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建筑丨读图时代

THROUGH TECHNICAL IMAGES

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WORK COLLECTION from 2019-2020

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ABSTRACT

Today, we are living in an era of image-reading. Our lives are inundated with a lot of superficial characteristics, such as imaged information media, scientific, and technical image carriers. We have reached an era with divergent means and forms of representations. The emergence of Internet of things led to the favor of virtual information over verbal information. Reading a diagram, line drawing or a rendering is far more compelling than text-based explanation in many occasions. From a macro point of view, the image reading era refers to the image society and visual culture, but in architecture, image is more than just the representation. We can personally feel that the "image" has infiltrated in to every aspects of our industry.

To allow effective and fair use of the image-reading period, and to avoid its limitations, my studio works focused on the investigation of the way technical image is produced in Architectural design. The traditional ways of architectural designing, manufacturing and communicating is undertaking an imperceptible shift with the development of computerization and informationization. It is crucial for us younger generations of architects to learn and examine these technical tools. Thus, based on the type and scale of technical methods, the discussion will be broken down into three chapters that demonstrates how contemporary application of technology is affecting our design and thinking process. The first Chapter talks about body and human scale, the image of weaving created by robotics in bio-fabrication; the second Chapter talks about at the building and street scale, how can we use Virtual Reality as a technical image tool to change our approaches to urban designing and planning. The last Chapter expands the scale into using GIS data in urban landscape design. How can the GIS data or mapping be understood as the technical image.

Keywords: technical image, digital fabrication, virtual reality, GIS data

CONTENTS

CHAPTER I

BIO-MATERIAL & DIGITAL FABRICATION

Weaving technology, as one of the most ancient handicrafts of human beings, from the former rope knots, fishing nets and other daily necessities, reflects the characteristics of typical traditional culture and regional culture, and is applied to architecture in a variety of forms. Weaving has long-standing value in construction and organization methods, and its development and application of uninterrupted, but weave topics related to construction problems, but by the complex of the weave construction often form and its own complexity, and it is difficult to accurately calculate and accurate operation, in the traditional design and modeling process has great limitations. Parametric modeling and digital fabrication design operation methods provide strong support for the application of weaving themes in architecture, improve the operability of complex weaving forms and complex weaving surfaces, and realize the quick adjustment and modification of the design scheme. Therefore, the combination of parametric modeling and digital fabrication has become an important research object of parametric design, which has practical application significance and research value that cannot be ignored.

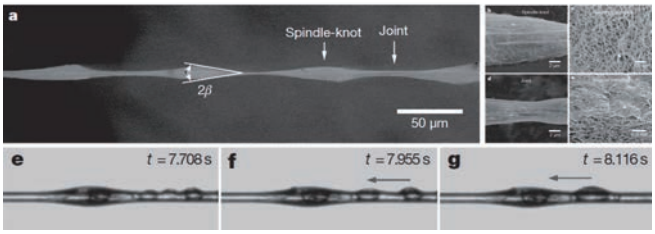
There are two aspects of understanding the weaving of architecture, material and methods. The method of robotic fabrication expanded the length of manufacturing, and the innovation of material increases the depth of design potential. The Hybrid Spider Silk project is aiming at researching new typology of bio-material that can be used to manufacture a hierarchical and systematic design through digital fabrication. The purpose of this innovation is to discover sustainable and reusable methods in architectural practice. The studio is led by Laia Mogas and Jorgo Duro. Both of them are experienced researchers in biological material systems and novel material practices in design.

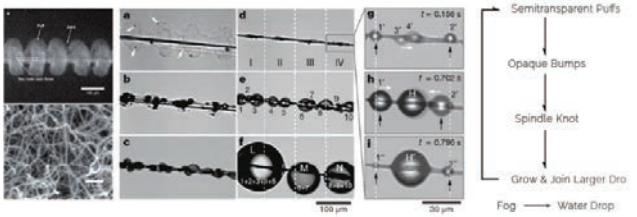
Bio-material quality

To think spider silk as a bio-material. It has several characteristics that can potentially be extracted and enhanced as a building material. 1)The ability to collect,absorb and release water to adjust its form. 2) The structural quality of spider silk that is related to each different layer within the string. Which directly determines the strength of the string, how much compression and tension force can it bear and take. 3) The light transmittance. The ability to reflect, deflect light and create various visual effects due to the density of the weaving, the angle of light and the level of lighting.

Water collection

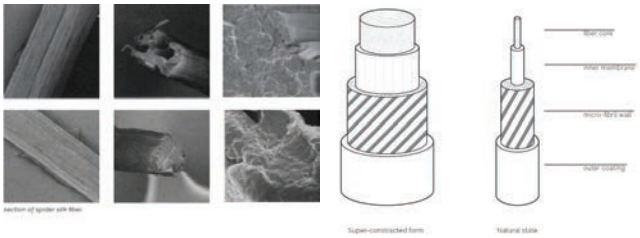
The fact that spider silk can interact with water is that the hydrophilic aqueous glue within it allows Capture Threads Extension up to 500% with hysteresis to save the energy dissipation crucial in prey culture. And the air pods formed by pressure inside the threads become a series of opaque bumps that let water to flow along it. Thus, when the moisture in the air forms into water, that water can be collected and guild into designated places.





Hierarchical Structure

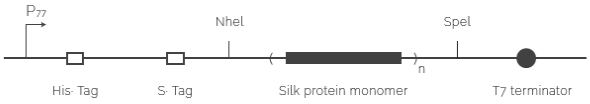
Spider silk has strong structural potential due to its tensile strength, layered biological structure. By using protein enhancement it can achieve even high structural standards. Hypothetical model for the structural of Nephila dragline silk. The model is microscope observations of Nephila silk Ampullate glands prepared in our urea is shown the super-contracted form, and how it might be in the natural state.



SPIDER VS. SYNTHETIC

Material	Strength (N/m²)	Energy to break (J/kg)
Dragline silk	1×10^9	1×10^5
Kevlar	4×10^9	3×10^4
Rubber	1×10^6	8×10^4
Tendon	1×10^9	5×10^3

The strength of each layer is related to the protein produced in the threads. The way we might begin to manipulate the structural quality of spider silk is through protein enhancement.



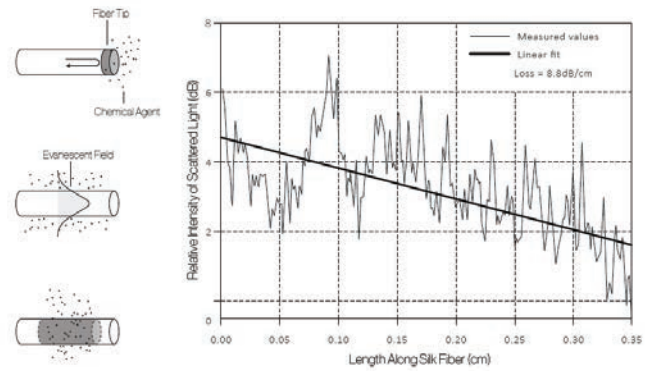
$[SGRGGLGGQGAGMAAAAAMGGAGQGGYGGLGSQGT]_n$

Recombinant expression of spider drag line silk proteins in Escherichia coil. Recombinant spider silk protein expression constructs an amino-acid sequence of the silk monomer. The GC content of the silk genes and molecular weight (Mw) along with glycine content of the encoded silk proteins.

