Adaptive Building Skin

Master Project Studio_Spring 2010_Illinois Institute of Technology
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BUILDING FACADE

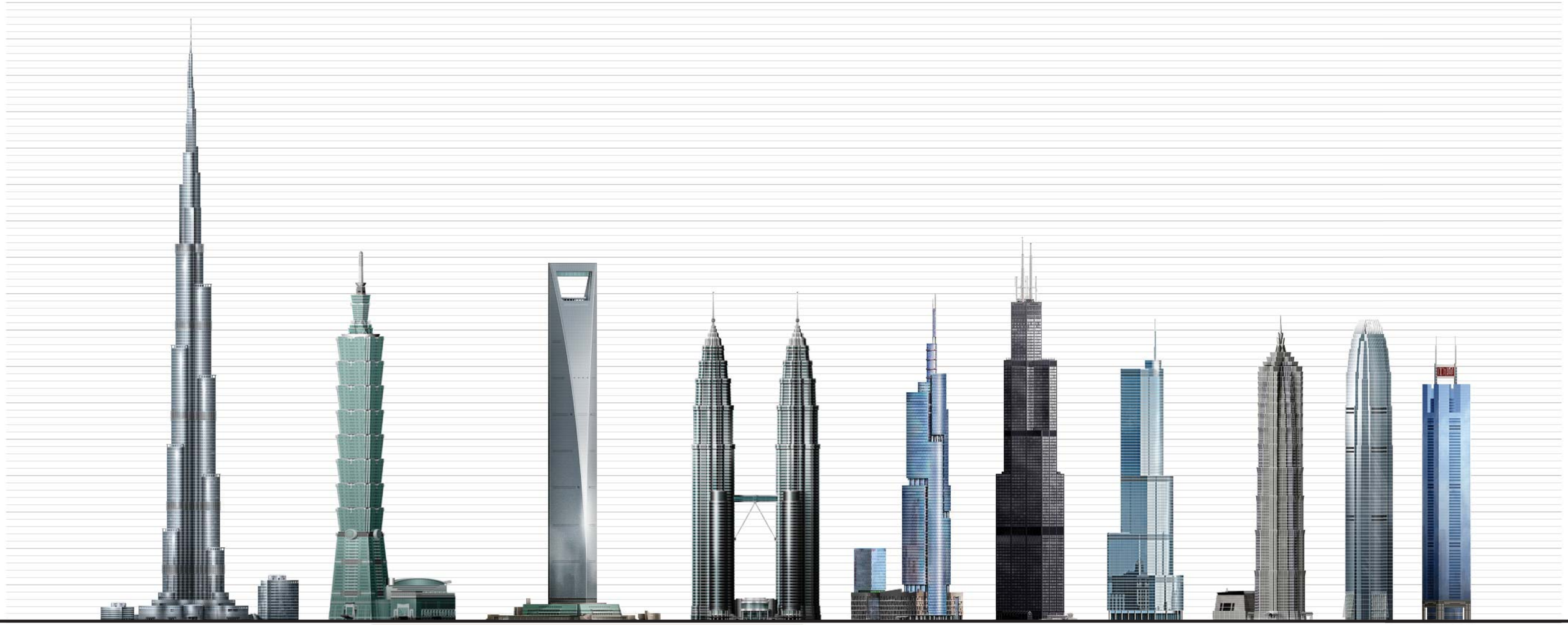
BACKGROUND IDEAS

City is made up of diversity and density. Diverse factors make activities and different relationships in a city. These are very sensitive to other factors' changes.
Their various responses make city dynamic and finally characterize the face of a city or a town. Buildings are one of dynamic factors in a city. The building facade which determines building's
identity marks the transition between outside and inside. The facade has a strong relationship between building programs and urban activities. Their looks make a huge effect on urban environment.
But buildings' configuration is fixed once designchoices are made. Buildings are conceived as a rigid objects and inflexible, unresponsive, and unsustainable. Considering that buildings are the largest contributor to the city environ
ment, building should be responsive to changes and facade performance should be more active to building programs. Adaptive building facade will be the means that can address these challenges.

MIXED PROGRAMS OF A BUILDING

BACKGROUND IDEAS

These are the tallest buildings in the world. They represent city or country like a symbol. These tall buildings are making huge space vertically like over 100 floors.
There are many different programs in a building and occupied programs are changed. Dynamic activities are happened inside a building, but the facade, outside look of a building, is almost always same like a statue.



