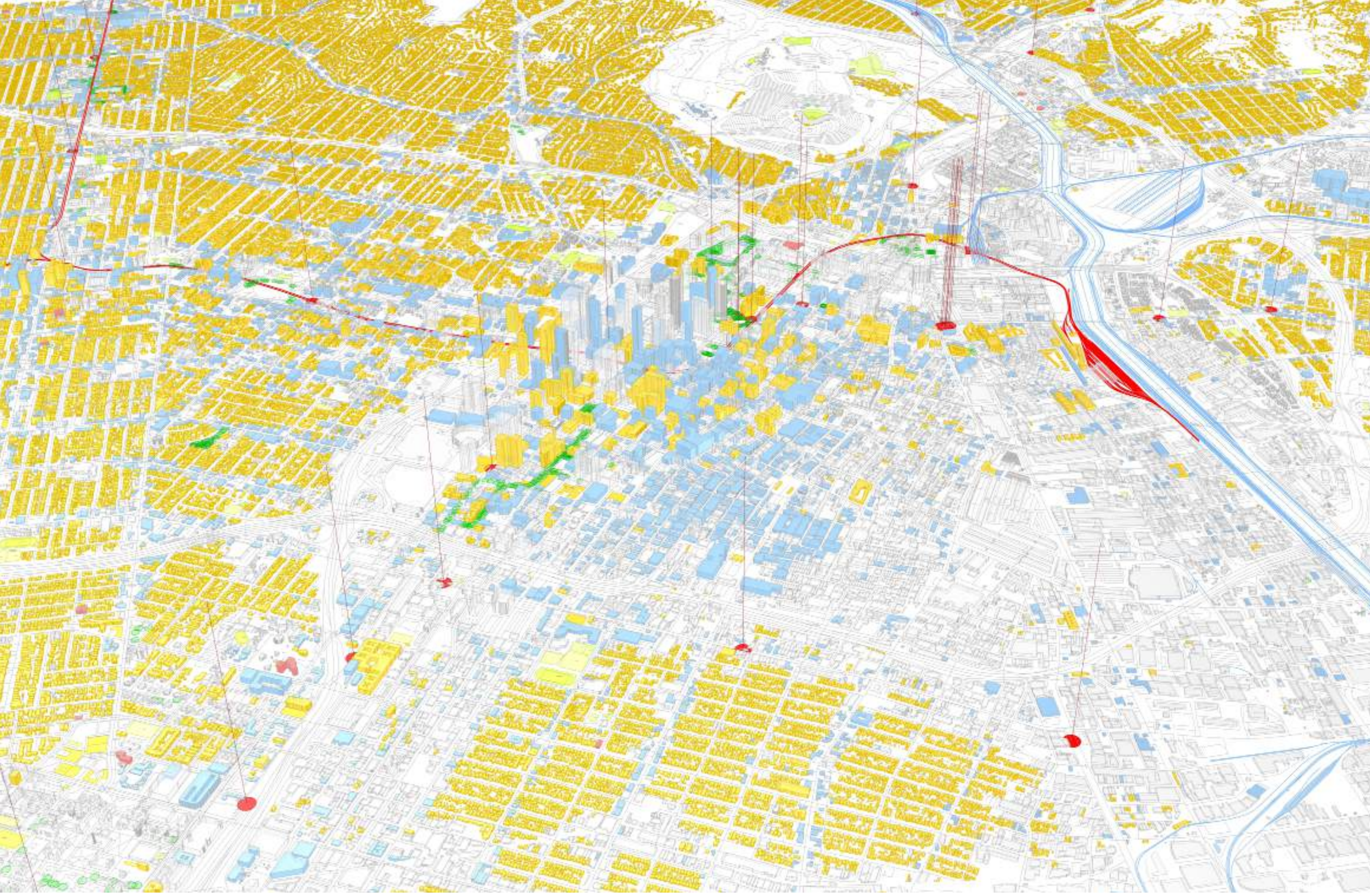

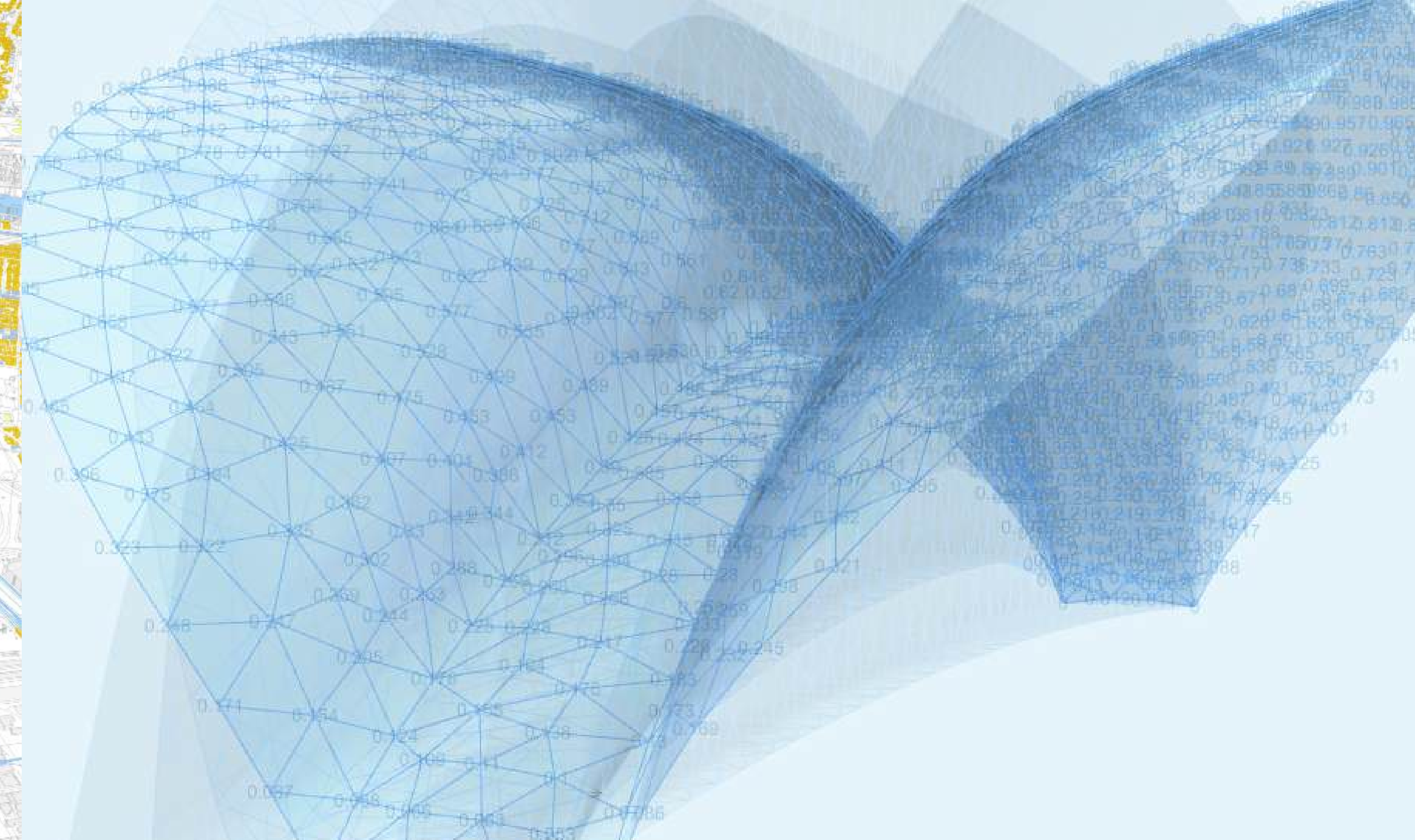

Algorithmic Design in Architecture Volume 9

DEVELOPMENT OF DATA DRIVEN DESIGN IN ARCHITECTURE

PART - II

DEVELOPMENT OF DATA DRIVEN DESIGN IN ARCHITECTURE PT.II

Algorithmic Design in Architecture Volume 9

H Architecture

This research paper was written and edited by Jake Han at H Architecture, 2024.

H Architecture

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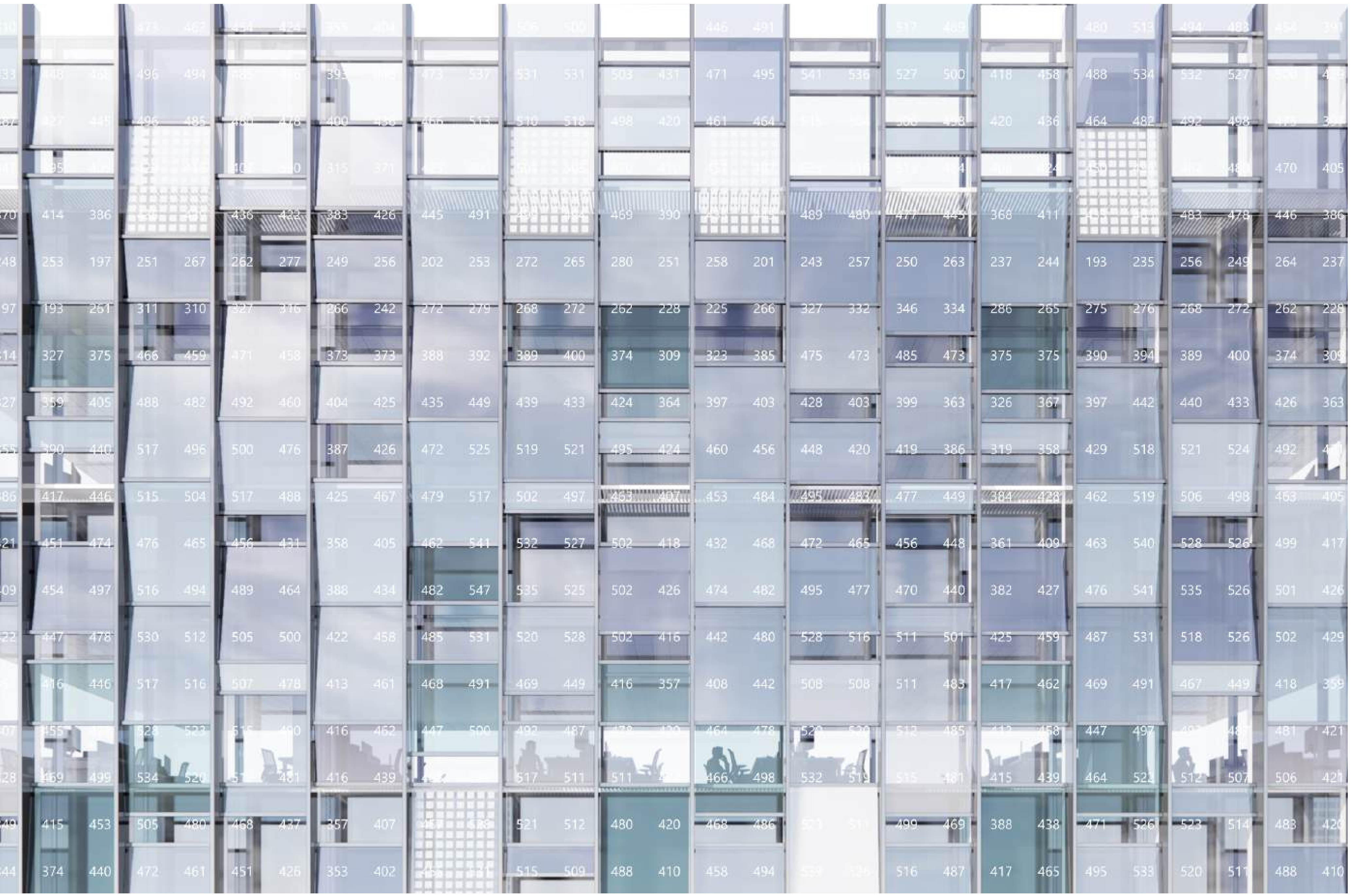
RECAP

Meta material applied kinetic facade module design, Sejong Center II Competition



RECAP

This study is part of the "Computational Design in Building Information Modeling (BIM)" initiative, led by H Architecture P.C. in New York, focusing on integrating computational design research with practical methodologies in architectural practice. Over seven years since its inception in 2017, significant advancements have occurred in data management methodologies, associated technologies, and software accessibility.

The research introduces recent technological advancements in data-driven design and identifies newly pertinent datasets for architectural practice, with Grasshopper serving as the primary design tool.

In the last chapter of the research, It covered Environmental analysis capabilities within Grasshopper, such as Ladybug and Honeybee. At the latter chapter of this research, it will cover Physic driven design and GIS data visualization.

Physics analysis tools like Kangaroo Physics and Karamba 3D, initially introduced in previous volumes, have undergone further development to enhance their capabilities for physical and structural simulation, with Kangaroo Physics integrated into Grasshopper as a built-in plugin and Karamba 3D continues to amass a wealth of case study projects on a global scale.

Geographic Information System (GIS) data plays a crucial role in data-centric decision-making processes, with tools like ArcGIS, Elk, TT Toolbox, and Open Street Map aiding in data conversion for compatibility with Grasshopper. These datasets are sourced from governmental or research institutions, with the City of New York's 'NYC Open Data' initiative providing free access to various public datasets, particularly significant during the planning phase for its implications on project outcomes.

The research presents preliminary case studies demonstrating the application of singular or multiple datasets in design and decision-making processes, with future studies aiming to explore more intricate iterations to understand the complexities of integrating diverse datasets within design frameworks.

PHYSICS DATA

Physics Data
Featured Technical Improvement

Night facade view, Sejong Center II Competition

Kinetic, meta-material bending study. Sejong Center II Competition

PHYSICS DATA

Physical data in architectural design refers to the tangible, measurable characteristics of a building and its components. This data encompasses a variety of aspects that are critical to the design, construction, and performance of architectural projects. Key components of architectural physical data include Geometric information, Structural Data, Material Properties, Constructability, etc

Kangaroo Physics is an interactive physics engine for simulation, optimization, and form-finding in architectural design and engineering. Developed by Daniel Piker, Kangaroo Physics operates within the Grasshopper environment, a visual programming language integrated with Rhinoceros 3D (Rhino). Kangaroo Physics is widely used by architects, engineers, and designers to explore complex geometries and structural systems through real-time simulations.
It is a powerful tool for integrating the principles of physics into the design process, allowing for the creation of innovative and efficient structures. Its versatility and interactive capabilities make it a valuable resource for designers seeking to push the boundaries of architectural and engineering design.

Karamba 3D is a parametric structural engineering tool that integrates seamlessly with Grasshopper and Rhinoceros 3D (Rhino). Developed by Clemens Preisinger, Karamba 3D enables architects, engineers, and designers to perform accurate and interactive structural analysis within the familiar environment of Grasshopper.
Karamba empowers designers to seamlessly integrate structural considerations into their design workflows, bridging the gap between architecture and engineering. Its parametric and interactive nature makes it an invaluable tool for creating innovative, efficient, and structurally sound designs.

Aerial view from north, Sejong Center II Competition

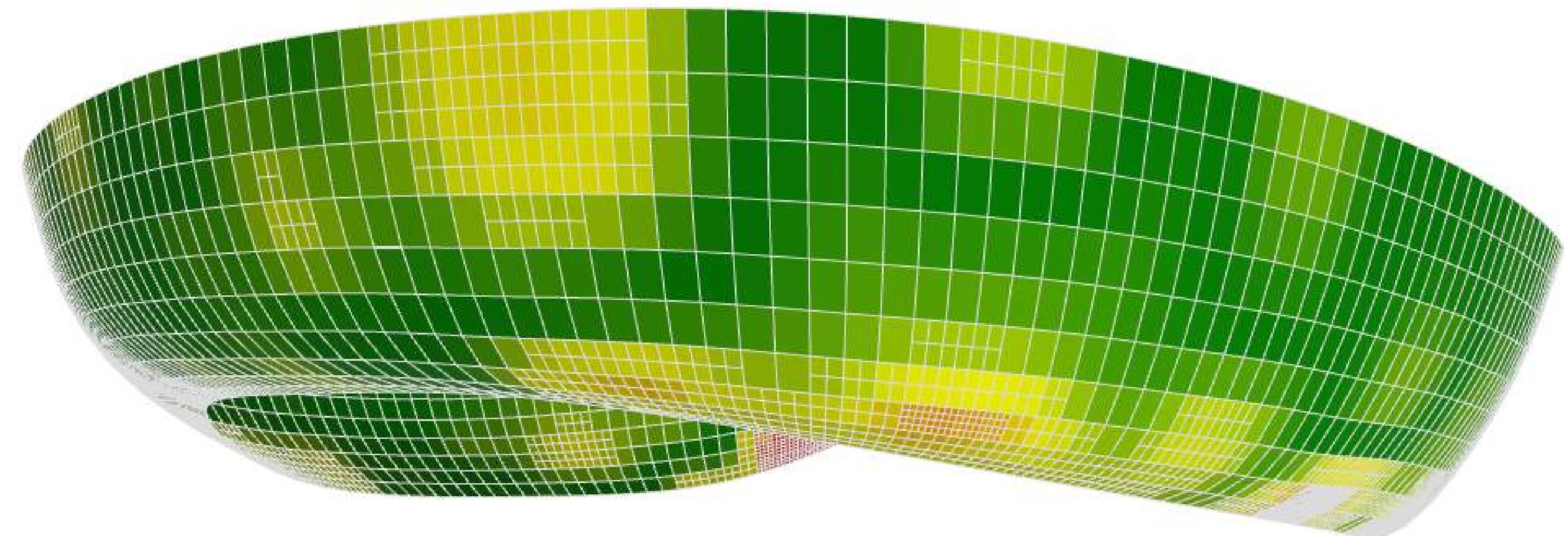
FEATURED TECHNICAL IMPROVEMENT

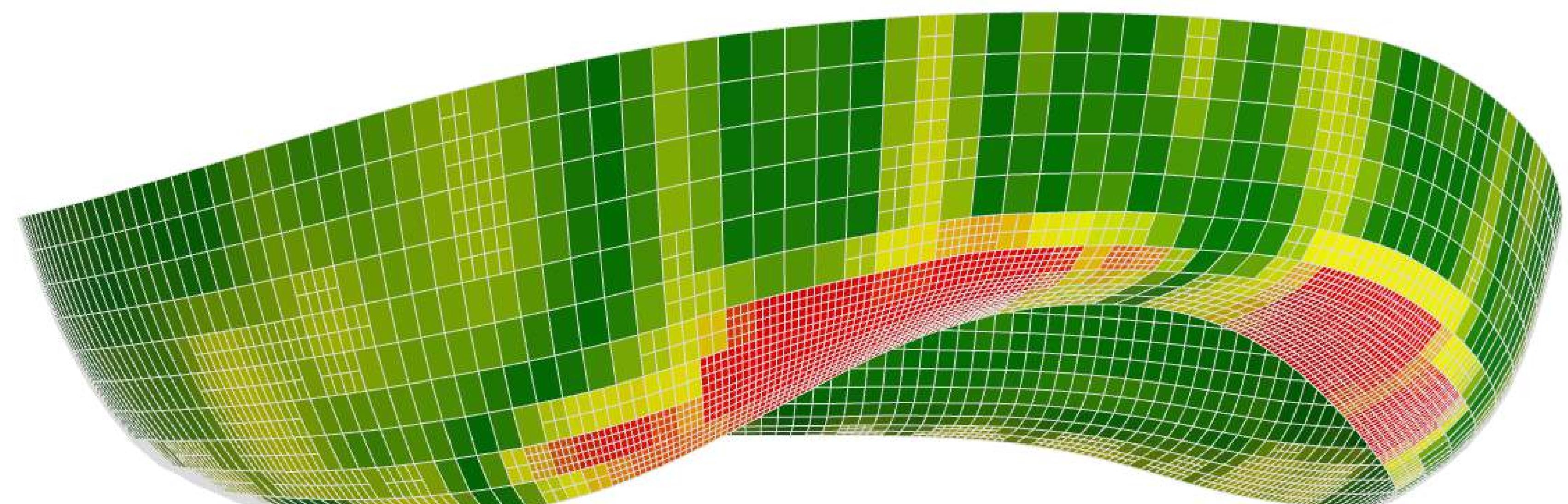
Kangaroo Physics, which originally started as a plug-in for Grasshopper, has now evolved into a fundamental component of the program, offering a range of advanced simulation capabilities that greatly enhance its functionality and versatility in design processes.

Initially, Kangaroo used a method known as ‘Dynamic Relaxation,’ which is a traditional approach to physics simulation. However, with the introduction of the more advanced ‘Projective Dynamics’ method, which allows for more direct and real-time simulation results, there have been significant improvements in stability and convergence speed. Additionally, the results now provide not only geometric information but also other numerical data sets such as collinearity, coplanarity, and plasticity.

With these enhanced features, Kangaroo Physics has become an exceptionally powerful tool in architectural design practice. It now plays a crucial role in form-finding, geometric optimization, and constructability improvement, providing designers with sophisticated tools to tackle complex challenges and achieve more refined and innovative solutions.

Facade Geometry Planarization & Subdivision Plan, Sejong Center II Competition





PHYSICS DATA

CASE INTRODUCTION

Sejong Center II Competition

CASE STUDIES

Planar Subdivision Of The Dual-curved Facade
Responsive Meta-Material Shading Module

SEJONG CENTER II

The project was competition project, designing two concert venue with relevant amenities in iconic shape of the volume. The aesthetic of the project required higher level of engineergin achievement due to its hyperbolic surfaces and cutting-edge kinetic technologies with creative usage of the material science. Thus it required to suggest the solution for constructing and fabricating the complex geometries and logical material application

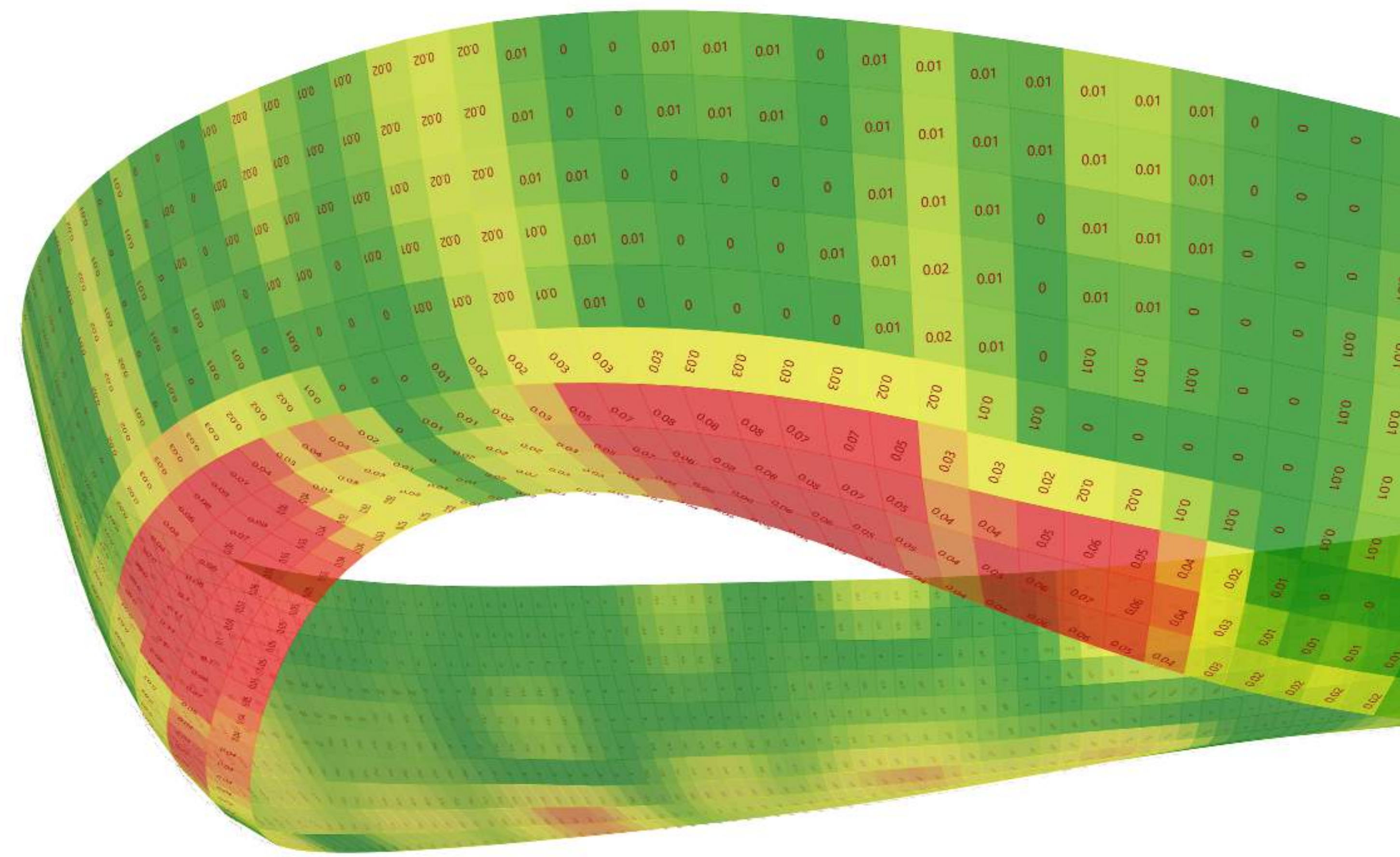
PHYSICS DATA DRIVEN DESIGN

Planar Subdivision of the Dual-Curved Facade

The outer shell of the project features a double-curved surface, presenting a challenge for architects and engineers in proposing cost-effective solutions. By applying techniques such as planarization and subdivision, the curved surface can be transformed into a flat or nearly flat surface, enabling a broader selection of systems and materials. For instance, three-dimensionally curved glass could be replaced with simpler twin-curved or even flat glass. This approach allows the original design's aesthetics to be preserved while facilitating practical and economical construction.

Responsive Meta-Material Shading Module

The project also incorporates a responsive shading device that operates in alignment with the solar meridian altitude. This device will utilize a material with elastic properties, enabling it to deploy through bending deformation facilitated by a simple mechanism. By merely applying pressure to the end of the device, it can expand and subsequently return to its original folded form. To ensure the functionality and optimize the design, the system must be simulated under real-world physics conditions.



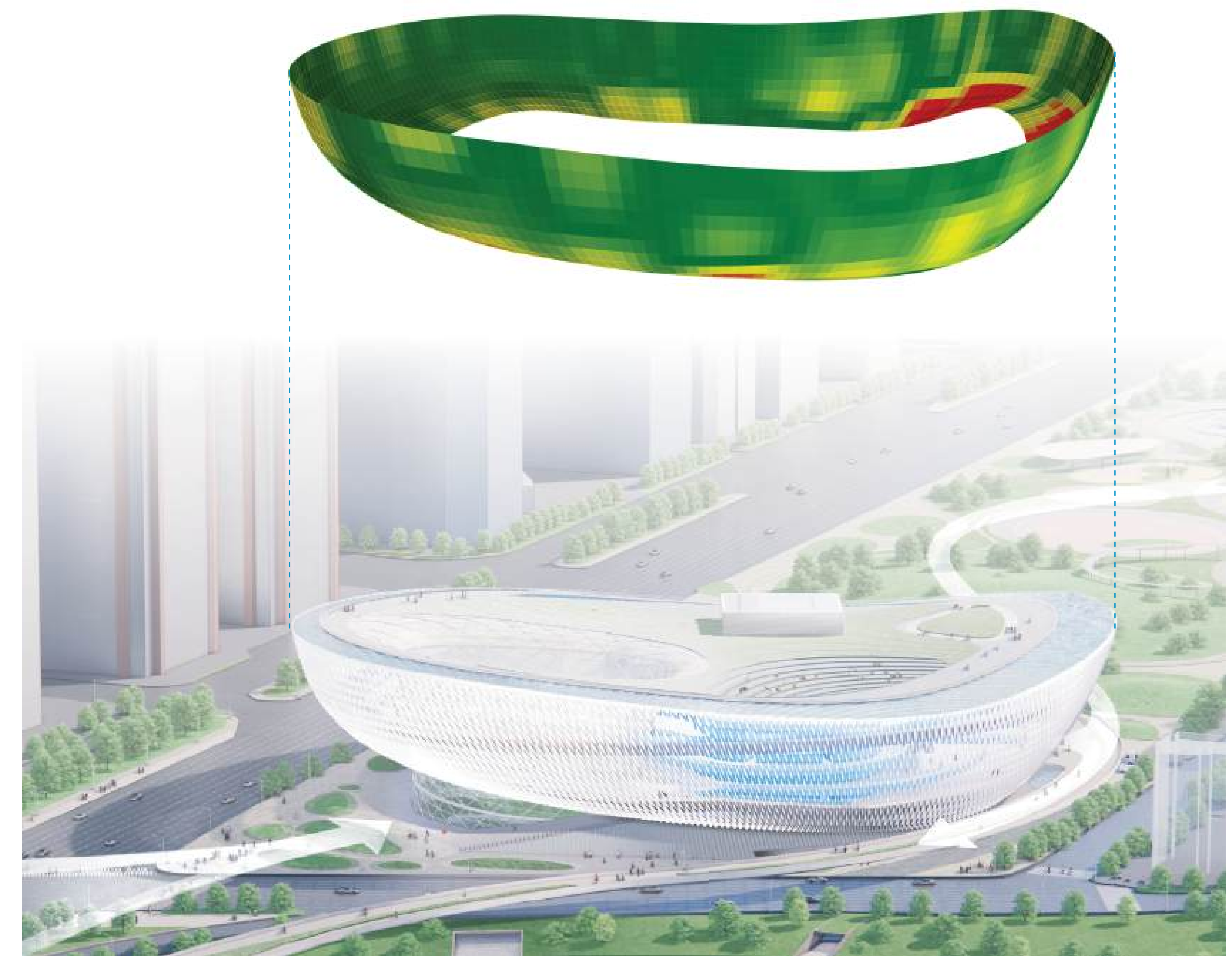
Planar Subdivision of the Dual-Curved Facade

Design Criteria

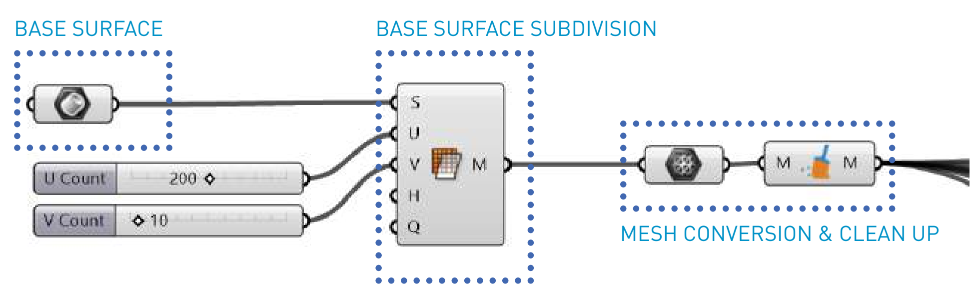
The architectural volume of the project features a surface with multiple curvatures. To ensure the cultivated design is maintained throughout the latter stages of the project, its constructability needed to be addressed in a persuasive and practical manner. Given that the dual curvature of the facade finish demands exceptional effort and precision during construction, it could significantly increase costs and potentially lead the client to reject the design. Therefore, as part of this physics-driven design solution, the curvature of the facade was treated to simplify the geometry, thereby enhancing the constructability and feasibility of the design.

Simulation Objectives

For improved constructability, the dual-curvature surface will first be flattened, and overly curved areas will be subdivided into smaller sections. Through this process, all surfaces will retain a resemblance to the original shape while reducing or simplifying the curvature to a manageable degree.

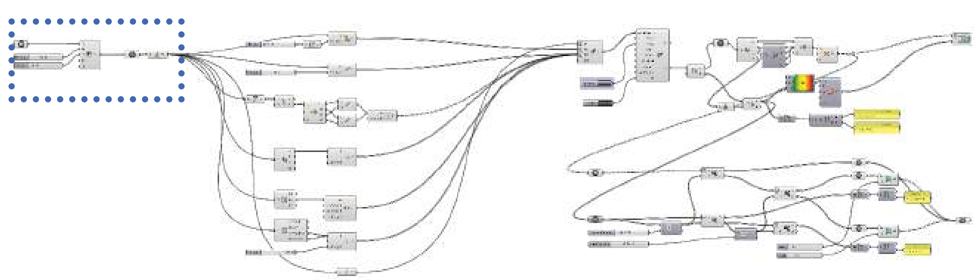


Exterior Surface Curvature Representation



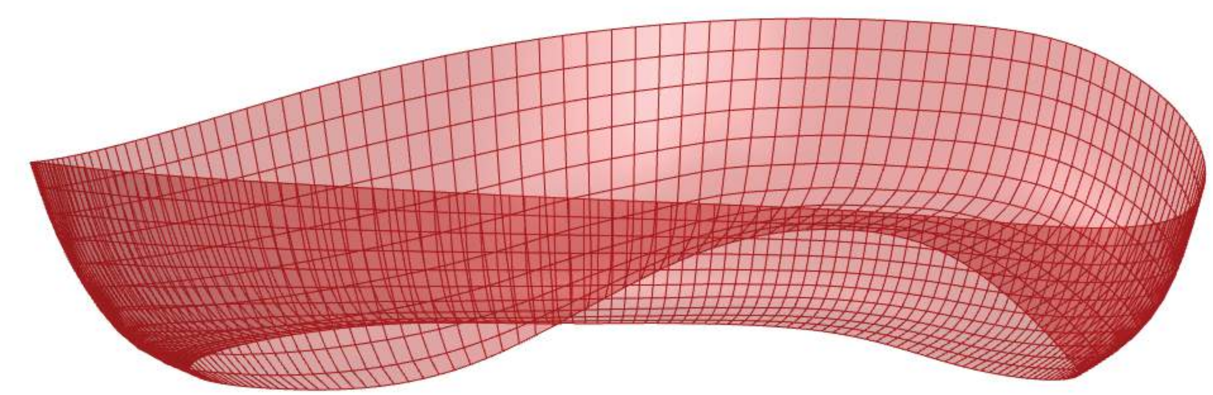
Kangaroo Physics are mesh based simulation. all input geometry to be prepared in mesh geometry to be plugged in to the simulation.

Mesh combine & clean removes minor flaws in mesh geometry which can cause potential error in the latter part of the code.