	SILK GENE	SILK PROTAIN	
Repeat unit	GC content(%)	Mw(kDa)	Gly content(%)
32mer	69.5	100.7	43.4
48mer	69.8	146.7	44.1
64mer	70	192.8	44.5
80mer	70.1	238.8	44.7
96mer	70.1	284.9	44.9

Light Transmittance

The ability to manipulate light by adjusting protein density, water density and structural form. Typical fibre-optic chemical sensors based on (a) fibre tip and (b) evanescent field sensing. (c) Simple transmission setup, based on a chemically-reactive fibre, proposed in this communication.

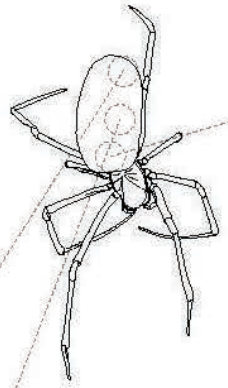


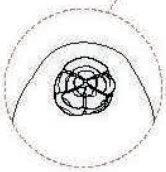
Nature

Natural Spider Silk Products

Bio-science

Human Intervention





Spinnerets

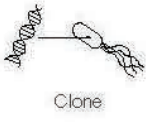
Spinneret is a silk-spining organ of a spider, usually found underside of spider's abdomen to the rear. Most spiders have 6 spinnerets which move independently and in concert.

Silk Glands

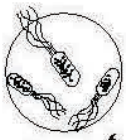
Silk gland distribution and corresponding silks produced by a typical orb-web weaving spider. Within its abdomen, the spider produces up to seven different silks in different glands, all used for different purposes.

DNA Sample

DNA segments that are relevant to silk protein making will be cop
using polymerase chain reaction. These DNA copies can be pu
bacteria for duplications.



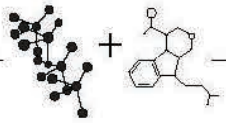
Clone



Bioreactor

Silk Protein

Gene Modification



Chemical Conjugation

Molecular Level Production

Ino-Beam Lithography

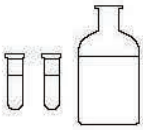
Electron-Beam Lithog

Soft Lithography

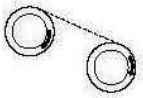
Nano-imprinting

Self Assembly

Multi-Photon Lithograp

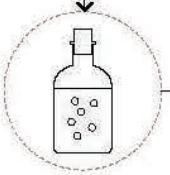


Material Mixing



Spinning

Purified Spider Silk Protein



Microscopic Assembly

Macroscopic Level Productio

Ultraviolet Lithography

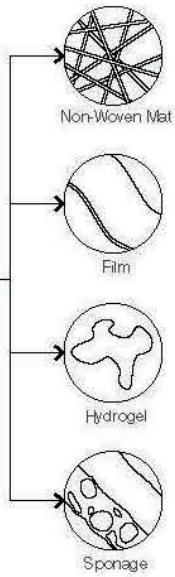
Inkjet Printing

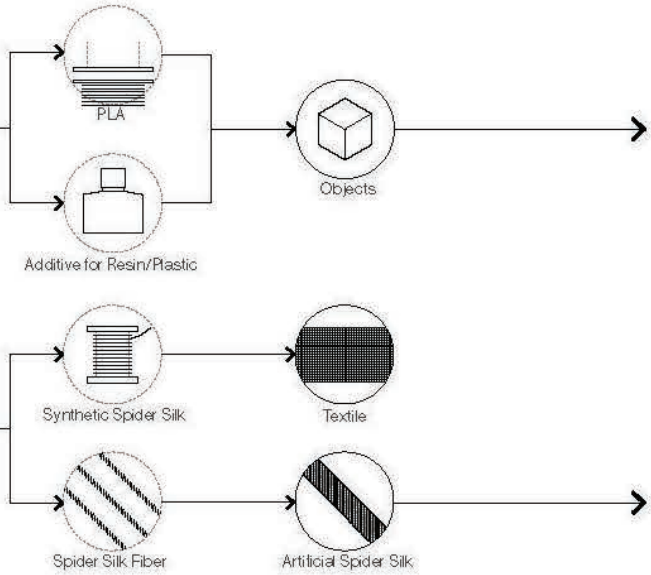
3D Printing

Industry

Artificial Spider Silk Products

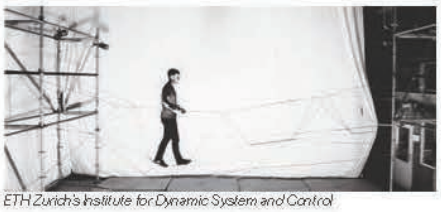
Original Products





Design

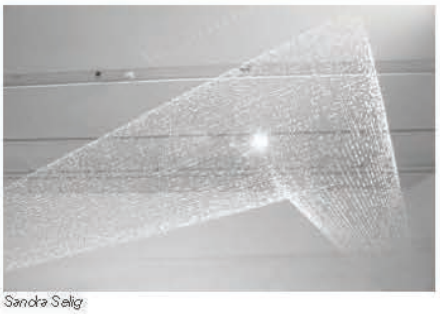
Precedents



ETH Zurich's Institute for Dynamic System and Control

Rope Bridge

Researchers at ETH Zürich's institute for Dynamic Systems and Control programmed three quadcopters to autonomously build a 24-foot rope bridge sturdy enough to support the weight of an adult human.

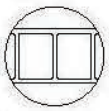


Sandra Selig

Mid-Air

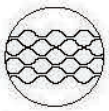
Mid-air comprises differently sized styrofoam balls 'beaded' intermittently on lengths of clear nylon thread. Two sets of these 'strings', arranged in tubular compositions, span both the length and the breadth of the space, bisecting at approximate right angles.

Design Features



Main Structures

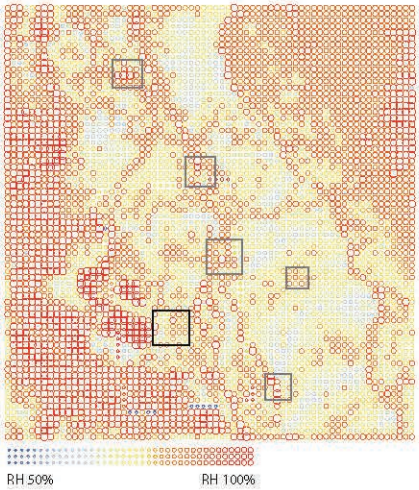
Main structures made from mixed spider silk protein products only inherits partial strength of natural strength from spider silk. Yet, it adapts multiple features from other materials that expands the fabrication potential of pure spider silk. Product of such mix material are no longer limit to fibers and textiles, but also digital fabrication objects.



Substructures

Intent to maintain the key identity of spider silk, the substructure will remain web or textile-like structures to display original features of a spider web such as water collection from air light transmittance, and tensile strength.

Site Influence



Humidity Map - WCP

Distribution of high-avg. Humidity areas in forest identifies locations of Water Collection Points(WCP)

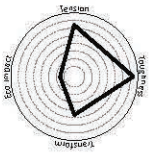
Trip Route - Visitor

The design of traveling paths follows the traditional trip route from Mississippi River > Great Lake > Forest > Site

Forest Density - Span

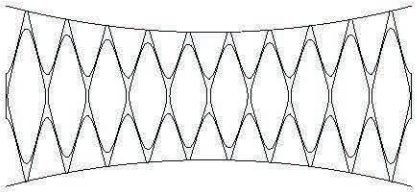
The variation of forest density unveals potential builtable spaces between trees.

