Reality Virtually: Case Study at the Memorial to the Enslaved People of George Mason

John Stinson
Project Designer – Perkins and Will

Justin Cooper
Sr. Landscape Architect – Perkins and Will

AUTODESK. UNIVERSITY

Welcome

About the speakers

John Stinson

John Stinson graduated with his Master of Architecture from degree from the University of South Florida and has since become a licensed architect, Design Technology Leader and Project Designer at Perkins and Will in Atlanta. Through the lenses of architectural imaging, physical/digital modeling, and animation, he constantly seeks to elevate the quality and excitement of the design process.

Linkedin

About the speakers

Justin Cooper

Justin Cooper is a landscape architect with over ten years of experience on a variety of project types. His experience includes planning for residential communities, the design and construction documentation of amenity areas for both suburban and urban mixed-use projects, and landscape plans for corporate office buildings. He has recently focused on the construction documents and construction observation for the landscape components of many Perkins and Will projects.

Linkedin

Course Objectives

- Explain what reality capture is
- Differentiate between reality capture technologies
- Apply basic photographic techniques to capture real-world objects using Recap Photo
- Describe how to prepare 3d scans for fabrication and visualization

Agenda

Introduction to Reality Capture

Overview of Photogrammetry Workflow

Case Study at the Memorial to the Enslaved People of George Mason

Questions

Reality capture — The process of creating a digital 3d model representation of a subject from the physical world.
Capture. Compute. Create.

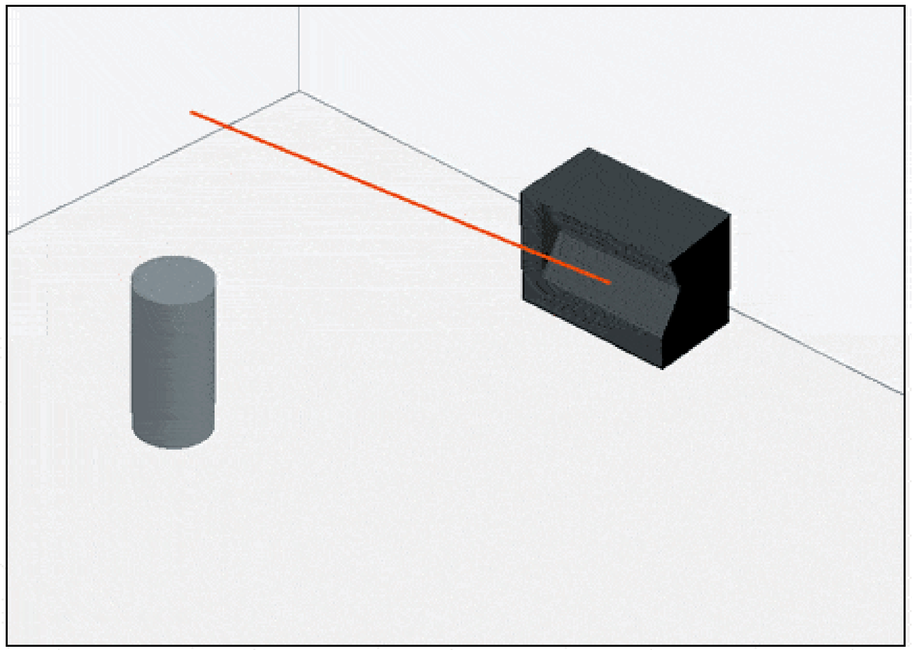
LiDAR (Light Detection and Ranging)

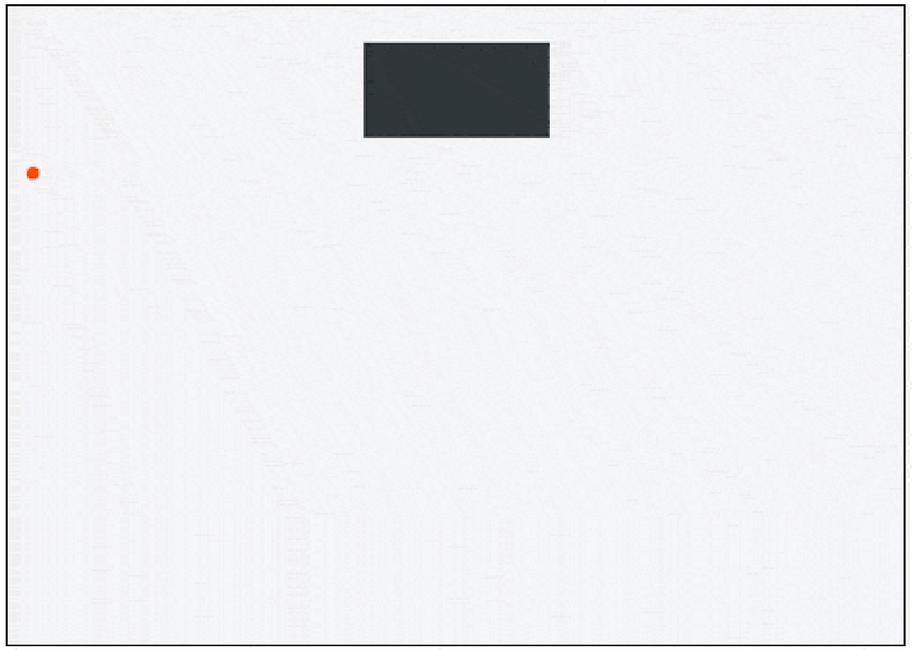
Photogrammetry

LiDAR (Light Detection and Ranging)

What is It?

LiDAR is a surveying method that measures distance to a target by illuminating the target with laser light and measuring the reflected light with a sensor. It is a direct measurement. The measurements are recorded as a colorless 3d point cloud.





Blickfeld

LiDAR (Light Detection and Ranging)

As-Built Documentation

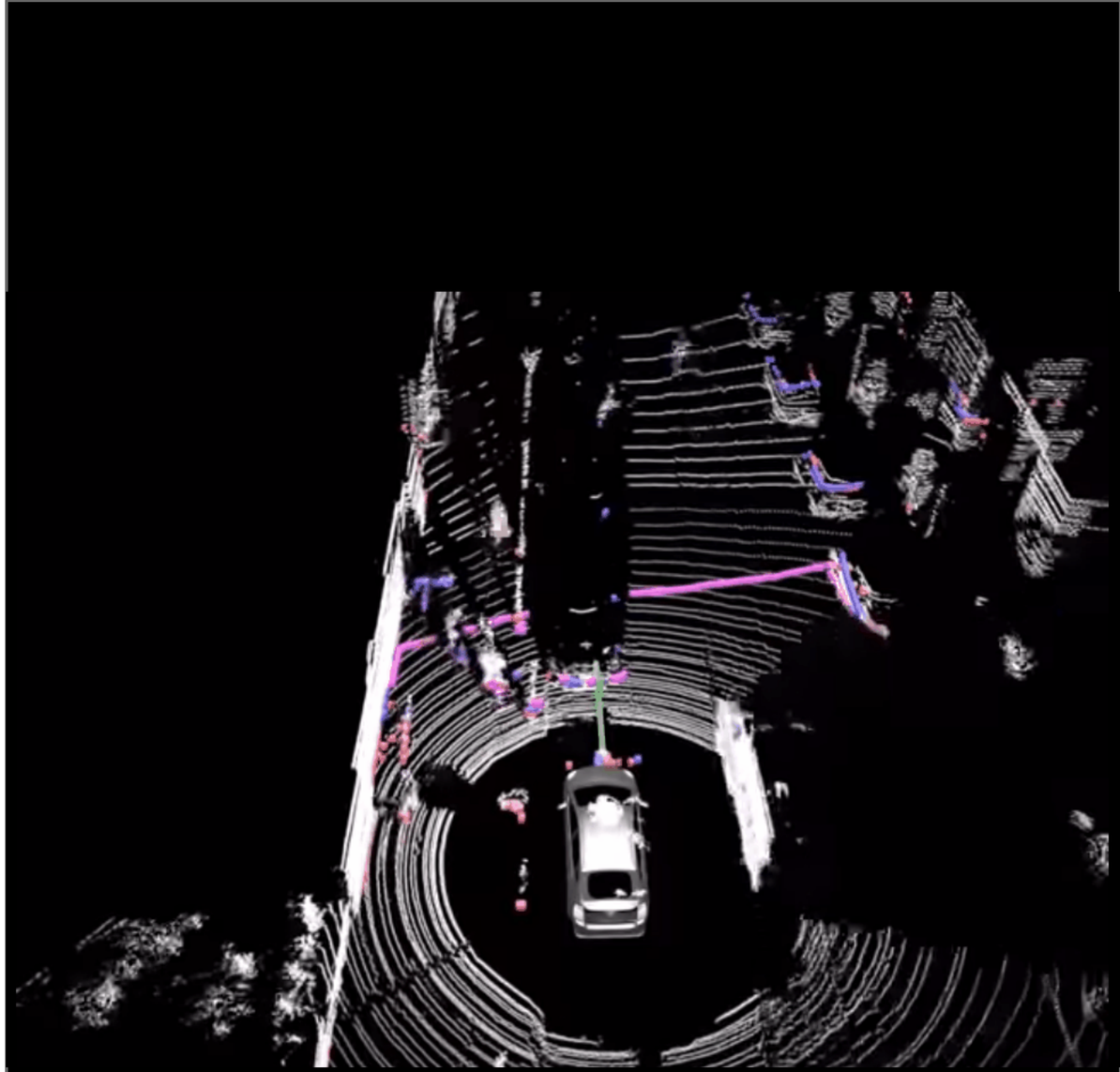
LiDAR can be used to document as built or existing conditions to within 5mm. Several years ago Notre Dame was scanned by an art historian named Andrew Tallon. At over 850 years old, there is no documentation on who built the cathedral or how. In his forensic analysis he found unsuspected thing like columns in the nave don't align because they were built around existing structure. That and that scan is now being used to reconstruct it after the fire earlier this year

NatGeo

LiDAR (Light Detection and Ranging)

Autonomous Vehicles

LiDAR appears to be the enabling factor for autonomous vehicles. LiDAR returns thousands of point data per second and an onboard computer uses those points to construct a 3d point cloud of the car's environment in real-time.

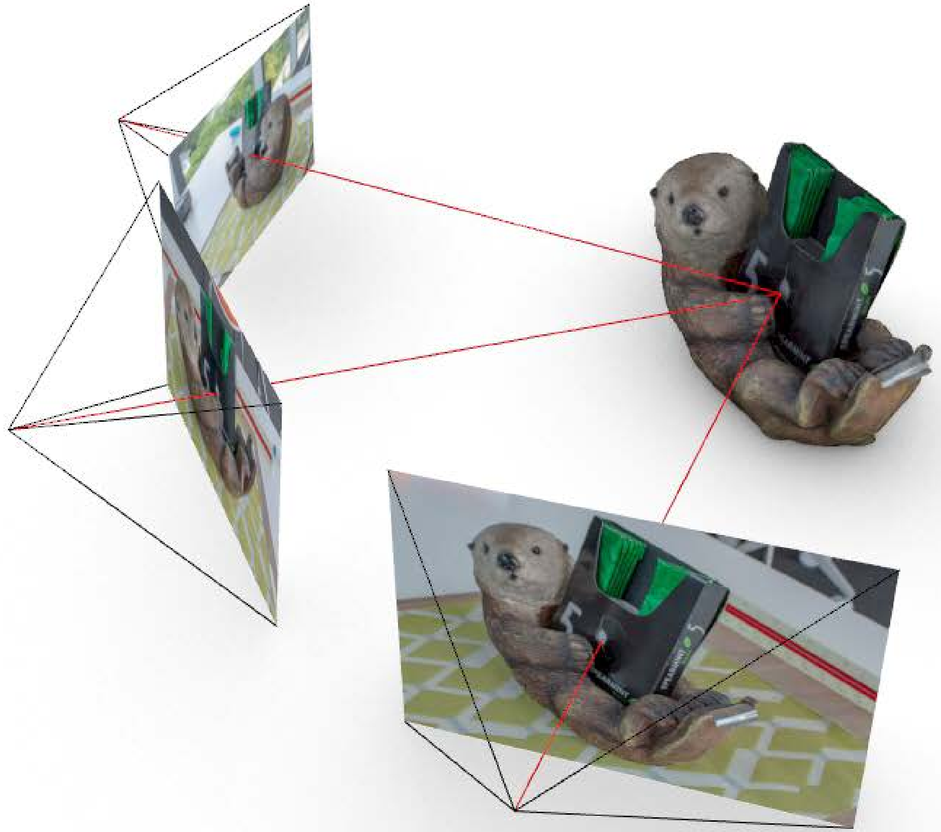


Alex Kushleyev

Photogrammetry (Structure From Motion - SFM)

What is it?

Photogrammetry is a technique for mapping distances of and between objects from a series of two-dimensional images. It is an indirect measurement. The output is full color 3d surface models or point clouds.



Otter courtesy of John Bittinger

Photogrammetry (Structure From Motion - SFM)

As-Built Documentation

Photogrammetry can also be used to scan full buildings for actionable data and illustrative data. Though scans can be as accurate as LiDAR, it takes more skill and time to produce comparable results at such scale.

Video

Alper Guler

Photogrammetry (Structure From Motion - SFM)

Entourage/Character Creation

Many companies like Render People and Human Alloy are producing scanned people entourage for architectural renderings and animations.

Photogrammetry (Structure From Motion - SFM)

VR Environments

Because of the level of detail and realism, 3d scanned environments are becoming more prevalent in VR simulation.

Azad Balabanian

Reality Capture

Comparison

- Reality capture allows quick analysis of existing and as-built conditions
- New technologies are becoming more efficient, less expensive and easier to use to the effect that almost anyone can collect and process data
- The 3d data attained can provide improved communication, understanding, and impressive visuals

LiDAR (Light Detection and Ranging)

+ Versatile Scanning(Building, Foliage, Under water)
+ Fast Processing
+ Easy/ less scans (20% - 30% overlap)
+ Highly Accurate

- Expensive ($20k - $350k)
- Custom Manufacturing (long lead/repair times)
- Only produces point cloud

Photogrammetry (Structure From Motion - SFM)

+ Highly Visual
+ Relatively Inexpensive ($1k - $20k)
+ Easily Repaired/Replaced
+ Accurate

- Processing 5 – 10x time slower
- Ineffective through foliage
- More Scans (60% -70% Overlap)

Workflow for Successful Photographs for Photogrammetry

Photogrammetry Equipment

Preparing for Photography

Photographic Techniques

Preparing Photos for Recap

Converting captured photos to 3d scan geometry

Photogrammetry Equipment

Digital Camera

The most important aspect of photogrammetry is taking quality images. A bad image is worse than no image. Luckily almost everyone has a capable camera right in their pocket.

12 Megapixels
$1250*

~18 Megapixels
$300

24+ Megapixels
$400

Photogrammetry Equipment

Digital Camera Lens

Lens selection is arguably more important than DSLR selection. The performance and character vary much more between lenses than most DSLRs. Typically it is recommended to invest in better glass than a better camera body.

Prime lenses

- More Durable – less complex
- Better low-light performance
- Weigh less
- Less Expensive

Photogrammetry Equipment

Lighting

Photography is basically the recoding of light, which makes scene lighting extremely important. Lighting determines not only the brightness of a scene but subsequently the texture, color and legibility of your subject.

Photogrammetry Equipment

UAV (Unmanned Aerial Vehicle)

Most large scans could use an UAV to help capture difficult perspective. While an extremely valuable tool, they come with a lot of responsibility. In the US you must register any drone over 250g. In addition, if flying for commercial purposes, you must pass a Remote Pilot test and adhere to any other local laws and ordinances.

DJI MAVIC AIR

DJI PHANTOM 4 PRO V2

DJI MAVIC 2 PRO

DJI SPARK

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Preparing for Photography

Pick a Subject – Establish Goals

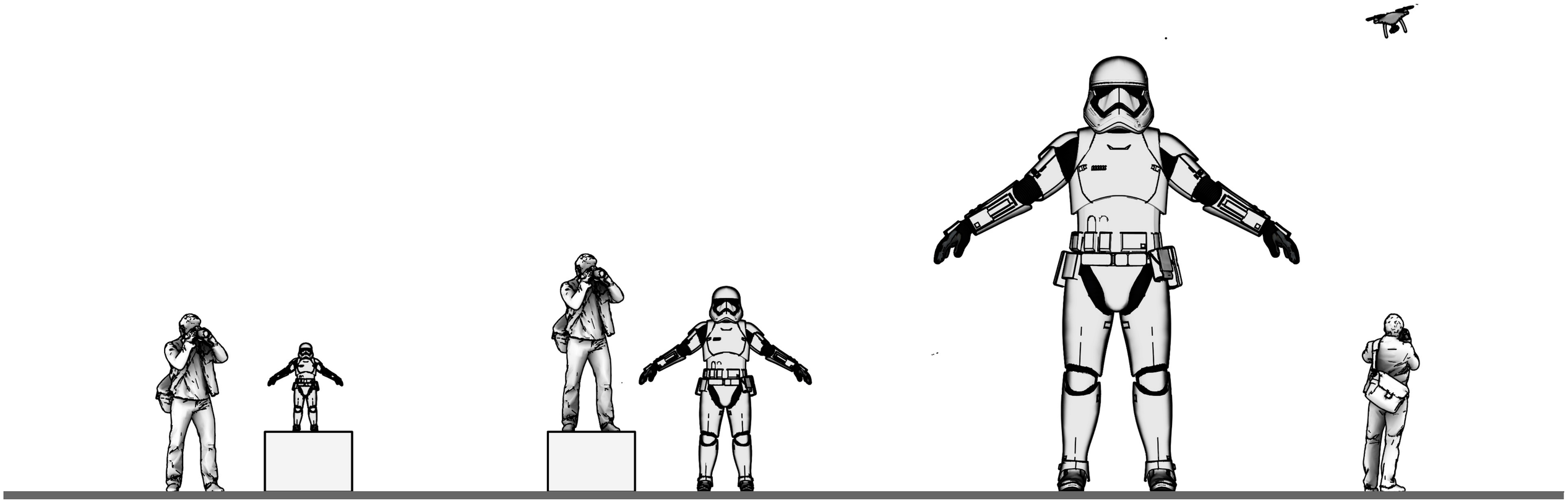
Once you have a subject selected you should establish goals to help you prepare a plan for scanning. Planning a head of time can help eliminate errors, missed opportunities, and rescanning.

- What will the scan be used for?
- What aspects of the subject are imperative?
- What is an acceptable deviation in accuracy?
- Does the scan need to record the textures of the subject?

Preparing for Photography

Scale

Small, light objects can easily be moved around for easy access for scanning and generally can be recorded in fewer pictures. You made need extra equipment such as ladders, lifts or drones to get to needed vantage points.



Preparing for Photography

Lighting

If possible, plan to use diffused natural light. Smaller objects can be scanned inside with a studio lighting set up. Try to minimize hard shadows, changing light and glare.

~~Hard Light~~

~~Dappled Light~~

Diffused Light

Preparing for Photography

Surface Properties

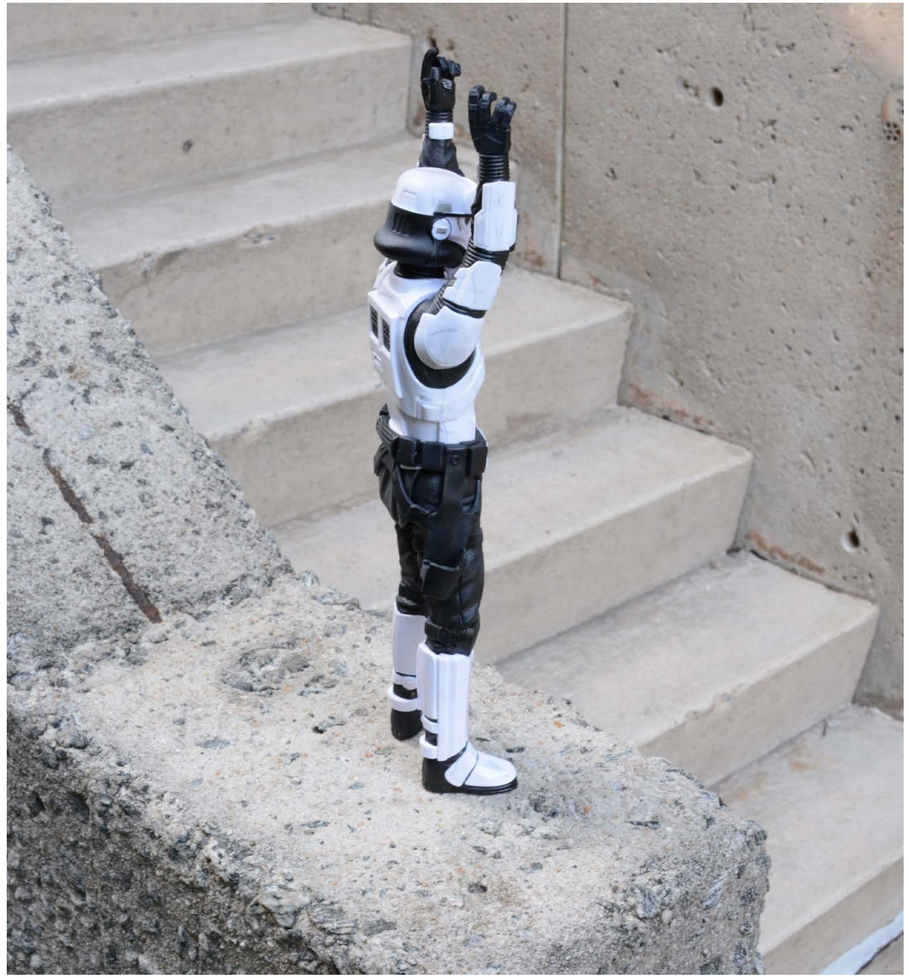
Recap photo identifies features in the surface texture of the subject. These feature are like puzzle piece edges that the computer aligns from the various pictures at different angles to make a 3d model. Any surface that has properties that disrupts the continuity of the discerning feature causes problems.

- Avoid translucent or transparent objects
- Avoid reflective or specular objects
- Plain, monolithic surfaces
- Highly repetitive surfaces

Preparing for Photography

Location and Position

You want to make sure that all the sides of your subject are visible and that you have camera access to them. Beware of significant overhangs and recessed nooks on your subject. These areas tend to be underlit and can create gaps in information in your photos. Choose locations where the subject will stand out and contrasts with the background. The environment needs to be as static as possible.



- Avoid areas where the subject will blend in
- Avoid Objects moving in scene, i.e. people, cars
- Elevating, lowering or rotating your subject can increase photo quality and quantity

Workflow for Successful Photographs for Photogrammetry

Photogrammetry Equipment

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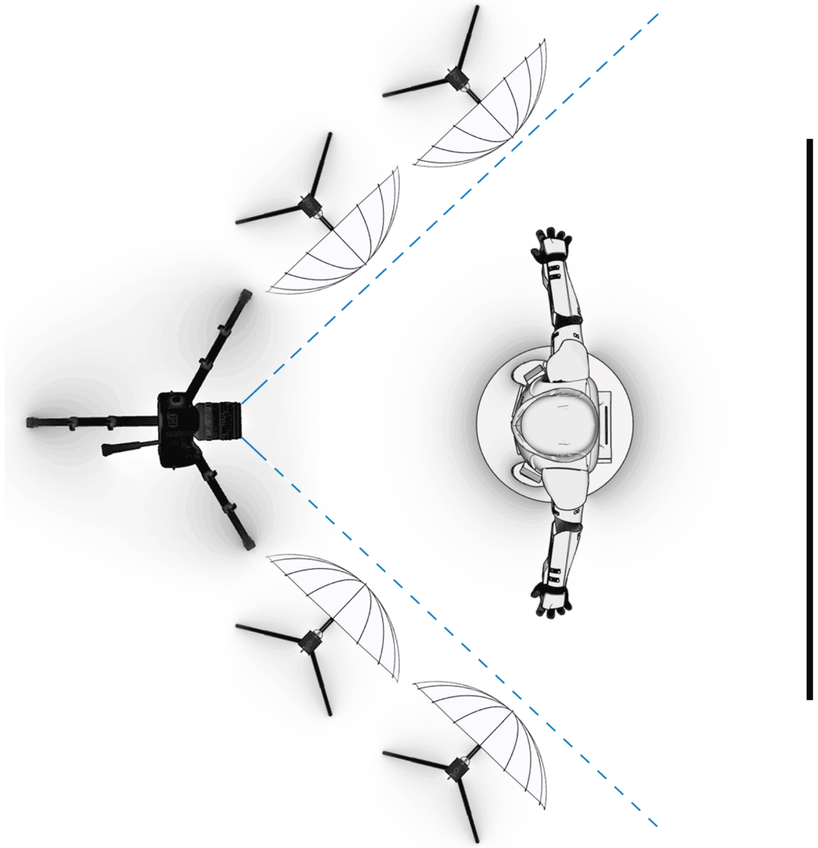
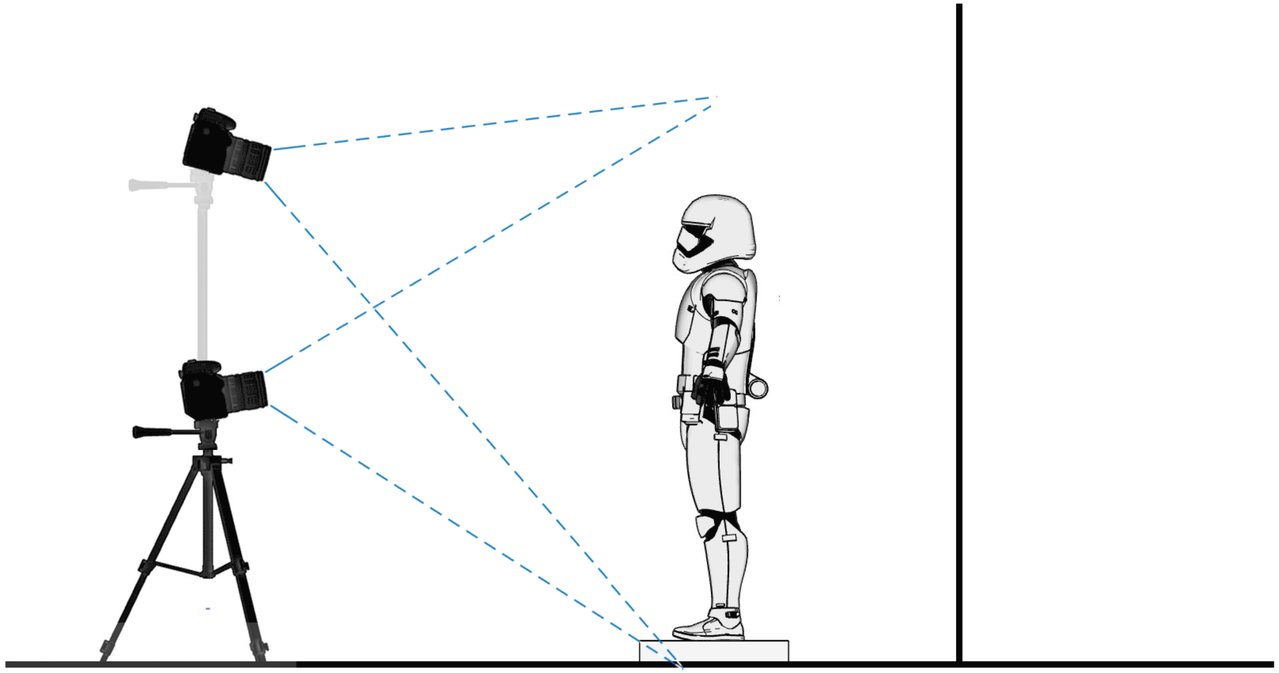
Photographic Techniques

The Turntable

With the turntable technique, the camera stays stagnant and the subject rotates on something like a lazy Susan. For best results, the camera should be set up on a tripod, lighting should be set up for one angle, and an evenly lit backdrop should be placed several feet behind the subject.