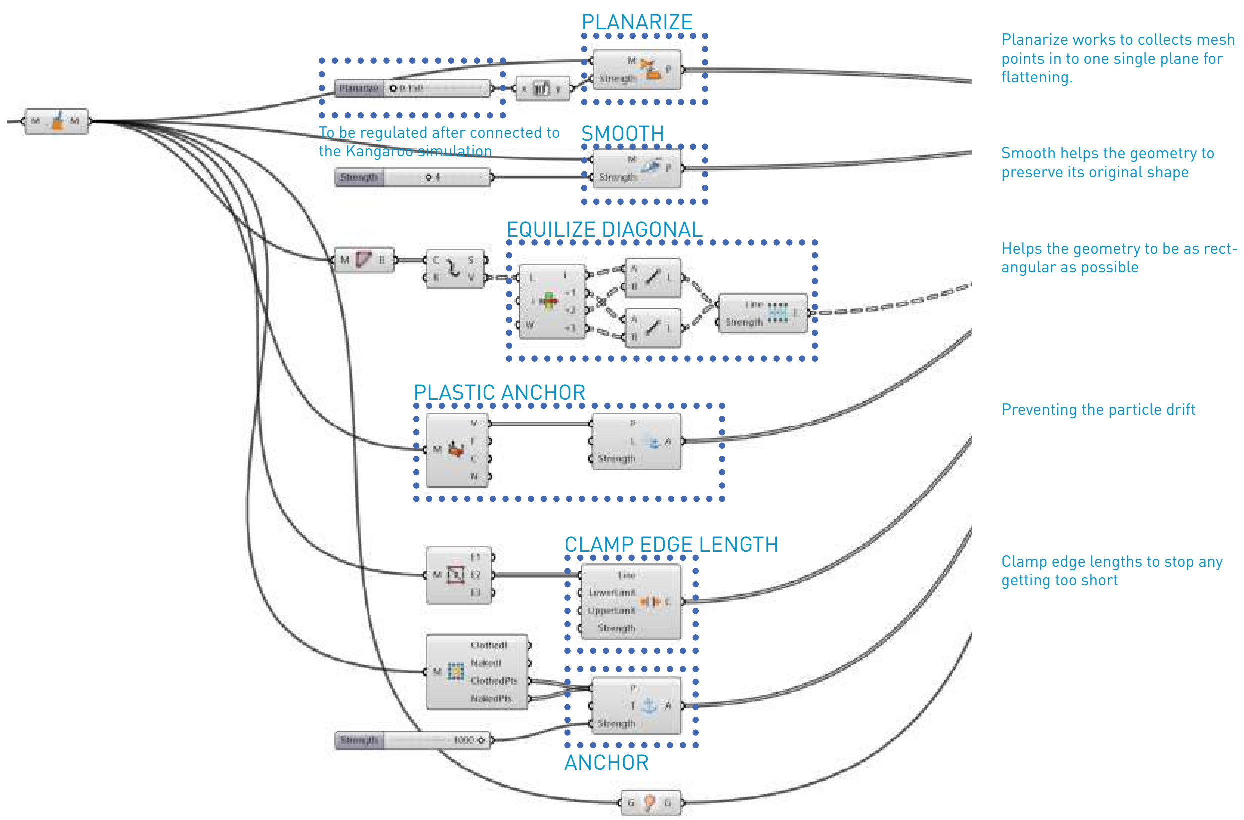
PREPARE BASE GEOMETRY

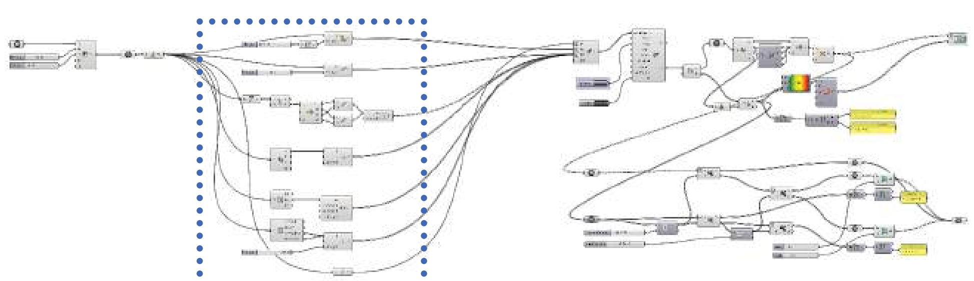
1) Import untrimmed surface geometry to the GH environment as brep
2) Change the boundary representation to mesh surface with relevant numbers



UNTRIMMED SURFACE TO MESH

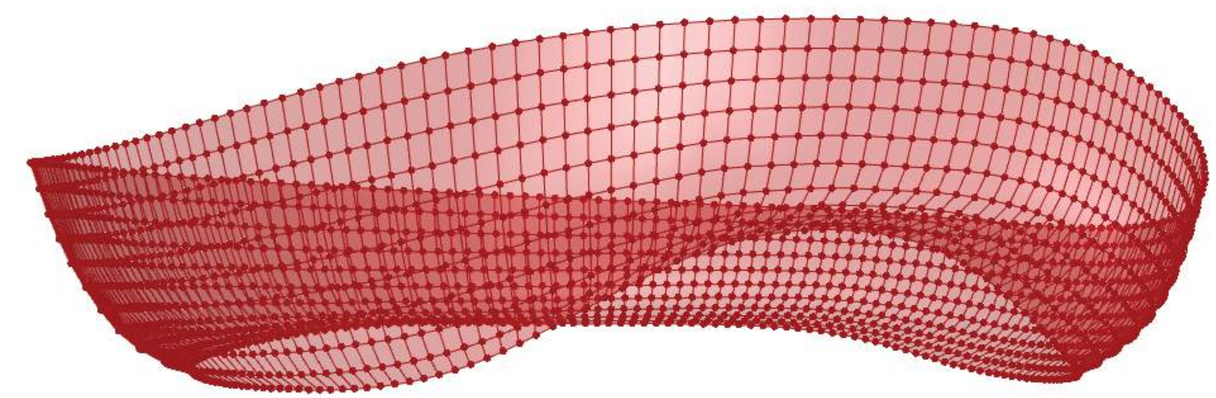
Inbitial geometry of the outer shell needs to be prepared in untrimmed surface to make it a regularly patterned mesh, which can be tranferred directly to the system geometry such as, mullion, window frame, etc





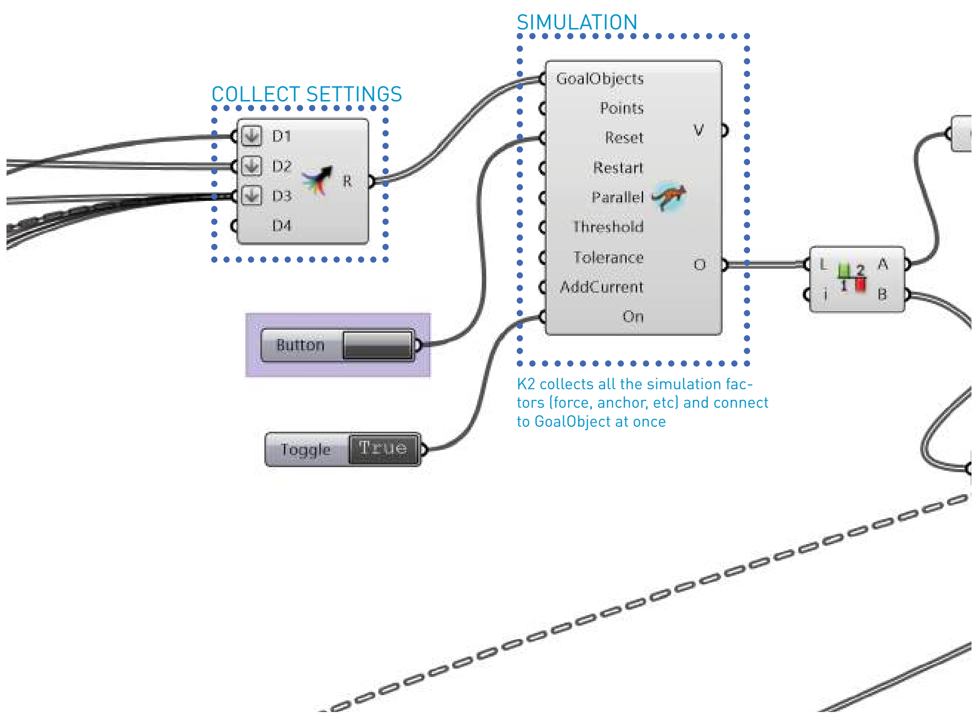
SIMULATION SETTINGS

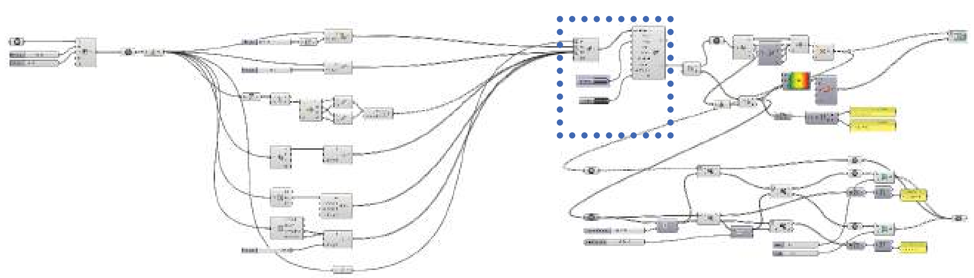
1) Once the mesh is created, several simulation settings for planarization needs to be connected
2) connect mesh to each settings with specified values above



SPRING-PARTICLE RELATIONSHIP OF THE ORIGINAL GEOMETRY

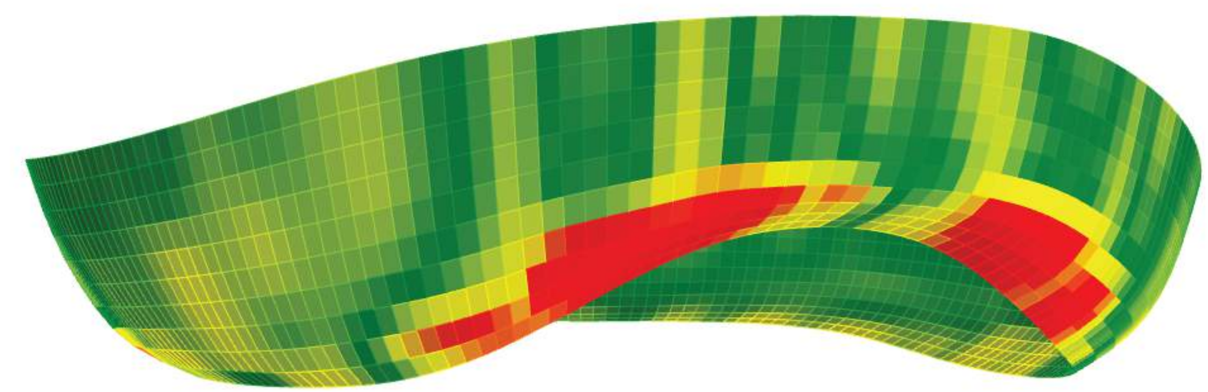
This point-and-network relationship ensures that the surface typology remains consistent throughout the process. The movement of points, as well as the stretching and extension of lines, will adhere to the same typological framework.





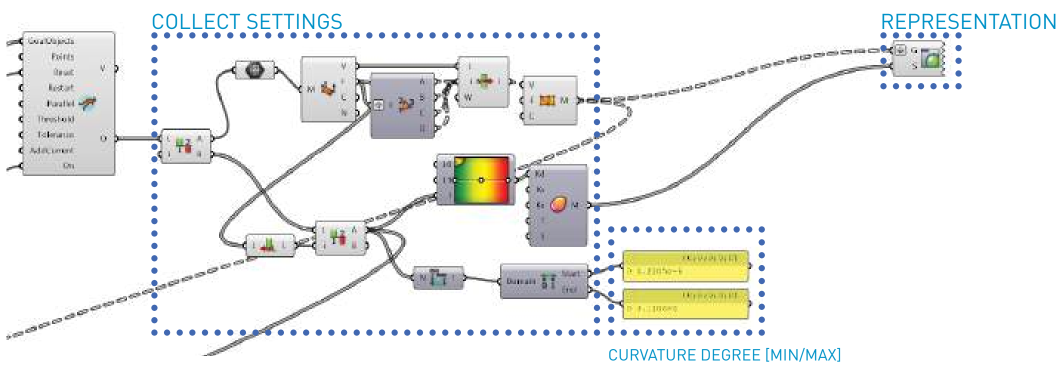
SIMULATION

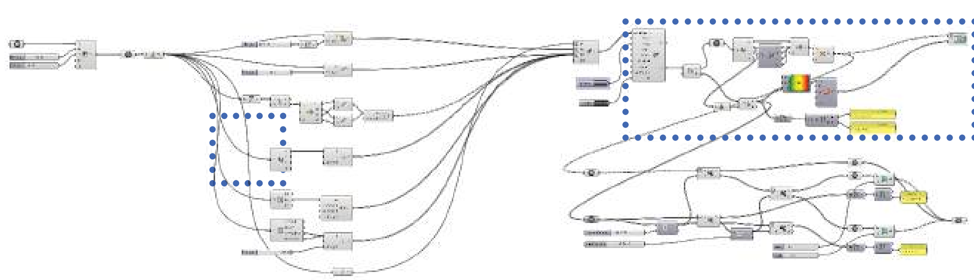
1) Collect all forces, anchors and settings at once and connect it to the simulation component
2) set button and boolean toggle for simulation control
3) run the simulation

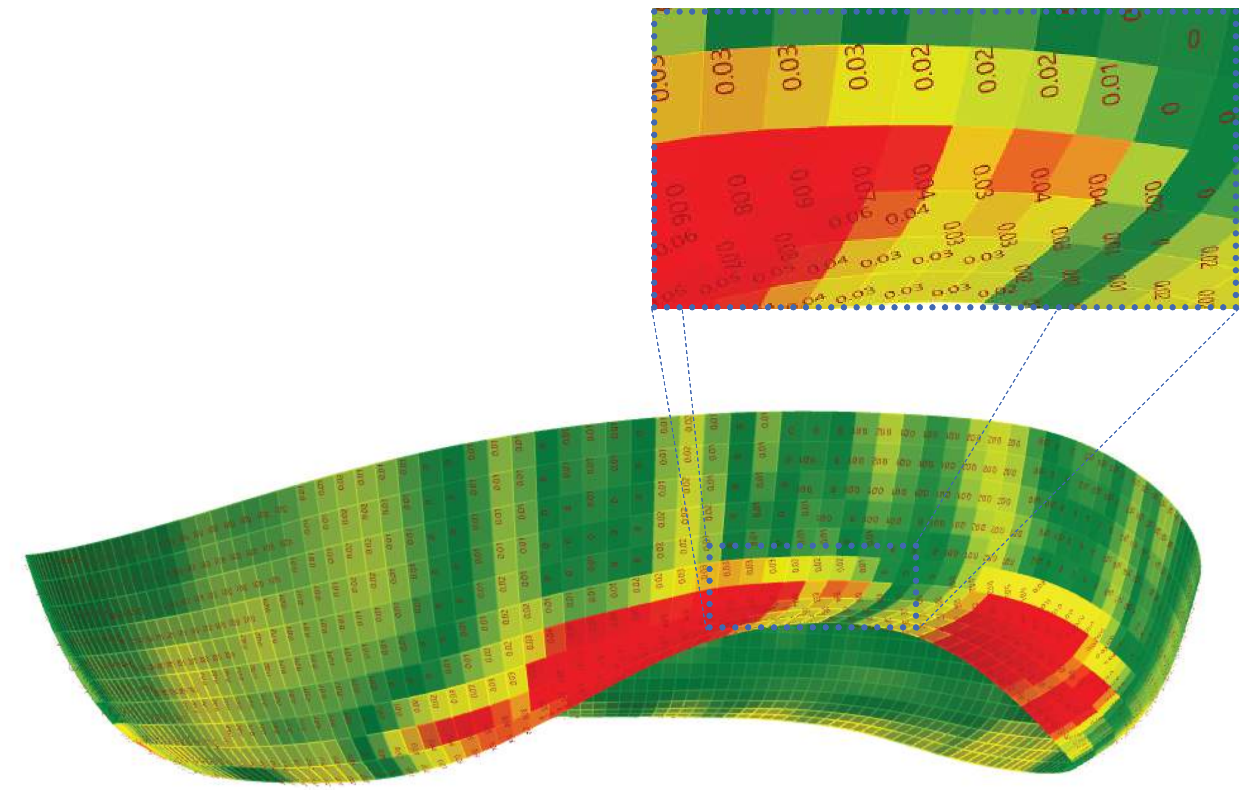


INITIAL CURVATURE ANALYSIS

The initial simulation will display the curvature of each mesh face using designated color representations. In the illustration above, red areas indicate regions with greater surface distortion, while green areas represent regions with minimal or no distortion.





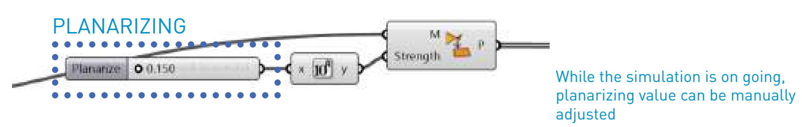


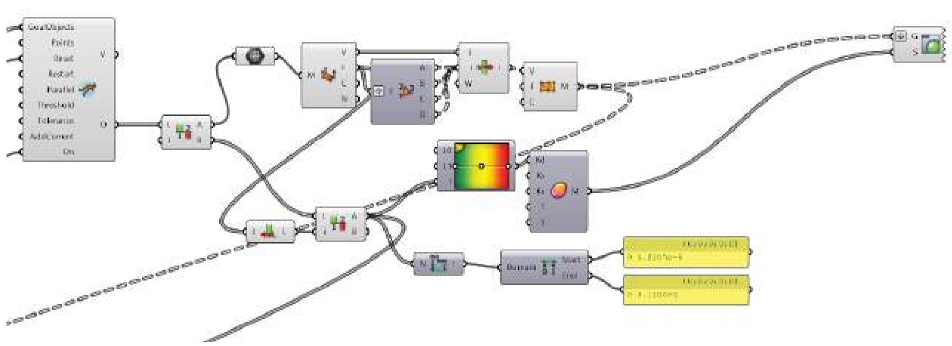
SIMULATION SETTINGS

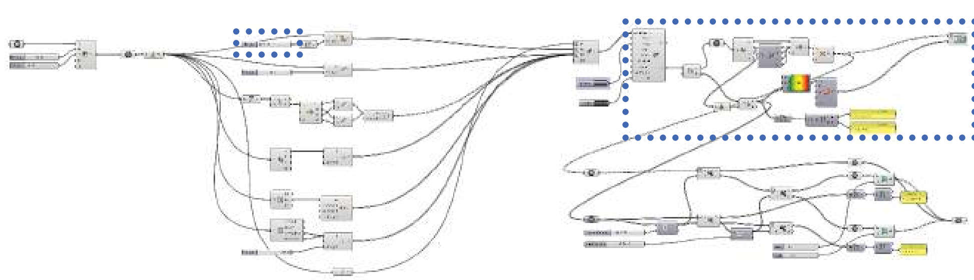
1) Find EPW weather file URL from the epw map (https://www.ladybug.tools/epwmap/)
2) Paste the URL to the GH note and connect to the weather URL input

EPW MAP

Ladybug's EPW map has developed to accommodate vast amount of EPW files regardless of the file types. the observation mainly took place in airport or research institute. For the use of the file in architectural practice, using the EPW files from vicinity is good enough to figure out the reliable result.

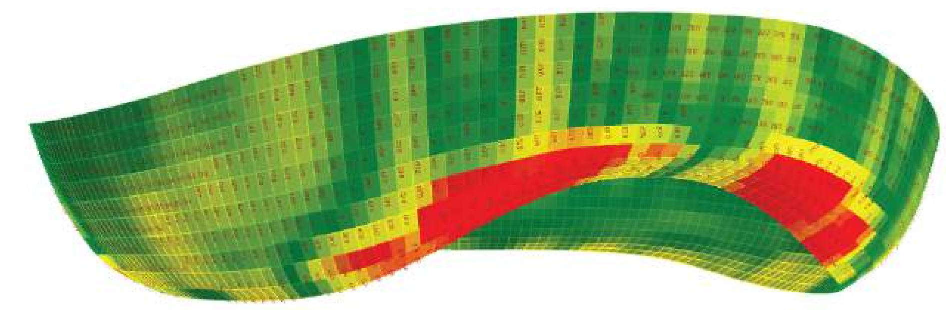


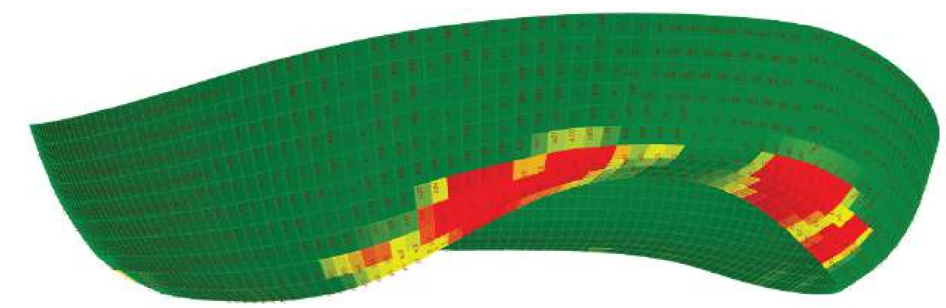


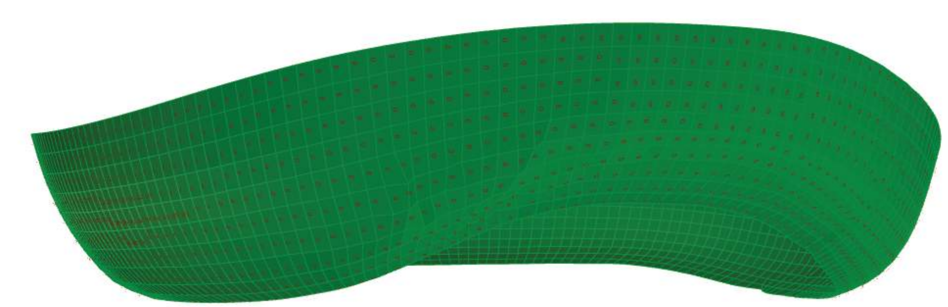


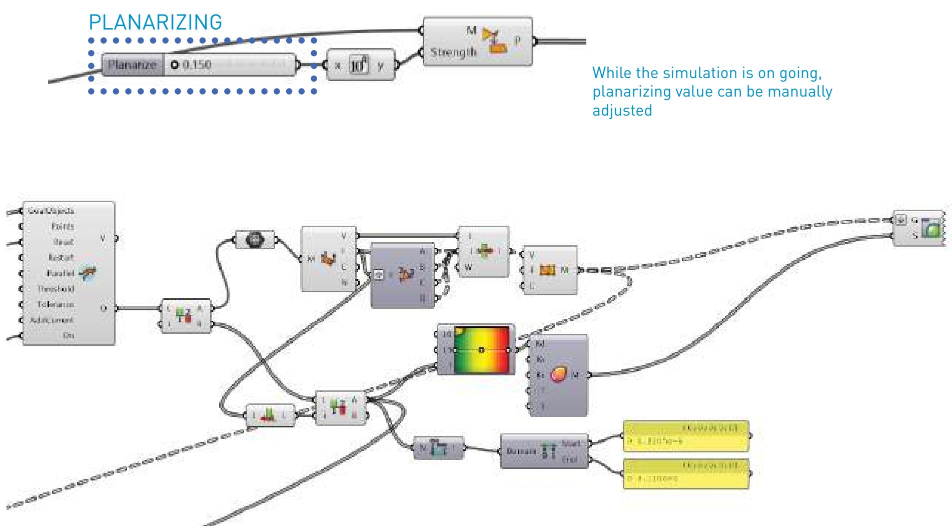
SIMULATION SETTINGS

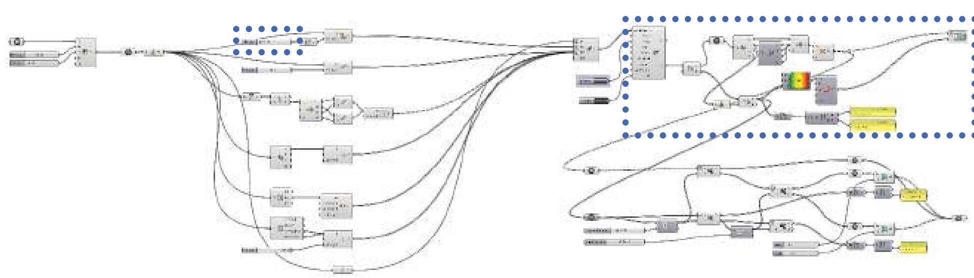
1) Once the simulation is turned on, move back to planarization and gradually increase the value
2) Increase the value till the overall geometry are not too much distorted





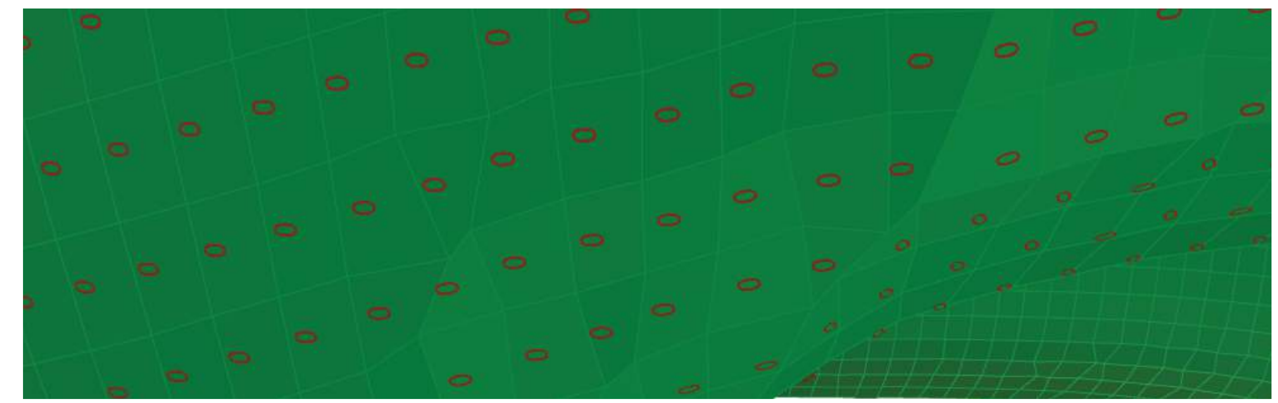




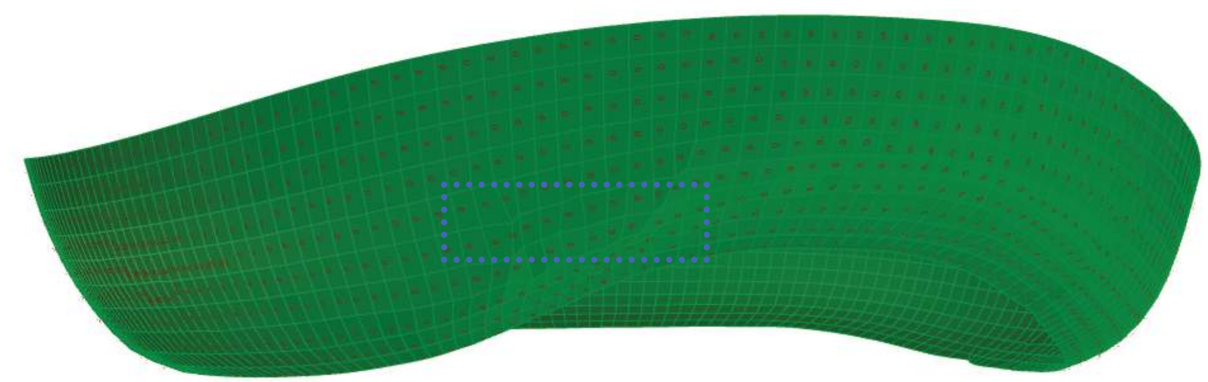


SIMULATION SETTINGS

1) If the number kept increasing, the simulation will reach to the maximum planarized status

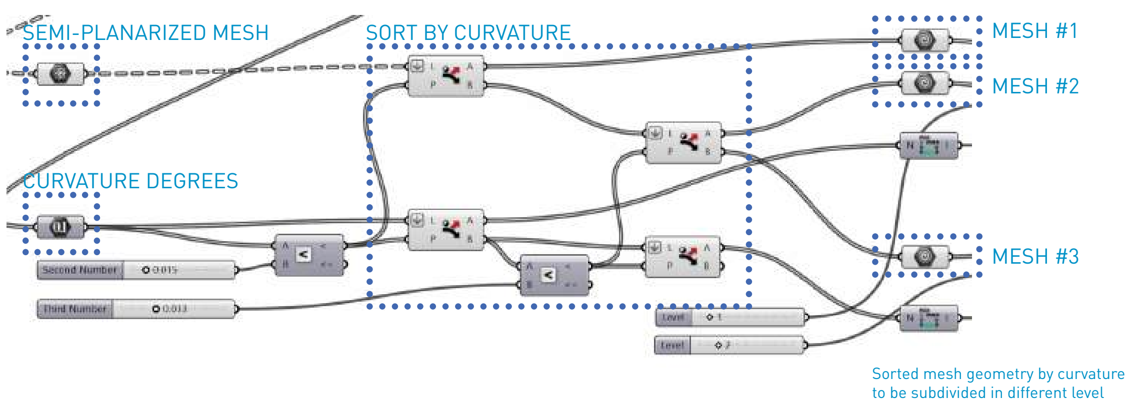


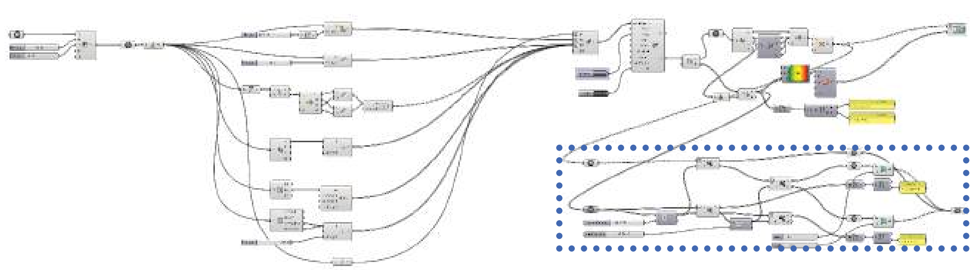
Planarizaion caused too much drft in certain region of the geometry



PLANARIZATION

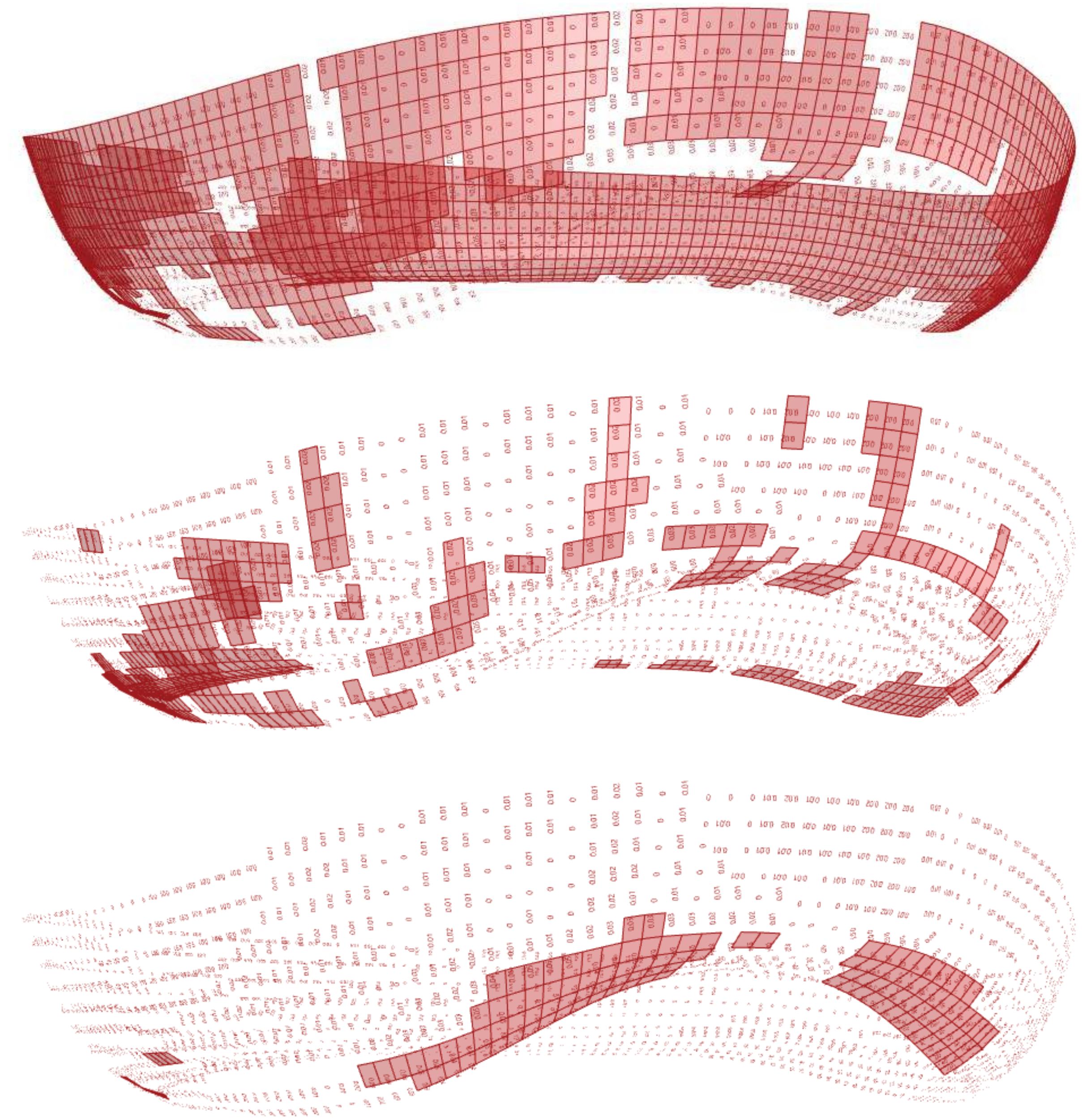
Planarizing the surface can lead to deformation of the overall geometry, depending on the level of constraints applied. In the example above, significant deformation occurs at the bottom of the entrance, requiring a different approach to be employed for specific parts of the shell





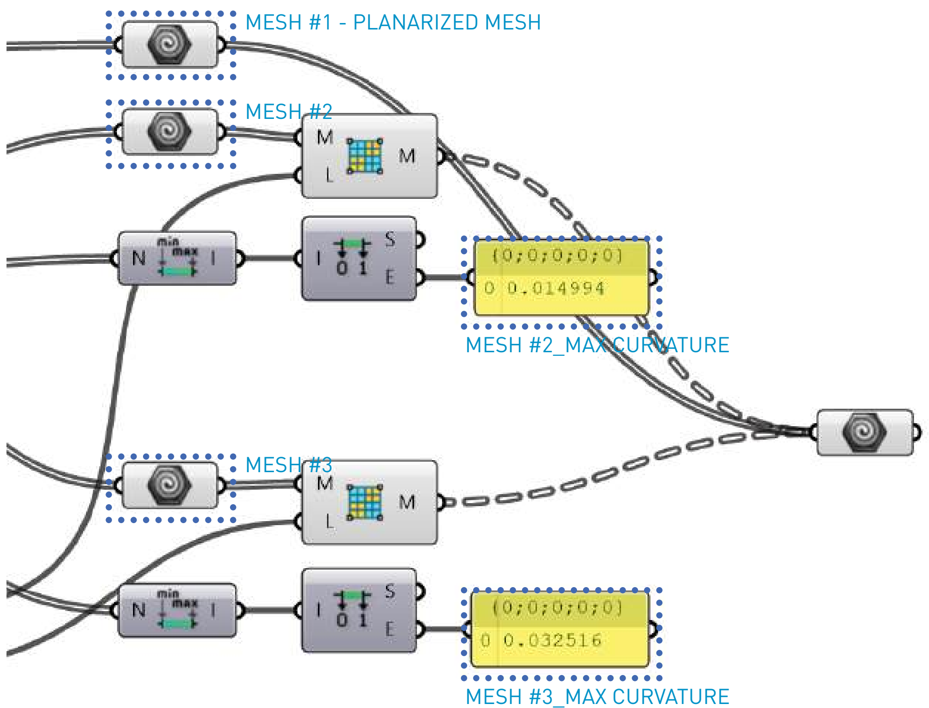
REGIONAL SUBDIVISION

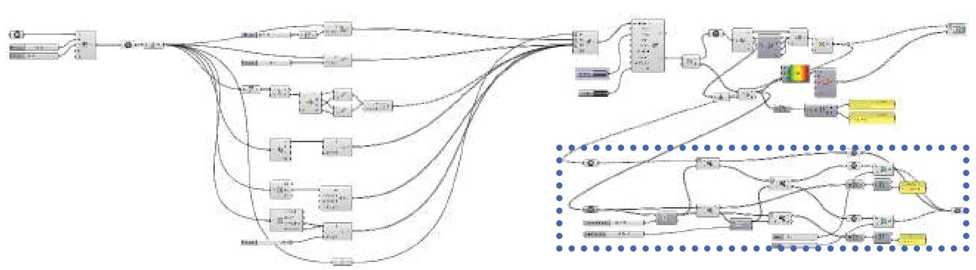
1) With partly subdivided mesh and it's curvature value, sort the meshes with flat and with curvature
2) Surface with curvature to be sorted again to less distortion and more distortion
3) 3 stages with maximum curvature value to be sorted in accordance to the above process



STAGED SURFACE GROUP VIA CURVATURE

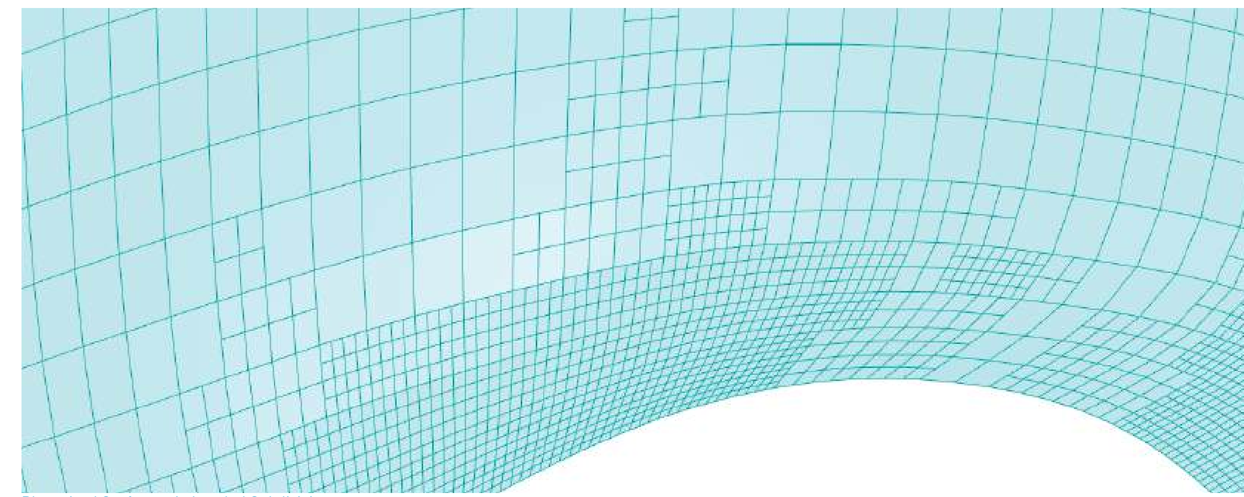
By categorizing the surfaces based on their curvature, they can be subdivided into smaller sections to reduce curvature, enhance constructability, and improve tolerance. This process will be evaluated in conjunction with the earlier planarization efforts.



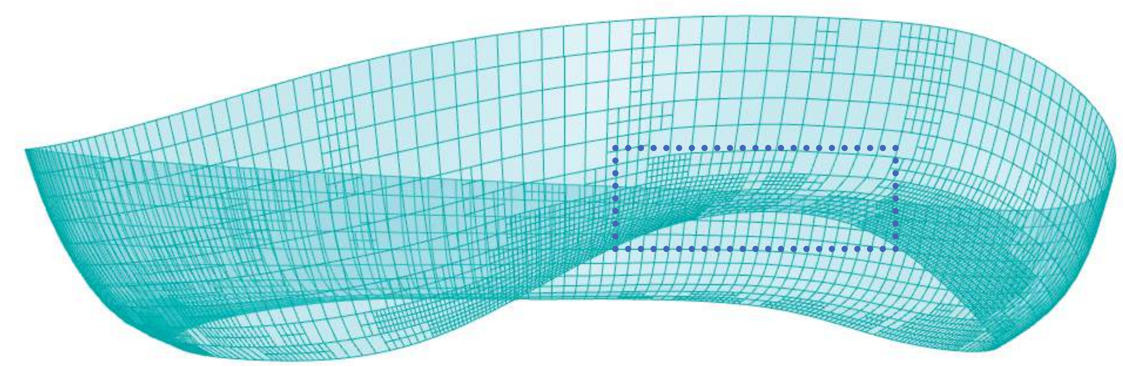


STAGED SUBDIVISION

1) Set the subdivision degree and connect it for subdivide mesh surfaces with distortion
2) Increase the degree until the max curvature reaches to the 0 or good enough level.

