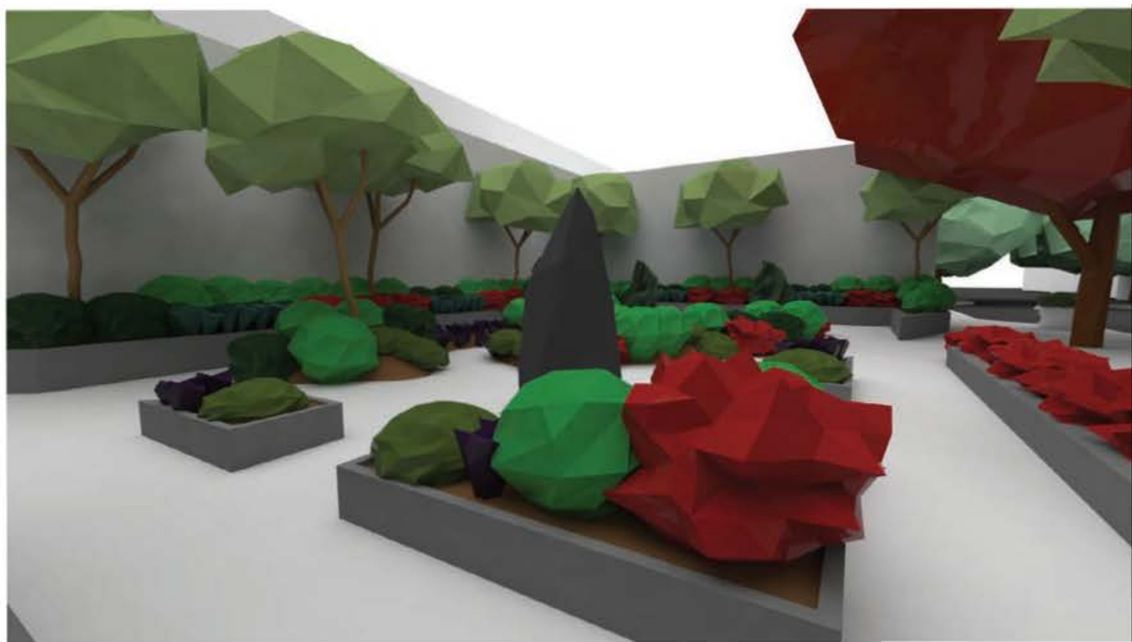
View #4



View #5

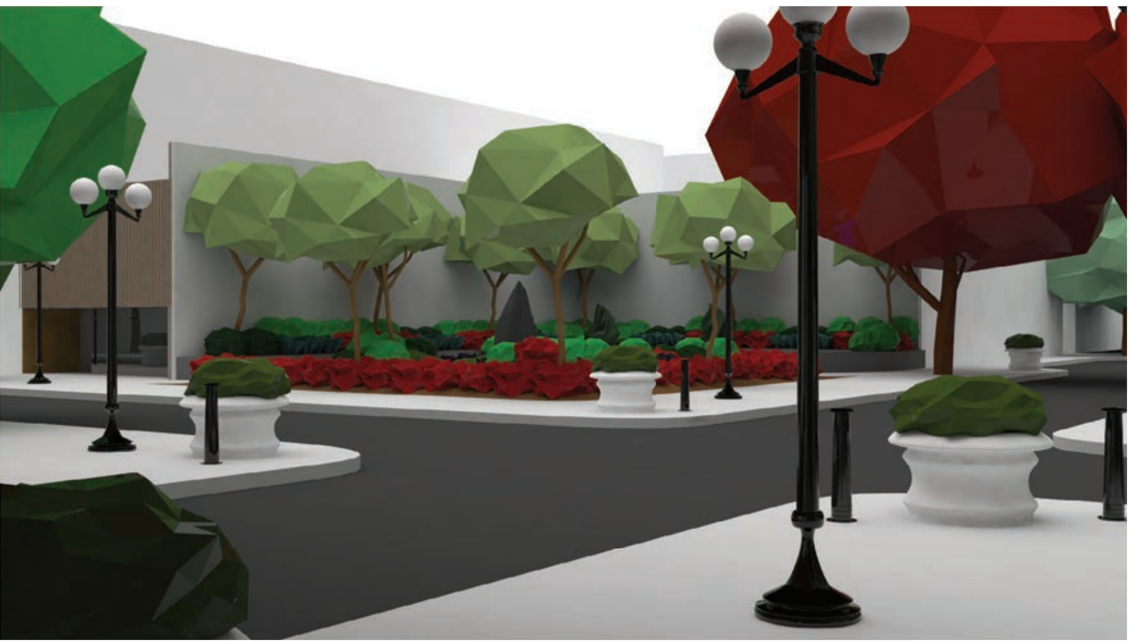


View #6



STATIC
DESIGN 2
LOW DETAIL

View #1

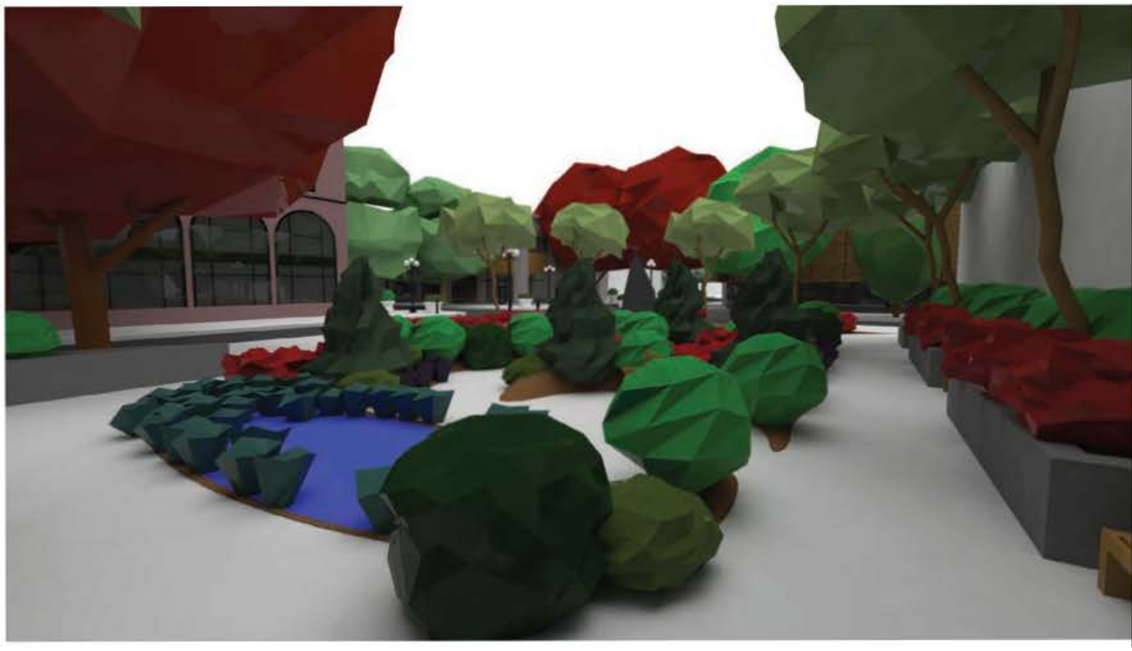


View #2

View #3

View #4

View #5



View #6

STATIC
DESIGN 1
HIGH DETAIL

View #1

View #2

View #3

View #4

View #5

View #6

STATIC DESIGN 2 HIGH DETAIL