Burj Khalifa
United Arab Emirates
Mixed use
2010

Taipei 101
Taiwan
Mixed use
2004

Shanghai World
Financial Center
China
Office
2008

Petronas Towers
Malaysia
Office
1998

Nanjing
Greenland
Financial Complex
China
Mixed use
2010

Willis Tower
United States
Office
1974

Trump
International
Hotel & Tower
United States
Mixed use
2009

Jin Mao Tower
China
Mixed use
1998

International
Finance Center
China
Office
2003

CITIC Plaza
China
Office
1997

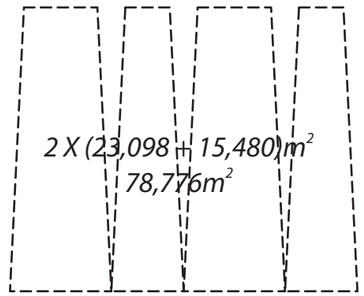
VERTICAL CITY

BACKGROUND IDEAS

Tall buildings in a city have huge facades. If their facade are unfolded on the ground, they can cover a city several times over.
A tall building is similar to a small town. If dynamic movements and different activities in a building are related with urban activities, they can make city more dynamic.
Building facade can be the new field for urban landscape in a city

John Hancock Center
1969

343.5 m roof height
5,104m² (88m x 51m)



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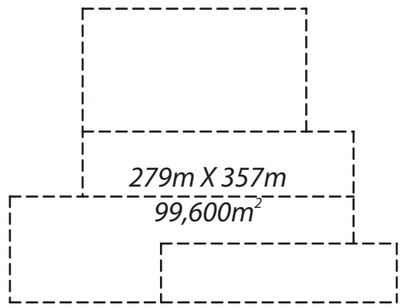
Trump International
Hotel & Tower 2009

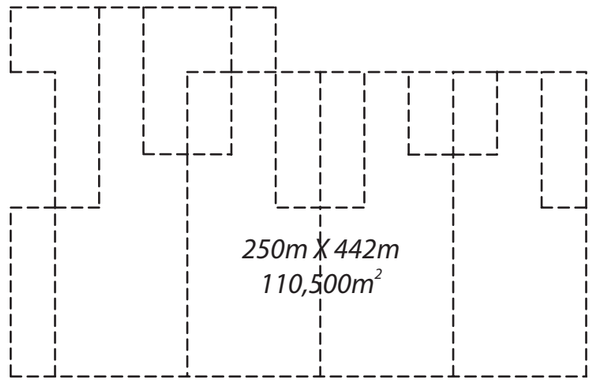
356.9m roof height
4,371m² (93m x 46.4m)



X 23 Times

Willis Tower
1974

442.3m roof height
3,774m²(51m x 74m)



