ICOA736: UTILIZING GENERATIVE COMPUTATIONAL ALGORITHMS IN INTERPRETING HISTORICAL ELEMENTS IN ARCHITECTURAL DESIGN

Subtheme 03: Protecting and Interpreting Cultural Heritage in the Age of Digital Empowerment

Session 2: Use of Digital Technology for Dissemination and Interpretation
Location: Silver Oak 2, India Habitat Centre
Time: December 13, 2017, 16:45 – 17:00

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Abstract: Computational design in architecture has evolved quickly in the recent years such that many architectural schools have made their programmes more inclusive towards it than ever before. With software and hardware becoming more affordable and accessible, architectural students have the opportunity to push the envelope further, including interpreting heritage and historical architecture in a new way.

This paper looks into an exploration of how computational design is used to generate new building language within context of heritage zone integrated in the general urban fabric. The site is situated in the old town of Johor Bahru, a city with long history and rich culture on the southern tip of the Malaysian peninsular.

The theoretical design project takes advantage the rich heritage elements in the immediate surrounding using algorithms managed by Grasshopper within Rhinoceros 3D modelling software. The process derives elements and architectural features from the surrounding traditional Johor shop houses as form generator, and produces contemporary interpretation unique to the site.

The outcome we explored is unhinged, bold and aggressive; but the process provides insight on how computational design could be used to produce alternative architecture that captures the historical and cultural elements and respects its surroundings.

Key words: *heritage, interpretation, digitization, adaptation*

Background

There has been a declining interest amongst the students as well as younger tutors in taking up design studio projects focusing on heritage or architectural legacies. Although the Department of Architecture in Universiti Teknologi Malaysia is home to KALAM, the one of the biggest research centre on heritage in the built environment in Malaysia, there has been less and less projects focusing on architectural history and heritage.

The younger designers in the B.Sc. Architecture programme are more inclined to explore on flashy and visually stunning designs for their final year projects. In 2015, the 60 3rd year B.Sc. Architecture students were tasked to explore design projects in Johor Bahru old town area as part of their mini-theses[1]. As a graduating design project[2], students are allowed to choose and formulate their own brief and explore issues that interest them. Despite having the opportunity to probe into the historical character of the town in the designated heritage zone, only 8 students attempted to directly address them.
The feedback acquired at the end of the semester revealed students were more interested in producing designs that are aesthetically prominent to mark the final design project of their undergraduate studies. As this will no doubt be featured prominently in their portfolio, the students deliberately chose design issues that are more likely to produce visually stunning end products.

This leaves issues such as urbanism, human behaviour, including heritage and conservation to become less favourable as a design project at the end of their studies.

Purpose

While working with the same group of 3rd year students, the tutor (Azari Mat Yasir) supervised the designer (Yeow Yann Herng) to try and address the heritage elements prevalent in the site. Like most of his peers, the designer was more inclined to engage bold and explorative form making which more often than not disregards the immediate context, regardless of high heritage value or otherwise.

After a few negotiations, the designer agreed to address and incorporate the heritage elements in the surrounding context, while be allowed to use it any way he pleases. The tutor with the support of the school decided to encourage such theoretical explorations to observe the possible outcomes. The objective was to evaluate strategies to make historical studies intrinsically attractive again.

This paper explores the narrative in the development of Yeow Yann Herng's design work in adopting computational design by utilizing parametric design software in context of Johor Bahru old town area.

[1] Mini-thesis is a lightweight version of a full-fledged academic thesis. The focus is more on the design project, but with some research elements exploring on issues or problems encountered, written in an academic way.
[2] The B.Sc.Architecture is a 3 year bachelor programme similar to ARB Part 1. It is followed by the M.Architecture, a 2 year master programme similar to ARB Part 2. This is the standard structure of all architectural programmes in Malaysia.