View #1

View #2

View #3

View #4

View #5

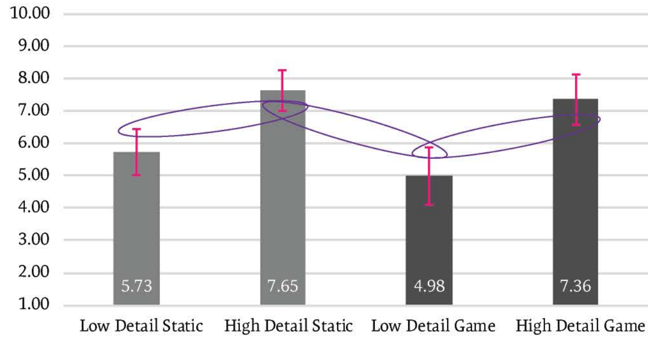
View #6

APPENDIX D

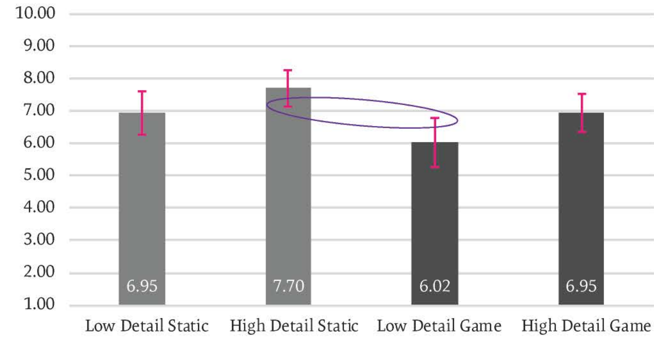
PREFERENCE TEST CALCULATIONS, GRAPHS AND TABLES

The figure on the next page is a combined spread of all the separate analysis graphs used for project survey data analysis. In addition to the graphs which were shown separately in the body of the document is the table of values and 95% confidence interval. As was stated in the document body, these confidence intervals were derived by finding the standard deviation for each value and using the excel function "=Confidence(alpha, standard_dev, size)" to generate 95% confidence levels.