Strategies



Bridge

Silk gland distribution and corresponding silks produced by a typical orb-web weaving spider.



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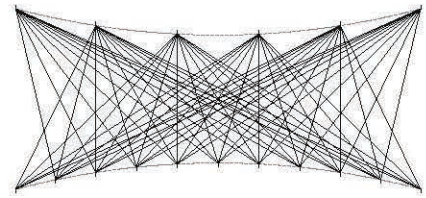

Pavilion

Silk gland distribution and corresponding silks produced by a typical orb-web weaving spider.

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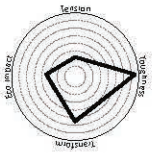
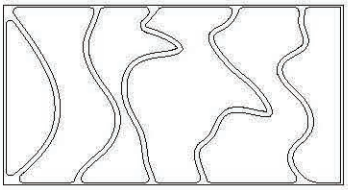
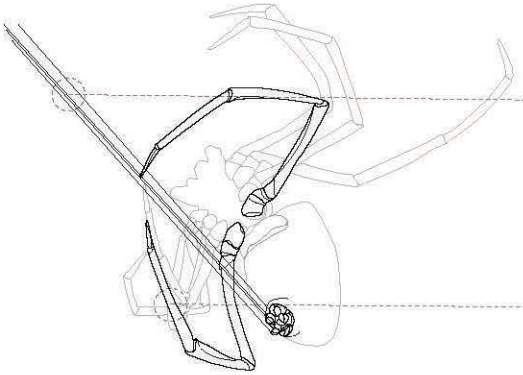


Sculpture

Silk gland distribution and correspo
silks produced by a typical orb-we
weaving spider.

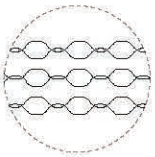


Nature Fabrication



Multiple types of Silks

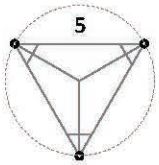
Most spiders vary the thickness and stickiness of their silk for different uses. These silks are produced from different silk glands with different properties.

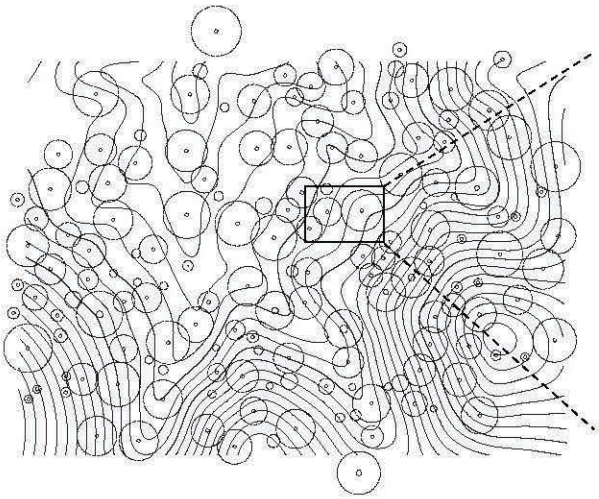


Manipulate + Weave

Spiders use thir 2 hind legs to direct and manipulate their silk into different silk products.

Structural Layers of Spid



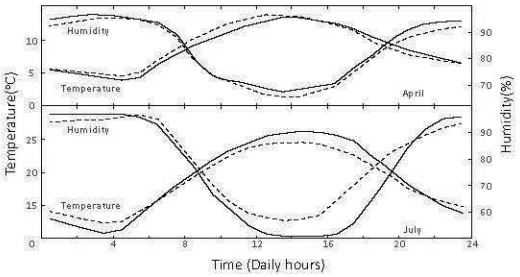


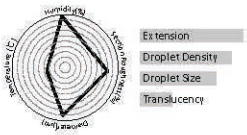
River & Trees - Layout

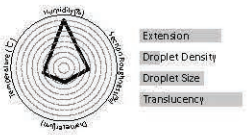
Humidity, the trip route and tree density, together, influence the pavilion design.

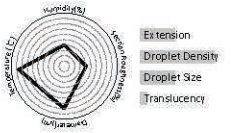
Through study, desirable building distance between trees will be 2 - 6m

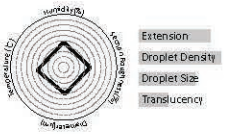
Natural Parameter











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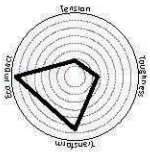

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Silk gland distribution and corresponding silks produced by a typical orb-web weaving spider.

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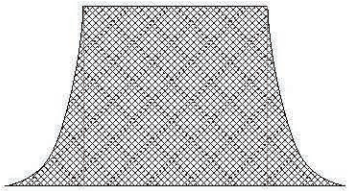

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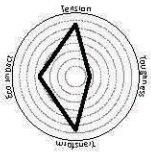
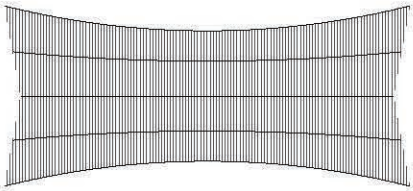
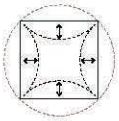
Envisioned New Properties



Pavilion

Combined with 4 ideas, the pavilion serves not only as a installation art, the feature of spider silk could also be responsive to its environment.





Transformable

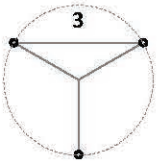
Water Collecting

Interactive

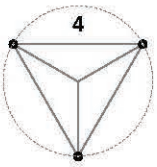
er Web

sing Thread

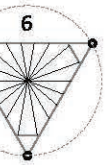
Y-Shape Frame



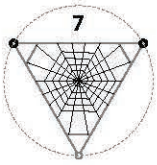
Main Frame



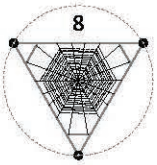
Radius



Auxiliary Spiral



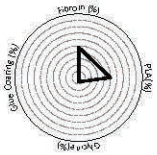
Sticky Coating

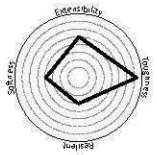


Artificial Material Specification

1

Main Structure
Ø 20~30mm





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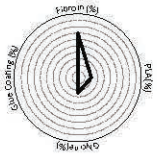
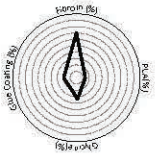
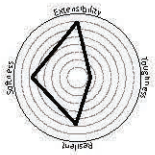
Auxiliary
Ø 10~15mm



3

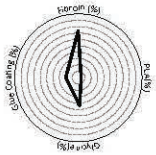
Enclosure
Ø 5~10mm





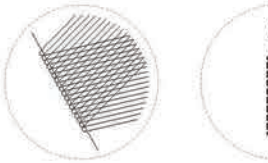
4

Water Collector
Ø 0.1~0.5mm



Multiple Silk Products

Inspired by the natural process of web building, there are basically 4 types silk products fabricated for the assembly of pavilion. In which, No. 1, No.2 and 3 silk members are produced by a 9-axis winding machine took from carbon fiber industry.