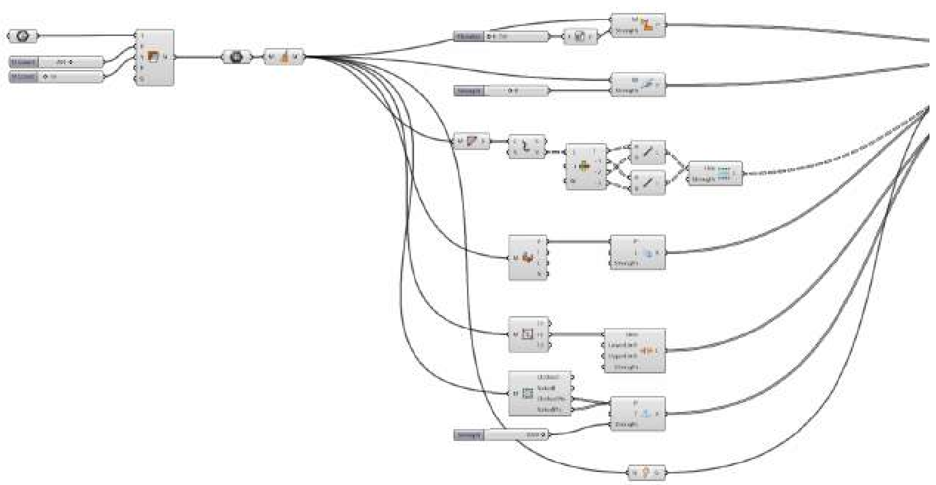


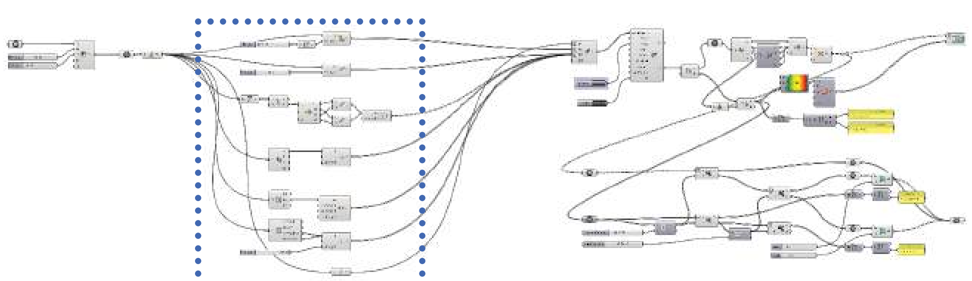
Planarized Surfaces via Leveled Subdivision



STAGED SURFACE GROUP VIA CURVATURE

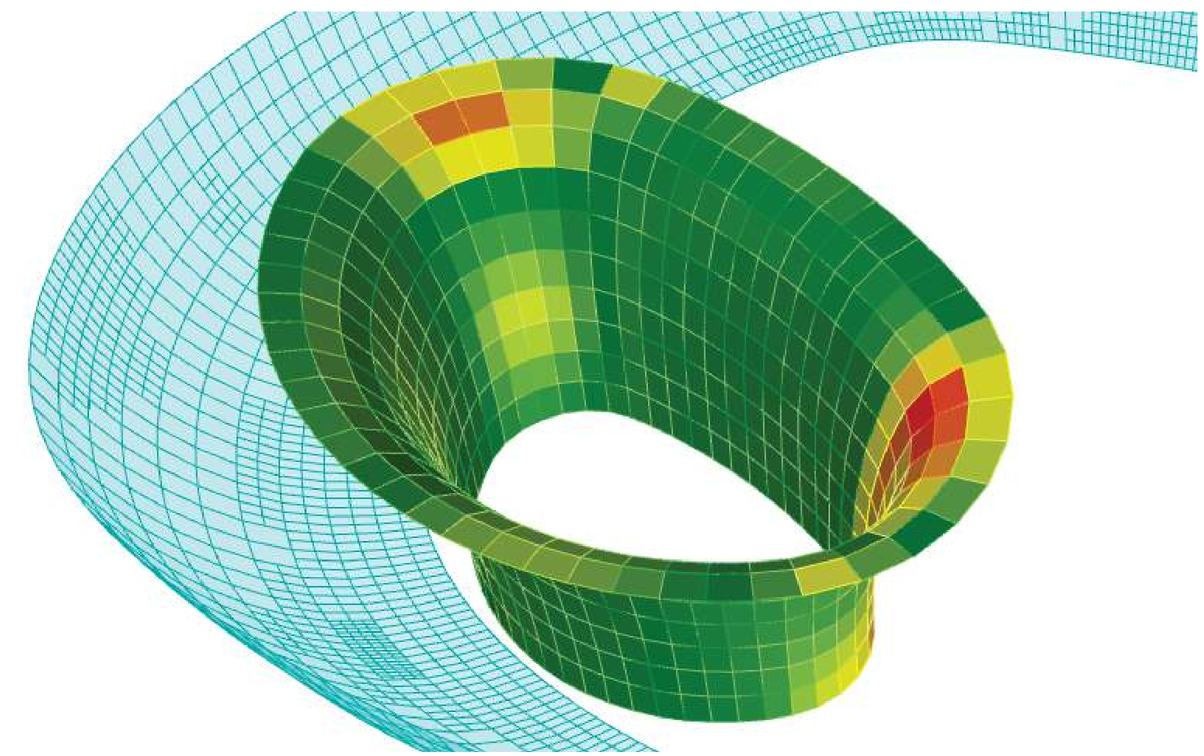
By categorizing the surfaces based on their curvature, they can be subdivided into smaller sections to reduce curvature, enhance constructability, and improve tolerance. This process will be evaluated in conjunction with the earlier planarization efforts.





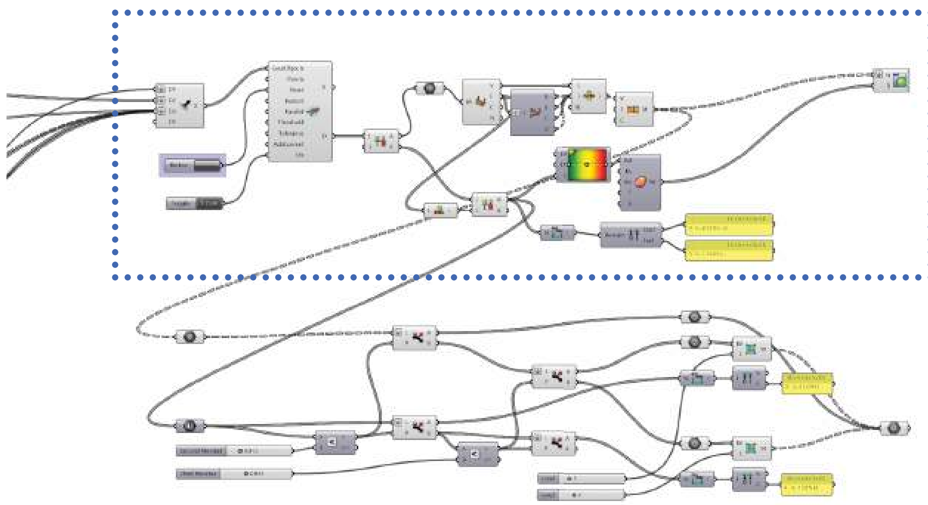
PLANARIZATION SETTINGS

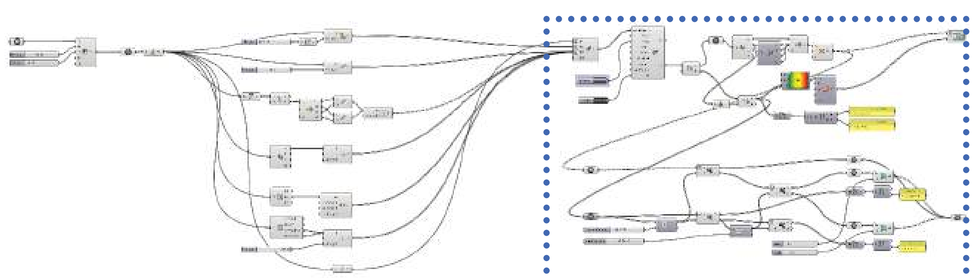
1) Repeat all the settings similar to the previous ourter shell planarization



PLANARIZATION OF THE GEOMETRY WITH LESS RESTRICTION

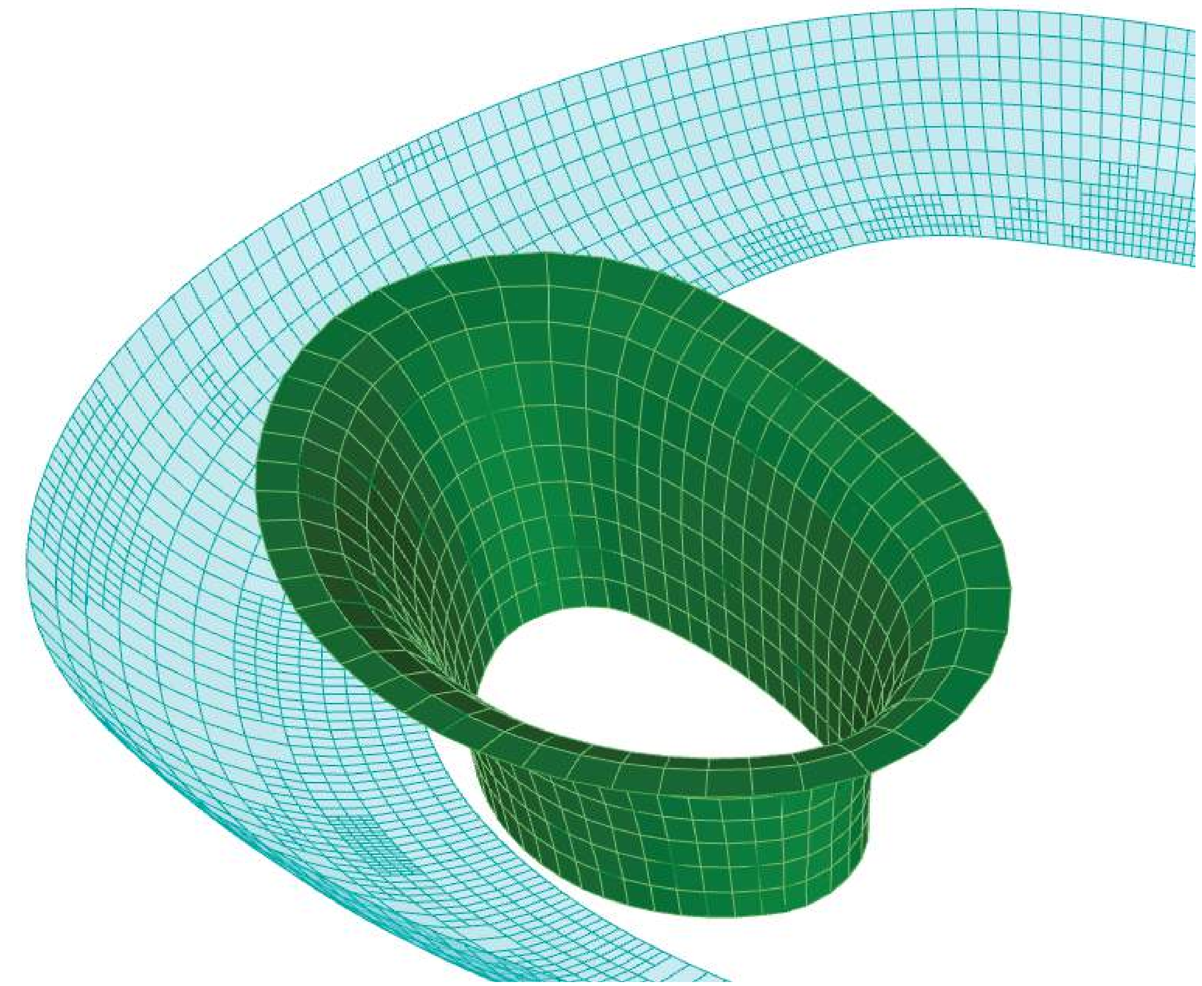
Although the rendering above depicts a triangulated frame system for the ETFE film, this design can also be achieved using a rectilinear approach by applying planarization techniques. Since this geometry exhibits less overall curvature, it can be optimized more easily by utilizing only the initial portion of the script, without requiring the mesh subdivision process





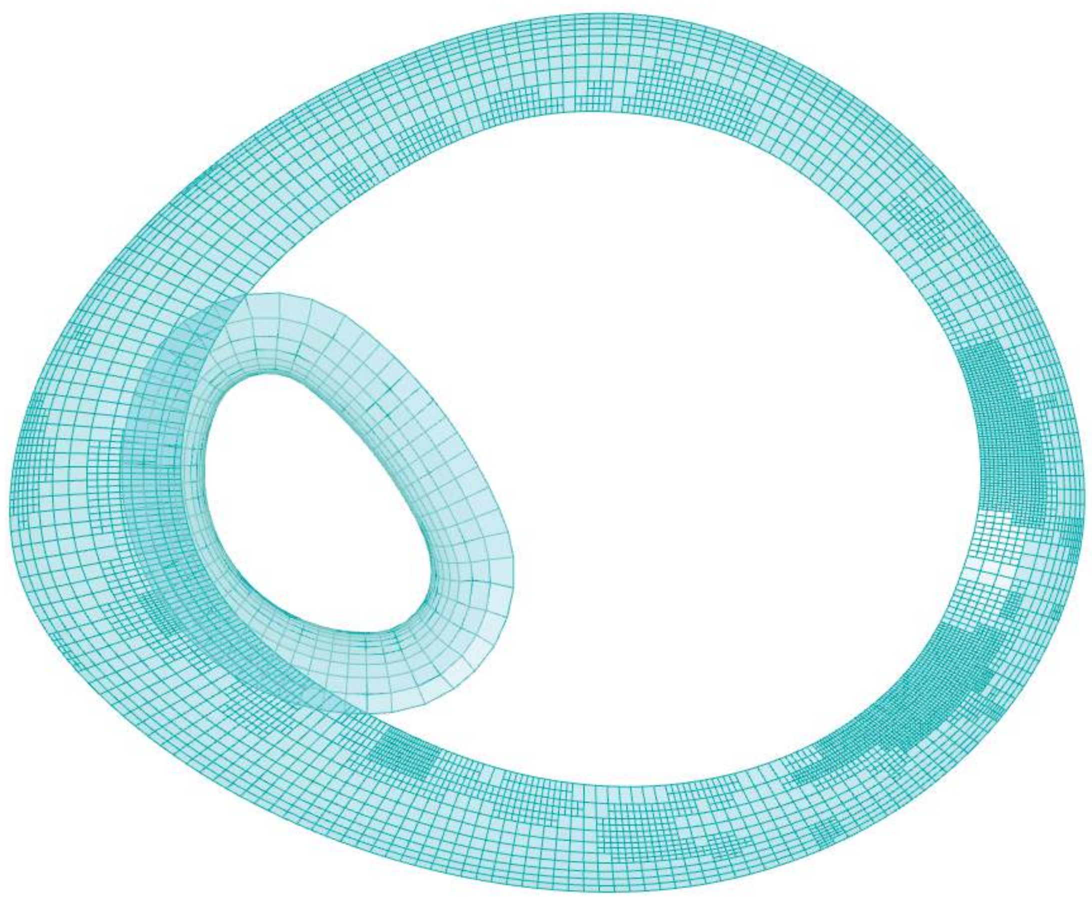
PLANARIZATION PROCESS

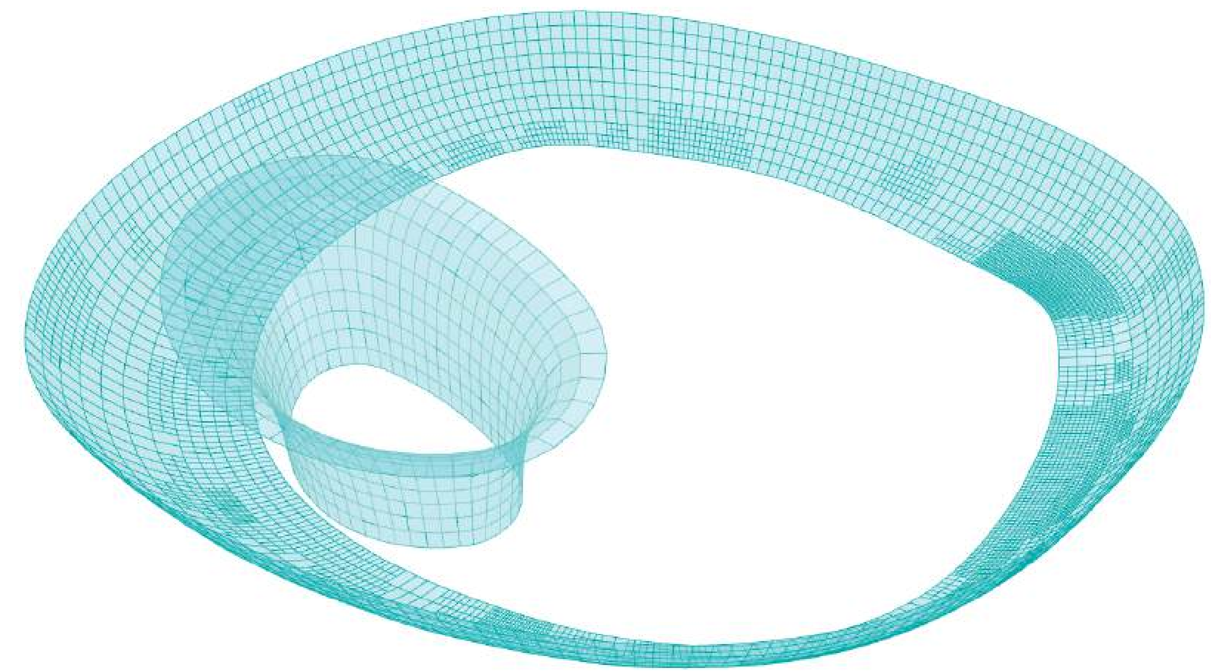
1) Repeat all the latter part of the planarization before mesh subdivision process

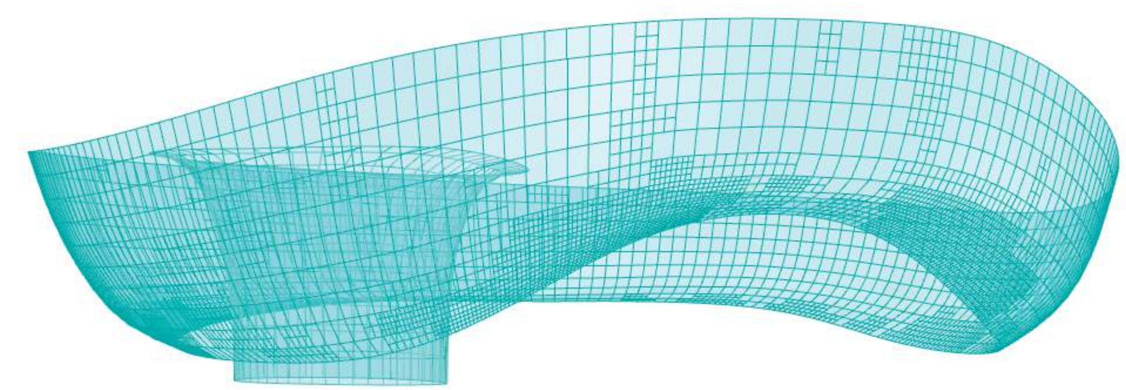


PLANARIZATION OF THE GEOMETRY WITH LESS RESTRICTION

As shown above, planarization is achieved without deforming the rectangular mesh surface. This is made possible by the less restrictive geometry and boundary conditions.

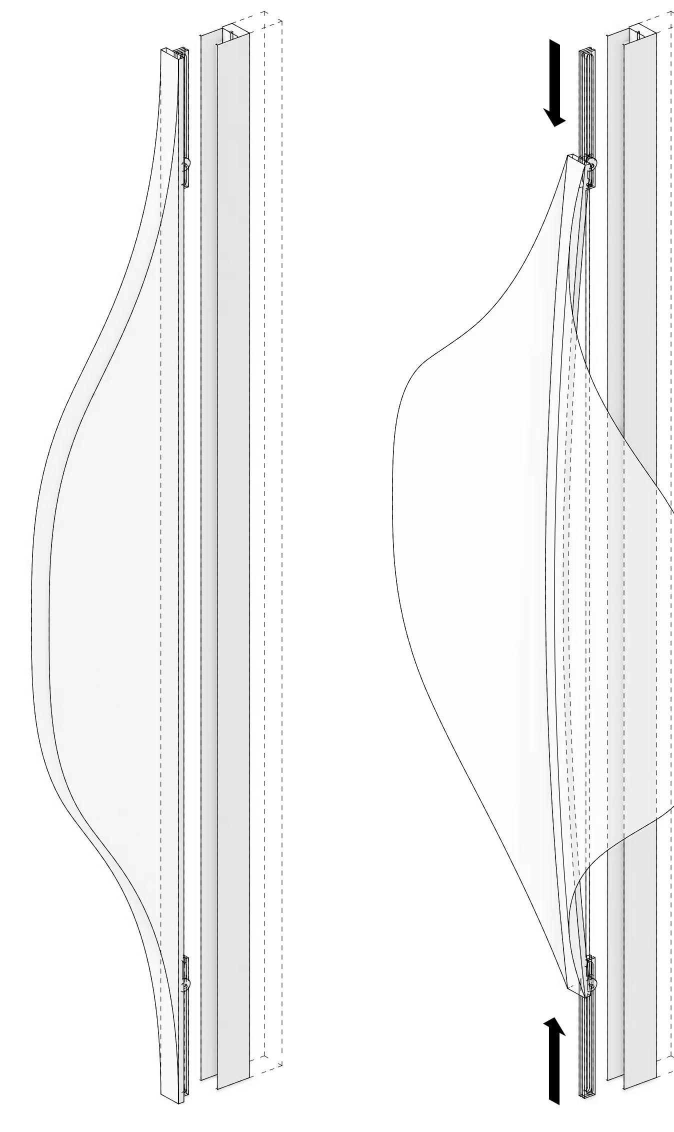






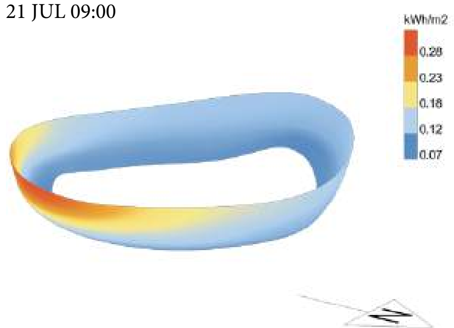
PHYSIC DRIVEN DESIGN FOR CONSTRUCTABILITY

Unlike physics-driven simulations explored in previous research, this approach can also enhance the constructability of geometries that were previously considered unfeasible due to limitations in construction techniques or economic constraints

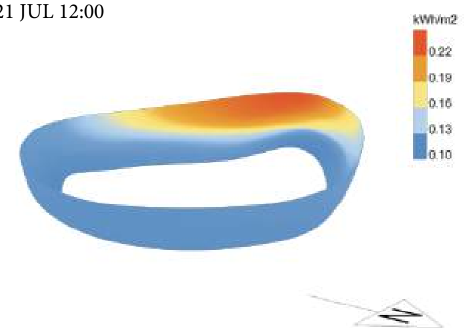


Responsive Meta-Material Shading Module

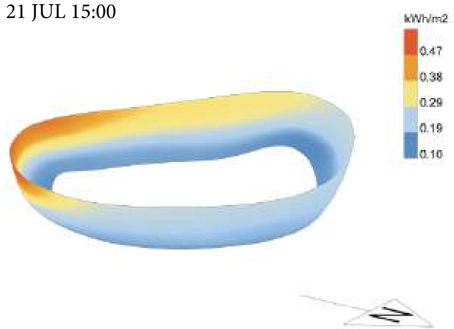
21 JUL 09:00



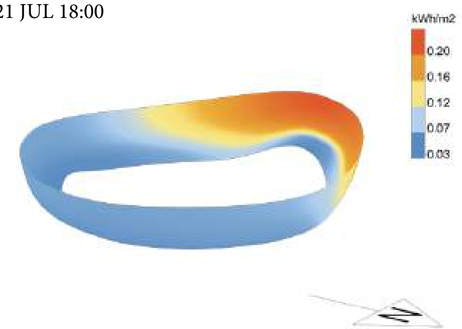
21 JUL 12:00



21 JUL 15:00



21 JUL 18:00

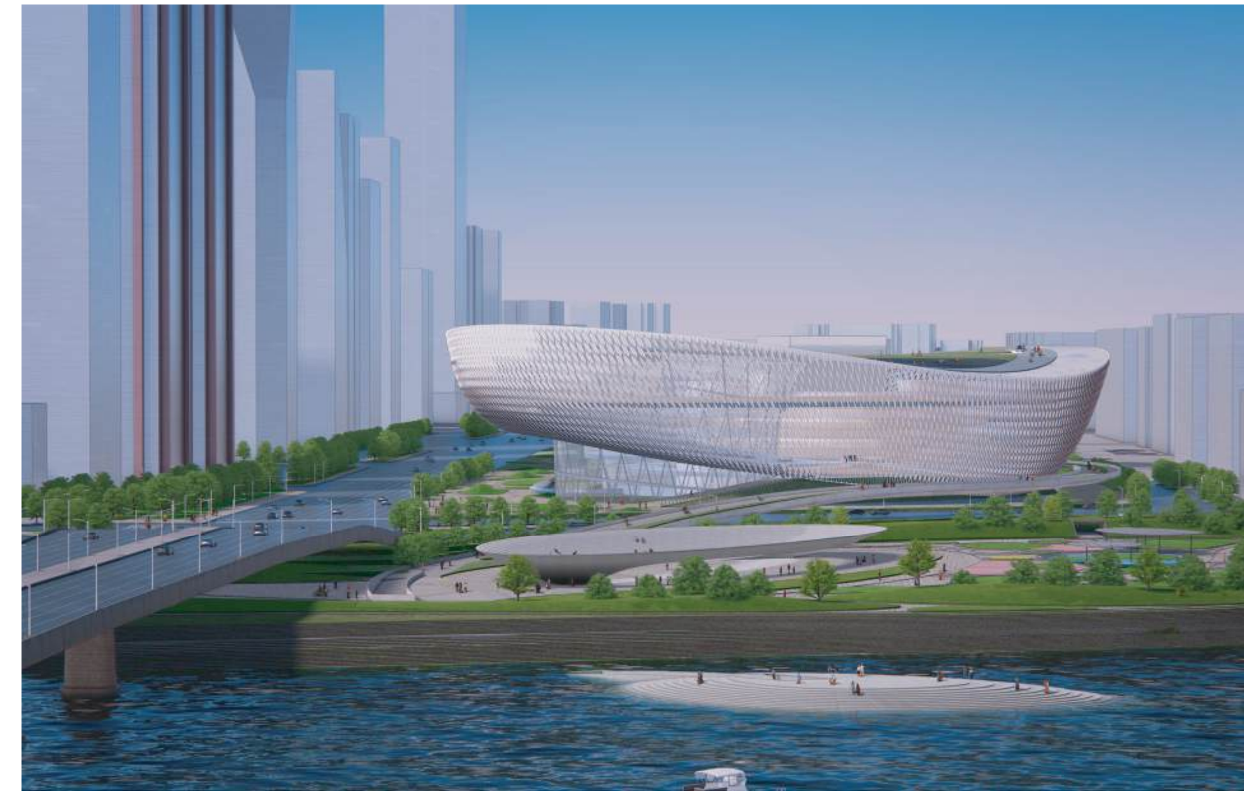


Design Criteria

The interactive kinetic facade system of the center is designed to embody the principles of sustainability, iconicity, and a dynamic vision of future Seoul. The meta-material bending module for the facade has been developed through careful simulations, incorporating scripted material properties and behaviors to ensure optimal performance.

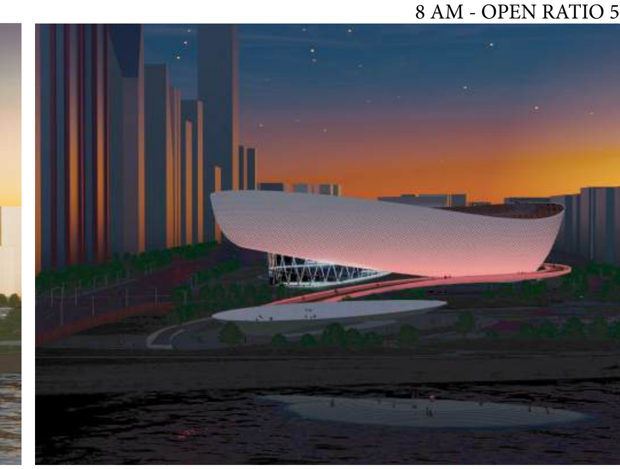
Simulation Objectives

Physics simulation for the module is employed to predict and control the kinetic movement and deformation of the geometry. The simulation settings are configured to replicate the behavior of the elements, guided by the principles of the K2 physics algorithm.

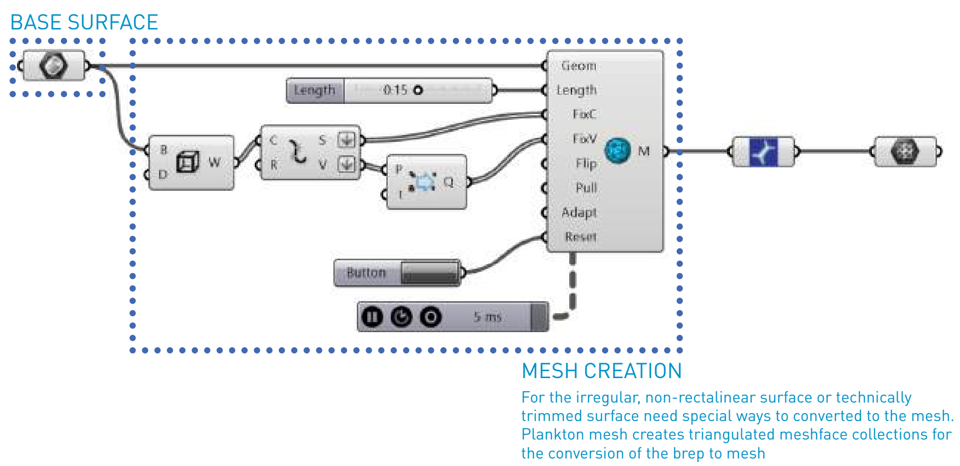


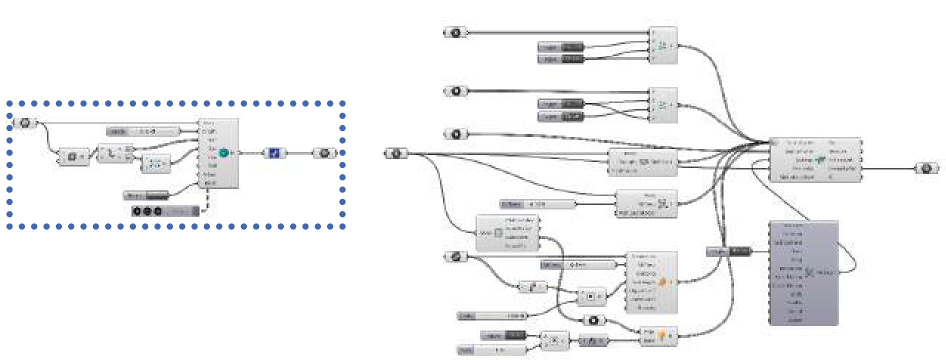
8 AM - OPEN RATIO 53%

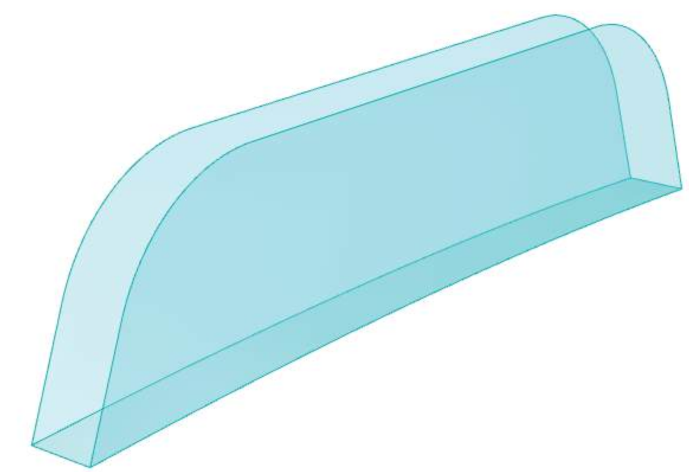
18 PM - OPEN RATIO 77%

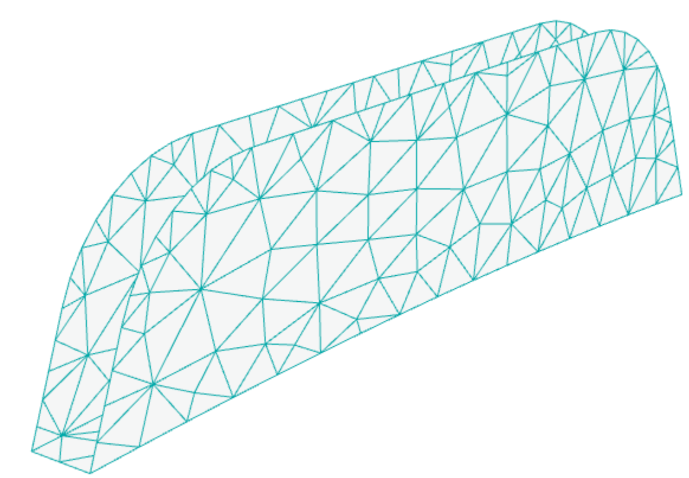


22 PM - OPEN RATIO 12%



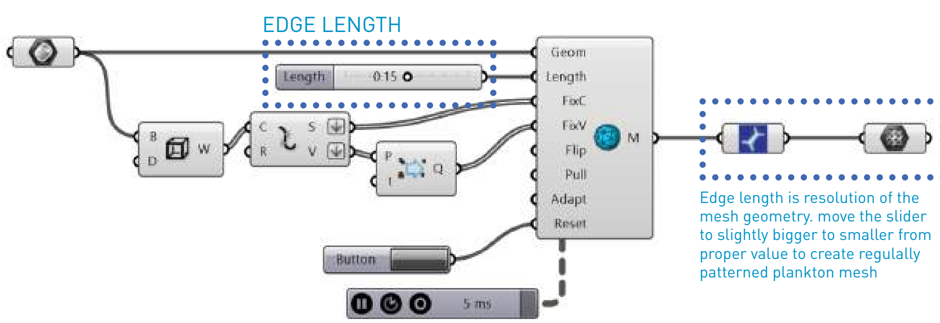


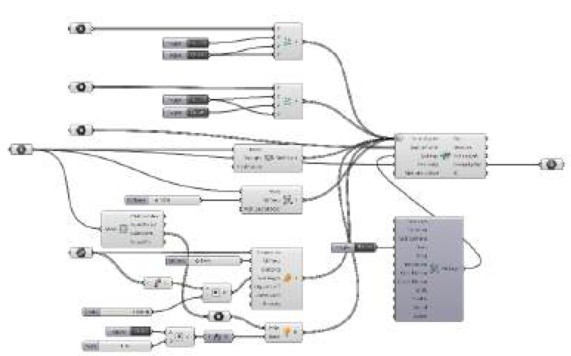




PREPARE BASE GEOMETRY

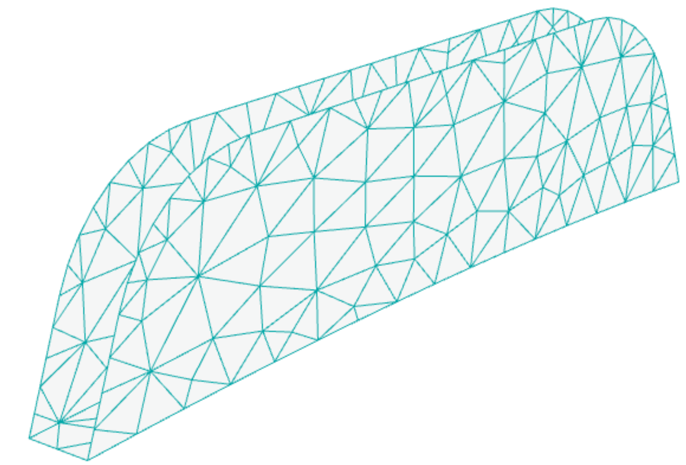
1) Import rhino geometry to GH environment as boundary representation
2) If the geometry is trimmed, irregularly shaped surface, connect it to the meshmachine

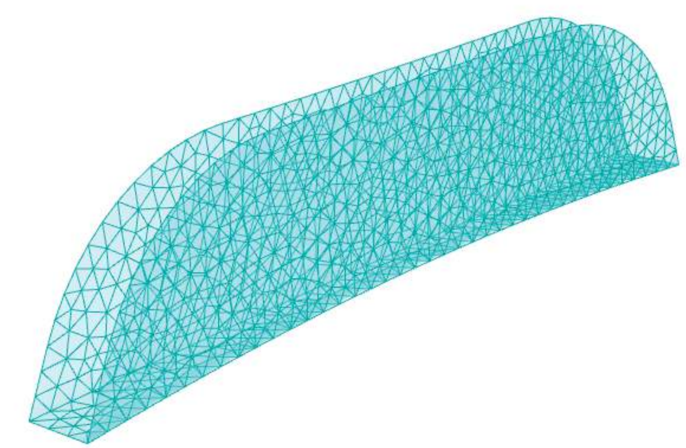




PLANKTON MESH

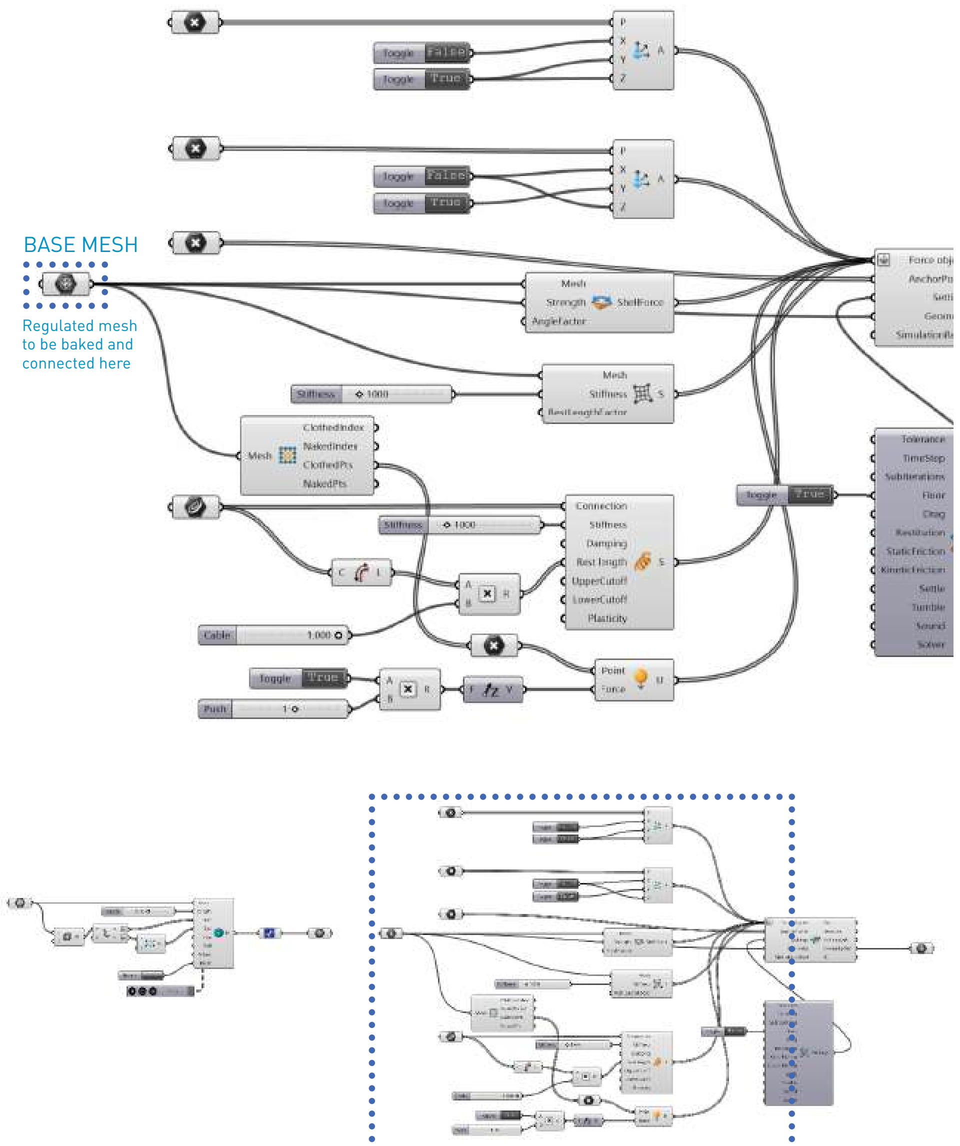
1) Once the Brep is connected, turn on the simulation and adjust the edge length
2) Once the density of the mesh is become high enough for accurate simulation, bake it.