Project Brief on Heritage

The designated site is located within the heritage zone in the old town section of Johor Bahru city, the southern-most city at the tip of Peninsular Malaysia. The project requires the architecture to respond to the immediate site context, both physically and culturally. It urges a dialogue between the old and the new building, creating a seamless bridge between buildings built decades apart.[3]

The site is predominantly populated with shophouses from the early 1900s. A traditional shophouse[4] has trading activities on the ground floor, directly accessible to the public. The upper floor is reserved as a residential home that is entirely private[5]. Originally were home to wholesale businesses, but due to modernization and business expansions, those activities have moved out and currently replaced with hip cafes and restaurants.

Fig.1- The site in the early 1960s. The Selected site is marked with dotted lines

The shophouses consist of several architectural styles, namely eclectic, early 'Teo Chew' style, modernist, art deco, palladian and neo-classical. These different architectural styles are largely influenced by the rich history of Johor which developed during formal colonialism era[6].

Computational Design

Traditionally, designers use pencil and paper to visualize and rationalize their designs. When computer-aided design (CAD) software is introduced, designers gradually adopt the tool to replace the traditional method. However, designers do not necessarily migrate their design process onto the new platform, but rather adopts them to expedite the visualization and production process so they could spend more time developing the design through the process. So instead of computer-aided design, CAD was more computer-aided drawing.[7]

It was not until the introduction of parametric design that new tools were introduced for the designers to play with. Parametric design allows designers to use a set of parameters and rules in a vast and complex

[3] 201516-2 3rd year Design Brief, 2015
[4] Shophouse is a typical commercial shop building common in Southeast Asia, usually two to three stories high.
[5] Yeang, 1987
[6] Yeow, 2016.
[7] Yeow, 2016

environment to govern complex geometries and systems. Utilizing it enables more elaborate and intricate designs to be achieved faster and more efficient, as most of the calculation process is taken over by the computers.[8]

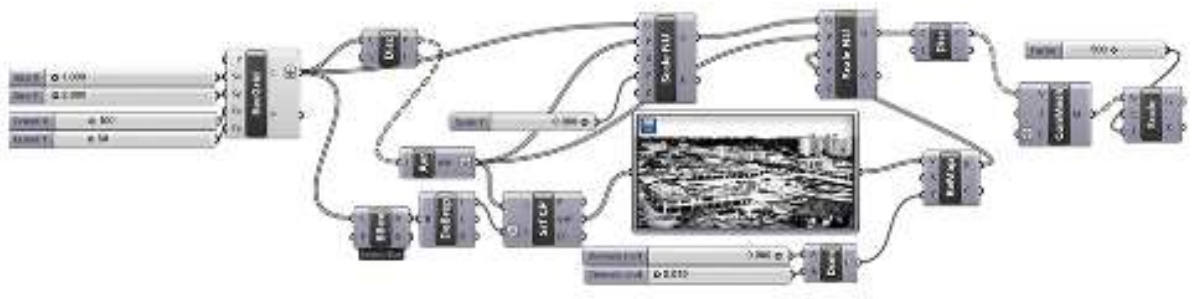

Fig.2- Diagrammatic representation of the script

In this project, the designer scripted the algorithm on Grasshopper developed by David Rutten, and runs within Rhinoceros 3D environment. It allows the designer to visually construct algorithmic modelling to manipulate the design using visual diagrams. The designer used samples of old photos from the site as the randomizer. Utilizing the Image Sampler tool in Grasshopper, the image supplies data that is used to feed the algorithm.

The Translation Process

Information on the dimensions from the neighbourhood shophouses were collected within 200 meter radius to be used as the data domain. The data is then interpolated with the red, green, and blue values (RGB) extracted from specific grid points. The distinct values on each point govern the dimensions for the blocks. Apart from that, the brightness value is also mapped to the angle data, governing the rotations of the blocks.