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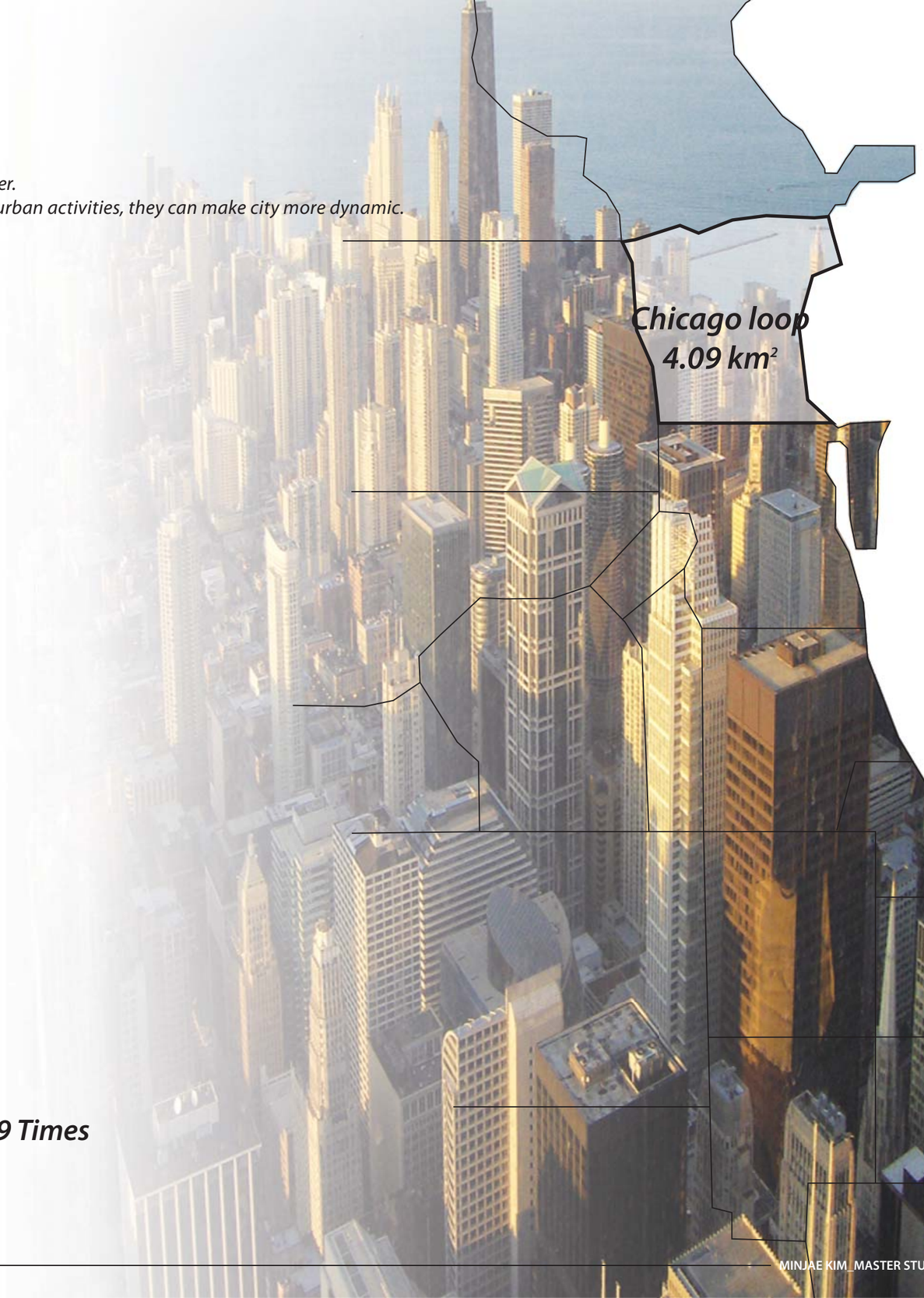


LIFE EXPECTANCY OF BUILDING COMPONENTS

BACKGROUND IDEAS

All building systems or components have a designed life expectancy or estimated number of years of service.
When the life expectancy is exceeded, but equipment remains in service, the number of repairs and the overall cost of maintaining the building increases.
The building functionality will suffer and the overall level of comfort for the building occupants will decline.
The chart below shows that the majority of Sangren Hall's key building components are in service long past their designed life expectancy.

ARCHITECTURE	LIFE EXPECTANCY	YEARS
STRUCTURAL SYSTEM		100 +
BRICK WALLS		100
ROOFING		15
FLOORING-SEALED CONCRETE		60
FLOORING-CERAMIC TILE		30
WALLS-CONCRETE BLOCK		60
WALLS-PLASTER		60
WALLS-CERAMIC TILE		30
CEILING-ACCOUSTIC TILE		20
ELEVATOR		25
DOORS		50
WOOD FRAME		30+
WINDOW ALUMINUM		15-20
WINDOW CLAZING		10+
VINYL WINDOWS		20-40

MECHANICAL & ELECTRICAL	LIFE EXPECTANCY	YEARS
ABSORPTION CHILLER		25
AIR HANDING UNITS		25
HEATING SYSTEM		25
PLUMBING		40
PLUMBING FIXTURES		40
DUCTING		10
HEAT RECOVERY VENTILATORS		20
FAN-COIL UNITS		20
LOW VOLTAGE SWITCHGAER		40
SUBSTATION TRANSFORMERS		40
POWER PANELS		20
RECEPTACLE PANELBOARD		20
PRIMARY SWITCHGAER		30

Note: Life expectancy varies with usage, weather, installation, maintenance and quality of materials. Items listed as lasting 100+ years, especially those that open and close, often fail prematurely due to misuse or overuse.
This list should be used only as a general guideline, not as a guarantee or warranty regarding the performance or life expectancy of any product.
Source from www.nachi.org

PROBLEMS SEEKING AND SOLVING

THE WAY BY WHICH ADAPTIVE BUILDING FACADE IS DESIGNED

Desires

As society improves, people life style changes and their needs, desires also changes. Theses changes are urban dynamic. A building in city should keep with urban needs and desire.