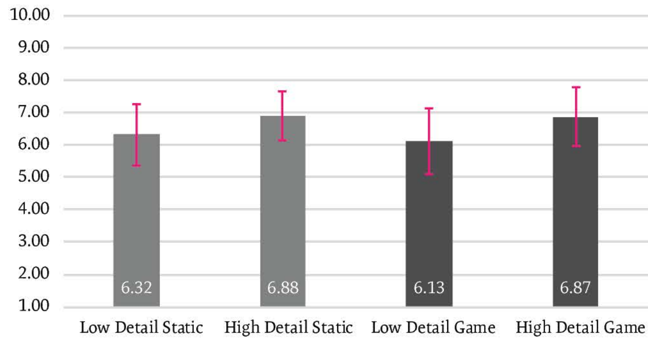
AVERAGE BEAUTY - OPPORTUNITY SAMPLE



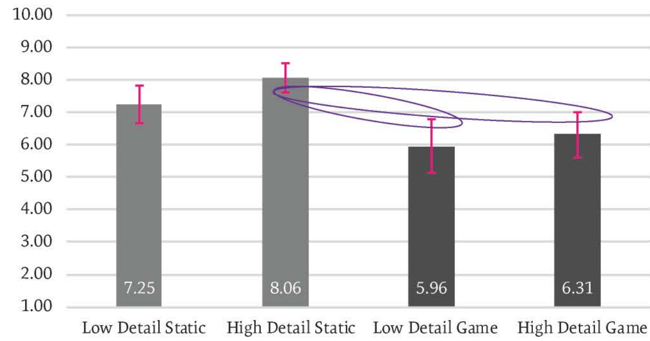
AVERAGE BEAUTY - QUALTRICS SAMPLE



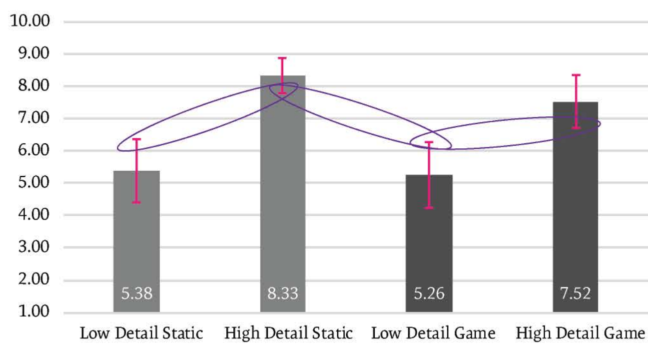
AVERAGE NAVIGATION - OPPORTUNITY SAMPLE



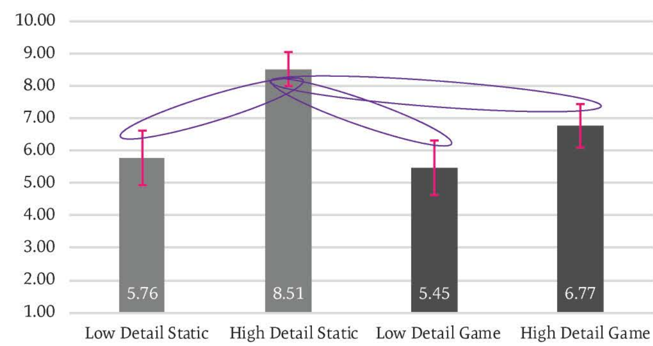
AVERAGE NAVIGATION - QUALTRICS SAMPLE



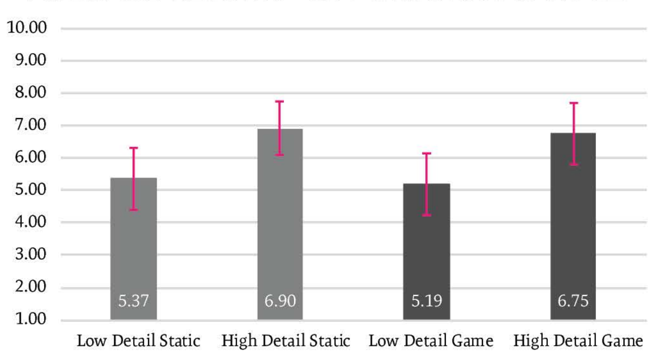
AVERAGE REALISM - OPPORTUNITY SAMPLE



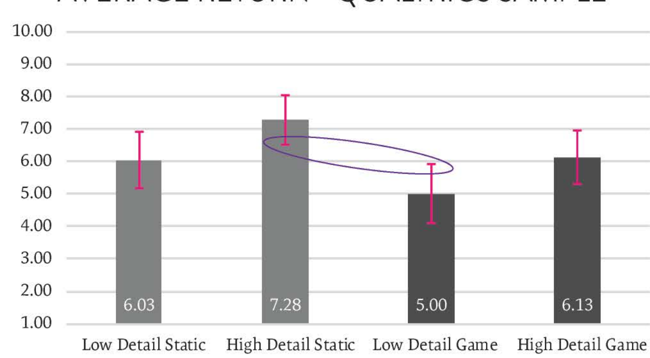
AVERAGE REALISM - QUALTRICS SAMPLE



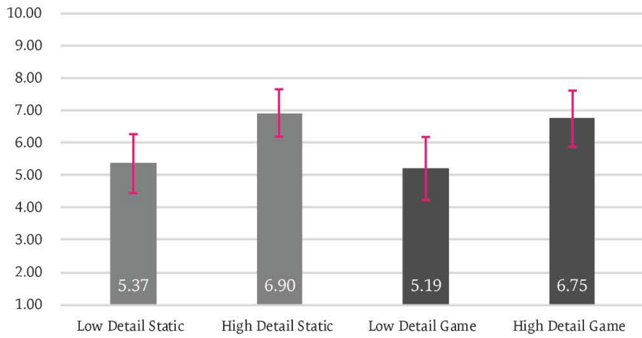
AVERAGE RETURN - OPPORTUNITY SAMPLE



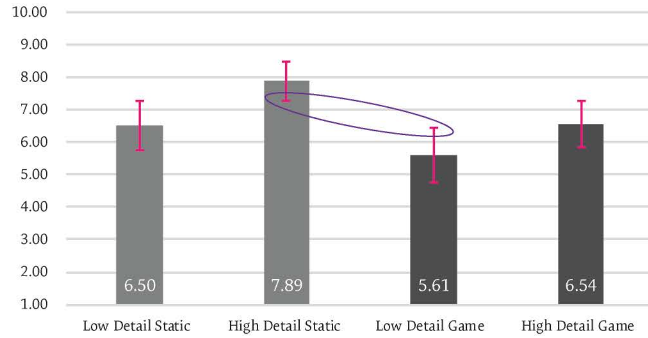
AVERAGE RETURN - QUALTRICS SAMPLE



AVERAGE TOTALS - OPPORTUNITY SAMPLE



AVERAGE TOTALS - QUALTRICS SAMPLE



OPPORTUNITY SAMPLE - 52 PARTICIPANTS

LOW DETAIL STATIC RENDERING	HIGH DETAIL STATIC RENDERING	LOW DETAIL GAME ENGINE SIM.	HIGH DETAIL GAME ENGINE SIM.	
5.70	7.44	5.39	7.13	AVERAGE TOTALS
0.915	0.736	0.982	0.869	95% confidence
5.73	7.65	4.98	7.39	BEAUTY
0.706	0.632	0.889	0.768	95% confidence
6.32	6.88	6.13	6.87	NAVIGATION
0.962	0.755	1.022	0.910	95% confidence
5.38	8.33	5.26	7.52	REALISM
0.982	0.531	1.013	0.812	95% confidence
5.37	6.90	5.19	6.75	RETURN VISITS
0.954	0.821	0.967	0.962	95% confidence

QUALTRICS SAMPLE - 80 PARTICIPANTS

LOW DETAIL STATIC RENDERING	HIGH DETAIL STATIC RENDERING	LOW DETAIL GAME ENGINE SIM.	HIGH DETAIL GAME ENGINE SIM.	
6.50	7.89	5.61	6.54	AVERAGE TOTALS
0.768	0.605	0.842	0.707	95% confidence
6.95	7.70	6.02	6.95	BEAUTY
0.676	0.576	0.757	0.589	95% confidence
7.25	8.06	5.96	6.31	NAVIGATION
0.584	0.470	0.818	0.688	95% confidence
5.76	8.51	5.45	6.77	REALISM
0.849	0.517	0.840	0.671	95% confidence
6.03	7.28	5.00	6.13	RETURN VISITS
0.869	0.760	0.911	0.835	95% confidence

APPENDIX E

QUALTRICS SURVEY PAGES

The following pages show the Online Survey interface as was established on the Qualtrics web-hosting service. The representations that were associated with the survey are not included here as they were displayed more fully in Appendix C. Each of the preference questions show were displayed on the same webpage as the digital representation content.

Respondents were forced to answer the preference questions with either the sliding rating bar (1-10) or by clicking the "I don't know" box. Once respondents moved the rating bar a numerical indicator would appear to the right of their given score to re-affirm their selection. Once they had responded to all the questions on a given page (at each visualization) they were allowed to move on the the next visualization and associated questionnaire.

The online survey had a statement of informed consent that preceded all content. If users did not agree with the statement Qualtrics automatically directed them immediately out of the survey. Likewise if individuals attempted to view the survey with mobile devices (which would be incompatible with the dynamic simulations) Qualtrics automated a message explaining mobile devices were incompatible and directed them out of the survey.

