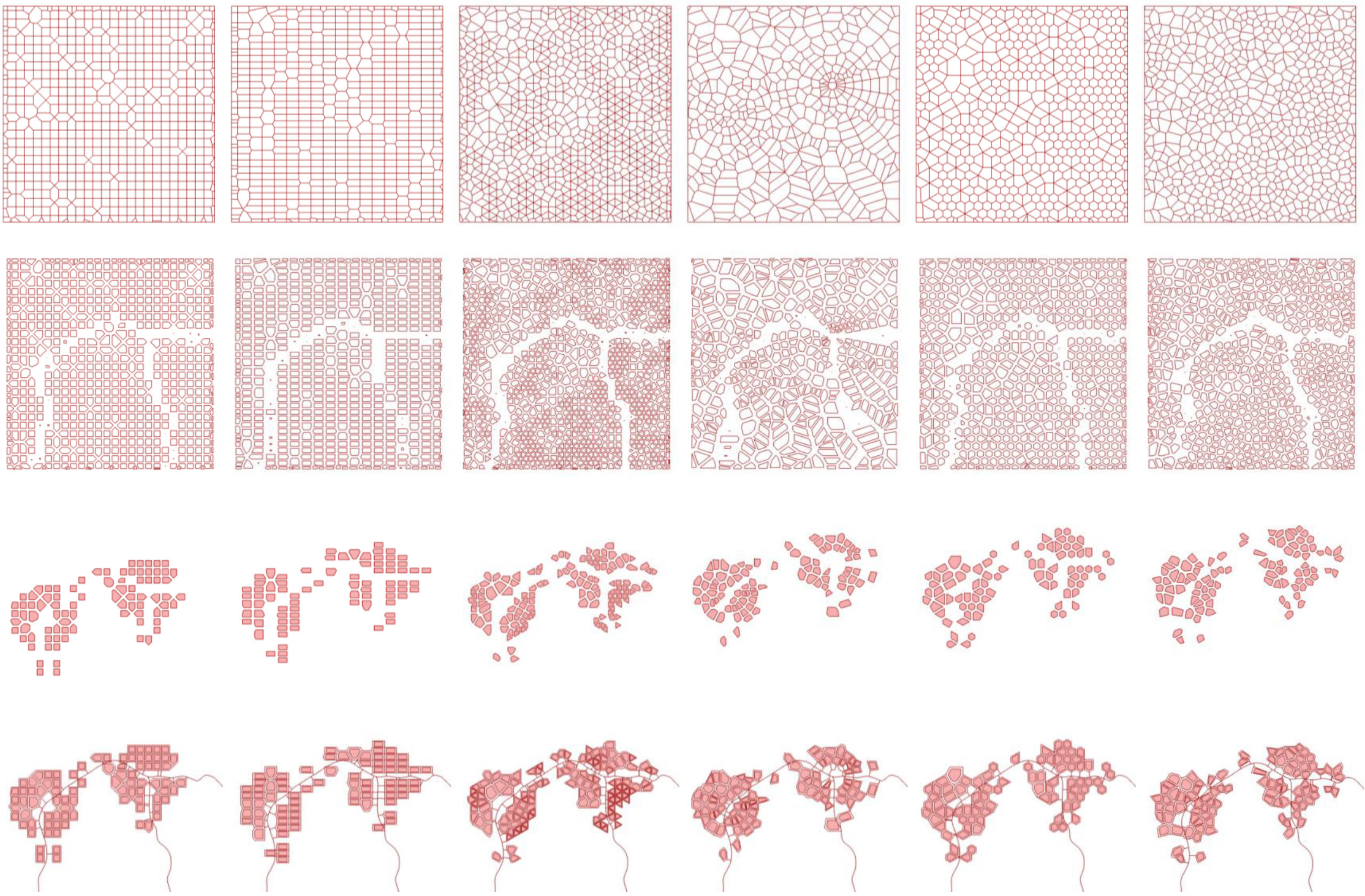
ETH zürich

Documentation of the teaching results from the spring semester 2017

Digital Urban Simulation

Peter Buš, Estefania Tapias, and Gerhard Schmitt



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Institute of Technology in Architecture
Faculty of Architecture / ETH Zurich

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Chair of Information Architecture

Digital Urban Simulation

Documentation of teaching results

Peter Buš, Estefania Tapias, and Gerhard Schmitt

Chair of Information Architecture

Teaching

Peter Buš, Estefania Tapias, and Gerhard Schmitt

Syllabi

http://www.ia.arch.ethz.ch/category/fs2017-digital-urban-simulation/

Seminar

New Methods in Urban Analysis and Simulation

Students

Daniel Rea Kragskov, Jack Kenning, Nicolas Zimmermann, Thomas Wüthrich, Ludovic Regnault, Zhe Dong

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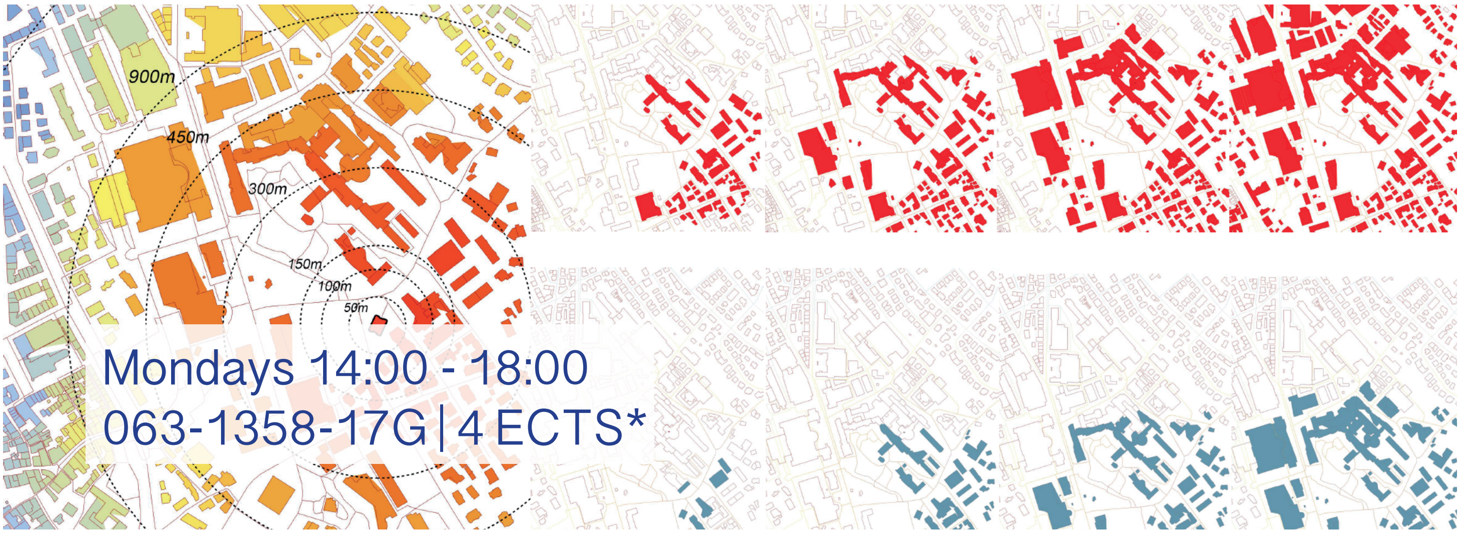
Front side: Laura Cowie, Comparison Grid Patterns

Course Description and Program



Mondays 14:00 - 18:00
063-1358-17G | 4 ECTS*

Digital Urban Simulation

In this course students analyze architectural and urban design using current computational methods. Based on these analyses the effects of planning can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of these corresponding methods in early planning phases.

The students learn how the design and planning of cities can be evidence based by using scientific methods. The teaching unit conveys knowledge in state-of-the-art and emerging spatial analysis and simulation methods and equip students with skills in modern software systems. The course consists of lectures, associated exercises, workshops as well as of one integral project work.

20.02.2017	Introduction into Analysis and Simulation Ex> Tool: Rhino Grasshopper
27.02.2017	Connectivity, Accessibility, Path Detection, Urban Networks. Ex> Tool: Rhino Grasshopper + Cheetah ConfigUrbanist addon
06.03.2017	Visibility: Isovist Analysis, Urban Attractors Ex> Tool: Rhino Grasshopper + SmartSpaceAnalyzer (or DecodingSpaces)
13.03.2017	Guest lecture - Dr. Beatrix Emo
20.03.2017	Seminar Week
27.03.2017	Urban Climate I Ex>Tool: Rhino Grasshopper + LadyBug
03.04.2017	Urban Climate II Ex>Tool: Rhino Grasshopper + LadyBug
10.04.2017	Guest Lecture
08.05.2017	Final consultation
15.05.2017	Project Presentations, Final Critiques

Where
HIT H 31.4 (Video wall)

Supervision
Dr. Peter Bus bus@arch.ethz.ch
Dr. Estefania Tapias tapias@arch.ethz.ch

*Total 120 h = 4 ECTS
5 Exercises: 50% (documentations)
Presentation of final project: 25%
Written documentation of final project: 25%

The most recent outline will be found on www.ia.arch.ethz.ch

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Chair for Information Architecture

Content

The Sun as a Design Tool

Student: Daniel Rea Kragskov

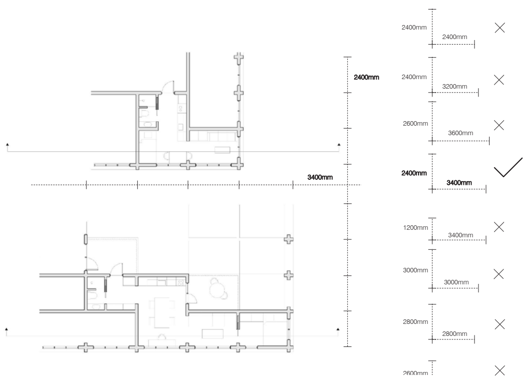
Summary:

Throughout this paper, I will use the Solar Envelope tool first envisioned by Ralph L. Knowles to investigate the potential of creating a design tool that will lend us informed knowledge with a specific urban area in mind about the sun and its shadow footprint. The Solar Envelope tool has been further developed by Carlo Ratti and Eugenio Morello into Iso-Solar-Surfaces. In the Grasshopper plugin for Rhino, a component allows me to use the Iso-Solar-Surfaces on custom geometry. The results of the investigation is a redesign of a previous project taking shadow footprint into consideration. The outcome is a structure that fulfils the criteria set forth in terms of shadow footprint and surface area. The aesthetic outcome is not sufficient though and as such, the tool should only be seen as a guide for the build volume and not a design in itself.

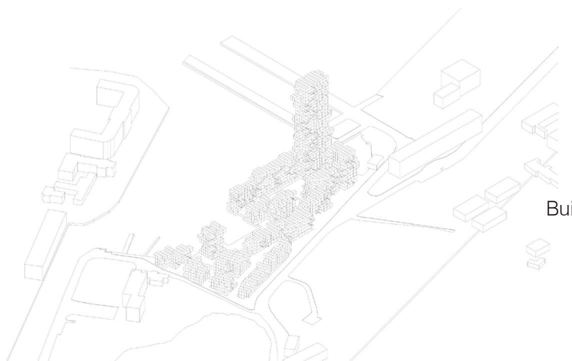
Location: The site for the investigation is situated on Refshaleøen in Copenhagen, Denmark.

Previous Project:

The previous project seeks to place a lot of apartments in a new part of Copenhagen to counter the housing shortage for people with low income. Therefore, the project uses a module as the building block to keep costs down. The typology is a mix between rowhouses, apartment buildings, and a skyscraper with shared space outside and inside.



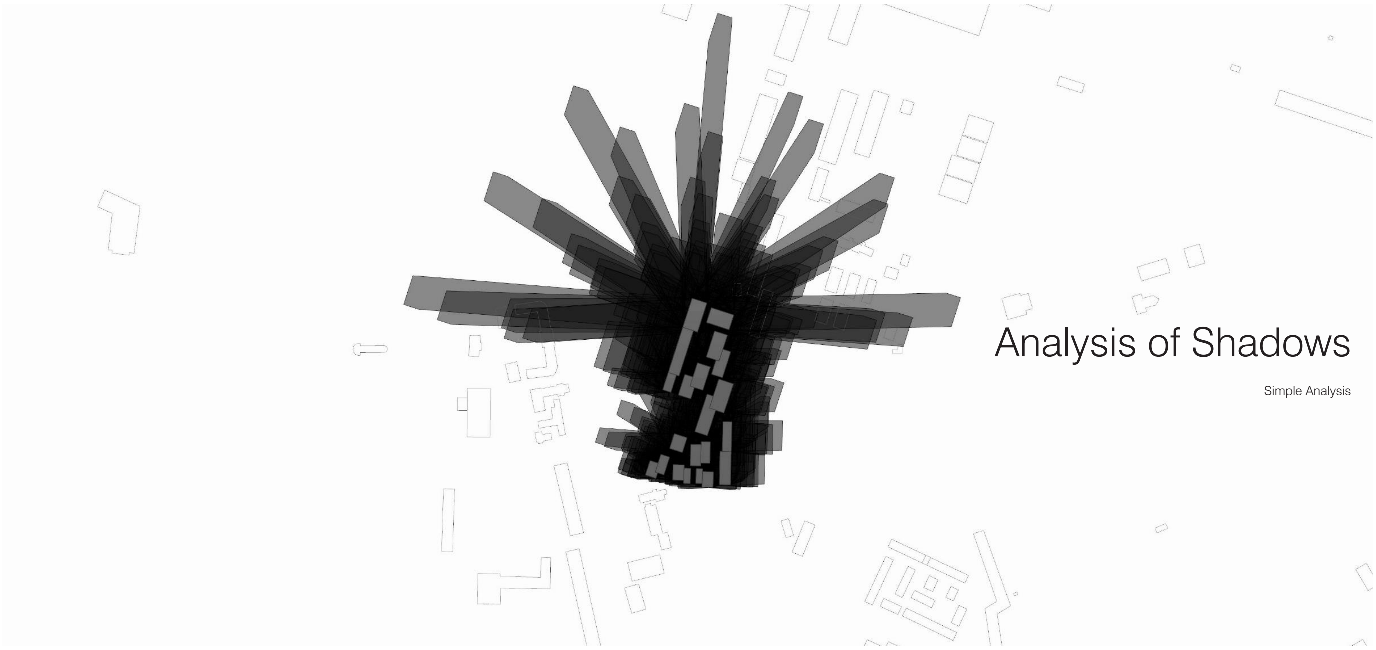
The Grid
Previous Project



Building Volume
Previous Project

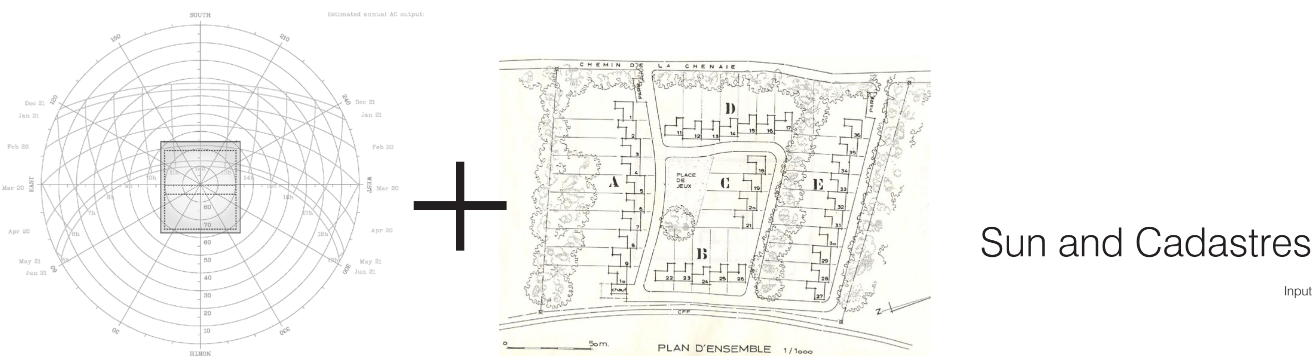
Shadow Footprint:

The footprint of the shadows from the building area is quite large as the project was developed without a thorough study of the shadow impact. The result is as follows:

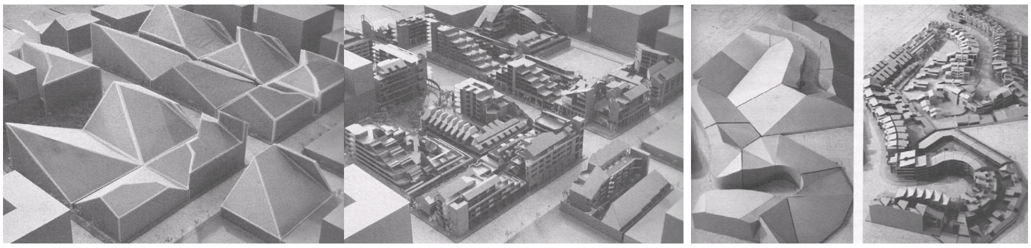


Solar Envelope Tool:

Ralph L. Knowles developed a tool to create a physical shape from knowledge of sun direction and the cadastres in an urban environment. The result was an urban planning tool that could be used, for instance, in American suburbs due to their regular patterns and therefore easy doable shapes.



Ralph L. Knowles describes his tool in this quote: "The solar envelope is a construct of space and time: the physical boundaries of surrounding properties and the period of their assured access to sunshine. The way these measures are set decides the envelope's final size and shape." (Ralph L. Knowles 2000, The Solar Envelope - Its meaning for urban growth and form, page 2)



Urban Context

Use

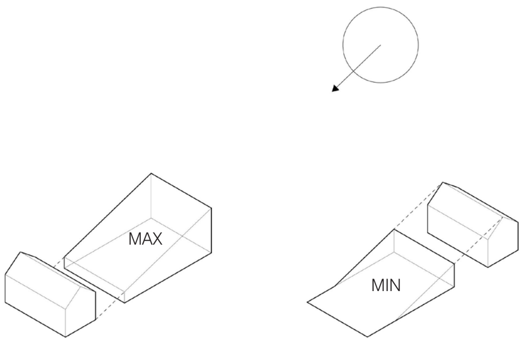
A problem with this method is that it becomes increasingly diffucult to calculate the shape if you would like to consider more sun angles and more complex patterns of cadastres. Therefore, Carlo Ratti and Eugenio Morello developed a computation method utilizing Iso-Solar-Surfaces to create the Solar Envelope for more complex situations.

Solar Rights and Solar Collection

There are two types of Solar Envelopes - Solar Rights Envelope and Solar Collection Envelope. The Solar Rights Envelope creates the envelope for which the building cannot extend if it is to allow a certain amount of sunlight to its neighbouring cadastres. The Solar Collection Envelope creates the envelope for which a specific cadastre is ensured to have sunlight within the criteria.

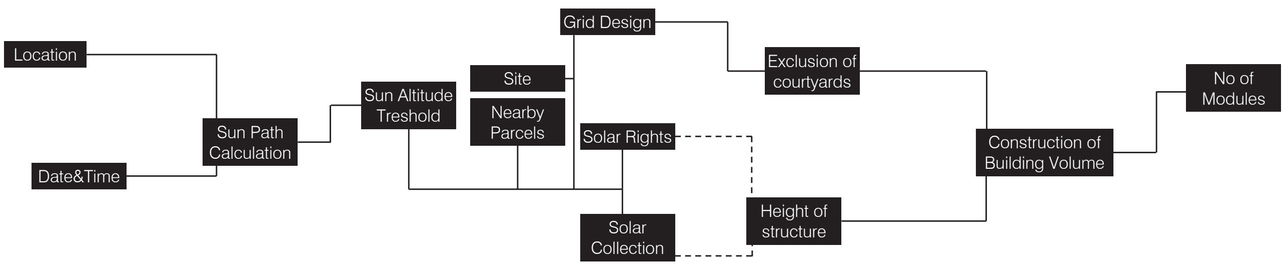
Grasshopper Definitions

The finished tool is developed in Grasshopper using the Solar Envelope Component. It takes in weather and location data as well as objects of the built environment. It then calculates the Solar Envelopes and translates this into a volume following the rules of the initial project of modulization, division of public space, and paths.



