Kaloyan Tomov

Building Information Mega-puzzle

Master thesis at Chalmers Architecture
PROJECT DESCRIPTION:

The project is about creating a design process. It's exploring the use of computational tools to enhance the decision making in early project stages. The process includes both quantitative and qualitative approach in its evaluation. It's based on my findings of an existing method. It consists of an instruction with a set of rules and an example of how they can be applied.

The process of Building Information Modelling – It is a technology-based approach to design and construction, based on digital information. This information contains key physical and functional characteristics.

“BIM HAS SO FAR FOCUSED ON INTEGRATING PERFORMANCE AND MAINTENANCE FEATURES, SUCH AS PRODUCTION, BUDGET AND QUALITY. HOWEVER, UNLESS NEW TOOLS SUGGEST ALTERNATIVE VERSIONS TO DESIGN, IT IS AT BEST A SOFTWARE FOR PARTIAL APPLICATION, AND AT WORST AN UNDESIRABLE SOURCE OF CONFUSION. RATHER, WHAT WE NEED IS A RENEWED VISION OF THE DESIGN PROCESS, ONE THAT COULD MAKE BETTER USE OF NEW TECHNOLOGY” - RYUJI FUJIMURA, architect and author of "A SEARCH ALGORITHM FOR GENERATING ARCHITECTURAL FORM" and “SUPER LINEAR DESIGN PROCESS THEORY” from JA70 and A+U "Architectural Transformations via BIM"

Often there's a lack of individual assessment (characteristic of traditional design methods) when the process is based on a digital model environment explicitly. The author of this model calls for a process of repeated collaborations and gradual revisions called 'Super Linear Design Process Theory'. At every step a model is made, followed by an analytical phase, that records all changes before moving on (case study page 1). In this way, they try to avoid shortcutting into the design phase. This would mean proceeding with a predetermined image of how the concept would look like. The SLDPT allows the building to materialize through the design process.

However it focuses on systematic documenting of information and collaboration/coordination.

I will remodel the structure behind this theory, using computational tools. My goal is to reinforce the design process with both quantitative and qualitative approach. I will examine the new structure and its implications on the design process, and test it on a site.
A quick search into the most commonly used approaches in design processes. All phases in the design can be commonly grouped into Brief, Design and Drawings. The brief is the program defined. The analysis part can be specified with studying existing conditions and form finding, followed by the summary – defining function and relationship between the building volumes, fitting the program and evaluation. The implementation and communication refer to how the building comes together – model making, drawings.

1. Series continuous linear steps with no redoing in back and forward movement.
2. This one involves no steps, everything is happening in the same time.
3. Investigative. This one is more exploratory. Each step is based on a selective investigation process of ideas and solutions. One idea leads to more ideas and eventually a solution is chosen.
4. Opposite to the exploratory. A linear process that involves redoing the initial idea, forming divisions of options at different steps.

The analysis and summary phases in this model is what my design process is focusing on (does not involve creating the initial building form, neither building design nor drawings). Let’s take a closer look.
INTRODUCTION

The process of Building Information Modelling – it is a technology-based approach to design and construction, based on digital information. This information contains key physical and functional characteristics.

"BIM HAS SO FAR FOCUSED ON INTEGRATING PERFORMANCE AND MAINTENANCE FEATURES, SUCH AS PRODUCTION, BUDGET AND QUALITY. HOWEVER, UNLESS NEW TOOLS SUGGEST ALTERNATIVE VARIATIONS TO DESIGN, BIM IS JUST A NUMERICAL APPROACH TO KEEP TRACK OF THE UNDESIRABLE SOURCE OF CONFUSION: RATHER, WHAT WE NEED IS A RENEWED VIEW OF THE DESIGN PROCESS, ONE THAT COULD MAKE BETTER USE OF NEW TECHNOLOGY" - RYUJI FUJIMURA, architect and author of "A SEARCH ALGORITHM FOR GENERATING ARCHITECTURAL FORM" and "SUPER LINEAR DESIGN PROCESS THEORY" from JA70 and A+U "Architectural Transformations Via BIM".

In parametric environments it is possible to associate geometric elements with a number of factors: constraints, structural feedback, program necessities... This helps the design team to structure meaningful relationships between geometry and build up hierarchies of relationships. This allows to embed a higher level of design intelligence than before. This association allows us to make our design decisions explicit. Then the team can question and inform these decisions, hopefully leading to better and more feasible design. Moreover the model is dynamic and variable and it can easily be tested in different configurations, even though initial setup can take long. Furthermore this can now be done in a very early stage.