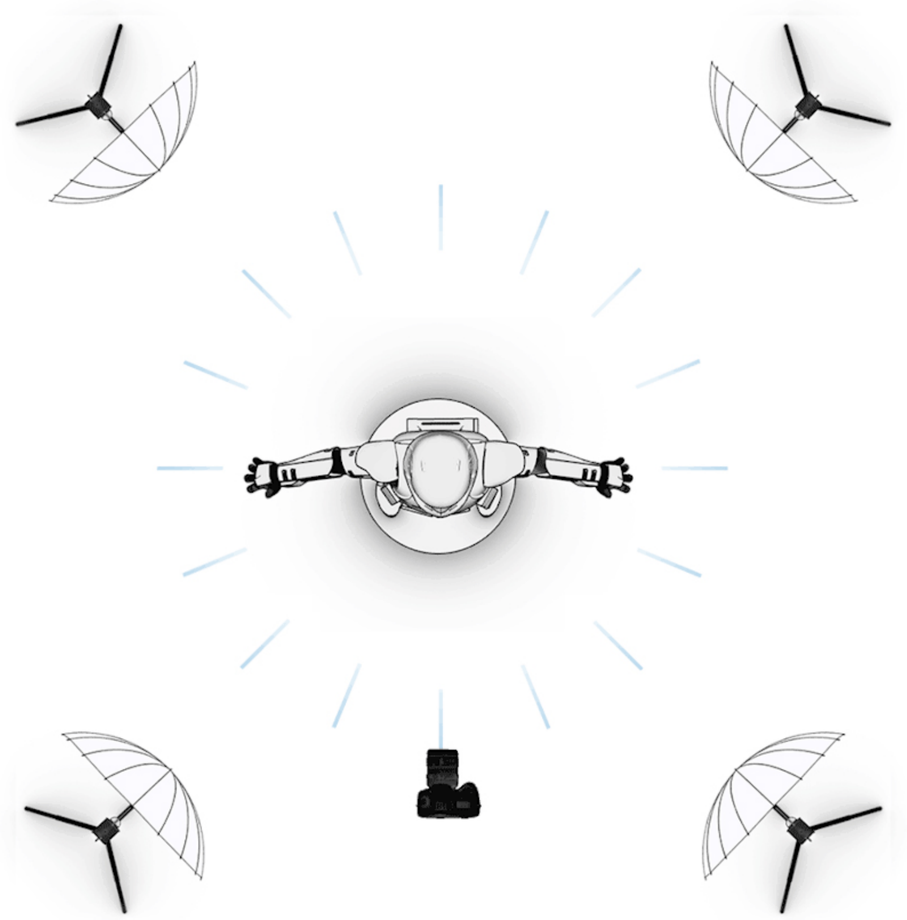


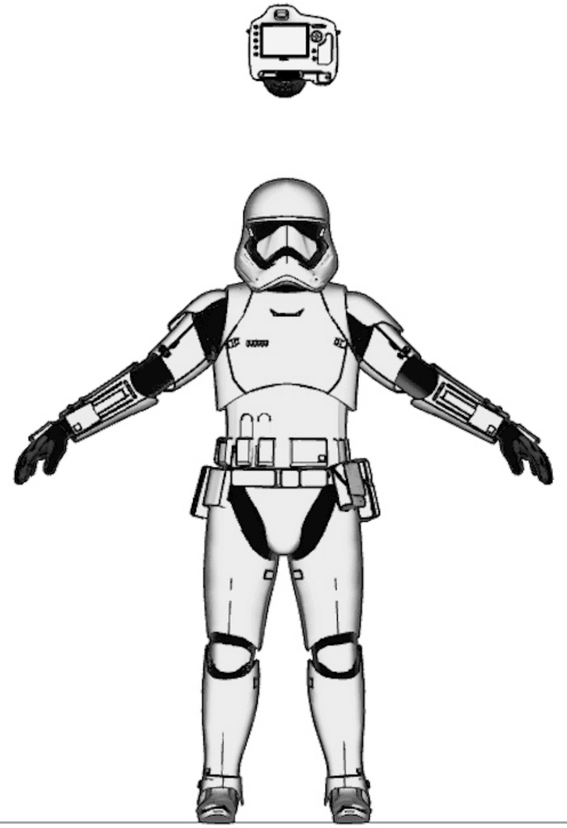


Photographic Techniques

The Walk-Around

Move radially in 15ish degree angles for each following shot. Take time to position yourself, steady the camera and focus on the subject between every shot. Depending on the subject, you may need to make this ring at multiple angles below and above the subject.





Photographic Techniques

The Inch Worm

Some objects are too large to scan by moving around them. Instead of circling them, move along their surface shooting in a grid pattern, still assuring proper overlap.

ELEVATION

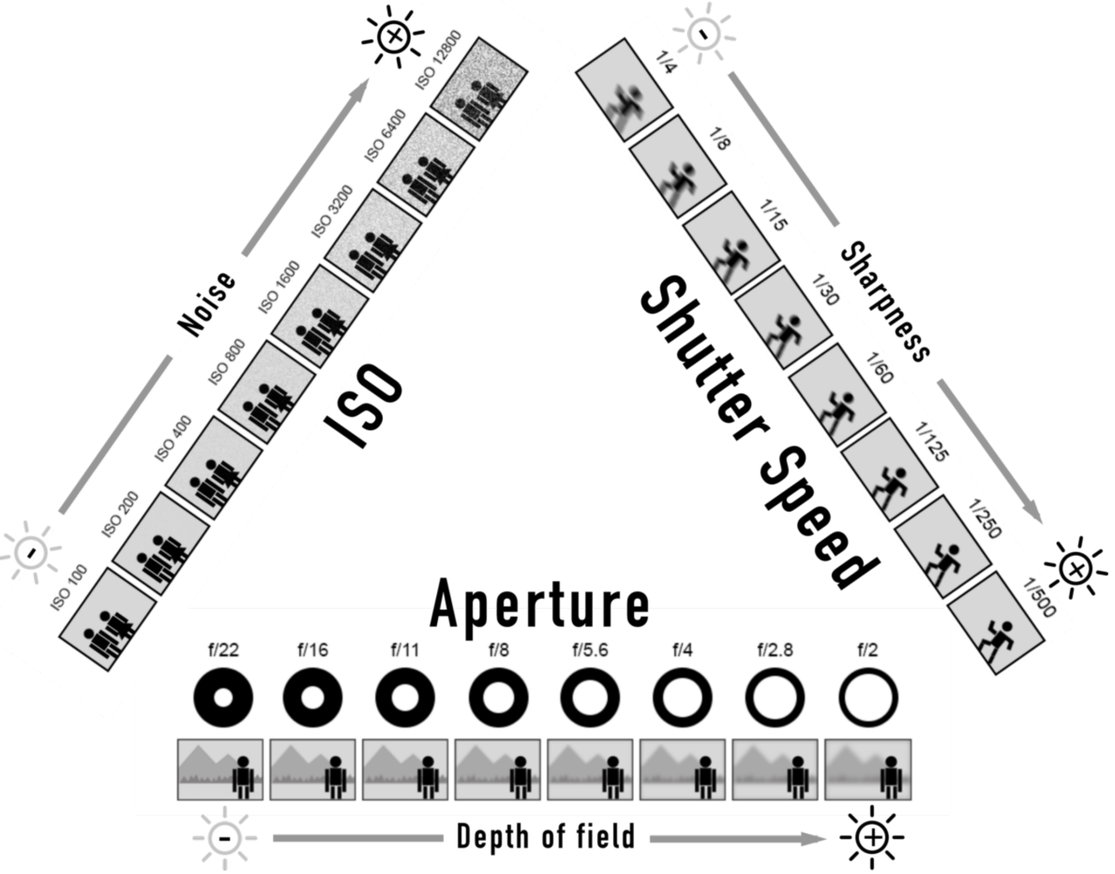
Video

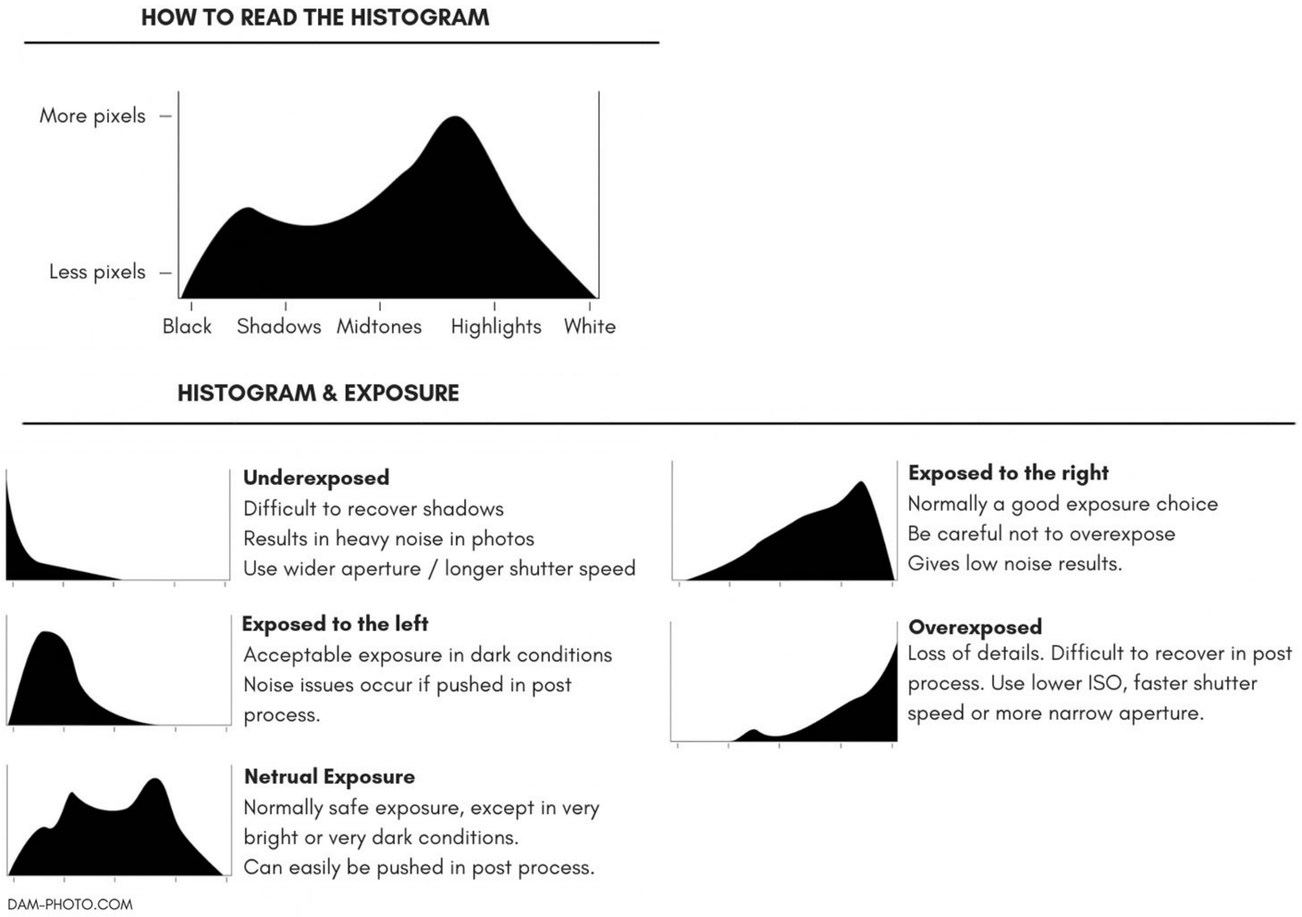
PLAN

Photographic Techniques

Camera Settings

It is best to use manual settings on your camera. Auto setting will expose each image differently, which will cause issues with the stitching in the software. Ideally, you want the shutter speed and aperture to be as high as possible and the ISO to be as low as possible.





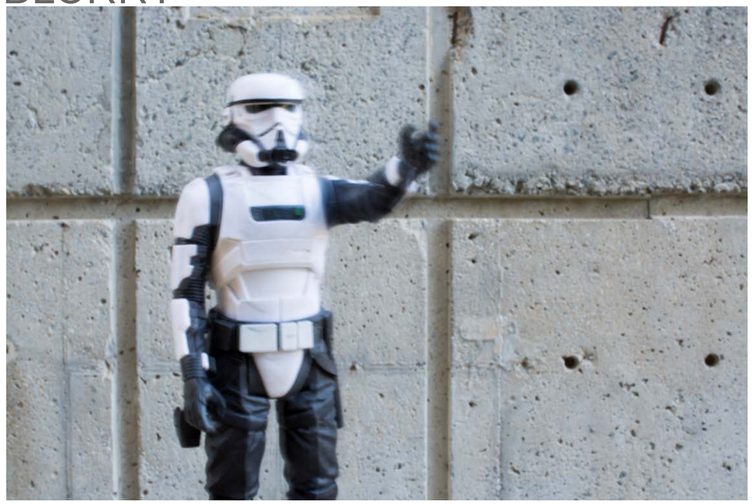
Photographic Techniques

Camera Settings

OVER EXPOSED

UNDER EXPOSED

BLURRY



DEPTH OF FIELD

Workflow for Successful Photographs for Photogrammetry

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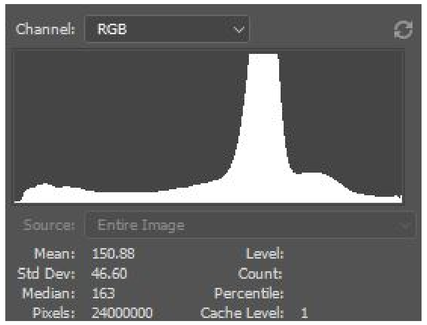
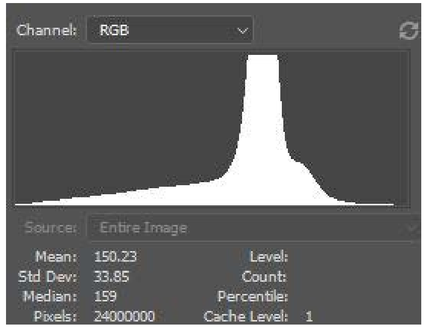
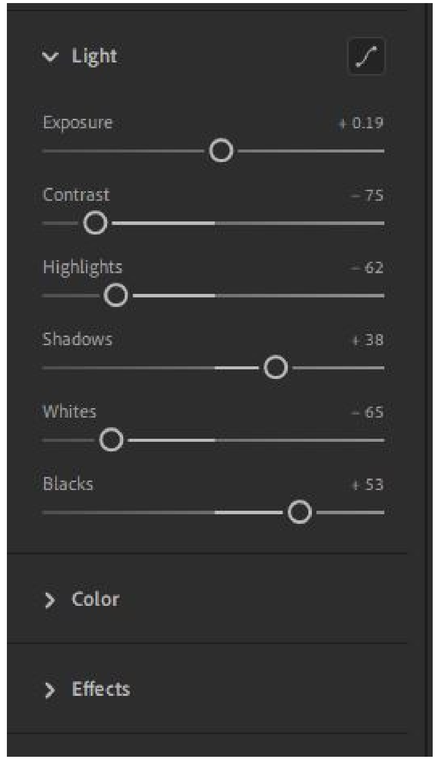
Preparing Photos for Recap

Post Processing

Contrary to typical photography, the goal is to make the images as even as possible. It is important to process all the images such that they still match each other.



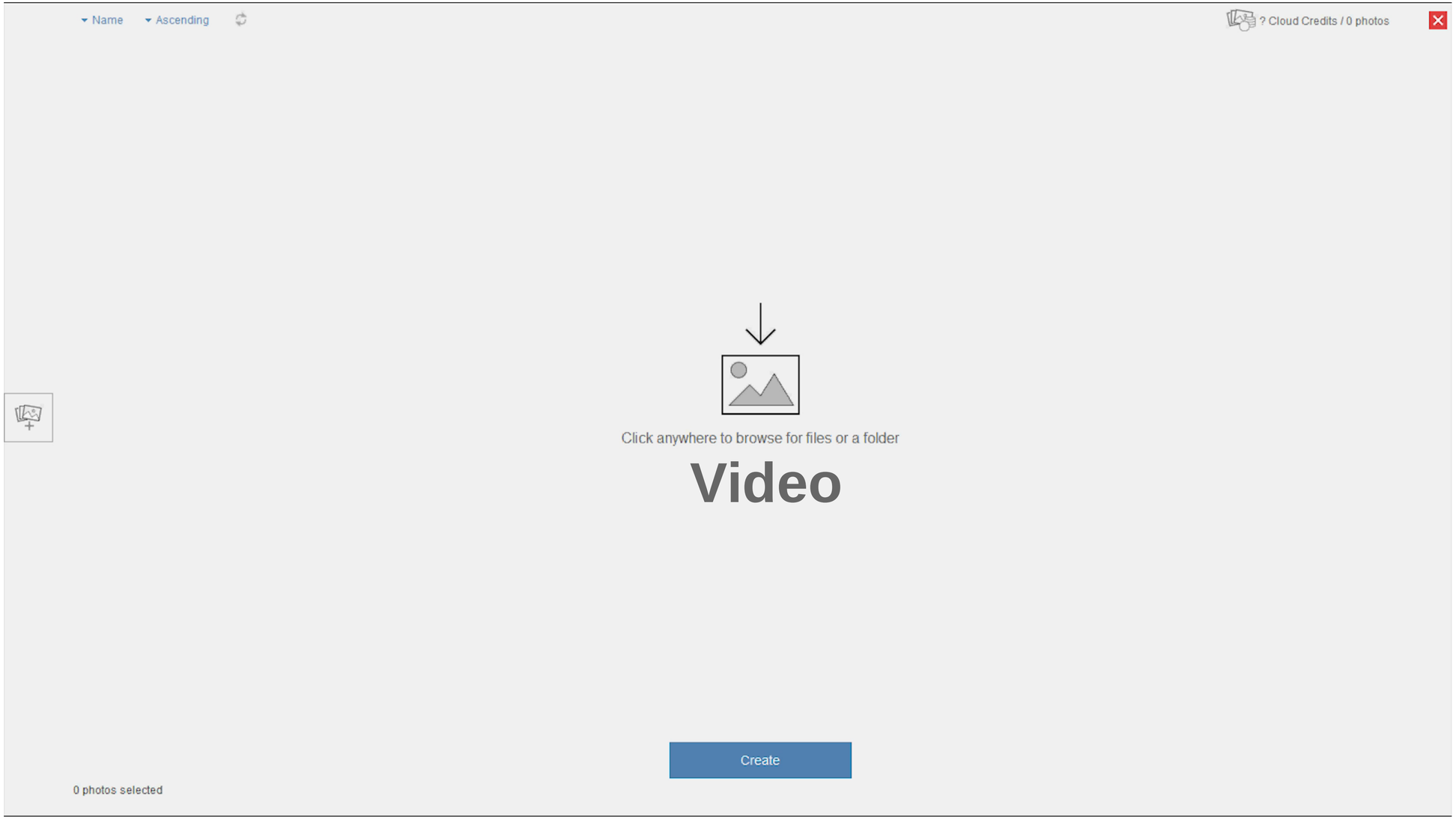




Overview of Photogrammetry Workflow

Converting captured photos to 3d scan geometry

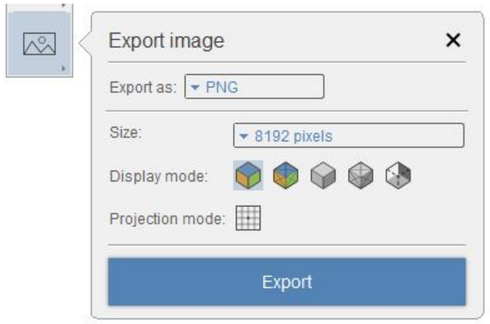
Introduction Demo

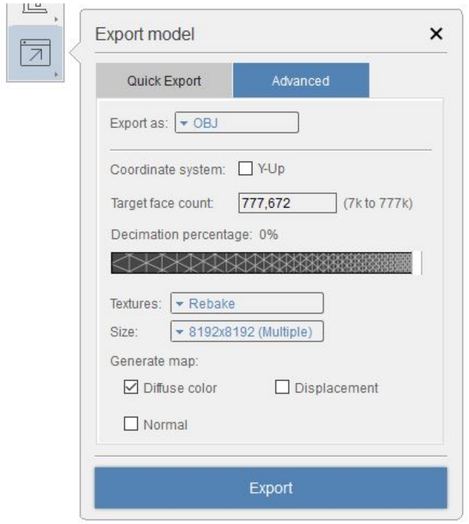


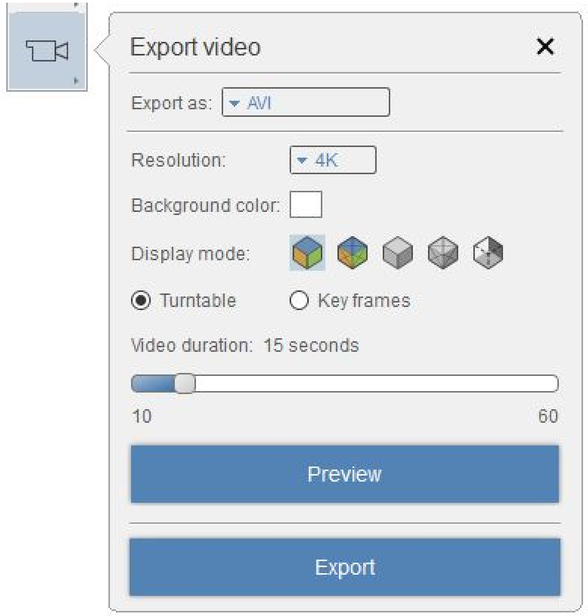
Overview of Photogrammetry Workflow

Exporting 3d Geometry From Recap Photo

Once you create and edit the model you can export 2d images(8k), video(4k) or the 3d mesh itself for use in other 3d software.