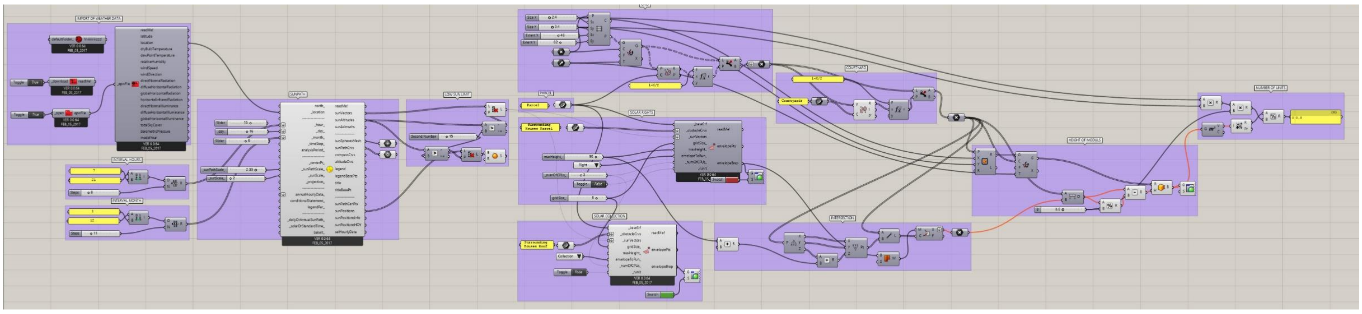
Solar Rights and Solar Collection

Output



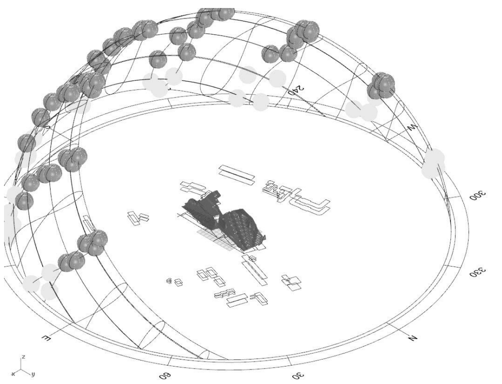
An Overview

Because Grasshopper can be a bit messy

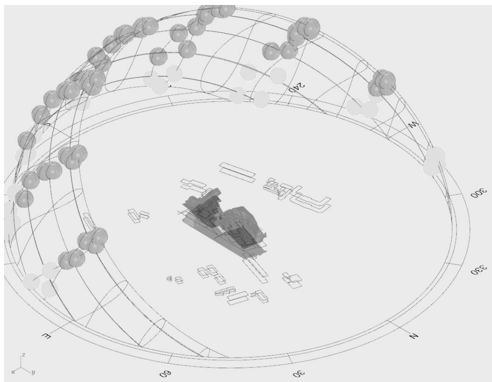


An Overview

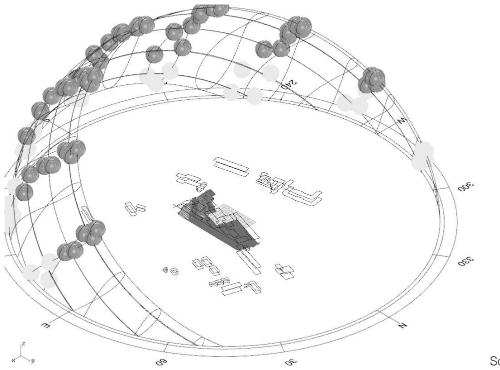
The tool only uses Solar Rights Envelope (though it is capable of doing also the Solar Collection Envelope), but for this project the task was to consider shadow footprint of the building itself.



Solar Rights



Combined



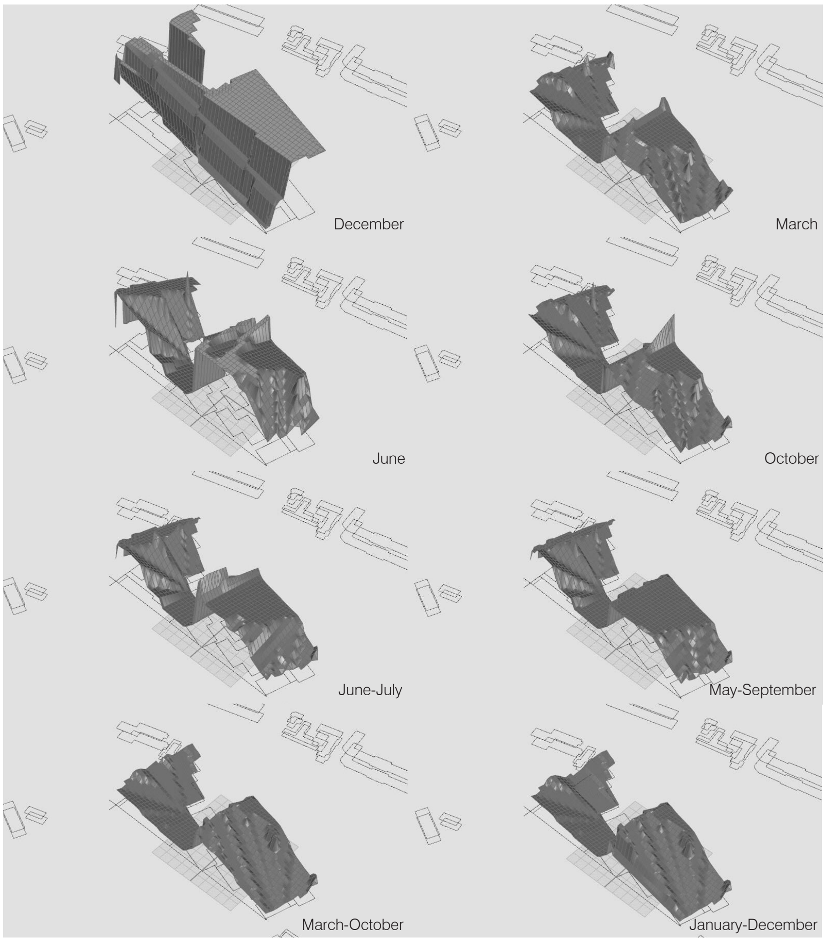
Solar Collection

Solar Rights or Solar Collection?

Design Decisions

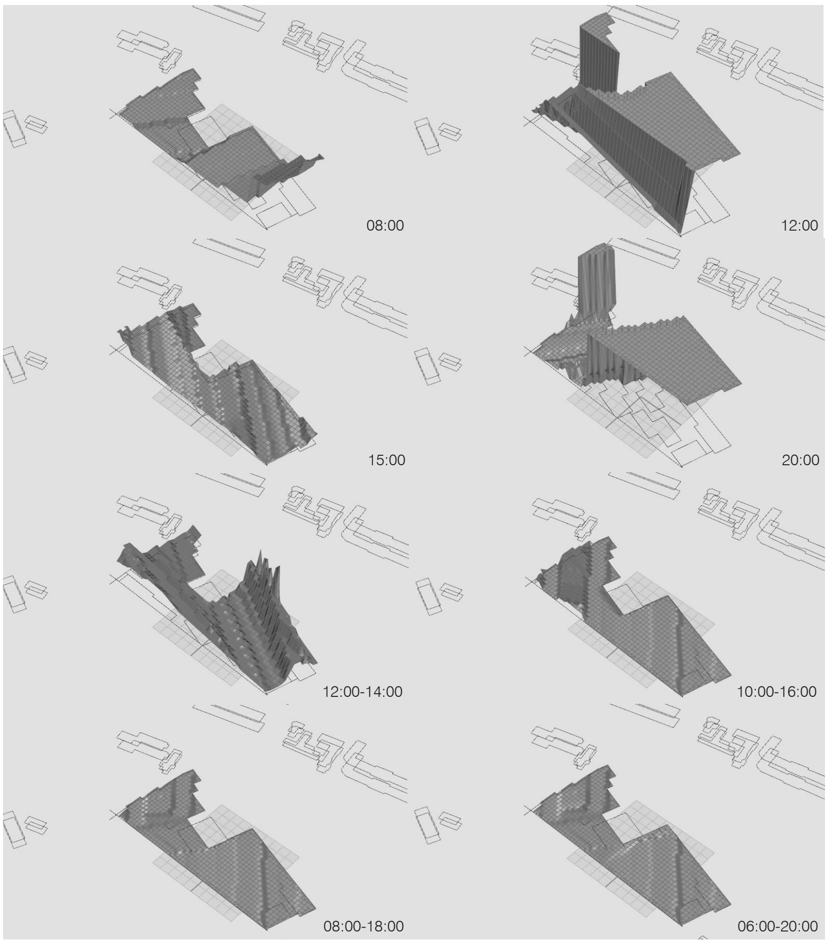
Results

Using different input data will drastically change the results of the tool. We can change the span of months and hours to consider as well as the lower limit of the altitude of the sun. The results can be seen on the following pages.



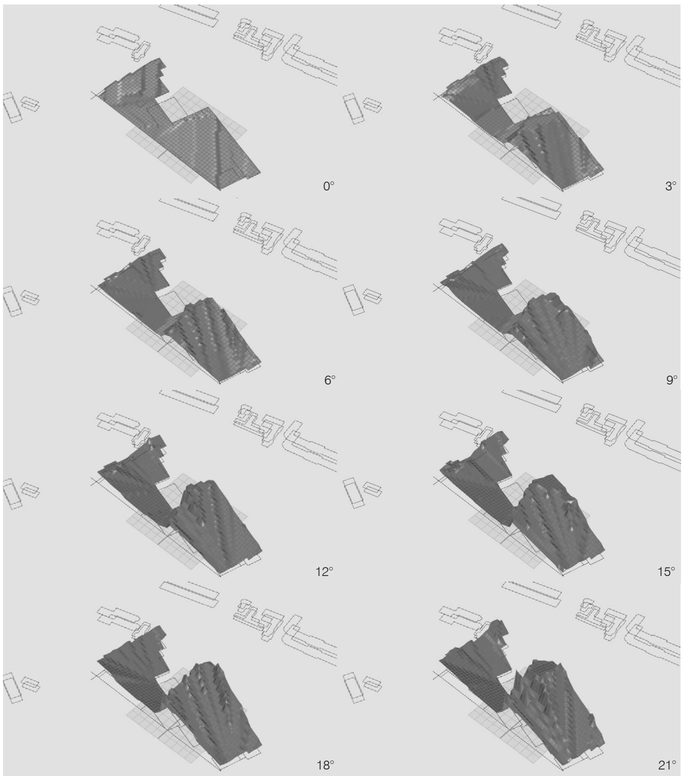
What months?

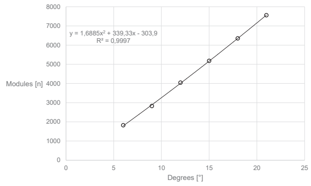
Design Decisions

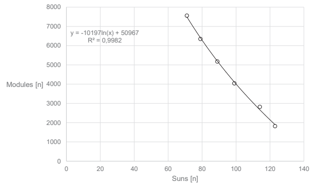


What hours?

Design Decisions







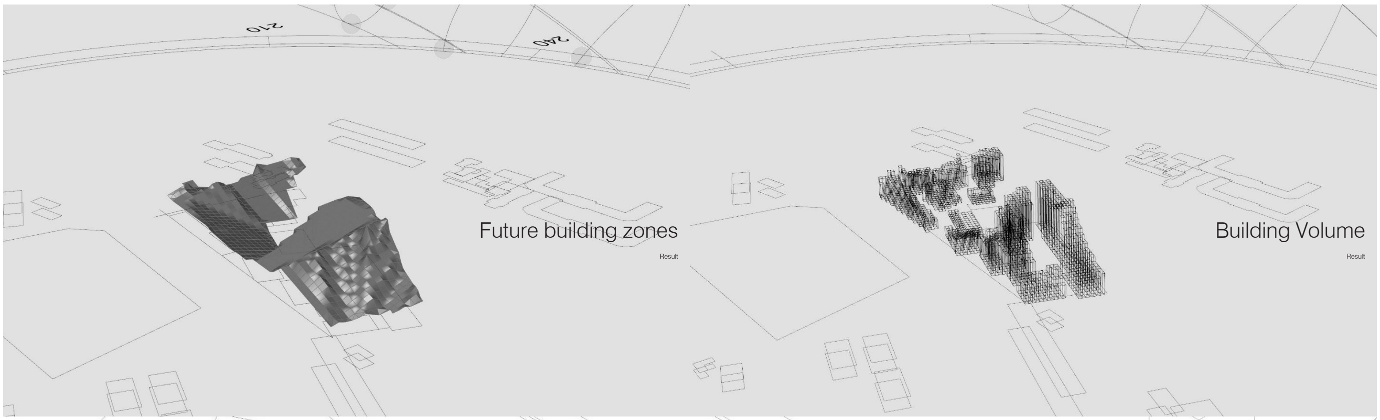
What sun altitude?

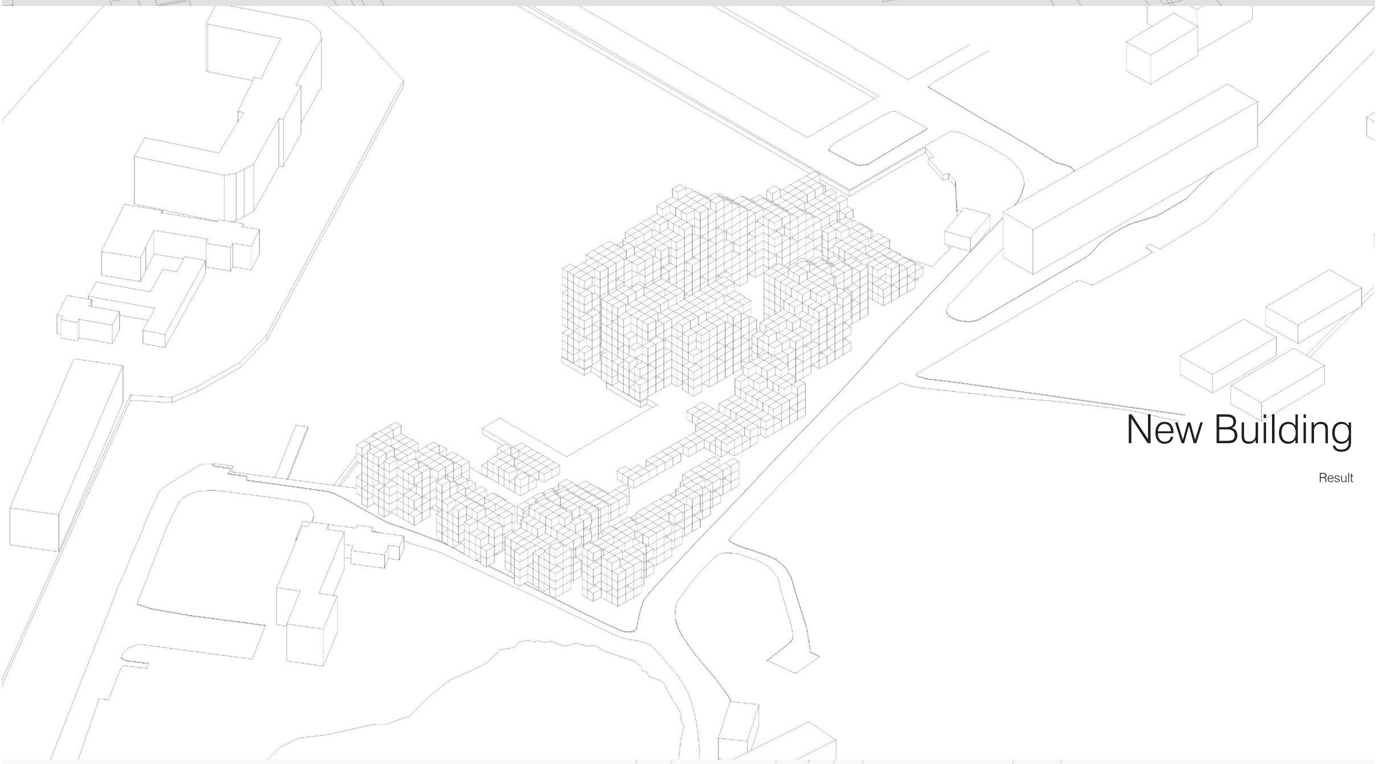
Design Decisions

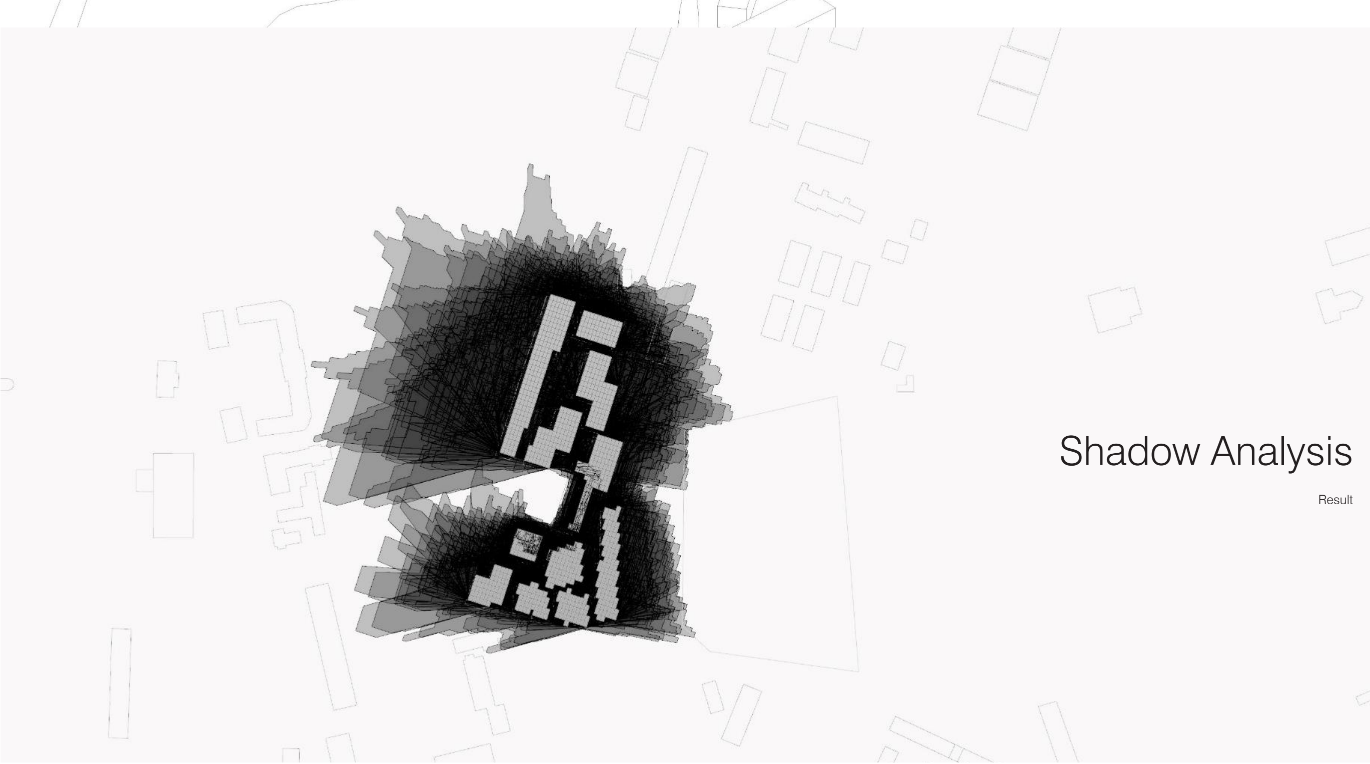
Generally, it is best to consider all of the hours of the day and all months of the year. This would lead to a problem though - the sun will always cast infinitely long shadows from the buildings just before sunset or just after sunrise. This will lead to an envelope so small that nothing can be build. Therefore, I have introduced a sun altitude limit that will exclude sun directions below a certain angle. In that way, we optimize the build volume versus the shadow footprint. The first graph show a plot of the relation between sun altitude limit angle and number of modules. We see that the tendency shows that lower angle equals lower amount of modules. The other graph shows the relation between number of sun calculations (which should reflect number of sun hours) and number of modules. The result shows that you get slightly better tradeoff between sun hours and build volume, the higher the angle. The graph is an inverted logarithmic graph which makes sense as the build volume would be infinite if no sun hours were considered. The tradeoff is therefore a design decision.