Huge Space

Gross area of a tall building is a huge space more than the place which 3,000 people can live. A building is almost same size as a town. A building should a huge infrastructure which accommodates urban lives.

Economic Issues

Asset value of a building changes. Components of building have a different time limits for life cycle. Building has to continuously be changed for required needs.

programs

infrastructure system

sustainability

Building facade as an active layer :

The protective layer from natural environment which makes building perform properly and the projected layer of building programs which contacts to the outside. The facade as the protective layer functions to keep space comfort from environmental changes like temperature, humidity, and thermal. As the projected layer, it has a character related with program activities and its look is strongly affected by city culture and people life styles. Building facade is designed by these interactive relationships and makes an urban dynamic scene. The way which building facade responds under different conditions determines the facade look, so when conditions change, the performing way of facade should be changed and make different a look. Most building facades actually are insensitive to these conditions and always have same looks even when dynamic programs are mixed. Building facade should be changeable, responsible when these conditions change for better interactive relationships.

" Adaptive Building Facade is an active layer to respond to environmental changes. According to different occupants, required conditions and activities, building facade can be changed.
The ways which building facade makes an relationship with indoor and outdoor environments are various.
The building facade is in the center of dynamic urban environment. "

THE 63 CITY, A LANDMARK IN SEOUL

RENOVATION A EXISTING BUILDING IN SOUTH KOREA

The 63 city is the 3rd tallest building in South Korea and was the tallest building in Asia when it completed construction in 1985.
The main program is office and at the lower levels, there are diverse public programs like the large shopping mall, a Imax theater, and an aquarium.
On the top floor, the observation deck is a popular place for a good view of Seoul.

As building components are getting old, the 63 city renovated the public space at lower level and has a plan to change their facade too.
My project proposes adaptive building skin. The 63 city which located at center of Seoul can give occupants and the public to experience dynamic environment.

_Building Information

Site Area : 20,203m2
Building Area : 9,870m2
Building to Area Ratio : 48.85%
Floor to Area Ratio : 624%
Floor Space : 160,082m2
Schematic design : SOM 1980
Construction :1985
(Steel and Concrete Structure)
Use : Office

_Building Height

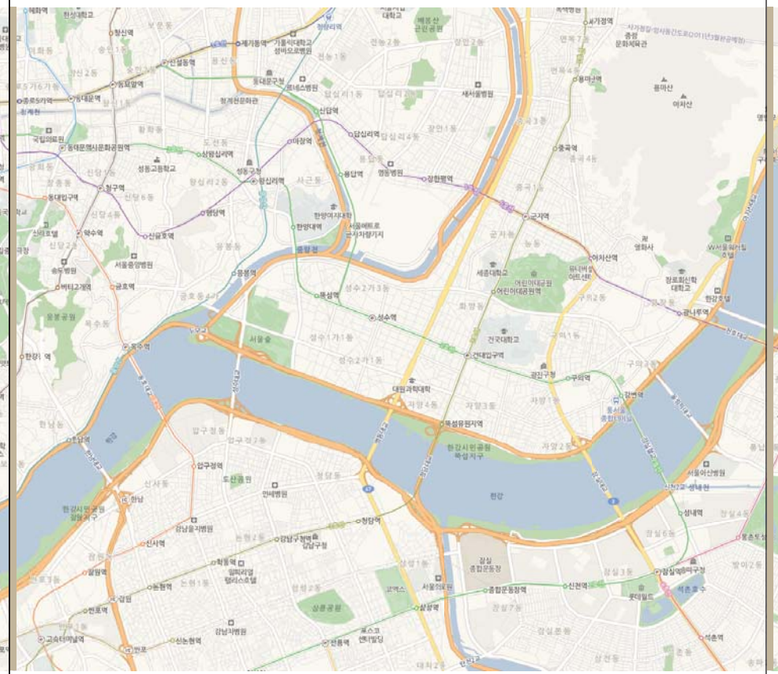
Antenna/Spire - 274 m (866 ft)
Roof - 249 m (817 ft)
Top Floor - 249 m (817 ft)