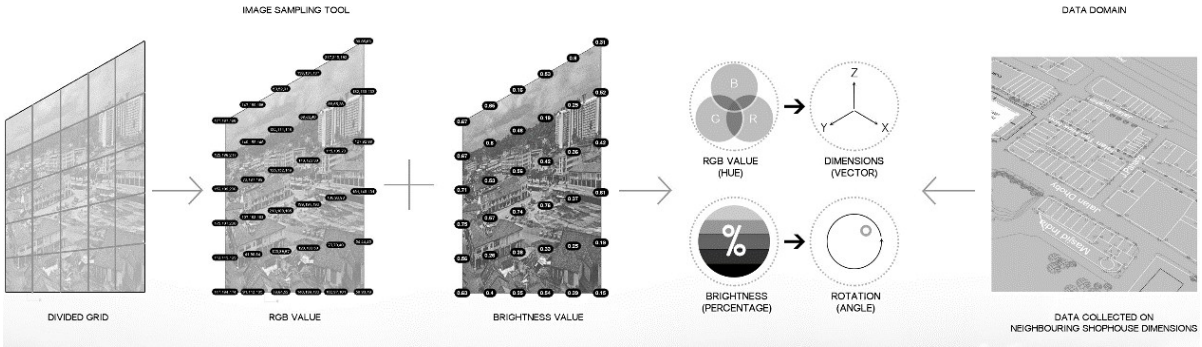

Fig.3- 2D to 3D Translation Process.

A series of rules were setup in the algorithm to control how information is translated, and this is a complete prerogative of the designer. A degree of rationalization and justification were required on each of the processes by the tutor, and this allowed the designer a considerable freedom to determine the outcome of the algorithm. The rules can be simplified in the figure below:

[8] Jabi, 2013

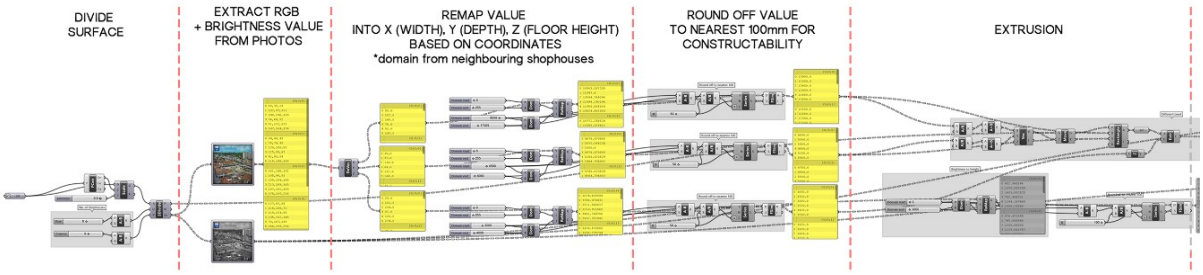

Fig.4- Steps 1 to 5 (out of 9)

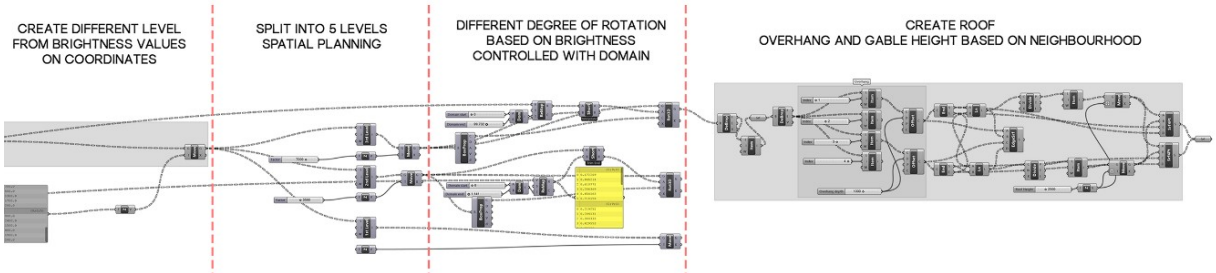

Fig.5- Steps 6 to 9 (continued)

When approaching the initial development process, it is imperative that the basic boundary rules are established. The intention is to provide a governing parameter that inhibits or limits the outer range of the algorithm. Imposition of the outer limits should also allow the design to conform to the existing site boundaries.