Video

Case Study at the Memorial to the Enslaved People of George Mason

Project overview

Photogrammetry Process

Utilizing Scanned Geometry for Modeling Operations

Preparing Scanned Geometry for Visualization

Converting Scanned Geometry to Physical Models

Project Overview

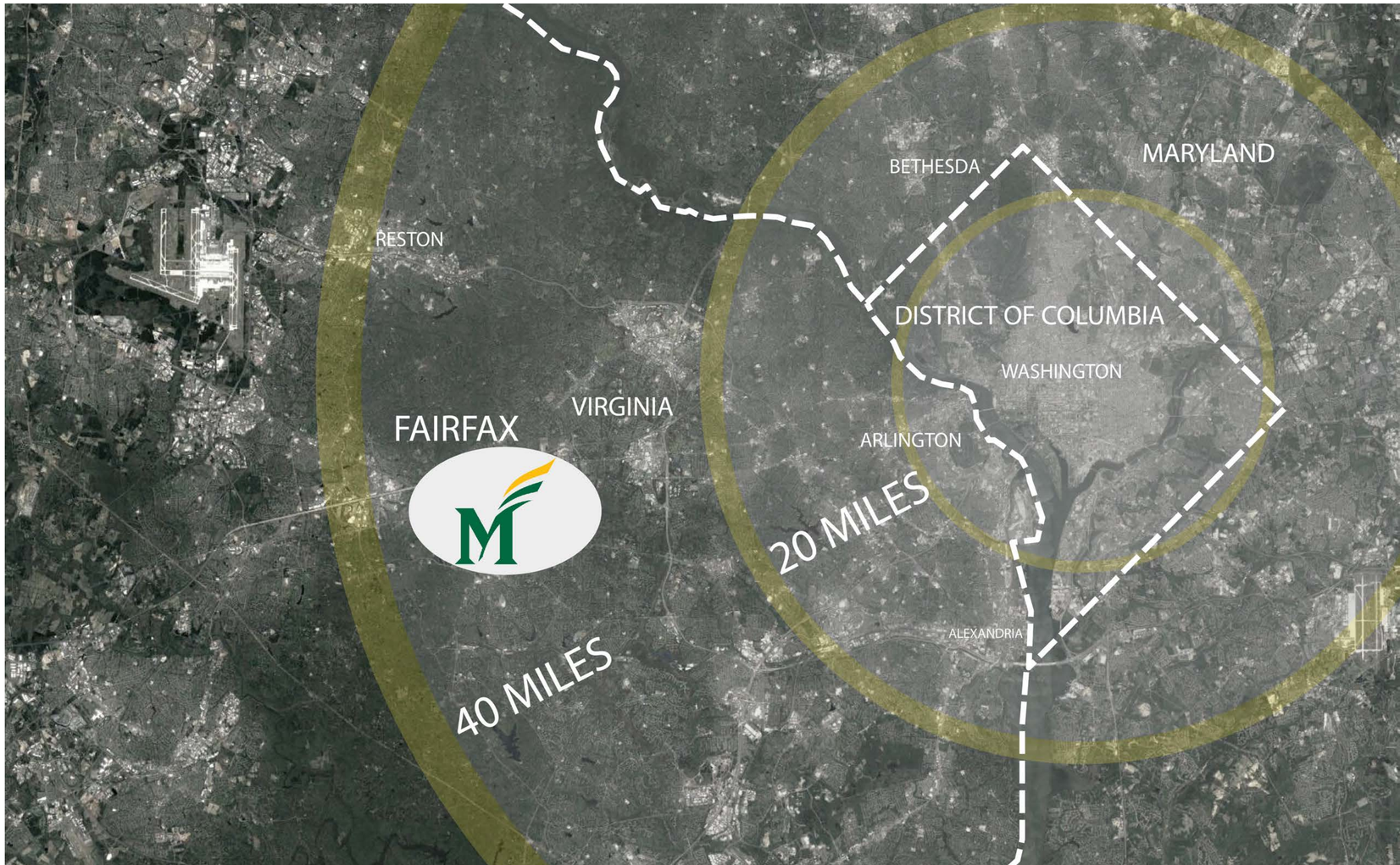
George Mason University

Fairfax, Virginia

- Established: 1972
- Originally a Satellite Campus for UVA
- Enrollment: 37,000
- Ranked one of the most diverse universities in the country. (#1 in the state of Virginia)

We Were Made to Make it Better

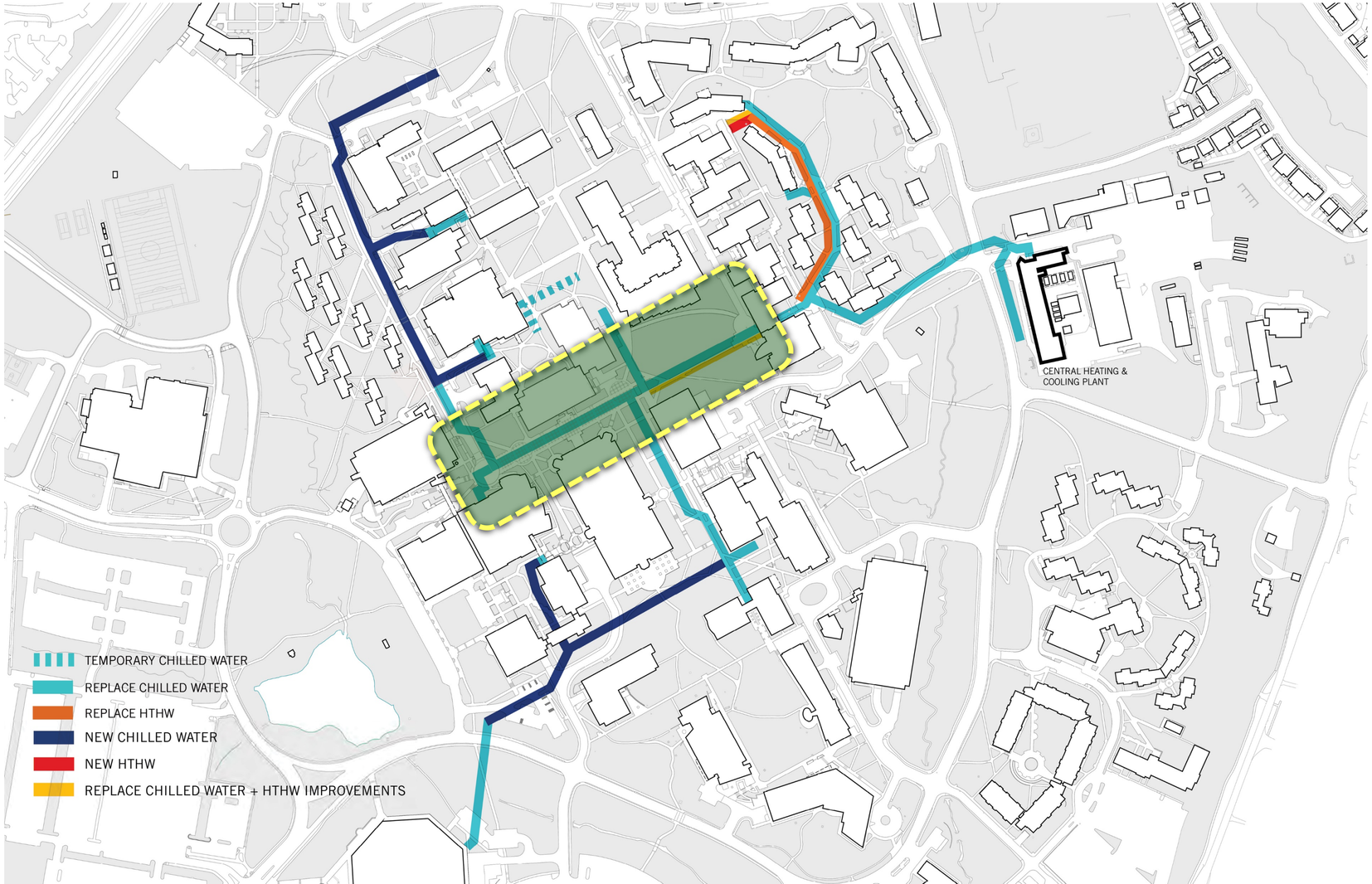
Our identity was forged in 1972 on Virginia's strong ideals of academic excellence and service. Today, that spirit energizes us as a leader in scholarship and research; preparing graduates to meet the complex needs of a rapidly changing world.



Project Overview

Utility Infrastructure Upgrades / Robinson Hall

Campus-wide utility upgrades / New academic building



- 800 Acre Campus
- Construction Budget: $43M
- Construction Schedule:

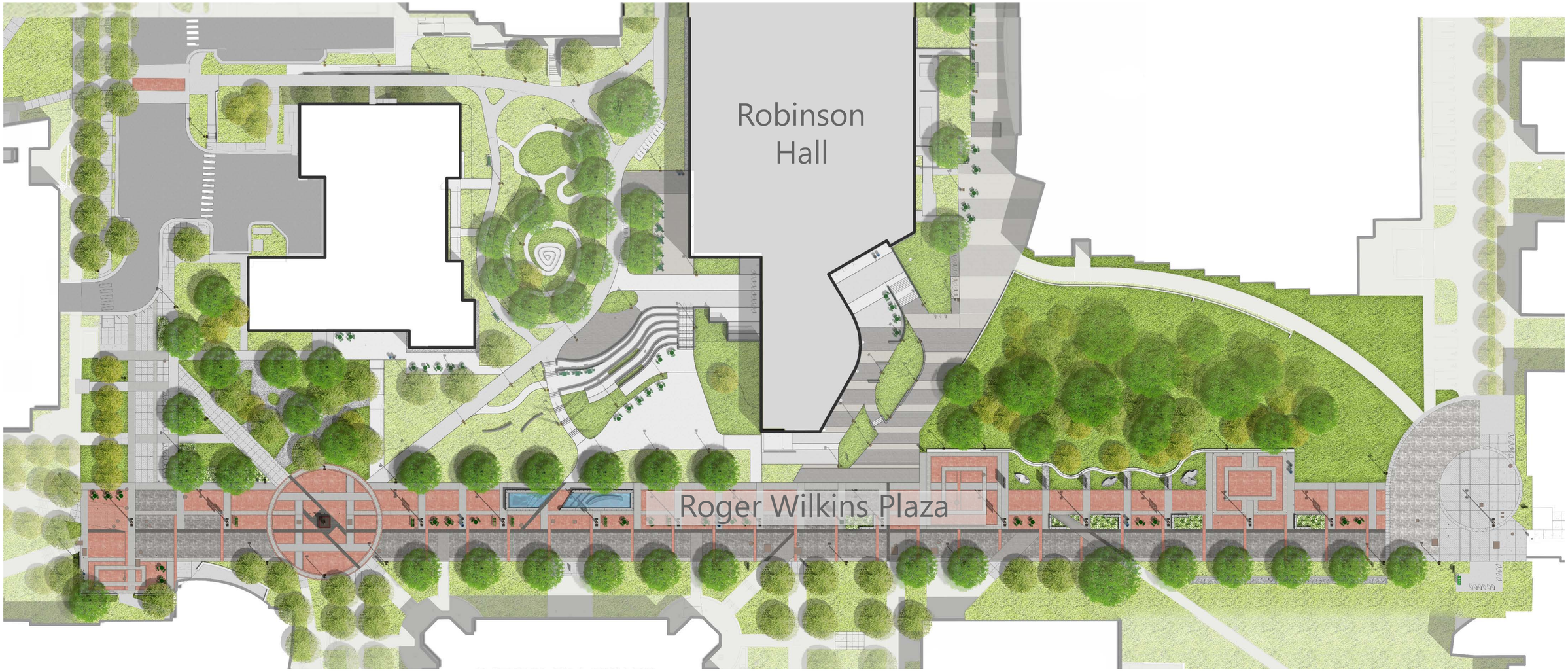
  3 Years (Complete 2021)
- Demolition of (2) Existing

  Buildings

Project Overview

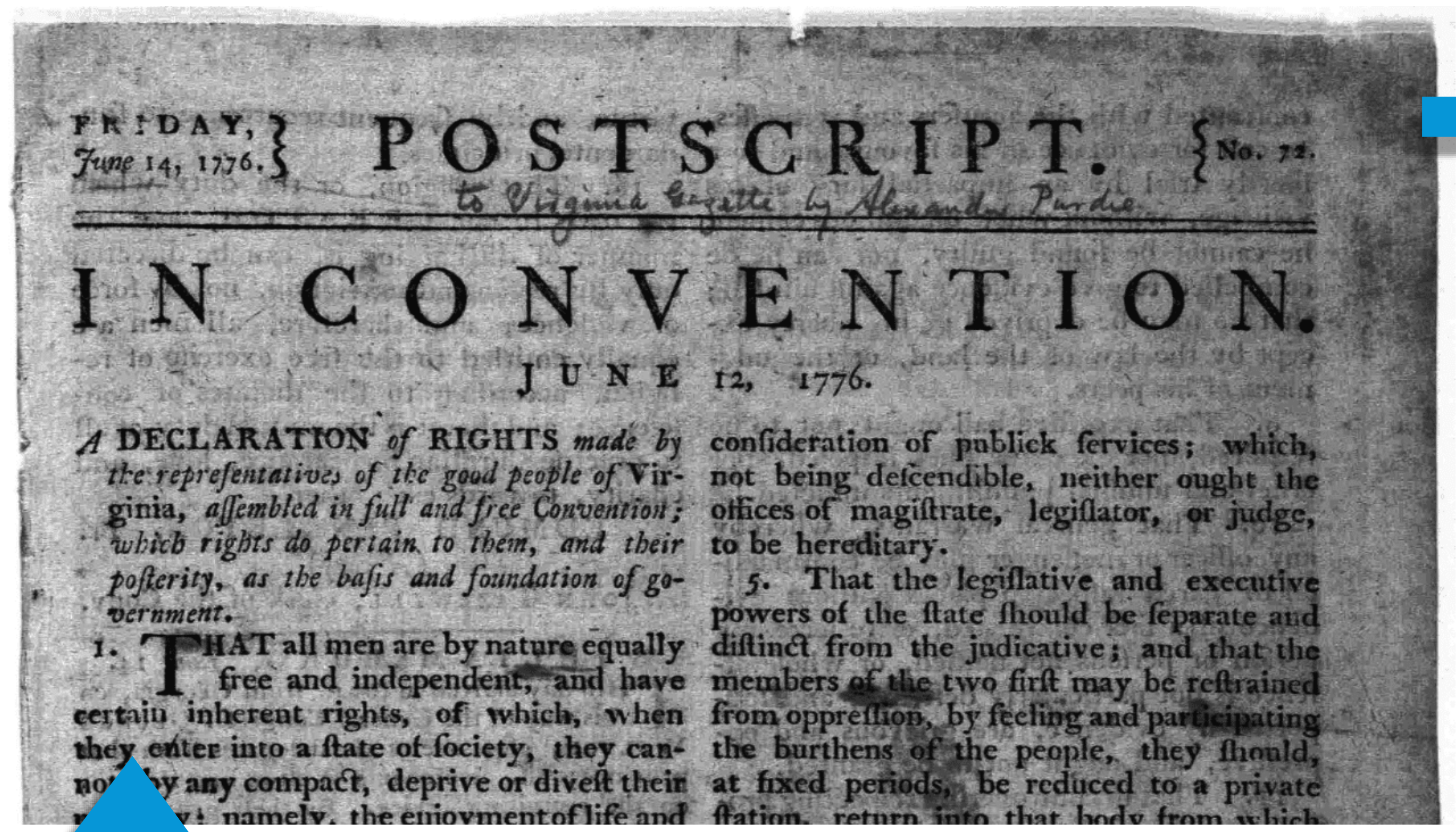
Roger Wilkins Plaza

“We have no hope of solving our problems without harnessing the diversity, the energy, and the creativity of all our people.”



Project Overview

George Mason – The Man, The Legacy, The Contradiction



FRIDAY, June 14, 1776. POSTSCRIPT. No. 72.

to Virginia Gazette by Alexander Purdie.

IN CONVENTION.

JUNE 12, 1776.

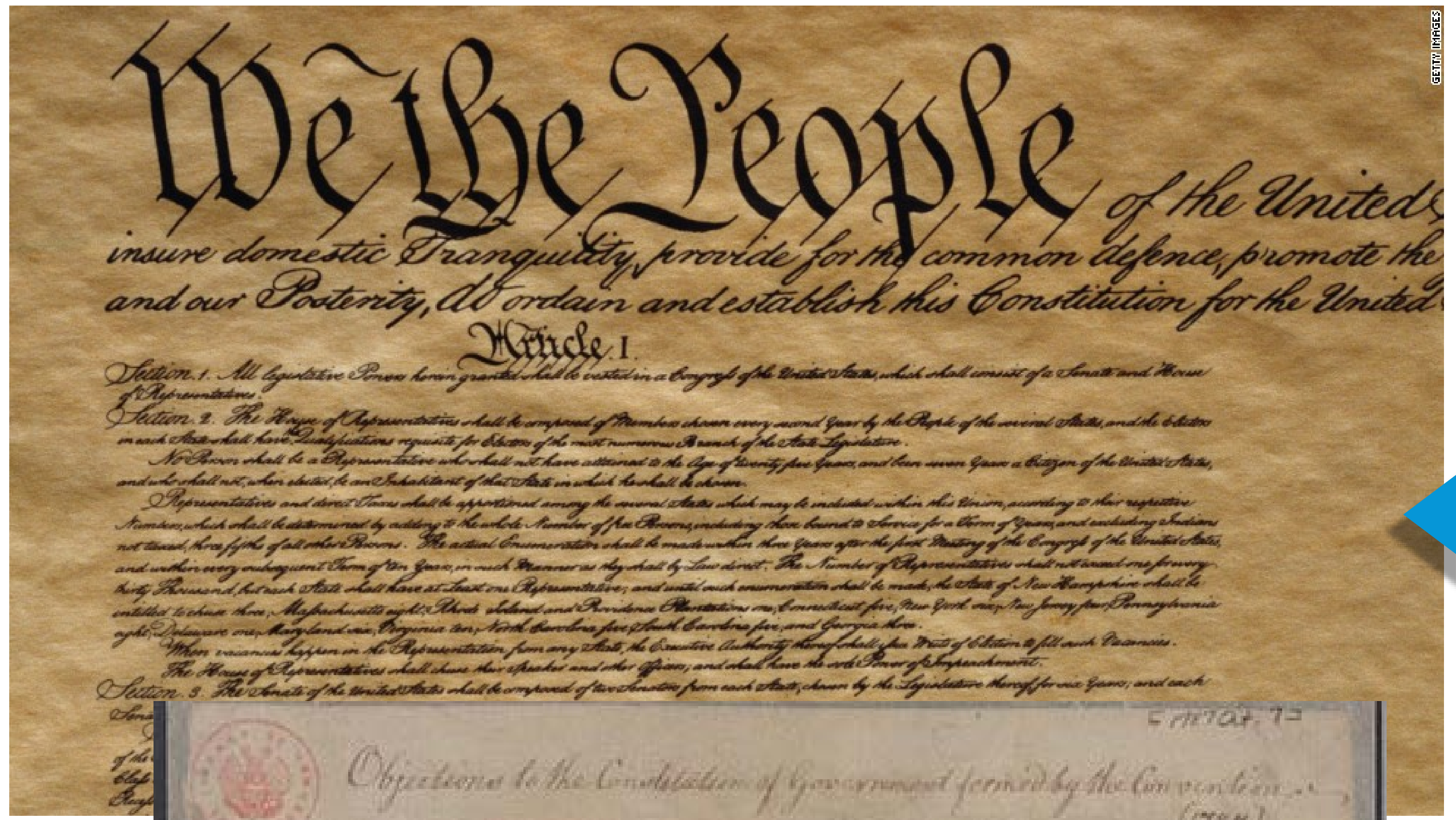
A DECLARATION of RIGHTS made by the representatives of the good people of Virginia, assembled in full and free Convention; which rights do pertain to them, and their posterity, as the basis and foundation of government.

1. THAT all men are by nature equally free and independent, and have certain inherent rights, of which, when they enter into a state of society, they cannot, by any compact, deprive or divest their posterity; namely, the enjoyment of life and

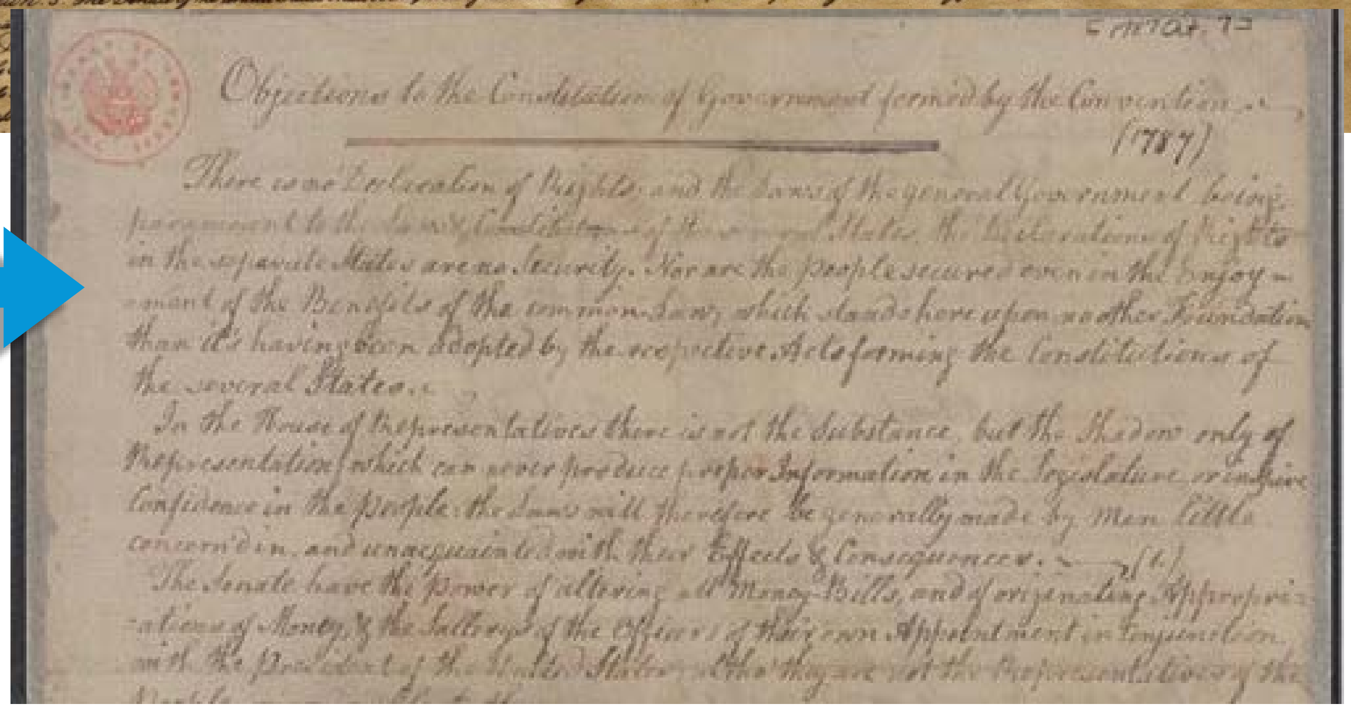
consideration of publick services; which, not being descendible, neither ought the offices of magistrate, legislator, or judge, to be hereditary.

5. That the legislative and executive powers of the state should be separate and distinct from the judicative; and that the members of the two first may be restrained from oppression, by feeling and participating the burthens of the people, they should, at fixed periods, be reduced to a private station, return into that body from which

Virginia Declaration of Rights - 1776

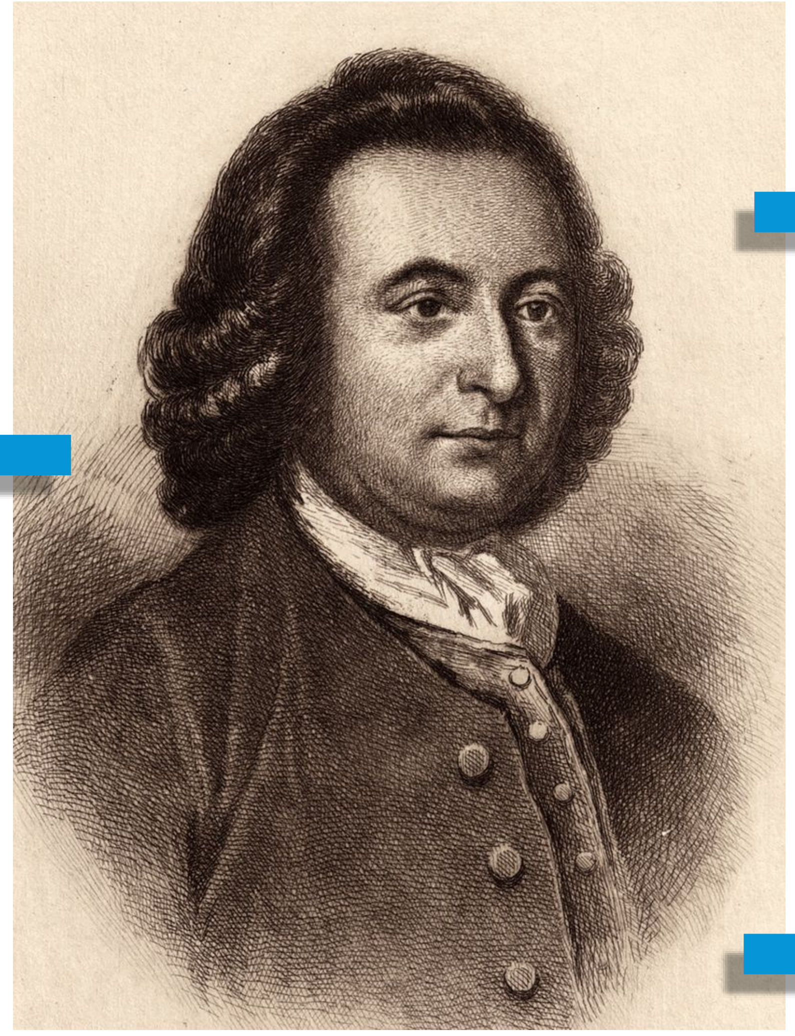


Bill of Rights - 1791



Objections to This Constitution of Government - 1787

George Mason IV



b:December 11, 1725
d:October 7, 1792

Gunston Hall


Video

Memorial Team Members

George Mason University

Wendi Manuel-Scott
ECGM director: School of Integrative Studies, History and Art History, African and African American Studies

Benedict Carton
ECGM director: History and Art History, African and African American Studies

George Oberle
ECGM director: History librarian Mason's Fenwick Library; affiliate faculty member History and Art History

Julian R. Williams
Vice President of Compliance, Diversity and Ethics, Compliance, Diversity and Ethics

Rick Davis
Dean, CVPA/Executive Director, Hylton Performing Arts Center, College of Visual and Performing Arts

Donald H. Russell
Director Provisions Research Library/University Curator, School of Art

Cathy Pinskey
Capital Program Director in Facilities; Project Manager, Core Campus Project

Michelle Gettle
Project Manager, Core Campus Project

Frank Strike
Vice President, Facilities

Student Researchers

Alexis Bracey
Ayman Fatima
Kye Farrow
Farhaj Murshed
Elizabeth Perez-Garcia

Stakeholder Groups

Executive Counsel
President's Counsel
Faculty Senate
Board of Visitors
VA Art and Architectural Review Board
Student Government

Project Overview

Initial Memorial Scope

1. Names of enslaved individuals: children, women, and men.
2. Smooth / cobble stone cylindrical design at bottom of water monument, centrally located.
3. Facsimile of the brick with thumb print of enslaved individual.