Often there is a lack of individual assessment (characteristic of traditional design methods) when the process is based on a digital model environment explicitly. The author calls for a process of repeated collaborations and gradual revisions called "Super Linear Design Process Theory". It advocates the emerging of a process of repeated collaborations and gradual revisions:

"At every step a model is made, followed by an analytical phase that records all modifications before moving on. Ultimately, this produces an iterative body of work that resembles the apparently sporadic cycle of fish movement, and thus beautifully materializes over time. In this way, he less to avoid shortcutting into the design process. This would mean proceeding with a predetermined image of how the concept would look like.

The strength of this theory is that the morphology of a building evolves from responding to new layers of information and every modification is precisely reflected in each design variation. The project acquires its character through specificity.

However this method uses features of BIM technology like sharing and systematic archiving of information.

STATEMENT

The building complex consists of residences and a retail in downtown Tokyo. The mega-structure that contains facilities and structure regained a common external space usually covered with air conditioning and plumbing equipment as a place for life.

The process of starting with a simple form, then interpreting the exterior environment, program and other information and gradually evolving into a complex form. It's like the growth process of an organism. Each stage of development is the adaptation of a new form. This method uses features of BIM technology like sharing and systematic archiving of information.

DESCRIPTION

I'd will remodel the structure behind this theory, using different application of BIM. My goal is to reinforce the design process with both quantitative and qualitative assessment. I'd like to examine the new structure and its implications on the design process, and test it on a site.

VISION:

Making faster and more efficient decisions in the early design stage by combining generative design with the quality of individually assessed design.
BUILDING INFORMATION MEGA-PUZZLE
FOR CONCEPTUAL DESIGN

RULES OF PLAY

HOW TO PLAY

WHAT IS THE OBJECTIVE?
The object of the game is to reach the most-efficient design solution, while completing all steps and fulfilling criteria.

VICTORY:
The sequence of iterations that passes all comparison filters is considered successful.

GAME MODE

» analytical mode
1. Choose a site
2. Define site parameters
3. Run SETUP: specify components, establish relationships between them and link to the site
4. Start playing and perform action steps for each scenario

» intuitive mode (physical model)
With the intuitive mode you can study design operations, that are not explored in the example (analytical mode)

ACTIONS IN SCENARIO:

1. Create scenarios based on parameters (each scenario consists of process branches - horizontal sequence of decision making in the process layout and steps - showing the progress of geometry change or evaluation step by step within the branches)

2. Generate geometry, based on found typology or previous games

3. Inject site specific parameters and use the demands and criteria

4. Make a design choice on the grey field ‘step’

5. Evaluate, display the results and explain. Results with lower value after first step are greyed out.

6. Make a new design choice as a follow-up to 5.

7. See if criteria for that scenario are fulfilled or go to 6.

8. Evaluate with another criteria (cross check)

9. Compare successful process branches and complete analytical mode

10. Proceed to physical mode or go back to Setup to reconfigure

COMPONENTS:

A SITE

B TYPOLOGY

C CRITERIA FOR SUCCESS

Listed further down

D SCENARIOS

The scenarios are consequence to the chosen parameters + a set of rules

COMPONENTS’ PROPERTIES:

A SITE

B TYPOLOGY

C CRITERIA

absolute demand - must be fulfilled
evaluation criteria - choice of individual assessment
design intention - check if the aesthetic idea is fulfilled

D SCENARIOS

environmental
social
economical
design aesthetics

GO!
A proposal for developing the area in specific came up in the early 2012. The site lies on the outer Hisingen area, near the foot of Ramberget. Dates casting deep shadows during winter sun. Additionaly, the proximity to Lindholmen and Port Line for rail deliveries to the outer port areas can mean noise and this needs to be investigated. Noise from traffic areas can mean noise and this needs to be investigated. Noise from traffic areas can mean noise and this needs to be investigated.

Old machine shop, M3: an, built in 1906 and extended in 1946. The house was added in two phases. Today, the eastern part workshops and the western part is rebuilt to office. The facade is in manor brick. In the west façade is visible from several direction, combining two different styles, and some of the long side treats planning area.

The oldest building on the site, M1. Built in three parts, very distinctive workshop building. Extended in 1940. The highest building part is prepaing to be converted to office use.

Exit of the planning area are two engineer- ing workshops from 1940 converted into offices and other business premises. The house closes Lindholmshamn also accommodates parking. The houses are clearly visible due their large volumes and characteristic expression.

 Newly built offices at the south side of the plot, next to the Lindholmen pier. The area near the site is still in construction.

The hotel is 9 floors high, there is an opportu- nity to extend it. Further towards Lindholmen it is a reason for tip overwhelm- ing us to half of the plot during winter sun.