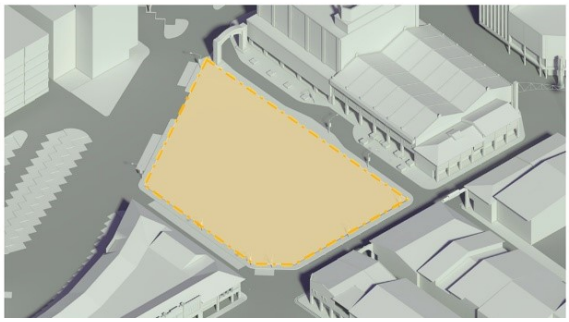

Fig.6- Site Boundary

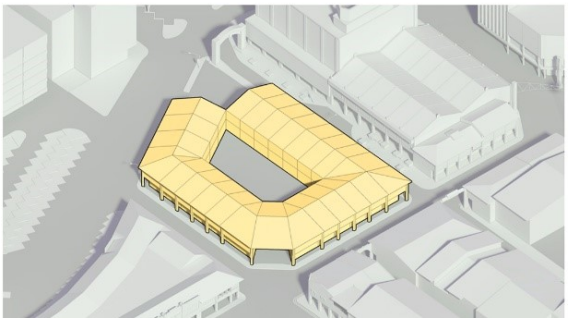

Fig.7- Restoring Pre-existing Building Form

The designer proposed early in the process to reintroduce the pre-existing shophouse layout on the now vacant site. It was previously in a very dilapidated state and was eventually demolished to make way for a new development. The designer decided that reviving the perished buildings would be the logical in respect to the site's rich history and culture.

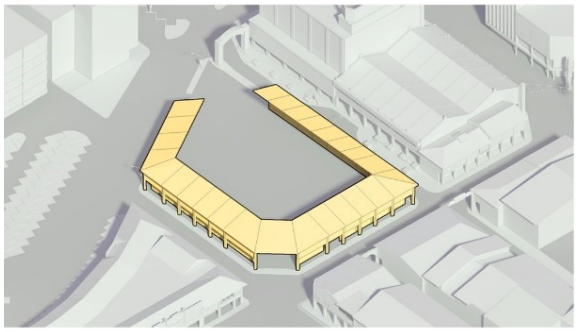

Fig.8- Remaining 'Kaki Lima'

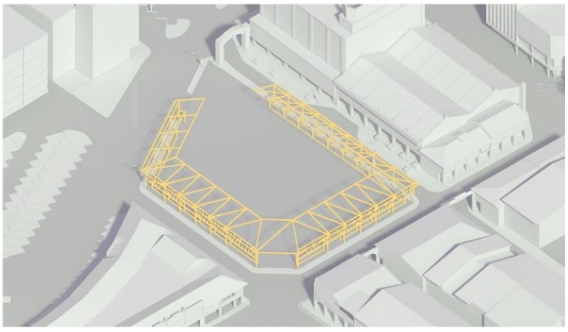

Fig.9- Exposing the Structures

Later during the exploration and development of the permutations generated by the algorithm, the designer made a conscious decision to tone down the scale of the revived buildings. Several proposals were discussed, from leaving structural walls to keeping only the traditional roof elements. Eventually, the tutor and the designer decided that restoring the kaki lima (five foot walkway) and maintaining the corridor was the best way to respond to the neighbourhood's commercial context as well as its physical character.

In addition to that, the designer also attempted to incorporate traditional elements from the existing historical context into the design. Elements such as the vertical privacy segregations (between commercial and residential areas of the shophouse), internal courtyard and also continuous unbroken five foot walkway are maintained in the design (Fig.10).

At this juncture, the designer will use the conceptual rules to help him determine which permutation is the most suitable for the design.