_Technical Detail

Floor count : 63
(above ground level : 60 / basement : 3)
Elevator : 6
Facade Material :
reflective double glass - gold color
13,516 sheets
Color changeable glass to respond with sun direction and temperature
(silver, yellow, gold, red)
(total glass sheet : 14,182)
Material properties :
Reflexibility ratio : 45%
Transmittance ratio : 17~20%
30% saving effect of energy comsumption

DIVERSITY_URBAN SECTION

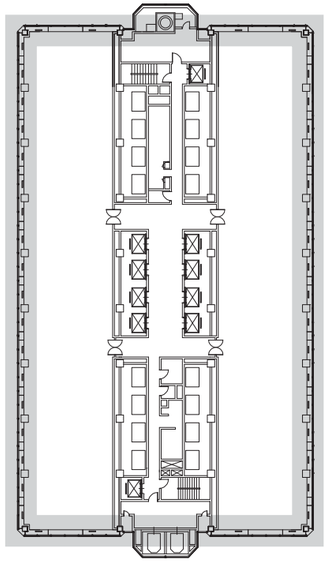
URBAN DYNAMIC WAY_DYNAMIC LEVELS



Diverse activities happen at different levels.
Geogrphy is a key factor for urban dynamic.

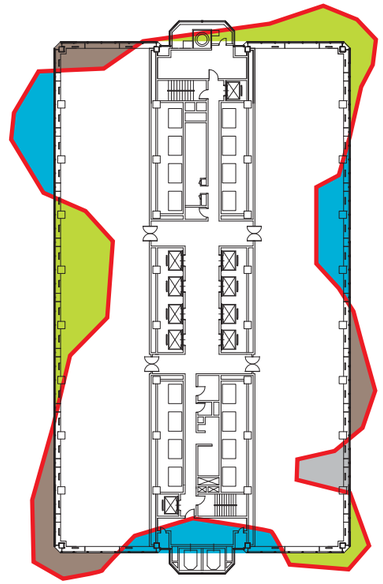
DIVERSITY_PROGRAM TOPOGRAPHY

BUILDING FACADE DYNAMIC WAY



Typicla building facade

Like dynamic geography of city,
the building responds to differnt program topography.



Program topography facade

PROGRAMS CHARACTERS

KEY FACTORS WHICH DETERMINES A SPACE AND A PROGRAM CHARACTER

private — ***Program Characters*** — *public*

RESIDENTIAL *sleeping and washing* *eating and watching* *outdoor working* *garden party*

