- Vertical circulation
- Configuration
- Floor-plate design
- Function of Service Core
- Service core types & placement
- Service Core & Building Economy
- Elevator design & configuration
- Population density
- Traffic analysis
- Quality of ride
- Service-core layout & space requirements
Vertical Circulation

• Cores = service cores = risers
• Contains:
  – Elevator shafts
  – Elevator lobbies
  – Main & escape stairways
  – Riser-ducts
  – Toilets
  – Other service rooms
• Elevators = MAIN vertical circulation system
At initial design stage, designer DETERMINES:

- Buildable net rentable areas (NRA)
- Gross floor areas (GFA)
- Typical & atypical floor-plates
- Prepare a diagram + propose elevator configuration:
  - No. of banks
  - No. of stops
  - Transfer floor(s)
### Example of area tabulation & elevator configuration diagrams:

<table>
<thead>
<tr>
<th>FLOOR</th>
<th>LEVEL</th>
<th>NET (NRA)</th>
<th>SERVICE</th>
<th>GROSS (GFA)</th>
<th>CAR-PARK</th>
<th>CAR-PARK EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASEMENT</td>
<td>B1 - B3</td>
<td>0</td>
<td>1,229</td>
<td>150</td>
<td>59,365</td>
<td></td>
</tr>
<tr>
<td>GROUND</td>
<td>1</td>
<td>2,274</td>
<td>2,231</td>
<td>4,105</td>
<td></td>
<td>55%</td>
</tr>
<tr>
<td>BANKING</td>
<td>2</td>
<td>9,799</td>
<td>2,231</td>
<td>12,034</td>
<td></td>
<td>81%</td>
</tr>
<tr>
<td>BANKING</td>
<td>3</td>
<td>9,799</td>
<td>2,231</td>
<td>12,034</td>
<td></td>
<td>81%</td>
</tr>
<tr>
<td>CAR PARK (15 levels)</td>
<td>4 - 18</td>
<td>0</td>
<td>6,148</td>
<td>548</td>
<td>249,525</td>
<td></td>
</tr>
<tr>
<td>LIFT FLOOR</td>
<td>19</td>
<td>7,769</td>
<td>2,231</td>
<td>10,000</td>
<td></td>
<td>78%</td>
</tr>
<tr>
<td>OFFICE (15 levels)</td>
<td>20 - 34</td>
<td>AVE 12,799</td>
<td>2,231</td>
<td>AVE 15,03</td>
<td></td>
<td>85%</td>
</tr>
<tr>
<td>LIFT FLOOR</td>
<td>35</td>
<td>7,769</td>
<td>2,231</td>
<td>10,000</td>
<td></td>
<td>78%</td>
</tr>
<tr>
<td>OFFICE (15 levels)</td>
<td>36 - 50</td>
<td>AVE 12,799</td>
<td>1,585</td>
<td>AVE 15,03</td>
<td></td>
<td>89%</td>
</tr>
<tr>
<td>PENTHOUSE</td>
<td>51</td>
<td>9,27</td>
<td>1,585</td>
<td>10,858</td>
<td></td>
<td>85%</td>
</tr>
<tr>
<td>PENTHOUSE</td>
<td>52</td>
<td>3,218</td>
<td>1,585</td>
<td>4,803</td>
<td></td>
<td>67%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>51</td>
<td>438,544</td>
<td>76,21</td>
<td>514,754</td>
<td>695</td>
<td>308,89  85%</td>
</tr>
<tr>
<td>GROSS</td>
<td></td>
<td></td>
<td></td>
<td>823,644</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Schematic diagram

No. of elevators:

- 3 car-park zone lifts
- 6 banking and lower offices zone lifts
- 6 upper offices zone lifts

● = Lift opening

- 2 levels penthouse
- 15 levels tower offices
- Interchange level
- 15 levels above ground car parking
- 2 levels banking

Core design
Designer’s consideration:

- Typical floor plate sizes
- Typical floor plate efficiency
- Staircase positions
- Tenancy options
- View outward
- M&E risers and routes
- Structural system options
- etc
Floor Plate Design

- Staircase usually grouped with elevators
- As means of escape & accessibility
- Same goes with M&E riser ducts
- Aspects that affect the floor-plate design:
  - Direction of best views out
  - Permissible ground floor plinth are
  - Car-parking grids in relation with floor-plate structural configuration