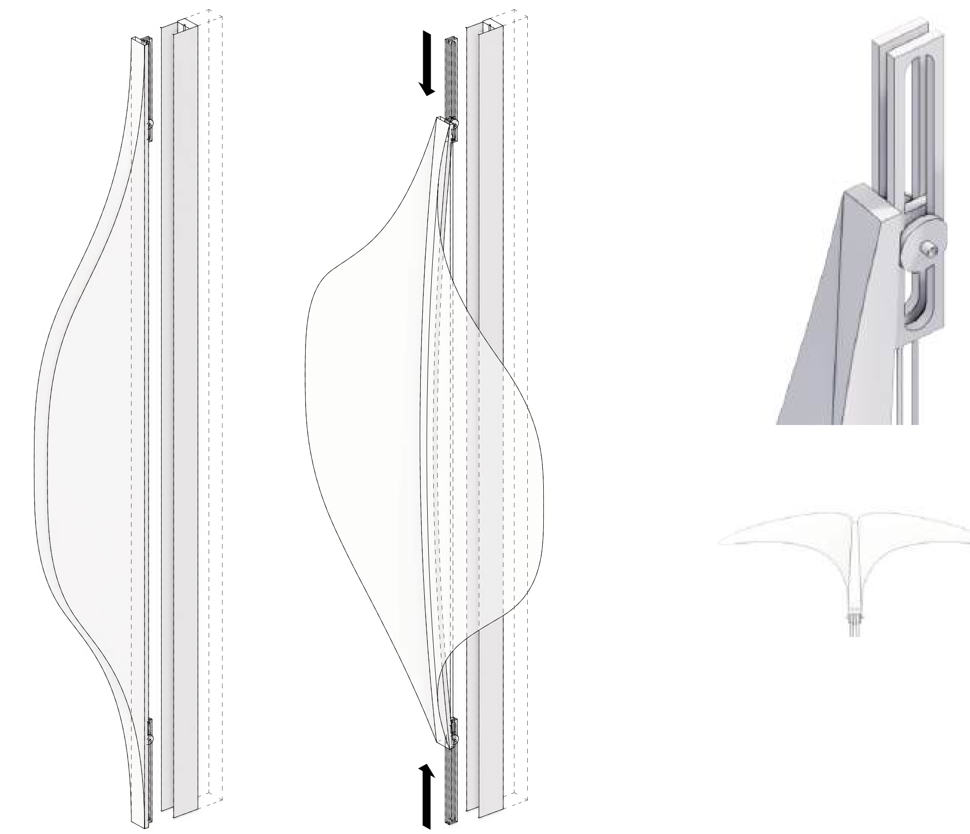
MESH CONVERSION

Untrimmed surfaces need to be converted into irregularly patterned meshes with consistent density. This process mimics the behavior of bendable materials, such as plastic or carbon fiber, which are typically composed of highly dense, irregularly patterned fabrics.



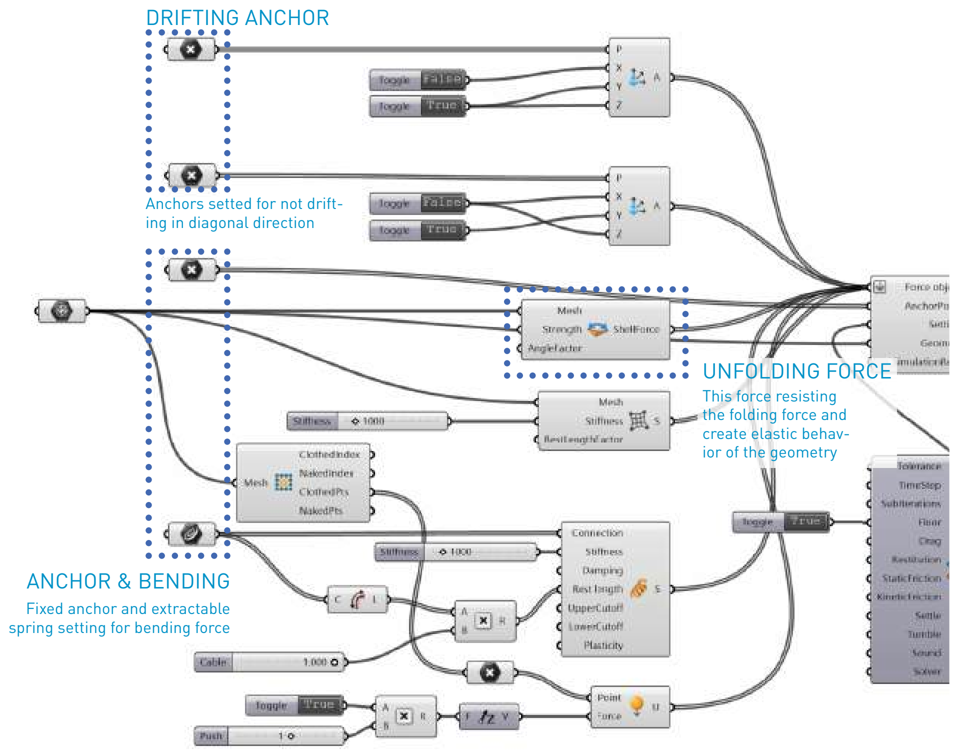
BENDING SIMULATION SETTING

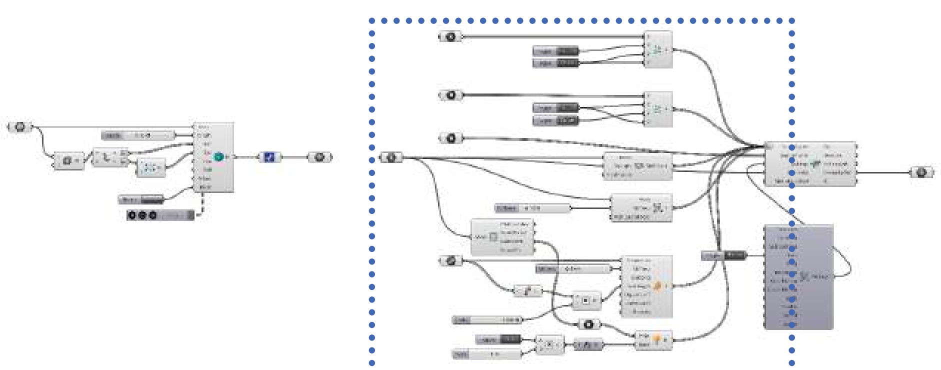
1) Import the baked mesh to base mesh geometry for simulation



KINETIC MECHANISM

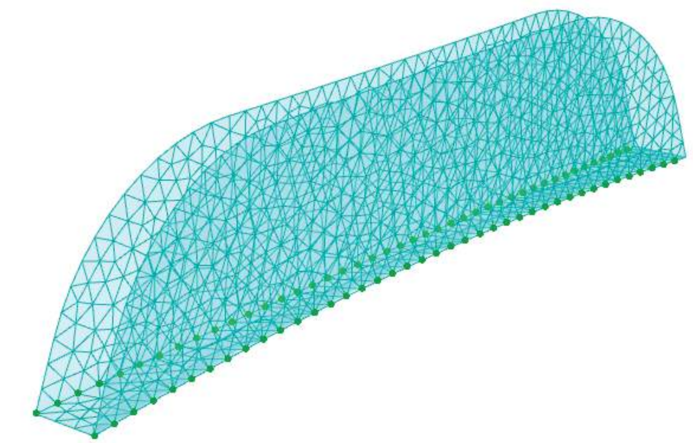
The simulation will explore the concept of bendable deformation, a kinetic mechanism that leverages the properties of flexible materials to achieve controlled deformation. This approach can be applied across various scenarios.



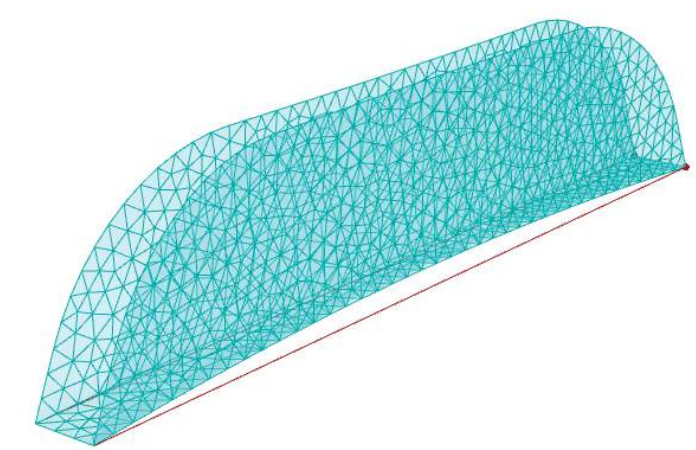


SIMULATION SETTINGS

1) Create anchors drift in specific axis. In this simulation
1-1) system constraints holds the anchors in X axis. but not for Y and Z axis
2) Create end point anchors for bending forces
2-1) a point setted as anchor will move to another anchor to squeeze the mesh



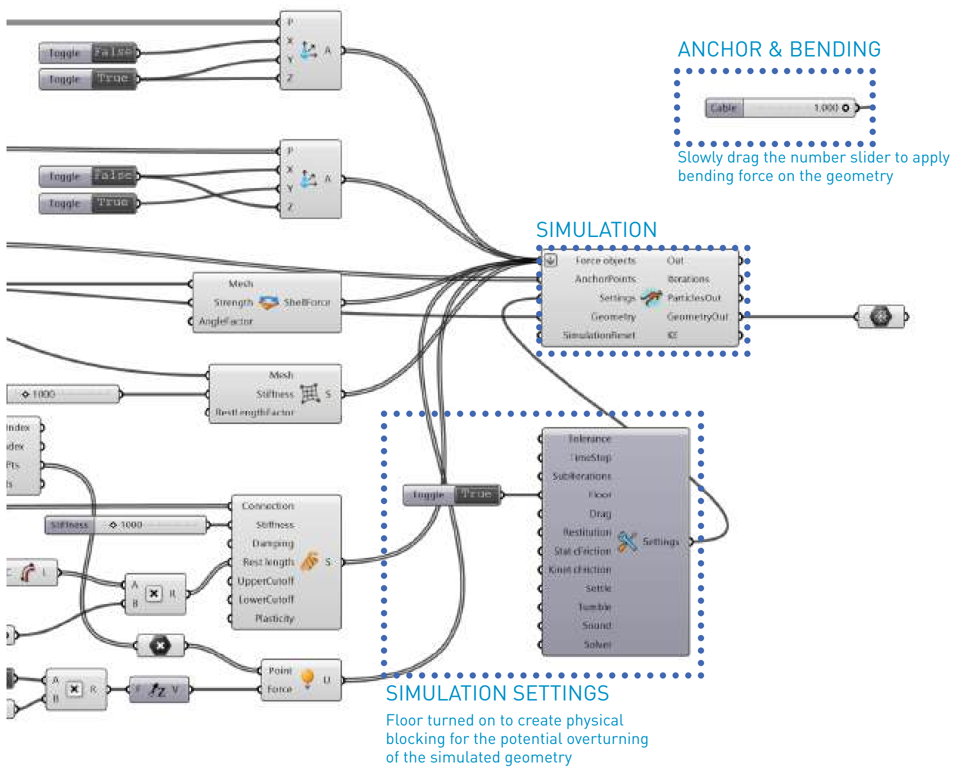
DRIFTING ANCHORS

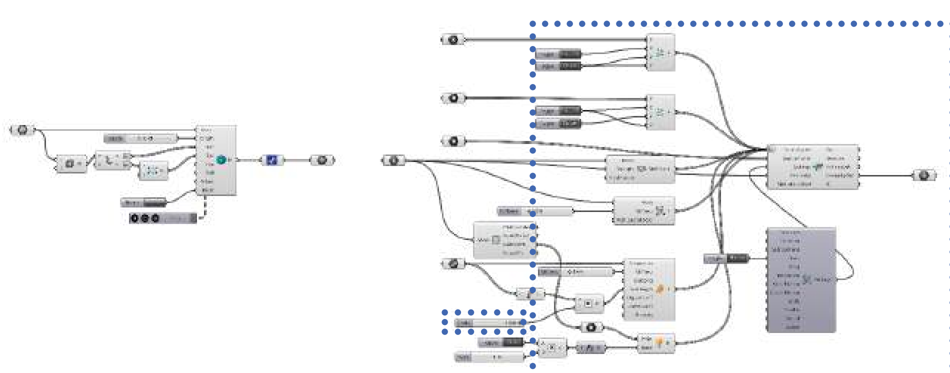


ANCHOR & BENDING ROD

BENDING DEFORMATION

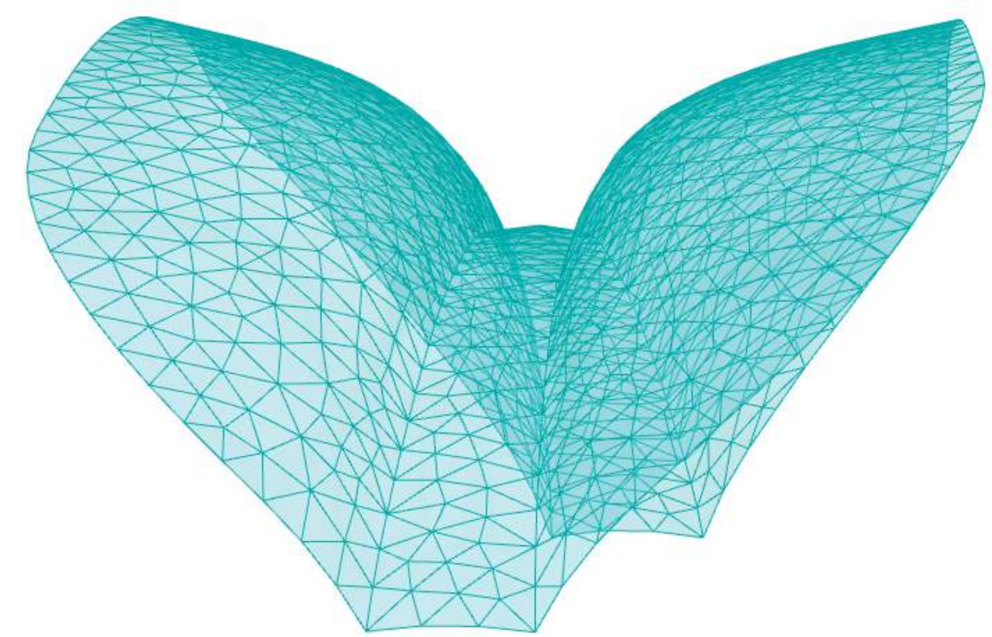
The simulation settings are designed to replicate bending deformation. The key factors influencing this deformation include a regularly patterned mesh, squeezing anchors, and the unfolding forces along the mesh edges. Additionally, depending on the context, the simulation can incorporate elements such as drifting anchors, floor constraints, or temporary uplifting forces.





BENDING SIMULATION

1) Add simulation settings as needed, such as add floor
2) Run the simulation
3) Slowly adjust the anchor distance to create bended form of the geometry



CONTROLLED BENDING DEFORMATION

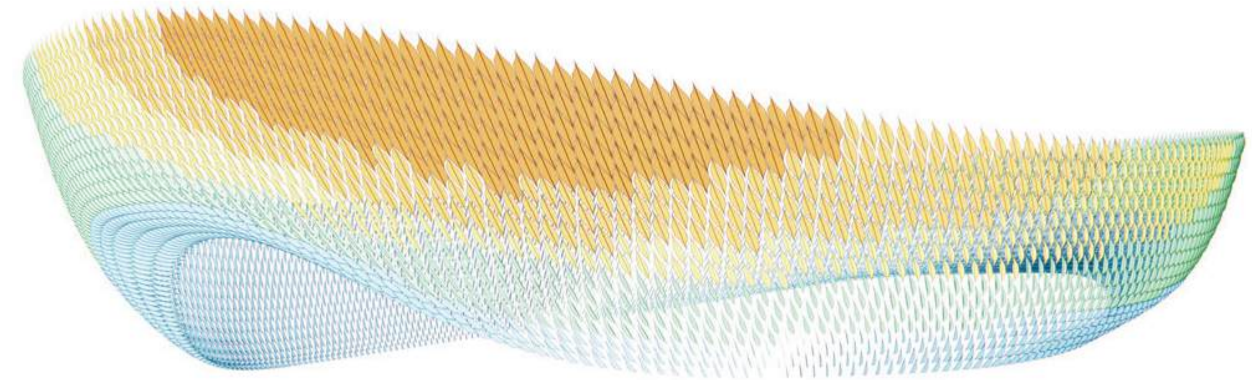
STAGED DEFORMATION

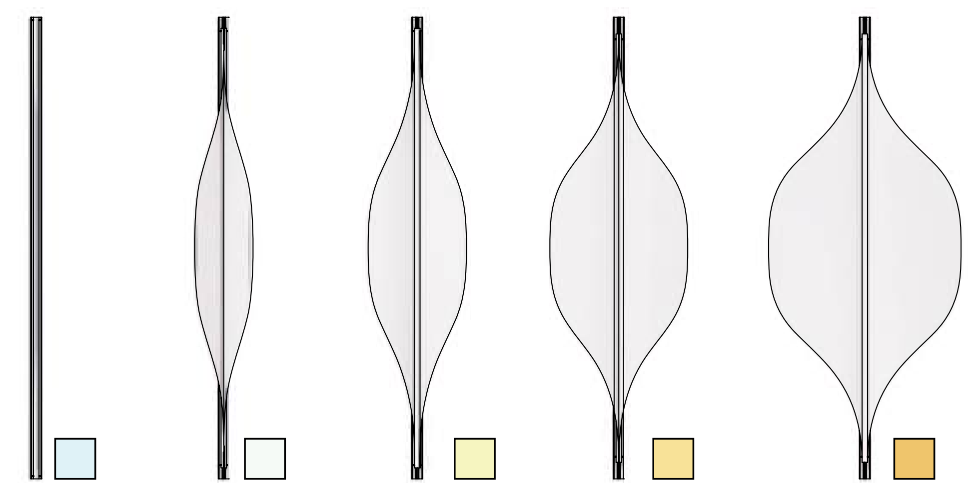
STAGED DEFORMATION

The most significant advantage of this deformation is its phase removal capability. With minimal force, it can seamlessly transition from 0% to 100%, allowing for an infinite number of intermediate stages to be achieved effortlessly. This system can be manually adjusted to create specific stages during the mock-up phase and applied to various architectural scenarios.

PROGRAM RESPONSIVE SYSTEM

This scenario is intended for interior spaces, where the system can create transformable environments. It can alternate between an outward-facing configuration to frame outdoor scenery and an inward-facing configuration to support indoor programs.



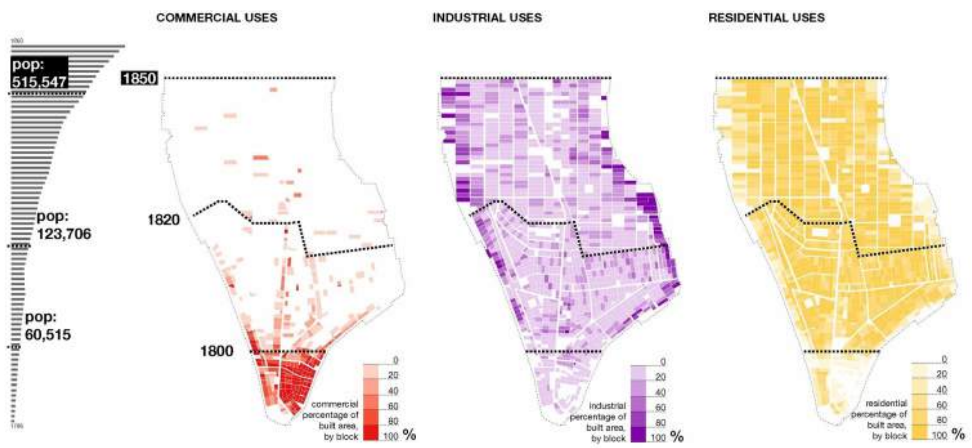


ENVIRONMENTALLY RESPONSIVE SYSTEM

The system can also enhance building energy performance by responding to environmental conditions. Utilizing environmental simulations from previous research, it can be easily integrated with physics-driven design.

GIS DATA

OSM, Geofabrik & Data Visualization



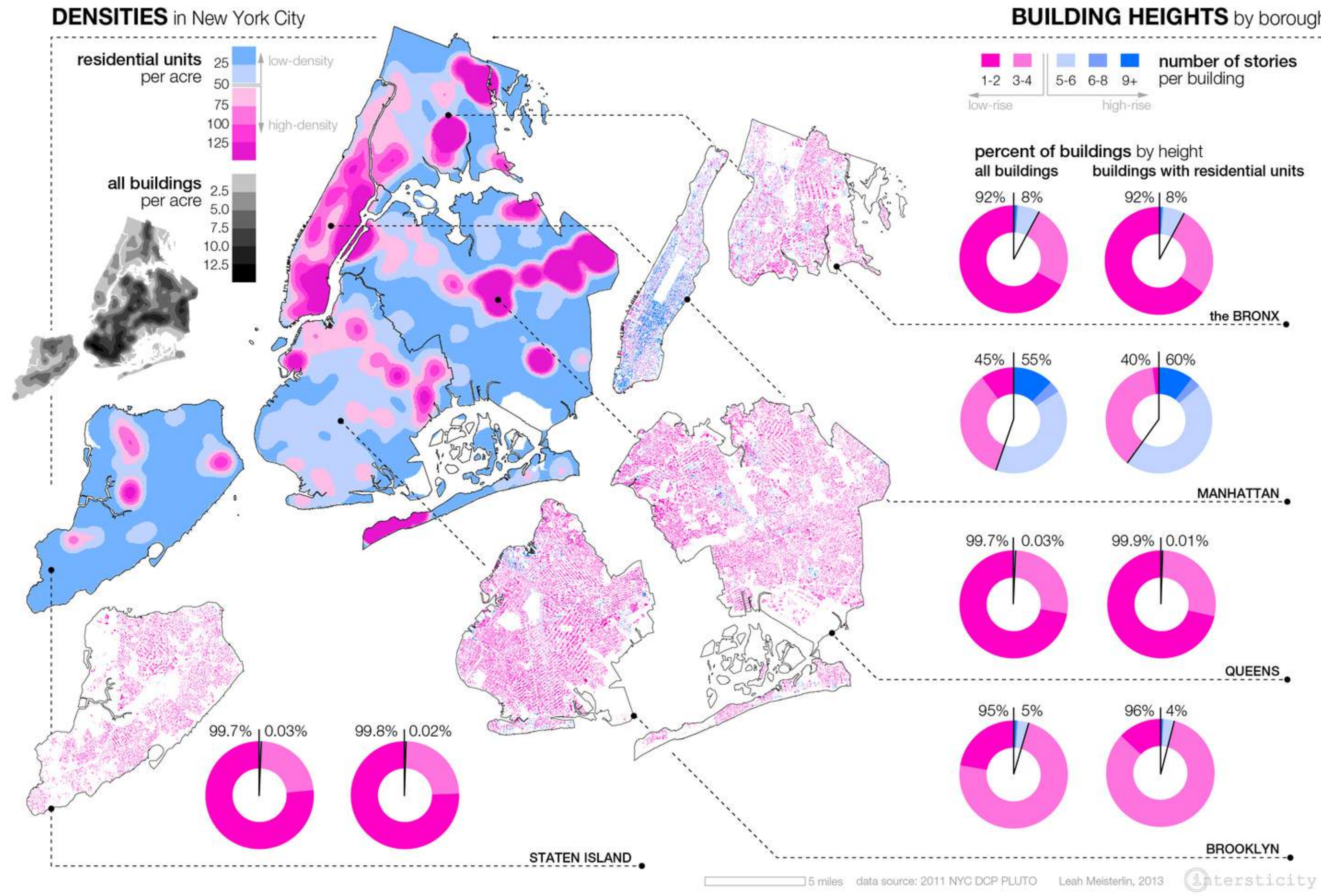
GIS DATA

Geographic Information System data in architectural design refers to spatially referenced information that provides insights into the physical and environmental context of a site. This data is essential for understanding the geographic, demographic, ecological, and infrastructural characteristics of a location, which can significantly influence architectural and urban planning decisions. Key components of GIS data in architectural design include Topography, Zoning or other regulation, Environmental conditions (specifically, such as flood zone or soil contamination), Infrastructure, Demographics, Historic or Cultural sites, Urban Morphology, natural ecosystems.

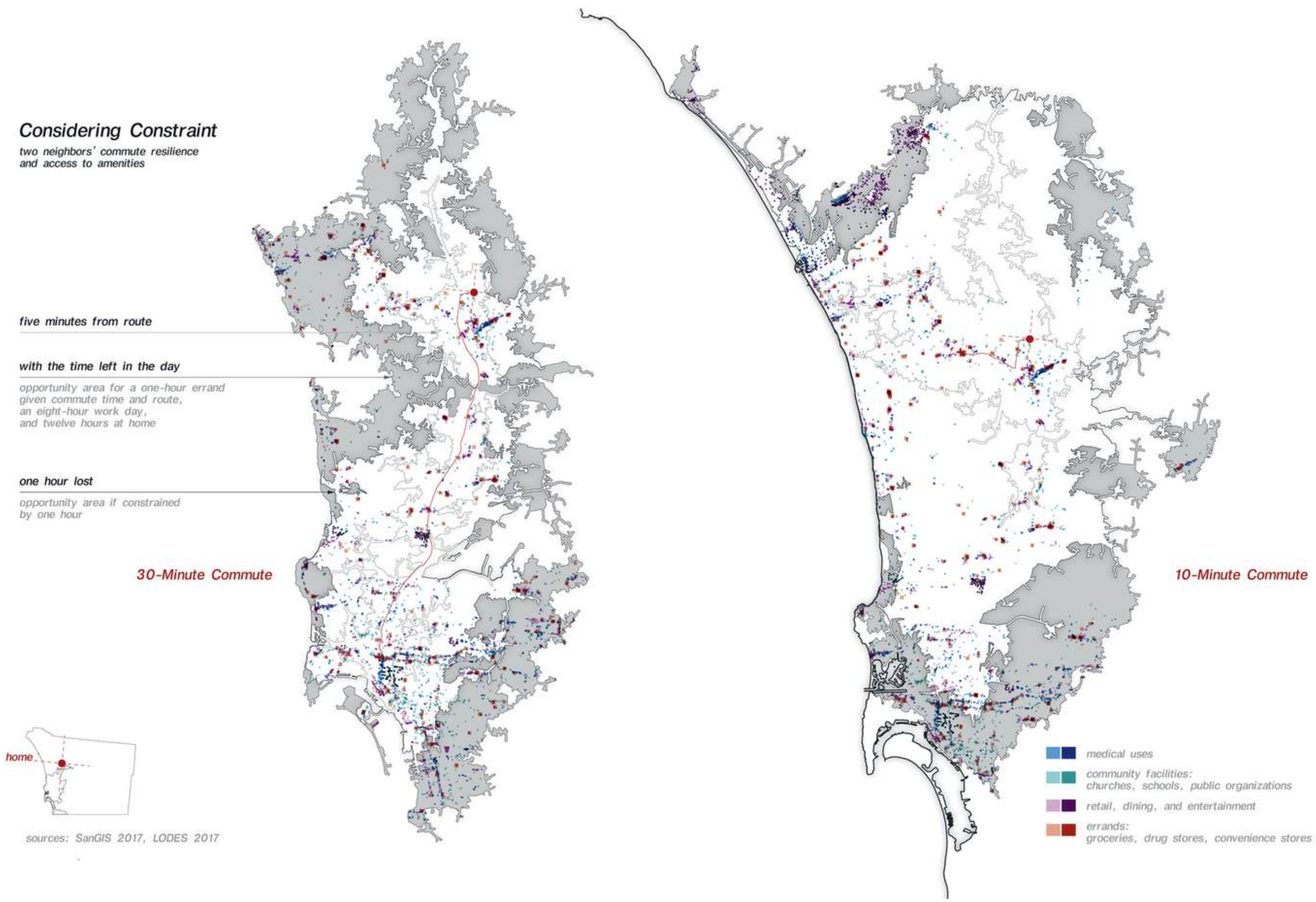
By integrating GIS data into the design process, architects and urban planners can create more informed, context-sensitive, and sustainable designs. GIS data provides a comprehensive understanding of the site and its surroundings, enabling better decision-making and enhancing the overall quality and resilience of architectural and urban projects.

In New York City area, a wealth of GIS data is readily accessible to the public, providing valuable resources for architects, urban planners, researchers, and other stakeholders. Some of the most commonly used and easily accessible GIS data sources in NYC include NYC Open Data, NYC Planning Department, NYC Department of City Planning, Metropolitan Transportation Authority, NYC Department of Building, etc.

These sources offer a wide range of GIS data that can be leveraged to support architectural and urban design projects, ensuring they are well-informed, contextually appropriate, and sustainable.



Cartographies of Distance, in L. Kurgan and D. Brawley, Eds. (2019) Ways of Knowing Cities. pp 250-72.



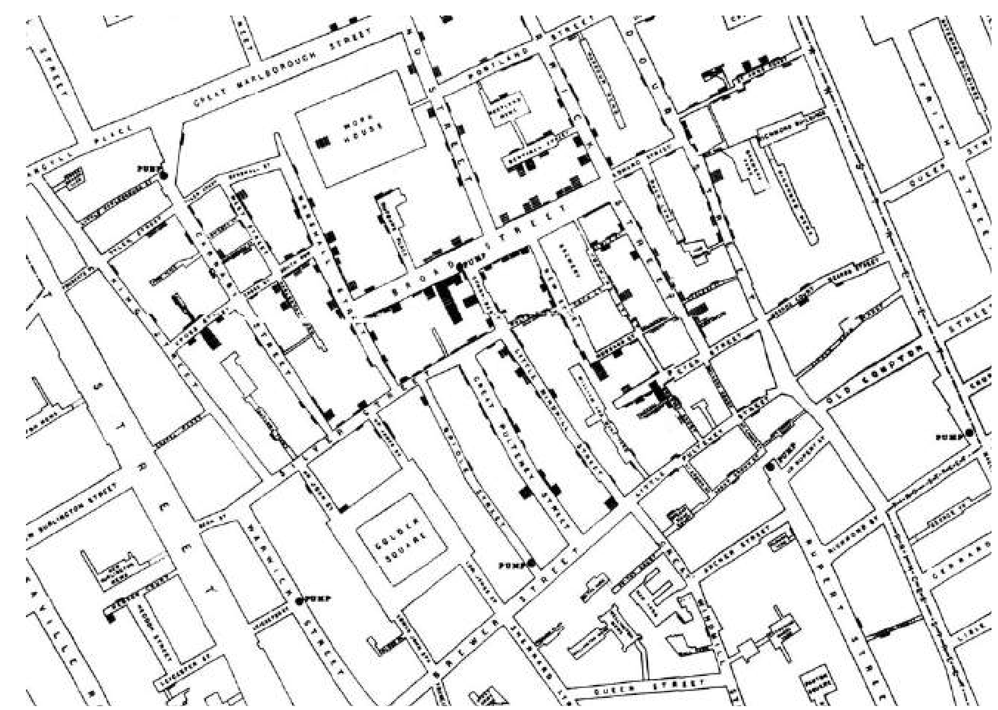
John Snow's map of cholera deaths in London's SoHo neighborhood in 1854.

CARTOGRAPHIC EVOLUTION IN THE ERA OF BIG DATA

Cartography, the craft of creating maps to represent geographical spaces, has always been an essential tool for understanding and navigating the architectural context. As the discipline evolves in response to technological advancements, its application in urban contexts has grown increasingly sophisticated.

This art and science of map-making, has undergone a significant transformation with the advent of Geographic Information Systems (GIS), particularly in the realm of urban mapping. In the context of modern urban planning, cartography is no longer limited to static representations of geographical spaces; it now involves the creation of dynamic, data-driven maps that convey complex spatial information in an intuitive and accessible manner.

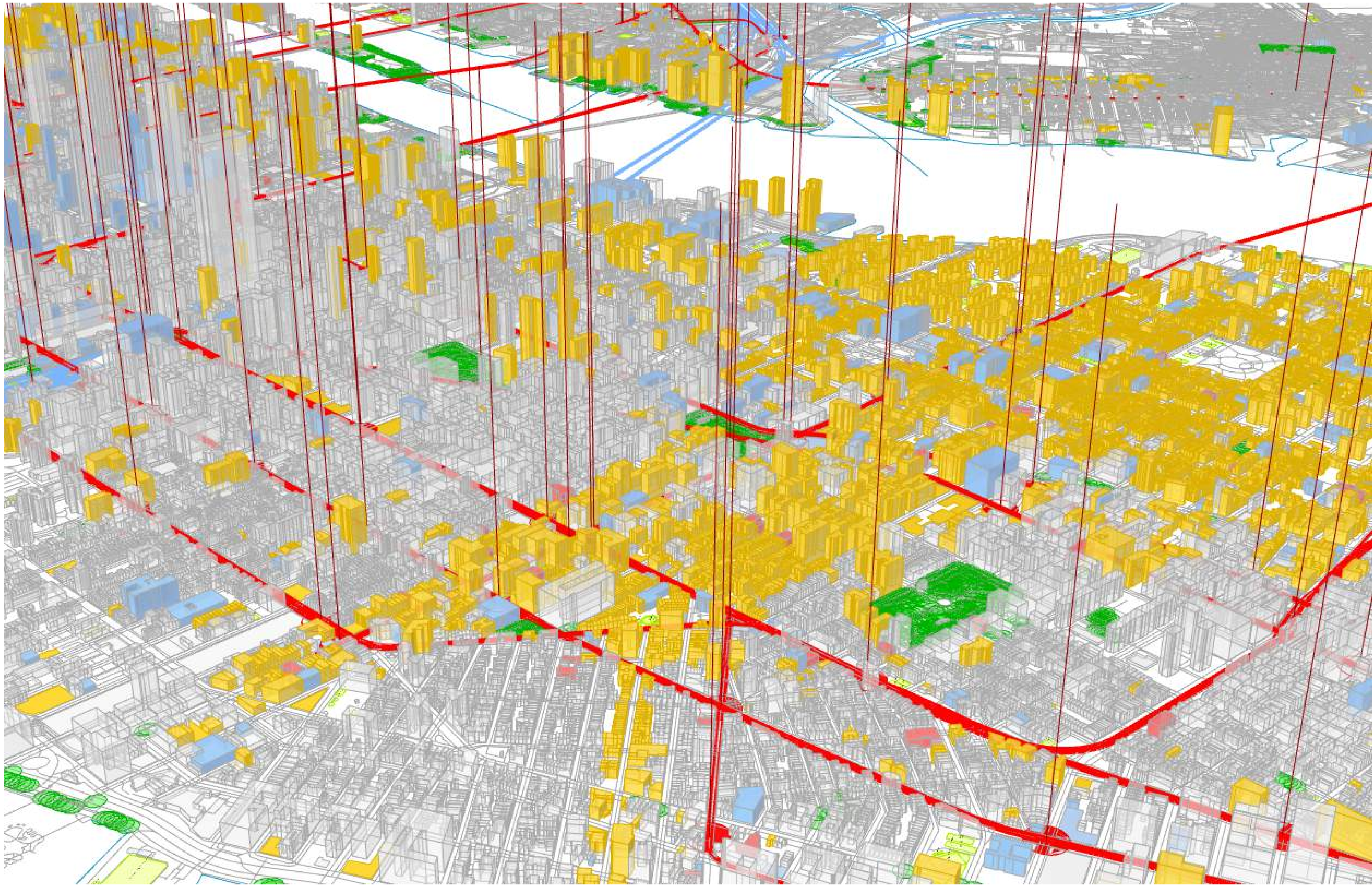
By harnessing the power of GIS data, modern cartographers can produce highly detailed urban maps that serve as essential tools for analyzing spatial relationships, understanding urban growth, and guiding sustainable development. This research delves into the role of cartography in contemporary urban mapping, emphasizing the synergy between traditional map-making techniques and advanced GIS technology.