Translation to a New Project

Taking into consideration a new development zone just next to the project site, we can create our final design and carve out modules in the structure to get an airy feeling comparable to the initial project. On the next page you see the Solar Rights Envelope, the translation into a build structure, and the translation into a new project. Furthermore, a shadow analysis shows the impact of the shadows for the new project.


Future building zones
Result
Building Volume
Result


New Building
Result


Shadow Analysis
Result

Comparison

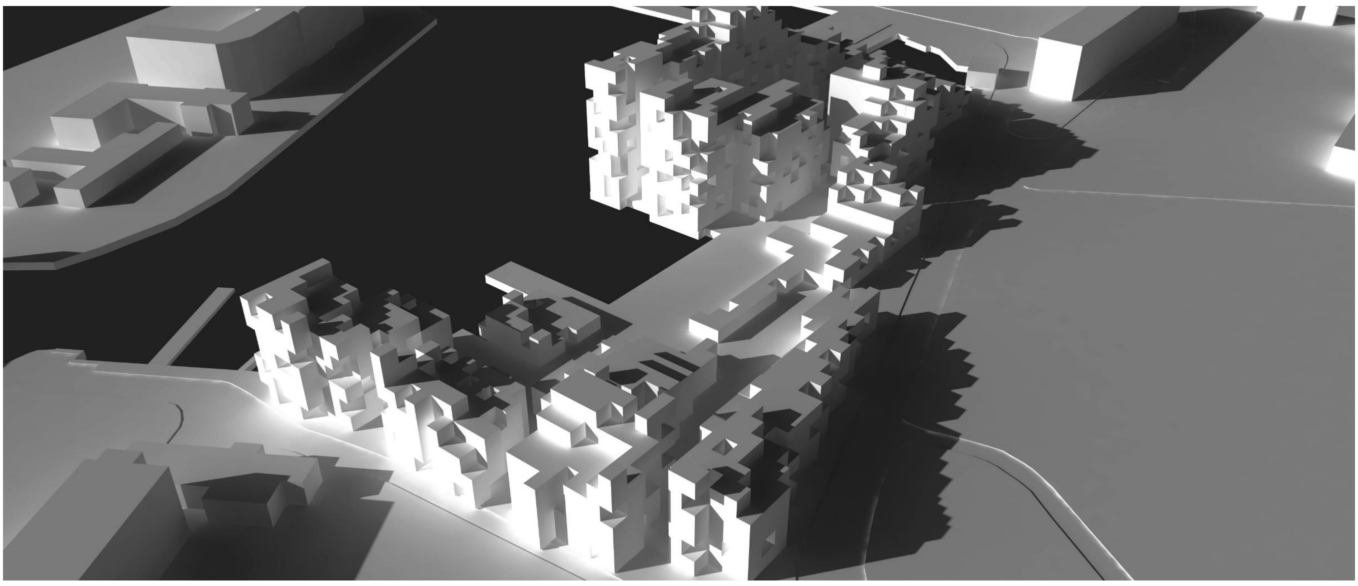
We can compare the new and the old project on certain paramters as seen below:

We see that the new project fulfils its goal of keeping its shadow impact to a minimal while still almost retaining the same volume as the previous project. The aesthetic qualities are not as powerful though, which might be something you would have to work with. This might lead to either a smaller volume or less strict shadowing restrictions.

Conclusion

From this investigation conclude:

- A design tool can be developed for the purpose of designing with sun rights in mind
- It succeeds in lowering shadow impact on neighboring buildings
- Design decisions needs to be taken to ensure a good relation between sun rights for neighbors and building volume
- Zoning of public spaces and/or future build areas can be part of the sun rights strategy
- Using sun altitude as the determining factor is an easy and reliable tool to decide between volume and sun
- The final building envelope should not be used as the final design but as a template for the building



Sources

Ralph L. Knowles:
The solar envelope - Its meaning for urban growth and form (2000)

Ralph L. Knowles:
The solar envelope - Its meaning for energy and buildings (2003)

Carlo Ratti, Eugenio Morello:
SunScapes: extending the ‘solar envelopes’ concept through ‘iso-solar surfaces’ (2005)

Shading our Cities: A parametric approach

Student: Jack Kenning

Figure 1: A proximity analysis based on the "closeness" to a selected site

Motivation

During the Digital Urban Simulation course, the main focus was placed on certain tools in the Rhino Grasshopper parametric environment in order to better understand the urban setting that we live and work in. From the different types of representation as you can see below, we based this analysis on the built environment, dominated by a street network and individual building masses. From these initial discoveries I soon realized that the role played by trees in an urban environment was being largely underestimated and I soon wanted to look into a better integration of them in the process.

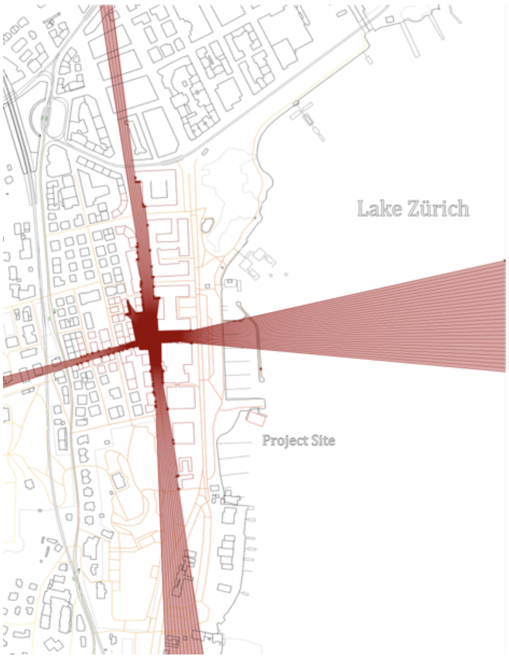


Figure 2: Isovist Representation

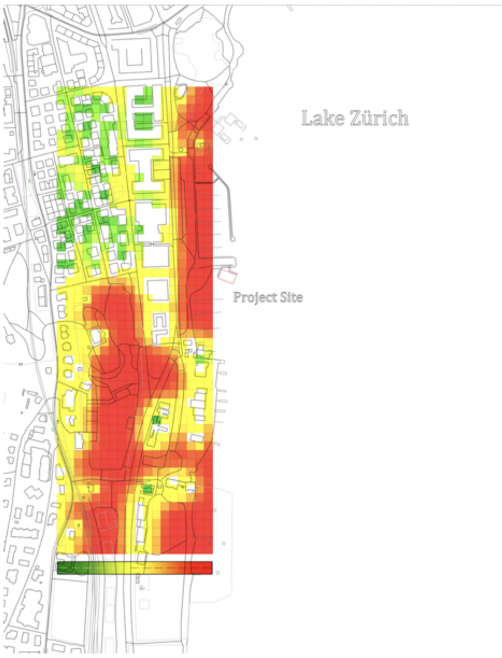
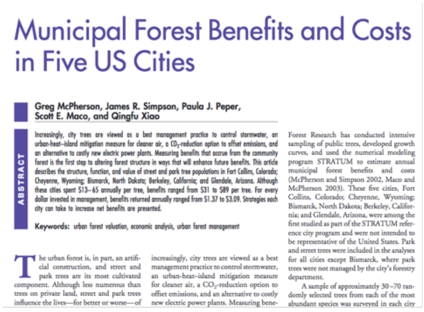


Figure 3: Isovist Area Field Representation

Two major studies have already been done in relation to the benefits of trees in urban environments and the specific case of shading and these provided a base point for my project:



Municipal Forest Benefits and Costs in Five US Cities

Greg McPherson, James R. Simpson, Paula J. Peper, Scott E. Maco, and Qingfu Xiao

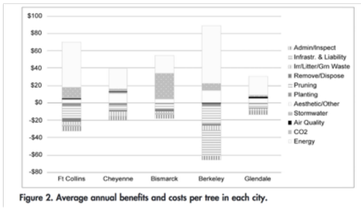
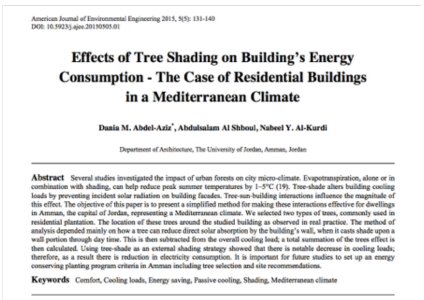


Figure 2. Average annual benefits and costs per tree in each city.



Effects of Tree Shading on Building's Energy Consumption - The Case of Residential Buildings in a Mediterranean Climate

Dania M. Abdel-Aziz, Abdulsalam Al Shboul, Nabeel Y. Al-Kurdi

Hypothesis & Research Questions

The project takes for granted that: “Shade trees on the south side of buildings lower summer-time electricity use by reducing the need for air conditioning.” This makes them a powerful tool in urban planning. The questions that we raise are:

- How can we accurately model first the trees, then the tree shadows?
- From there, can we predict the amount of energy saved by planting a tree?
- For a given urban area, can we easily identify the places where a tree would be of most benefit?

Approach & Methods

The method consisted of first learning about the different tools available, sourcing the correct data and then building and testing a model that would accomplish the task. The data collection was assisted by the City of Zürich's Open Database, which provides the positions of individual trees over the whole city, totaling around 50 000 trees.

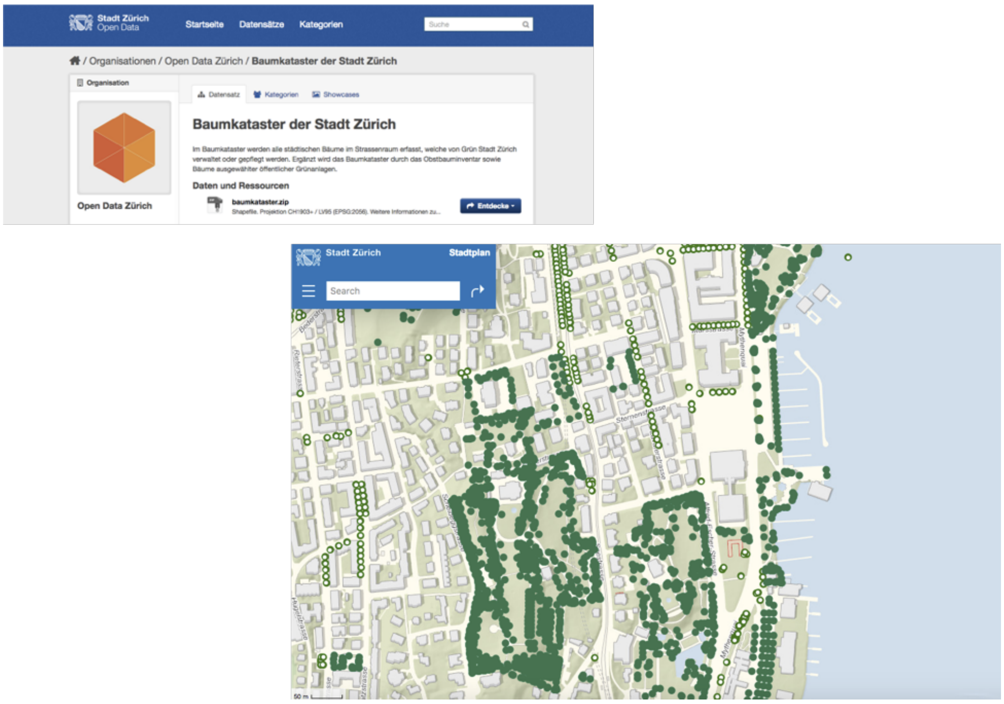


Figure 4: Zürich City Tree database

From the source, it was necessary to extract the raw data and integrate that into a Rhino 3D model that would be the base for the study. A simple grasshopper construct makes it possible to read the data file and to produce a representation of each point on top of a city map.

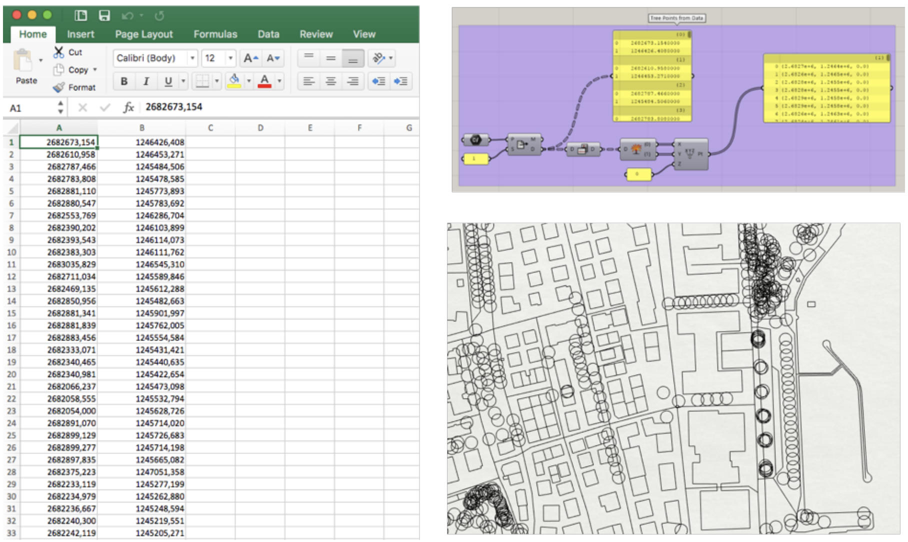
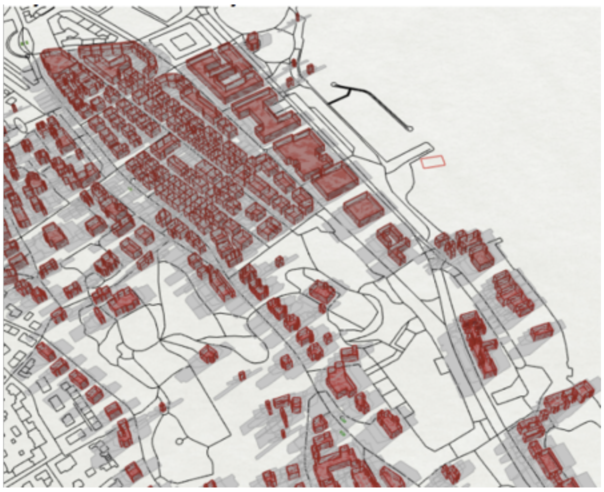


Figure 5: Tree modelling

The initial output was twofold: on the one hand the urban tree model and on the other the shadow analysis for the buildings around the chosen site.



In order to answer the research questions these methods had to be combined. In the end, the decision was to focus on a small urban area and make a method which could be generalized to any future research site. The initial construct was a simple urban arrangement over which a tree was constructed depending on certain parameters. This consideration was based on the fact that the data source also contained for many trees the tree-type and the age of the tree, which would be easy to integrate in a further project.

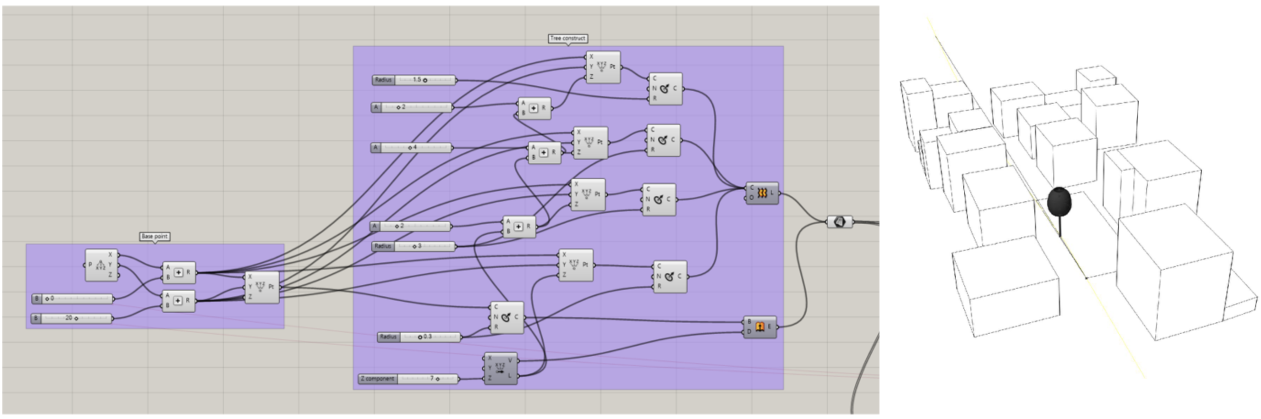


Figure 7: Parametric urban tree model

This initial parametric model made it possible to move the tree around the specified area depending on restrained coordinates. This was important in order to have sliders that the optimization component could work with.

Results & Discussion

The first visualizations show the different measurements. By calculating the radiation on each facade during the simulation, we can easily see the affect that the presence of a tree has when close to the buildings. The drop in this value when the coordinates are changed give the efficiency of the tree's presence.