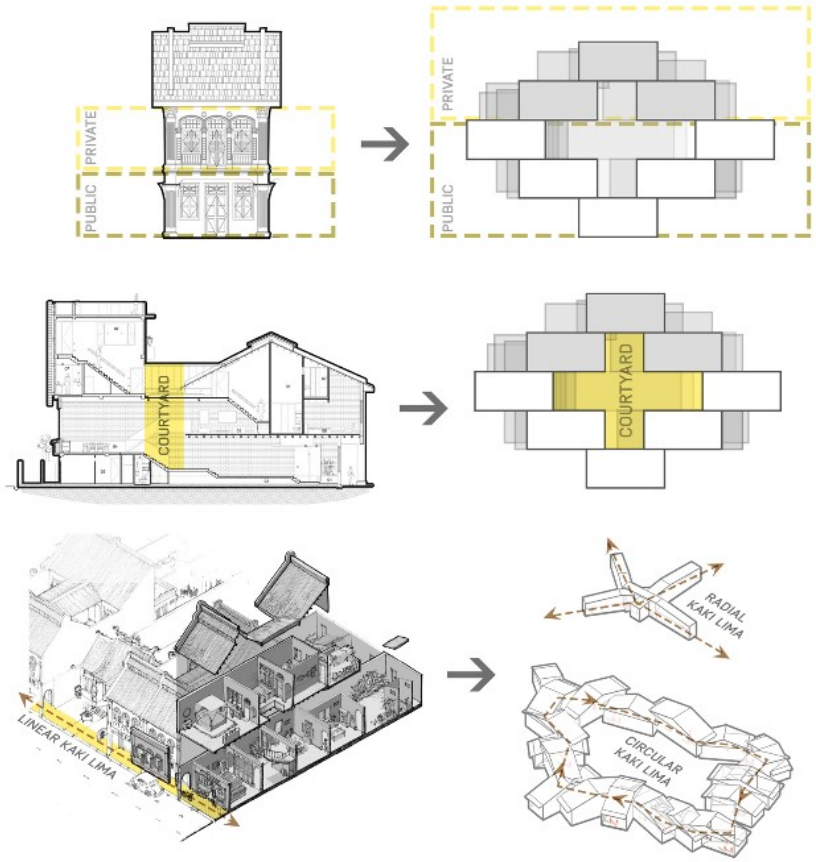

Fig.10- Series of traditional concepts being translated into the proposed design

Sampling and Permutations

The designer used different photos acquired from the site to produce different permutations that utilizes the geometry. The geometry is based on the basic shophouse external form where the dimensions are maintained proportionately using the algorithm. The exact dimension, location and rotation of each of the shophouse forms or blocks is controlled by the algorithm.

