Refurbishment

- **Work** undertaken to an existing building
- Including **renewal, change, modification or upgrading** of some part of the building
- It is **not due to failure**
- Concept of change:
  - Change in function
  - Change in capacity
  - Change in performance
Change in Function

• Conversion from one use to another
Change in Capacity

• Upgrading of HDB flat
Change in Performance

- Rehabilitation to improve the building or facility

- Victoria Theatre and Concert Hall, Singapore

- Complete construction in 1862

- Refurbished in 2014
Refurbishment of Victoria Theatre and Concert Hall, Singapore

- Arup upgraded and improved acoustic system
- Enhanced fire protection and evacuation route
- Installed multi-modal lighting system
Range of Refurbishment

- MINOR
- MEDIUM
- MAJOR
<table>
<thead>
<tr>
<th><strong>Purpose</strong></th>
<th>To secure, for the long term, the benefits of existing planning consents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration</strong></td>
<td>At least 15 years</td>
</tr>
</tbody>
</table>
| **Scope of Works** | - Need to meet modern expectations for specification and performance standards  
- All fittings, finishes and services will be replaced  
- Structural alterations may include the re organization |
Major Refurbishment

September 4, 2014

London ranked the best city to invest in major office refurbishment

by Sara Bean • Facilities management, News, Property, Workplace design

London offers the best returns on office refurbishment of any city in the world, according to a new report from ARCADIS. The firm’s survey of buildings more than 20 years old in thirteen cities found that returns on capital invested in major refurbs (which extend the life of the office by up to 20 years) in London were nearly ten percent, significantly higher than second placed Warsaw (7.5%) and Milan (6%). However, London was only ranked second for return on investment in minor office refurbishment, defined as a refurbs that aims to extend the life of the building by up to 5 years. Top place in this instance went to Madrid (9.6%), followed by London (6.5%) and Shanghai (7.9%). The least attractive market for office refurbishment was found to be Dubai, which the report claims is due to the large supply of new office space.

Top five city office refurbishment rankings – ‘major’ refurbishment
1. London 9.9%
2. Warsaw 7.5%
3. Milan 6%
4. Frankfurt 6.8%
5. Amsterdam 5.5%
Major Refurbishment

• Refurbishment of Victoria Theatre and Concert Hall, Singapore
Major Refurbishment

- Refurbishment theatre building of Star Vista
## Medium Refurbishment

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Renew the existing fabric and services of a building to present day standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>The investment timeframe is typically 15 years</td>
</tr>
<tr>
<td>Scope of Works</td>
<td>- Fittings, finishes and elements of building services will be replaced or upgraded, taking advantage of technological advances</td>
</tr>
</tbody>
</table>
Medium Refurbishment

- The City Hall and former Supreme Court buildings were refurbished to be the National Gallery Singapore in 2015
Medium Refurbishment

- Toshiba motors upgraded railway East-West and North-South lines using high-efficiency Permanent Magnet Synchronous Motors (to cut 30% power consumption and reduce noise)
• In 1926, power sub-station building was constructed at Armenian Street
• In 1991, it was refurbished to be arts centre under national art council’s art housing scheme
Minor Refurbishment

Purpose
Extend economic life by up to 5 years

Opportunities
- Confined to redecoration and repair works, together with minimal alterations to building services
- Minimal alterations to building services.
- Payback are limited with the scope of work being confined to redecoration and repair works

Use
Often carried out in an occupied building, with phased working and a decant plan being necessary.
Minor Refurbishment

The trend for older offices with character and in good locations to be refurbished. We are also seeing investors interested in investing to create workplace environments that align to support occupier business and brand strategies."

The report found that, in other cities, a programme of minor refurbishment would be a better strategy to gain the strongest returns. For investors taking this approach, Madrid and London were judged to be the most attractive, whilst Shanghai and Singapore also made it into the top five.

**Top ten city refurbishment rankings – ‘minor’ refurbishment**

1. Madrid 9.5%
2. London 8.5%
3. Shanghai 7.9%
4. Singapore 7.53%
5. Warsaw 7.47%
6. Milan 7.35%
7. Hong Kong 7%
8. Paris 6.99%
9. Frankfurt 6%
10. New York 5.4%

*Note: a minor refurbishment aims to extend the life of the office asset by up to 5 years.*

The report also highlights that investment strategies can vary depending on the location of the office asset. In many cities modern, accessible new office space is being delivered in city quarters away from the established Business District, for example Marina Bay in Singapore, Kings Cross in London and Amsterdam Zuid in the Netherlands. If vacancy levels increase due to these new competing areas, the report recommends investors focus on the protection of office asset revenue streams by taking a ‘defend’ refurbishment strategy which will prevent the offices from becoming obsolete where there are relatively low tenant voids. The least attractive market for office refurbishment was found to be Dubai where the large supply of quality new commercial space makes the disposal of old office buildings potential a better option to maximise the value of the asset.