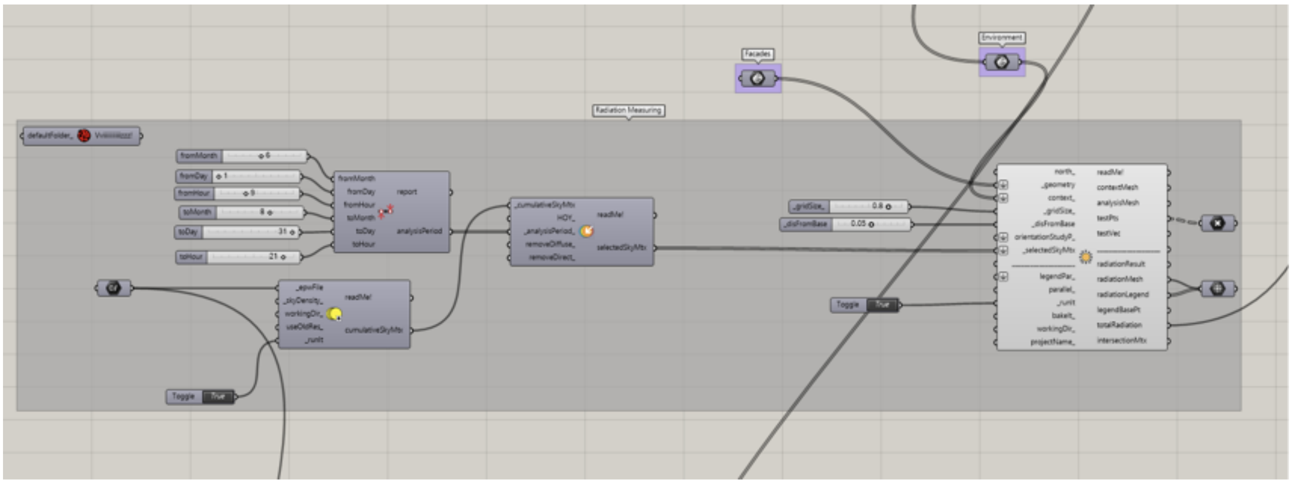


Figure 8: Radiation measurement

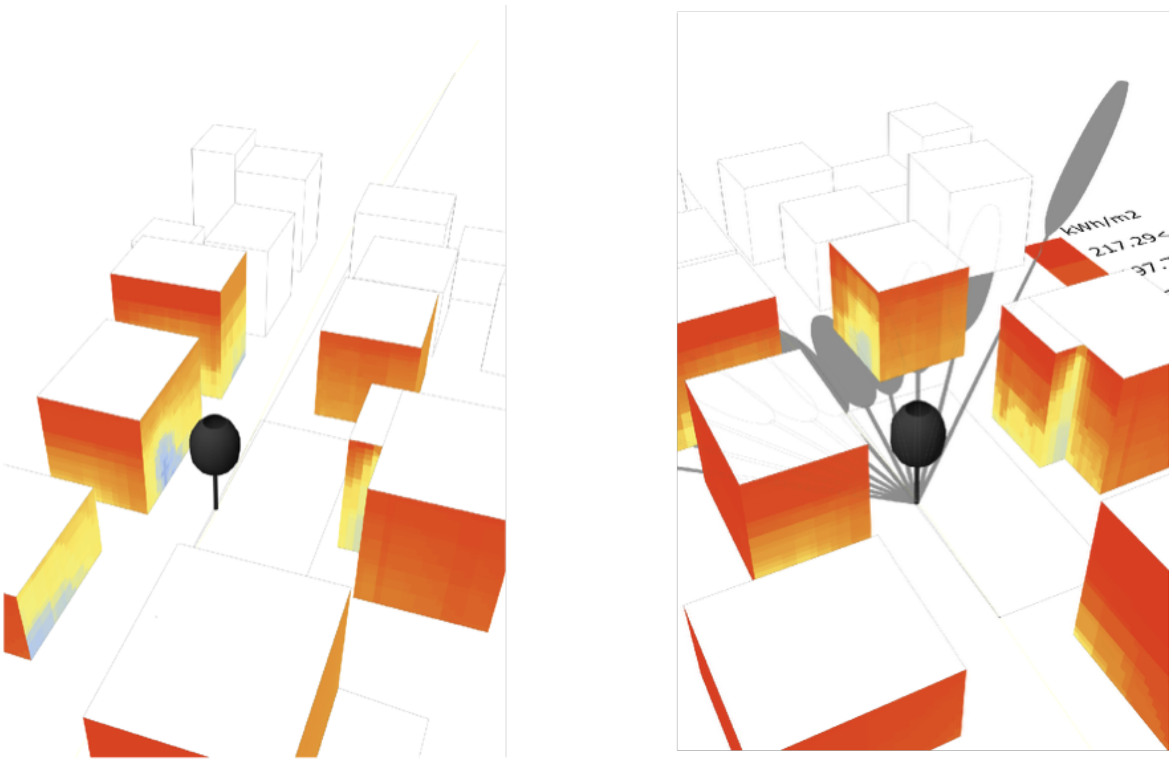


Figure 9: Visual output from radiation measuring and shadow casting

The next stage was to identify where the tree would be of most benefit. The Grasshopper integrated optimizer uses a gene-trained fitness algorithm to maximize a certain input value. Therefore, here we would like to minimize the radiation on facades for the summer months while modifying the coordinates of the tree itself.

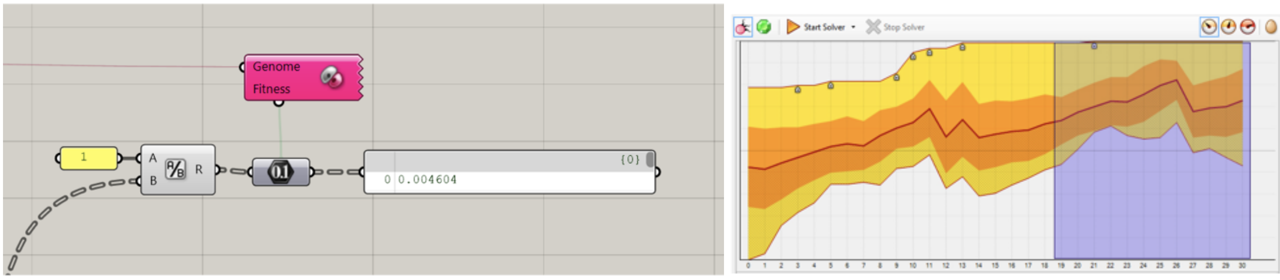


Figure 10: The optimization process for finding the best position

The process runs unassisted until finding the best position for the tree, this being applicable on a larger scale, for more trees or on a neighbourhood scale.

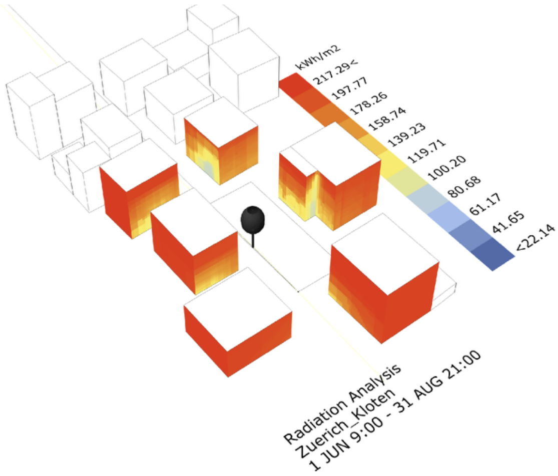


Figure 11: Optimized result for best-shade positioning

Conclusions

When going back to the initial research questions, we can gain some sense of how this tool can be used in other urban projects and on different scales. We can accurately model first the trees, then the tree shadows depending on type and age of tree and different possible modelling techniques. From there, we can predict the amount of energy saved by planting a tree as a direct output of the radiation levels measured on the facade and for a given urban area, we can easily identify the places where a tree would be of most benefit using the galapagos component. To develop the project at a later stage we can imagine further reduction of urban heat islands through evapotranspiration or on a city-scale, municipalities may soon be using a tool to measure the benefits and efficiency of every tree in order to invest where necessary.

References

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Maco, S.E.; Xiao, Q. 2005. Municipal forest benefits and costs in five U.S. cities. Journal of Forestry. 103(8): 411-416.

Open Data Zürich [https://data.stadt-zuerich.ch]

Shading and Solar Irradiation on a Cylindical Building

Student: Nicolas Zimmerman

1. Summary:

The analysis was done on a free standing cylindrical tower, the Schlotterbeck Areal apartment tower, which is being erected on Badenerstrasse close to Albisriederplatz. As a thought experiment the apartment tower was converted into an office tower, which requires a comfortable day climate. This means that the offices should not overheat and the sun should not shine directly into the the computer screens. Due to the cylindrical shape of the building, the idea fell on a system which could track the sun around the tower hit most stongly by direct sunlight in order to best shade the most intensively hit areas of the facade. These areas are also the most atractive for a pv facade system. This made it a given to combine the shading device with a PV facade. Two such systems where tested and compared on how much radiation they can catch over a summer design day (21.07) and a winter design day (21.12). The first system is a trasparent thin film screen moving around the tower, it is being referred to as *Thin Film Facade* (TFF). The second system is an array of A*dabtive Solar Facade* (ASF) panels, which is also following the sun around the building but it can also track the sun verticaly. The ASF is a research project by Prof. Arno Schlüter at the ETH Zurich, it consists out of small thin film PV panels. Which are able to track the sun over three axes. Both facades provide shading and electricity.

Situation Schlotterbeck

Schlotterbeck Areal (Guiliani Höngger)

2. Motivation:

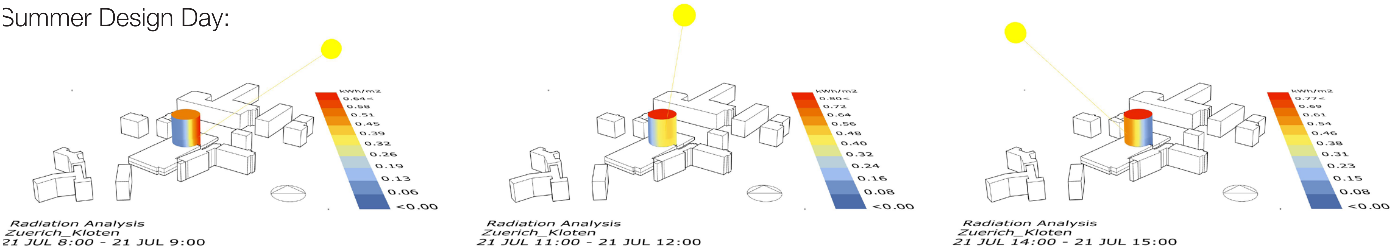
Architecture will face a lot of changes in the future in terms of the handling energy. This is due to the goals of the swiss energy strategy 2050. I see a big possibility in ideas of how to deal with facades. Especially in renovations or stacking up of city building, like is the case here. These are chances to turn protected or old but still viable building structures into well performance buildings. However it means that we have to find clever and appealing solutions in those areas. Like this we can save the embedded gray energy in the old structure and turn the cities into modern energy saving and energy producing habitats. Additionally, I was also interested of what can be done with the rather uncommon building shape of the tower of the Schlotterbeck Areal. What possibilities does a freestanding cylindrical tower bring with it and then how can we deal with two problems of an office tower, shading for comfort and electricity consumption.

This might lead to new practical Ideas for applying the ASF. This investigation, however, naturally comes with many problems: like how does one actually get the electricity from a rotating facade in to the building (basic wiring problems).

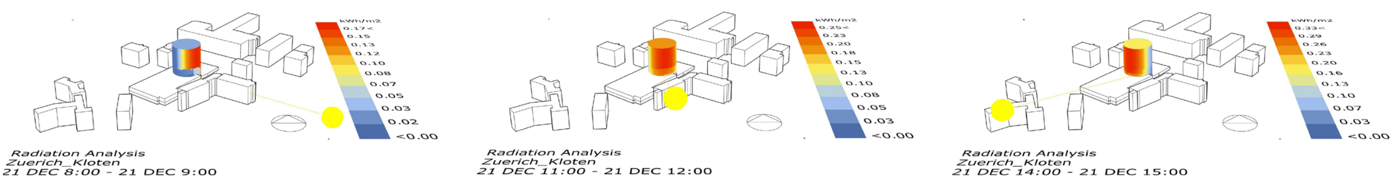
1. Analyses and Interpretation:

The Schlotterbeck Areal Tower was selected as the building of interest because of its cylindrical shape and the fact that it is almost completely free standing. The solar irradiation across the facade of the cylindrical building was simulated. This was done on a summer design day (21.07) and a winter design day (21.12). With the help of the results, the width of the shading device moving around the facade was decided.

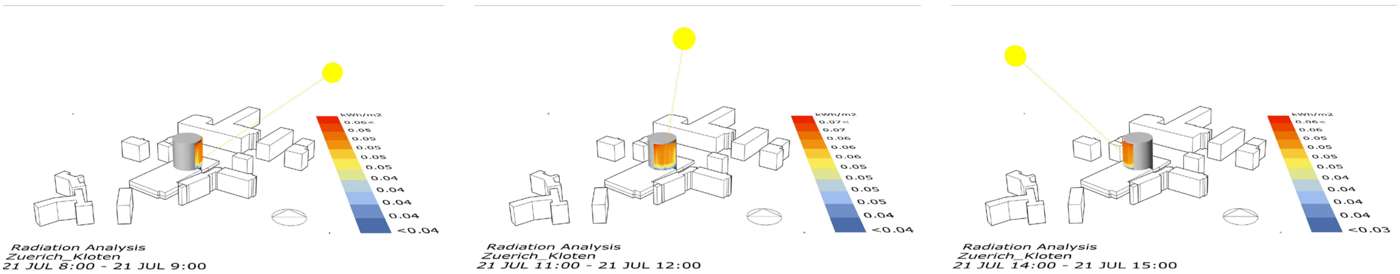
Summer Design Day:



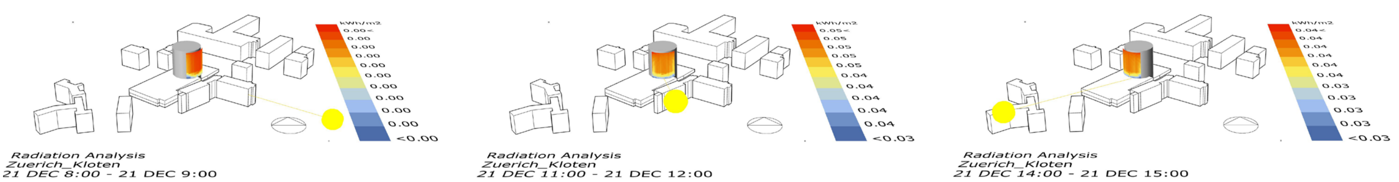
Winter Design Day:



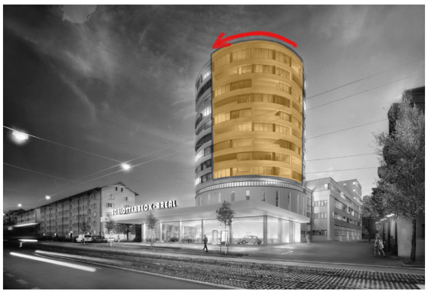
The next step was then testing the two types of systems: the TFF and the ASF. The TFF is a continous screen of verticly orientated thin film PV moving around the building cylinder with the path of the sun. It constantly defuses the sun light of the part of the facade facing the sun. Which also means the the view out of the offices would be constantly blurred. Due to its verticality, the amount of sun rays caught decreases with the solar altitude. But it is a nice big and even surface.



TFF Winter Design Day:



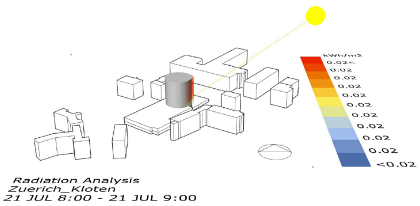
Thin Film PV

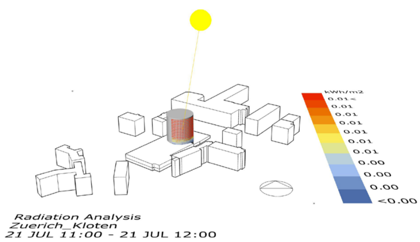


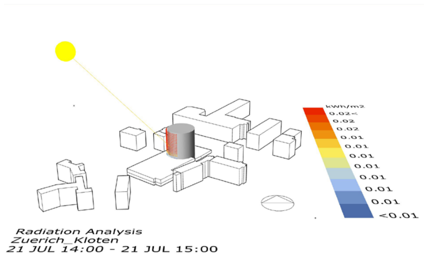
Thin Film Facade (TFF)

The ASF is a an array of adaptive solar facade panels, which can be tiled in all directions and track the sun while also moving around the building cylinder with the path of the sun over the day. The Adaptive Solar Facade is a research project by Arno Schlüter here at the ETH (though his research is not moving around a building). And comes with the advantage that the panals are always oriented perpendicularly to the sun so it can harvest the maximum amout of irradiation. It is also possible to adjust them manually so users of the office could create openings to have an unblocked view outside. Due to the perpendicular orientation to the sun the ASF always harvests the maximum possible solar irradiation. Because it is split up in separate panels, however, it has less surface area then the TFF.

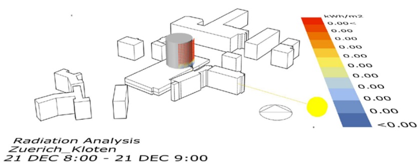
ASF Summer Design Day:

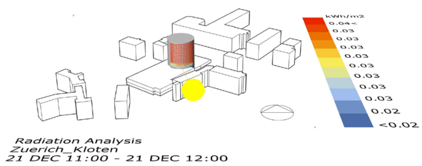


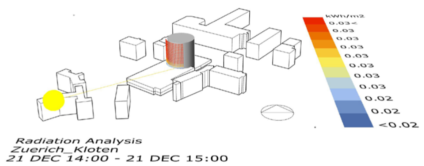


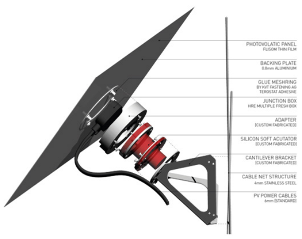


ASF Winter Design Day:

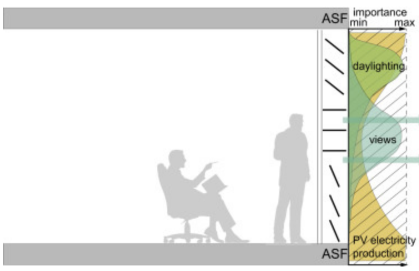




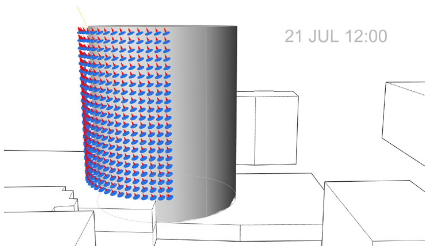




ASF Panel



Opening of ASF

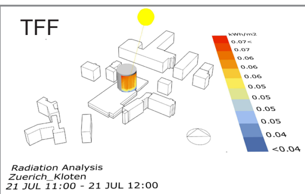
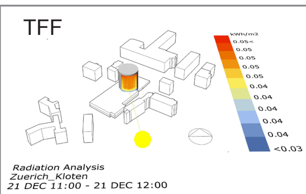
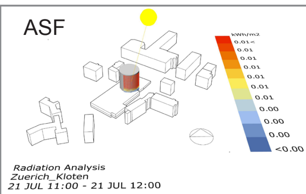
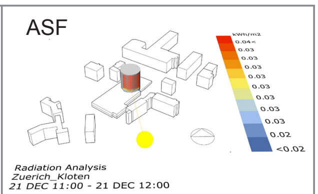


ASF on Cylindrical Building

4. Conclusion:

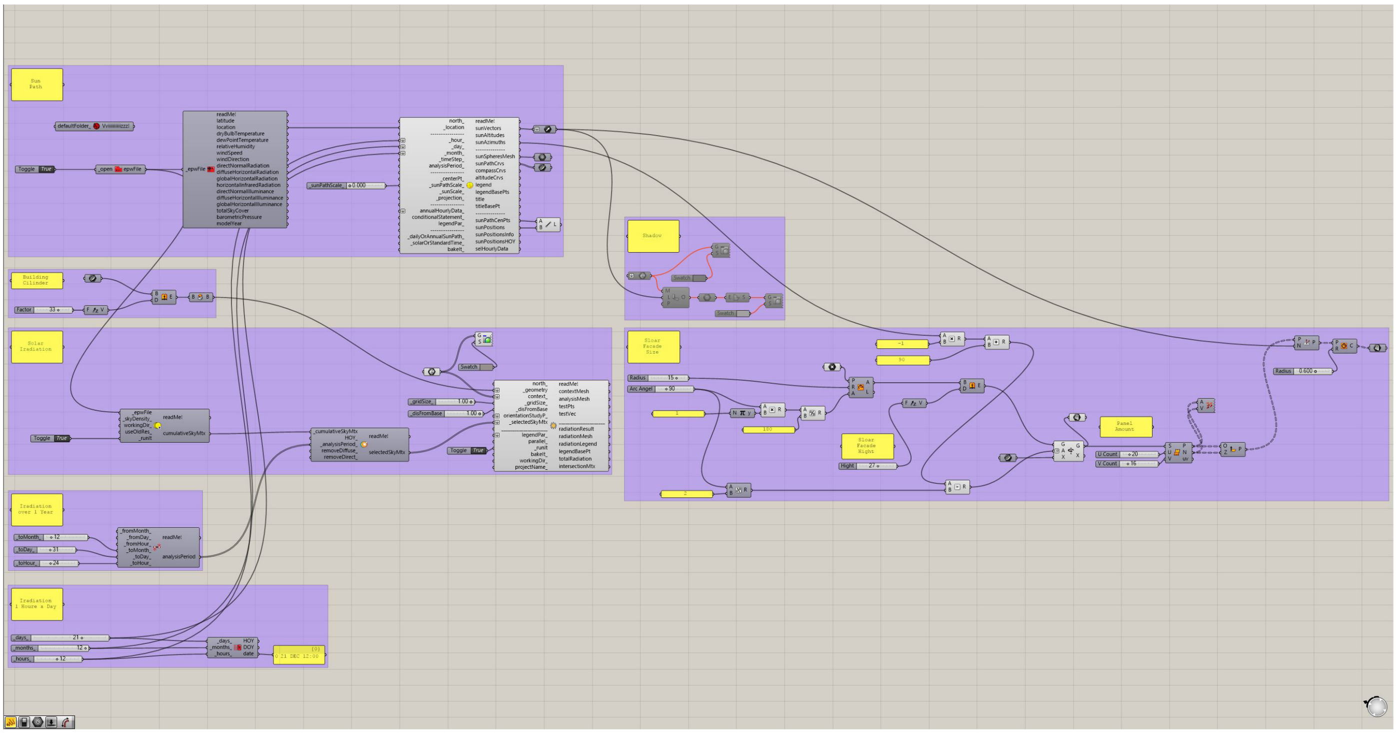
If the TFF and the ASF are compared in terms of the amount of solar irradiation captured. We see that TFF is performing worse on a summer design day (21.07), with 524.36 kWh radiation compared to 684.00kWh for the ASF. This is due to the fact that the sun is rising higher in the summer. The ASF can take advantage of its ability to track the sun vertically while the TFF is only a flat vertical surface, which only tracks the sun around the building cylinder. But over the winter design day (21.12) the TFF is performing better. Capturing 117.10kWh compared to the ASF with only 34.70Wh captured radiation. In this case the TFF has the advantage that it has the bigger surface with 636m2 against 404m2 of the ASF. This is due to the fact that the sun has a lower path in winter, which means it shines more horizontally in to the big surface of the TFF and the additional tracking of the ASF doesn't make up for the smaller surface of it. Additional analysis would have to be done in terms of how the two facades perform over a whole year to actually decide which one would be capturing more solar irradiation. The actual shading effect should also be tested, as well and how much it would reduce the cooling load and thereby enhance the performance of the building. In general this study shows us that there are possibilities to be creative in terms of facade shading.