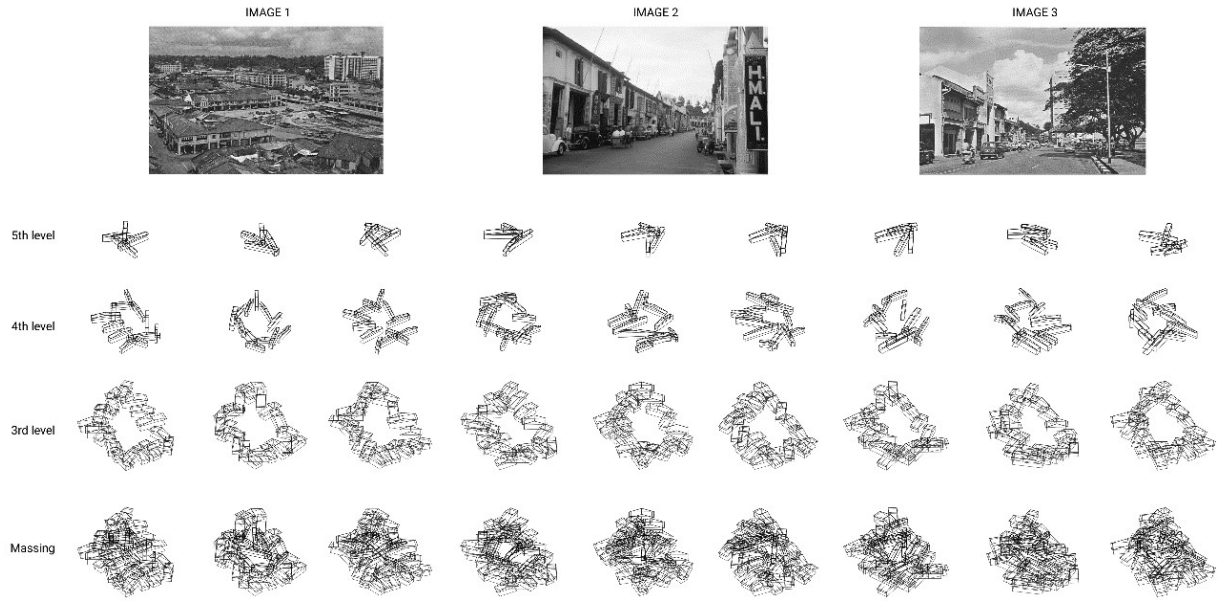

Fig.11- Permutations from three different image samples

The figure above demonstrates different permutations of the geometry based on different images fed into the algorithm with different rotation domain. The elaboration of the geometry is also being actively controlled to minimize structural issues later. This generated a complex collection of modules at the 3rd level and gradually becomes simpler on the upper levels. The outcome is a unique geometry that is specific to the site based on the image used as randomizer (figure below).