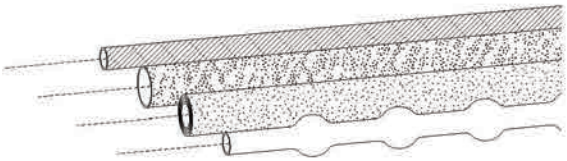


Cross Weaving

A silk member's physical characteristics can be manipulated through cross weaving multiple types of silk.

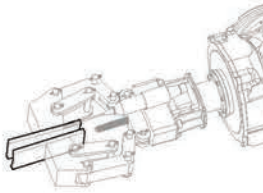
Product Diversity

Through simple weaving and manipulation, silk products will display in diverse sizes, characteristics, and shapes

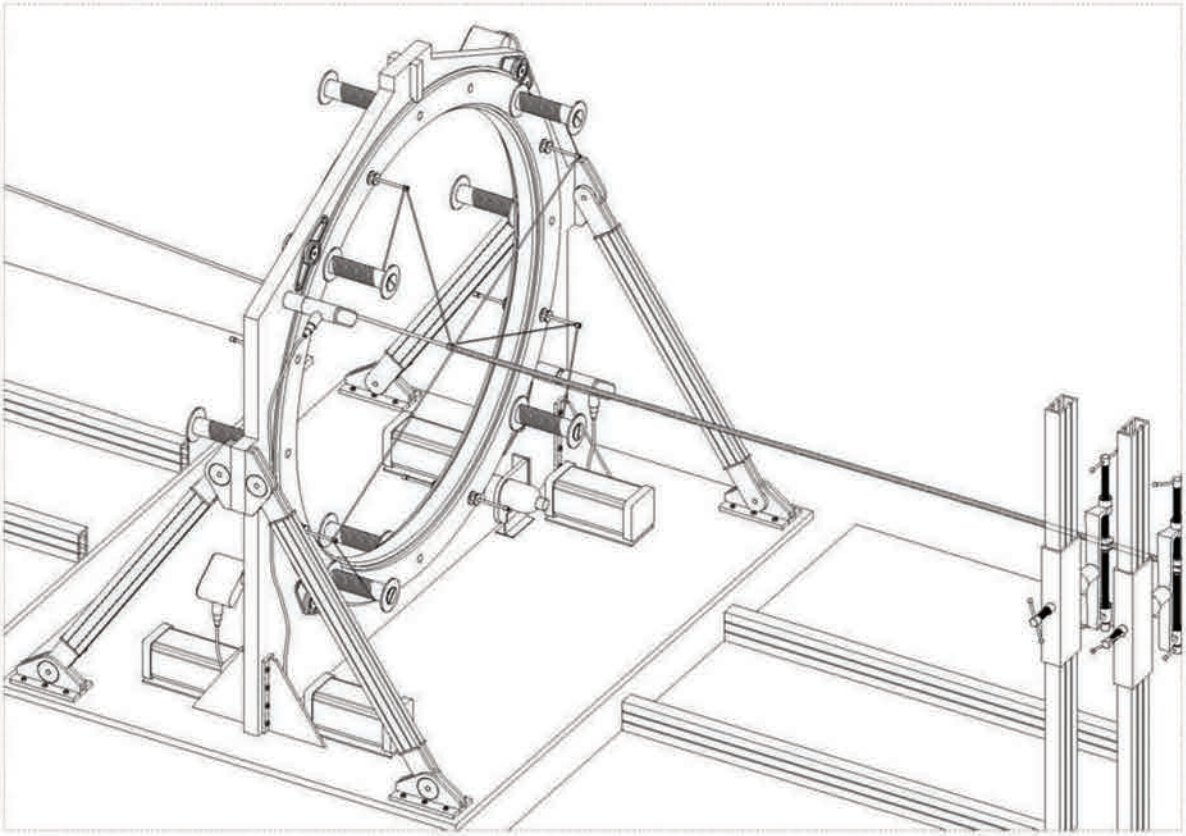


Grabbing Pads

A pair of soft sticky grabbing pad
to robotic arm's grabbing module
building efficiency and minimize t
damage to silk members.



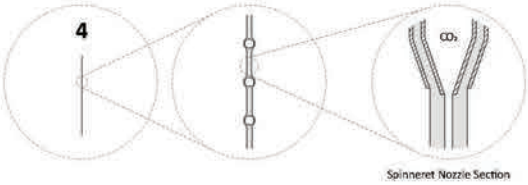
9-Axis Winding Mechine



6 Axis Robotic Arm (Conv

Build and Coating

Similar to those hind legs of a spider, the 6 axis robotic arm will be the main character of building process for No.2 and 3 silk members.



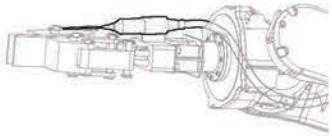
Delicate Works

No.4 silks in avg. diameter of 0.3mm work as the water collector by mimicking the nodulated form of the natural silk in capture web. The shape can be achieved through intermittent injection of air into the silk. A spider drone is created for such scale production, as well as building water collection layer on the pavilion.

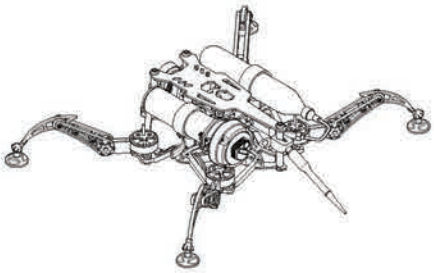
s are added
to optimize
he potential

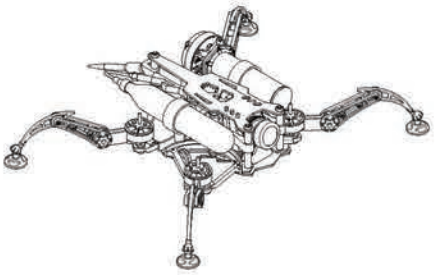
Aqueoue Coating Sprinkler

Aqueous coating for No.3 silk members will be sprayed from the sprinkler that is attached on the robotic arm.



