Densifying Istanbul
Final Review 12|16|2011

Team:
Anne Schmidt
Bing Wang
Nari Yoon
Timur Dogan
6th Century

Population Development & Urban Growth

Constantinople
Population Development & Urban Growth

Istanbul

Population (m)

1,000,000

1910

1900 1950 2000
Population Development & Urban Growth

Istanbul

Population (mths)

1,200,000

1955

1900 1950 2000
Population Development & Urban Growth

2,700,000

Istanbul

1970
Population Development & Urban Growth

Istanbul

6,500,000

1990

Population Development & Urban Growth
Population Development & Urban Growth

Istanbul

Population (in millions):

- 1900
- 1950
- 2000

8,700,000

Population Growth Over Time
TOKI Tower Blocks in Atasehir
Gated Communities
Fabric of Old Peninsula
"Loose teeth" in the Urban Fabric
“Loose teeth” in the Urban Fabric
Weave the Fabric
• Old construction
• Little open spaces
• Ventilation issue
• Daylighting issue

**Guidelines**
• Not high-rise apartments
• Less than 5 stories
• Providing public spaces for better communication of the neighborhood
• Preserve the existing urban scale

*Individual units are simplified/refined as show boxes for the sake of simulation.*
Fabric 1

- Ample open spaces
- Creating
- Improved ventilation and daylighting situation
- Higher building heights to make the same density as before
- Open to two facades
- Less flexible to be adjusted to the existing fabric

*Individual units are simplified/refined as show boxes for the sake of simulation.
• Open spaces
• Improved ventilation and daylighting situation
• Accessible by four sides
• Flexible to arrange

*Individual units are simplified/refined as show boxes for the sake of simulation.
Fabric 3

- Improved Ventilation
- Improved Daylighting Condition
- Use of the terrace/natural ventilation
- Less open spaces (but can be compensated by the roof terrace)

*Individual units are simplified/refined as show boxes for the sake of simulation.
Models on Site

Daylighting

Natural Ventilation

Idea of Natural Ventilation
UMI Simulation

**Existing Fabric**
- Total Urban Heating Loads: **29652.6 kWh**
- Total Urban Cooling Loads: **51181.8 kWh**
- Total Urban Lighting Loads: **39423.1 kWh**

**Fabric 1**
- Total Urban Heating Loads: **13556.3 kWh**
- Total Urban Cooling Loads: **36611.6 kWh**
- Total Urban Lighting Loads: **39863.8 kWh**

**Fabric 2**
- Total Urban Heating Loads: **18687.0 kWh**
- Total Urban Cooling Loads: **34874.7 kWh**
- Total Urban Lighting Loads: **39777.3 kWh**

**Fabric 3**
- Total Urban Heating Loads: **21469.3 kWh**
- Total Urban Cooling Loads: **25608.0 kWh**
- Total Urban Lighting Loads: **43262.6 kWh**
UMI Simulation

There are some **missing** factors in UMI Simulation

- **Daylighting Simulation**
  - UMI works with lighting schedule that we have made in DesignBuilder.
  - If letting UMI calculate lighting loads according to the sun position, it will take forever.

- **Ventilation Simulation**
  - UMI does not calculate ventilation values.
  - So we tried FlowDesigner8 as an alternative.
FlowDesigner Simulation

Olden Fabric

Existing Fabric

Fabric 2

Fabric 3
FlowDesigner Simulation

What we could find out from FlowDesigner Simulation are,

• Wind speed, wind pressure, and wind direction
• Sketchy idea how forms affect ventilation, thus how to design buildings according to different seasons, climates, etc.
• Neither evaluate thermal comfort nor energy

What we wanted to know more is,

• Quantitative Analysis
  o Energy Calculation

Therefore, we will introduce our new software that can explain daylighting and ventilation!

• UrbanDaylighting (UD) for Daylighting Simulation
• CFD Simulation for Natural Ventilation Simulation
GENERIC STUDY
WHAT IS THE RIGHT TYPOLGY?

Parameters of Comparison:
PAR (Floor-Area-Ratio: Plot size/Total floor area)
Energy Use: Heat Balance
Fuel Breakdown
Fuel Breakdown - Comb Building, 6 stories
1 Jan - 31 Dec, Monthly

FAR: 1.65
EUI: 85,473 Wh/sqm
Fuel Breakdown - Tower, 6 stories
1 Jan - 31 Dec, Monthly

FAR: 2.16
EUI: 87,728 Wh/sqm
FAR: 1.80
EUI: 85,952 Wh/sqm
Fuel Breakdown - Mat Building
1 Jan - 31 Dec, Monthly

FAR: 1.56
EUI: 87,063 Wh/sqm
Fuel Breakdown - Cross Building, 6 stories
1 Jan - 31 Dec, Monthly

FAR: 1.73
EUI: 86,479 Wh/sqm
Form matters?
winter wind coming from here.

summer wind coming from here!
HOW TO EVALUATE?
DAYLIGHT TOOL DEVELOPMENT

150 #BLINDCONTROL [WAIT]
0.4 #SHADING COEFFICIENT
0.4 #WINDOW TO WALL RATIO
500 #DAYLIT AREA TARGET ILLUMINANCE [LUX]
HOW DOES THIS TRANSLATE TO ENERGY?
READ CFD RESULTS
Workflow Diagram

LIBRARY
  CALCULATION
  WO SHADING

RHINO GEOMETRY

GRASSHOPPER

CFD ISOTHERMAL

URBAN DAYLIGHT SIMULATION

INTERIOR ILLUMINATION

EXTERIOR RADIATION

DAYSIM

Workflow Diagram
Air Temperature With and Without Natural Ventilation
Air Temperature Distribution With and Without Natural Ventilation
Ventilation Simulation
Pressure, Pa
6.782333
5.710696
4.639059
3.567422
2.495785
1.424148
0.352511
-0.719127
-1.790764
-2.862401
-3.934038
-5.005675
-6.077312
-7.148949
-8.220586
-9.292223
-10.36386

Probe value
-0.432203
Average value
-0.325226

0-case4-3
Probe value
-0.537239
Average value
-0.367854
Total Site Energy Per Total Building Area [kWh/m2]
Thank you for your attention