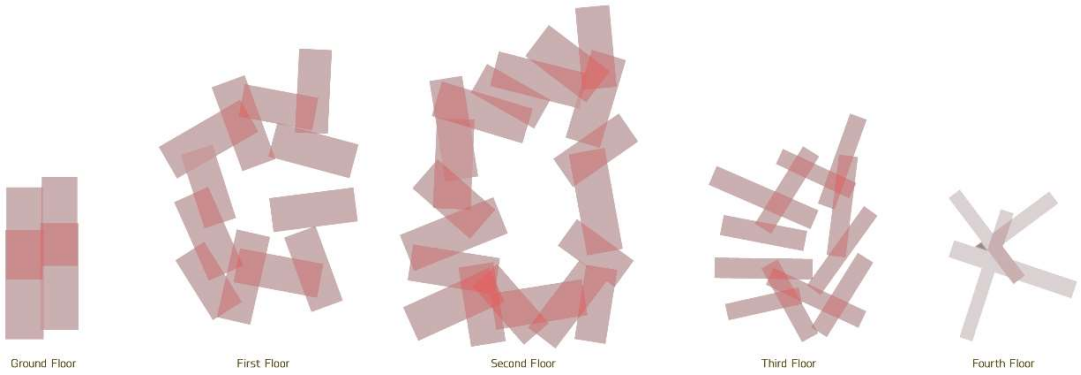

Fig. 12- The chosen permutation of the block layout

Additional Application

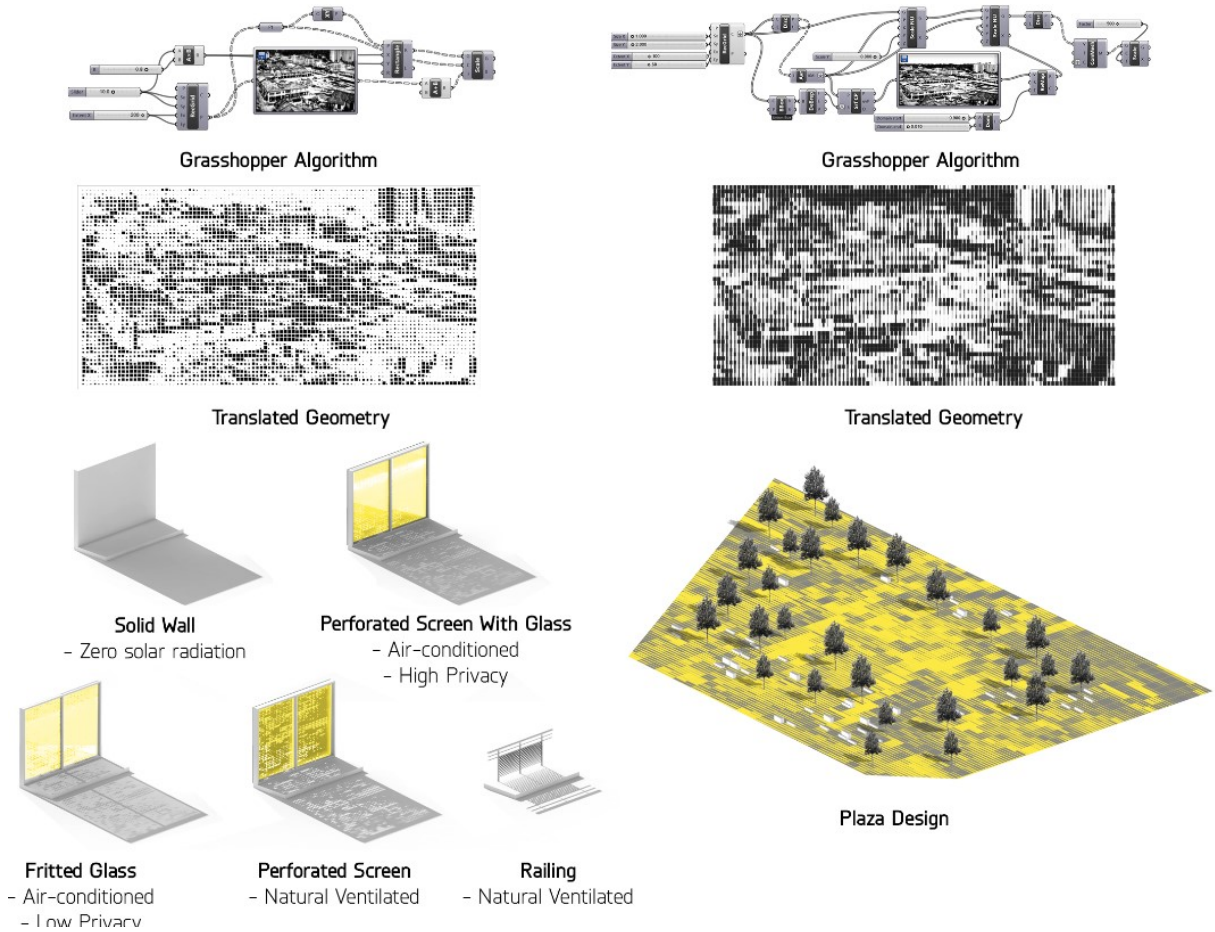

Fig.13- Facade and plaza design

During the development process, the designer also decided to use the algorithm to create two dimensional patterns. The intention is to create perforations on screens and walls that functions as an alternative to windowed louvres[9]. A repetition of square patterns were used as a motive, creating perforations and frits on glass, and installed as part of the façade. The same is also used for the plaza design where rectangles create formations for grass and decking.

Discussion on Outcome

The thesis is an experiment on using generative design to explore architectural form. Using the elements from existing contextual language, the designer selected the old shophouse feature to enrich the design vocabulary to create bold and exciting architectural form. At the centre of the study is the possibility of utilizing computational design to attract interests amongst young designers towards historical studies.
What Yeow Yann Herng as the designer had explored is just one instance of what could be done. In the interest of his thesis and the theoretical nature of the project, the School encouraged him to explore the full extent of the form making process.

[9] Louvred windows are a common element in Southeast Asian vernacular architecture that maintains ventilation flow but blocks views and excessive sunlight.

Fig.14- Elevation of the Final Design (Johor Bahru City Gallery)

The form generation utilizing historical elements approach is not fully developed at this point. There are plenty of weaknesses that should be addressed in the future design studio:

i. Neither the tutor nor the designer had a lot of experience in using Grasshopper within Rhino 3D environment.
ii. The designer needs to make quick decisions based on a large number of permutations that is churned out by the algorithm.
iii. There is also the dilemma of how much the designer should meddle in the permutations to produce a favourable outcome.
iv. At this level the designer had less time to resolve the technical issues to make the building functional and produce proper architecture.