Lindholm can be reached either by bus going in Lindholmen or by ferry to Göta River. Lindholmshamn is the main street for rail, double transpant etc main road. This is connected to the other areas Via walking and cycling. Opens a view towards a forest hill.

The proximity to Lindholmen and Port Line for rail deliveries to the outer port area can mean noise and this needs to be investigated. Noise from traffic areas can mean noise and this needs to be investigated.
A BIG PART OF THE SOUTH HARBOUR WAS FILLED WITH WASTE IN THE PAST AND LATER IT WAS AN UNATTRACTIVE AREA TO SETTLE IN. NOW SUCCESSFULLY TRANSFORMED AND DEVELOPED INTO A RESIDENTIAL COMPLEX WITH COMMERCIAL PART AND ACCESS TO RECREATIONAL AND RECREATIONAL SPACES AND A HARBOUR BAY. IN THE DESIGN OF THESE BUILDINGS, HAS BEEN VERY IMPORTANT TO CAPTURE THE ATTRACTION TO THIS LOCATION, WHILE ЕNSURING THAT THE HOUSES HAVE THE BEST ORIENTATION TO THE SUN.

FOR EXAMPLE, A FOCUS HAS BEEN THAT ALL APARTMENTS ARE PLACED TOWARDS THE NORTH WHERE AN ELEVATED FACADE FACING THE WATER IS INCREASED. SIMILAR TO THE IDEA WITH LINDHOVEN. HERE, WE HAVE THE CITY LIFE’S PULSE IN CLOSE PROXIMITY TO HOUSING. THIS SITE HAS SIMILAR CONDITIONS TO THE ONE ON LINDHOLMEN. ACCESS TO WATER IS A UNIQUE ADVANTAGE OF THIS SITE. WHAT IF INDUSTRIAL LOOK CAN BE, BEYOND AS A PARAMETER AND WHAT ARE THE SPECIFICATIONS OF THIS PARAMETER?

In the following example, I choose all typology, criteria and exploitation ratio, wind speed and solar radiation/view from the scenarios, considering them most relevant to the site.

THE FOLLOWING IS BRIEFLY SHOWING THE ARRANGEMENTS OF THE BUILDING VOLUMES OVERALL IN RELATION TO EACH OTHER’S POSITION ON THE SITE, DESENGAGING THE TYPOLOGY, WHEN CONNECTING THE BUILDING ACTIONS TO THE TYPOLOGY THAT WILL BE USED, THE OFFICE WILL BE FIXED TO A POINT TYPE, AND THE HOUSING WILL HAVE BLOCK AND LAMELLA TYPE.

**SITE**
- lamella
- block
- point

**TYPOLOGY**
- absolute demand - must be fulfilled

**CRITERIA**
- evaluation criteria - choice of individual assessment
- design intention - check if the aesthetic idea is fulfilled

**SCENARIOS**
- environmental
- social - pedestrian flow (evaluation criteria)
- economical - exploitation ratio (absolute demand)
- design aesthetics - industrial look (design intention)

**COMPONENTS: DETAILED INSTRUCTIONS**

### Criteria in detail:

**ABSOLUTE DEMANDS**
- THE CRITERIA Tries to fulfill the most important and critical part of developing the site parameters that is often the main goal of an architectural program. This criteria must be met, least qualitative assessment of the geometry's form and function.

**EVALUATION CRITERIA**
- CRITERIA WHICH EVALUATES GENERED DESIGN, BUT IS MAINLY INDIVIDUAL THINKING STUDYING THE POSITION OF THE VOLUMES/VECS INFORMATION ABOUT PROBLEMATIC AREAS, THEN THE DESIGNER'S CHOICE DETERMINES WHAT THE ACTUAL DESIGN SOLUTION WILL BE, WHICH WILL BE EVALUATED IF NECESSARY.

**DESIGN INTENTION**
- MOST QUALITATIVE ASSESSMENT AND ARCHITECTURAL CHOICE, IN THIS PAR ALL PROPOSED OPERATIONS ARE BELONG DEPENDENT ON THE DESIGNER'S CHOICES AND HOW THE PARAMETER(S) OF QUESTION ARE BEING HANDLED.