Spider Drone





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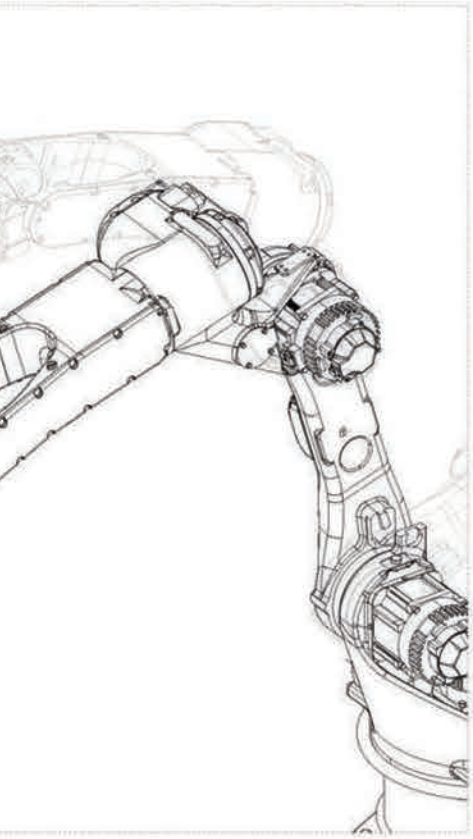
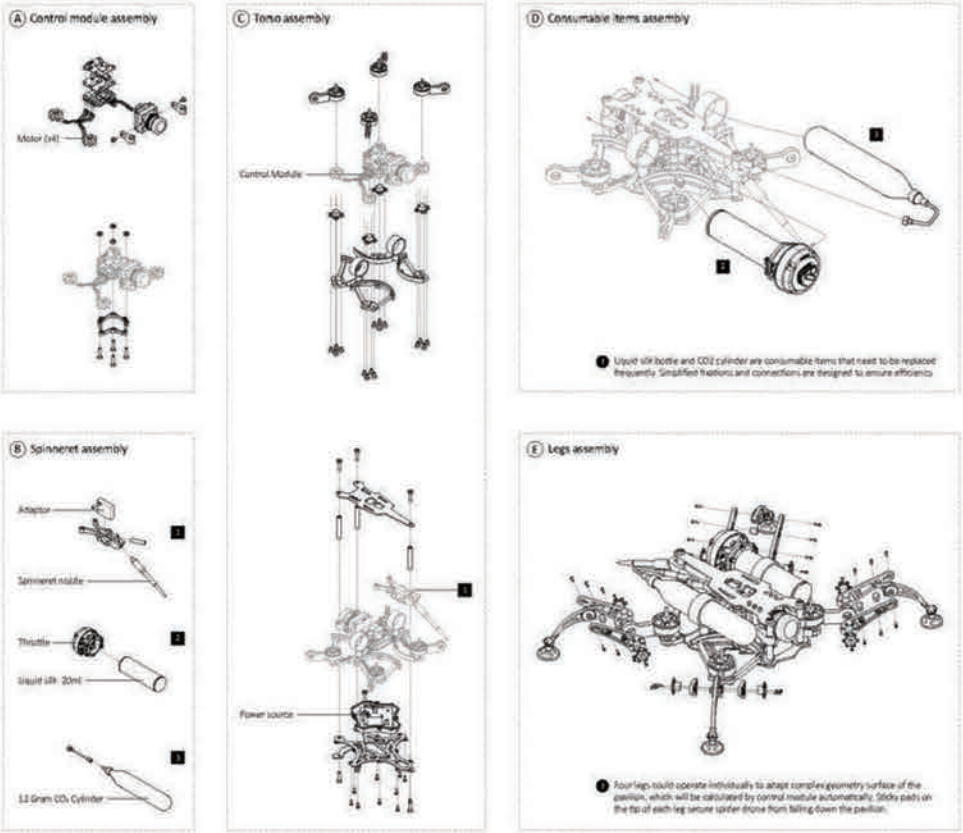


Assembly Instruction



CHAPTER II

VIRTUAL REALITY & SCENE RECONSTRUCTION

The field of architectural design is evolving at an unprecedented rate. A new generation of architects and designers is growing up with real-time technology that is starting to affect every aspect of their lives -- not just the living Spaces they will design in the future, but the way they shop, entertain, learn, travel and communicate. Real-time technology is changing the way designers understand concepts and interact with them. The new ability to experiment with architecture in the early stages of design influences the evolution of the design and enables rapid iteration and exploration of the design. It has the potential to foster innovation and reveal new possibilities.

As we move from being a car city to a pedestrian city, a bicycle city that emphasizes the human experience, the architectural density of the city is getting higher and higher. This project requires a programmatic approach to generating cities. But instead of trying to build a new tool for that purpose, the team turned to Esri CityEngine, an off-the-shelf parameterized building-creation program that has been used in city-level engineering. The company has enthusiastically come to the rescue, offering technical assistance, licenses for CityEngine and engineering examples. To monitor The technical level of The project and ensure that it meets The requirements of relevant stakeholders, The team relied on The expertise of local VR and AR platform company The Group. In collaboration with Esri and Epic, the company has built a plug-in that Bridges CityEngine with the unreal engine. Novostos has also improved the virtual engine's collaborative viewer template, allowing multiple people to experience and edit the parameterized building in both desktop and VR devices. The ability to see rendered, photo-realistic results in VR allows users to modify the design while experiencing the environment.

Site Documentation

360 Degree analysis with drone, identifying key intersections and existing building and landscape conditions.

Locating Problem

Defining the proposal area and conditions that don't work well in current street life of Browns Race.

VR Study

Bring the first draft proposal into VR. Than identifying materials, floor height and street width with more accurate feedback.

Feedback

Document the details that need to be modified in sketch and 2D drawings.

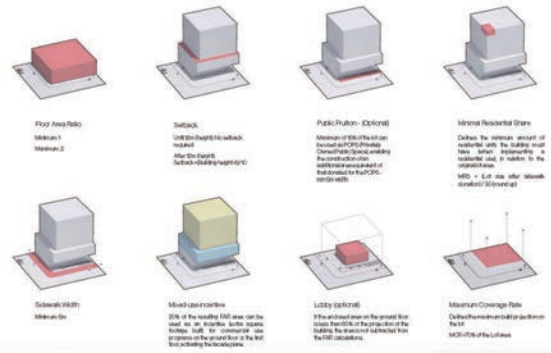
Digital Modeling

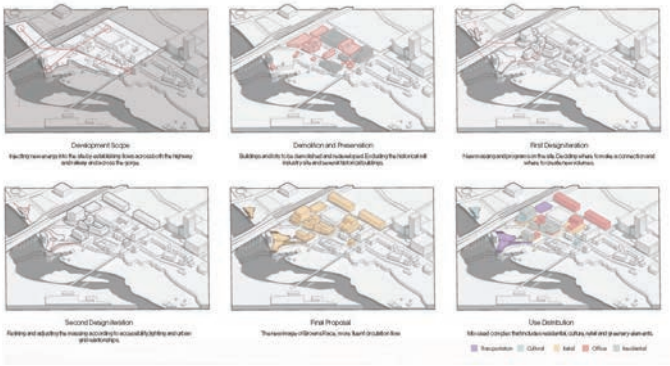
Transferring the updated details and design into 3D modeling.

The site Browns Race is located near downtown Rochester. The site was famous for its historical mill industry and the gorge as a natural wonder. The canal was used for ships to transport industrial material to the site. However, the site today was almost abandoned, there is no space for people to stay on the street and no interaction between people and Browns Race. Not to mention the highway and railway bridge cut off the connection between Browns Race and the other side of the city. Although different proposals were brought up by the government through the years, including introducing a laser show on the Gorge. However, little had changed on the street.

Therefore, the proposal is aimed to bring life back on the street and to the area by reactivating the canal and establishing a new entry point from commercial street. Also, in order to create an ecosystem that not only attracts visitors but provides space for the locals to live and work. Several existing buildings are redesigned to fit programs like residential, retail and offices.

Based on the research of existing buildings, new massing with different programs are designed. Along with this, two cultural buildings were designed on each side of Browns Race. A museum and an information center. A cable car station was designed to make connection to the trail on the other side of the Gorge and also providing more intimate connection to the Gorge. A series of rule sets were also designed to create a more systematic streetscape on the site.





Possibility of VR in Architectural Design

The goal of this studio is to explore how VR can play its role in architecture design. How will it change the typical approach and process to a project. How different is perception of space in VR compared to 2D/3D drawings. Especially in large scale urban planning.