HOTEL *sleeping and washing* *resorting* *eating and meeting* *moving*

OFFICE *working* *meeting* *eating and resting* *informing*

SCHOOL *studying* *playing ans resting* *sharing* *communicating*

COMMERCIAL *selling and buying* *looking* *displaying* *locating*

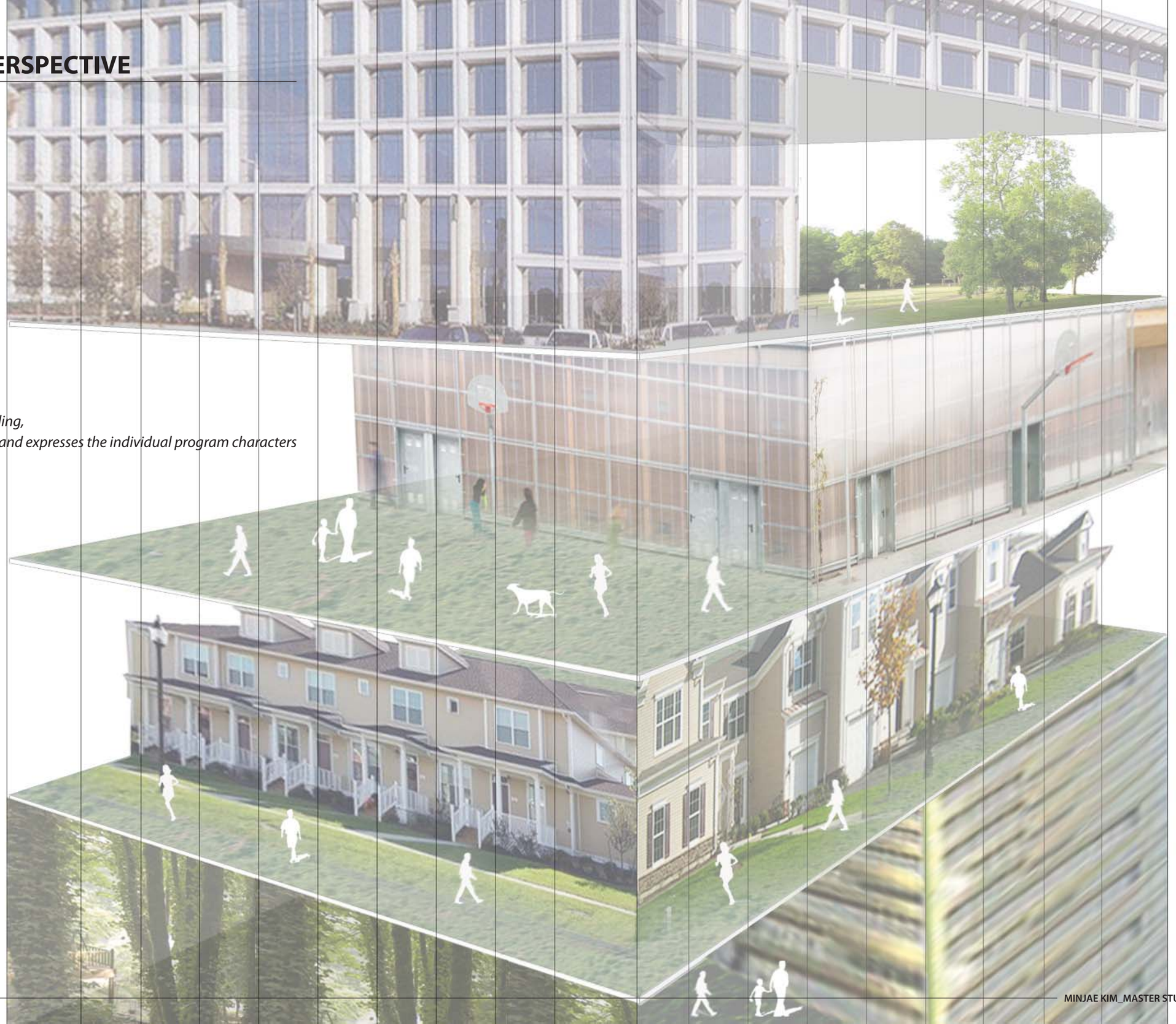
a core and basic character of program + ***these activities make program much more unique***

DIFFERENT PROGRAMS PERSPECTIVE

MIXED PROGRAMS IN A TALL BUILDING

Diversity + Density = Dynamic

When diverse programs are mixed in a tall building,
the building accommodates different activities and expresses the individual program characters