Comparision:

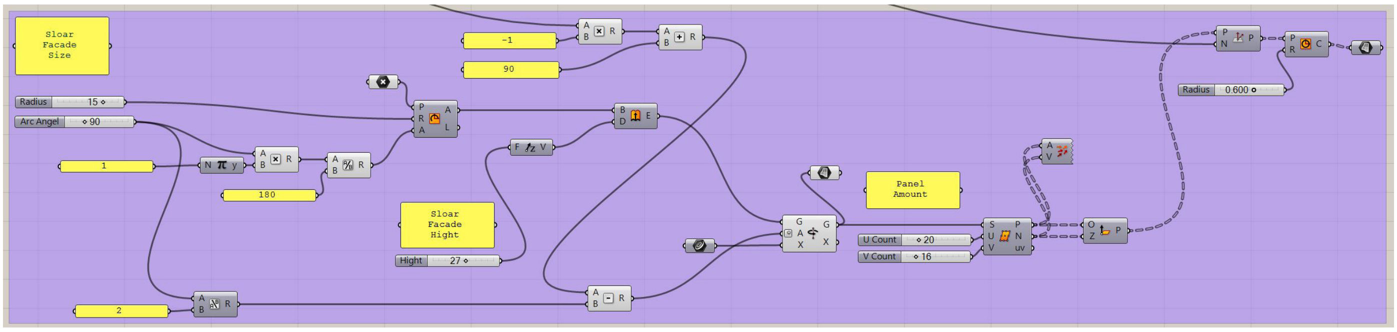
	TFF 	TFF 	ASF 	ASF 
Radiation	524.36 kWh	117.10 kWh	684.00 kWh	34.70 kWh
Area	636 m2		404 m2	

TFF: Thin Film Facade ASF: Adaptive Solar Facade

5. Appendix:



Complet Grasshopper Definition



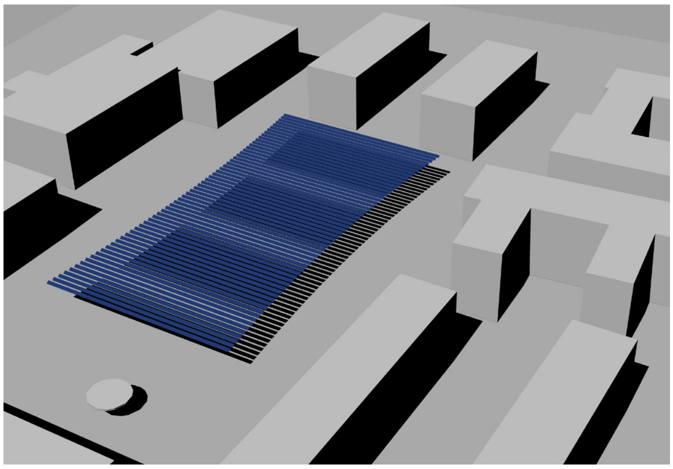
Definition ASF

Follow the Path of the Sun

Student: Thomas Wüthrich

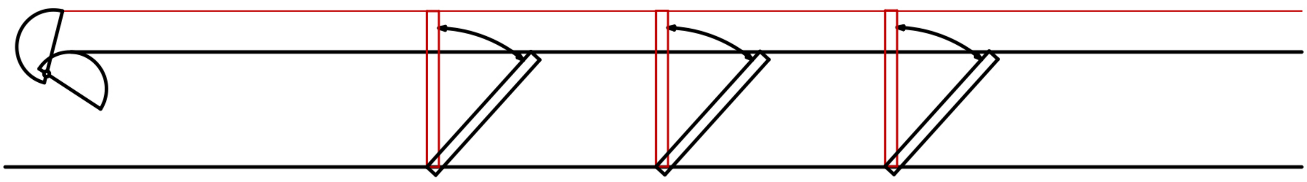
1. Project Description:

Aerial view of Neu Oerlikon



Shading and PV production installation

Due to warmer temperatures during the summertime the importance of shading devices will increase. The Traugott Wahlen park in Zürich Oerlikon is characterized by an open field with a very tiny installation that provides just a little bit of shading. Due to the north south orientation of the park and the soccer field a possible shading installation could be combined with the production of electrical energy with solar panels. The panels could be mounted on steel wires spanned from one building to the other in a north south direction. Each panel can be adjusted to the sun angle and can track the sun in one axis. Due to the almost perfect north south orientation such a tracking system could lead to a quite high efficiency of the overall system. The shading system provides shading during summer and winter. The obvious problems PV production in combination with shading are not entirely solved. During winter one could think about using only a certain percentage of the panels to let some light through or to prevent snow accumulation of the panels. Finally it is about a tradeoff between maximal solar power and shading. One has to take into account that during the wintertime the demand for electricity is high and all the panels should operate. Despite those disadvantages the setup was chosen to learn more about the Shadow range analysis. In the analysis, I connected the incident solar vector with the tilt angle of the panels in order to get the maximal efficiency of those panels.



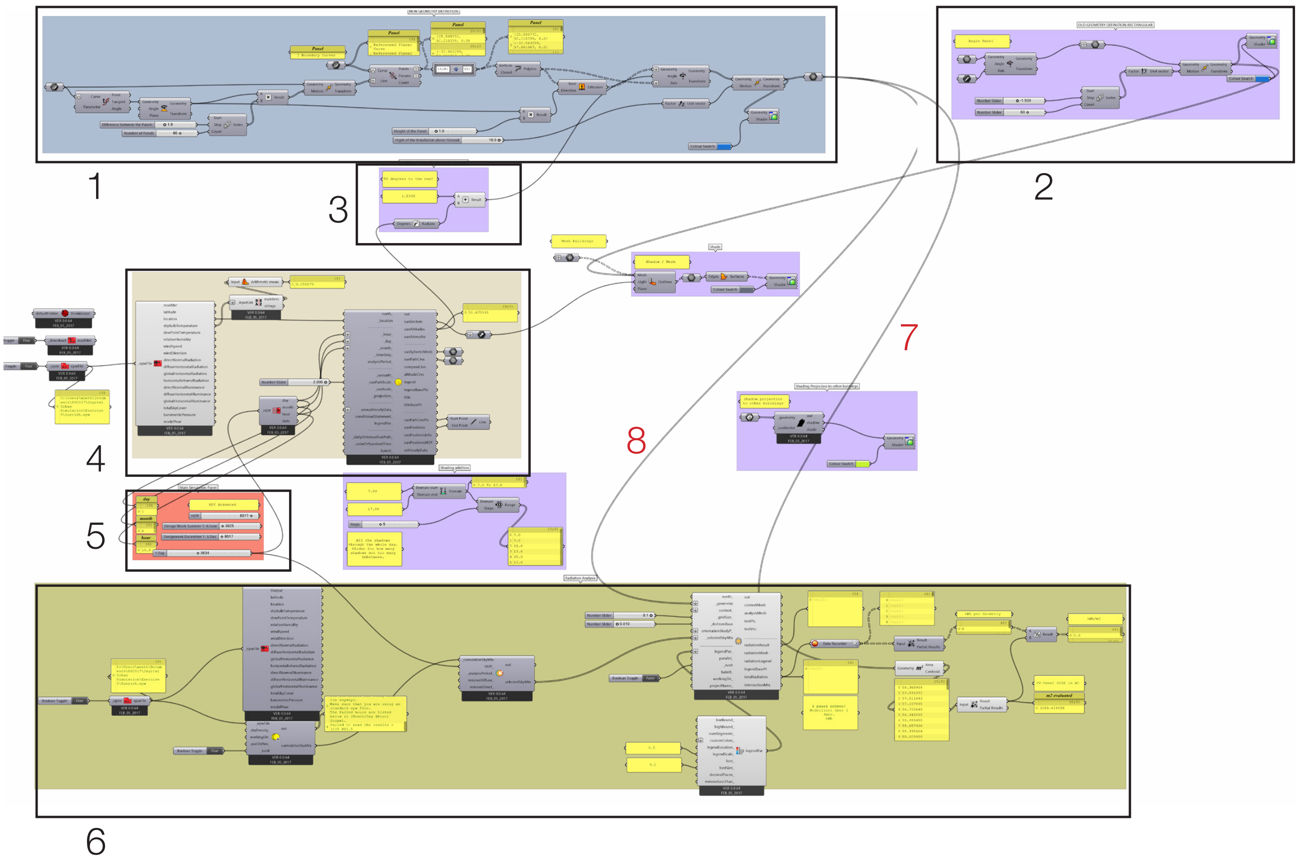
Tilt angle mechanism

2. Motivation and Tools

The main motivation to work on this idea is the aim to gain a deeper understanding of the Ladybug component and its possible applications. PV-Production installations become more often used in the Urban context and play an important role. With the help of the analysis tool the design of the shading and pv production installation will be improved and tested and a critical discussion of the used tool should help to understand its potential. The goal of this project was to create a model with the possibility to have a parametric and therefore adjustable geometry of the combined solar pv and shading installation that is instantly connected to the radiation analysis. This should enable the user to set the optimal parameters fot the installation.The challenge is to set up an hourly simulation with data recording due to the fact that the panels track the sun in one axis. For that reason every hour has to be simulated in order to get sufficient results.

3. Analysis and Interpretation
3.1 Analysis Setup and Grasshopper Definition

In the following graph one can see the basic grasshopper setup for the model. The different components and interactions will be explained on the following page.



Grasshopper Definition

1. The improved parametric geometry of the panels that is spanned between two curves. Parameters: Dimensions of the panel, number of panels, distance between panels, height above ground of the installation.
2. Simple Geometry for simple calculations. Parameters: number of panels, distance between panels.
3. Solar altitude angle conversion
4. Solar path component
5. Main control panel. Parameters: Hours of the year, summer design week, winter design week, design day
6. Radiation Analysis with Results. Parameters: Grid size
7. Mesh of the panels connected to calculate the kWh/m2 solar radiation
8. Input Geometry: Parametric panels

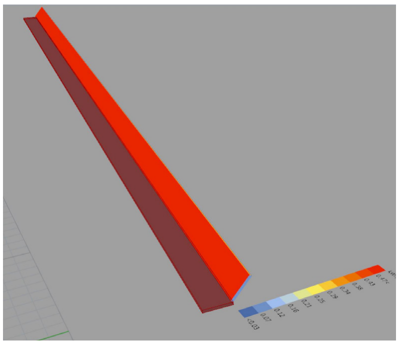
3.2 Analysis and Results

Analysis 1_Flat surface vs Tracking

In the following graph one can see the basic grasshopper setup for the model. The different components and interactions will be explained on the following page. The first analysis deals with the advantages of a PV system that tracks the sun in one axis. The solar altitude angle can be taken into account. It is no problem to execute a static annual simulation with the Ladybug component for a horizontal surface. When it comes to solar tracking an hourly simlation has to be set up. The hourly radiation is linked to the solar altitude angle and with an animated slider that induces a measurement every hour of the year can be simulated with its respective tilt angle of the panels. The main problem is the overall calculation duration of this process. With the help of a data recorder the results can be summed up to get to the total annual radiation on the given panel for the case of solar tracking in one axis.

Simulation Period	Result	Entity	Tracking Yes/N	Comment
Winter Design Week	5.34	kWh/m2	Yes	
(1.Dec)	4.3	kWh/m2	No_Horizontal	20%
Summer Design Week	17.5	kWh/m2	Yes	
	20.27	kWh/m2	No_Horizontal	
Annual Simulation	1140	kWh/m2	Yes	3% Improvement
Annual Simulation	1102	kWh/m2	No_Horizontal	Simple Process
Total Area 60 panels	3268	m2		
Efficiency Panel	15%			
Total Electricity	558828	kWh		

Results



Example Radiation hour 4000

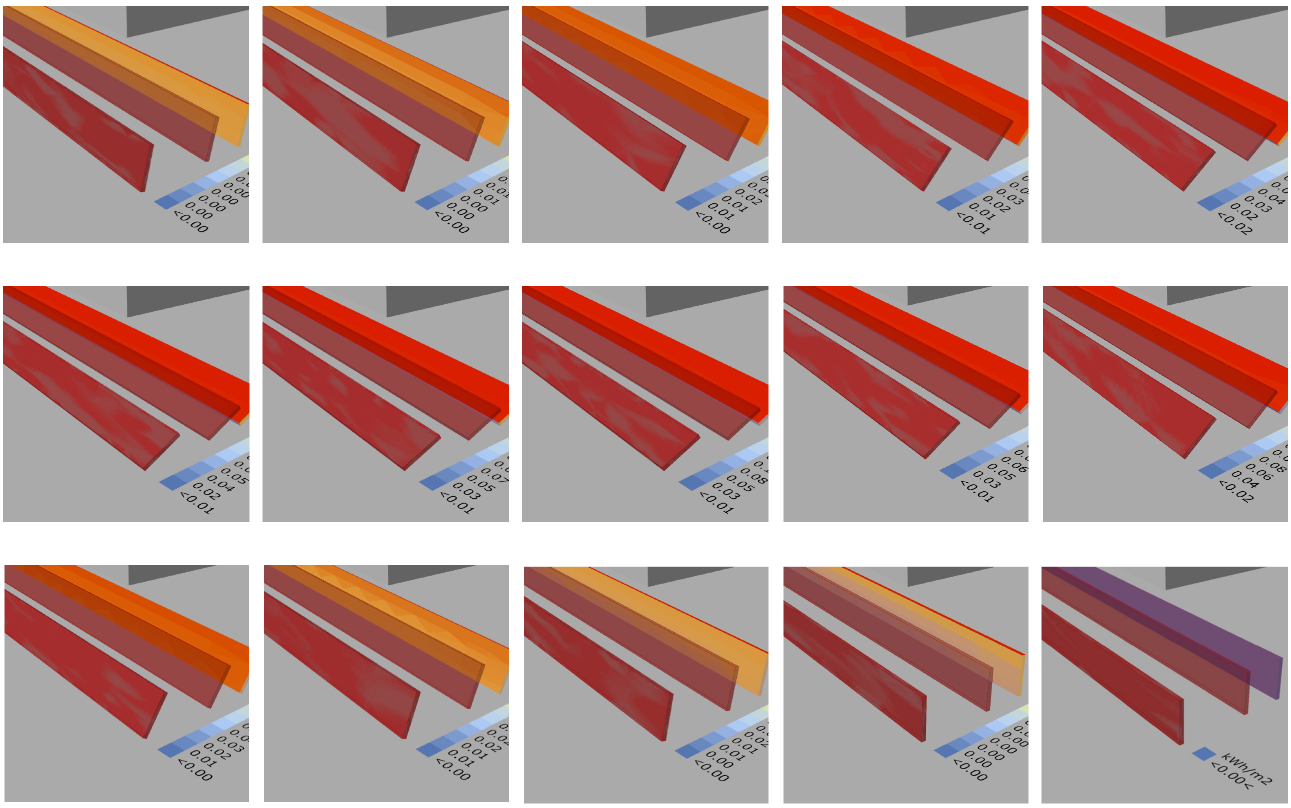
Because of the fact that the model is not calibrated the values are difficult to prove. The annual simulation for each hour of the year shows that the tracking results in an improvement of the yield by only 3 percent. If we compare those values with the literature up to 30 % should be possible. It is difficult and quite time consuming to figure out if the results can be correct or if the model is not well calibrated. The tracking is more efficient in Winter. The tracking is related to the solar altitude. Especially in the Morning and the evening the horizontal surface would have a higher yield because of the way the angle is measured. The closer to noon the more accurate is the tracking. The total annual electricity productions is equivalent to the electricity demand of 120 households over one year. Of course storage options have to be taken into account. But close to the site an energy company from Zürich built up the biggest battery for electricity storage purposes in Switzerland.

Analysis 2_Optimal Distance between the panels

There exists a trade-off between the provided shade of the self-shading device and lowering of the efficiency of each panel and the total amount of panels that can be installed. This is a complex optimization problem. With the simple geometry 6 distances between two panels were tested in order to get the hightest total radiation. To simplify the calculation task a design day in June with 24 hours was used. The results are listed below:

1.13 m distance => 135.63 kWh/geometry (110m2)
1.71 m distance => 155.63 kWh/geometry (110m2)
1.38 m distance => 150.50 kWh/geometry (110m2)
2.00 m distance => 156.52 kWh/geometry (110m2)
2.68 m distance => 158.52 kWh/geometry (110m2)

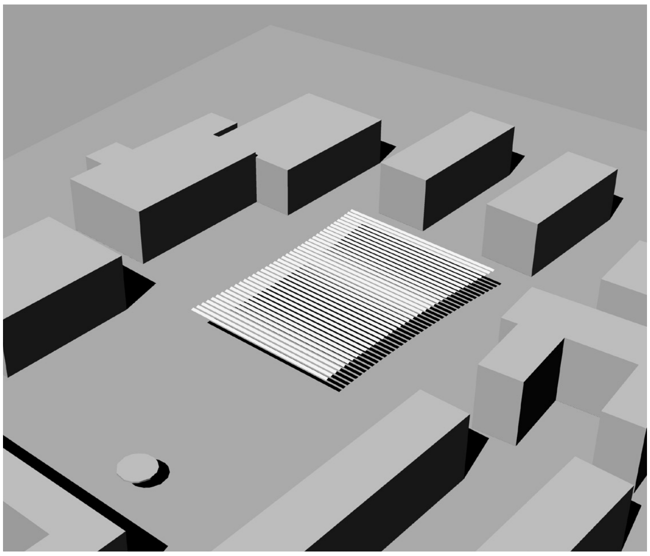
In order to fit quite a lot of panels a distance between 1.5 and 2 m should be used. Below a series of hours is listed. The panel in the middle is not active. The first panel is the context and thelast one is the geometry with the solar radiation on it.