Matthew Cutts continued: ‘Office refurbishment offers an excellent opportunity to improve the
Minor Refurbishment

- Mall, house, flat renovation
Adaptation Rationale

- Obsolescence and redundancy:
  - Financially / structurally need to change

Medium refurbishment of Pan Pacific Hotel in 2012
Adaptation Rationale

- Life cycle phase:
  - End life of existing facility

SMRT Refurbishment

Electrical relay boards

- Train builder
  - Hyundai - ROTEM
- Operator
  - SMRT - Singapore

In Singapore Mors Smitt refurbished ordered by Hyundai Rotem type C151 metro cars. The 20 years old trains were refurbished; all the panels were replace by new panels with new type relays. Through the lack of basic train information it was a challenge to design the circuit diagrams of the panels. Mors Smitt has been several times on site to check and compare the existing diagrams with the new design. To relieve the customer, a turnkey construction for delivery of the relay panels was choosen in 5 different configurations. This was succesfully due to good teamwork between Hyundai Rotem, SMRT and Mors Smitt.
Adaptation Rationale

- Indoor environment:
  - Water / gas leaking
  - Light fitting
Adaptation Rationale

• Deterioration:
  – Building fabric requires remedial improvement
Adaptation Rationale

• Lacking in performance:
  – Existing components do not accept current standards (i.e. the telecommunications need to be upgraded – broadband, fibre)

• Statutory control:
  – Change in safety / healthy regulations
Adaptation Rationale

• Grants:
  – Funding from government or local authority to support building adaptation

• Sustainability:
  – Building that consume excessive resources requires adaptation, i.e. energy saving
Refurbishment VS New Building

• Economic:
  – Fast and cost saving

• Technical:
  – The existing structure provide structural frame and temporary enclosure
  – Space constraint
  – Not fully satisfy client’s need

• Legal:
  – To accommodate tricky legal issue
Refurbishment VS New Building

• Legal:
  – Difficult to incorporate current standard to old building

• Social:
  – Adaptation existing building will conform to neighbourhood

• Environmental:
  – Adaptation countermeasure environmental issue, i.e. noise and pollution
Stages of Refurbishment

- Building Investigation
- Recommendations for Refurbishment
- Construction
Building Investigation

- To obtain sufficient information about the building condition.
- Examination and observation of the exterior and interior of buildings.
- To identify or investigate and diagnosis of defects in existing buildings
Building Investigation

- To recommend for the most appropriate course of action
- Identifying types of building systems - evidence of material deterioration from weathering and identifying combinations of movement, defects, deterioration and load effects
Recommendation for Refurbishment

- Outline scheme design
- The team will carry out with recommendation and method works for refurbishment within consideration during the building investigation steps.
- Minimal repairs to enable the building to be fit for its purpose of use
• Start to construct the refurbishment according the decision from owner or clients.
• Good management and supervision are required.
• Aftercare strategy is needed to ensure quality of adaptation works.
Phasing of Adaptation

• Temporal phasing:
  – Short term phasing: small scale works where disruption is minimal and the building can be occupied during the works.
  – Long term phasing: larger scale works where the building needs to be vacant during the works.
Phasing of Adaptation

• Spatial phasing:
  – The building needs to be vacant during the works
  – Major refurbishment
  – The adaptation works can be programmed to reduce disruption, i.e. floor to floor or bottom up or top down
Lecture 5.2 - Sustainable Buildings – Energy Efficiency
### Energy Consumption Per Capita for Selected Countries in 2006 (toe/capita)

<table>
<thead>
<tr>
<th>Country</th>
<th>EIA</th>
<th>IEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singapore</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>8.4</td>
<td>6.8</td>
</tr>
<tr>
<td>Australia</td>
<td>7.0</td>
<td>5.9</td>
</tr>
<tr>
<td>Finland</td>
<td>7.1</td>
<td>6.4</td>
</tr>
<tr>
<td>Japan</td>
<td>4.5</td>
<td>4.1</td>
</tr>
<tr>
<td>UK</td>
<td>4.1</td>
<td>3.8</td>
</tr>
<tr>
<td>World</td>
<td>1.8</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Survey in USA – green building is 28% more energy efficient than conventional building.
Energy Consumption

Report of National Climate Change Strategy – energy used in building made up 16% Singapore energy demand (mainly comes from air-conditioning consumption)
An analysis of commercial retail electricity tariffs offered by Singapore's main utility, SP Services, clearly shows a Compounded Annual Growth Rates (CAGR) of 3.52% over the past 13 years.