Floor-plate efficiency should not be less than 75%
Function of Service Core

Fig. 5A: Diagram of elevators (three zone system in which users have to change floors after each zone)
Service core types & placement

Central Core  Split Core  End Core  Atrium Core

Plan

Single Tenant  Double Tenant  Multiple Tenant

Core design
### Core Design

#### Service core types & placement

<table>
<thead>
<tr>
<th>Core Type</th>
<th>Case Study</th>
<th>UOB Plaza 1</th>
<th>BNI Building</th>
<th>Rufino Pacific Tower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central cores</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass to core depth (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landlord efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenant efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central cores</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass to core depth (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landlord efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenant efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central cores</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass to core depth (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landlord efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenant efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass to core depth (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landlord efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenant efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution cores</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass to core depth (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landlord efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenant efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landlord efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenant efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Side or hybrid cores</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass to core depth (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass to glass depth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landlord efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenant efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Service Core & Building Economy

- Minimization of material cost
- Optimization of core geometry
- Minimization of core area
- Minimization of construction time
Benefits of a peripheral core position:

- No fire-fighting pressurization duct is needed
- Good view out
- Natural ventilation
- Natural sunlight
- A safer building in the event of total power failure
- Solar-buffers & energy savings
Requirements for elevator selection service

<table>
<thead>
<tr>
<th></th>
<th>EXCELLENT SERVICE</th>
<th>GOOD SERVICE</th>
<th>FAIR SERVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMMERCIAL BUILDING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up-peak interval</td>
<td>28 secs</td>
<td>30 secs</td>
<td>35 secs</td>
</tr>
<tr>
<td>5-minute up-peak</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>handling capacity</td>
<td>14 - 15%</td>
<td>13 - 13.5%</td>
<td>11 - 12%</td>
</tr>
<tr>
<td><strong>HOTEL BUILDING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 way lobby traffic</td>
<td>35 - 40 secs</td>
<td>45 - 50 secs</td>
<td>55 - 60 secs</td>
</tr>
<tr>
<td>5-minute up-peak</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>handling capacity</td>
<td>14%</td>
<td>13%</td>
<td>12%</td>
</tr>
<tr>
<td><strong>APARTMENT BUILDING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 way lobby traffic</td>
<td>50 - 55 secs</td>
<td>60 - 65 secs</td>
<td>70 - 75 secs</td>
</tr>
<tr>
<td>5-minute up-peak</td>
<td>7%</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td><strong>CAR-PARK BUILDING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 way lobby traffic</td>
<td>35 secs</td>
<td>40 secs</td>
<td>50 secs</td>
</tr>
<tr>
<td>5-minute up-peak</td>
<td>13.5 - 14%</td>
<td>12.5 - 13%</td>
<td>11 - 12%</td>
</tr>
</tbody>
</table>

2 common performance criteria:
- Average waiting interval (AWI, in seconds)
- 5-minute handling capacity (in %)
Suggested elevator capacity

<table>
<thead>
<tr>
<th>Capacity/Persons</th>
<th>Commercial</th>
<th>Hotel</th>
<th>Apartment</th>
<th>Car-Park</th>
</tr>
</thead>
<tbody>
<tr>
<td>884kg (13 persons)</td>
<td>yes</td>
<td></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>952kg (14 persons)</td>
<td>yes</td>
<td></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>1088kg (16 persons)</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>1360kg (20 persons)</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>1564kg (23 persons)</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>1768kg (26 persons)</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Elevator Design & Configuration

Elevator design should give optimum:

- Number of elevators
- Types of elevators
- Elevator capacities
- Arrangement of elevator
Examples of GOOD & BAD elevator arrangement

TWO-CAR GROUPING
- Side-by-side arrangement is best
- Passenger face both cars & can react immediately
- AVOID separation of elevators
- EXCESSIVE separation destroy advantages of group operation

THREE-CAR GROUPING
- 3 cars in a row is PREFERABLE
- 2 cars opposite 1 is acceptable
- PROBLEM: location of elevator call button
Examples of GOOD & BAD elevator arrangement

FOUR-CAR GROUPING

- commonly in large, busier buildings
- 2-opposite-2 arrangement is the most efficient