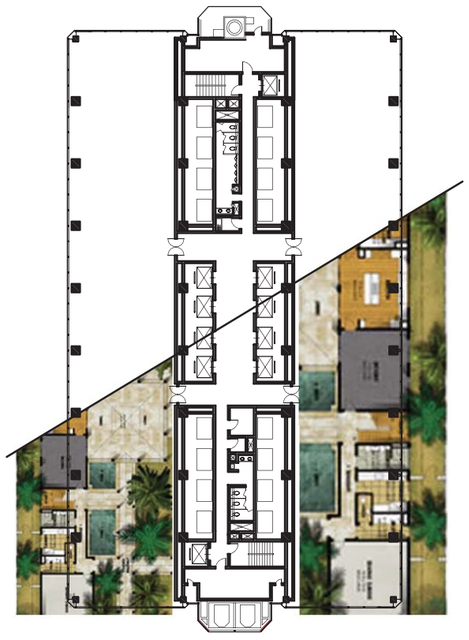


PROGRAMS ADAPTABILITY

TYPICAL PLANS WITH PLUGGED-IN DIFFERENT PROGRAMS

Needs

natural light/ privacy
comfort/ healthy environment
community



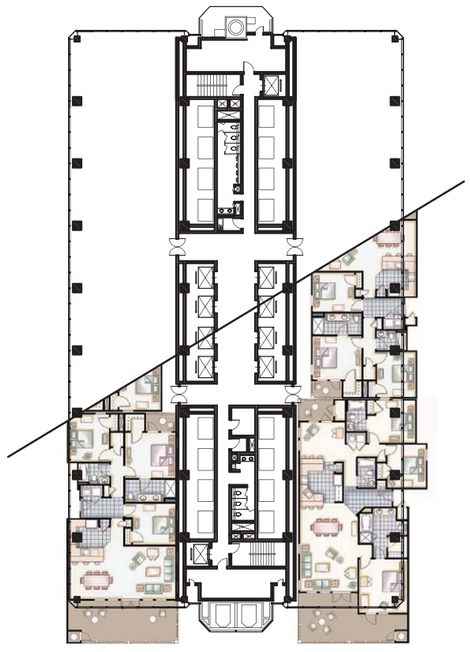
Hotel Program

Adaptability

openable window/ garden
outdoor balcony
private room

Needs

relaxation/ resort
lesiure/ party
privacy/ pleasure/ view



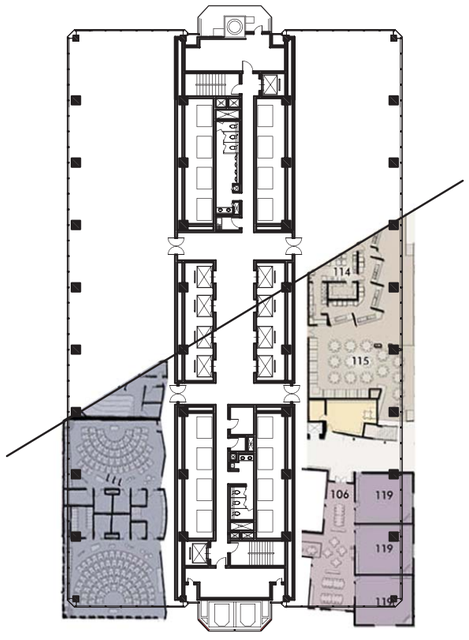
Residential Program

Adaptability

indoor garden
outdoor terrace
open hall/ private room

Needs

free activities /events
natural light /ventilation
comfort community



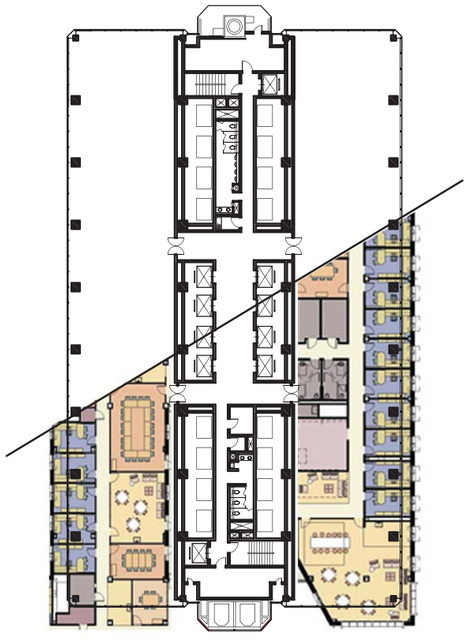
School Program

Adaptability

open yard/ green deck terrace
large hall/ formal classroom
openable window

Needs

comfort environment
workability/ zone
breake/connection



Office Program

Adaptability

convertible wall
outdoor reat area/ open hall
private room

PROGRAM SPACES

THE WAY WHICH A SPACE IS DEFINED BY A PROGRAM

Hotel

indoor garden
outdoor terrace
open hall
private room

Condo

openable window
green garden
outdoor balcony
private room
convertible space

School

open yard
green deck terrace
large hall
formal classroom
openable window

Retail

display wall
show window
information facade
open rest area

Offices

convertible wall
outdoor reat area
open hall
private room

How could a space be defined by program ?