The conclusion is that nowadays, VR is still regarded more as a examining tool or reviewing tool instead of designing tool. After our exploration with City Engine to Epic Game's Unreal Engine, we realized the limitation of Designing in VR. Personally I believe the use of VR doesn't bring us revolutionary changes, it doesn't break our traditional designing process completely. Part of it is because we don't directly design in VR. like extruding or creating massing inside of VR. And I also doubt that it will be efficient or even health for people to spend too much time doing stuff inside of VR. It's just more accurate and more efficient for architects to design in computers and think in VR.

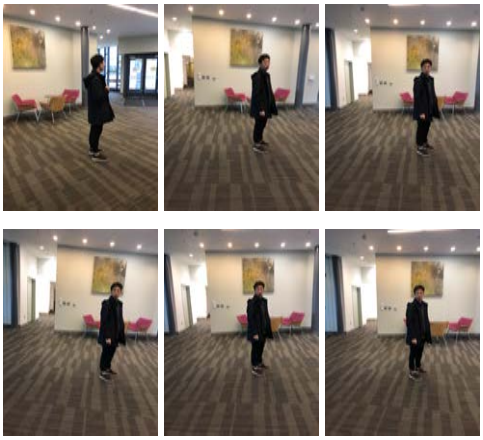
The good thing about VR is that VR instantly shrunk the distance between a well experienced architect and someone who doesn't have a sense of space by looking at a 3D model. Although I don't think VR dominated our working process completely, it did help a lot with the feedback and editing design. During our design process, in order to capture the historical feeling of Browns Race in its material, street width and building heights. After our first iteration, I went into VR and walked around the site, and instantly realized things like this pavement needs to be changed, the height setback blocked too much light, the trees have too many shadows and a bike rack is not in the right position, etc. And my partner can find out the things I just pointed out and make changes right away.

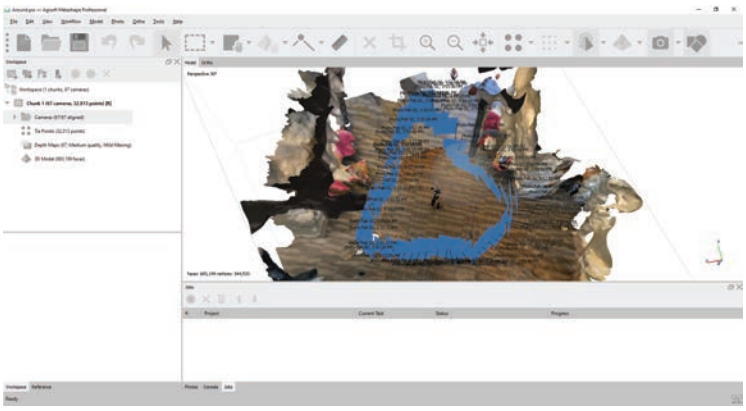
Therefore, I believe at this stage, VR is good for architects to bring more reality aspects into their design, and good for helping us make decisions. But it isn't something that would dominate our designing nor do I think it should. For clients and reviewers, it quickly sets the right starting point instead of listening to architects talking about a 2D drawing or 3D model and have no clue of what's going on.

3D Scene reconstruction

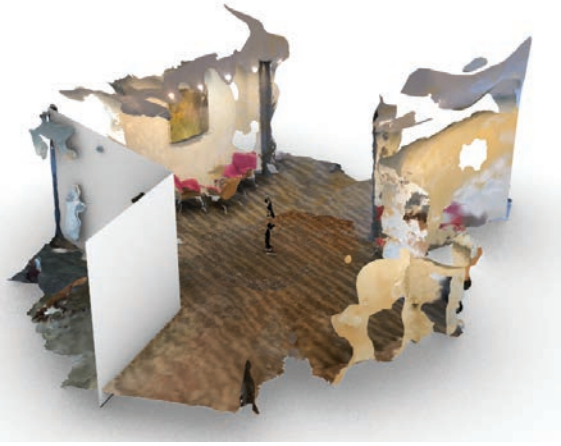
In John Zisovicci's studio, we looked at 3D scene reconstruction and how does it help us understanding spaces and landscape. When we scan a space, the outcome becomes one continuous mesh with texture, it in a way simplifies the objects in the space but catches the crucial quality of the overall shape. Also, the reconstructed camera path provides another way of thinking and looking at space. To be exact, an image-based 3D reconstruction algorithm can be described as to explain a set of photos or video of a certain object or scene through generating a most similar 3D shape to mimic the material texture, camera angle and lighting condition. A complete 3D reconstruction usually contains the following steps.

1) Collect images
2) Calculate camera parameters for each image
3) Reconstruct the 3D geometry of the scene and corresponding camera parameters
4) Optionally texture the reconstructed scene.

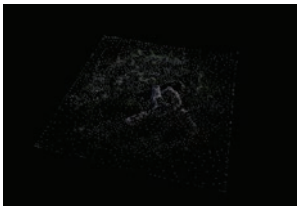
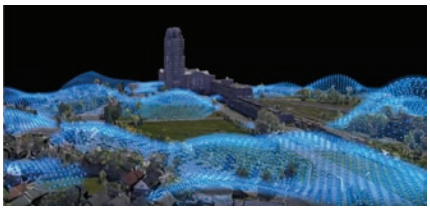
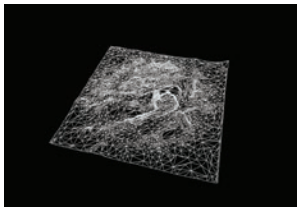


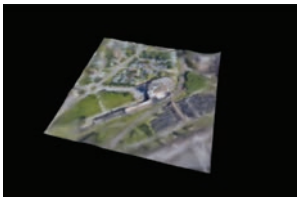


Here we practiced with two different tools, Agisoft metashape and cinema4D. In the first exercise, I use my own body as a reference point and have my partner take a series of photos around me to capture the lobby space. Based on the resolution of images, material color map, shadow and lighting. The scene was roughly reconstructed around my body. From this practice I begin to discover and understand how the scanning software "sees" our world. Where it registered as one face and what can not be registered. The lobby is a transitional space that connects to four corridors, the scanning managed to build the core but failed to build the branches. In terms of the texture, the white wall is supposed to be glass panels but glass can not be identified here.