Page 1: Statement of Informed Consent

UNIVERSITY OF OREGON

Statement of Informed Consent

Participants must be at least 18 years old to participate in this study. The following study is being conducting for research within the field of Landscape Architecture at the University of Oregon. The purpose is to better understand the ability of video game engines to create simulated representations of landscape design, and how those representations compare with two-dimensional imagery. It is expected that this study should take no longer than 15 minutes for any one subject. In the following study each subject will be presented with two-dimensional imagery, and two different forms of self-navigated computer simulations. After a brief exposure to each of the representations subjects will be asked preference questions regarding each experience. There are no experimental procedures within this study. There are no anticipated risks or expected discomforts associated with this study; however, if you feel any discomfort please immediately discontinue participation and inform the principal investigator (jkau2@uoregon.edu). This study will not be collecting any identifying records, and all responses are voluntary. The survey information will be collected by and hosted through the online survey tool Qualtrics, (see privacy statement https://www.qualtrics.com/privacy-statement/). Any questions about the research, subjects' rights, or in the event of research-related injury, please contact the principal investigator (jkau2@uoregon.edu). Participation in this study is entirely voluntary, refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and the subject may discontinue participation at any time without penalty or loss of benefits, to which the subject is otherwise entitled. Estimated participation in this study is 50-150 subjects.

I have read and agree to the statement of consent

I do not agree to the statement of consent

→

Page 2: Explanation of Procedure

UNIVERSITY OF OREGON

After seeing each of the following simulated experiences just once, you will be asked four questions about that single experience. These questions will ask you to consider four different aspects of the simulated experience you have just viewed.

The topics of the four questions are:

1. The beauty of the vegetation in the park
2. Navigating the layout of the park
3. The realism of the simulation
4. How often you would want to use the park

→

Page 3a-4a: Static Visualizations (shown directly above questions)

Evaluation Criteria:

Beauty: How beautiful do you find the vegetation and planting design of the place you just experienced?

Ease of Navigation: How easy was it for you to understand this simulated place's layout so you could easily discover what it looks like and notice nice places to sit down?

Degree of Realism: How easy was it for you to grasp this simulated place's appearance so that you could easily get a good sense of what it would feel and look like if it were actually built?

Return Visits: How much would you want to come back and visit this place more than once to enjoy its beauty?

	Lowest Value 1	2	3	4	5	6	7	8	9	Highest Value 10	Don't Know
Beauty											☐
Ease of Navigation											☐
Degree of Realism											☐
Return Visits											☐

→

Page 3b-4b: Static Visualizations after indicating choices

Evaluation Criteria:

Beauty: How beautiful do you find the vegetation and planting design of the place you just experienced?

Ease of Navigation: How easy was it for you to understand this simulated place's layout so you could easily discover what it looks like and notice nice places to sit down?

Degree of Realism: How easy was it for you to grasp this simulated place's appearance so that you could easily get a good sense of what it would feel and look like if it were actually built?

Return Visits: How much would you want to come back and visit this place more than once to enjoy its beauty?

	Lowest Value 1	2	3	4	5	6	7	8	9	Highest Value 10	Don't Know	
Beauty											☐	9
Ease of Navigation											☐	6
Degree of Realism											☐	
Return Visits											☑	

→

Page 5-6: Dynamic Simulations (linked at Itch.io)

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Please spend only 1 - 2 minutes exploring the simulation by clicking on the link below.

Be sure to explore both the streets and into the park.

The link will open a new tab in your browser containing the embedded simulation. It may take a moment to load. For the best experience please maximize the screen by pressing the small blue button in the bottom right of the simulation (ESC key to minimize).

Please explore the simulation only once and then close the simulation tab to return to the survey.

Click Here to view simulation.

Evaluation Criteria:

Beauty: How beautiful do you find the vegetation and planting design of the place you just experienced?

Ease of Navigation: How easy was it for you to understand this simulated place's layout so you could easily discover what it looks like and notice nice places to sit down?

Degree of Realism: How easy was it for you to grasp this simulated place's appearance so that you could easily get a good sense of what it would feel and look like if it were actually built?

Return Visits: How much would you want to come back and visit this place more than once to enjoy its beauty?

	Lowest Value 1	2	3	4	5	6	7	8	9	Highest Value 10	Don't Know
Beauty											☐
Ease of Navigation											☐
Degree of Realism											☐
Return Visits											☐

→

Page 7-11: Demographic Questions