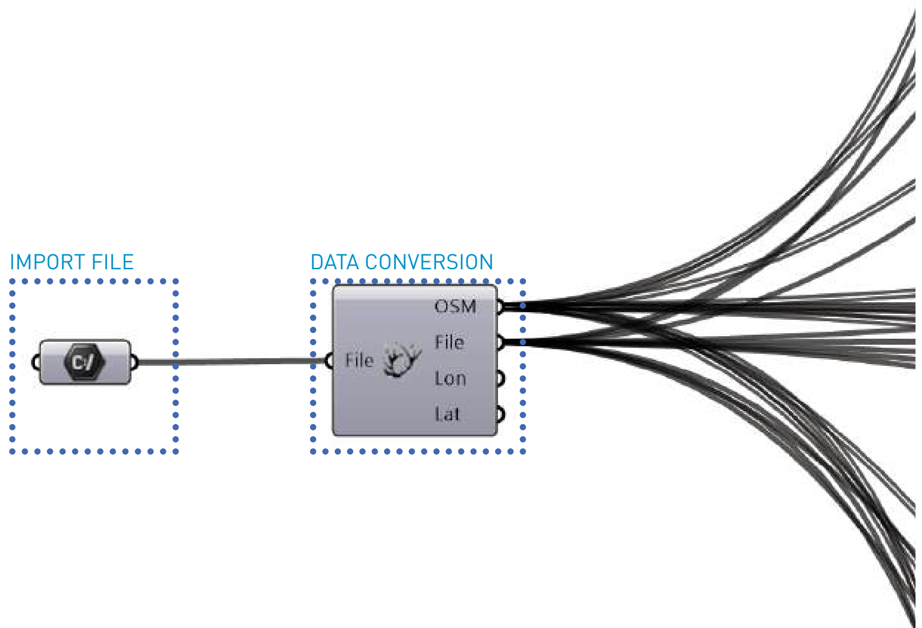
GIS DATA VISUALIZATION

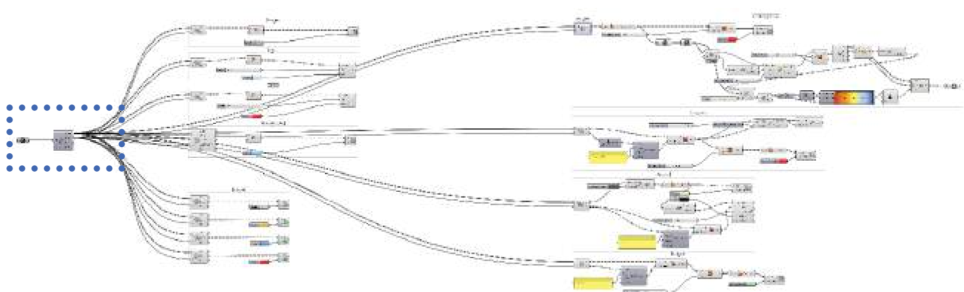
OSM, Geofabrik & Data Visualization

OpenStreetMap data is created and maintained by a global community of mappers who contribute detailed information about various elements such as roads, trails, cafés, railway stations, and much more. By leveraging this extensive dataset, architects and designers can gain valuable insights into the character of a site, as well as its surrounding urban context and patterns. This chapter will focus on how to effectively utilize OpenStreetMap data within the Rhino and Grasshopper environment, providing a practical guide for incorporating this data as a parameter for generating architectural design outputs. This approach allows for a more informed and data-driven design process, facilitating the integration of real-world urban features into the design workflow.



OSM, Geofabrik & Data Visualization

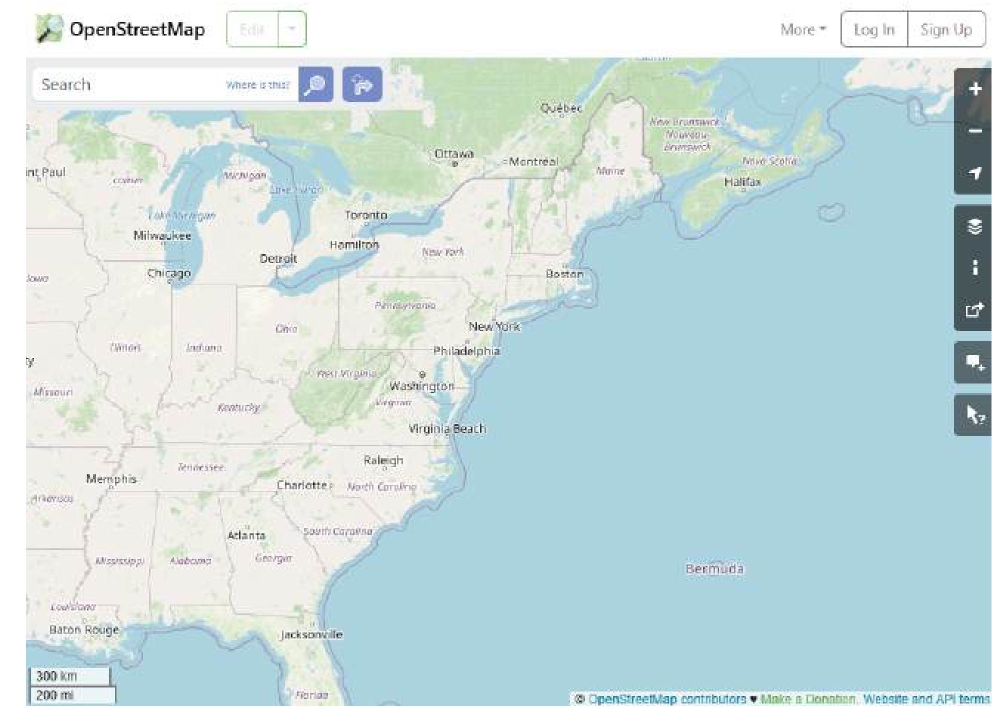




FILE PATH SET UP

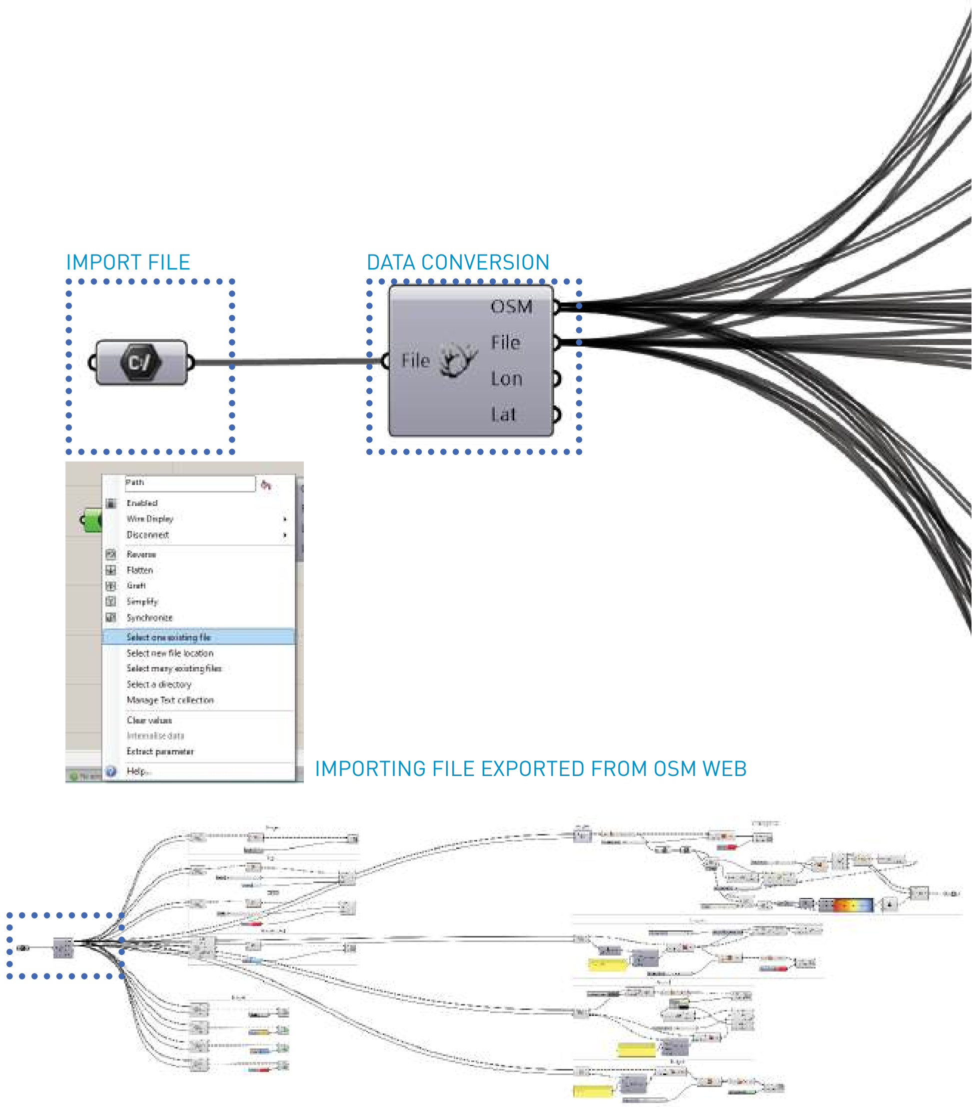
1) Find EPW weather file URL from the epw map (https://www.ladybug.tools/epwmap/)
2) Paste the URL to the GH note and connect to the weather URL input

Top: ELK, https://www.food4rhino.com/en/app/elk
Bottom: Open street map, https://www.openstreetmap.org/



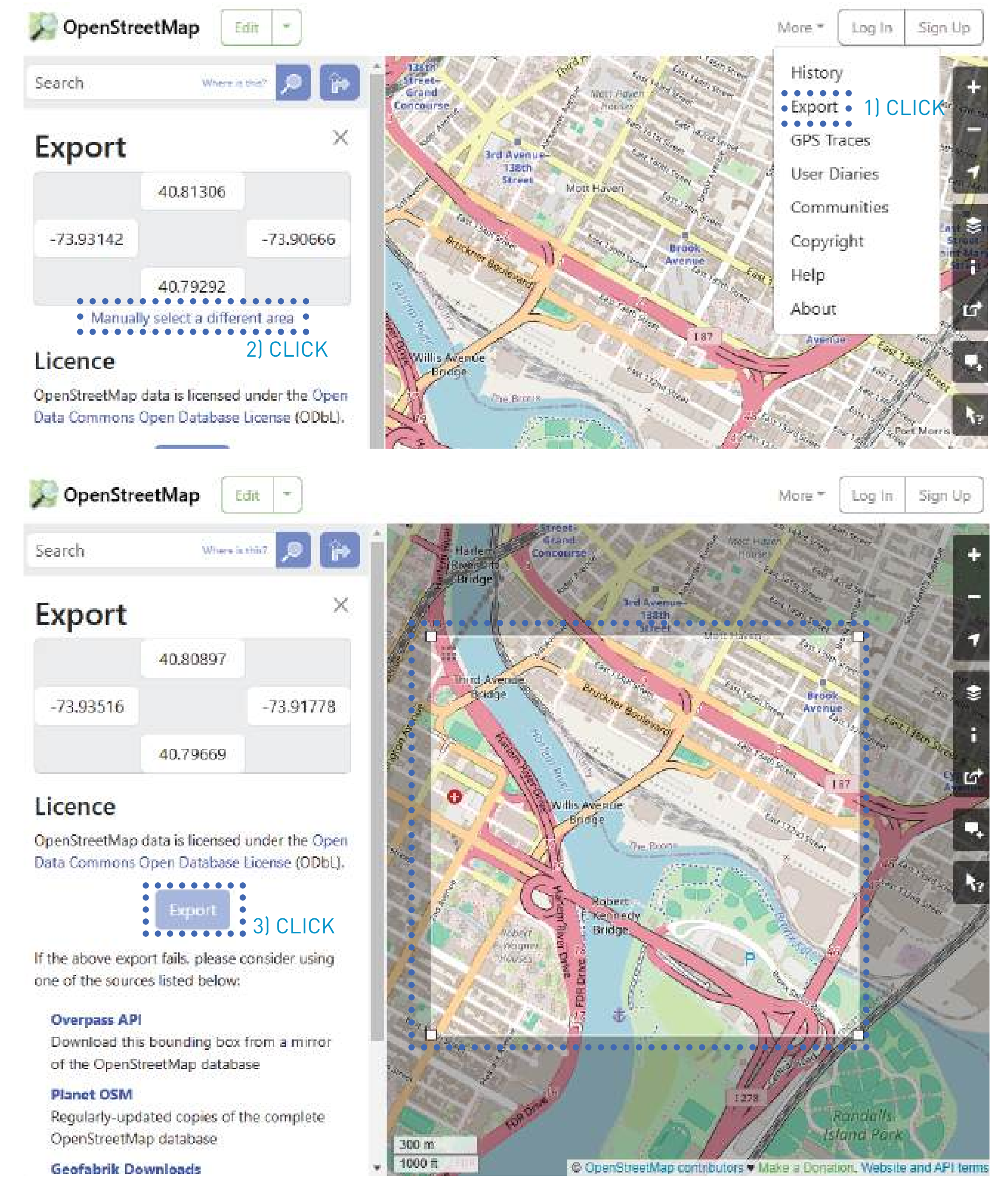
OSM FILE

Ladybug's EPW map has developed to accommodate vast amount of EPW files regardless of the file types. the observation mainly took place in airport or research institute. For the use of the file in architectural practice, using the EPW files from vicinity is good enough to figure out the reliable result.



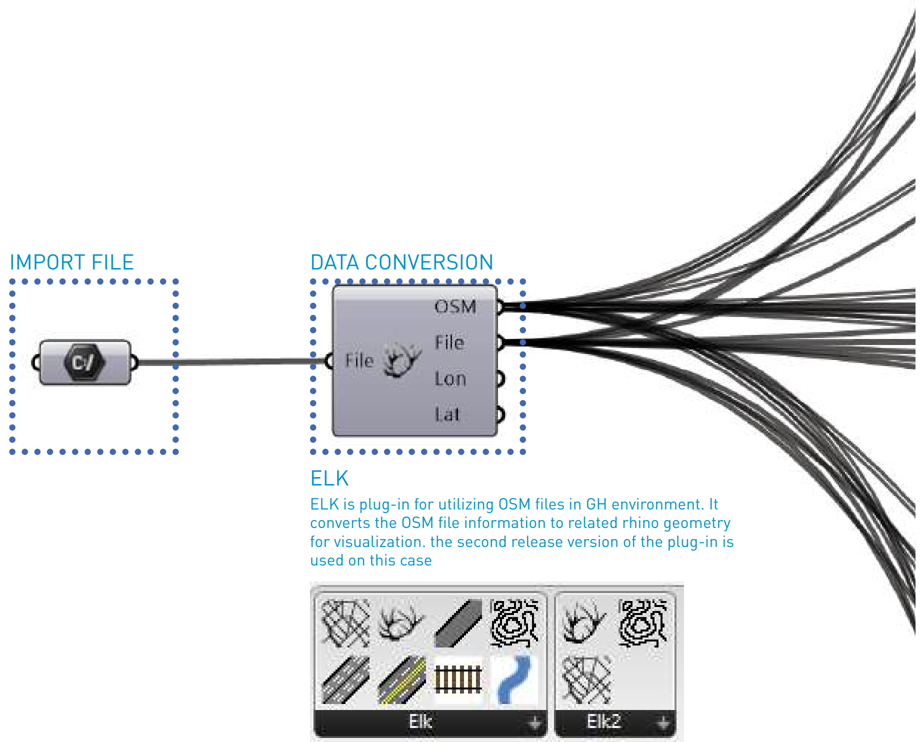
IMPORTING OSM FILE

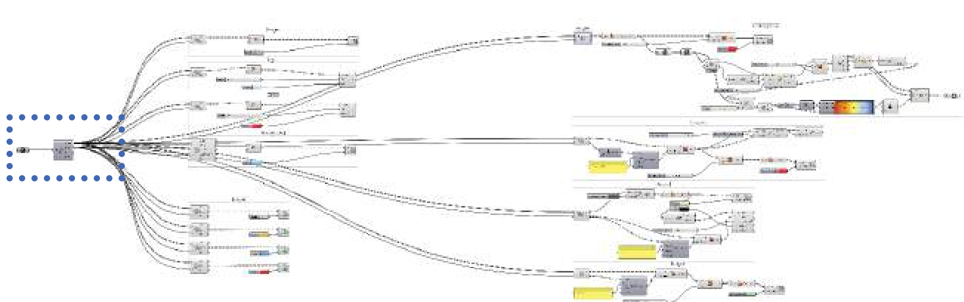
1) Find EPW weather file URL from the epw map (https://www.ladybug.tools/epwmap/)
2) Paste the URL to the GH note and connect to the weather URL input



DOWNLOADING OSM FILE

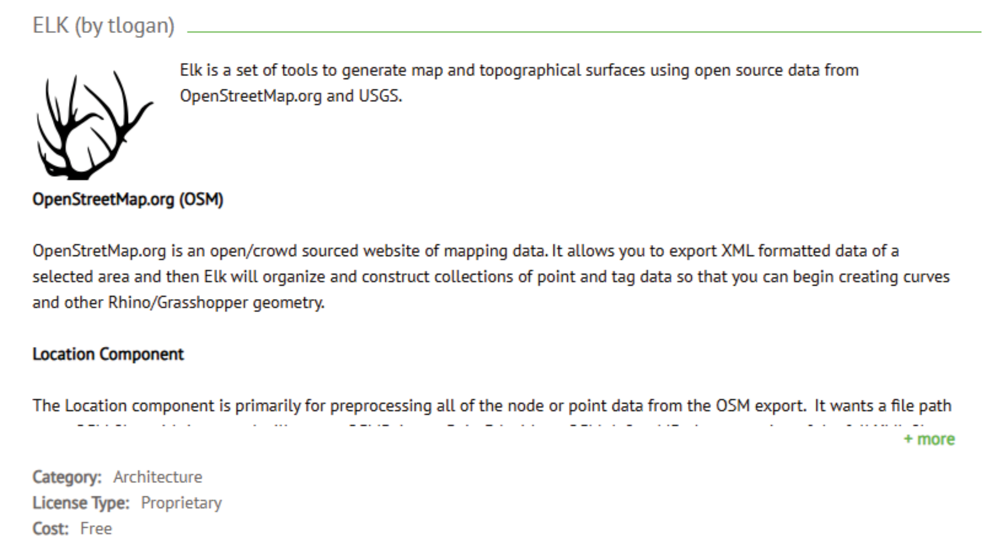
Ladybug's EPW map has developed to accommodate vast amount of EPW files regardless of the file types. the observation mainly took place in airport or research institute. For the use of the file in architectural practice, using the EPW files from vicinity is good enough to figure out the reliable result.





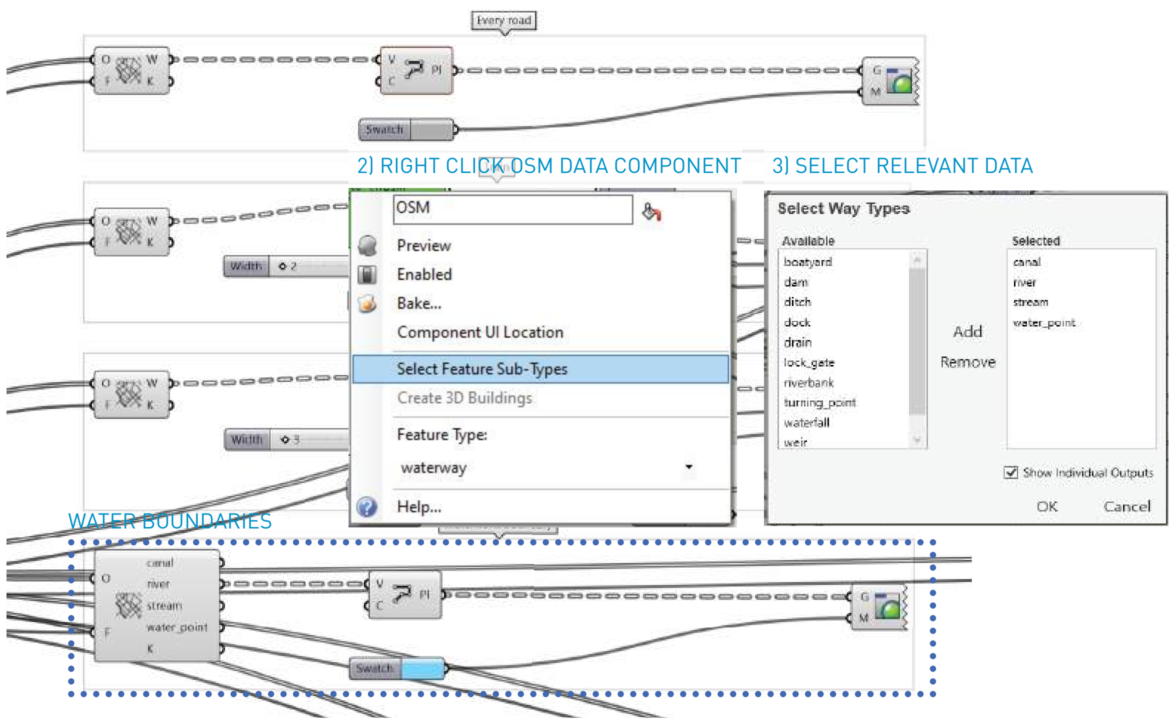
ELK CONNECTION

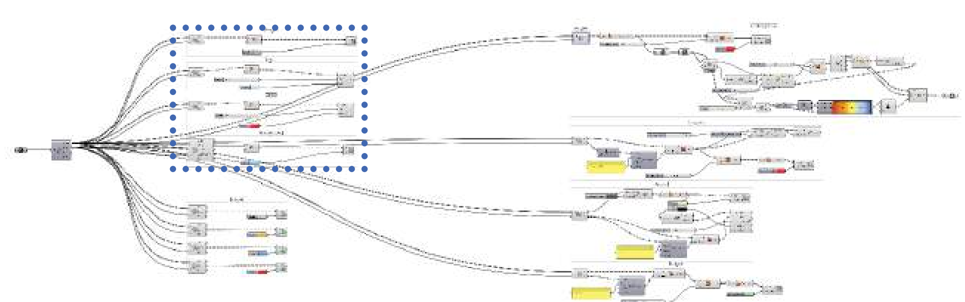
1) Find EPW weather file URL from the epw map (https://www.ladybug.tools/epwmap/)
2) Paste the URL to the GH note and connect to the weather URL input



ELK PLUG IN

Ladybug's EPW map has developed to accommodate vast amount of EPW files regardless of the file types. the observation mainly took place in airport or research institute. For the use of the file in architectural practice, using the EPW files from vicinity is good enough to figure out the reliable result.



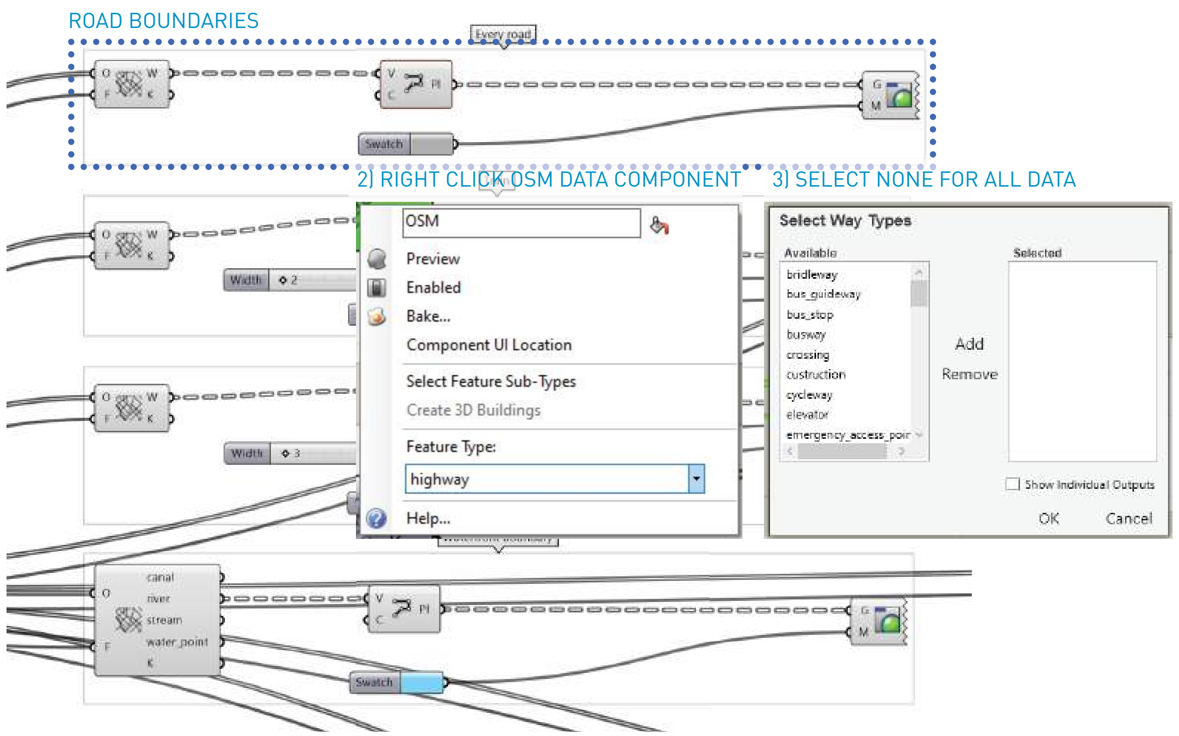


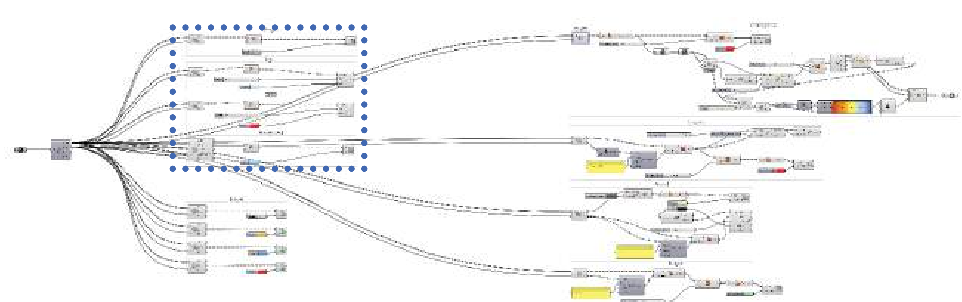
IMPORT INFORMATION - WATER BOUNDARIES

1) Connect OSM file to 'OSM data' component
2) Right click the component and click 'Select Feature Sub-Types'
3) Select and add relevant data and click 'ok'
4) Connect to representation part

OSM FILE - BOUNDARY DATA

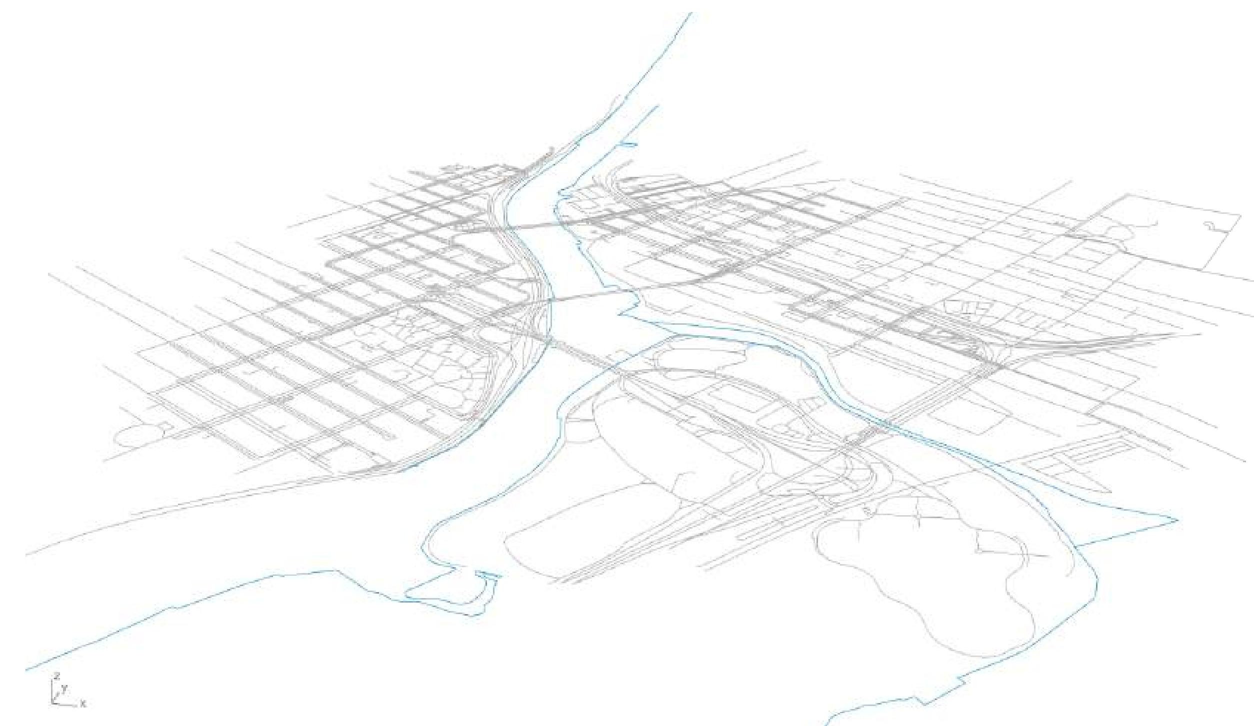
Most OpenStreetMap (OSM) files consist of physical data represented as a list of points. These points can be utilized in their raw form or connected to form closed loops or open loops, depending on the desired application. This data can serve various purposes, such as point location data, boundary definitions, or the creation of surface geometries, providing flexibility for use in architectural and urban design projects.

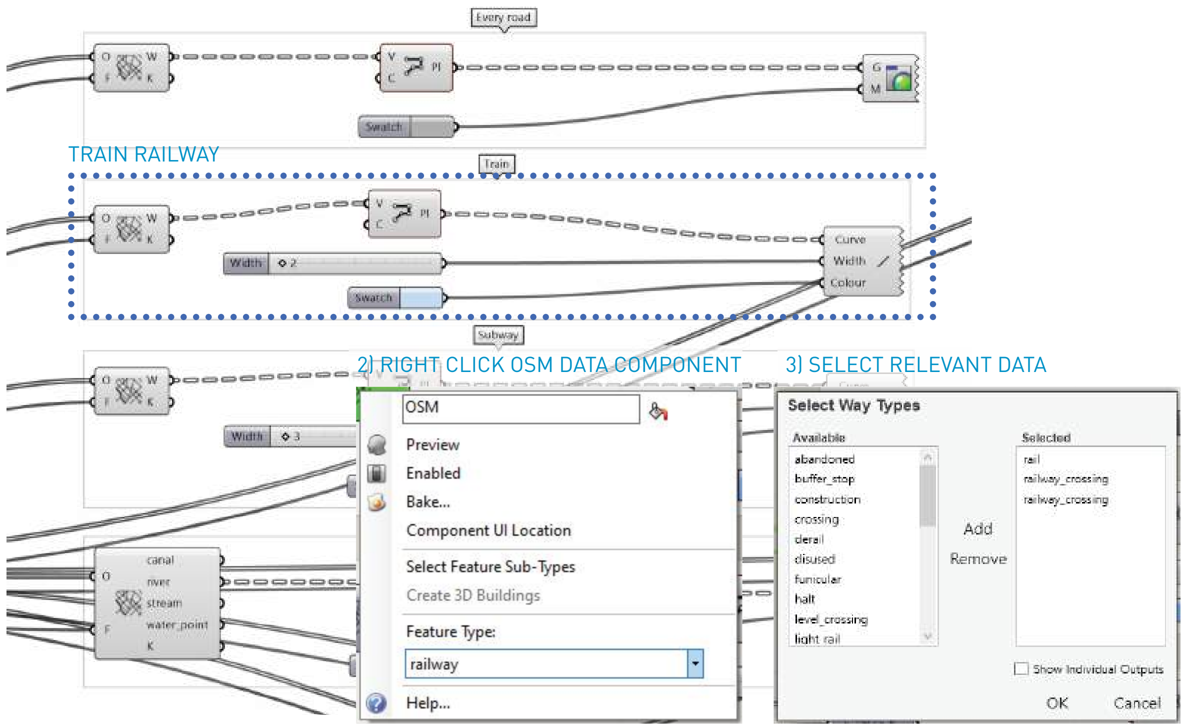


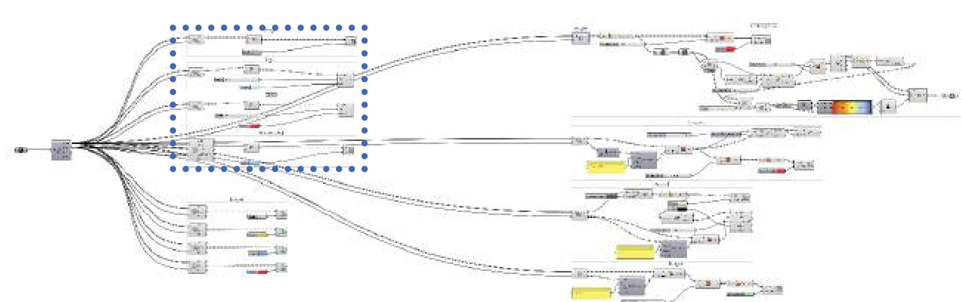


IMPORT INFORMATION - ROAD BOUNDARY

1) Connect OSM file to 'OSM data' component
2) Right click the component and click 'Select Feature Sub-Types'
3) Select none to import all of the data without filter
4) Connect to representation part

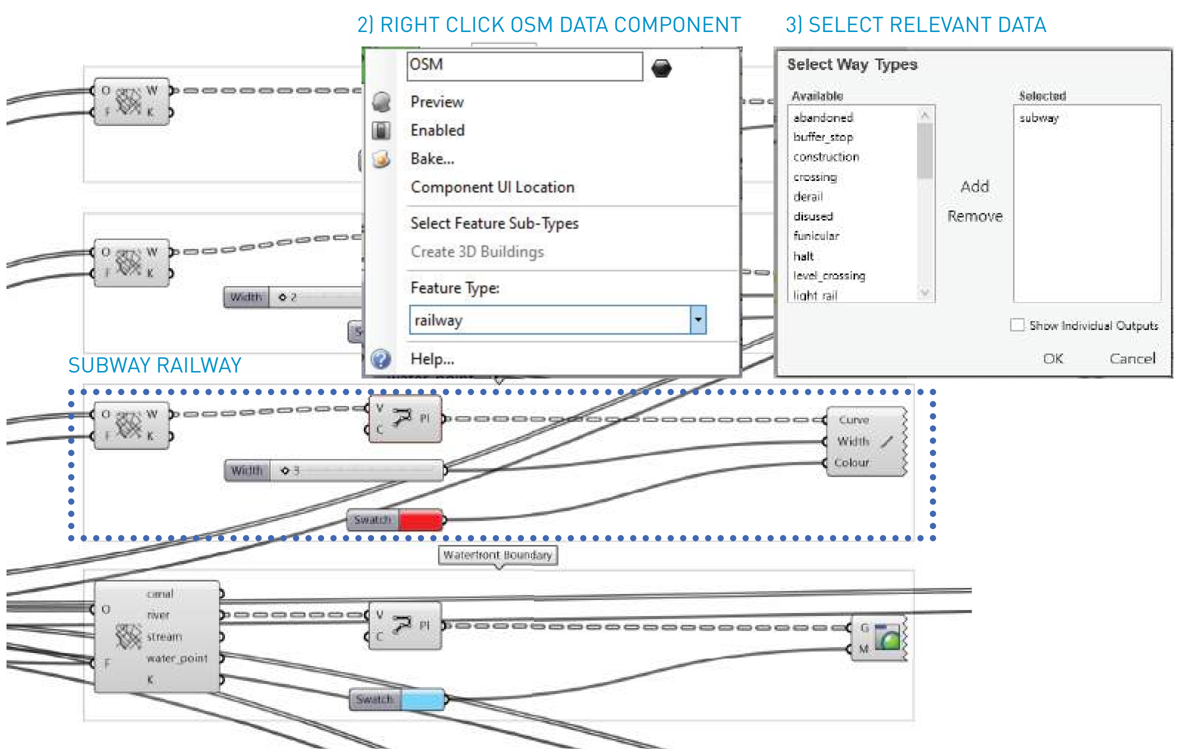


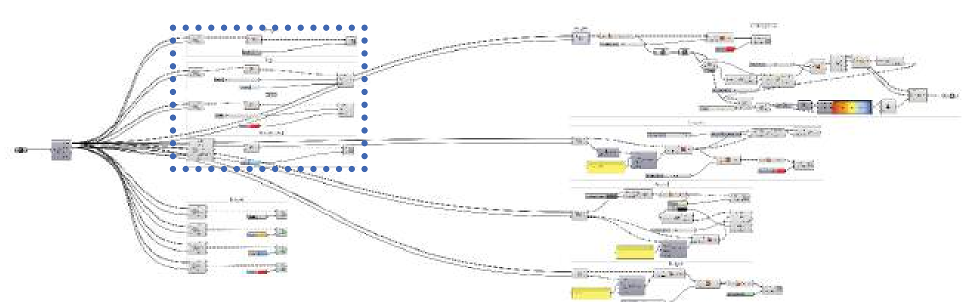


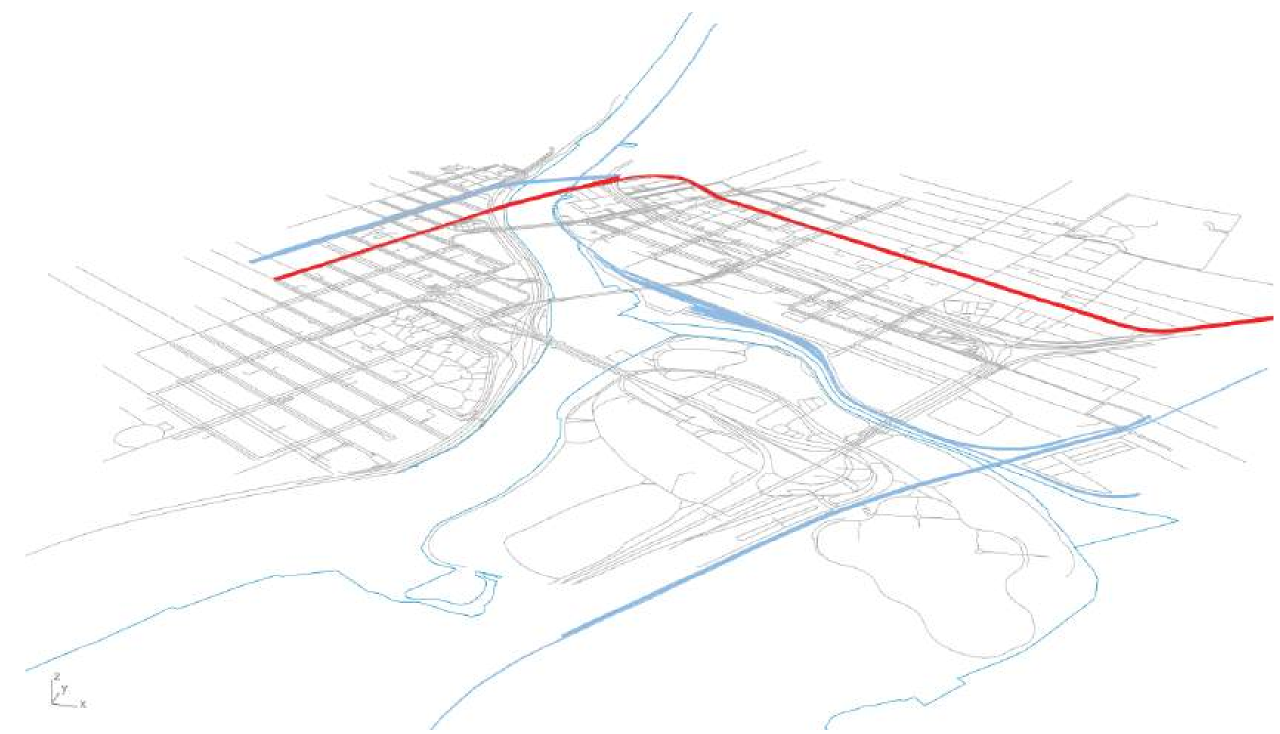


IMPORT INFORMATION - TRAIN RAILWAY

1) Connect OSM file to 'OSM data' component
2) Right click the component and click 'Select Feature Sub-Types'
3) Select and add relevant data and click 'ok'
4) Connect to representation part