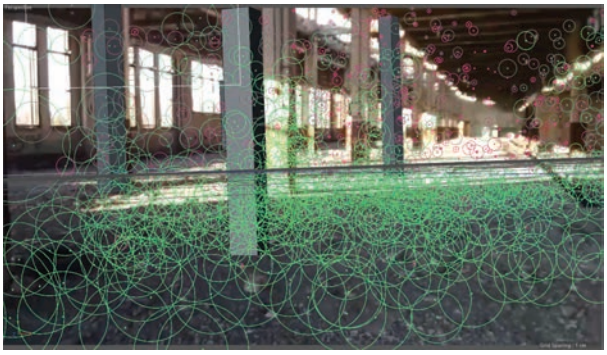
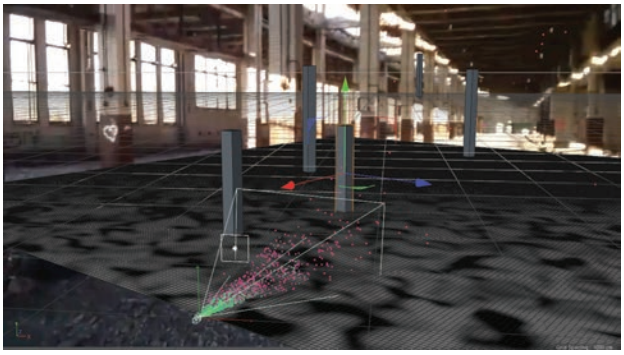
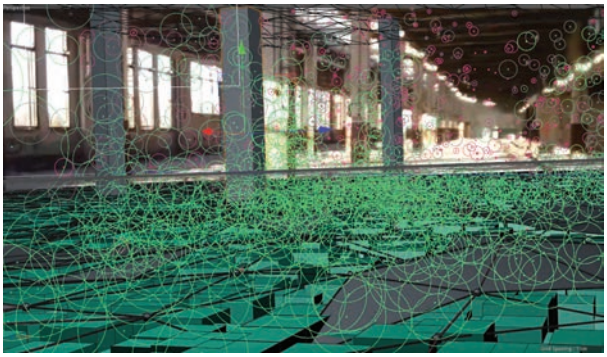
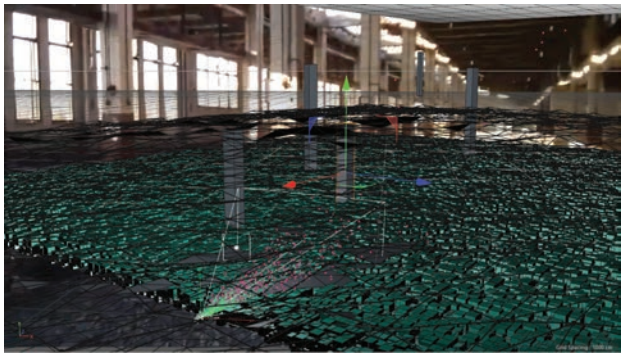


Then I tried to reconstruct a part of urban space in Buffalo central terminal using the technique of scanning dense point clouds, mesh surfaces and 3D geometries. The result is a reconstruction based on google earth images, which gives a further abstract understanding of the landscape and topological conditions of the site. Because of the nature of the scanning software, it turns to smooth and connect the edges of the building. So that the building can be read as part of the landscape which opens possibilities for new accessibility and renovation.




This is a scene inside of the abandoned Buffalo central terminal building tracked in Cinema4D, the 3D tracking established a new camera path and new 3d relationship between objects(the columns in the scene). Based on this, a set of new columns were assigned and snapped to the tracking point clouds according to this new camera perspective. Then if we take step back to see the overall spatial relationship. The new column grid is not rigid anymore and the distance between them are not equal. If the columns are the factor that defines the space and controls the speed and direction people move through the space. Then this "second-hand" information provides us a new reality of thinking and designing the space.

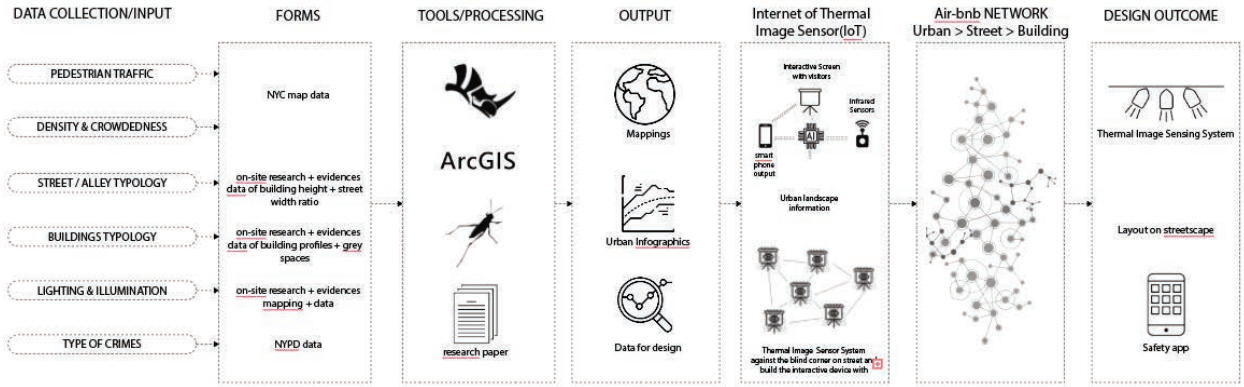
CHAPTER III

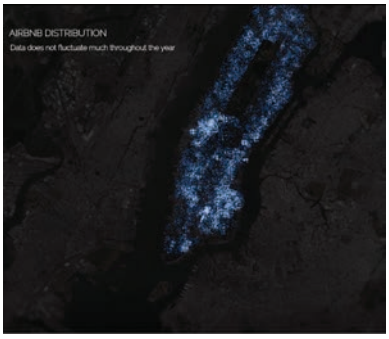
THE TECHNICAL IMAGE OF GIS DATA

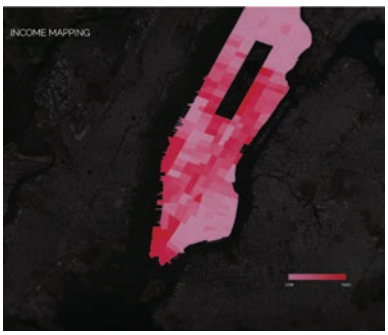
At present, the creation of urban design schemes is mainly carried out in the form of freehand sketches and two-dimensional in-depth design in AutoCAD or Rhino. The advantage of this method lies in the directness of drawing, while the disadvantage lies in the fact that the whole working process is always oriented to design results, rather than to the design process。 The separation between the case design and the current situation analysis in the early stage and the scheme analysis in the later stage. In addition, the later work of this method (analysis chart making, index statistics, etc.) is rather time-consuming and laborious, and the scheme has to be redone once it is adjusted, resulting in excessive time and energy spent by the designer.

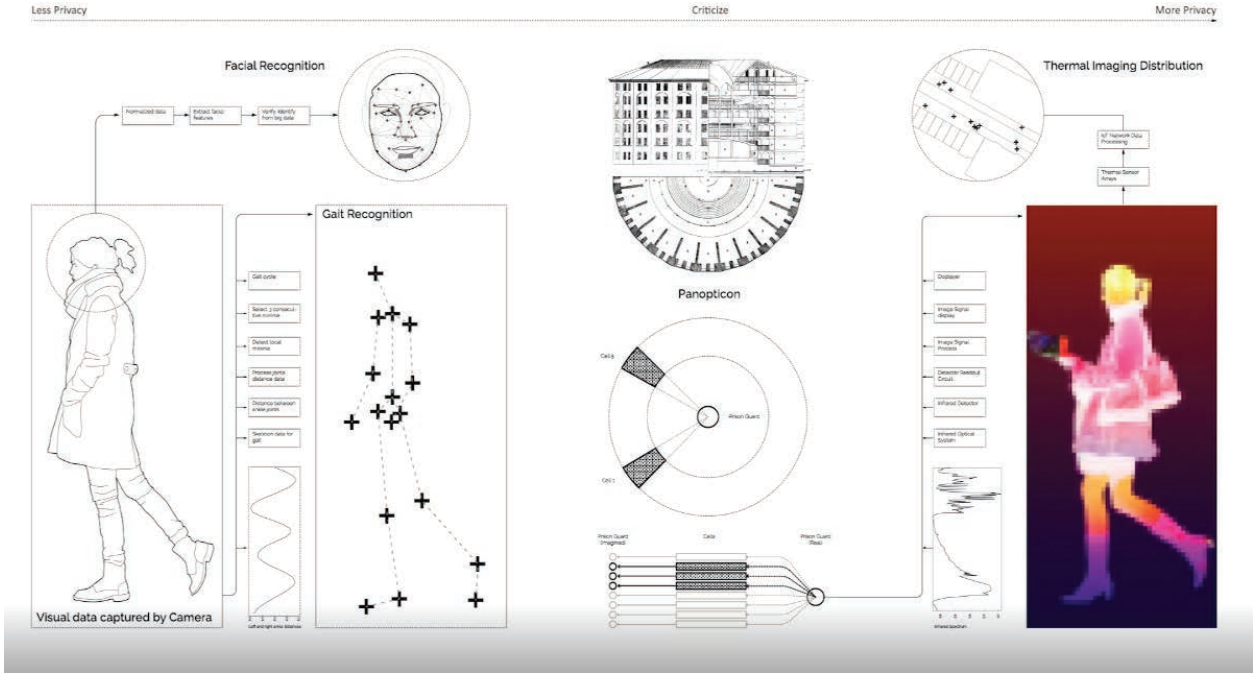
In this stage, the GIS-based urban design method USES the geographical design tool to carry out the sketch design directly on the current situation analysis map, so as to truly combine the design and analysis. In the work of program deepening and multi-program comparison, by virtue of the advantages of ArcGIS parametric modeling, for each adjustment, the results of its indicator statistics and thematic analysis can be semi-automatically refreshed, so as to dynamically and real-time feedback to the scheme design, and achieve a high degree of integration between the scheme design and the scheme analysis.

