Methods and Tools for Urban Design

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Accelerated Urbanization in Asia

- Urban population is lower than Europe
- But the rate of urbanization is much higher
- This results in an accelerated urbanization process
  - For example: Delhi Mumbai Industrial Corridor

Delhi Mumbai Industrial Corridor

- Mega project between the political capital and the business capital of India
- Includes building new ‘mega cities’ from scratch
- E.g. Gujarat International Finance Tec-City
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Planning Support Systems

• A collective term for a wide variety of tools (Harris, 1989)

• The tools emerged in the 1980s

• Initially focused on municipal information systems and land use-transportation models

• By the 1990s, cheap PCs and GIS based planning systems
The Challenge in Practice

- Dynamic processes
- Collaborative work
- Time constraints
- Skill constraints
- Tools constraints
Context

Issue

Case Study

Stage 1
Data Collection

Parametric CAD to GIS

Stage 2
Data Synthesis

Parametric CAD to Game Engines

Stage 3
Data Mining

Future work

Conclusions
Case Study

- International Forum on Urbanism (IFoU)
- 2015 winters school in Singapore
- Topic
  - In collaboration with Jurong Town Council (JTC)
  - Transform Jurong West area into an Industrial City
- http://ifou2015.sg
The transformation of the Jurong West area from an almost mono-functional, segregated and fragmented, highly polluted industrial area into a major catchment area for future population growth that integrates clean(ed) industrial plants with green lungs, attractive housing and vibrant urbanity for one million people.
5000 Hectares
1,000,000 people by 2050
Team 9

- IFoU studio
  - Jaume Pla
  - Goh Jia Li
  - Geraldine De Neuvile
  - Ravish Kumar
  - Delon Leonard
  - Made Perwira
  - Tanzir Taher
  - Marco Berger
  - Josef Odvarka
  - Xiameng Jia
  - Meng Jing
  - Peter Lie
  - Fei Bo
  - Zhao Danyu
  - Jasmin Mok
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  - Jasmin Mok
Quantification?

- In general, there was a lack of quantified evidence

- Problems with working at large scale
  - Quantifying floor areas
  - Quantifying densities
  - Quantifying travel distances
  - Quantifying ...
Stage 1
Data Collection
Parametric CAD to GIS

Stage 2
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Future work
Conclusions
Data Collection Methods

- Downloading
- Tracing
- Web scraping
Downloading

- Government data portal
- 8600 datasets (textual and spatial) from 60 government ministries and agencies
Tracing

- Maps from OpenStreetMap had to be corrected
- Only method was to trace the images from data.gov.sg
Web Scraping

- A technique of extracting information from websites programmatically.
- Used to collect data
  - public housing types
  - business listings

http://search.ingsing.com/singapore/browse/art-galleries
Web Scraping

Housing Type Data

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Geospatial Address Point Data

Join by Postal
Synthesis tools

• Tools are needed to generate large-scale 3D models
  – Generation process needs to be highly automated
  – Designers need to be able to define
    • Typologies
    • Urban variation
Experiments with Esri CityEngine

- Very good at making models for visualization
- But level of automation is limited
Experiments with Sidefx Houdin

- Parameters
  - Floor Area Ratio
  - Number of floors
  - Site coverage
  - Function
Project 1: Ecotopia

• Credits
  – Andrea Meinarti Rachmat, Tey Hui Ping Serene, Delon Leonard, Wu Xin Peng, Loh Sze Sian
  – Urban Planning Studio, 2014-15
  – Master of Urban Planning
  – Tutor: Prof Oscar Carracedo
Project 1: Urban Metabolism

• Credits
  – Ravish Kumar, Tulika Agrawal, Yuting Liu
  – Urban Design Studio 2
    2014-15
  – Master of Arts (Urban Design)
  – Tutor: Prof Jurgen Rosemann, Prof Low Boon Liang
Rule-base urban design