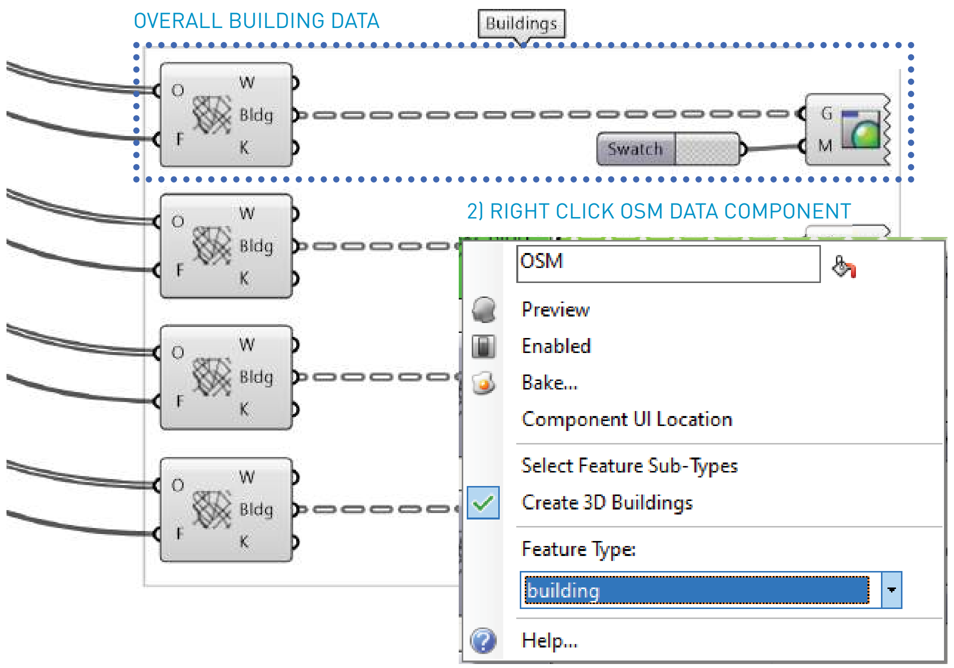


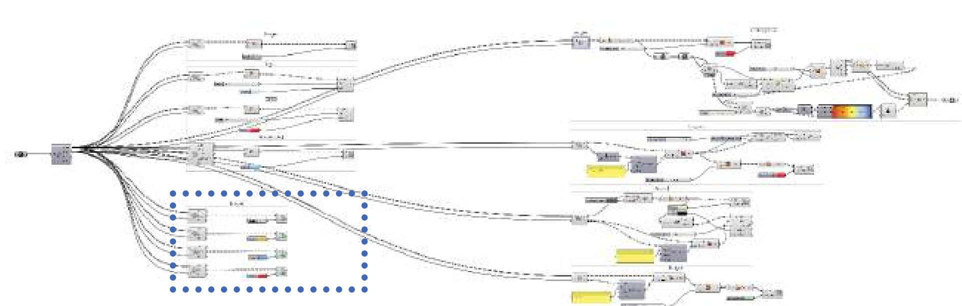


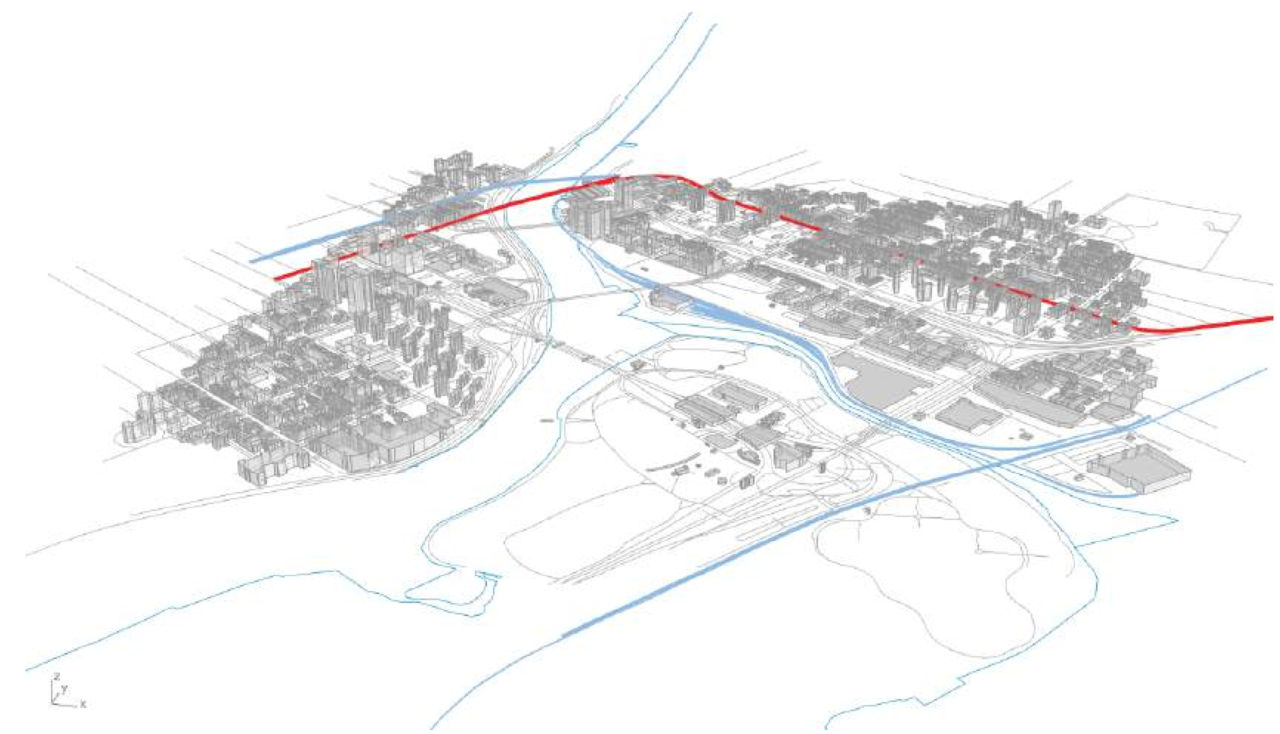


IMPORT INFORMATION - SUBWAY RAILWAY

1) Connect OSM file to 'OSM data' component
2) Right click the component and click 'Select Feature Sub-Types'
3) Select and add relevant data and click 'ok'
4) Connect to representation part





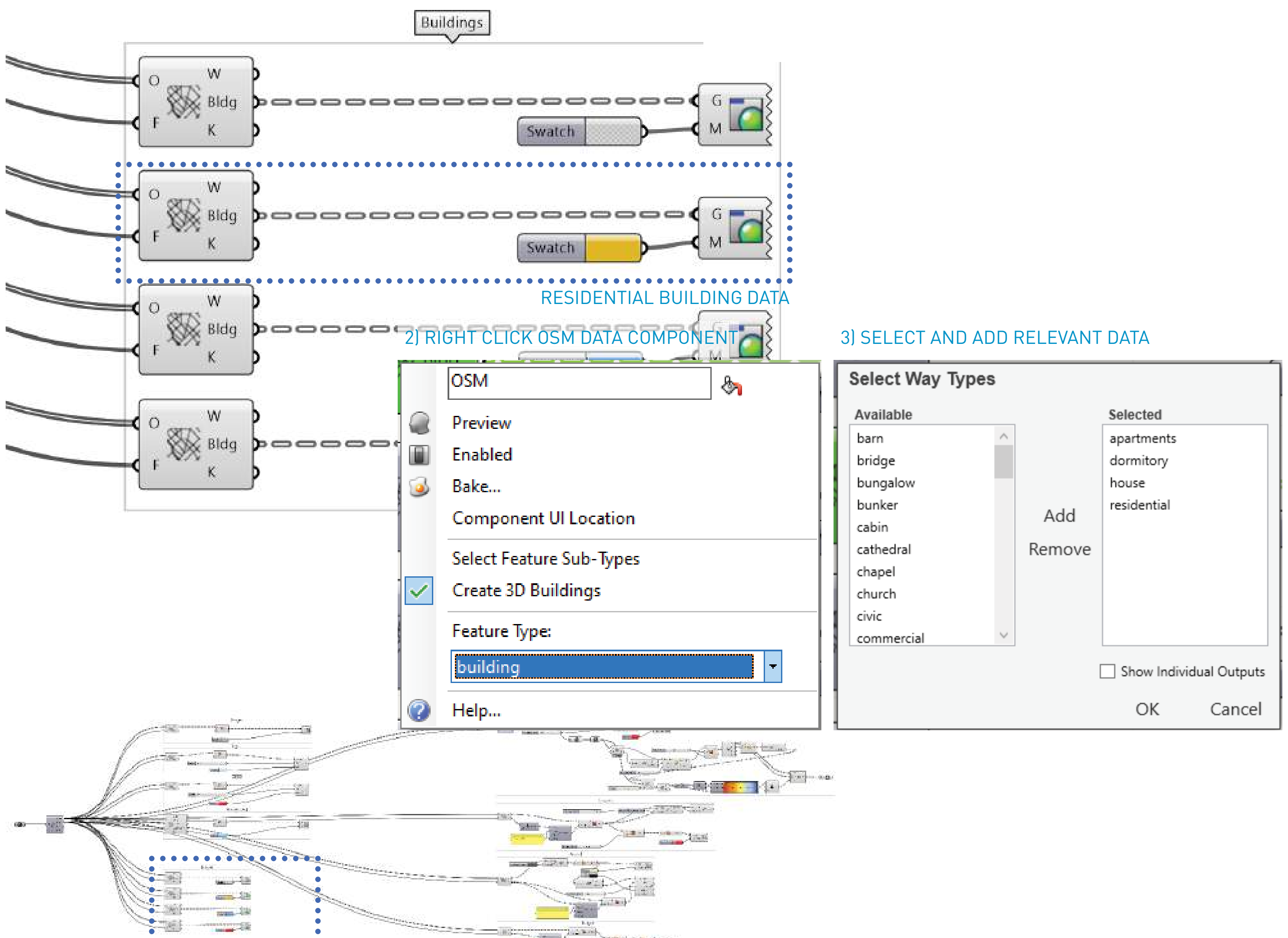


IMPORT INFORMATION - BUILDING

1) Connect OSM file to 'OSM data' component
2) Right click the component and Select 'Building' in Feature type drop down menu
3) Check Create 3D Buildings to make it 3D
4) Connect to representation part

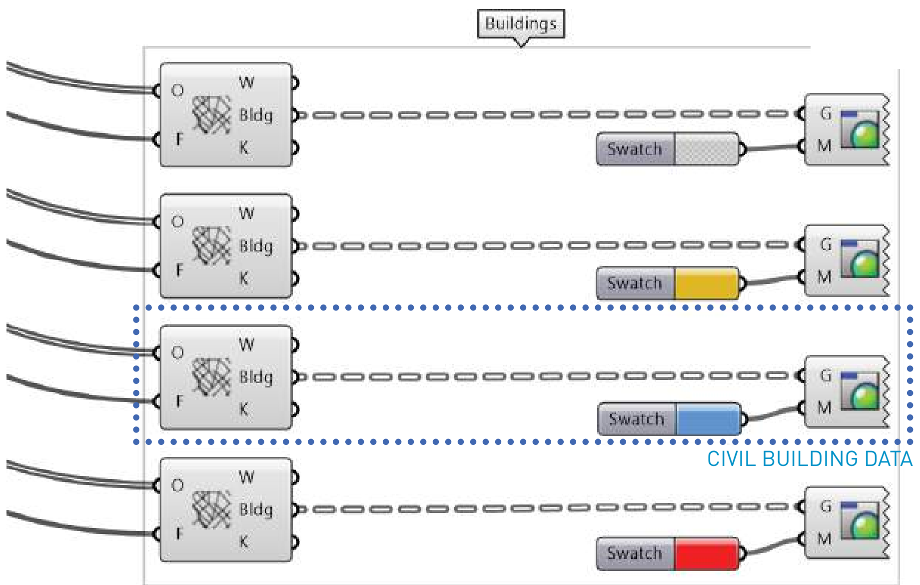
OSM FILE - BUILDING DATA

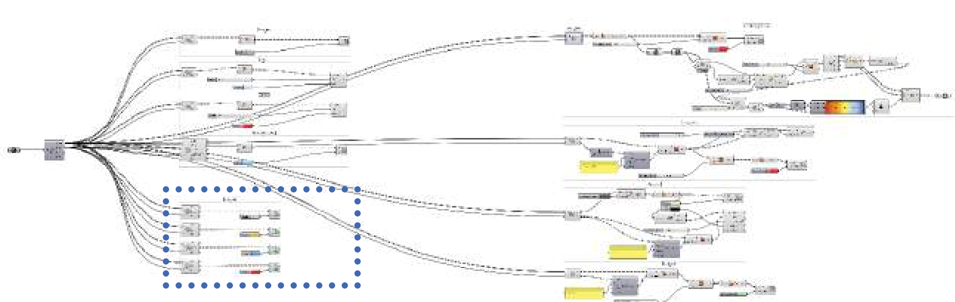
By selecting the feature type as 'building,' OSM files can generate boundaries representing the footprints of recorded building data. Additionally, since the dataset often includes building height information, these footprints can be extruded into 3D geometries, providing a simplified representation of the city skyline and offering a rough visualization of the urban context.



IMPORT INFORMATION - BUILDING BY PROGRAMS

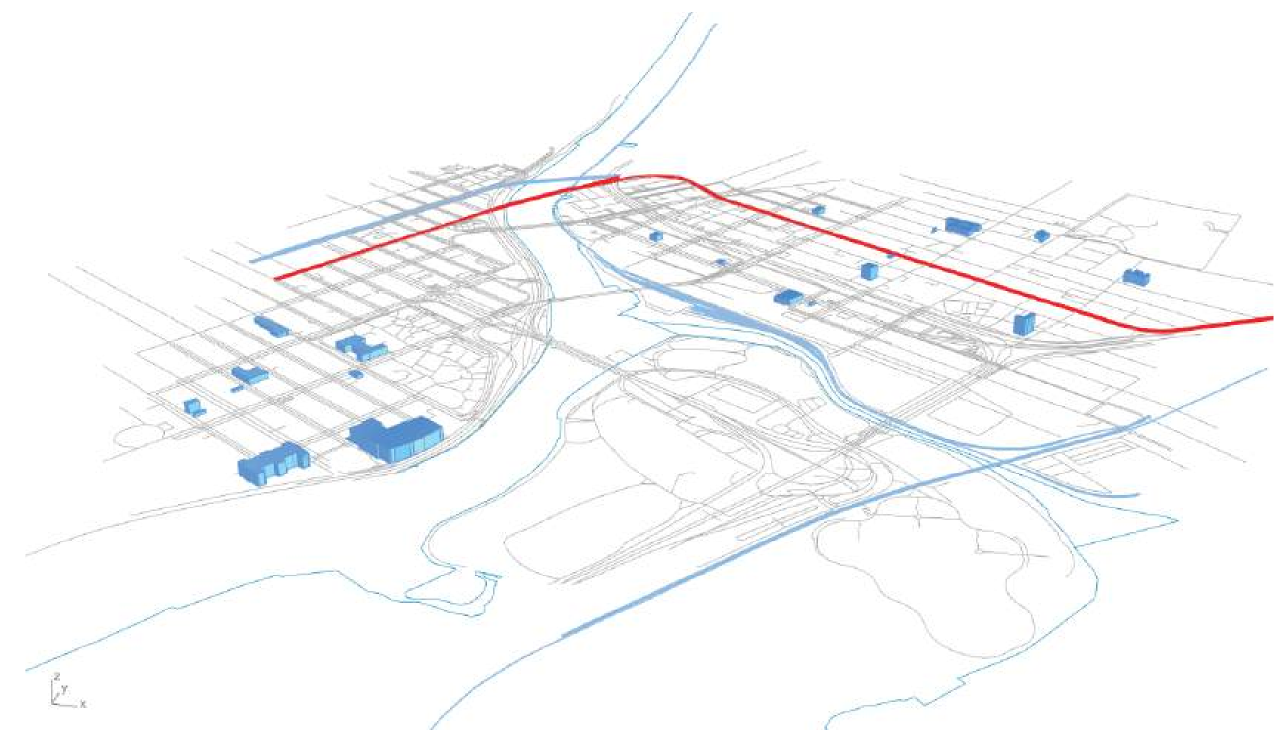
1) Connect OSM file to 'OSM data' component
2) Right click the component and Select 'Building' in Feature type drop down menu
3) In 'Select Feature Sub-Types,' select residential programs
4) Check Create 3D Buildings to make it 3D
5) Connect to representation part

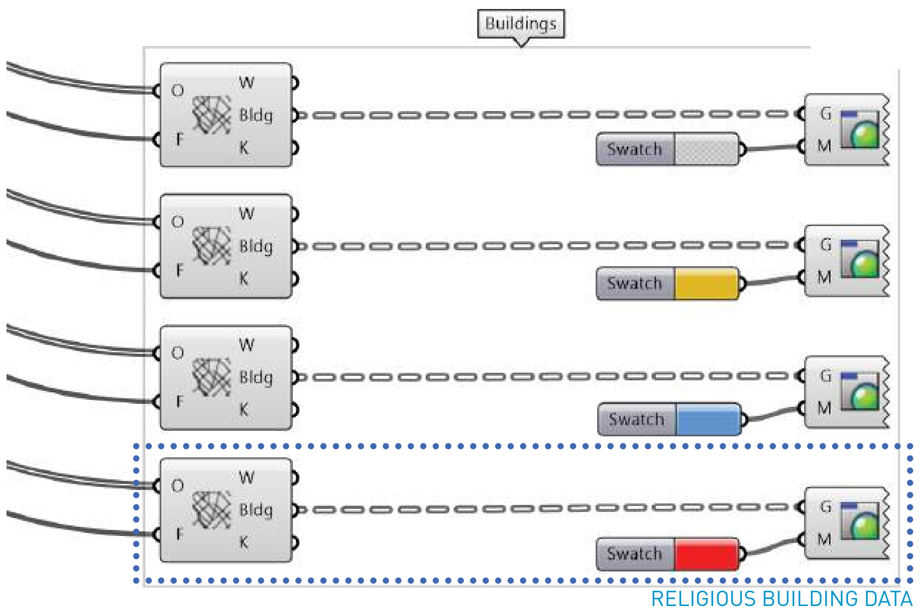


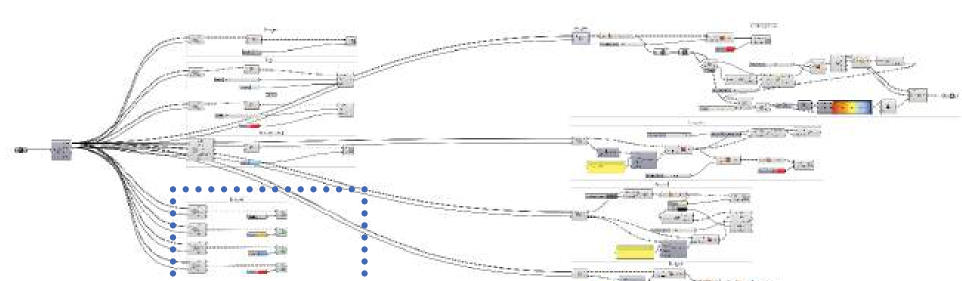


IMPORT INFORMATION - BUILDING BY PROGRAMS

1) Connect OSM file to 'OSM data' component
2) Right click the component and Select 'Building' in Feature type drop down menu
3) In 'Select Feature Sub-Types,' select civic programs
4) Check Create 3D Buildings to make it 3D
5) Connect to representation part

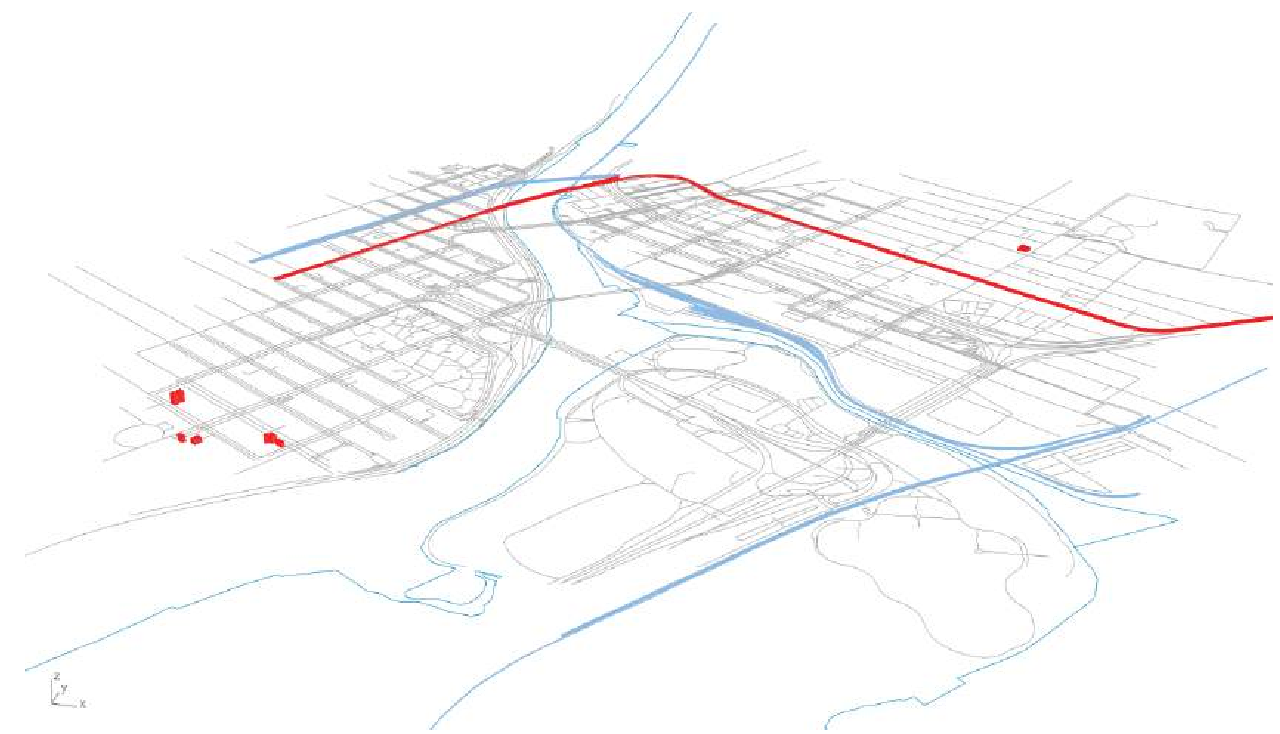


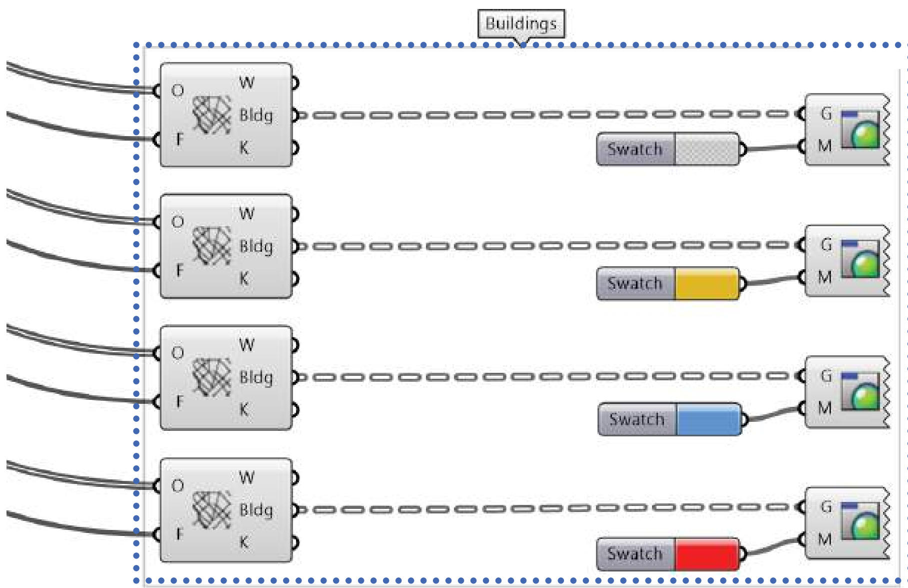




IMPORT INFORMATION - BUILDING BY PROGRAMS

1) Connect OSM file to 'OSM data' component
2) Right click the component and Select 'Building' in Feature type drop down menu
3) In 'Select Feature Sub-Types,' select religious programs
4) Check Create 3D Buildings to make it 3D
5) Connect to representation part




Buildings
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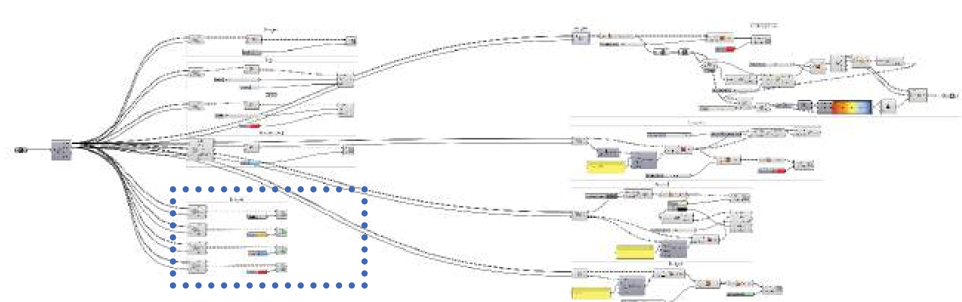
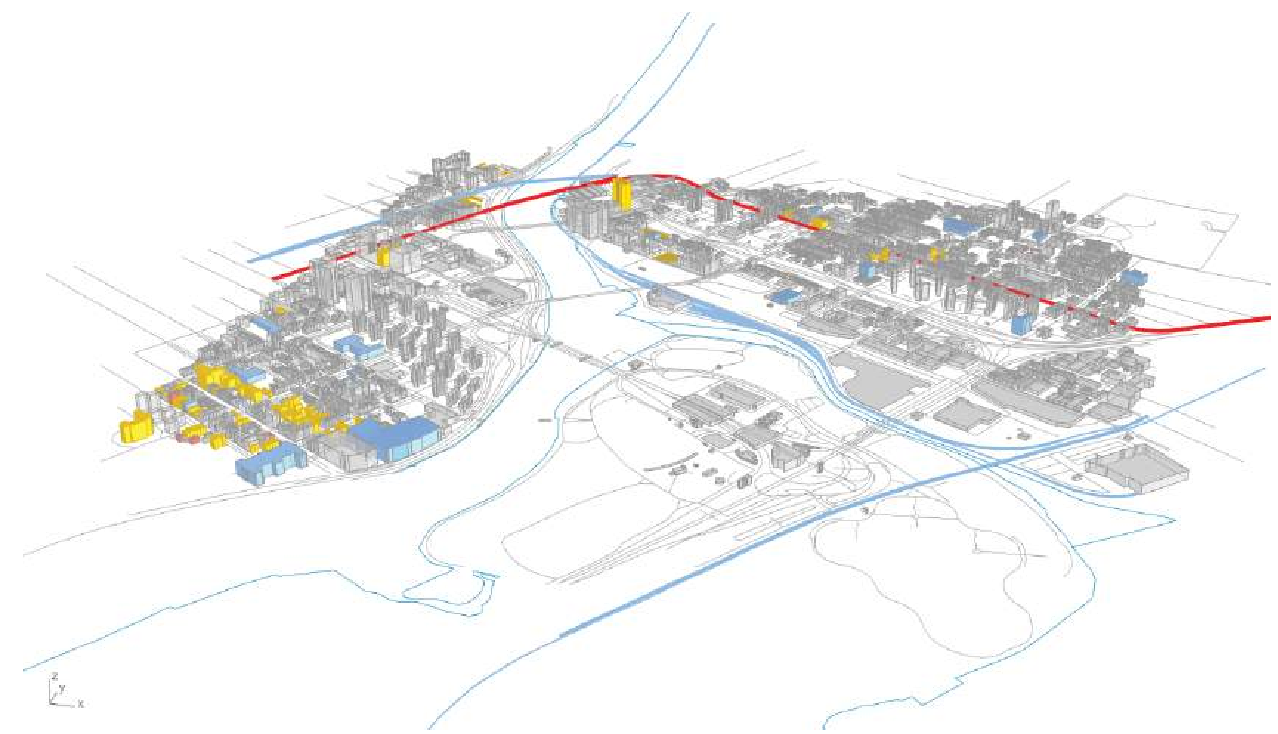
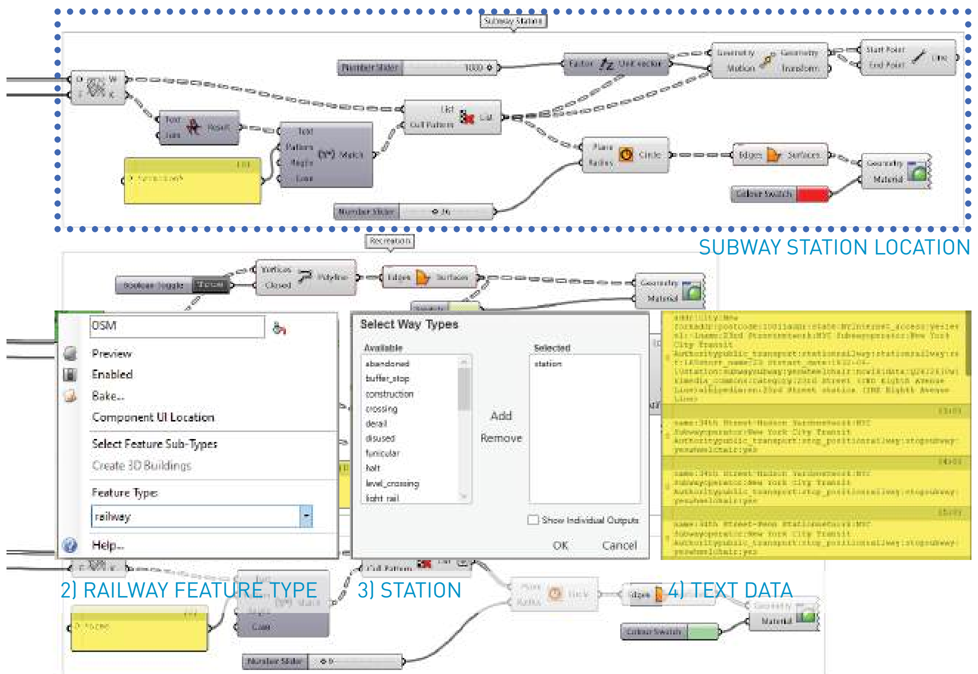
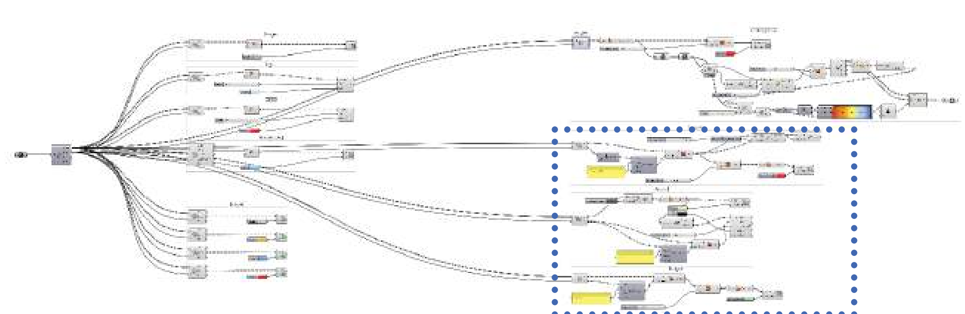
Swatch







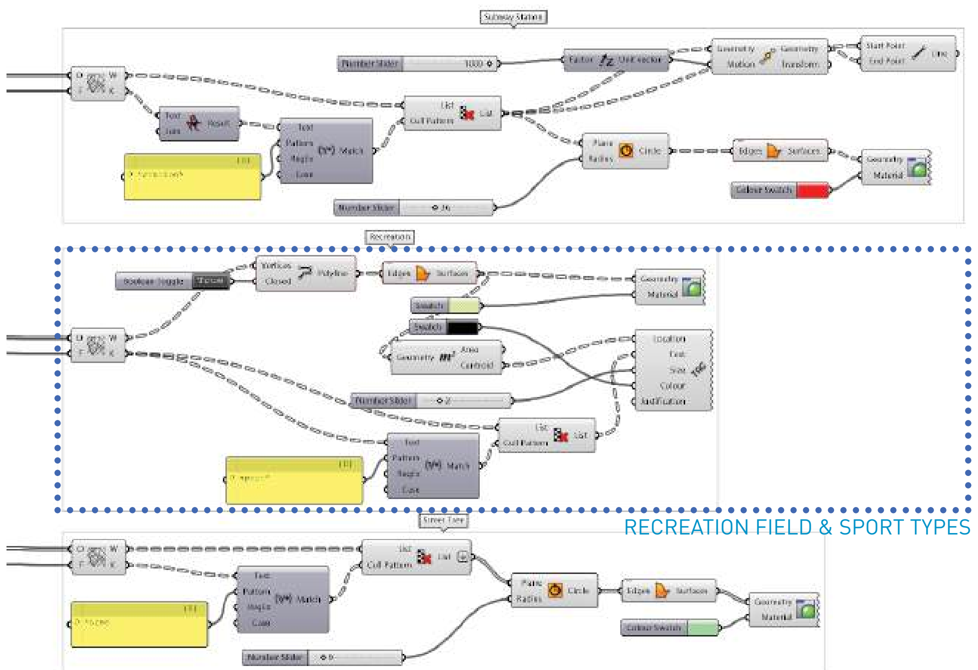


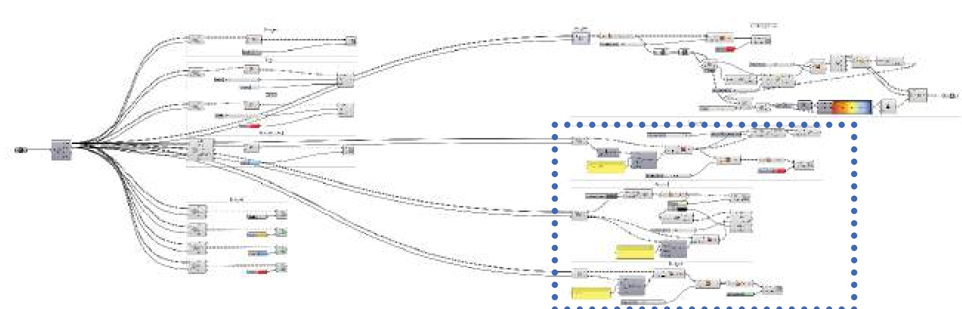
IMPORT INFORMATION - STATION LOCATION

1) Connect to OSM data component
2) Select 'railway' feature from feature type
3) Select and add 'Station'
4) Check text data to filter station via 'match text' component
5) Connect to representation part to show vertical lines from station locations

OSM FILE - LOCATION DATA & TEXT FILTER

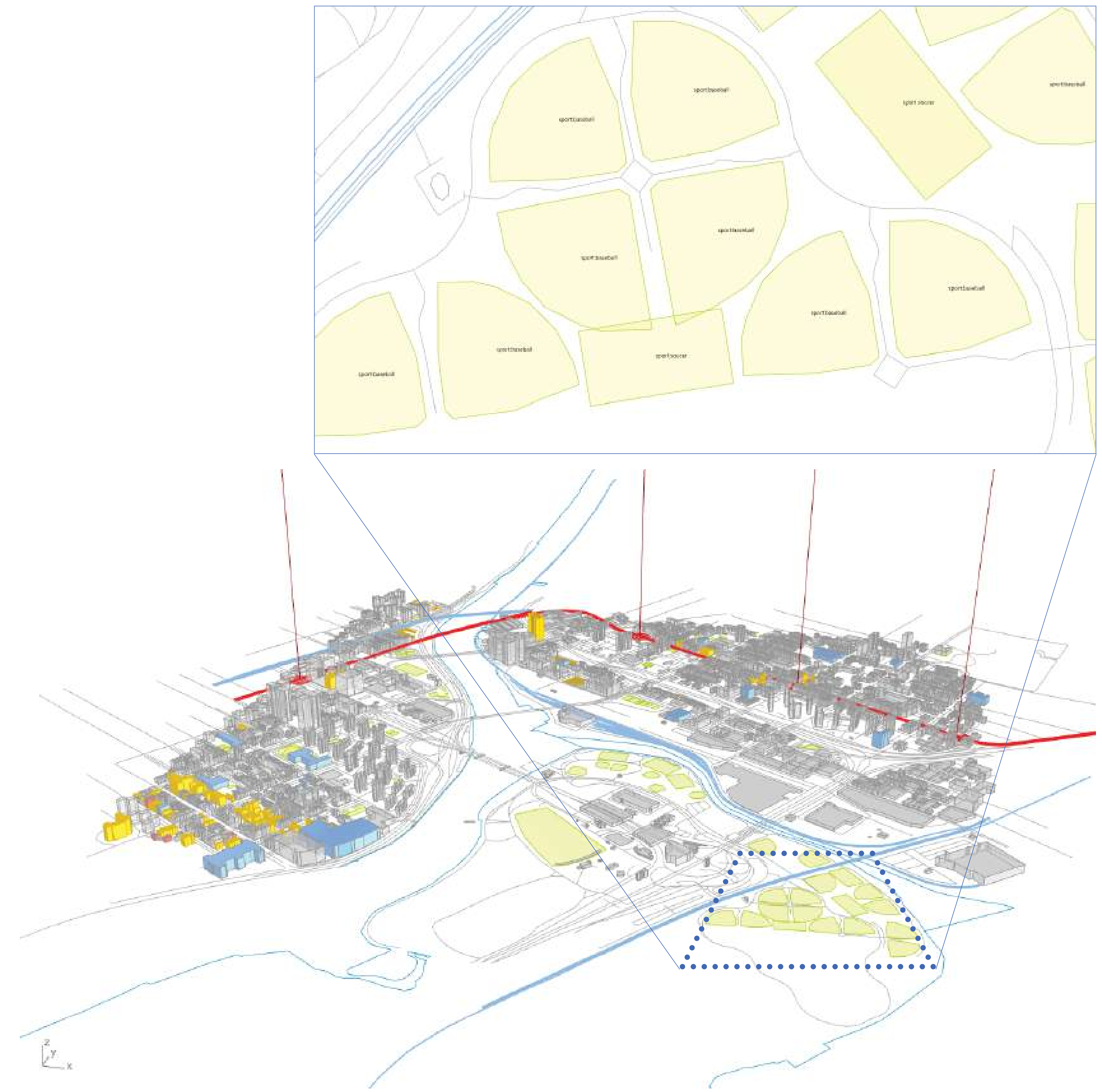
When the OSM data component is insufficient for filtering the desired data, additional text culling techniques can be employed to refine and sort the information from the original data stream. This allows for more precise extraction of relevant data, enhancing its usability in specific design applications.