Figure 48. The small pit feature (F1-13), showing the top of the cobble deposit. A spiral pattern can be traced starting with the cobble with the red dot. The effect became more apparent after some of the soil matrix had been removed from between the stones. The arrangement may or may not be intentional.

Figure 50. A cowrie shell with a Mason bottle seal and one of the two pieces of petrified wood found near it in the pit feature F3-13.

LIST OF SLAVES OWNED BY GEORGE MASON IV

** Note: Two or more slaves with the same given name may be listed together due to lack of evidence distinguishing one slave from another.

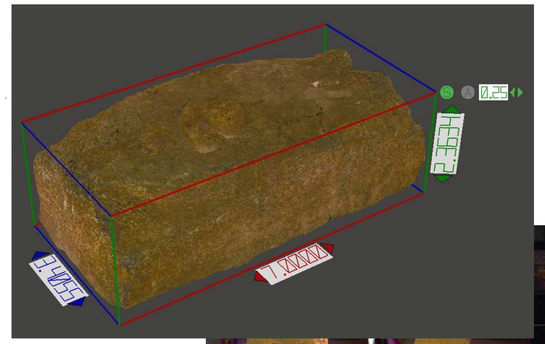
1749 According to Rev. Green's Tithable List for Fairfax Co., GM owns **11 tithable slaves** [i.e., slaves over age 16]. Donald Sweig, in Fairfax County, Virginia: A History, doubles this figure for a total estimate of **22 slaves**.

1782 According to the tax lists of Martin Cockburn and Charles Little, GM owns **128 slaves**.

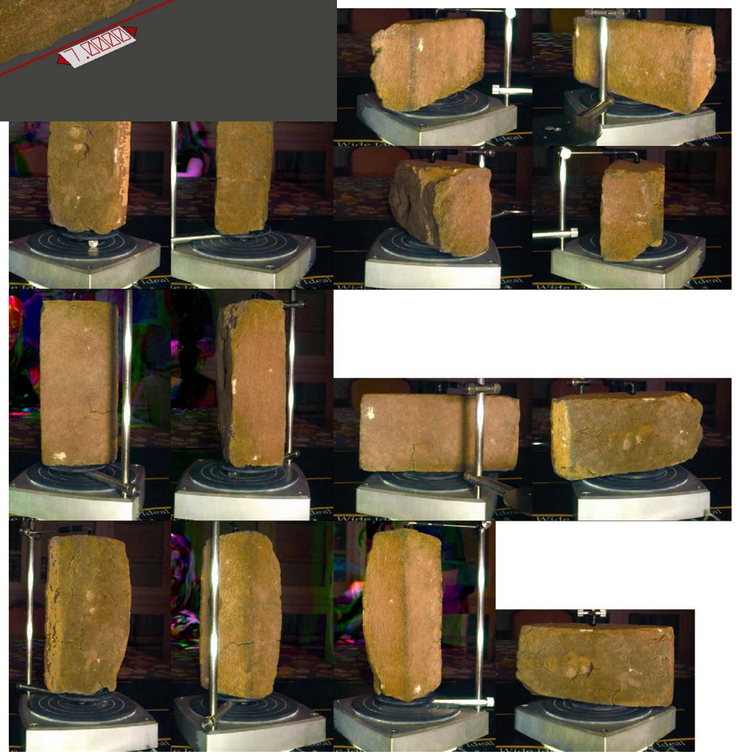
1787 According to the tax lists of Martin Cockburn and Charles Little, GM owns **100 slaves**; i.e., 45 over age 16 and 55 under age 16.

****

Alice - bequeathed to GM in Ann Thomson Mason's will (25 Aug. 1760); listed in GM's will (20 March 1773).



COURTESY OF VCU



Project Overview

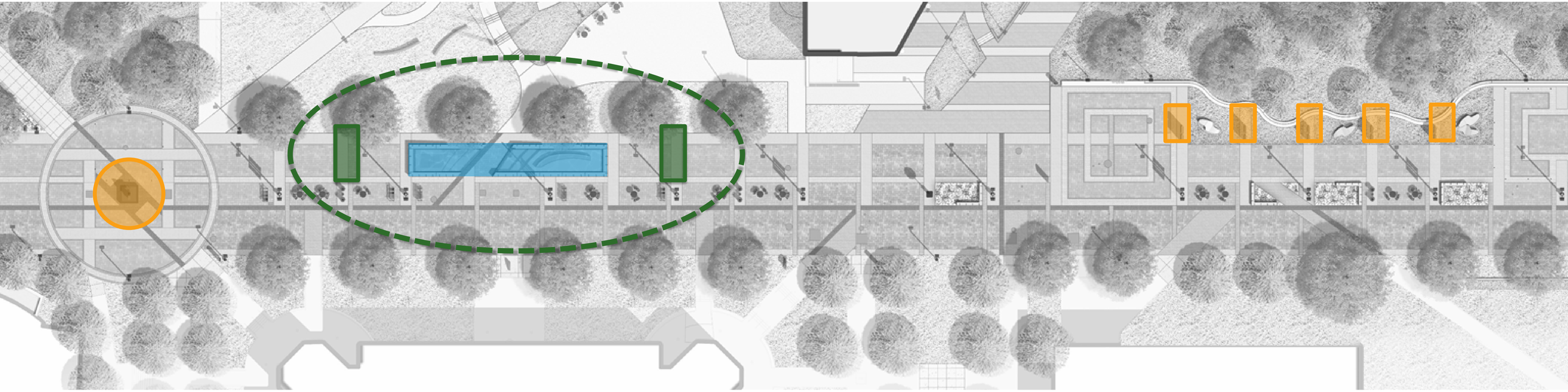
Design Parti

Incorporate the Memorial into a larger context encapsulating existing campus language / elements.

Existing Statue

Memorial

Relocated Voice Walls



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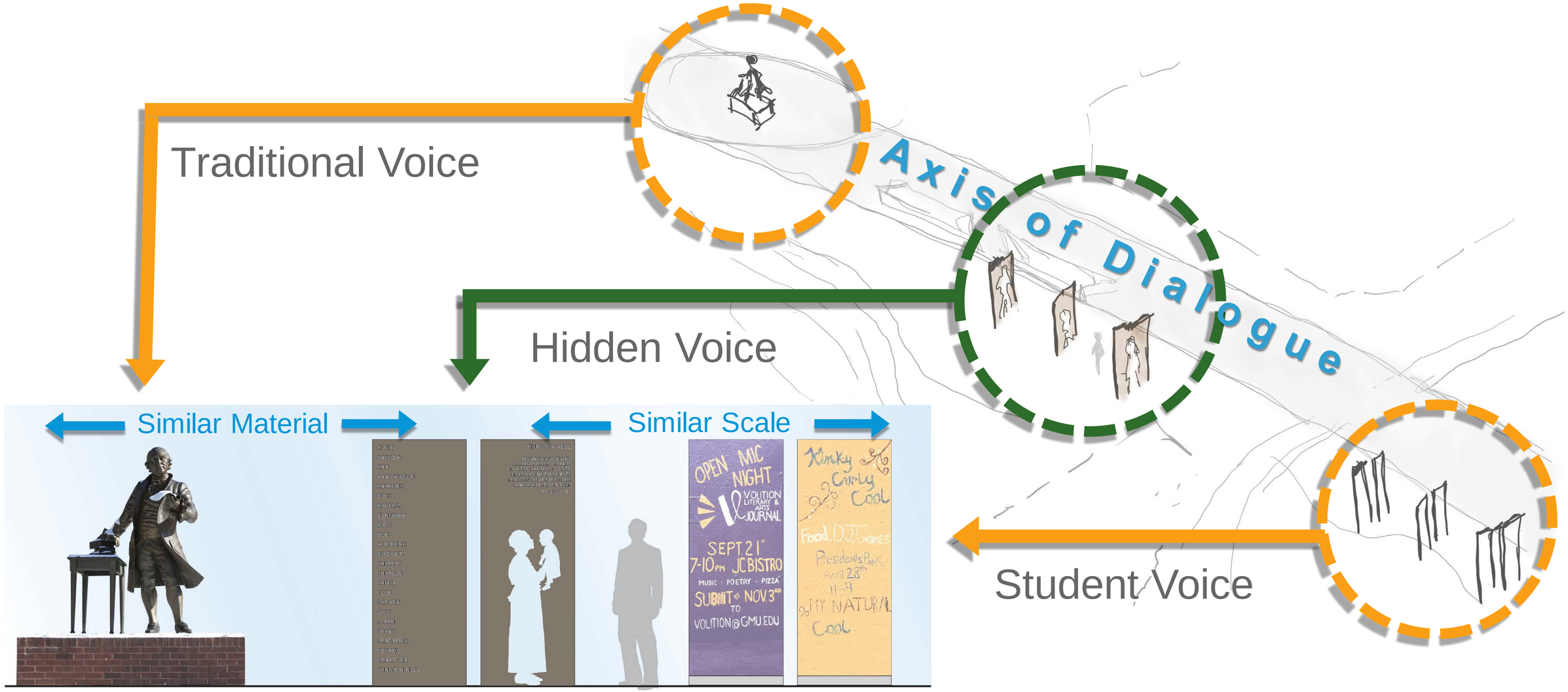
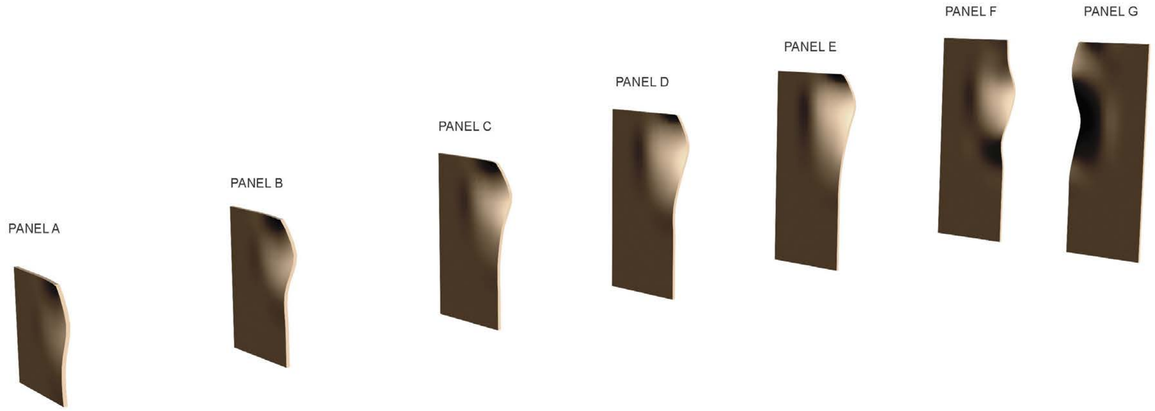
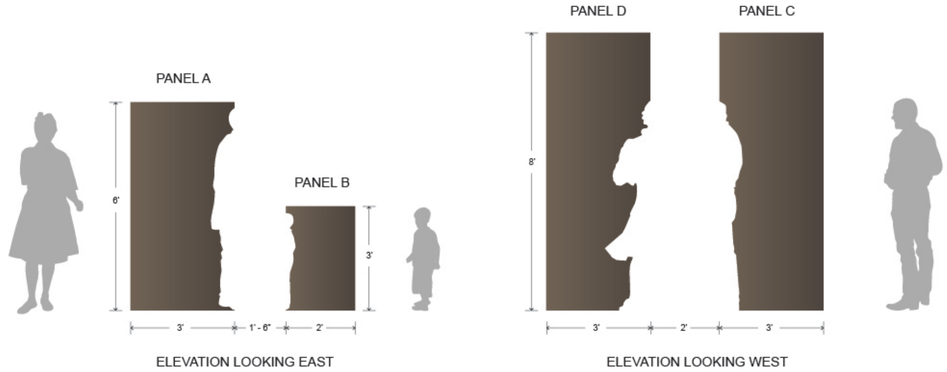


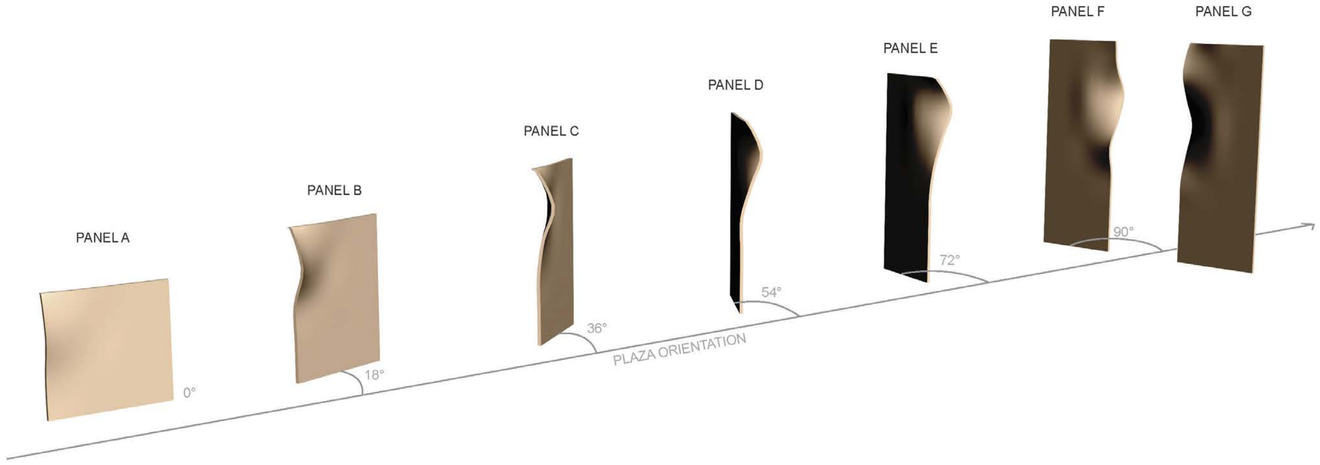
Project Overview

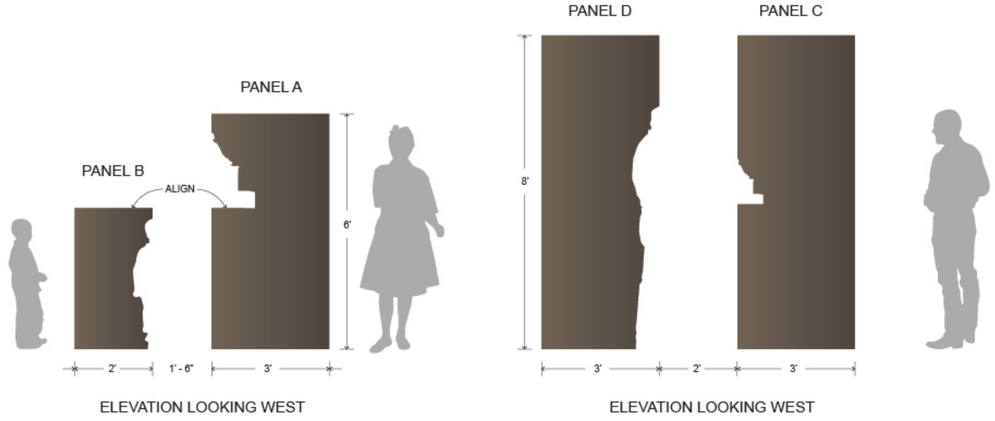
Memorial Design Iterations

Personal Connection was preferred to the Abstraction of the message.









Project Overview

Memorial Design Iterations

Interpretation of Selected Individuals

Penny came to live at Gunston Hall as a young girl. Grandfather Eilbeck gave each of the first six Mason children a slave child - a companion to grow up with and to have as a personal body servant or traveling companion. Penny became such a gift to Nancy Mason probably when both girls were about the age of 10 or 12. For Penny, this meant leaving her Maryland home and family and moving to Virginia.

„., Penny may have lived in the mansion house and slept on a pallet or mattress on the floor in the same room with Nancy. Or she may have been assigned a place to live with other slaves in the adjacent outbuildings - with people she did not know. Either waif, young Penny had many adjustments to make in her new life with Nancy.

Her tasks probably included laying out clothes, mending, tending Nancy when she was ill, and traveling with her to friends' homes. An occasional reward might be some hand-me-down clothing or a piece of unwanted jewelry. Certainly Penny watched as young men courted Nancy. Perhaps it was with excitement that she learned that Nancy would marry a young man from Maryland! Now Penny would return to an area of family and friends.

Penny spent more than 40 years serving Nancy. She probably did not marry; she had no children of her own.

James, the one individual mentioned by name in John Mason's *Recollections,* served as the personal body servant to George Mason. John wrote, "[My father's wigs] were dressed & prepared by his man James, a mulattoe man, who attended on his person and traveled with him." As a manservant to the master of the plantation, James held a unique position. He not only waited on George Mason personally, but he also wore livery (or uniform) that distinguished him as he opened the door for visitors to Gunston Hall. A family friend would be escorted directly inside, but a traveler or someone there on business (Mason was the county justice of the peace) might be made to wait. James had authority and discretion. In the hierarchy of enslaved individuals, James also had the greatest privilege and freedom of movement. He traveled with George Mason to Williamsburg, Richmond, and perhaps Philadelphia. His experiences in other places and his comparison to life outside of Gunston Hall filtered back into discussion with others in the slave community on his return.

Project Overview

Memorial Design Iterations

Final Design

TIED TO EACH OTHER THROUGH THE EXPERIENCE OF THE SPACE

FOCUS: HOW MASON VIEWED HIMSELF

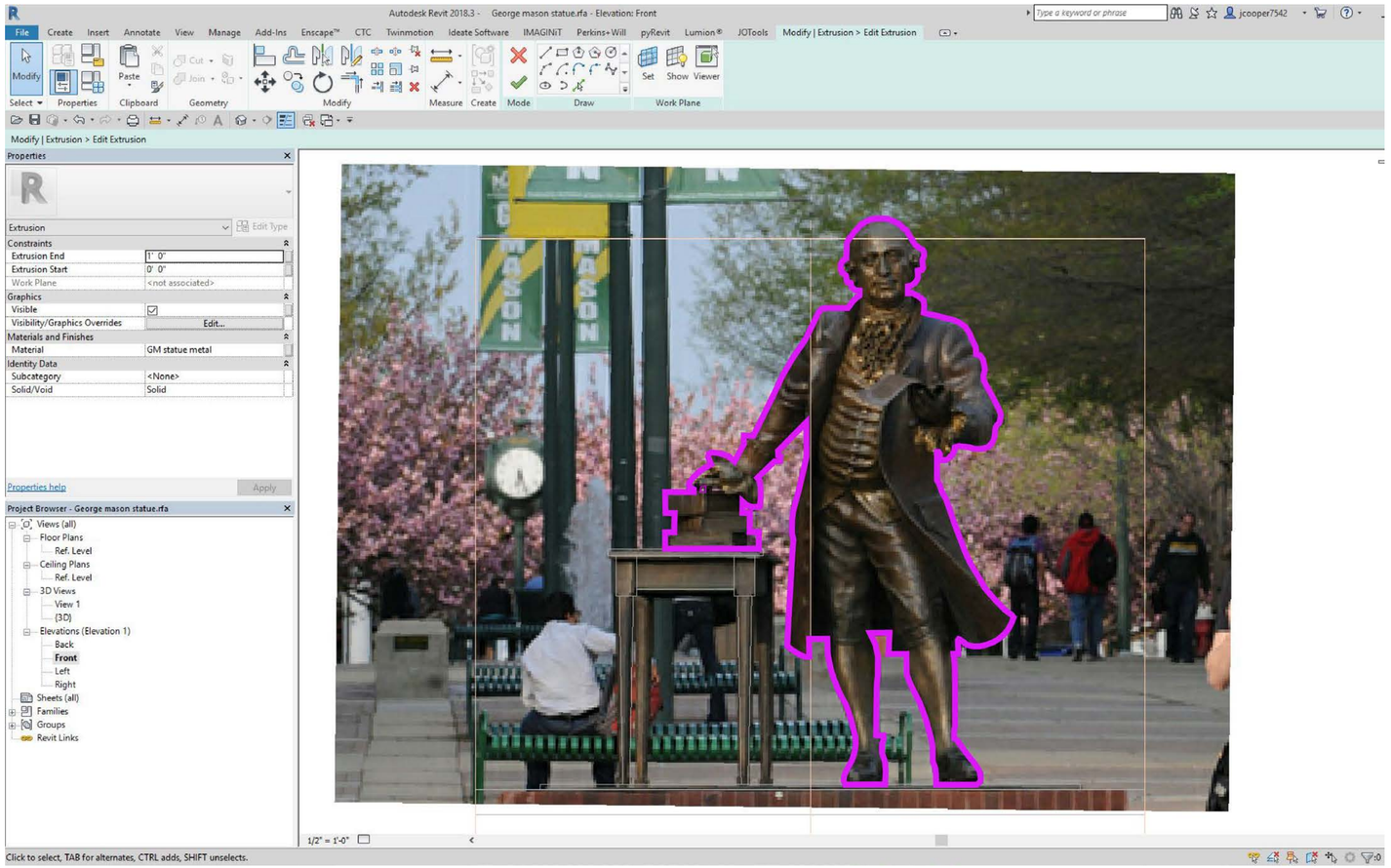
FOCUS: REFLECTIONS ON MASON'S CONTRADICTIONS AND WHERE WE ARE TODAY / CIVIL RIGHTS

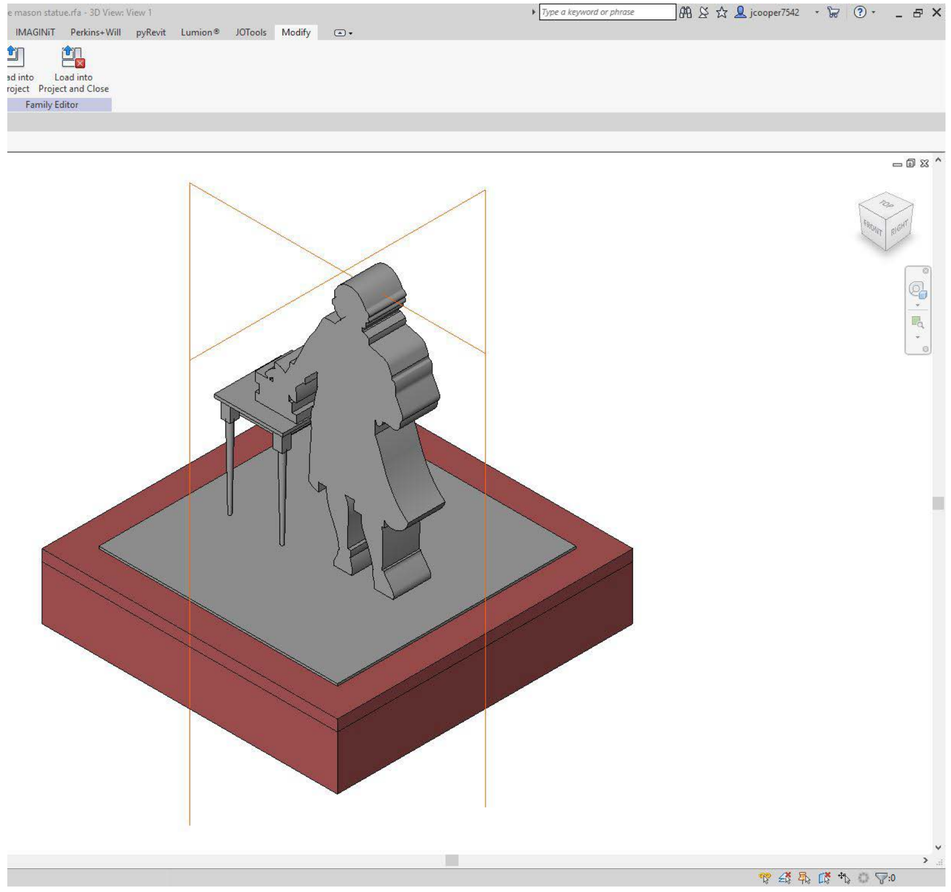
Video

Case Study: Memorial to the Enslaved People of George Mason

Statue Extrusion has Served its Purpose

Thank you, ‘Flat’ Mason





Case Study: Memorial to the Enslaved People of George Mason

Project Goals

WHAT WILL THE SCAN BE USED FOR?