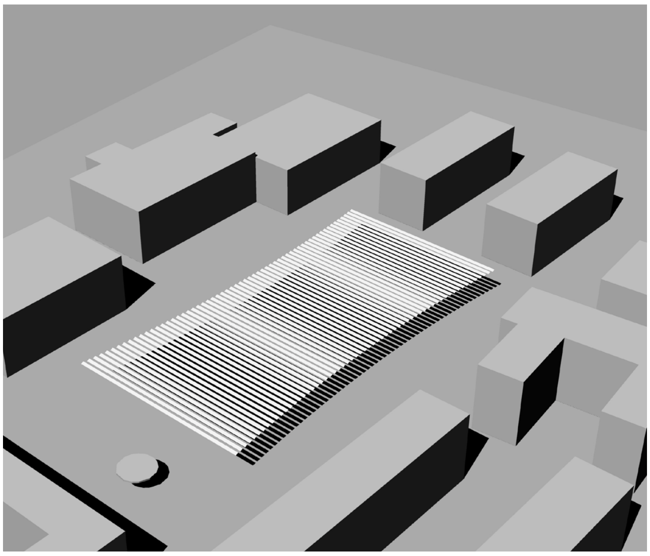


Design Day 21st of June

Analyisis 3_Variant study of appealing shapes of the installation

In order to find a pleasing architectural shape of the installation the geometry was modelled in a parametrically and can be adjusted. Parameters that can be adjusted are: Width of the panels; number of panels; distance between the panels; height above ground of the whole installation. The outer border of the surface that can be set wherever it needs to be is slightly curved and adapted to the surrounding buildings. Finally a version with 60 panels and a distance of 2 meters between them seems to be a good solution.


Version A 40 panels


Version B 60 panels

4. Conclusion

In order to do a scientific analysis it is crucial to understand the model in detail. Therefore it is crucial to calibrate the model and compare with real parameters and check possible mistakes. Nevertheless it is a great tool to work with. The following points need to be taken into account:

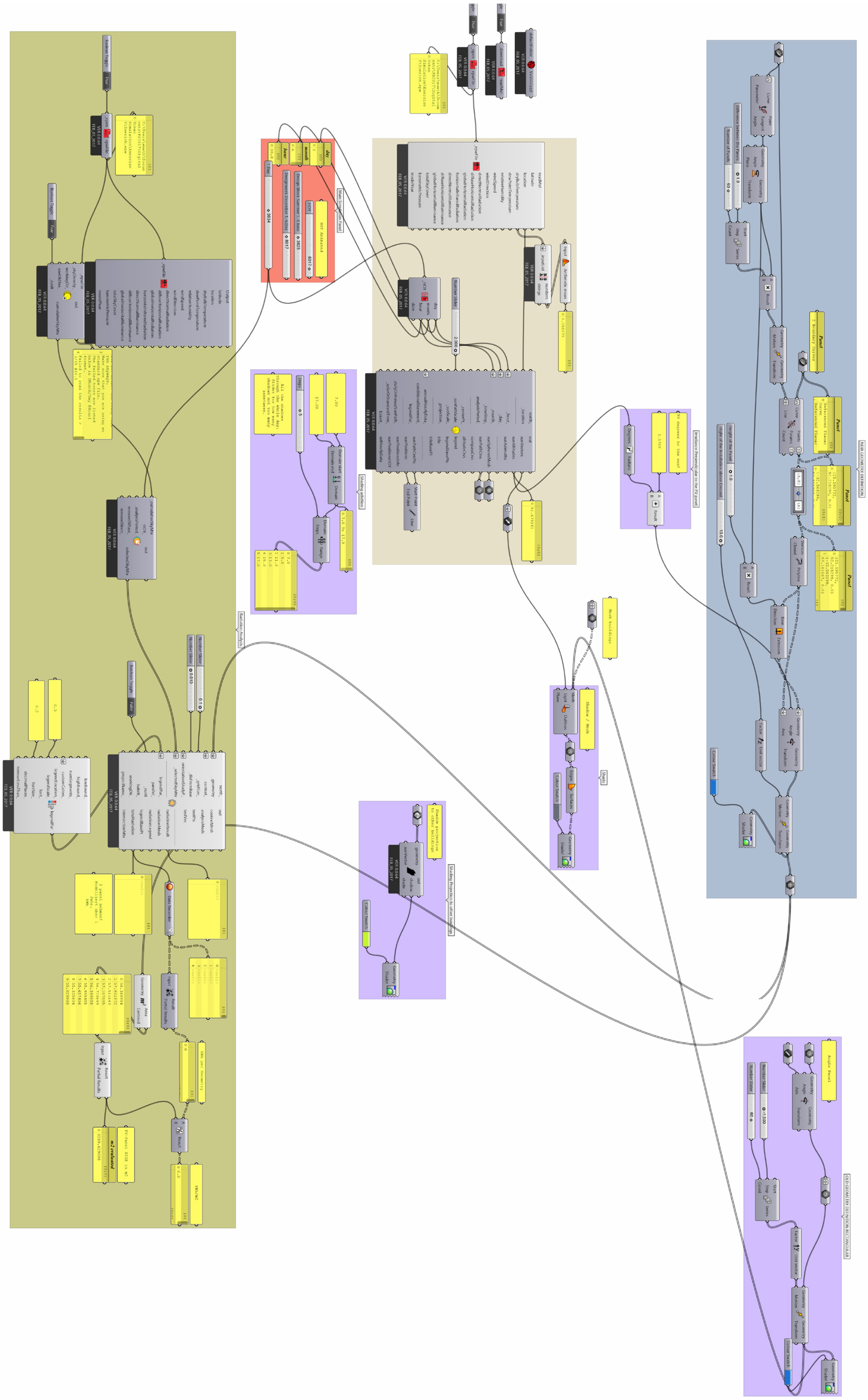
-Tracking 1 Axis (Literature +30%)
-Tracking 2 Axis (Literature +45%)
-Model has to be calibrated (compared with real values)
-Calculation power is crucial to get more detailed results

Concerning the installation itself:

-There will always be a tradeoff between Sunlight and PV-Production
-Snow coverage in Winter might be a problem
-The East-West orientation of the system has to be analysed as well in a further step

The tool nevertheless provides a good option to combine simple engieneering tasks with the possibility to generate variable architectonical solutions. Such installations have to be accepted by the public and therefore this interconnection between engineering and architecture is crucial. Therefore grasshopper enables the user to generate different options once the model is set up.

5. Annex



Infinite Isovist

Student: Ludovic Regnault

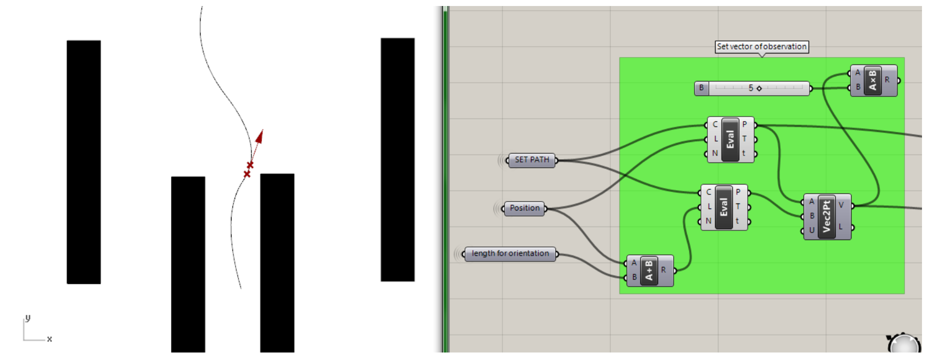
1. Summary :

The goal of this project is to develop a general tool helping to analyse the field of view when the view is not totally enclosed by a geometry. We will call the view stopped by a geometry “stopped vew”, and the view nonstopped “infinite view”. It can, for example, be used to analyse the view in a room by the window. More preciesly the goal is to compute the proportion between the stopped view and the infinite view. Also the goal is to calculate the angle the infinite view, it’s number of parts (when a geometry cut the field) and the average angle of each part. The isovists will be calculated on a point moving on a way with a certain angle of vision. The results will be showed graphically and numerically.

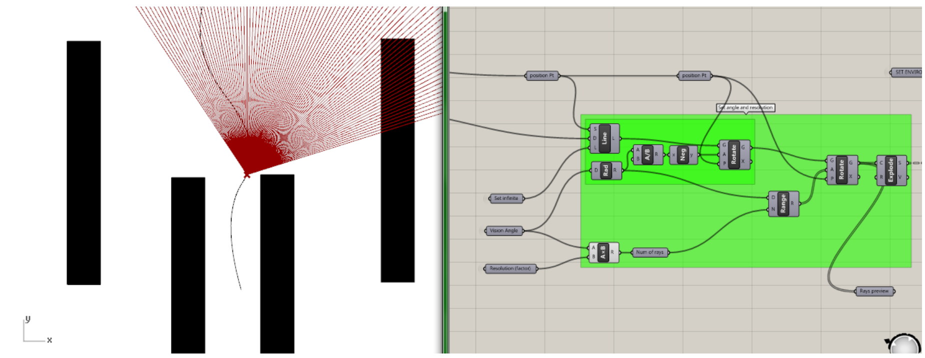
2. Motivation :

This idea comes from the fact that the interest of a view in an urban context is often linked to its openings looking outwards to far distances. It is also related to buildings which are oriented to a landscape view.

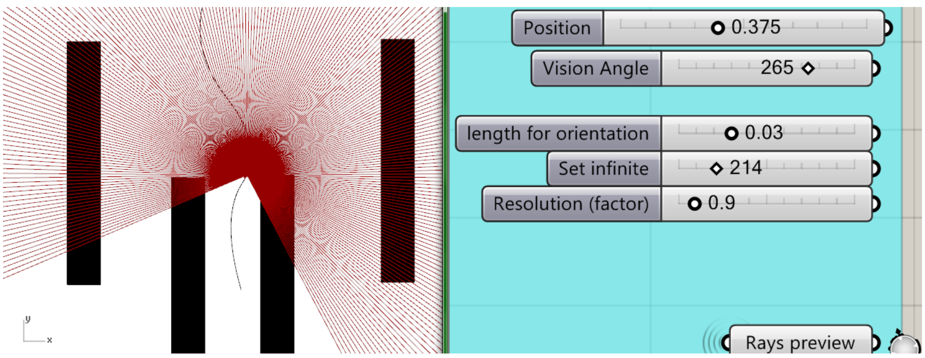
3. Setting of the definition :



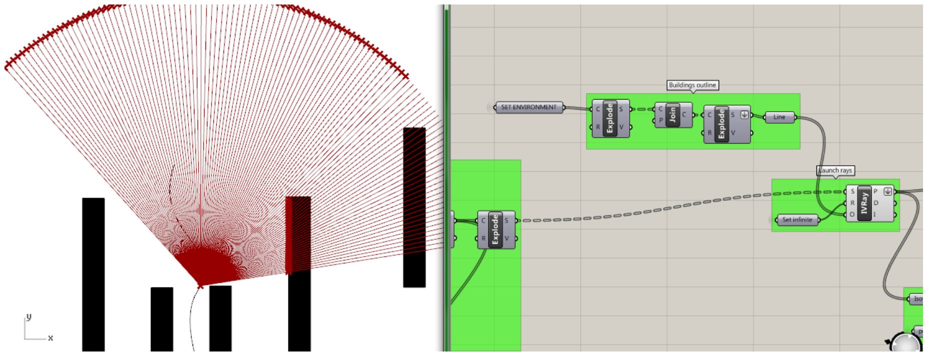
Setting of the moving vector on the way



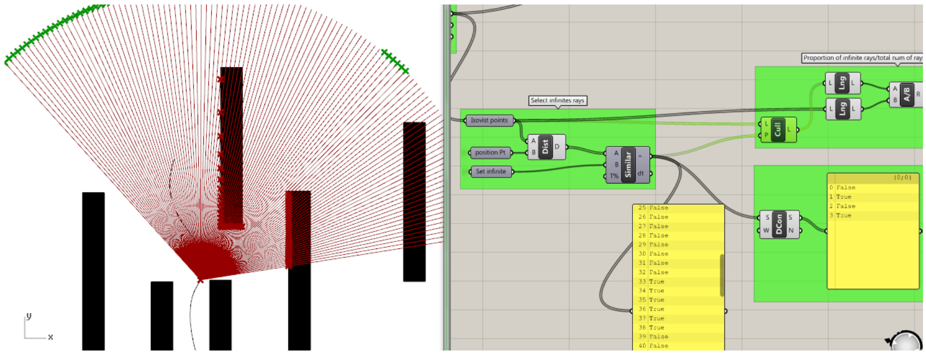
Projection of lines on the right and left of the vector, respecting the demanded angle of view.



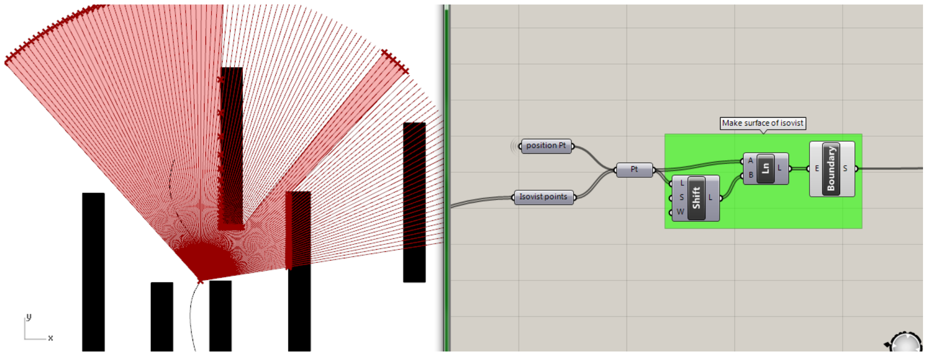
When the angle of view is changed, the number of lines is automatically recalculated to fit with the demanded resolution



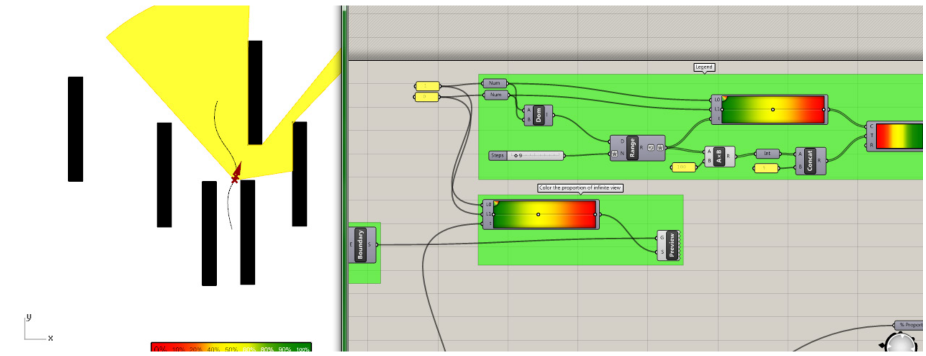
Use of the component Isovist rays to compute them on each line



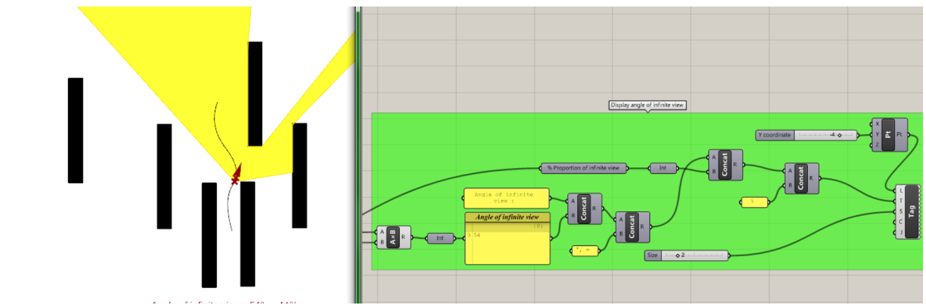
Selecting the infinite views by measuring equality between the radius and the distance of the isovists points



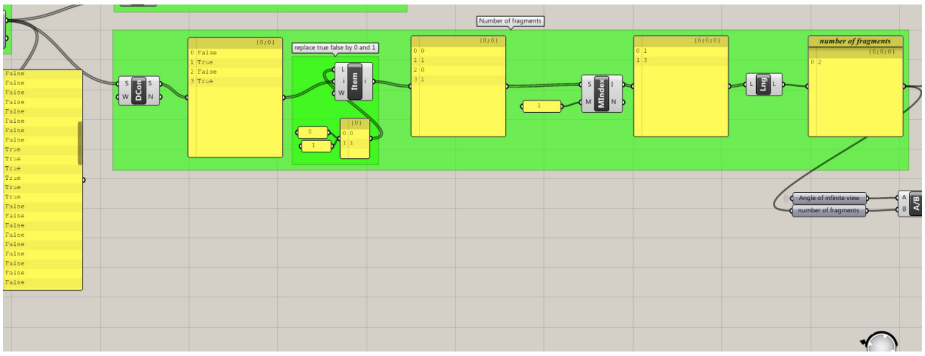
Creating an isovist surface



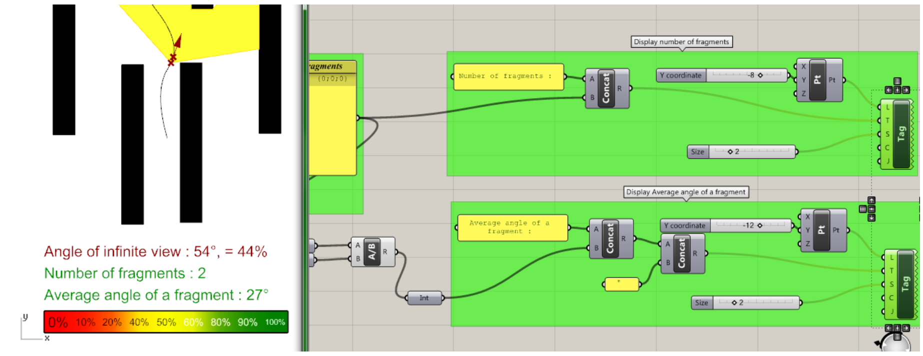
display a color on the surface corresponding to the percentage of infinite view



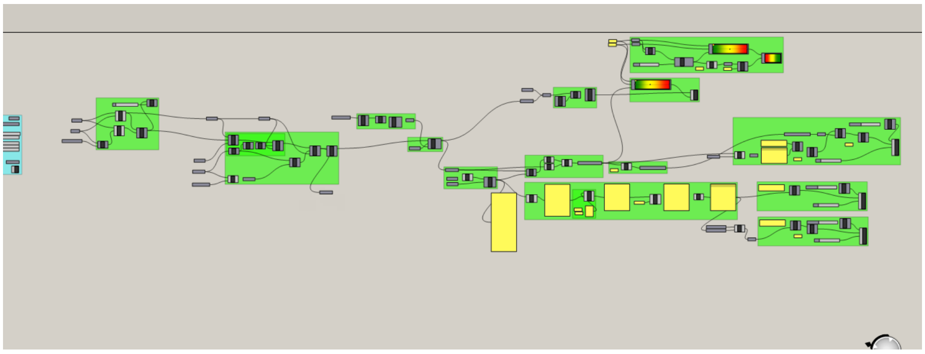
Calculation and display of the total angle of infinite view



Calculation of the number of infinite view-parts by measuring how much time it changes from infinite view to stopped view.