Singapore's fuel-indexed electricity pricing structure means volatile retail utility tariffs are likely to follow their historical price increase curves.
Energy consumption in Singapore mainly comes from air-conditioning usage (NEA, 2010)

Major usage:
1. Air conditioning/ Refrigerator
2. Lighting
1. Building envelope
2. Energy efficiency index
3. Building orientation
4. Sun-shading
5. Facade materials
1. Building Envelope

- Energy efficiency should be considered in the conceptual stage of architecture design.
- Envelope Thermal Transfer Value (ETTV) → key efficiency in air-conditioned building.
- Building must be designed to have low ETTV or low heat gain (ETTV < 50 W/m²).
- Guideline on Envelope Thermal Transfer Value for Buildings - BCA
Building with EETV less than 50 W/m²

Republic Polytechnic
2. Energy Efficiency Index

- Energy efficiency index (EEI) should be used to assess the energy consumption of buildings as compared to building size, height, or age.
- Building with energy efficiency must have EEI < 150 kWh/m²/yr.
- Study by energy efficiency of office buildings in Singapore → only 10 % of Singapore office building have EEI < 150 kWh/m²/yr.
Building Energy Standards (BEST) Software

![Energy Performance](image)

**Figure 2: The Energy Performance Standard form in BEST**
3. Building Orientation

- Has significant impact on
  - Building’s ability to reduce cooling load
  - The extent of natural ventilation
  - Utilization of daylighting

- Heat from sun for east/west direction is higher than north/south direction

- Glazing area: 20% - 40% (to avoid excessive heat)

- With external sun shading: up to 50% of glazing area
Building Orientation

DIRECTION OF SUN - SINGAPORE

Path of Sun

8pm  5pm  2pm  12pm  10am  7am

©http://hdbliving.blogspot.sg/
4. Sun-Shading

- For building facing east-west direction
- For aesthetic reason
- Inter-block shading is preferable to reduce glass window installation
- Selection of color for sun-shading $\rightarrow$ reflecting solar radiation
5. Facade Materials

- Glazing with low emissivity coatings
- Roof top garden
- Light color building to reflect sunlight and excessive heat absorption
- Cavity wall
- Double glazed window → up to 32% cooling energy cost
- Curtain wall glass
Low Emissivity Glass

Microscopically thin, transparent coating
Roof Top Garden as Insulation

Thermal properties of green roof

a. Evapo-transpiration
b. Shading by plants
c. Thermal insulation
d. Thermal mass storage

Hui, 2009
Light Color Building Material
Cavity Wall

Cavity wall insulation

- Face brick
- Masonary block
- Small hole (typically 25mm) in face brick for foam spray to be pumped through
- Spray Polyurethene Foam
Double Glazed Window

- **Low Iron Glass**
  (high light transmission, encourages solar gain)

- **Low-E Glass**
  (reflects heat back in)

- **Light**
  (sunlight, short-wave radiation transmitted through glass)

- **Gas Filled Cavity**
  (Argon or Krypton, reduces heat transfer)

- **Thermal Sleeves**
  (reduces thermal transmittance)

- **Spacer Bar**
  (warm edge spacer bar reduces thermal transmittance)

- **Slim Profile**
  (slim sight line profiles)

- **Heat**
  (long-wave radiation reflected back into home)
Energy Efficiency with respect to Day Lighting

- Day lighting should be incorporated in the design of energy efficiency to reduce cost and lighting load.
- Avoid excessive heat gain.
- Use sufficient and proper sun-shading.
- Light sensor is recommended.
- Solar panel roof
Energy Efficiency with respect to Natural Ventilation

- Natural ventilation should be incorporated in the design of energy efficiency to reduce cost and lighting load.
- Suitable for lobbies, courtyard, car park.
- For multipurpose hall (i.e. sports hall): hybrid ventilation (combination between natural and mechanical ventilation)
Energy Efficiency with respect to Air-Conditioning System

- In Singapore, 52% of electricity consumption from air-conditioning and refrigeration.

- Factors need to be considered:
  - District cooling, chiller efficiency, variable speed drive, variable speed cooling tower, variable air volume, zoning, motion sensor, chiller plant system control, energy label.
District Cooling

Keppel DHCS District Cooling System

In Changi business park and Biopolis – space saving & flexible design
Chiller Efficiency

- Selection of chiller number and size is important to ensure energy efficiency

- Chiller type:
  - Centrifugal $\rightarrow < 0.56 \text{ kW/ton}$
  - Screw $\rightarrow < 0.64 \text{ kW/ton}$
  - Reciprocating $\rightarrow < 0.92 \text{ kW/ton}$
Variable Air Volume (VAV)

- Control air distribution for better zone temperature control → saving up to 15% energy consumption
Motion Sensors
Energy Labels

1. Ticks Rating System
2. Energy Efficiency Rating

<table>
<thead>
<tr>
<th>Green Ticks</th>
<th>Energy Efficiency Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Low</td>
</tr>
<tr>
<td>1</td>
<td>Fair</td>
</tr>
<tr>
<td>2</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>Very Good</td>
</tr>
<tr>
<td>4</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

3. Energy Consumption in KWh/hr
4. Cooling Capacity
5. Type of Airconditioners
6. Brand Name
7. Model Number
8. Test Standards
9. Disclaimer
10. Registration Number
THANK YOU