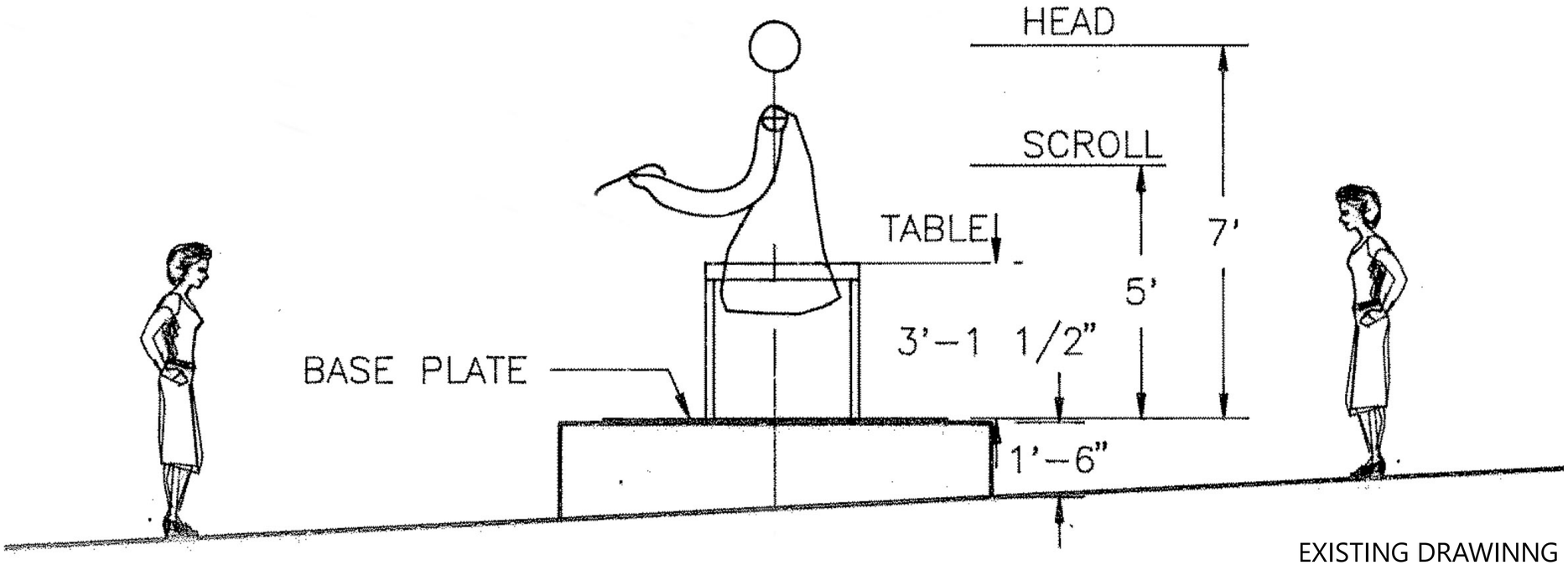
- To determine for the profile design of the Penny and James panels
- Basis for new plinth design
- Visualization, 2d images to virtual reality

WHAT ASPECTS OF THE SUBJECT ARE IMPERATIVE?

- Mason’s form, especially the northeastern profile
- Textures need to be included for visualizations
- As accurate as possible

Case Study: Memorial to the Enslaved People of George Mason

Preparing for Photography



EXISTING DRAWINNG

SCALE

- Large, heavy, and secured; Immovable
- Drones not allowed, Campus within FRZ (Flight Restricted Zone) WASHINGTON D.C.
- Requires lift or ladder

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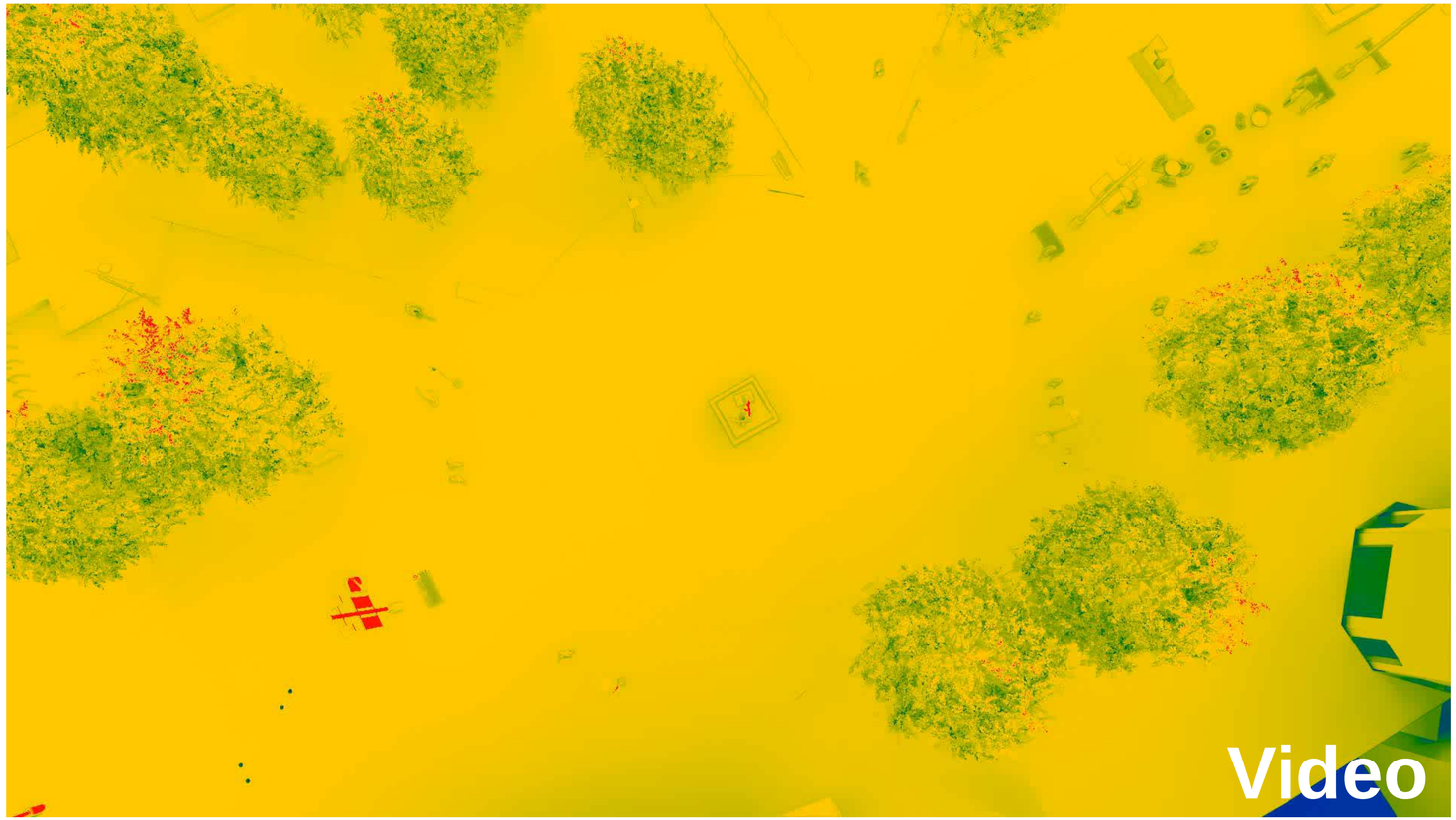
Preparing for Photography



LIGHTING

- Too large a scene for artificial lights
- Possibly could use a large diffuser during day
- Dusk, dawn and cloudy skies are the best bets

Case Study: Memorial to the Enslaved People of George Mason

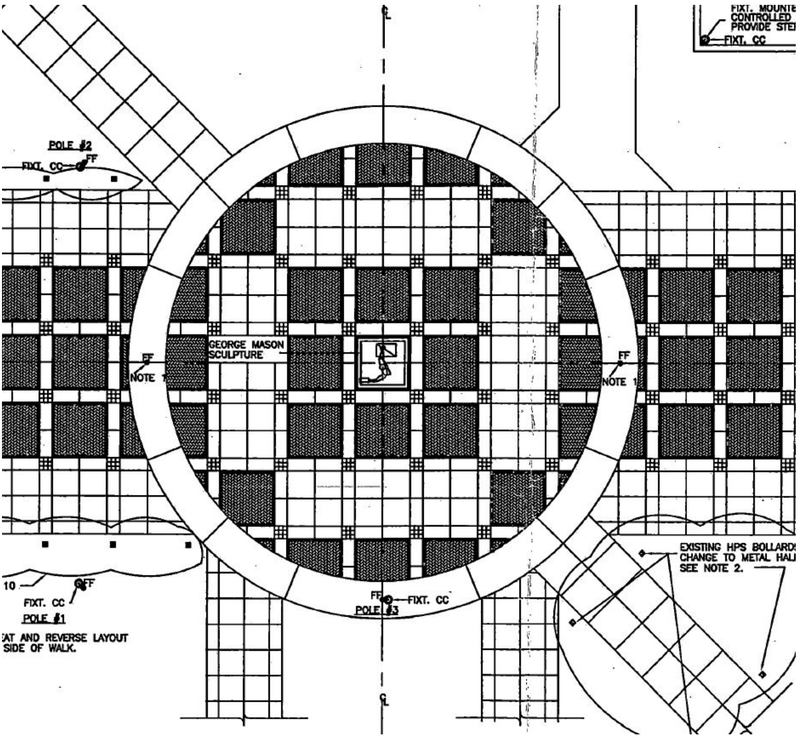
Preparing for Photography

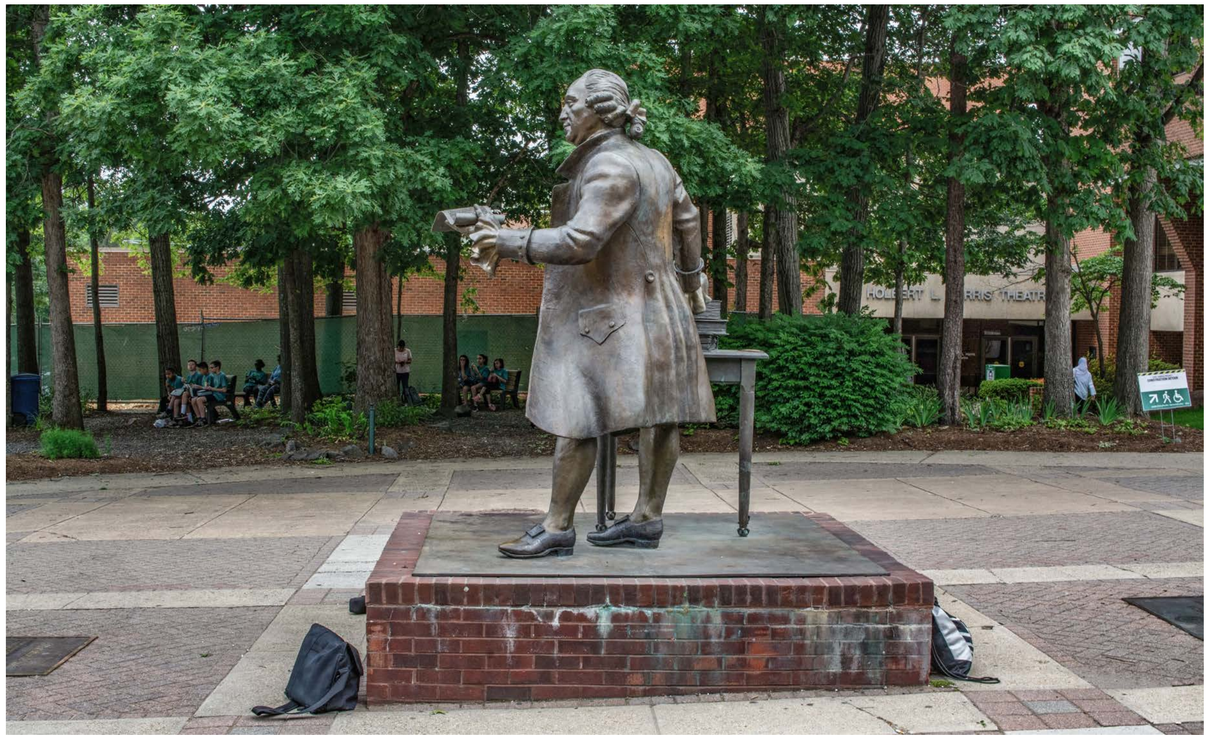
SURFACE PROPERTIES

- Bronze - moderately reflective
- Highly textured with discernable features
- No sprays or “dullers”, Polarizing filter to help decrease reflections

Case Study: Memorial to the Enslaved People of George Mason

Preparing for Photography





LOCATION

- Statue has decent contrast with the environment
- Informed of possibly utility construction in adjacent area
- Took note that it is located on a heavily used pedestrian path
- GMU Delivery drones!

Case Study: Memorial to the Enslaved People of George Mason

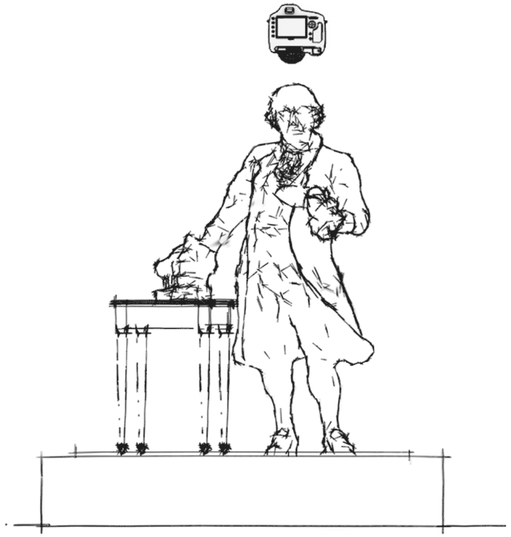
Preparing for Photography

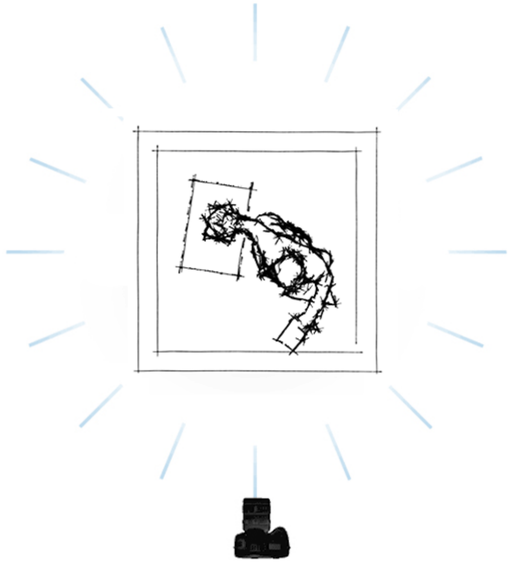
POSITION

- Cannot be moved
- Identified areas of concern: table, scroll, area between table and Mason

Case Study: Memorial to the Enslaved People of George Mason

Photography Technique





WALK AROUND

- Move around mason in even increments at two to three levels
- Get close ups of detailed areas: face, hair, coat and books
- Pay attention to hard to the areas between table and Mason

Case Study: Memorial to the Enslaved People of George Mason

Photogrammetry Equipment

CAMERA

- Nikon D3300 – Entry Level DSLR
- 24 Megapixel

LENS

- Sigma 30mm F1.4 Art
- Prime lens (non zoom)
- Angle of View 50.7° (Human Eye central angle 40-50°)

Memorial to the Enslaved People of George Mason

Scan Day!

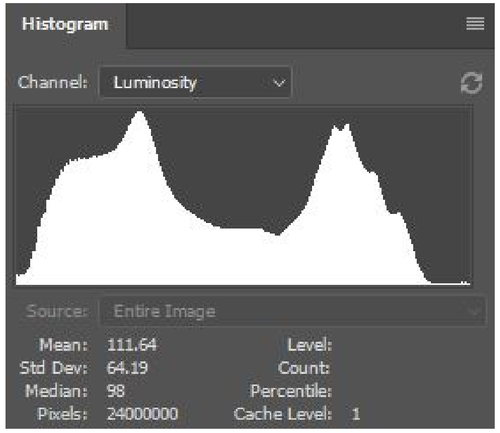
Case Study: Memorial to the Enslaved People of George Mason

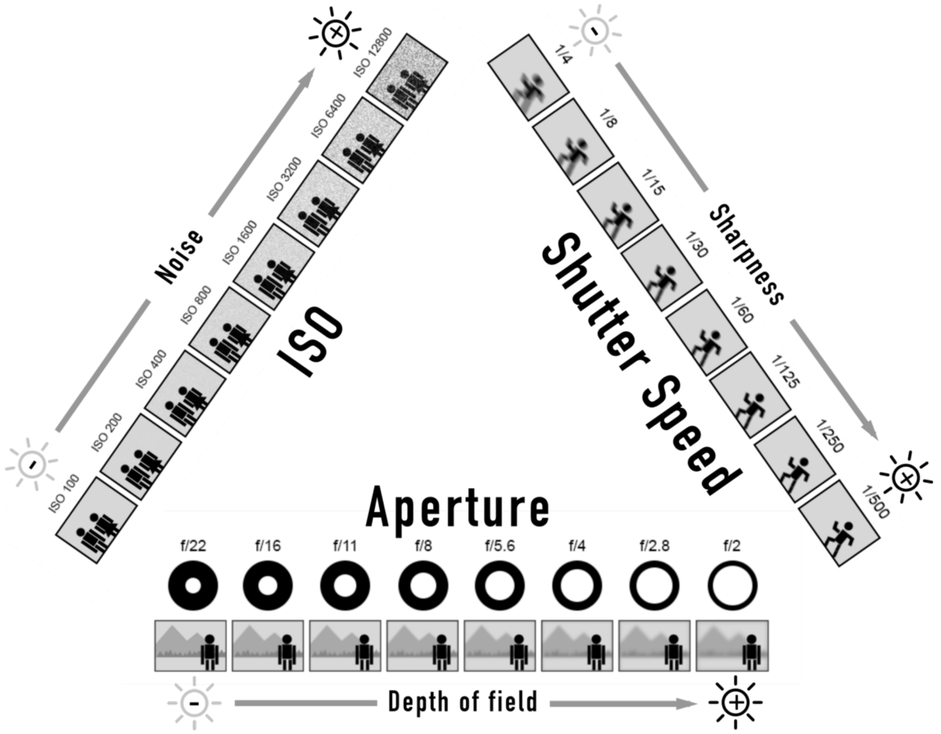
Photograph Set 01

Aperture: F/16

Shutter Speed: 1/100 sec.

ISO: 640





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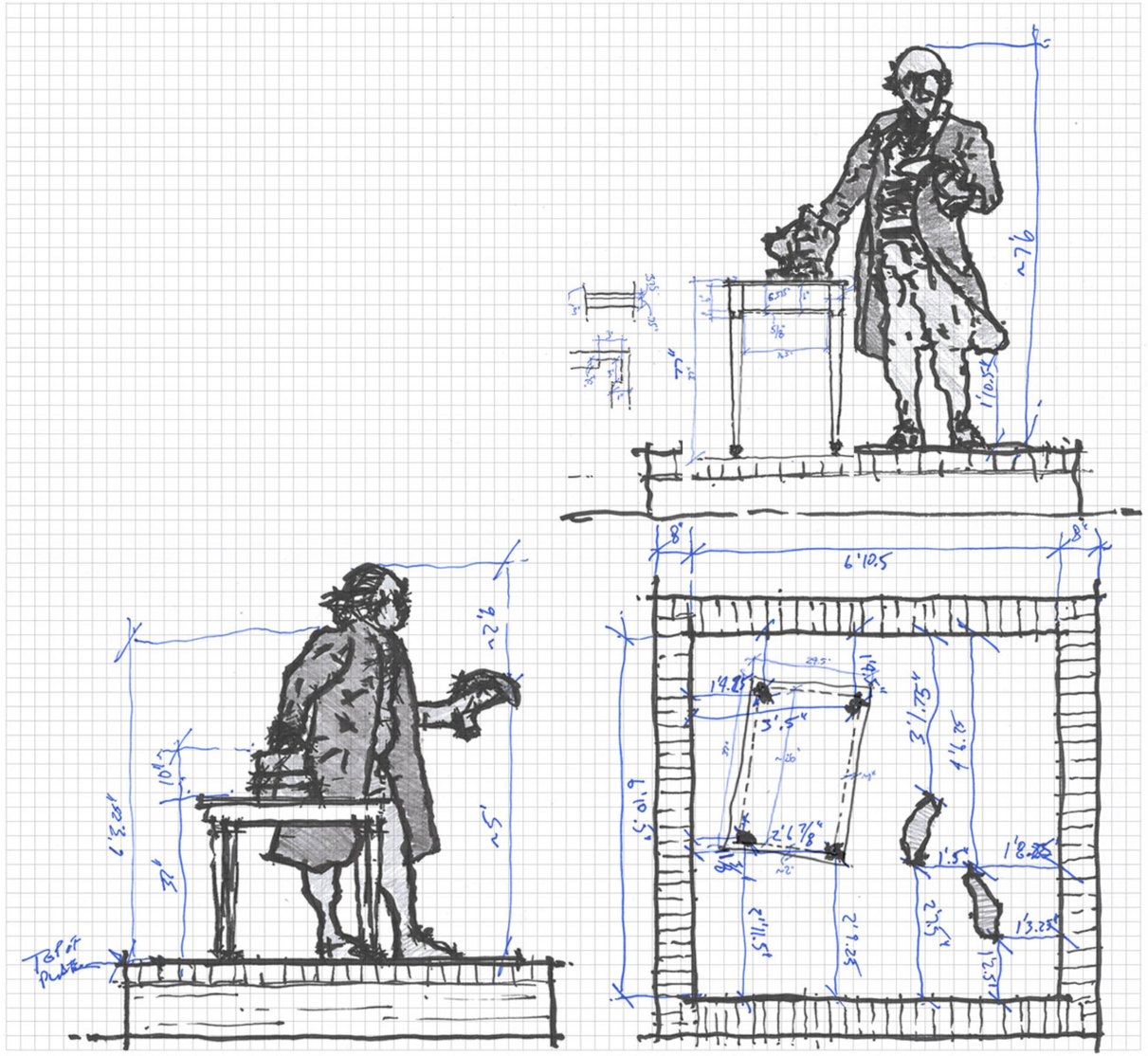
Dimension Sketch



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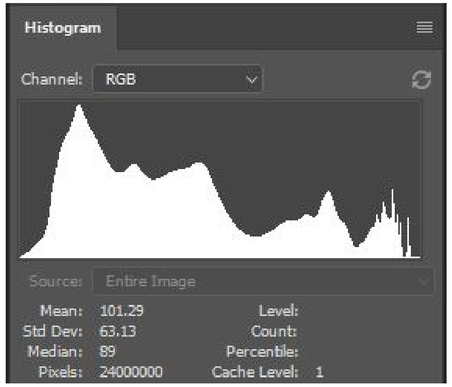
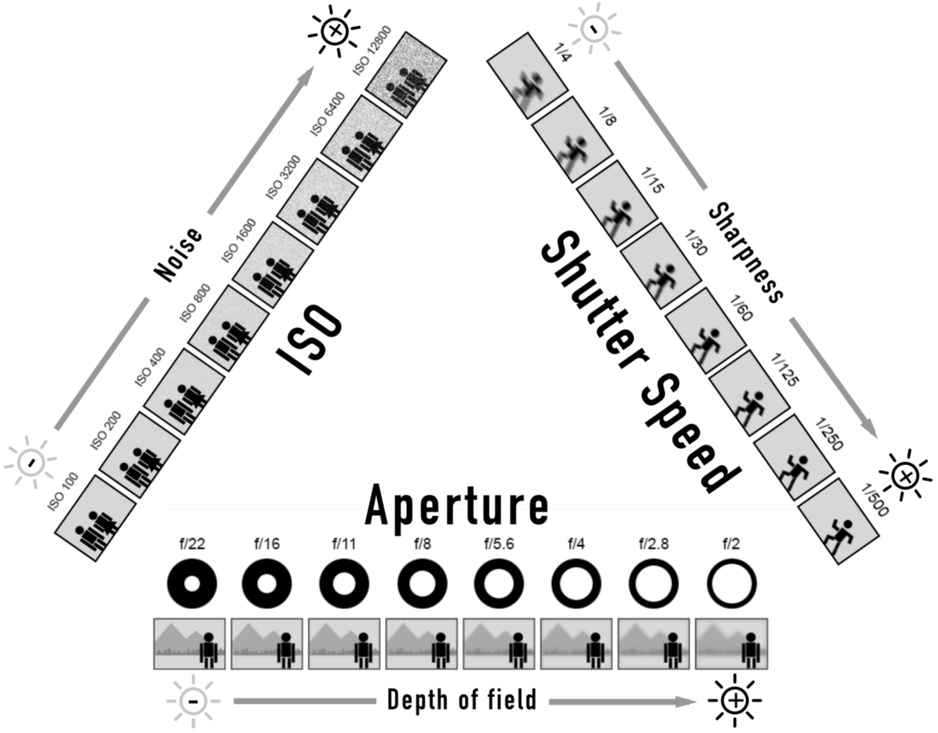
Photograph Set 02

Aperture: F/8

Shutter Speed: 1/200 sec.