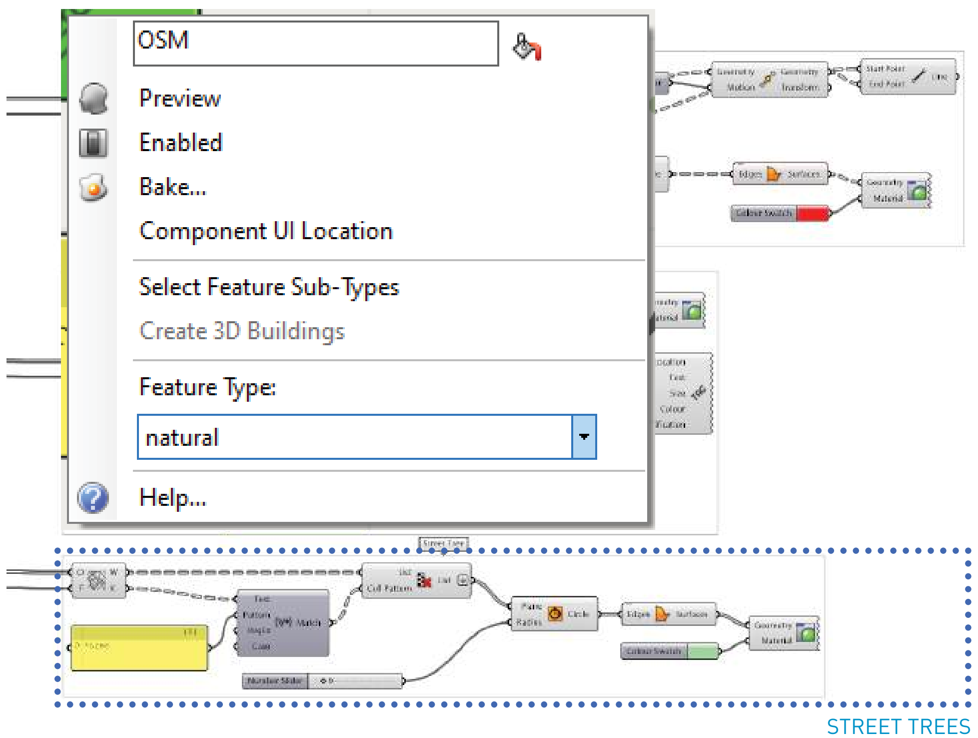
IMPORT INFORMATION - RECREATION PARK & TEXT INFORMATION

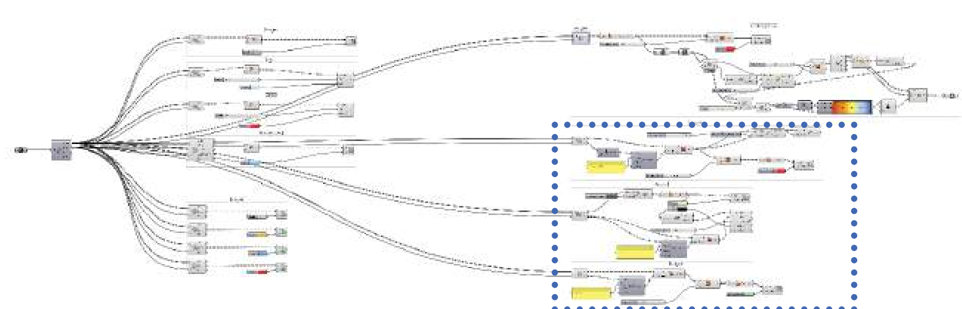
1) Connect to OSM data component
2) Select 'sport' feature from feature type
3) Check text data to filter station via 'match text' component
4) Connect to representation part to show text at the center of the park location



OSM FILE - LOCATION DATA & TEXT FILTER

Text information can also be displayed when needed. The zoomed image above demonstrates how text data can be integrated with geological information. Recreational parks and their areas are represented as surfaces, while text describing the specific type of sport designated for each park is placed at the center of the corresponding geometry. This integration provides a clear and informative visualization of both spatial and descriptive data.



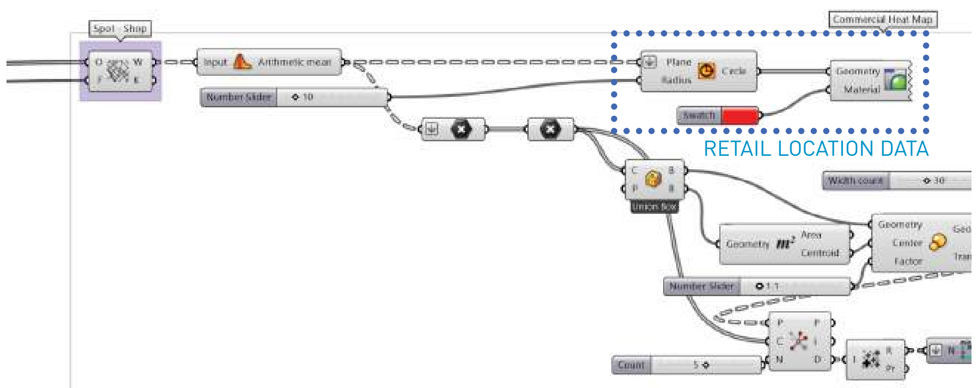


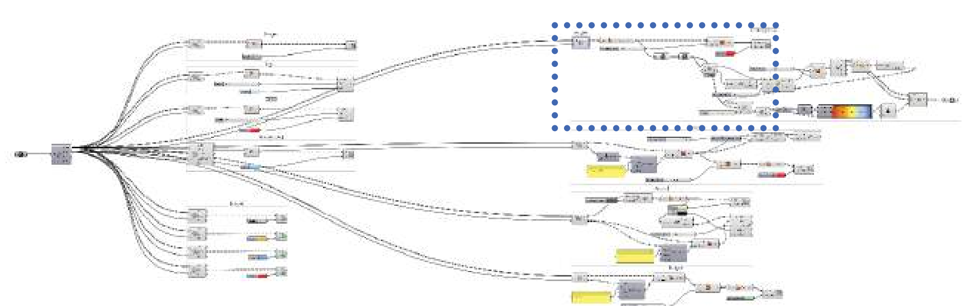
IMPORT INFORMATION - STREET TREE

1) Connect to OSM data component
2) Select 'natural' feature from feature type
3) Check text data to filter 'tree' via 'match text' component
4) Connect to representation part to illustrate tree locations

OSM FILE - LOCATION DATA & TEXT FILTER

Text information can also be displayed when needed. The zoomed image above demonstrates how text data can be integrated with geological information. Recreational parks and their areas are represented as surfaces, while text describing the specific type of sport designated for each park is placed at the center of the corresponding geometry. This integration provides a clear and informative visualization of both spatial and descriptive data.



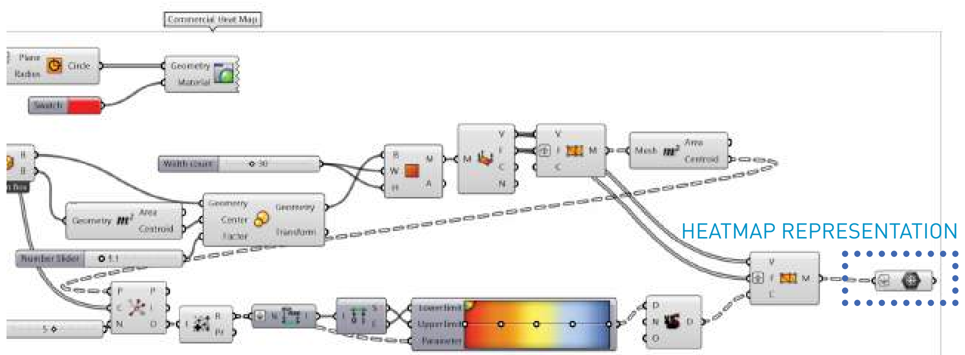


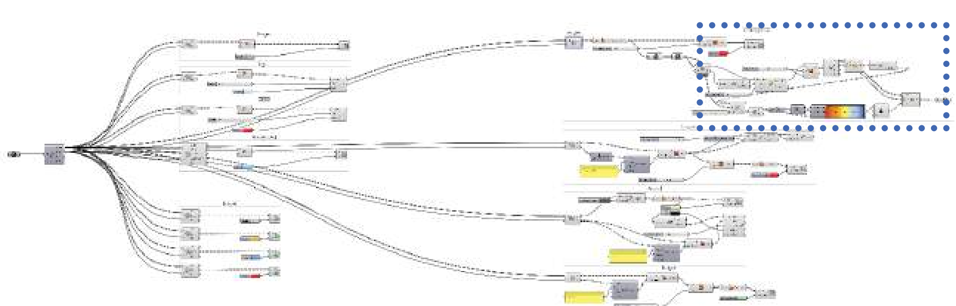
IMPORT INFORMATION - RETAIL LOCATION

1) Connect to OSM data component
2) Select 'shop' feature from feature type
3) Import retail center point through 'average' component
4) Create circle geometry and connect to representation part

OSM FILE - COLLECTION OF POINTS

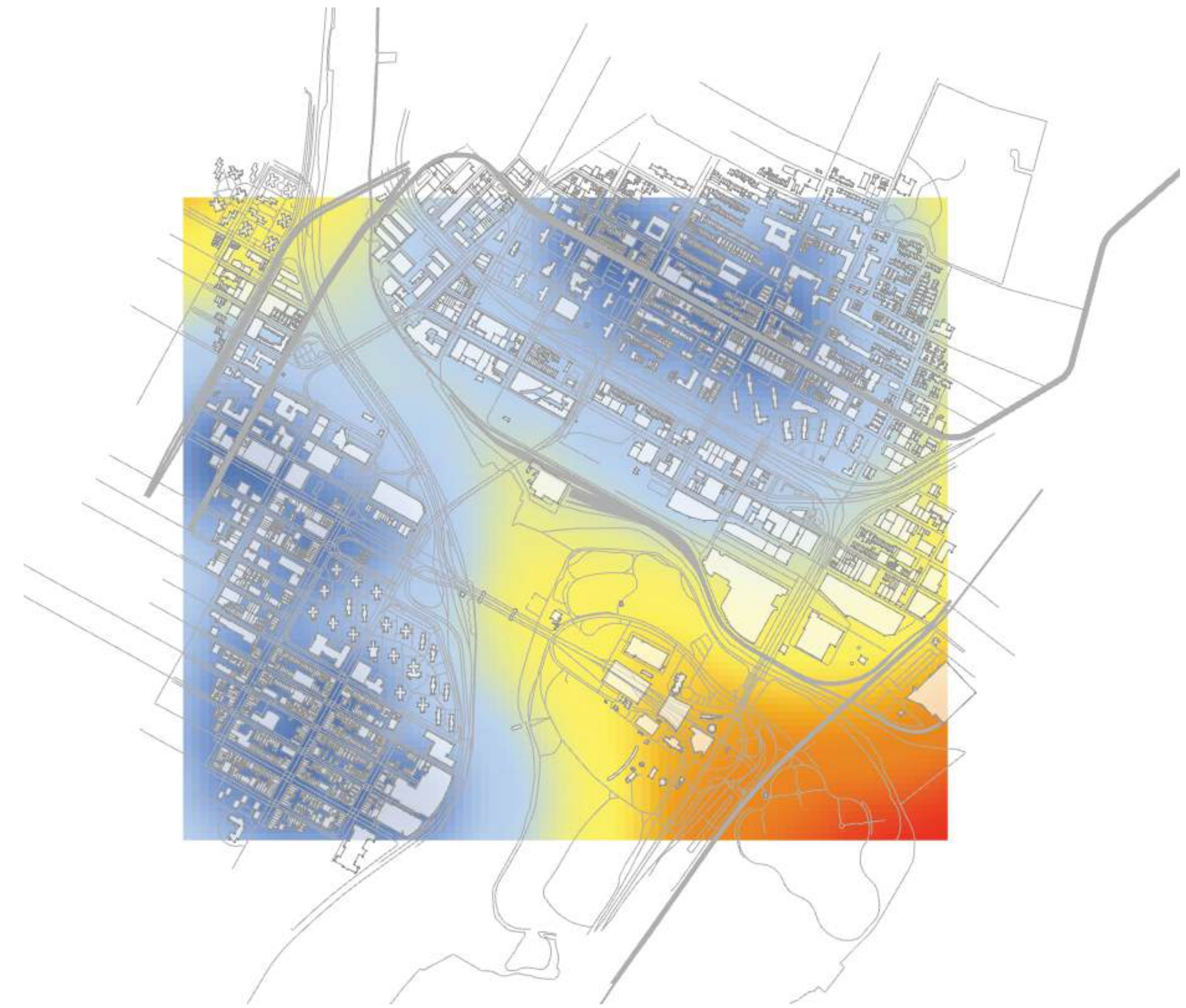
The retail feature type consists of a series of points accompanied by matching text information for each recorded retail establishment. These series of points form closed-loop boundaries that represent the retail footprints. In the context of the above image, the goal is to provide an understanding of the number of retail establishments and their distribution. To achieve this, each series of points is treated as a single entity. The average component is used to calculate the centroid of each retail footprint, simplifying the data while maintaining its spatial context for analysis.





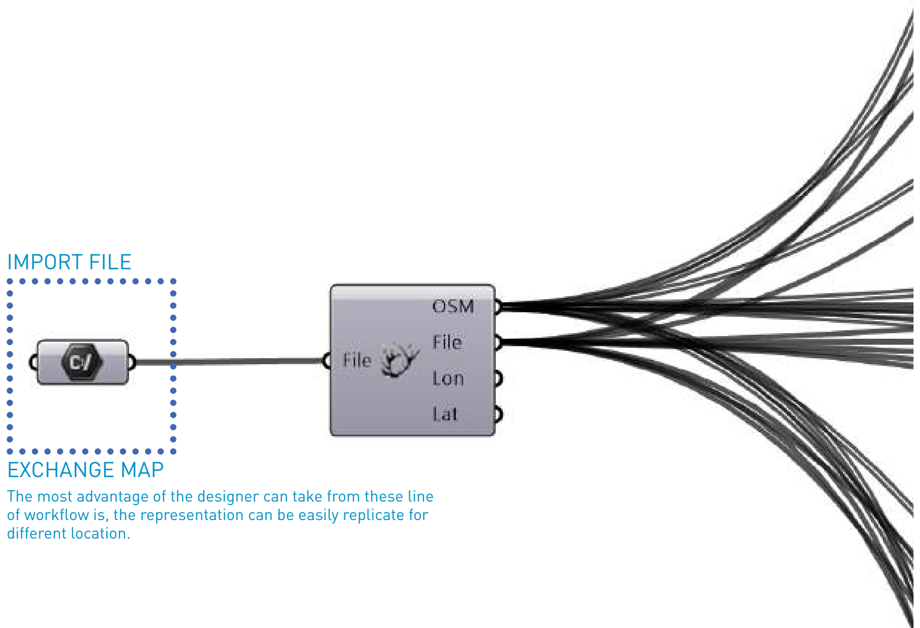
HEAT MAP REPRESENTATION

1) Connect point collections to the 'closest point' component
2) Connect 'distance' results to the mass addition
3) Connect numbers to the designated colored gradient
4) display through mesh geometry - resolution to be differ

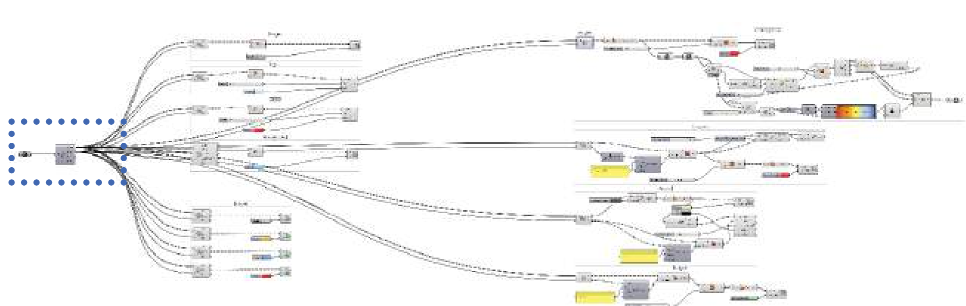


HEAT MAP

This is an example of how GIS data can be visualized within the Grasshopper (GH) environment. In the map shown above, the red areas highlight regions suffering from a scarcity of retail amenities, while the blue areas indicate regions with an abundance of retail facilities serving the community. This visualization helps identify spatial disparities and supports data-driven decision-making in urban planning and design.



The most advantage of the designer can take from these line of workflow is, the representation can be easily replicate for different location.



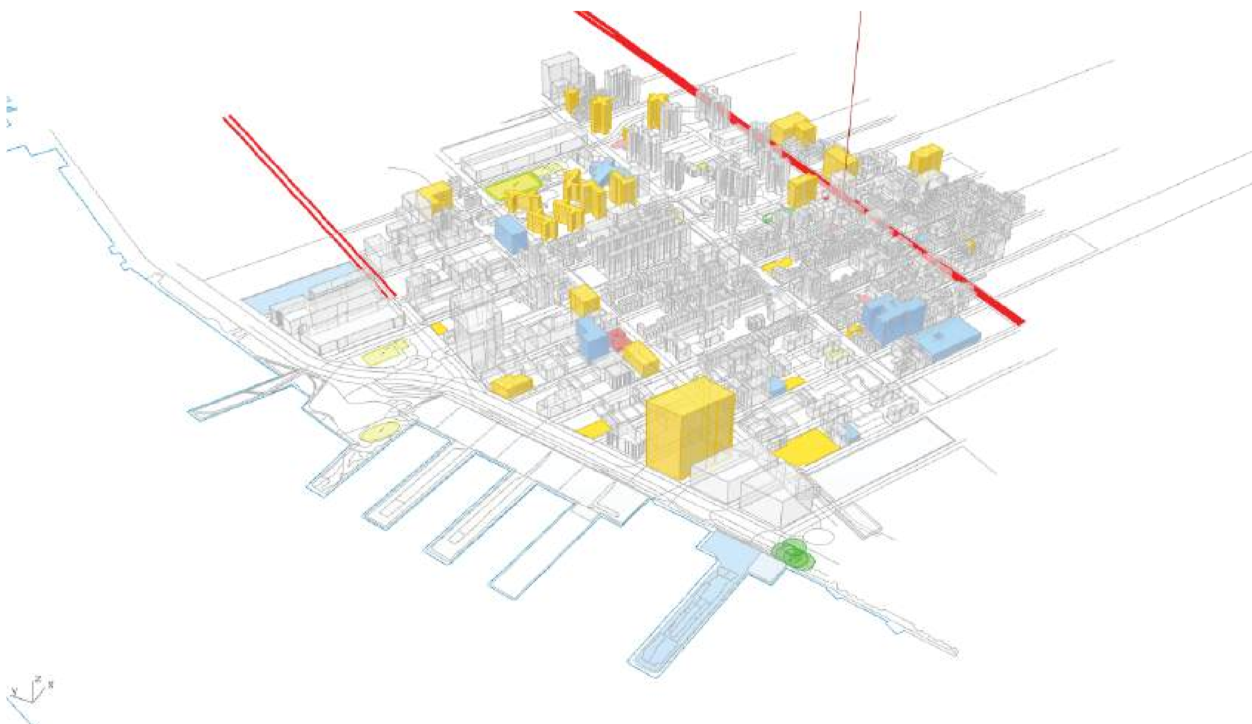
REGENERATION

1) Mapping can be regenerated for different geological location via changing OSM file
2) Change the file path to another OSM file for regeneration

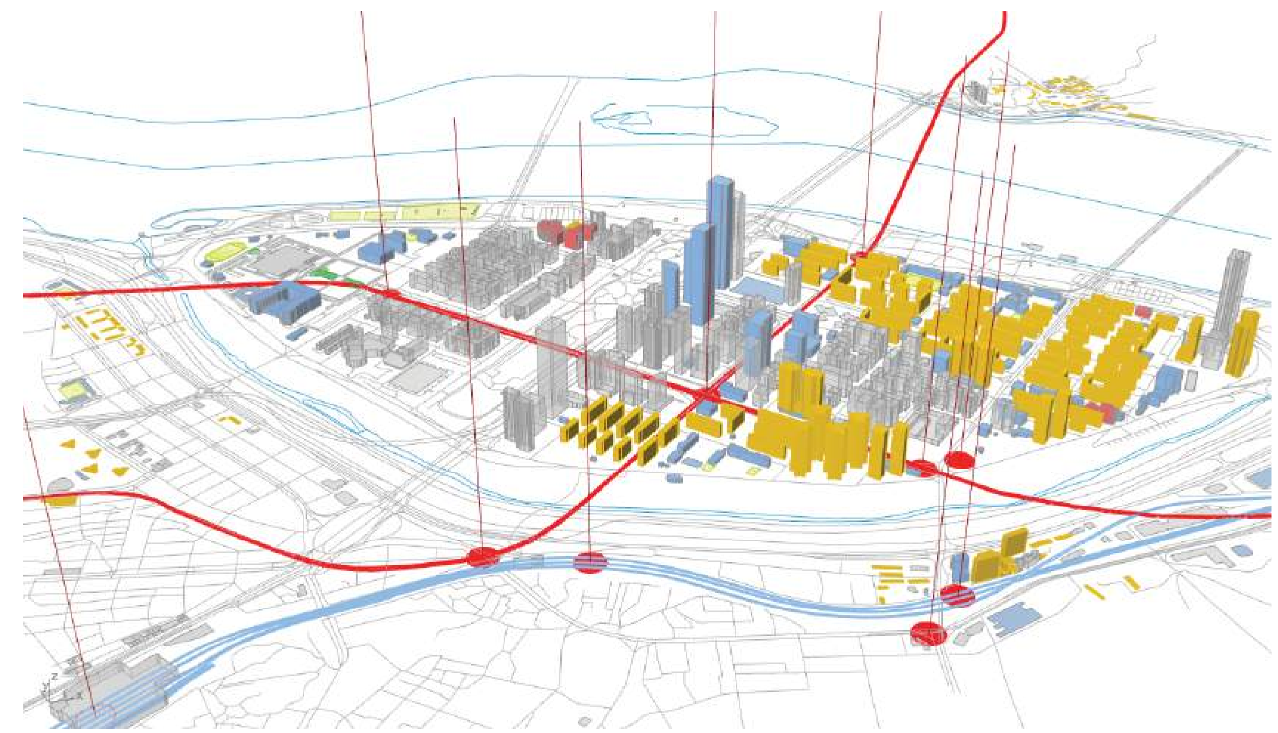
MOTT HAVEN,NY

MOTT HAVEN,NY

LONG ISLAND CITY,NY



CHELSEA,NY



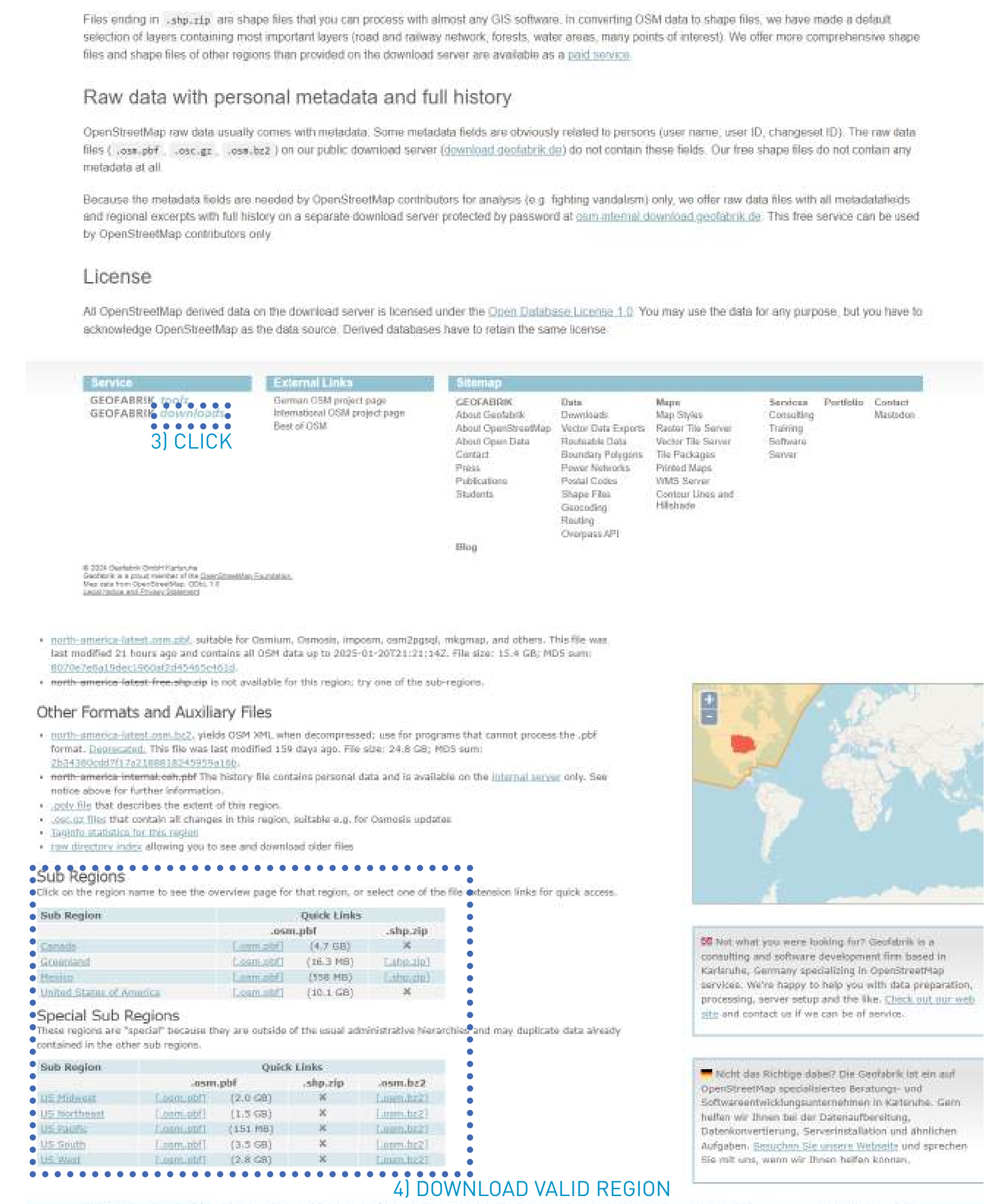
YEO-UI DO,NY

REGENERATION IN SAME REPRESENTATION SYSTEM

Although certain details may vary due to language or cultural differences, this mapping technique enables the creation of multiple cartographic maps with a consistent aesthetic in a timely manner. This approach is particularly efficient when addressing issues that benefit from comparisons between different urban environments, allowing for clear and effective visual analysis.

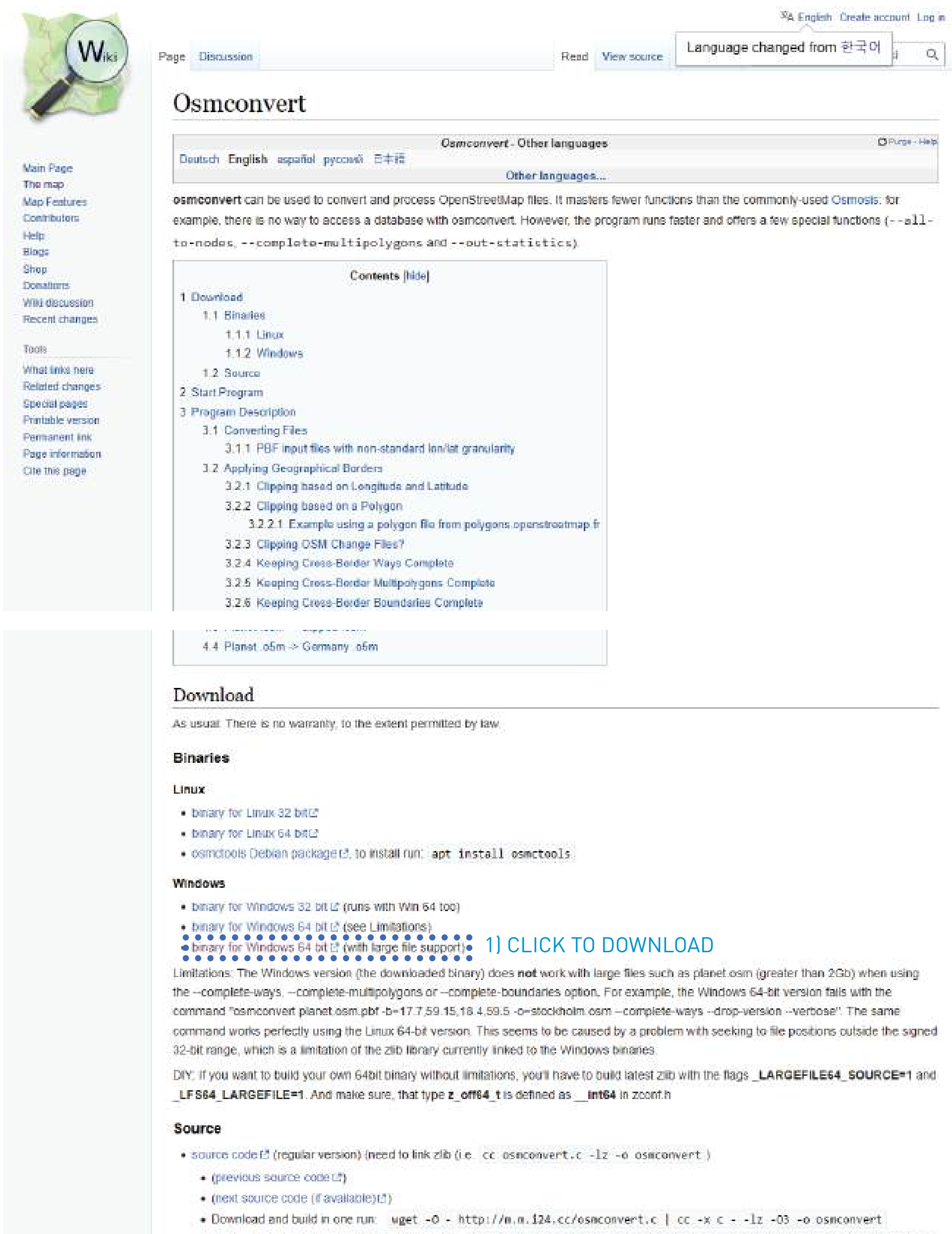
LIMITATION OF THE OSM DATA VIA WEB

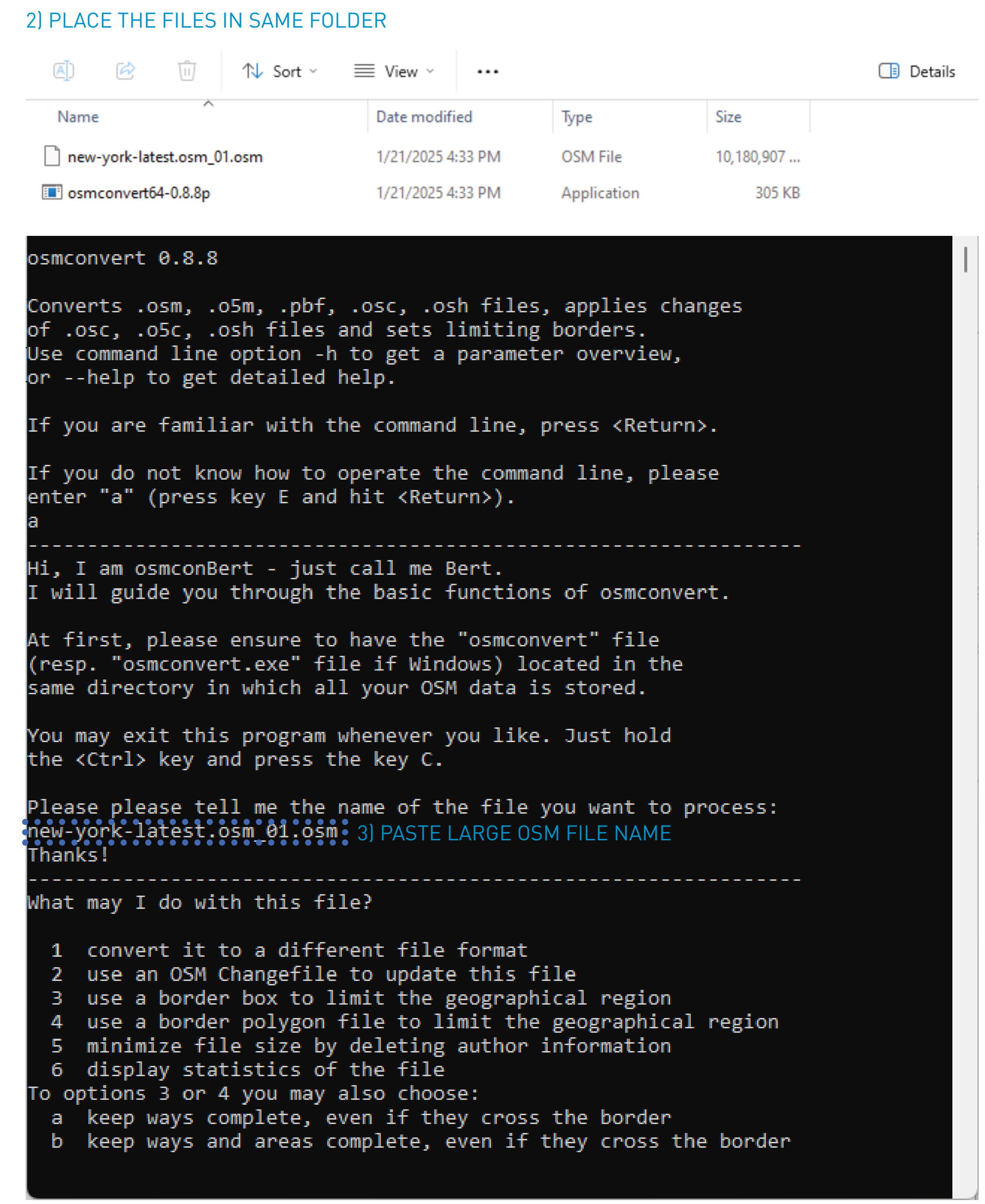
Although the technique described above is highly effective, the boundaries of maps downloadable from the OSM website are limited due to file size restrictions. For larger-scale mapping, OSM data for broader regions must be obtained through platforms like Geofabrik. The data can then be processed and trimmed using specialized programs to fit the required scope and ensure manageable file sizes.



ACCESS TO THE GEOFABRIK OSM

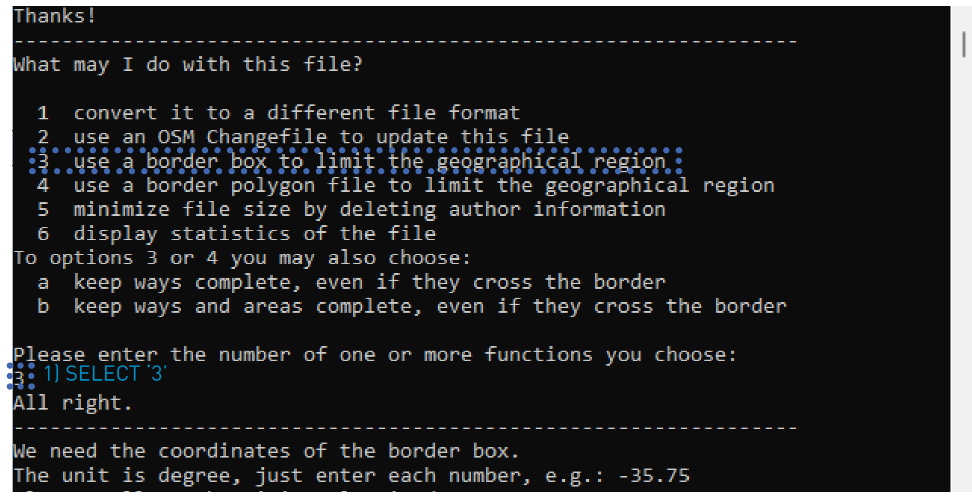
1) Access to “https://www.geofabrik.de/” and click ‘Data’
2) Click ‘Downloads’ link
3) Read information and License information and Click ‘downloads’
4) Download valid region. In a larger region, multiple sub regions are provided.