**RESULTS - SUCCESSFULLY DEVELOPED BRANCHES**
- THE PROCESS RUNS SIMILARIZED BY 2 DIFFERENT SCENARIOS, WITH FOCUS ON DIFFERENT PARAMETERS, AFTER THE CRITERIA of FOCUS HAS BEEN MET, THE PAREMETERS OF THE OTHER SCENARIO SHOULD ALSO BE EVALUATED [cross check - refer to the flow chart on the previous pages] BRANCHES THAT PASS THAT EVALUATION ARE CONSIDERED SUCCESSFUL, THE BEST END WITH A BLACK AND WHITE IMAGE

### Criteria and parameters:

**ABSOLUTE DEMAND**
1. OPTIMIZING THE EXPLOITATION RATIO (FAR) FROM MINIMUM 1.75 [THE MINIMUM DENSITY FACTOR FOR RESIDENTIAL AND OFFICE BUILDINGS COMBINED] AND MAX. 10
2. MAXIMIZING NUMBER OF APARTMENTS FACING THE WATER (SOUTH)
   1. MIN. DISTANCE BETWEEN BUILDINGS 10 m
   2. WIND SPEED WITHIN THE SITE < 5 m/s
3. MINIMUM OF 400 APARTMENTS, WITH A DIRECT VIEW TOWARDS THE WATER/HARBOUR /SOUTH DIRECTION/ THAT CONSTITUTES 6000m². This criteria can be used for a cross check/evaluation of an additional parameter

**EVALUATION CRITERIA**
1. LEVEL OF SATISFYING THE CRITERIA FOR WIND SPEED
2. LEVEL OF MAXIMIZED SOLAR RADIATION/view to the harbour
3. LEVEL OF SATISFYING THE CRITERIA FOR WIND SPEED /STILLNESS/
4. LEVEL OF MAXIMIZED SOLAR RADIATION
5. LEVEL OF FULFILLMENT OF THE INDUSTRIAL LOOK INTENTION

**DESIGN INTENTION**
1. INDIVIDUAL ASSESSED DESIGN
2. GENERATED DESIGN

**NOTE:** FIRST PARAMETER TO BE INVOLVED IN THE EXAMPLE IS THE EXPLOITATION RATIO (FAR), IT DETERMINES WHICH ITERATIONS QUALIFY TO GO ON TO THE NEXT STEP. FURTHER BOTH FAR AND THE DIFFERENT SCENARIO PARAMETERS ARE CONSIDERED
OVERSHADOWING FROM THE HOTEL
FLEXING VOLUME TO AVOID OVERSHADOWING FROM THE OFFICE AND
10 floors residential, 15 floors office

SUN/SHADOW STUDIES - WINTER SUN

6.5

7900 m

2 SFA

Fulfille absolute demand
Facade area, facing the water is more than 6000 m

5.3 FAR

Pitching roofs to let the light deeper in

4.2 FAR

Equal distribution

Wind turbulence in the inner space, exceeding 5 m/s

SUN/SHADOW STUDIES - WINTER SUN

5.3 FAR

2 SFA

Connecting the south and north part

INCREASING BUILDING VOLUME

6.5

7900 m

2 SFA

Fufill absolute demand
Facade area, facing the water is more than 6000 m

5.3 FAR

Pitching roofs to let the light deeper in

4.2 FAR

Equal distribution

Wind turbulence in the inner space, exceeding 5 m/s

SUN/SHADOW STUDIES - WINTER SUN

5.3 FAR

2 SFA

Connecting the south and north part

INCREASING BUILDING VOLUME

6.5

7900 m

2 SFA

Fufill absolute demand
Facade area, facing the water is more than 6000 m

5.3 FAR

Pitching roofs to let the light deeper in

4.2 FAR

Equal distribution

Wind turbulence in the inner space, exceeding 5 m/s

SUN/SHADOW STUDIES - WINTER SUN

5.3 FAR

2 SFA

Connecting the south and north part

INCREASING BUILDING VOLUME

6.5

7900 m

2 SFA

Fufill absolute demand
Facade area, facing the water is more than 6000 m

5.3 FAR

Pitching roofs to let the light deeper in

4.2 FAR

Equal distribution

Wind turbulence in the inner space, exceeding 5 m/s

SUN/SHADOW STUDIES - WINTER SUN

5.3 FAR

2 SFA

Connecting the south and north part

INCREASING BUILDING VOLUME

6.5

7900 m

2 SFA

Fufill absolute demand
Facade area, facing the water is more than 6000 m

5.3 FAR

Pitching roofs to let the light deeper in

4.2 FAR

Equal distribution

Wind turbulence in the inner space, exceeding 5 m/s

INCREASING BUILDING VOLUME

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED

Facade area, facing the water

Wind conditions are acceptable

ANALYZING WIND SPEED
CONCLUSION:

The result in the example is NOT to be seen as an image of a building, but a matrix, a new design process embracing the very early design stage. It shows exemplification of how the use of digital analysis tools can be applied in those stages.

What aspects of SLDPT are improved?

The formed process can be viewed as a theoretical design tool/guide – easy to use, accessible and routine based. The part with the physical model presents different media to explore the process in a more intuitive way (and also loops back to the original theory). There you can easier discuss and present your idea to anyone.