ISO: 200





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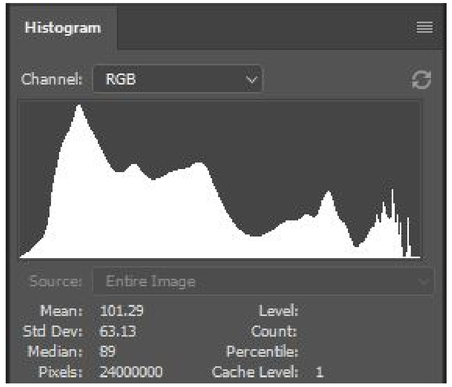
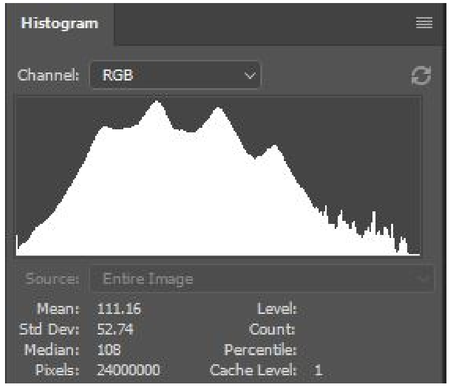
Post Processing Set 02





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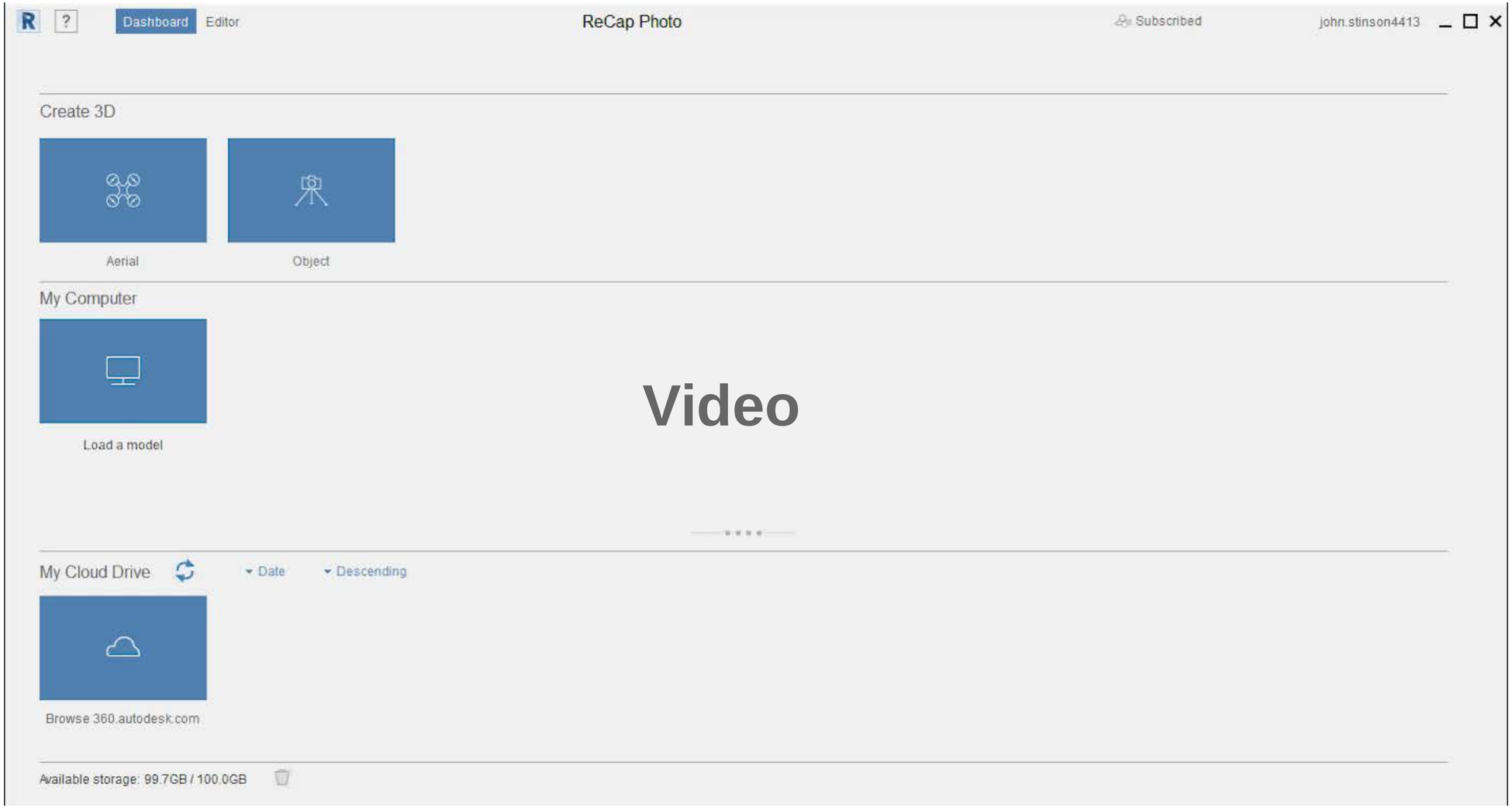
Uploading Picture Set



Case Study: Memorial to the Enslaved People of George Mason

Mesh Review

- Remove brick plinth
- Model bronze plinth, table, and scroll from dimension sketch

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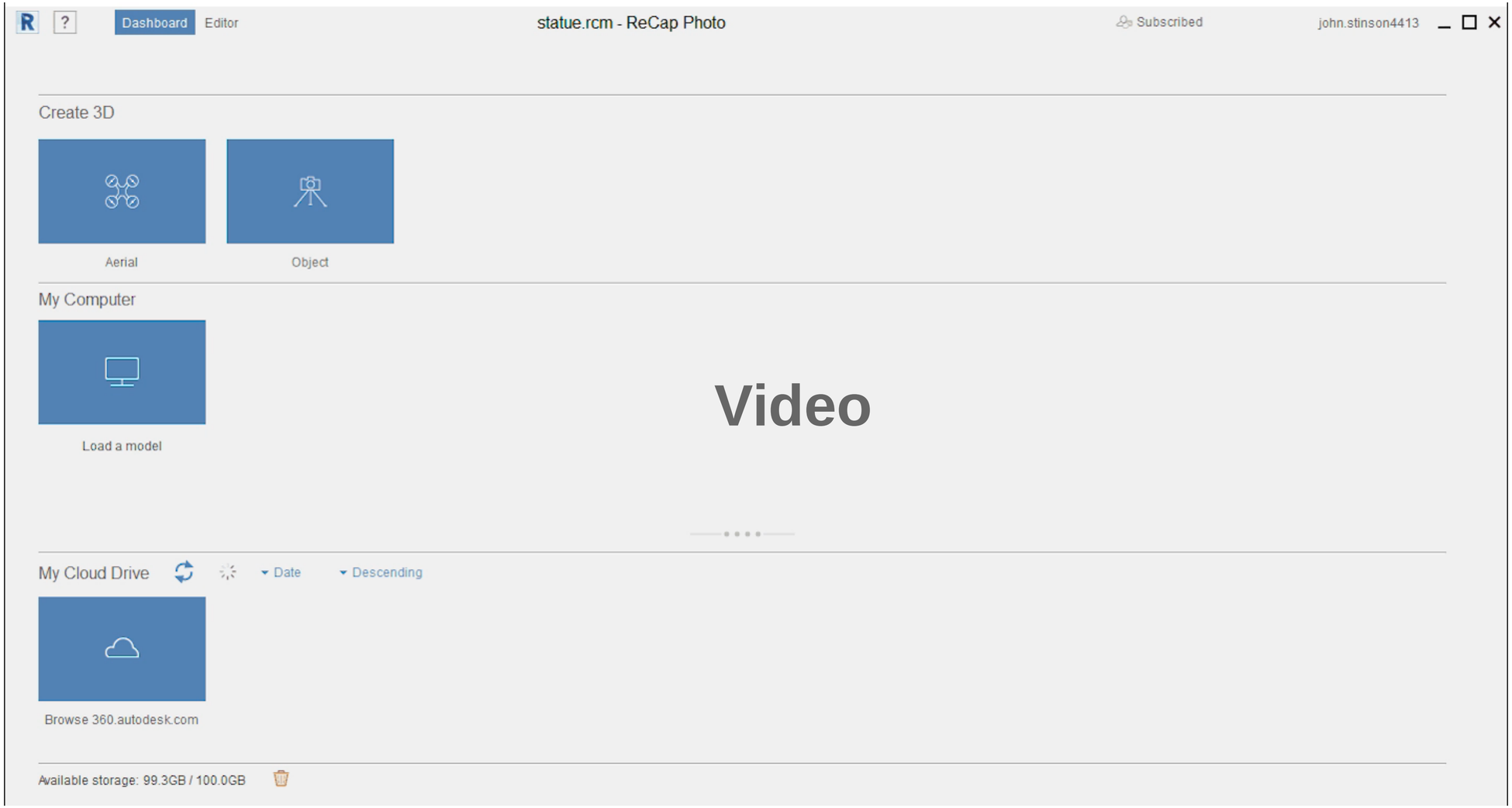
Editing Scanned Mesh

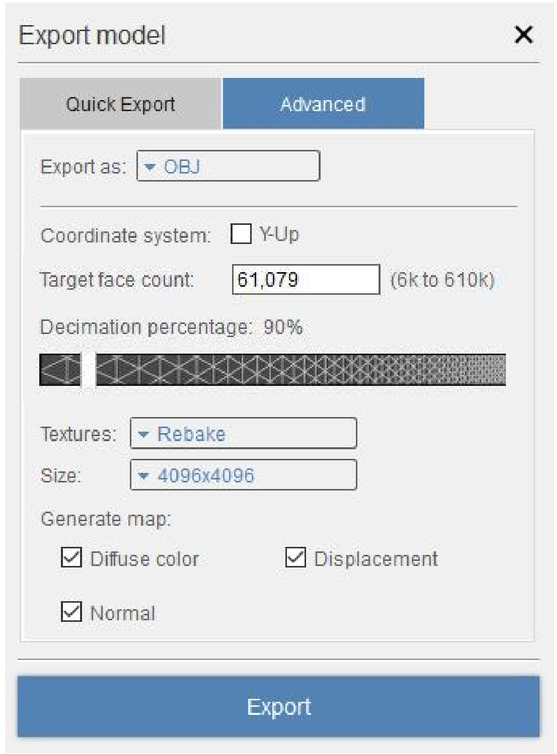


Case Study: Memorial to the Enslaved People of George Mason

Exporting Scanned Mesh

FULL RESOLUTION
~600K FACES

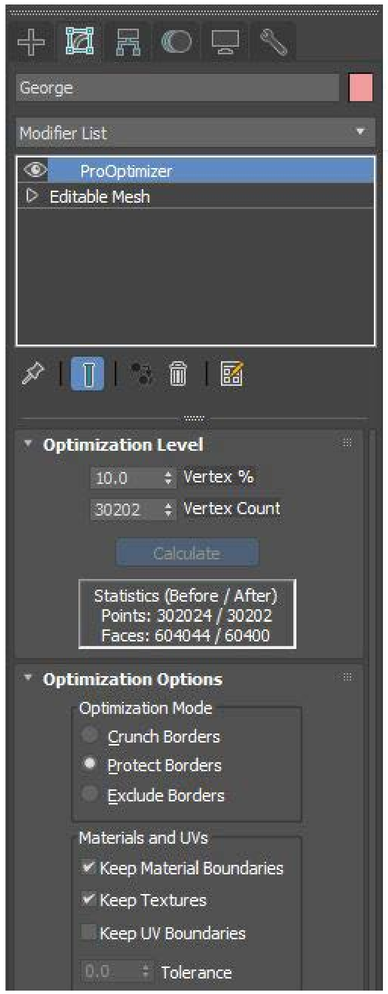
FULL RESOLUTION
~600K FACES



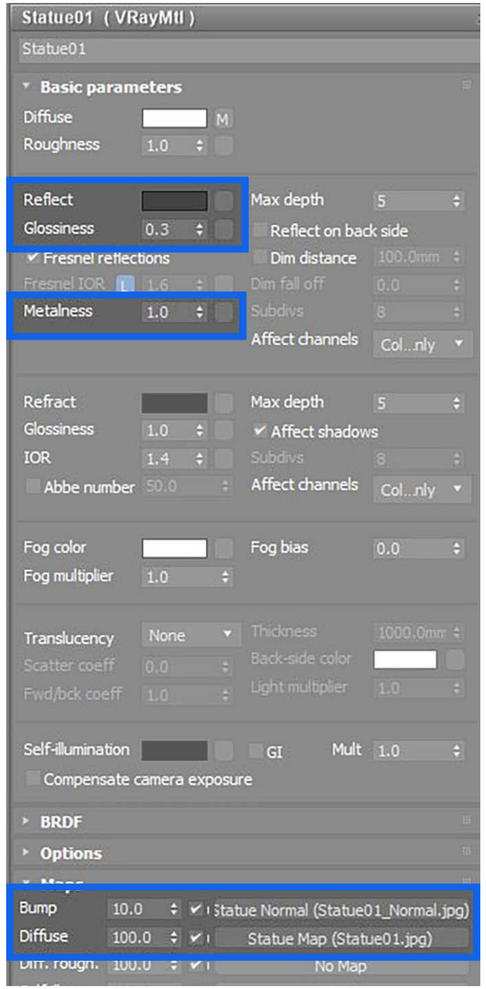
DECIMATED MESH
~60K FACES

DECIMATED MESH
~60K FACES

Preparing Scanned Geometry for Visualization



ProOptimizer Modifier



Metallic Material

Video

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Rendering

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Conceptual Design Model vs Scanned Model

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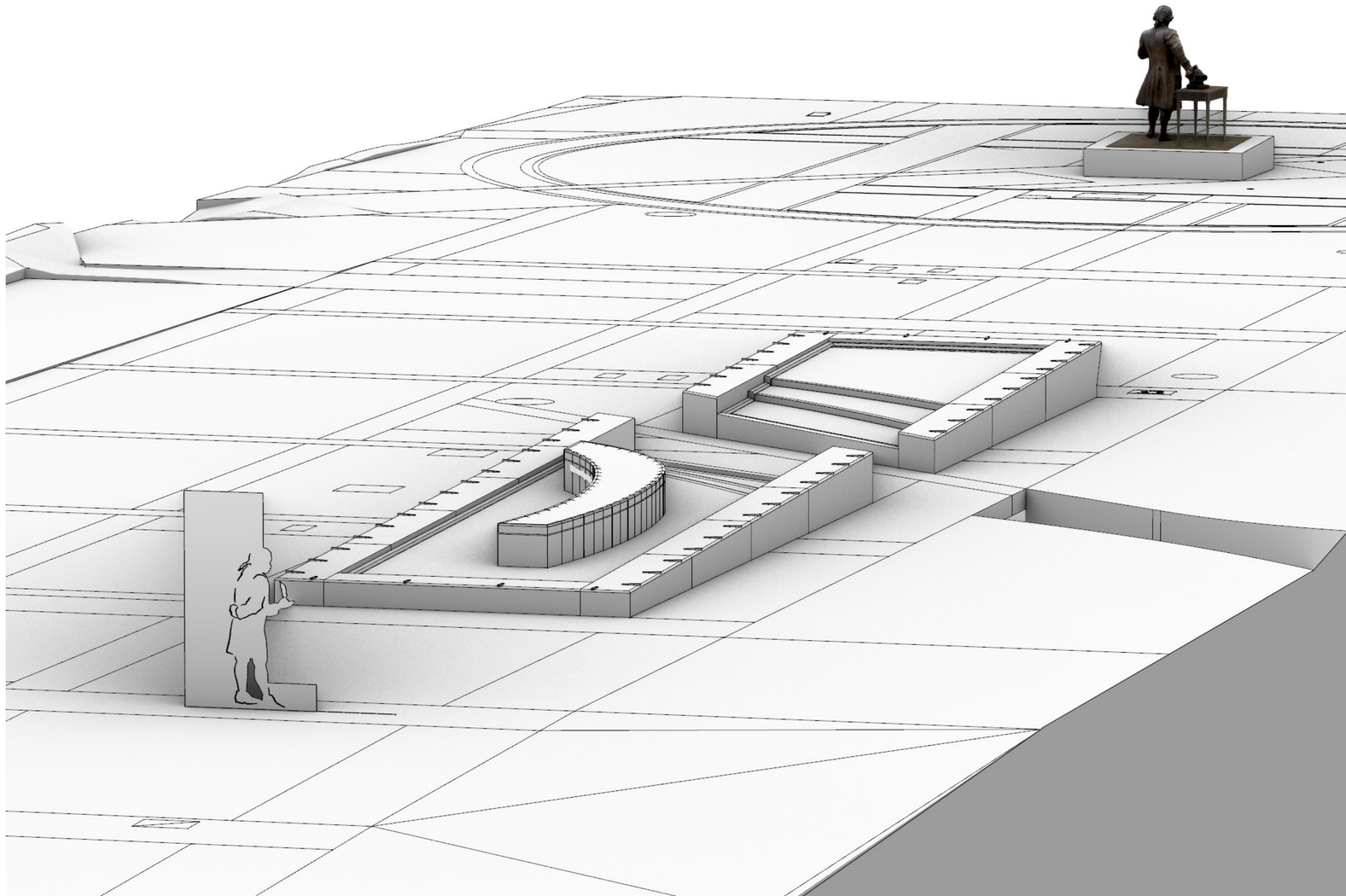
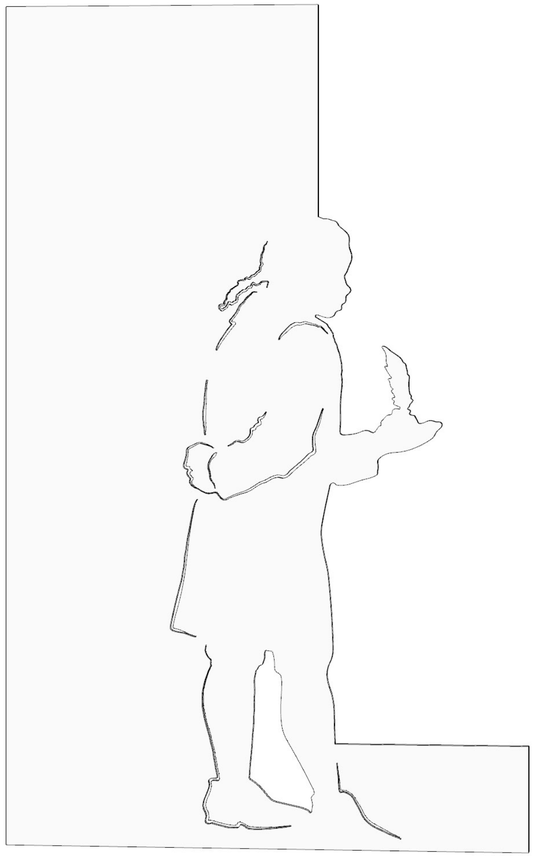
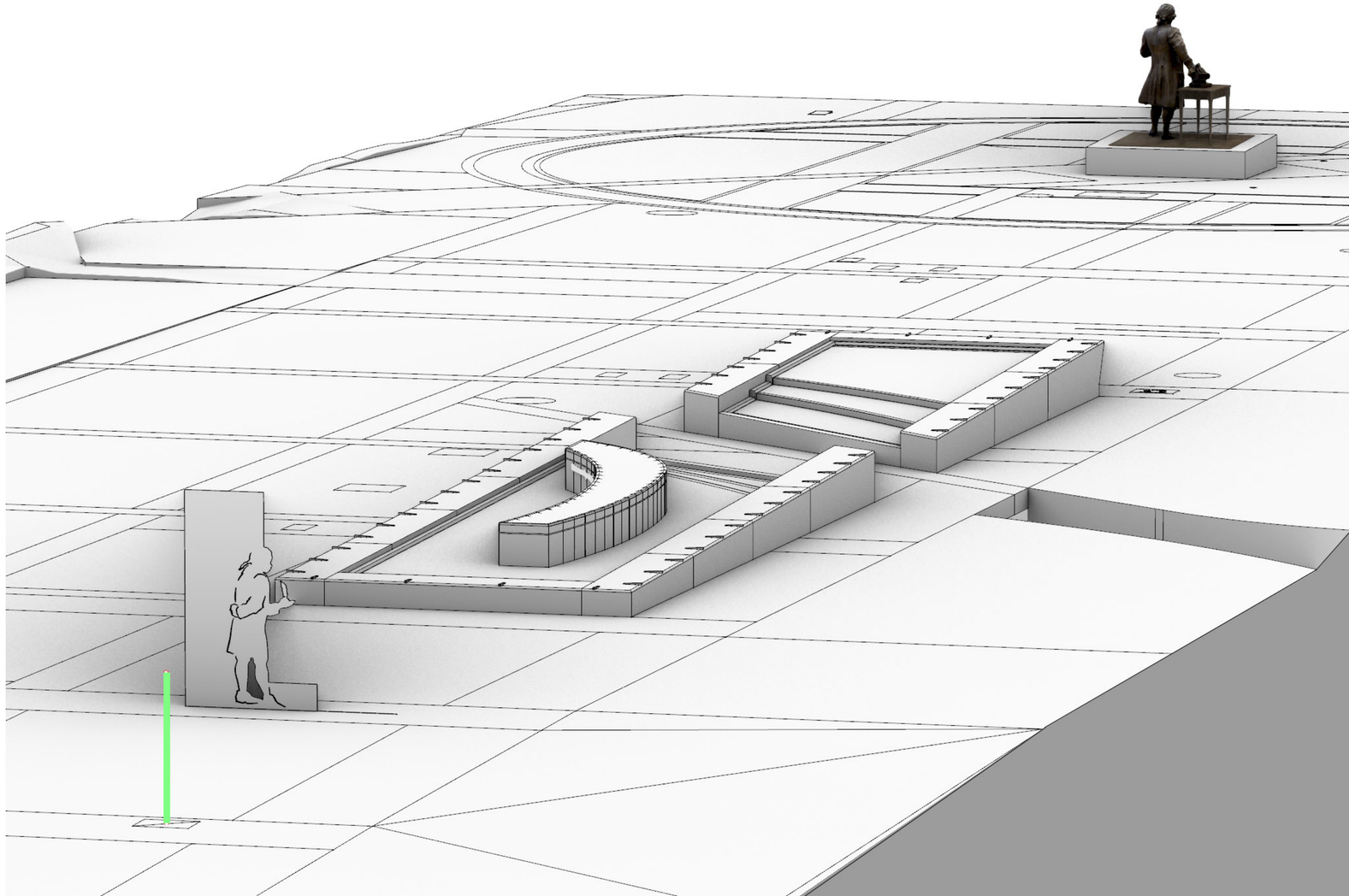
Utilizing Scanned Geometry for Modeling Operations