Future

At this point, one instance is not enough to gauge the feasibility of this approach to promote interest towards heritage in young designers. The design mini-thesis situated at the end of the architectural studies is a good place to observe trends among students as they are allowed to choose the path they're interested in.

The example illustrated by Yeow here shows a daring and deliberate interpretation of heritage elements, not shying away from breaking norms. The School's reaction is mixed; almost half of the Department members are reluctant to acknowledge that it was a heritage-based project. The end product was too outlandish that it doesn't conform to any traditional design approach. The others encouraged further exploration, albeit suggesting control and additional parameters to relate back to conventional approach practiced in the 3rd year group.

Nonetheless, it has been a fruitful venture. It is hoped that this approach would entice more architectural students to venture back into heritage in their design studio projects. Heritage-based projects do not necessarily have to be restrictive and routine. As the interest builds, it is hoped that designers with more experience in computational backgrounds would undertake similar projects, helping to build a wider and stimulating design glossary.

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ICOA736: UTILISER LES ALGORITHMES DE CALCUL GENERATIF DANS L'INTERPRETATION DES ELEMENTS HISTORIQUES DE LA CONCEPTION ARCHITECTURALE

Sous-thème 03: Protéger et interpréter le patrimoine culturel à l'ère de l'autonomisation numérique

Session 2: Utilisation de la technologie numérique pour la diffusion et l'interprétation
Lieu: Silver Oak 2, India Habitat Centre
Date et heure: 13 Décembre, 2017, 16:45 – 17:00

Auteur: Azari Mat Yasir and Yeow Yann Herng

Azari mat Yasir est un conférencier à l'Université Technologique de Malaisie, où il a obtenu son diplôme en architecture avant d'obtenir un Master en environnement bâti (environnement virtuel) à l'University College de Londres. Azari est membre du Conseil d'accréditation et d'enseignement de l'architecture en Malaisie auprès du Conseil des Architectes malaisien, et co-auteur du manuel d'accréditation actuellement utilisé par les écoles d'architecture en Malaisie. Azari est actuellement en train de préparer son doctorat en Education de l'architecture à l'Université Technologique de Malaisie.

Résumé: La conception assistée par ordinateur en architecture a évolué si rapidement au cours des dernières années que les écolesd'architectures sont de plus en plus nombreuses à l'ouvrir incluse dans leurs programmes. Avec des logiciels et du matériel informatique devenus plus abordables et accessibles, les étudiants en architecture ont désormais la possibilité d'élargir le champ, y compris vers une nouvelle approche de l'interprétation du patrimoine et de l'architecture historique.

Cet article aborde la façon dont la conception informatique est utilisée pour générer un nouveau langage de construction dans le contexte d'une zone patrimoniale intégrée dans un tissu urbain plus général. Le site est situé dans la vieille ville de Johor Bahru, une ville avec une longue histoire et une culture riche, située sur la pointe sud de la péninsule malaisienne.

Le projet de conception théorique tire parti des riches éléments patrimoniaux situés dans l'environnement immédiat en utilisant des algorithmes gérés par Grasshopper du logiciel de modélisation 3D Rhinoceros. Le traitement consiste à extraire des éléments et des caractéristiques architecturales des hangars traditionnels de Johor environnants et de les utiliser en tant que générateurs de forme, ce qui produit une interprétation contemporaine spécifique au site.

Le résultat que nous en avons tiré est déséquilibré, audacieux et agressif ; mais le procédé fournit un aperçu de la façon dont la conception informatisée pourrait être utilisée pour produire une architecture alternative captant les éléments historiques et culturels et respectant son environnement.

Mots clés: *patrimoine, interprétation, informatisation, adaptation*