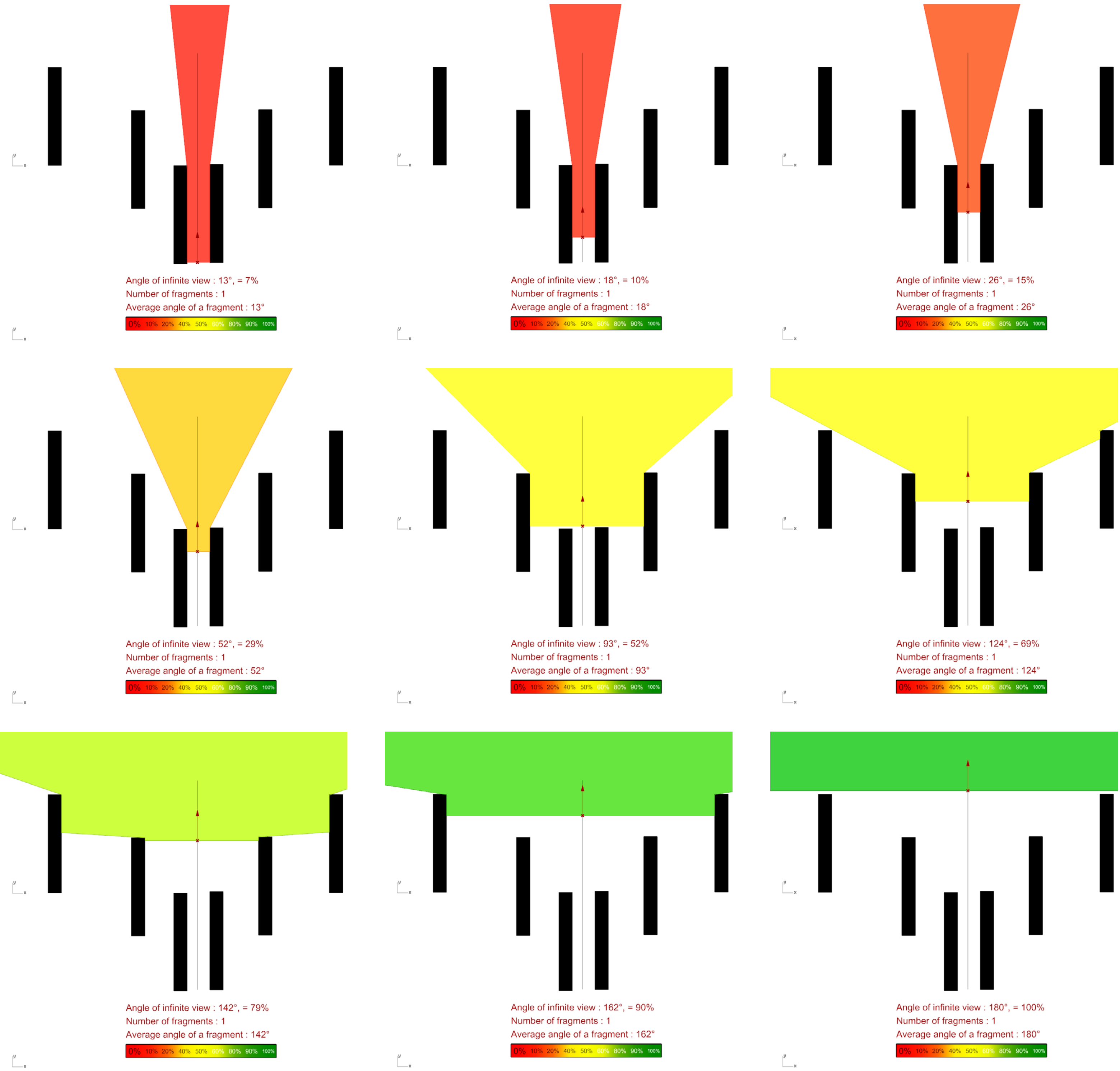
Calculation and display of the number of infinite view-parts and their average view-angle.



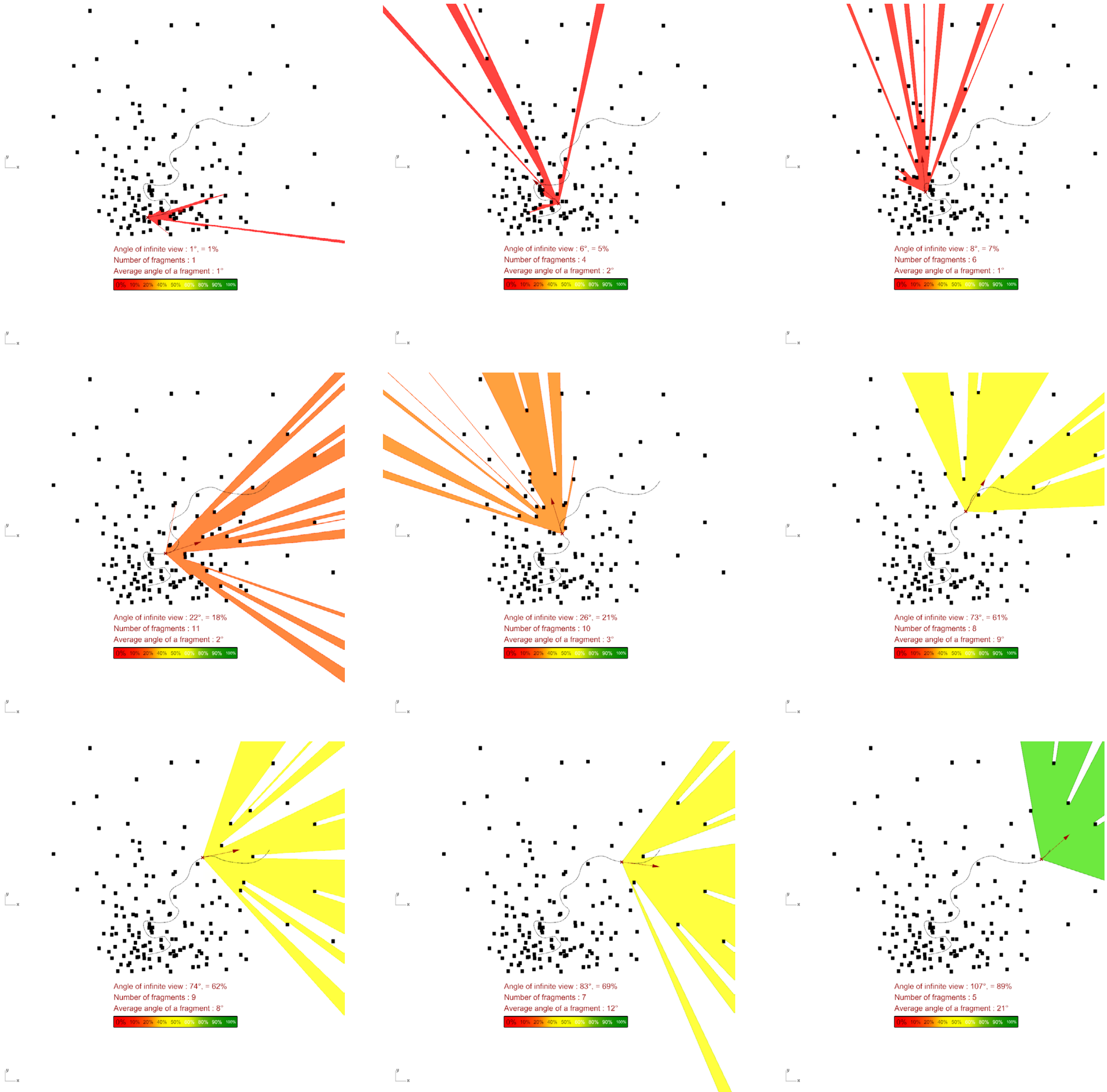
Overview of the definition. The tool is ready !

4.Examples

Here are three examples to see how the tool works and to understand its potential.



Here is a succession of frames shaping a view on a landscape for example. At the begining the view is very small and while moving on the way, the view is more and more wide.



This example features a lot of little obstacles, which cut the infinite view in many parts. In this particular case the average view-angle of each part seems to be related to the number of parts.

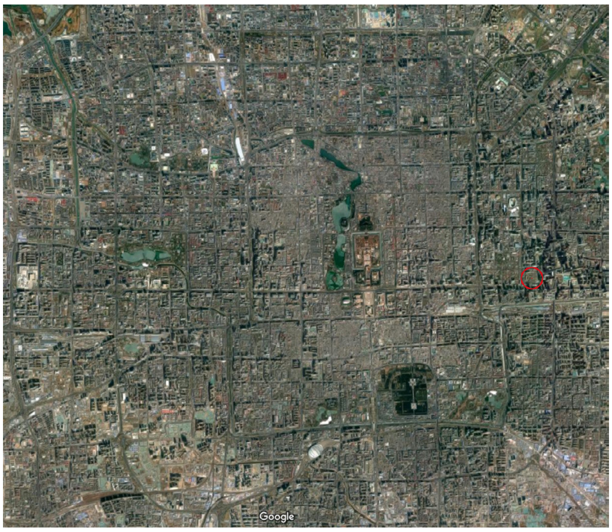
Finally this example shows the evolution of views by the windows of a building. In the end this tool is fitting the necessity of analysing the long-distance views, the views from the inside to the outside, and the views projected to a landscape. It allows to analyse the proportion of infinite view and its fragmentation.

Sanlitun Taikooli

Student: Zhe Dong

A - Summery and Motivation

Sanlitun Taikooli is one of the most successful commercial buildings in Beijing. It is located between Beijing's Second Ring Road and Third Ring Road and consists of 19 low density buildings. Sanlitun Taikooli is divided in to north and south two areas. This opening type of architectural group is no more than 4 storeys.



The main concerns about the design of a commercial area is how to attract more consumers. The following aspects are crucial elements for commercial design:

1. Location : is the place convenient to reach by walk and vehicle? (Integration-high integration shows a space to be a highly desired destination)

2. Entrance : Does the location of the entrance correspond to the street situation ? (Choice) the entrance should be put toward more popular street (shortest path)

3. Function layout : hotels, cinemas, and supermarkets are suitable to layout in the corner (relative low integration), while retail activities should be placed in a more lively area (relative high integration).

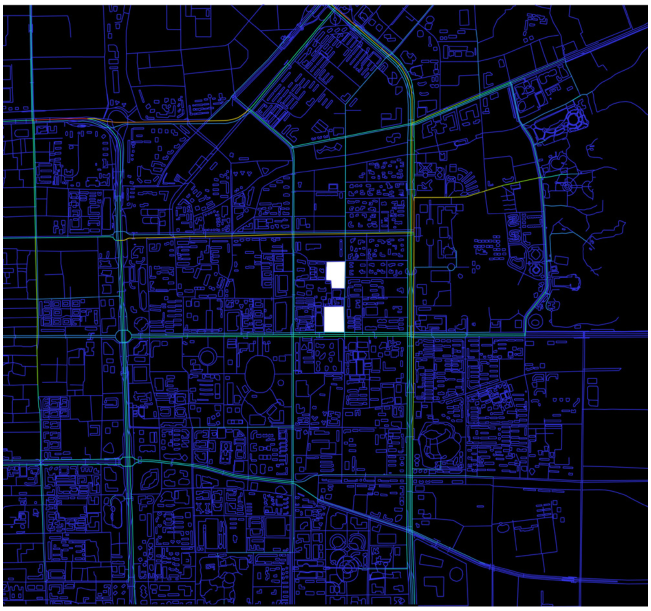
4. Visibility : too compact layouts will decrease visibility. Fancy facades, attractive labels, posters and infrastructures will attract more customers to certain places.

5. Microclimate: comfortable environment will contribute to more customers.

According to these aspects, I will analyse why this commercial area is a success with respect to space syntax, and the reasons for remaining questions, such as:

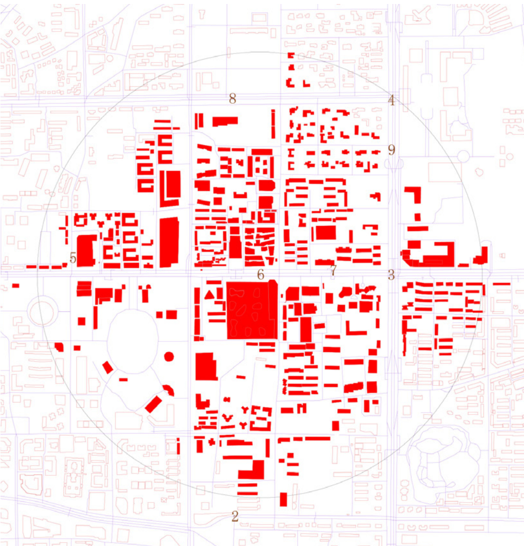
- Why is the north area less active than the south one?
- Why is there a big decrease of customer flow in winter?
- possible methods to improve realistic situation.

B - Location and entrance



Segment analysis-Choice, Integration

The segment analysis choice and integration show both the high potential of to-movement and through-movement. Especially on the south side of the area that is located directly to the main street Workers' Stadium Road. This is reflected in the consumers flow. A large quantity of people choose to enter the whole area through the south side.



1. I select the center of this shopping mall as the starting point
2. The red area has high accessibility to the shopping mall by foot
3. I choose the bus stations and subway stations within this area and two really important subway stations nearby.

5,6,7,8,9 Bus stations

2,3,4 Subway stations of Line 6,10

0,1 Subway stations of Line2

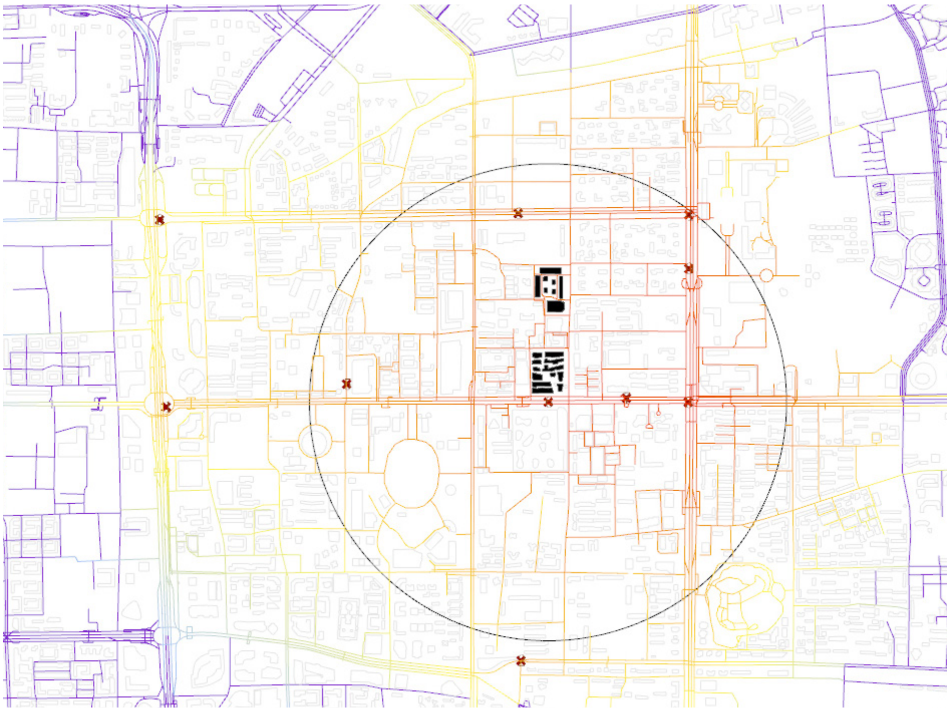
(big stations with large quantity of passengers)

4. With 5 bus lines and 3 subways it is quite easy to reach the location within 15-minutes- walk.

Catchment analysis- Accessibility by walking

To determine the neighbourhood area within 15 minutes / 1.2km walk

To determine how close a location is to any attraction points, in this case it means how conveniently people can arrive from Sanlitun to any station, I determined the importance of each bus station by the number of bus arrivals there. Because subways can carry more passengers, point 3 and 4 has the highest importance. Point 0, 1, 2 also have significan flows of people, but they are all beyond the 15-minutes-walk circle, so their importance are less.



Vicinity-Integration

As the result shows, Sanlitun has quite high integration (red colour), which suggests this area to be a highly desired destination according to the public traffic situation.

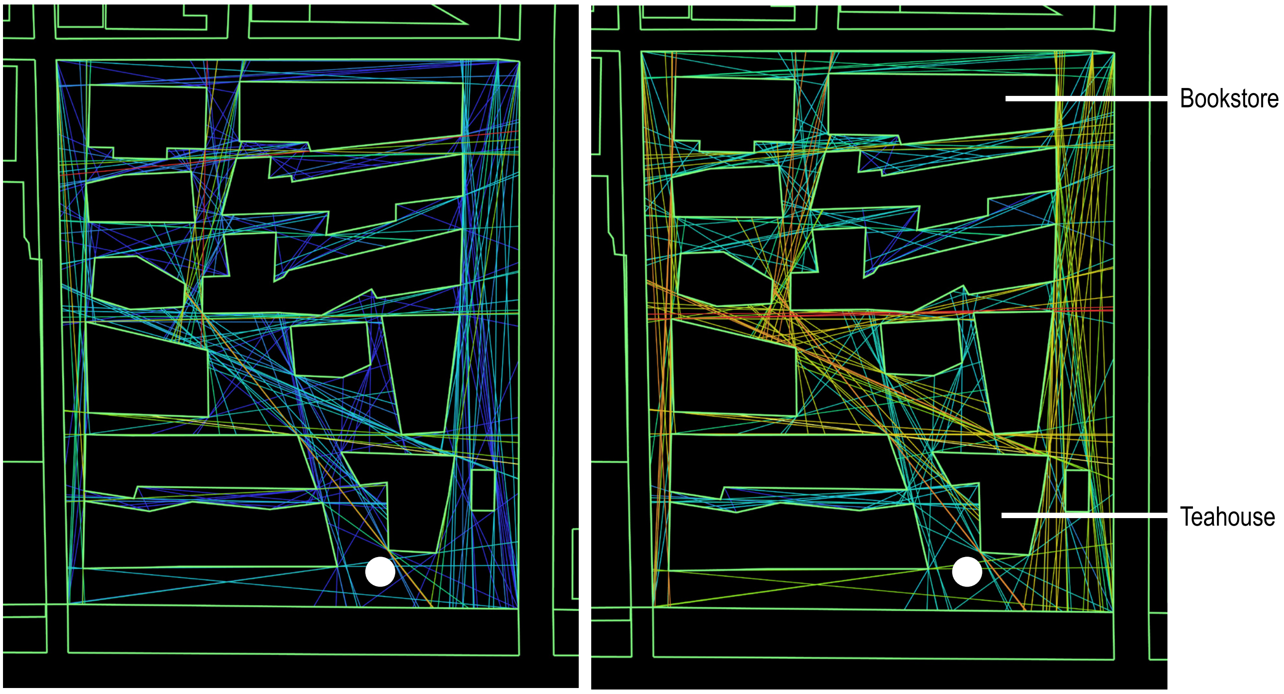
In detail, the east side shows higher integration then the west side.

The real situation confirms the results of analysis. High integration shows more exchanges of social encounters. An interesting phenomenon is the photographers. They wait in the southeast side of the shopping mall for fashion icons to walk by. As the last part of analysis shows, the south has a better location as the north. What are the others that make the south more attractive?