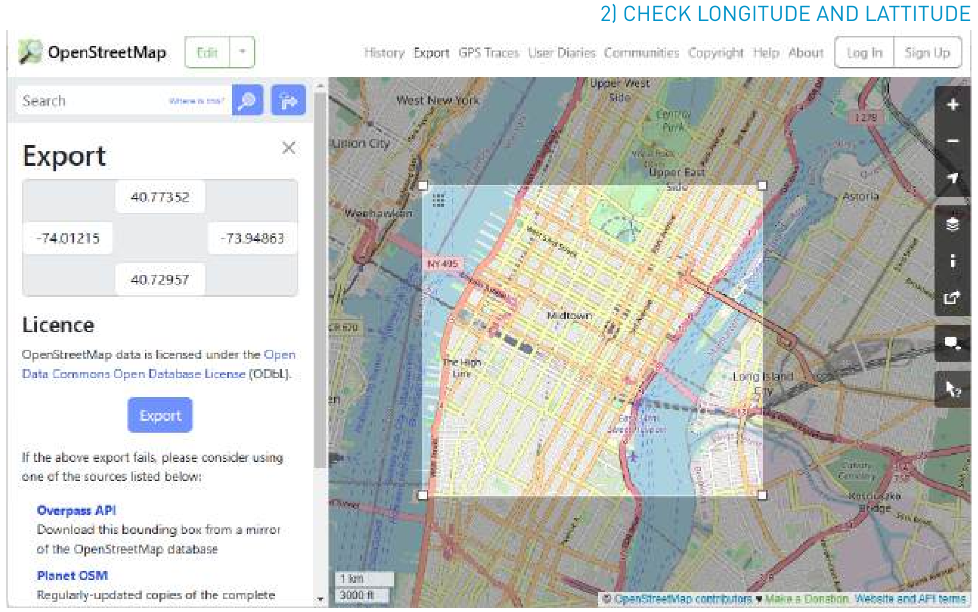


ACCESS TO THE OSMCONVERT

1) Access to "https://wiki.openstreetmap.org/wiki/Osmconvert" and download the file
2) Place the OSMCONVERT and OSM file in the same folder and run program
3) in CMD mode, Paste the OSM file name

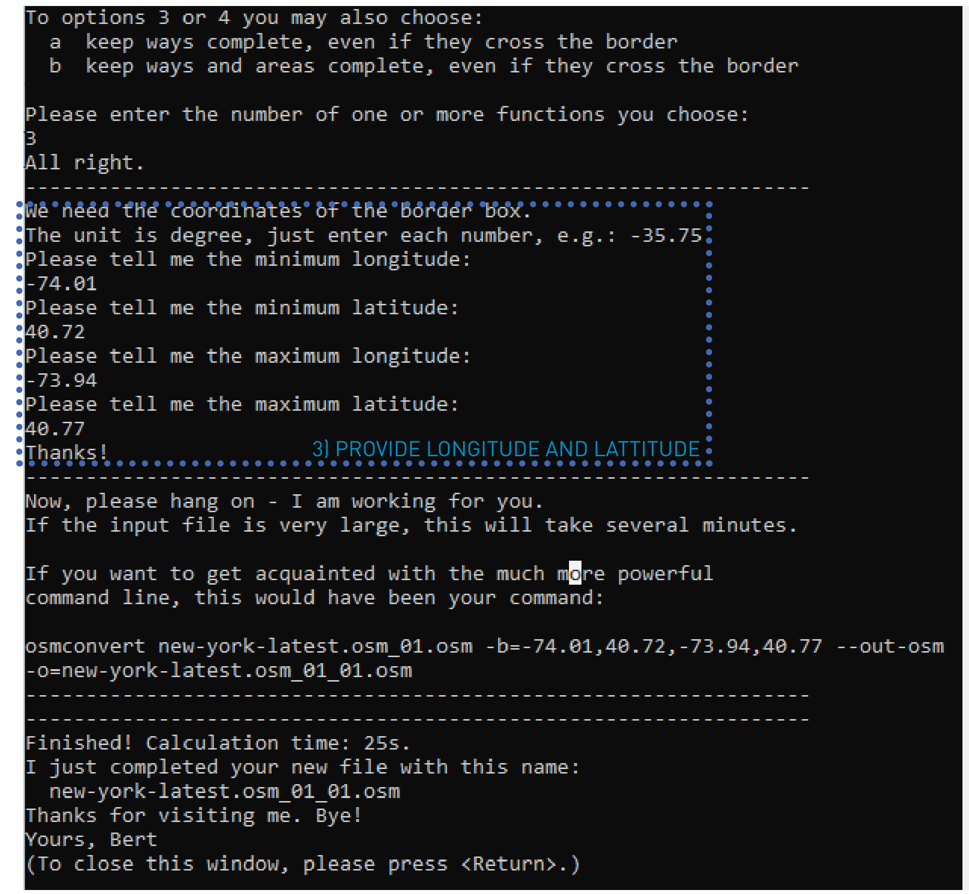


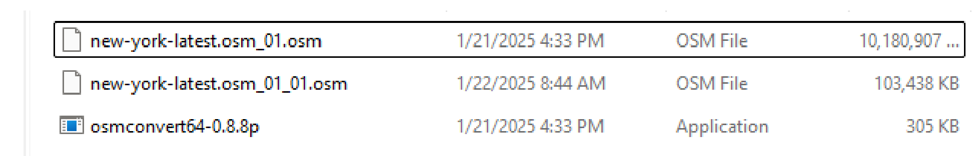
2) CHECK LONGITUDE AND LATTITUDE



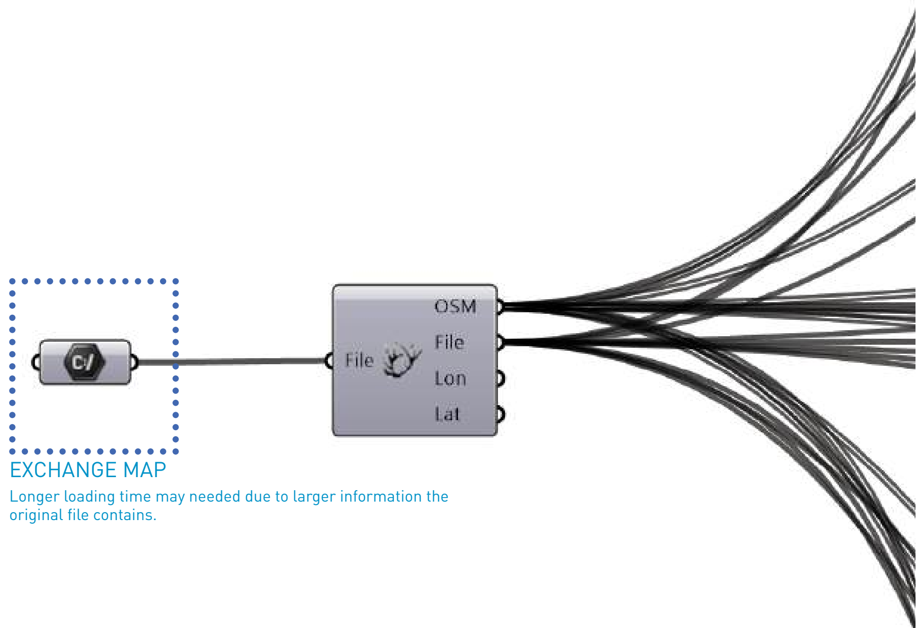
ACCESS TO THE OSMCONVERT

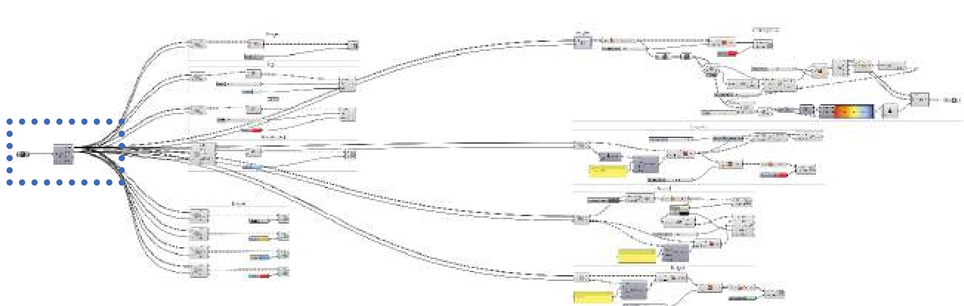
1) Enter '3' for OSM cropping
2) Check location information from any maps showing the longitude and lattitude
3) Type minimum and maximum longitude and lattitude for boundary setting
4) Check new OSM files being created in the same folder





4) NEW OSM FILE IN SAME FOLDER





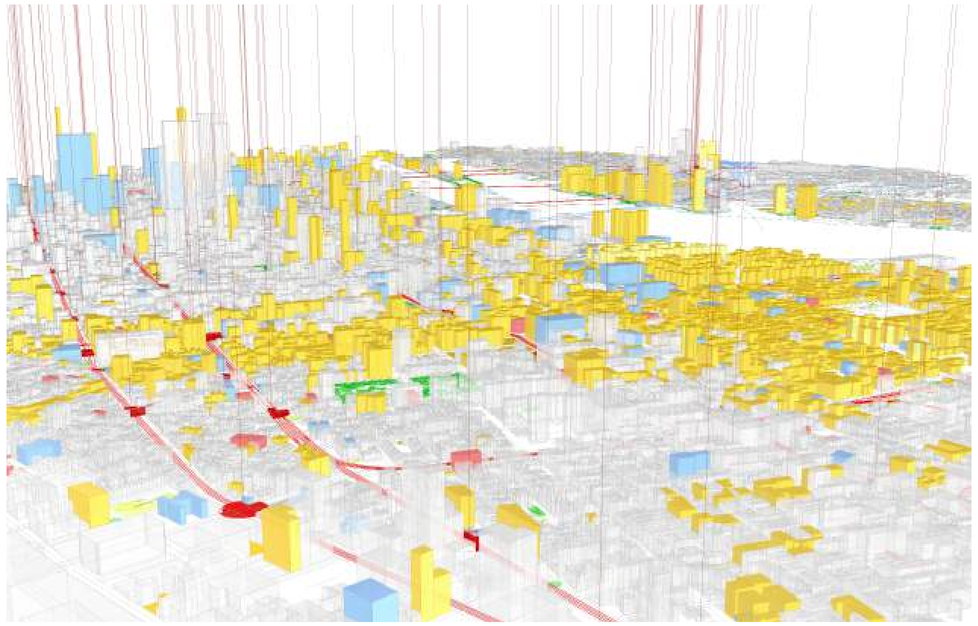
IMPORTING LARGER OSM FILES

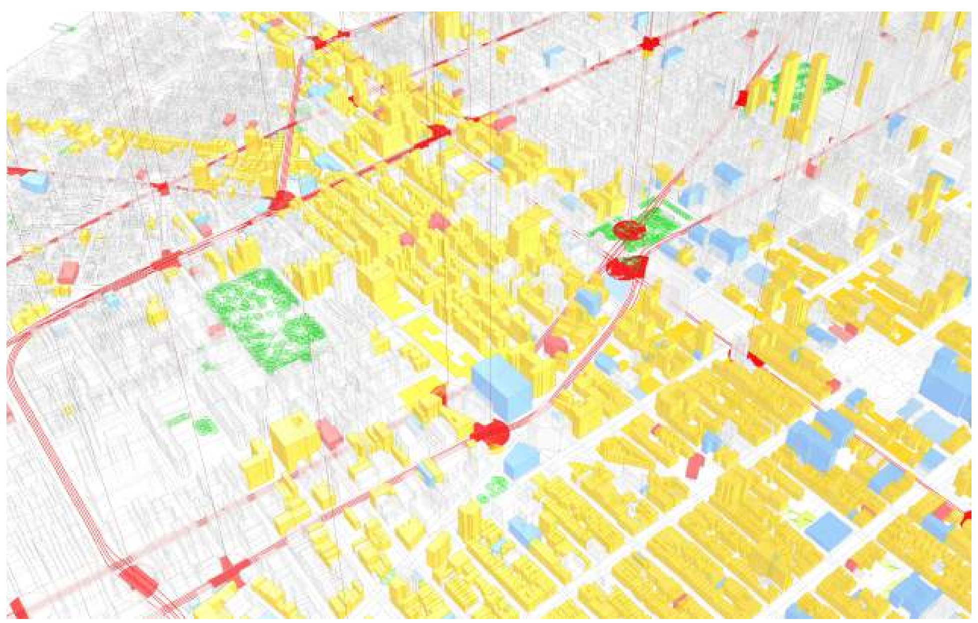
1) Import new OSM file from 'file path' component

LARGER NYC MIDTOWN AREA AND ADJACENT NEIGHBORHOODS

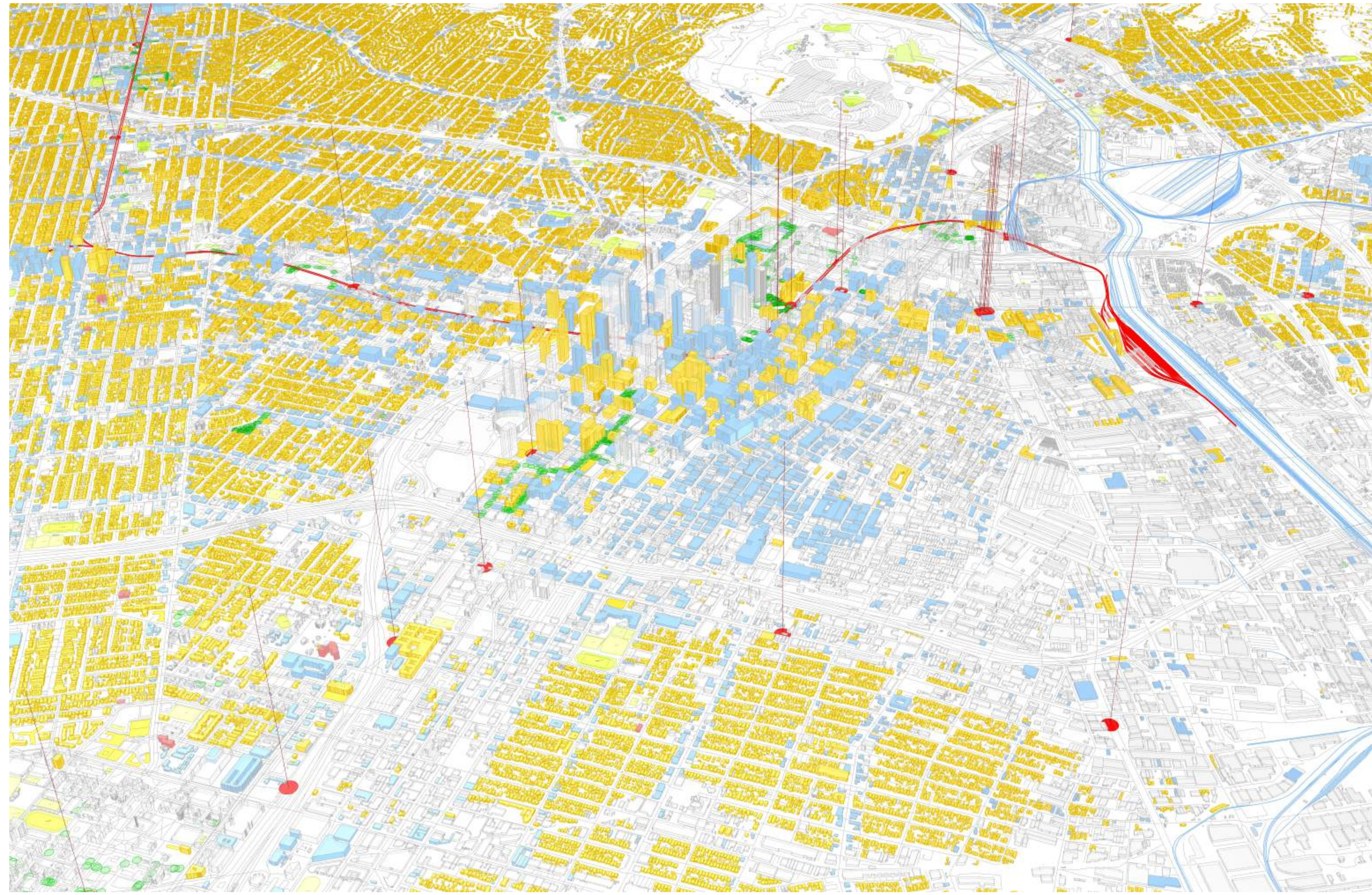
LARGER OSM FILE

Due to the nature of computational processing, larger OSM files require more time for mapping. However, larger datasets offer significantly better legibility of urban textures, patterns, and site context. As illustrated above, this mapping provides a clearer representation of urban programmatic patterns and infrastructure networks compared to the smaller region files used previously.

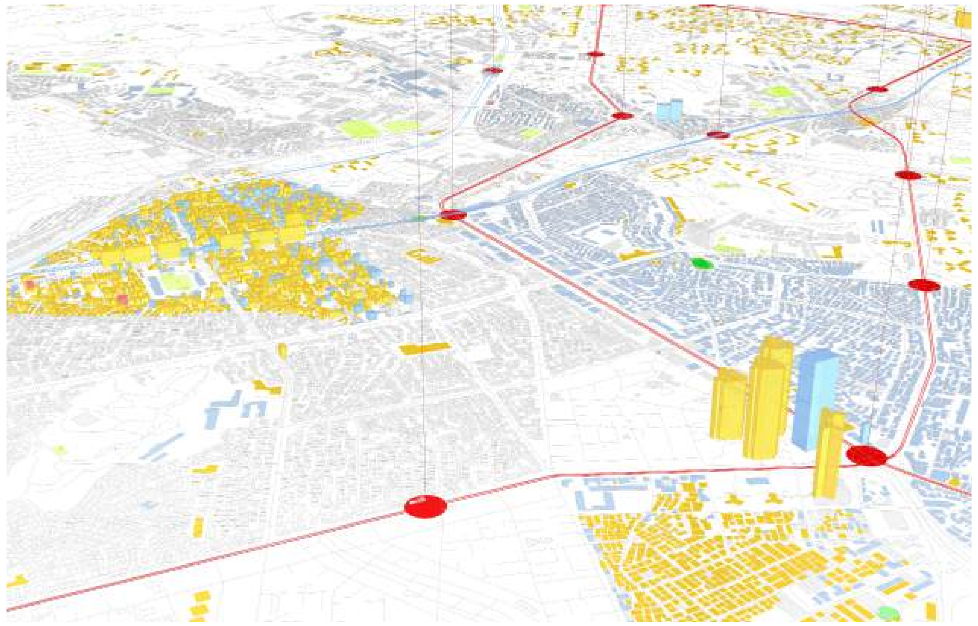


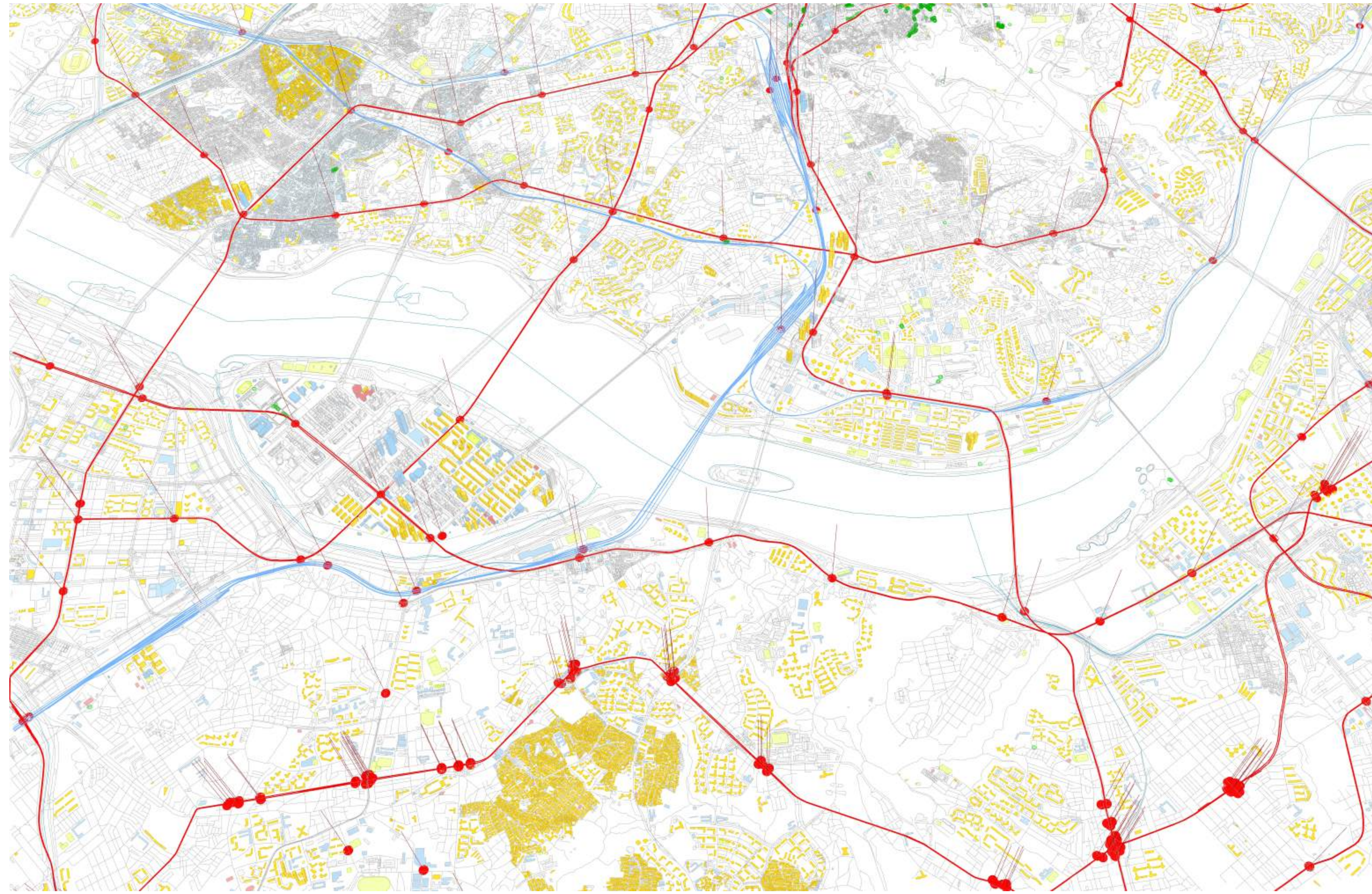


LARGER NYC MIDTOWN AREA AND ADJACENT NEIGHBORHOODS



LARGER LOS ANGELES DOWNTOWN AREA

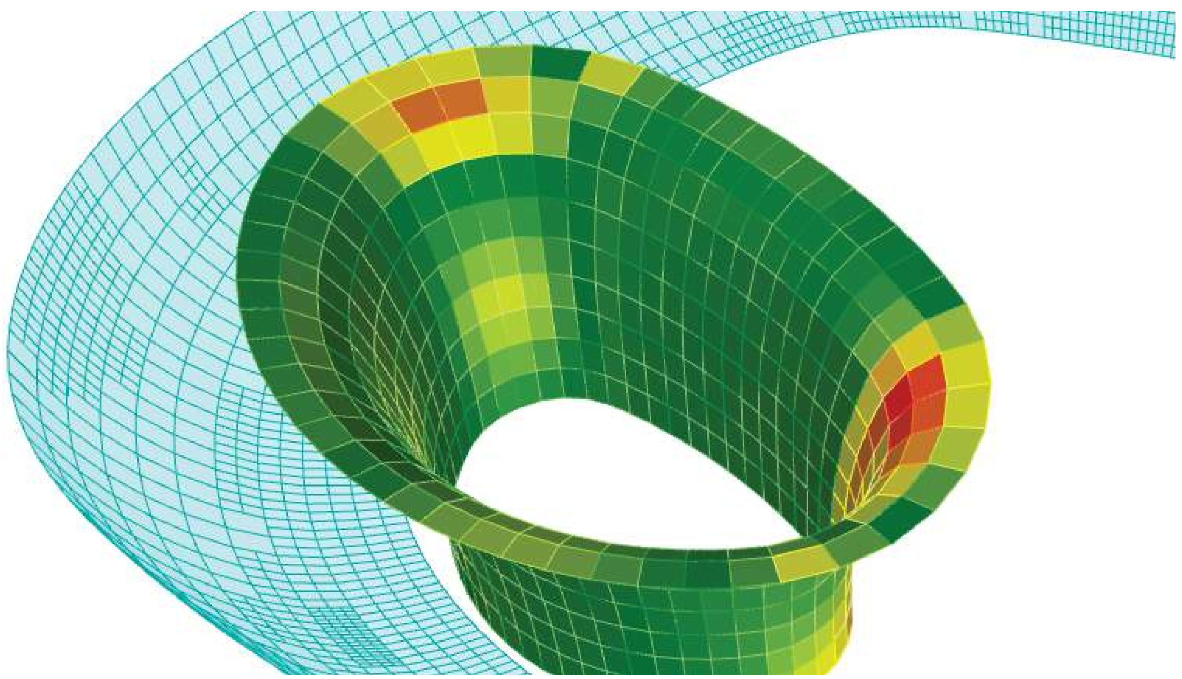




LAERGER SEOUL DOWNTOWN AREA

CONCLUSION

Conclusion & Future study
References



Conclusion & Future Study

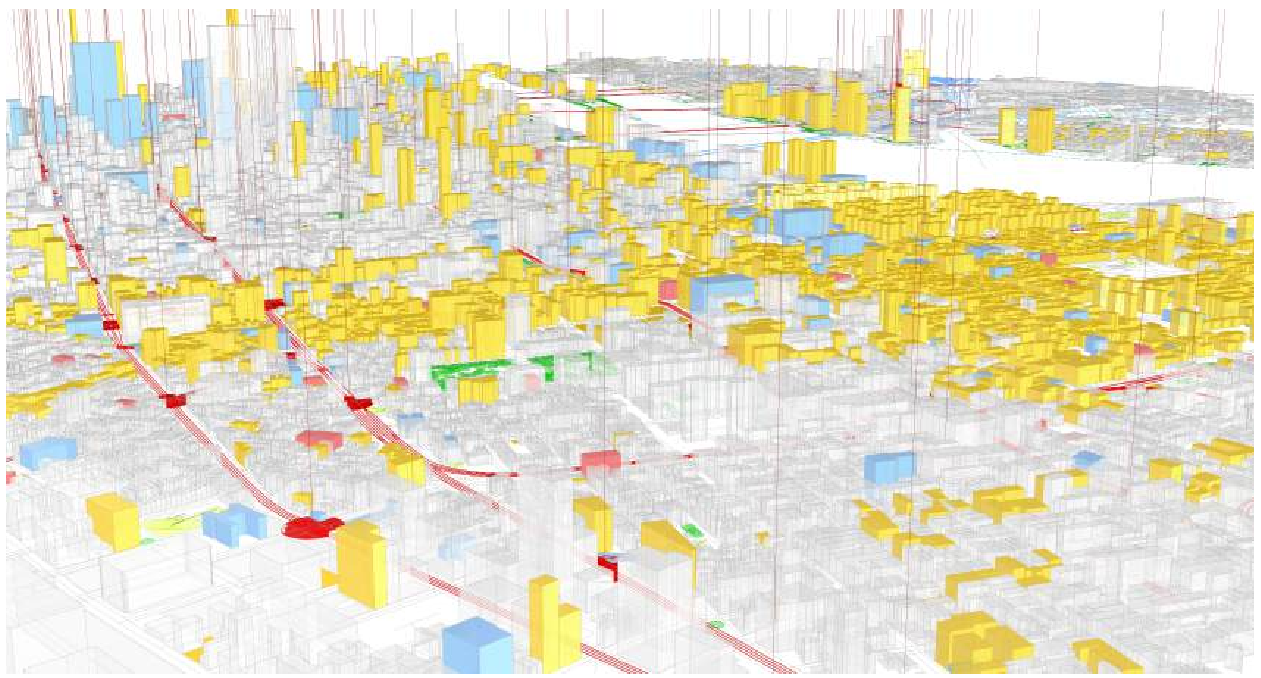
Recent research efforts have emphasized the integration of environmental and physics-driven design technologies, along with GIS data-driven analysis, throughout the design process—from the pre-schematic phase to the design development phase. These methodologies provide architects and designers with the tools to establish a strong foundation for their projects, enabling more informed design decisions while enhancing the narrative and conceptual depth of their work.

Physics-driven design plays a critical role in this process by bridging advanced geometrical modeling techniques with practical design outcomes. This research highlights the importance of developing 3D digital models grounded in robust geometrical principles. When combined with traditional and contemporary form-finding methods, this approach empowers designers to work with nontraditional, informal geometries in a manner that is both feasible and efficient. Such methodologies not only expand the designer's creative potential but also enhance the realization of complex architectural forms in practice. Future research into physics-driven design could delve deeper into areas such as agent-based modeling, adaptive systems, and dynamic design simulations. Moreover, the integration of physics-driven modeling with digital fabrication techniques offers significant potential for construction precision and innovation. Collaborations with consulting engineers and industry pioneers will be crucial in advancing these technologies and translating them into real-world applications.

GIS data, meanwhile, offers a complementary and equally powerful toolset for architectural design. While often utilized as an analytical tool during the pre-schematic phase, GIS data has the potential to act as a driving parameter in design processes, particularly when addressing large-scale urban contexts. By incorporating environmental and physical datasets into decision-making, architects can unlock new opportunities to create designs that respond dynamically to site-specific constraints and opportunities.

However, the limitations of current GIS data sources, such as OSM files, present challenges. These datasets often lack detailed information and customizability, restricting their application in more nuanced design scenarios. To address this, future research should focus on the development and utilization of customized GIS datasets, leveraging big data to enhance the richness and applicability of information available to designers. Such advancements would enable architects to design projects with a more profound understanding of urban context, site dynamics, and environmental performance. By integrating GIS data seamlessly into the design process, architects can produce designs that not only achieve greater contextual sensitivity but also provide opportunities for richer storytelling and narrative development.

This intersection of physics-driven design and GIS data-driven analysis represents a transformative shift in architectural practices. Together, these methodologies can elevate the potential of data-driven design processes, fostering innovation and bridging the gap between conceptual ideation and practical realization. By addressing the challenges and exploring the opportunities within these areas, future research can create a foundation for more responsive, sustainable, and impactful architectural designs.



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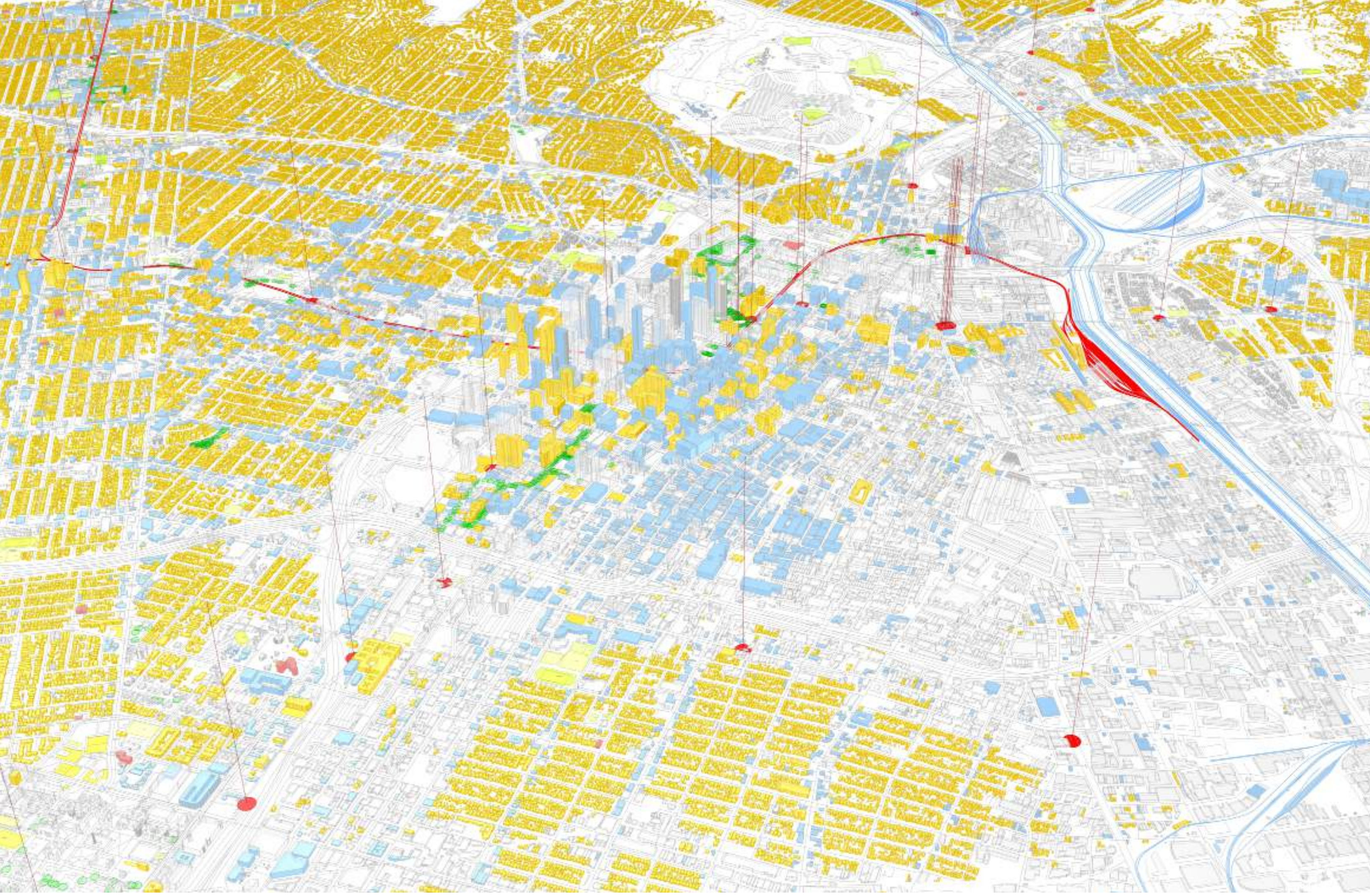
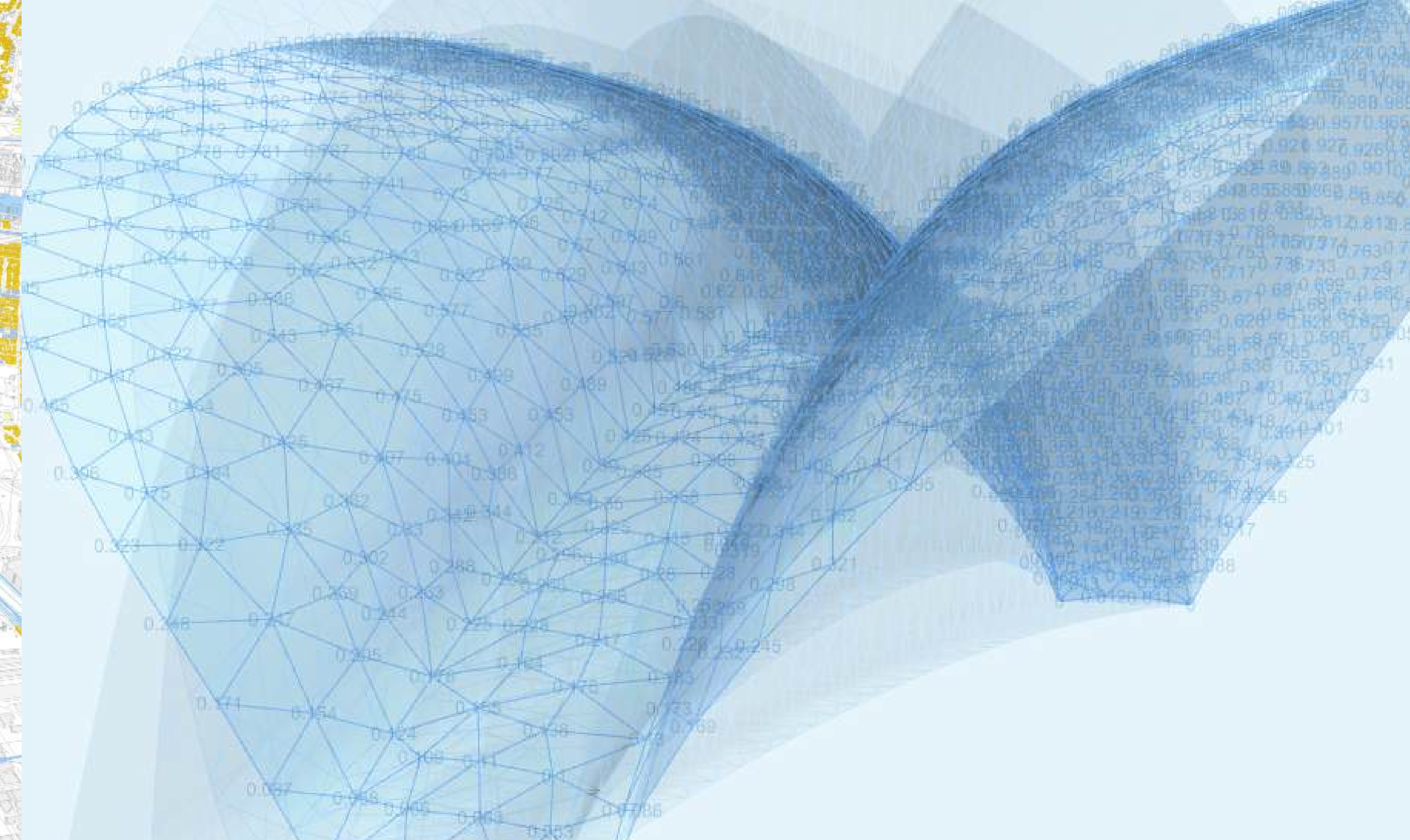


DEVELOPMENT OF DATA DRIVEN DESIGN IN ARCHITECTURE PT.II

Algorithmic Design in Architecture Volume 9

H Architecture

This research paper was written and edited by Jake Han at H Architecture, 2024.



Algorithmic Design in Architecture Volume 9

DEVELOPMENT OF DATA DRIVEN DESIGN IN ARCHITECTURE

PART - II

H Architecture