ZONE

- enclosed space
- semi closed space
- open space

SIZE

- wide depth > 40 ft
- regular depth 30ft
- narrow depth < 20ft

ENVIRONMENT

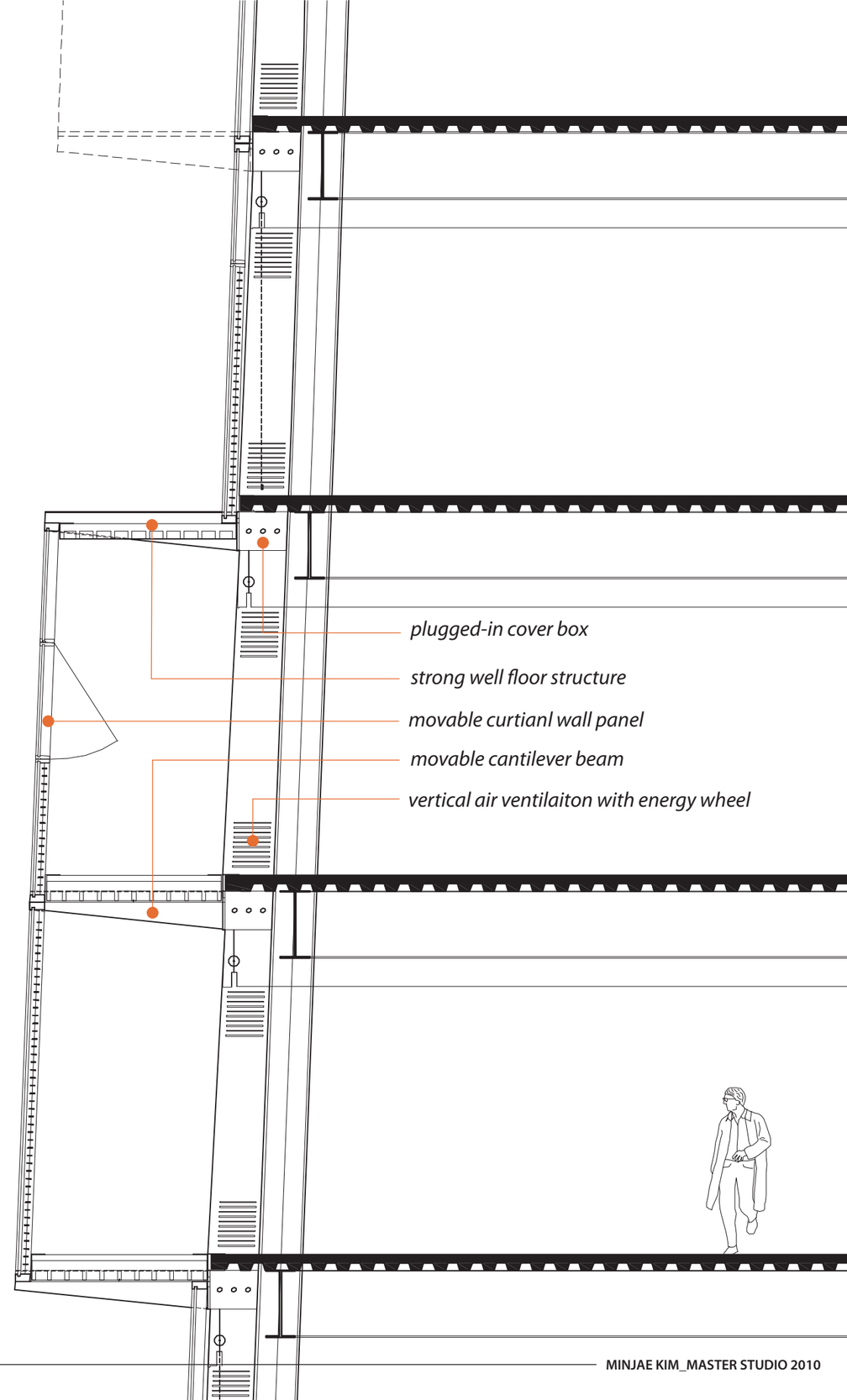
- high control
- regular control
- low control

These different parameters make program space into dynamic volume.

DESIGN DETAILS

BUILDING PARTIAL SECTION AND 9 TYPES PANELS

different types panels of curtain wall



DESIGN ASSEMBLY

MOVABLE ADAPTIVE ZONE ASSEMBLY PROCESS

PROGRAM CHANGES_DEFAULT

PROGRAM CHANGES_RESIDENTIAL

PROGRAM CHANGES_HOTEL

PROGRAM CHANGES_OFFICE

PROGRAM CHANGES_SCHOOL

BUILDING CHANGES_2010

BUILDING CHANGES_2015

BUILDING CHANGES_2030

BUILDING PERSPECTIVE