Case Study: Memorial to the Enslaved People of George Mason

Utilizing Scanned Geometry for Modeling Operations





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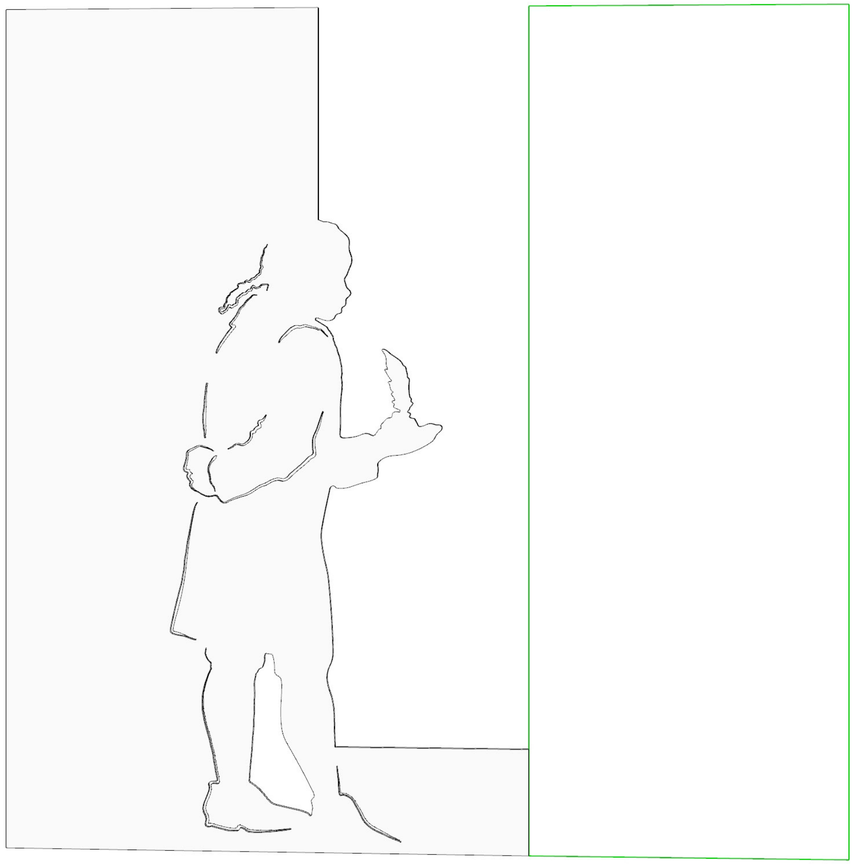
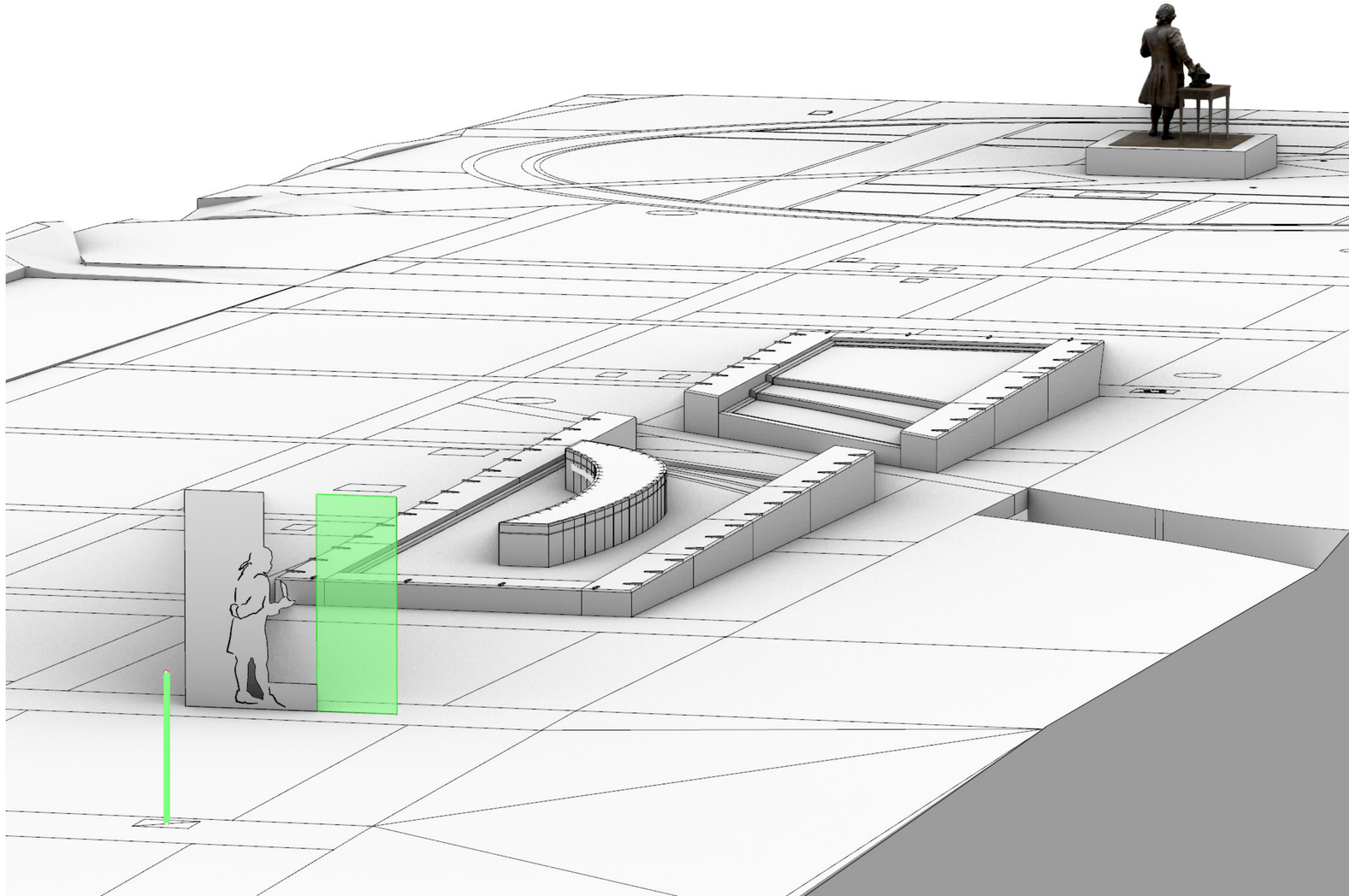
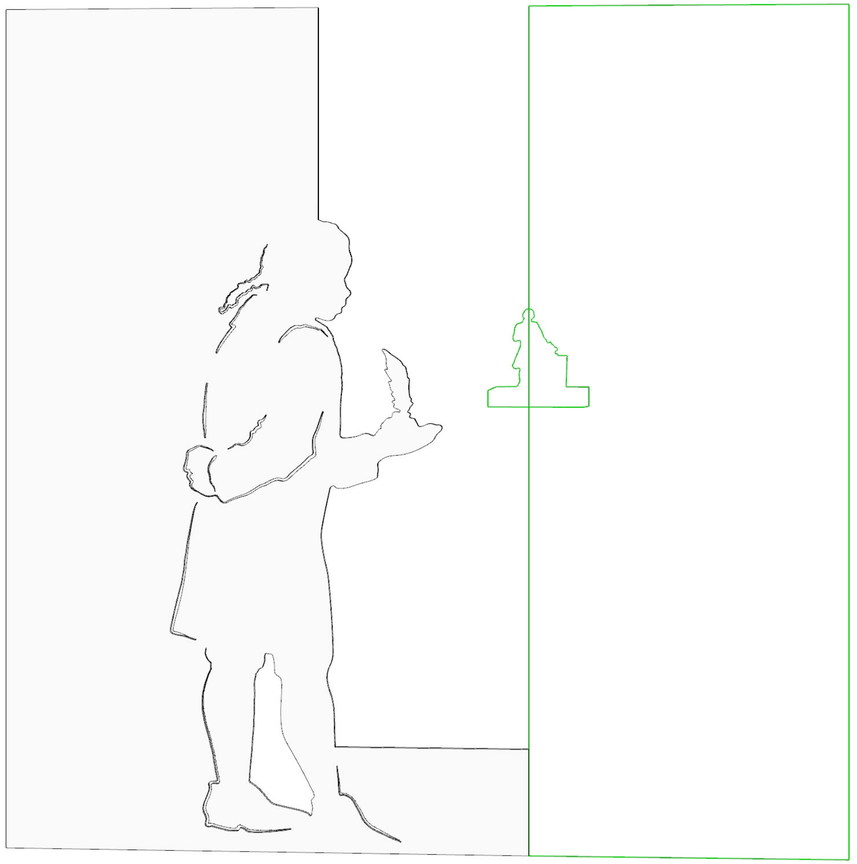
Utilizing Scanned Geometry for Modeling Operations

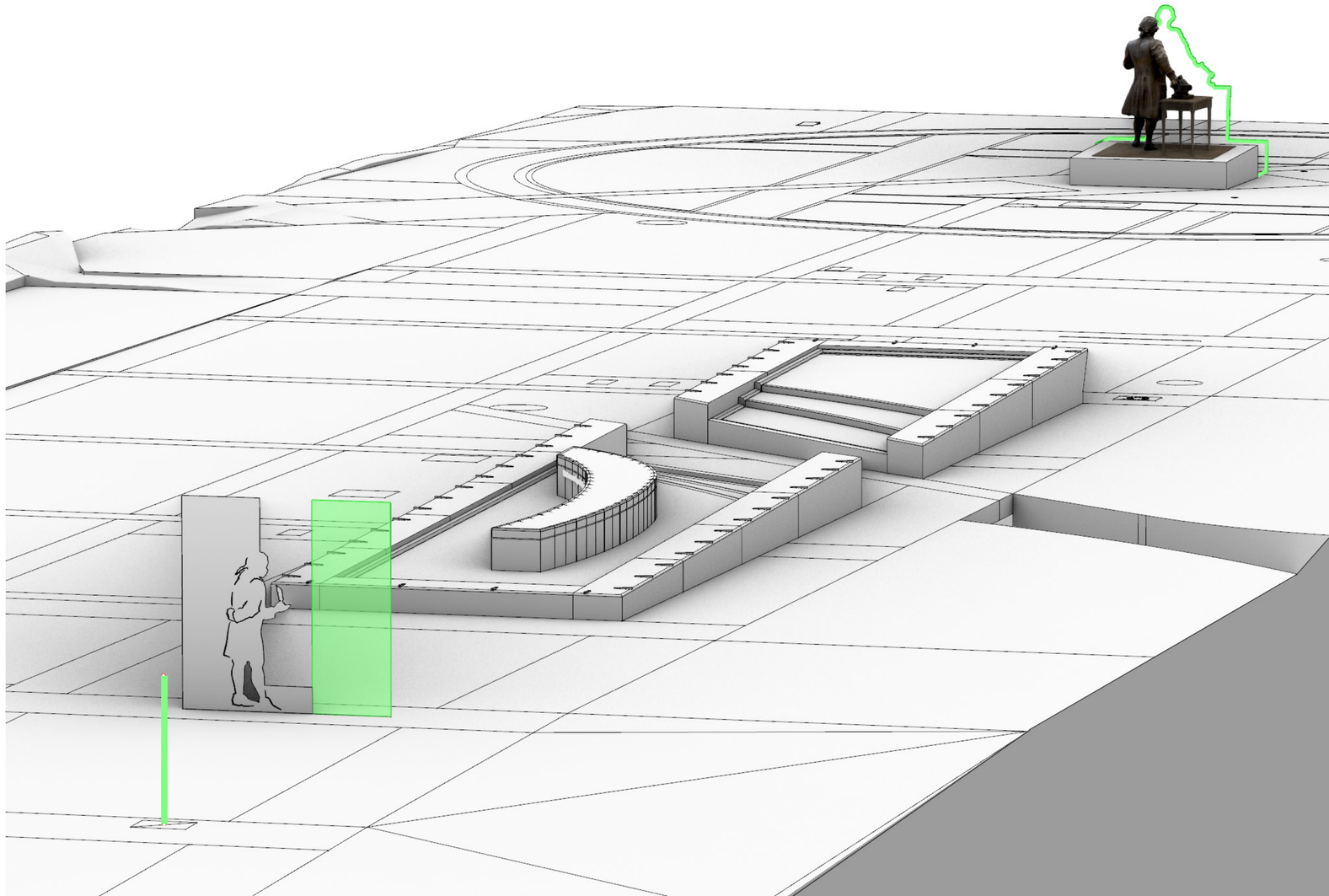




Case Study: Memorial to the Enslaved People of George Mason

Utilizing Scanned Geometry for Modeling Operations





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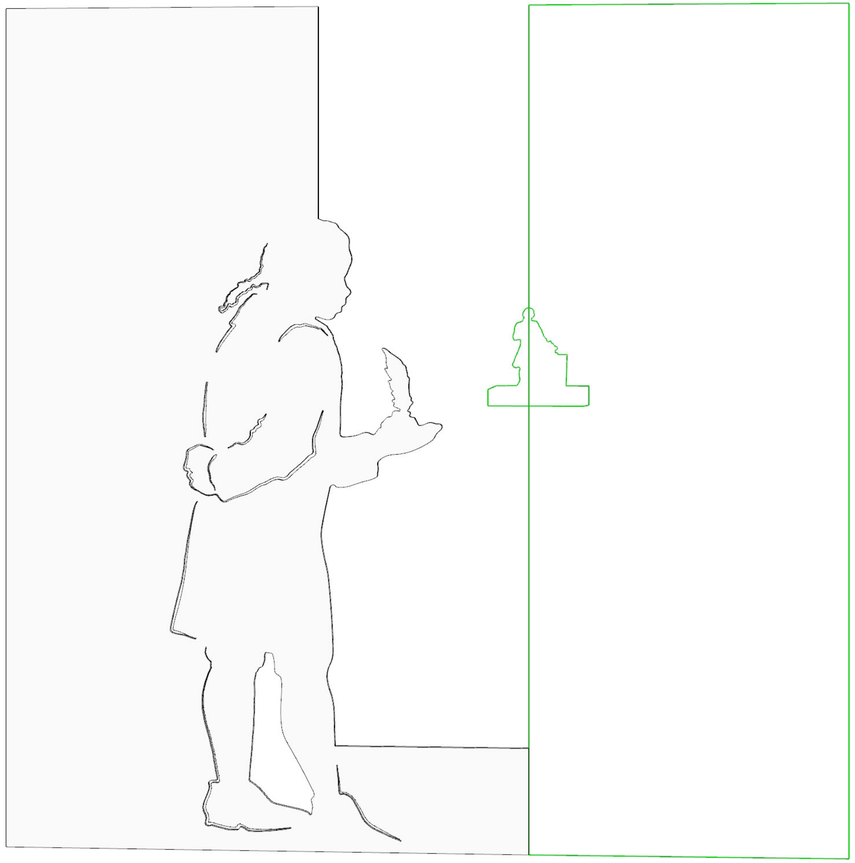
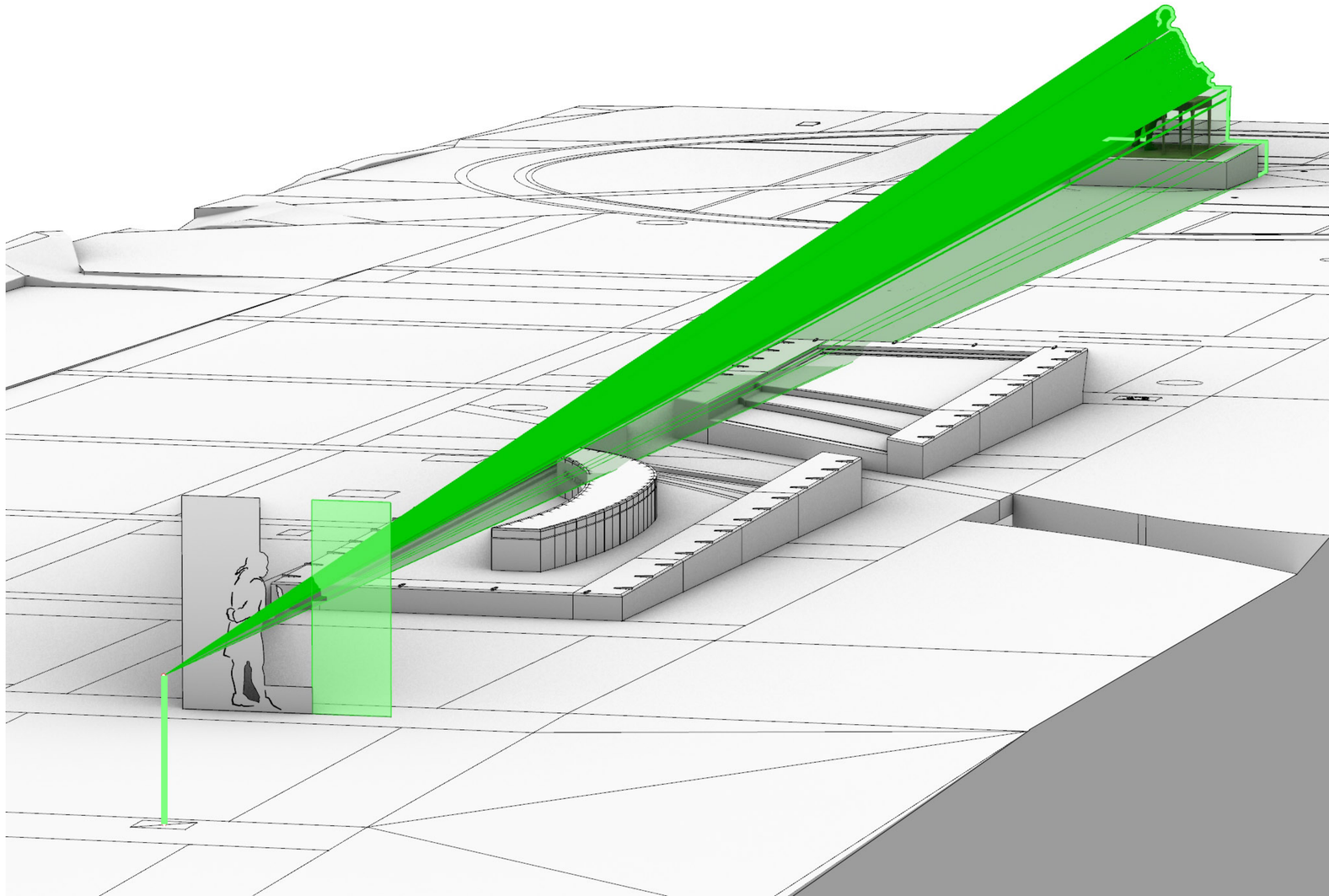
Utilizing Scanned Geometry for Modeling Operations





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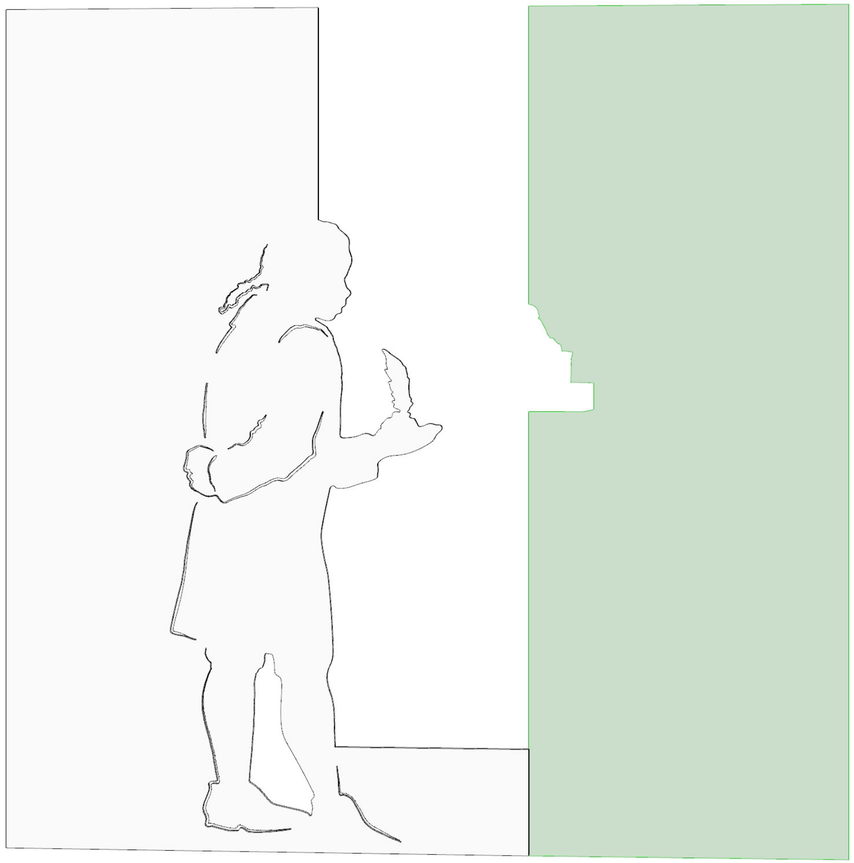
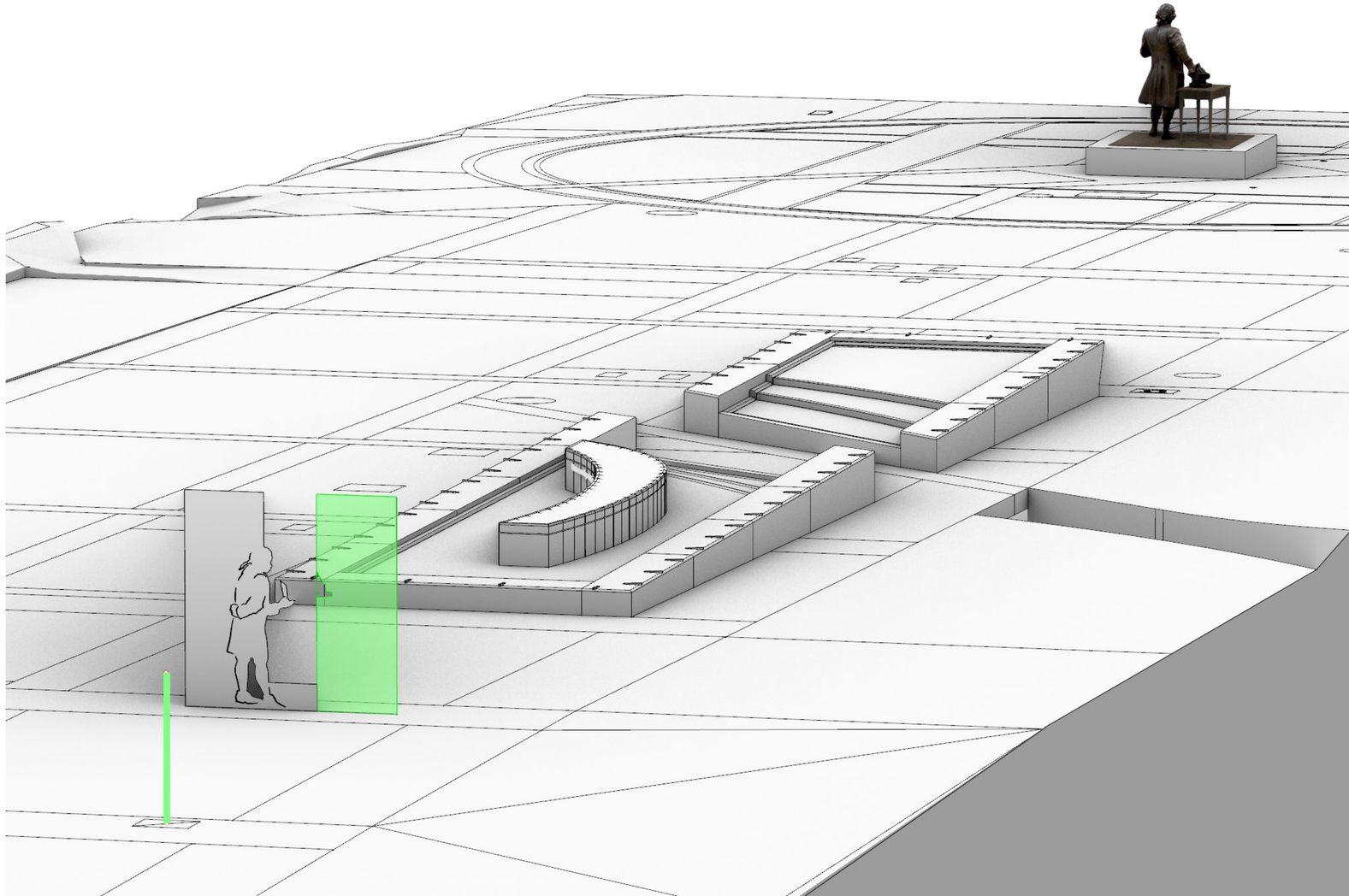
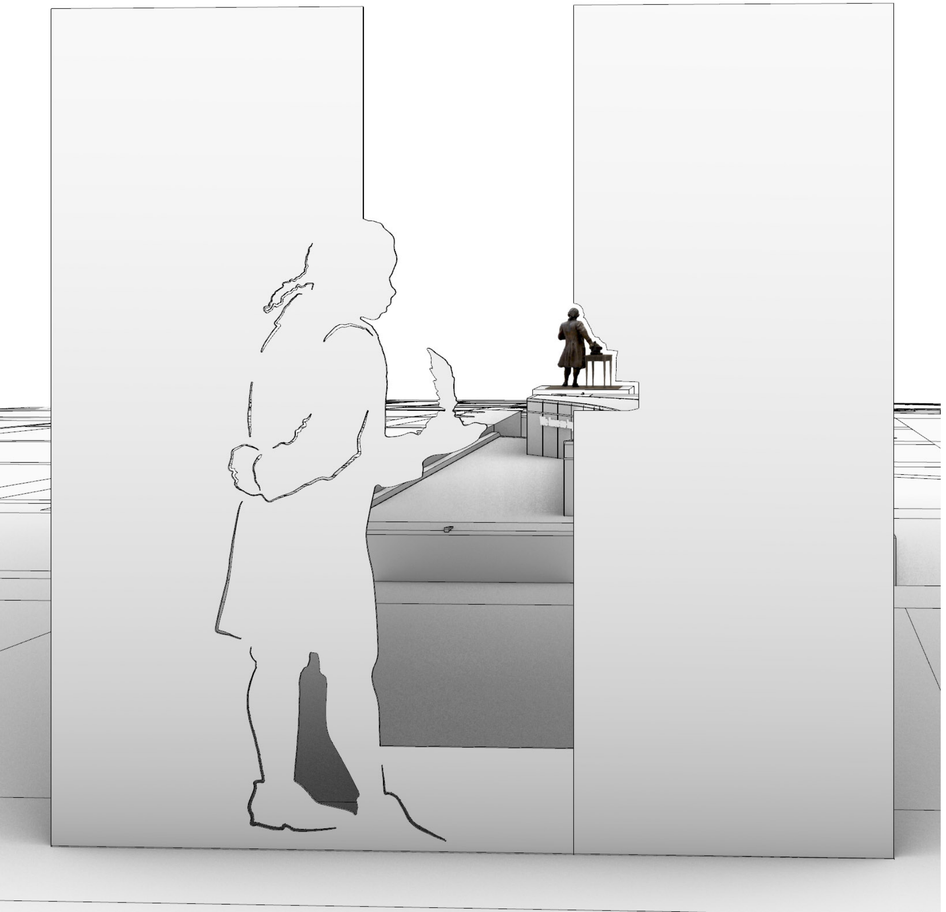
Utilizing Scanned Geometry for Modeling Operations