The first project I worked on in the summer 2019 semester in Architecture+Urbanism studio led by Biayna Bogosian. In this project, we aimed to design a street thermal lighting device which helps increase the sense of safety on the street in New York at night. By using GIS data to analyze the crime rate and residential typology distribution, the street lighting would change brightness, color based on the thermal energy on the street. Creates an indication of being company and protected.



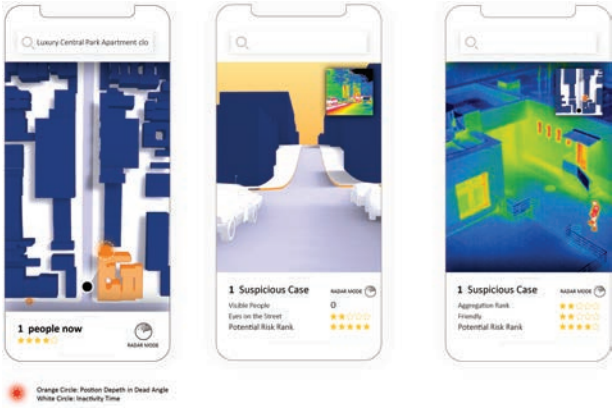


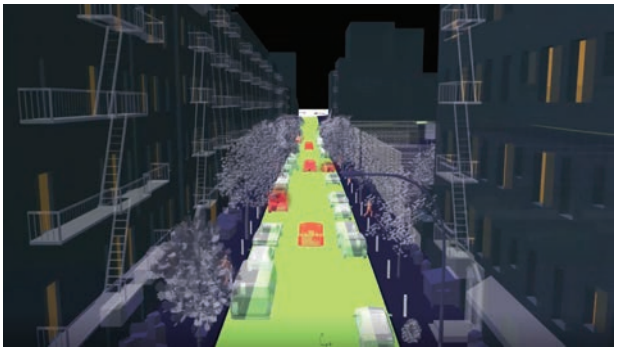


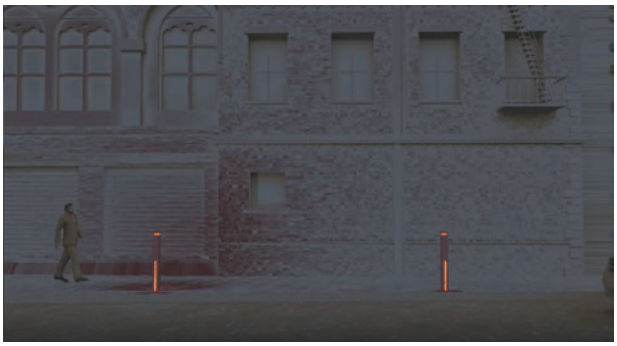


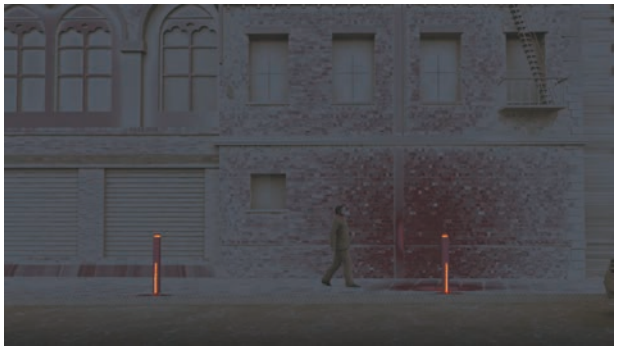
With the initial analysis on transit, crime and airbnb distribution map, we picked our site in east Harlem because the density of transportation, density of residential apartments and crime rate are high enough to give a more obvious feedback. Then the installation with thermal imaging, infrared sensor will be distributed on the street. When a pedestrian passes by the device, their thermal energy will cause the light to change, which gives a feeling that this light is a company and also alerts people at afar that someone is nearby. These lights are also serving as a smart grid that records accident locations as people can have access to the system like parking meters on their smartphones to acquire city information. While people access into the system, they are also feeding data back to the map that improves the accuracy of the mapping system.

The thermal energy generated by pedestrian traffic flow feeds data into the system, then the GIS system uses these data to guide traffic flow. The technical image does not only exist on every cellphone screen, the entire block, neighborhood and city is a map of technical image. It is a way to record and document how the life pattern of modern city is shaped and formed with GIS data. How history is being written.









Our history is not possible without writing, because writing transforms scenes into processes, it generates historical consciousness. However, the history before technical image is a linear understanding of time. Technically produced images, drawings encourage a nonlinear form of composition and reading. An experience of all-at-oneness. In these images we get information first and then try to decompose them instead of the other way around. The mechanic weaving, Virtual reality and GIS data is all about designing the progress and experience, not a destination. And that is where I believe the thinking of architecture is heading towards. From concrete to abstraction. In the book *Into the Universe of Technical Images*, the author Flusser defines, If we look back on the history of human civilization, there five stages of transition. 1) Primitive people immerse in an animate world, using their concrete experience to document the nature. And this is a 4D experience with no hierarchy. 2) They began to distinguish subjects and object with grasping and shaping, stone blades and carved figures represent a 3D world. 3) Homo sapiens started to imagine, creating 2 dimensional mediation zone between itself and its environment. This level of observation and imagining is represented by traditional pictures like cave paintings. 4) 4000 years ago, linear texts, introduced between human beings and their images. Where humans can owe most of their insights, is a historical level, Homer and the Bible. 5) Texts are inaccessible recently, they don't permit any further pictorial mediation. They have become unclear. This is the level of calculation and computation, the level of technical images. We are currently at hte last stage where our understanding of architecture comes from concrete to abstract, the primitive shed to computations of concepts. However, at certain point, new understanding of concrete will born from the abstraction. And these robotic, virtual technical images will be the methods for use to generate meaning.

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