- Students defined sets of rules that controlled the urban fabric
- Rules were based on distances to certain elements
  - Train stations
  - Expressways
  - Waterfront
  - Canals
  - Parks
Project 1: Ecotopia
Version 2
Project 2: Urban Metabolism
Version 2
### Context

### Issue

#### Stage 1
Data Collection

#### Stage 2
Data Synthesis

#### Stage 3
Data Mining

### Case Study

- Parametric CAD to GIS
- Parametric CAD to Game Engines

### Future work

### Conclusions
2D Data mining
3D Data mining

- Solar radiation
- Scenic views
- Unobstructed views
Digital workflow

QGIS 2D → Shape file → Houdini 3D → OBJ file → Unity3d / Unreal 3D

QGIS 2D → Shape file → QGIS 2D

CityGML → FEEDBACK

Data Collection → Data Synthesis → Data Mining
GIS-based data mining

- Colour Maps
- Buffer Analysis
- Network Analysis
- Space Syntax

ANALYSIS

QGIS

2D
From 3D CAD to 2D GIS

• A GIS shape file is exported

• Data from the 3D model needs to be transferred to the 2D model

• This data can then be analyzed using existing GIS based tools
Parametric model

- Parameters are guides
- The model tries to satisfy the parameters
- ‘Intensity’ parameters are relative to one another
- Reducing plot ratio
- Constant intensities
- Constant plot ratio
- Increasing industrial intensity (red)
Data extraction from parametric model

Parameters

GIS
Shape File

Data

3D to 2D
Design decision support

• Workflow

1. Create parameter fields
   • 4 image maps for each option

2. Generate 3D CAD model
   • Full CAD model
   • Simplified GIS model

3. Analyze results in GIS
   • Quantitative design data
   • Buffer analysis
Option 1 – Parameter fields

Plot ratio

Industrial

Residential

Commercial
Option 1 – 3D CAD model
Option 1 – Data Analysis

1. People density
2. GFA
3. Building height
Option 1 – Buffer Analysis

- Total (residents): 910,000
- 300m buffer: 1% of residents
- 600m buffer: 6% of residents
- 900m buffer: 14% of residents
Option 2 – Parameter fields

Plot ratio

Industrial

Residential

Commercial
Option 2 – 3D CAD model
Option 2 – Data Analysis

1. People density
2. GFA
3. Building height
Option 2 – Buffer Analysis

- Total (residents): 650,000
- 300m buffer: 2% of residents
- 600m buffer: 9% of residents
- 900m buffer: 20% of residents
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Conclusions
From 3D CAD to 3D Game Engine

- Data from the 3D model is exported as an OBJ file

- The model can then be interactively explored with real-time effects
  - Rain
  - Wind
  - Noise
Visual analysis - Unity3D
Visual analysis - Unreal
Context

**Issue**
- Stage 1: Data Collection
- Stage 2: Data Synthesis
- Stage 3: Data Mining

**Case Study**
- Parametric CAD to GIS
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**Future work**

**Conclusions**
Network Analysis

- Network Analysis will allow a additional types of analysis
  - Isochrone analysis
  - Space Syntax analysis
  - Walkability analysis

- Requires a well defined network of roads, transport links, and other pathways
Isochrone analysis

- A map connecting points of equal times

- Requires a connected network with travel speeds define for each link in the network
Space Syntax Analysis

• Various types of centrality analysis

• Requires an axial map of the street network

• SpaceSyntax plugin exists for QGIS
Walkability Analysis

- For example, WalkScore
- Requires location of amenities such as shops and schools to be define
- For existing neighborhoods, the data can be extracted from OpenStreetMap
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Urban Optioneering Platform

- A future platform that integrates all these tools
  - Define ‘what-if’ questions
  - Build models
  - Explore models
Collaborators and credits

• Dr Rudi Stouffs, NUS
• Dr Zhang Ye, NUS
• Dr Zhang Ji, NUS

• Research assistants
  – Lin Xiong, NUS
  – Elvira Tan, NUS
  – Andrea Rachmat, NUS
  – Ravish Kumar, NUS
  – Delon Leonard, NUS

The End.