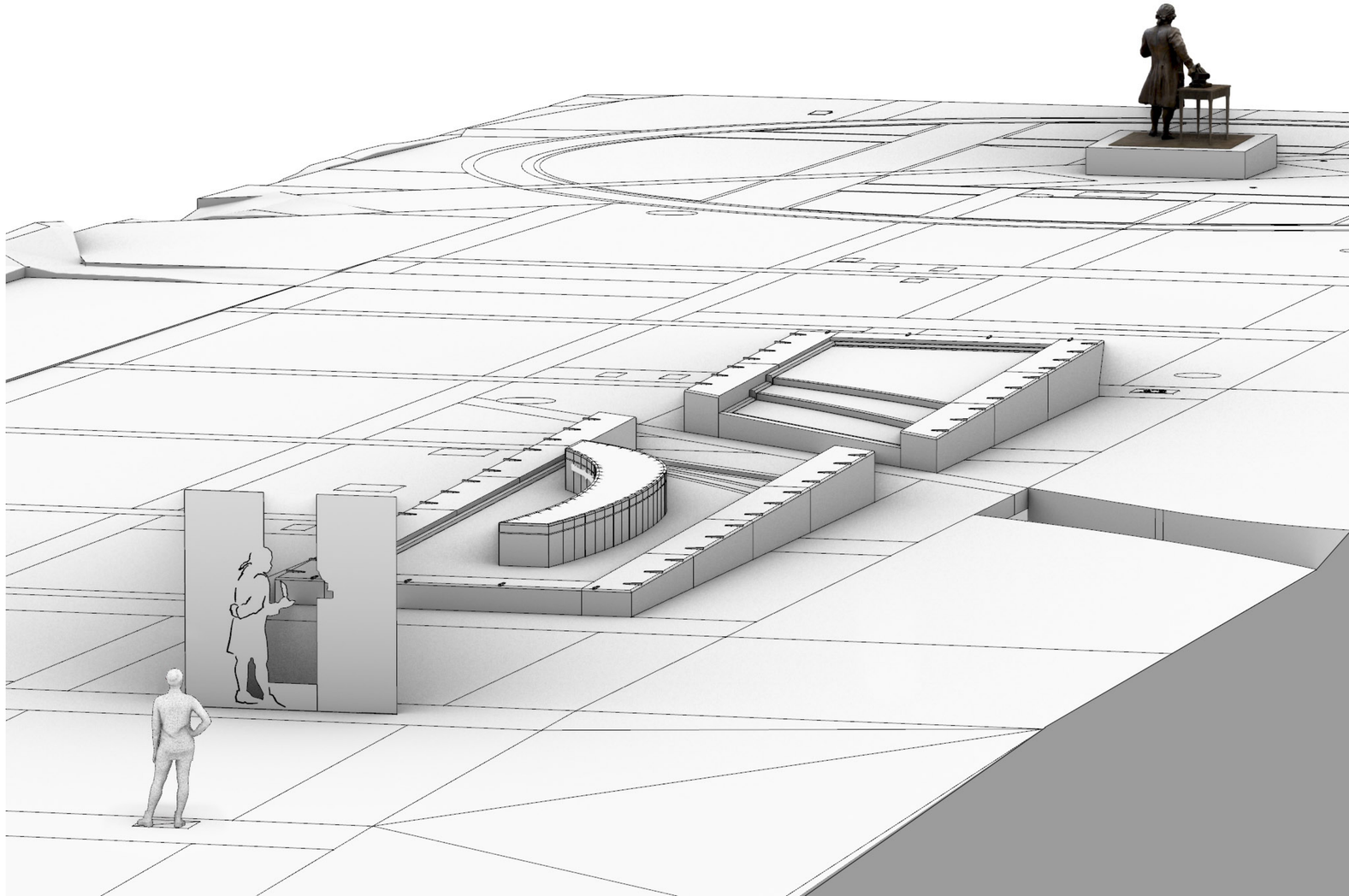




Case Study: Memorial to the Enslaved People of George Mason

Utilizing Scanned Geometry for Modeling Operations





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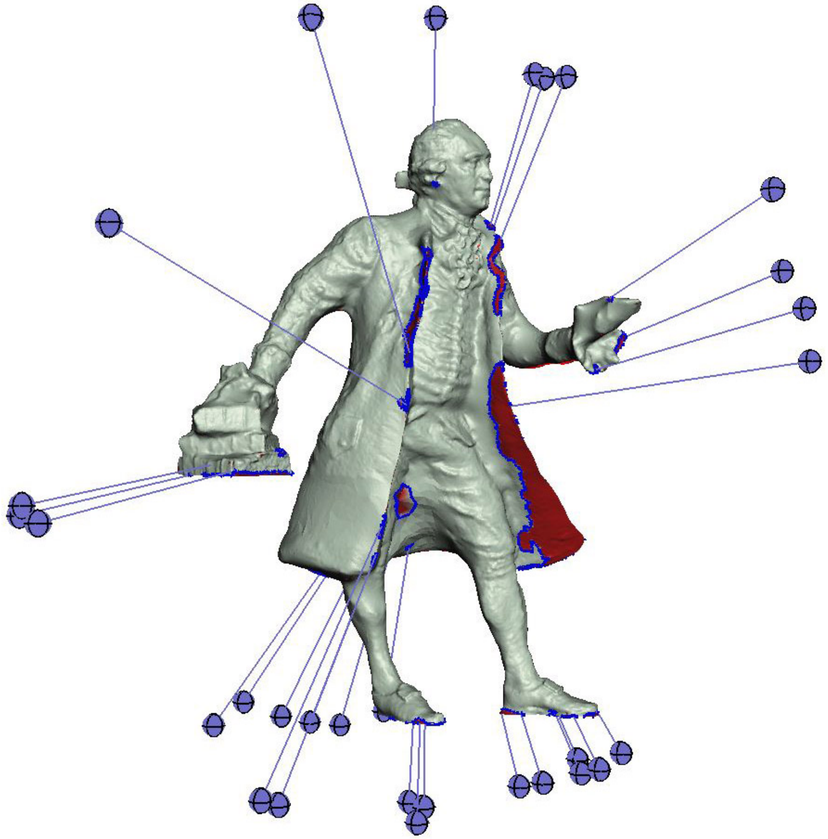
Before After

Converting Scanned Geometry to Physical Models

AUTODESK
MESHMIXER

Stability

Strength



Thinness

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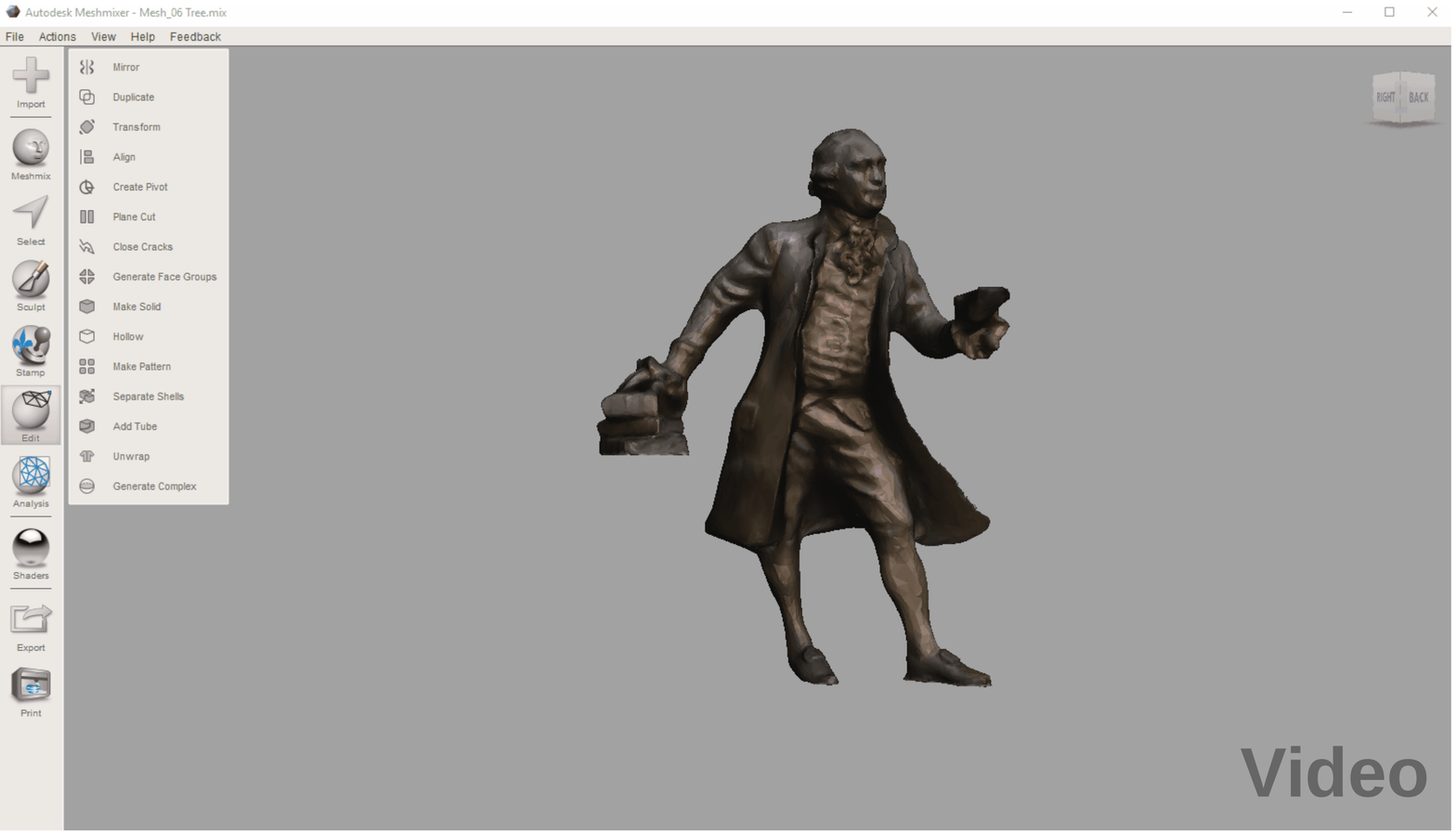
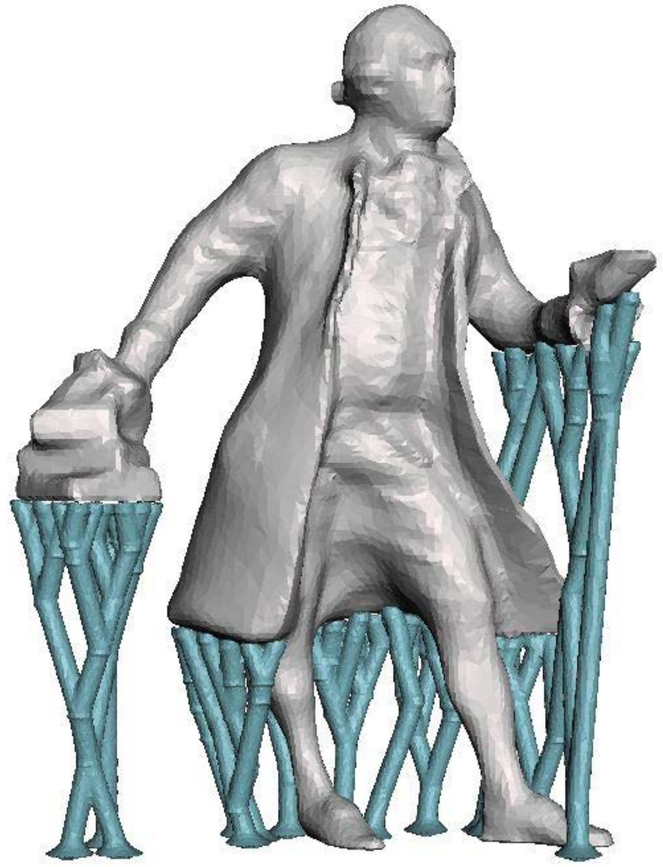
Converting Scanned Geometry to Physical Models





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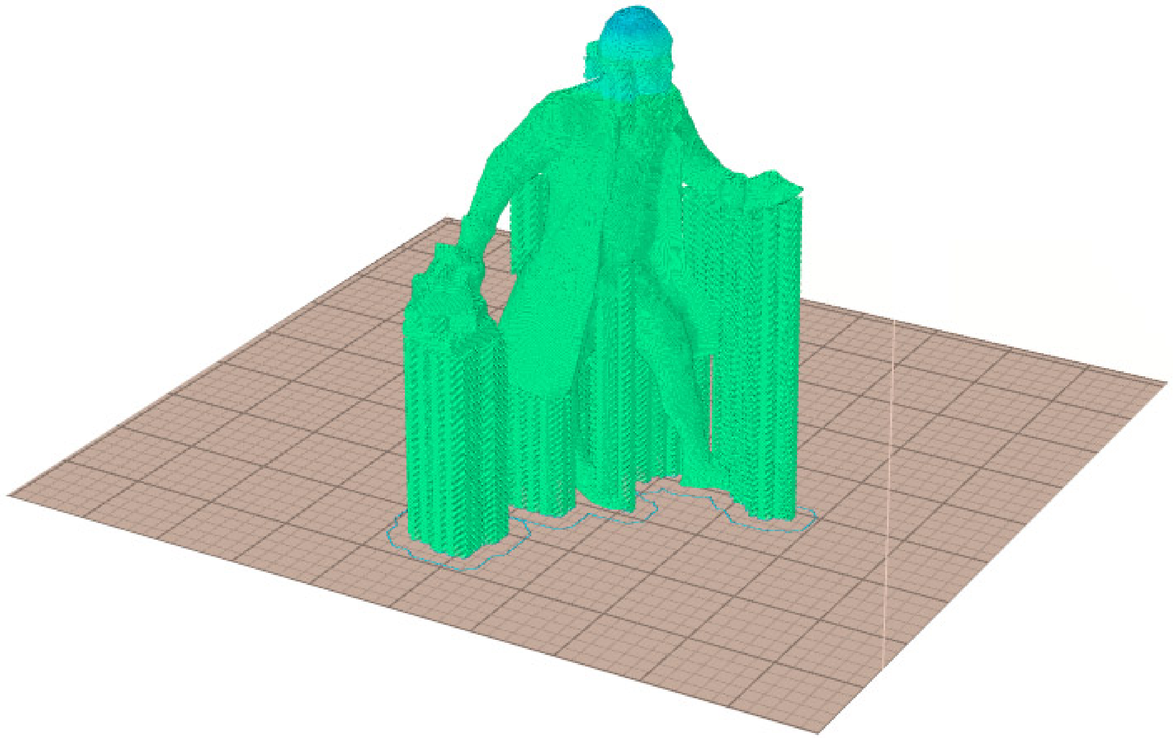
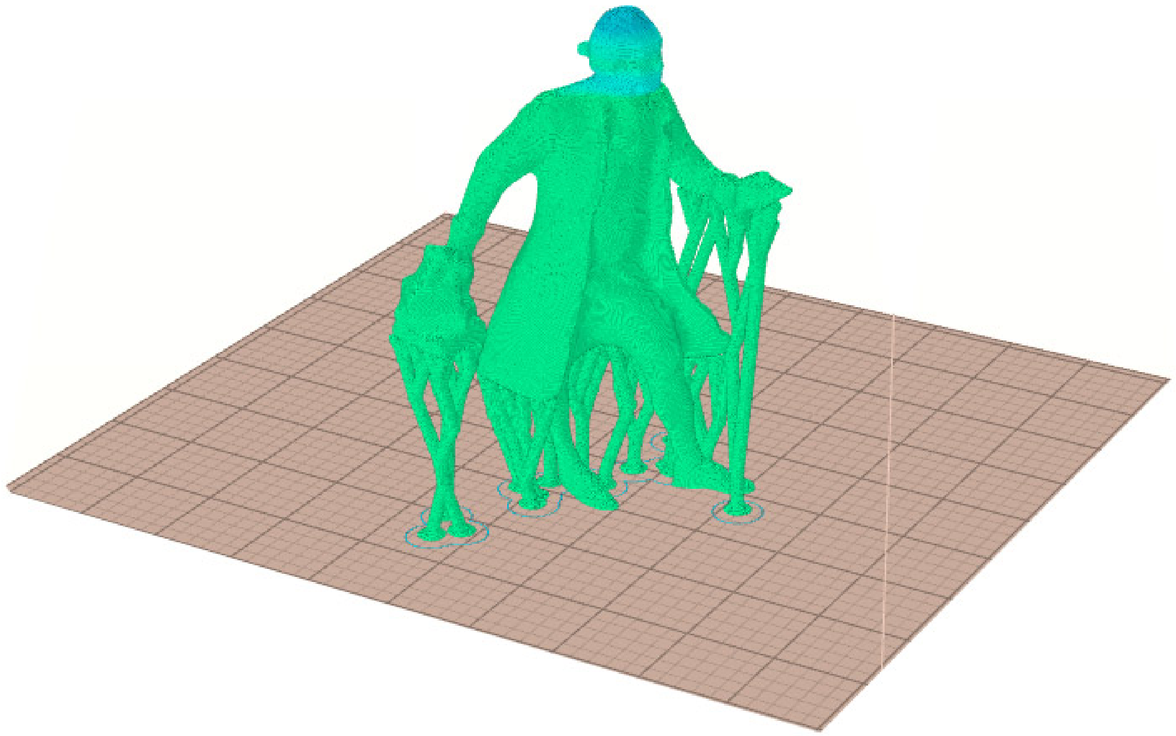
Converting Scanned Geometry to Physical Models



Build Time: 2 hours 43 Minutes

PLA Weight: 101.51g

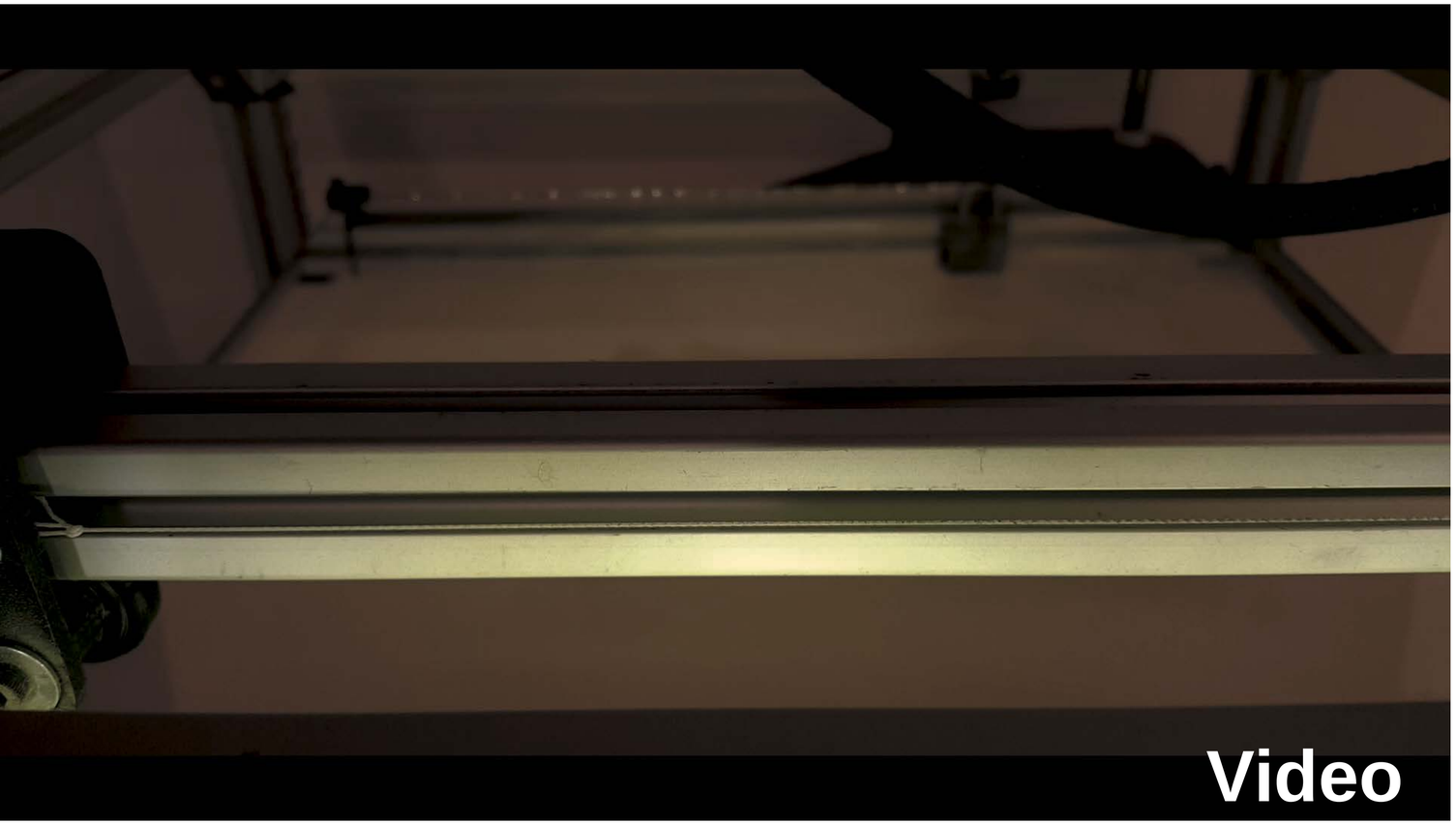


Build Time: 2 hours 3 Minutes

PLA: 73.69 g

Case Study: Memorial to the Enslaved People of George Mason

Converting Scanned Geometry to Physical Models



Case Study: Memorial to the Enslaved People of George Mason

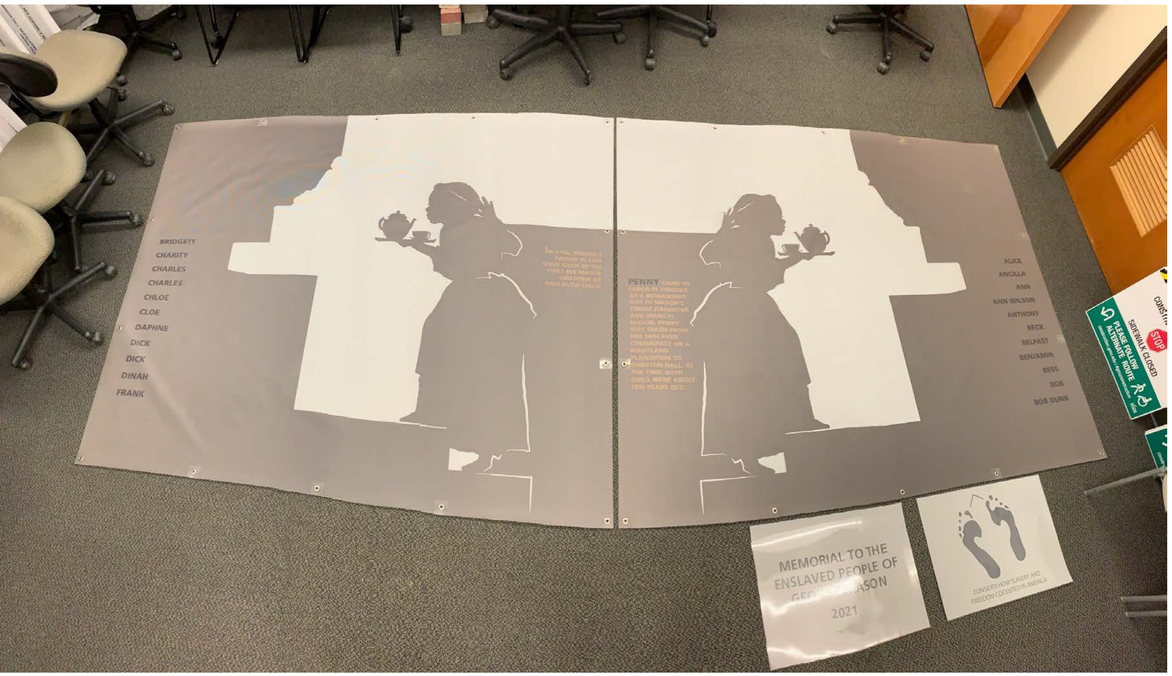
Converting Scanned Geometry to Physical Models

Case Study: Memorial to the Enslaved People of George Mason

Virtual Reality Mock Up

Case Study: Memorial to the Enslaved People of George Mason

Converting Scanned Geometry to Physical Models



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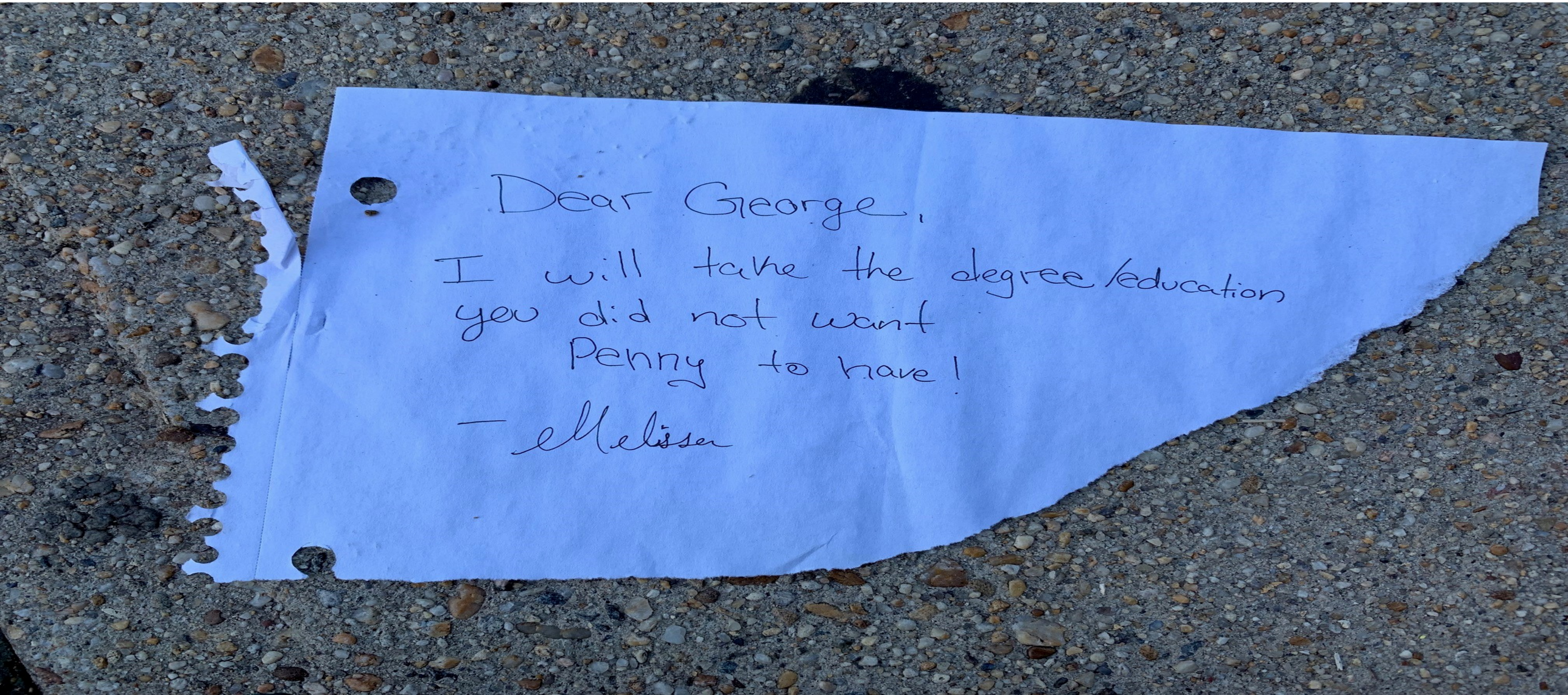
Reactions



Lessons Learned

- Preplan and have contingencies
- Take too many pictures
- Have realistic expectations
- Moving from software to software, check system units
- Exercise Patience
- Document everything

Thank You

AUTODESK®

Make anything™