My hypotheses are:

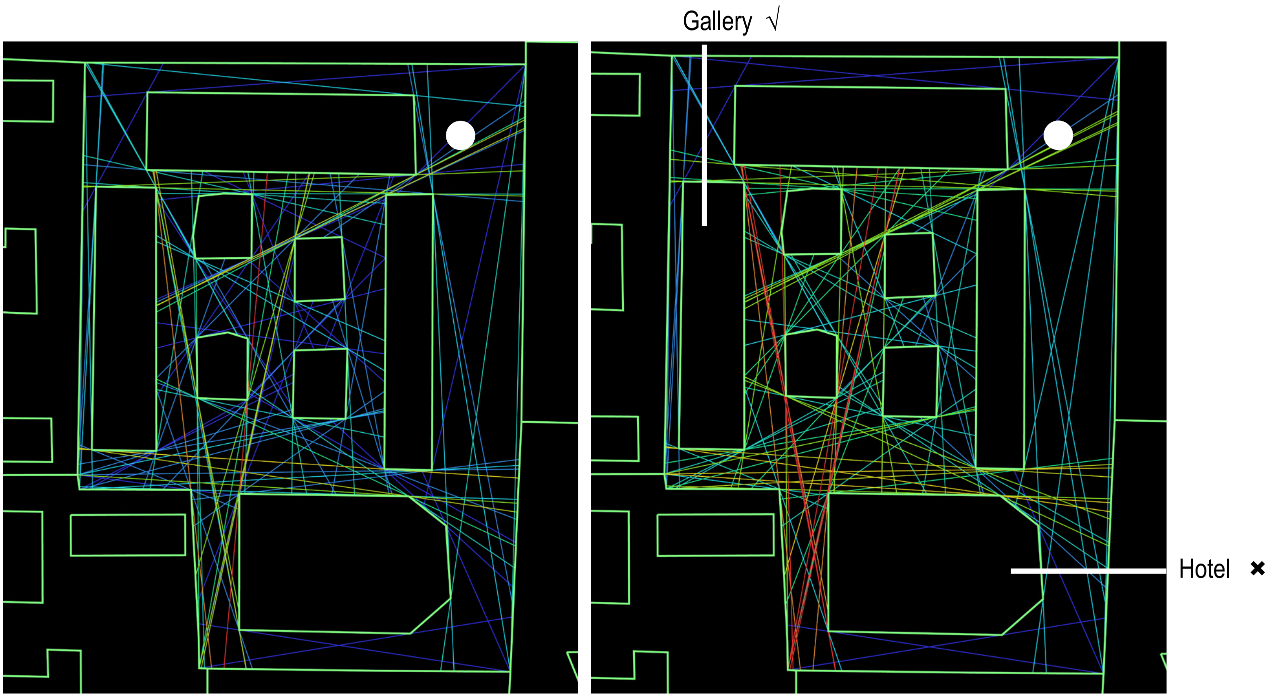
1. The layout of functions is more reasonable in the south site.
2. The square of the south site enables a better visibility and connects directly to the main entrance.

	Customer flow quantity	Commercial activities
High integration	large	retail
Middle integration	middle	restaurant, leisure, salon
Low integration	small	hotel, cinema, supermarket, department store



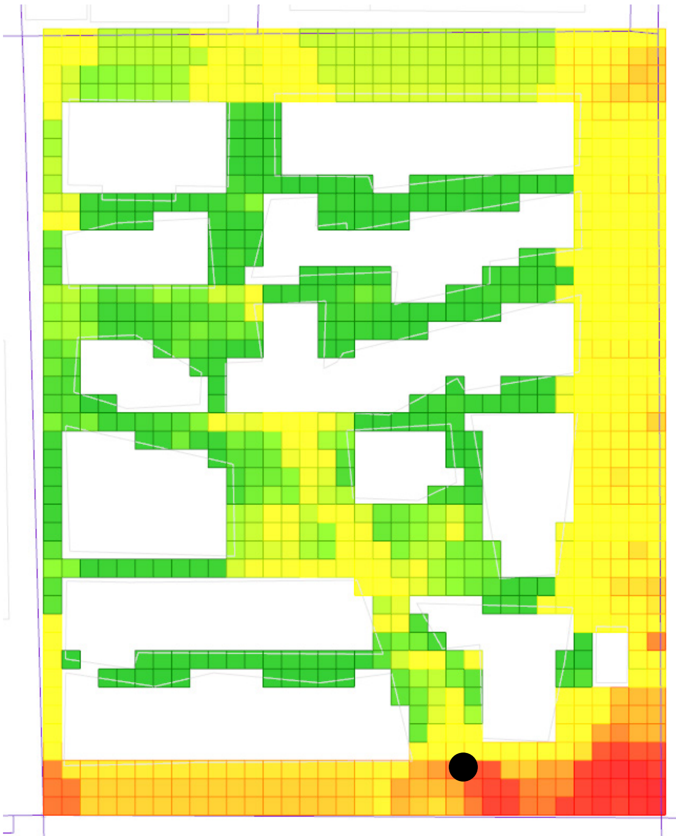
Axial analysis-Choice, Integration
South Area

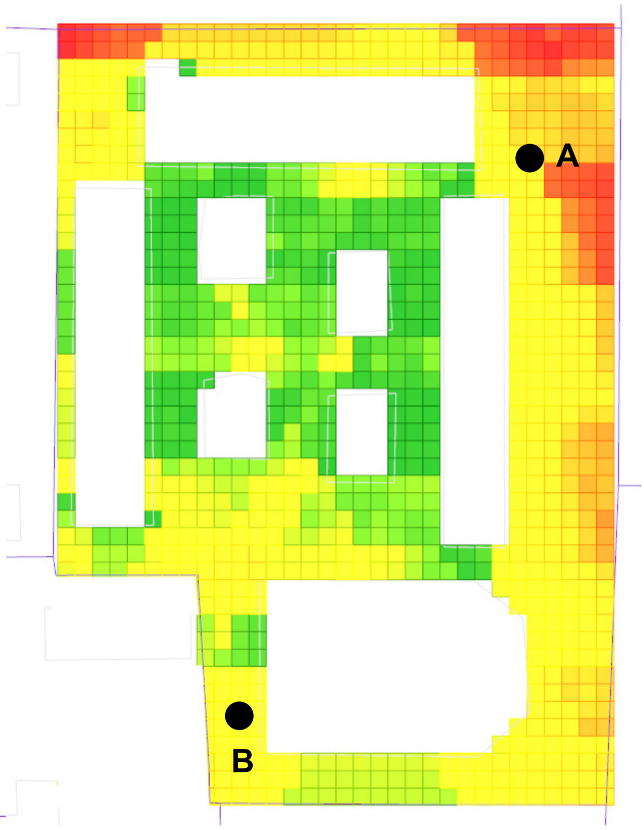
The functional layout of the south site corresponds well with the different integration degree. The retail shops are around the square, while bookstore and teahouse lay in the corner and the 4th storey.



Axial analysis-Choice, Integration
North Area

But the situation in the north site is not so ideal. A large hotel sits in the area of the highest integration. And the retails shop that are highly depended on customer flow are located in less attractive places.That will decrease the potential of economic activities.
And hypothsis 1 is confirmed.

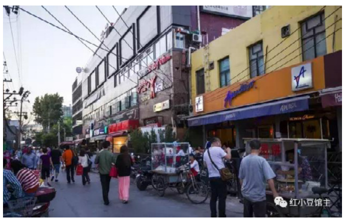


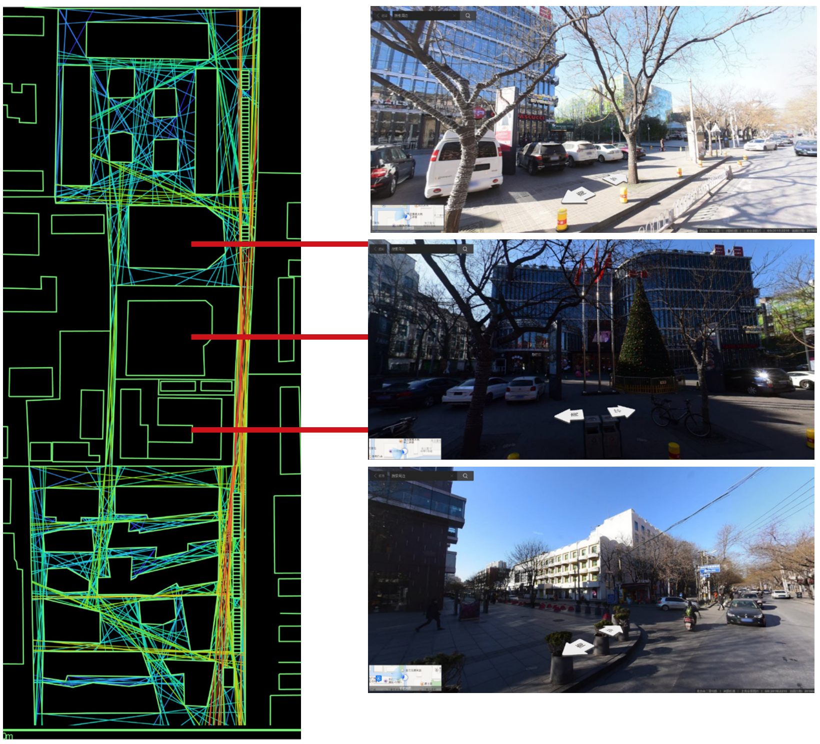


Isovist field analysis- Isovist area

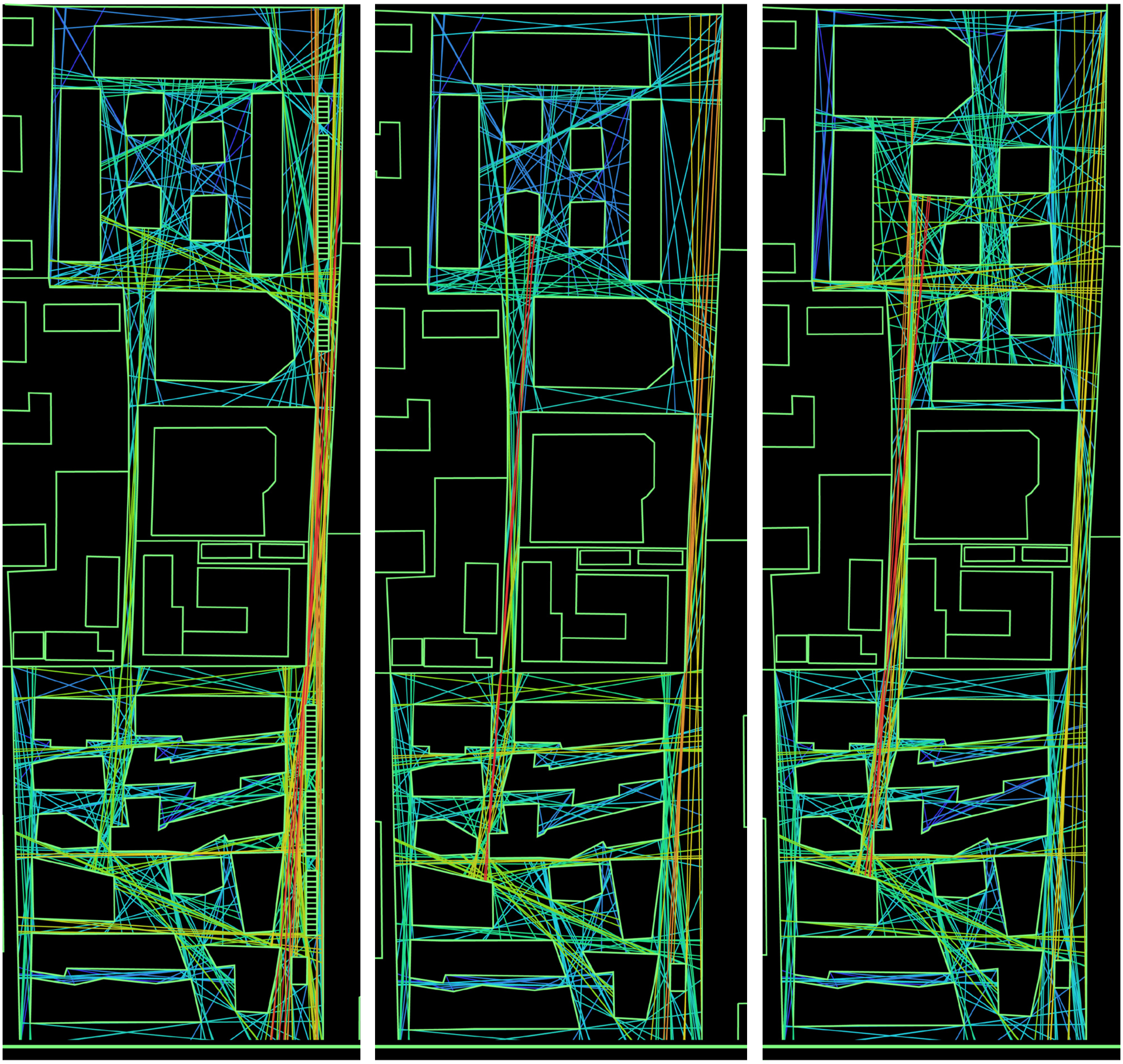
Both sites show higher isovist area in the open square
Compared to the south site, the active open sapce is less closely connected to the main entrance. It is more connected to entrance B, which means to enter the site through the south area is a possible way to increase the customer flow in the north.

Connectivity- Reality





In reality, the situation is more severe. The left street is taken up by stalls, while the right street is used for car parking. Also the three individual buildings block the vision.



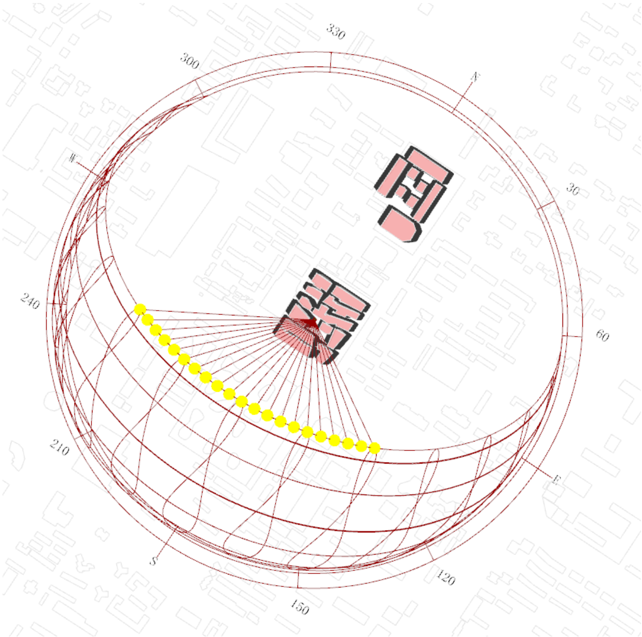
Connectivity- Compare

a- Regulation the left street, make it wider
b- Remove the parking spot
c- Reorganize the functional layout of north area

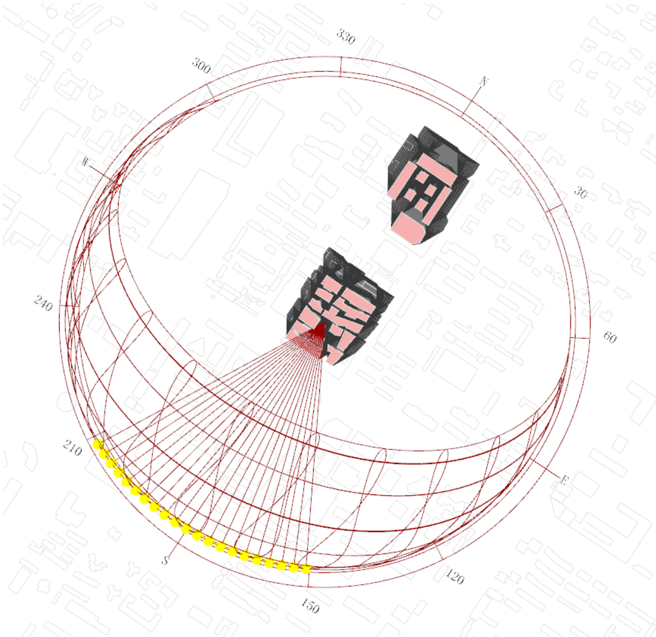
These three measures increase the connectivity between the two sites. That can lead more people from south site to the north and make full use of the high integration place in the north area. Moving the hotel to the corner and reorganize the functional layout are going to cost too much investment, so maybe the first two measures are more realistic.

The opening type of space applies more possility to improve the customer flow through the improvement of the surrounding rather than an utter change in the shopping area. So this new mode of shopping centre is more flexible than traditional department store.

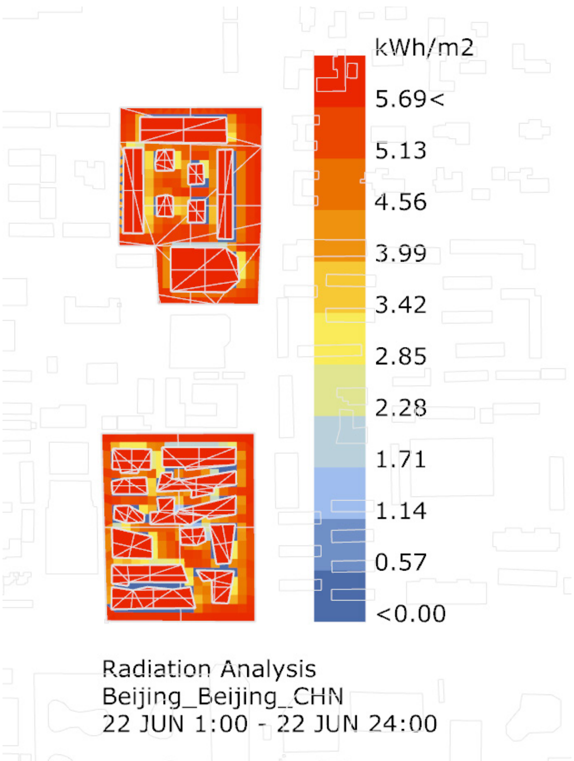
D - Shadow and Solar radiation



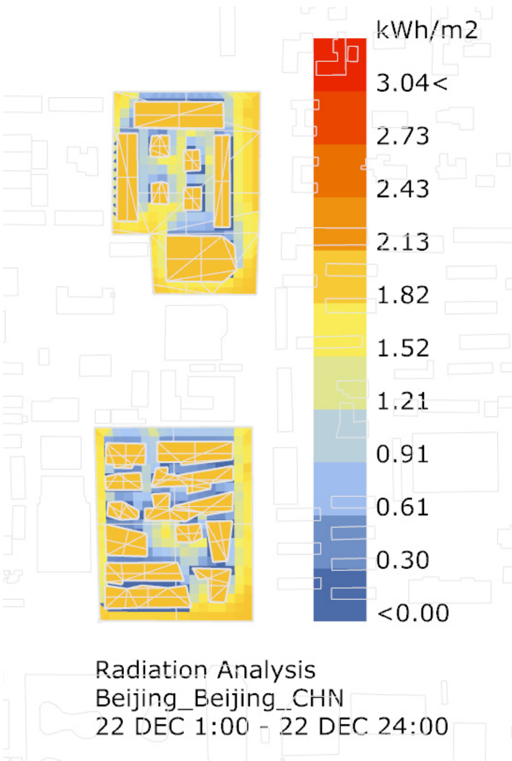
the Summer Solstice 10:00-14:00



the Winter Solstice 10:00-14:00



the Summer Solstice



the Winter Solstice

The situation in both summer and winter is pretty severe, since the microclimate in open spaces are much harder to control than the closed building envelope. In summer most of the squares can not be covered by shadow, in winter only small area can receive sunlight. Beijing can reach 40 degrees centigrade in summer and -15 degrees centigrade in winter, which may contribute to a sharp decrease of flow. In reality, there is a fountain in the square, which people can walk through and play inbetween. Also spray devices are used to cool down the outdoor climate. However in winter there is no efficient method to keep people warm outdoors. So the decrease is more severe in winter than in summer.

Conclusion:

I choose this case to analyse because in reality the architects also apply digital simulations to predict the wind and solar situation, as well as the visibility situation in the whole area. Then they adjust the angle of the facade, the entrance and the windows to achieve the best result by balancing all aspects. That means the methods of digital urban simulation are step by step used in the design process and quantify the result of design. This will help designers to balance the investment and production, leading them to make more rational decisions.