SIX-CAR GROUPING

- found in large office buildings, public buildings & hospitals
- provide quantity & quality
- 3-opposite-3 position is PREFERRED
- dimension of the LOBBY must not be less than 3m or 3.6m if function as a passageway

EIGHT-CAR GROUPING

- the largest PRACTICAL group
- 4-opposite-4 arrangement
The common performance criteria is based on 5 minute morning up-peak condition & measure:

- Quantity
- Quality
- Travel Time

Densities of 'sq m of NRA per person' for a diversified commercial office

<table>
<thead>
<tr>
<th></th>
<th>LOW</th>
<th>MEDIUM</th>
<th>HIGH</th>
<th>SKY</th>
</tr>
</thead>
<tbody>
<tr>
<td>SINGLE SEGMENT BUILDING</td>
<td>11</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>TWO-SEGMENT BUILDING</td>
<td>11</td>
<td>N/A</td>
<td>12</td>
<td>N/A</td>
</tr>
<tr>
<td>THREE-SEGMENT BUILDING</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>N/A</td>
</tr>
<tr>
<td>FOUR-SEGMENT BUILDING</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
</tr>
</tbody>
</table>
## Population density

<table>
<thead>
<tr>
<th>LEVEL OF SERVICE</th>
<th>EXCELLENT</th>
<th>GOOD</th>
<th>FAIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWI (SECONDS)</td>
<td>28</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>(% OF POPULATION)</td>
<td>14 - 15</td>
<td>13 - 13.5</td>
<td>11 - 12</td>
</tr>
<tr>
<td>TRAVEL TIME (SECONDS)</td>
<td>100</td>
<td>120</td>
<td>&lt;150</td>
</tr>
</tbody>
</table>
Traffic Analysis

- General planning
- Multiple rises
- Multiple entry levels
- Car-parking floors
- Special purpose floors
Quality of ride

- **Elevator shaft area** should be at least 20% greater than the car platform area.
- **Guide rails** with fixing points at a maximum of 2.4 m are required to provide a rigid running surface for the car guides.
- **Guide-rail alignment** must allow for vertical movement.
- **Car guides.** Roller type car guides fitted with a tyre compound suited to local conditions & approx. 30 cm dia. Necessary to achieve quality of ride.
- **Pendulum car** as means to reduce negative effects of poor guide rail alignment.
Elevator car sizes & shapes
Elevator door types & sizes - common widths 1.1 m or 1.2m
Elevator shafts - are according to car shapes & sizes, and door sizes. Sufficient air around cars & counterweights should be provided to minimize buffeting & air-borne noise during operation.
Elevator core & lobby planning - ‘outward facing’ elevators VS ‘inward facing’ elevators.
Service-core layout & space requirements

- Single Zone
- Single Bank
- Double Bank
- Two Zone
- Common Lobby
- Separate Lobby
- Multiple Zone
- Zone 1
- Zone 2
- Zone 3
- Multiple Zone/Sky Lobby
- Express
References

1. commercebank frankfurt by foster & partners

2. petronas twin towers by cesar pelli & associates
1. escape stair
2. service lift
3. lift lobby
4. lavatories
5. service rooms
6. combi-offices
7. team offices

typical floor plan layout

commercebank frankfurt by foster & partners
1. escape stair
2. service lift
3. lift lobby
4. stair pressurization duct
5. document hoist
6. risers

blow-up plan of service core

commercebank frankfurt by foster & partners
commercebank frankfurt by foster & partners
commercebank frankfurt by foster & partners
petronas twin towers by cesar pelli
petronas twin towers by cesar pelli & associates
petronas twin towers by cesar pelli & associates

Level 43 plan

typical floor plan layout

service core
1. escape stair
2. service lift
3. lift lobby
4. lavatories
5. risers
6. office

level 43 plan

petronas twin towers by cesar pelli & associates
petronas twin towers by cesar pelli & associates

level 76 plan

1. escape stair
2. service lift
3. lift lobby
4. lavatories
5. risers
6. office
petronas twin towers by cesar pelli & associates
Innovations in core designs
cctv china, beijing by OMA
burj dubai by skidmore, owings & merrill
dancing tower by zaha hadid
dancing tower by zaha hadid
The End