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
**Major Refurbishment**

**Purpose**
To secure, for the long term, the benefits of existing planning consents

**Duration**
At least 15 years

**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 reorganization

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**Major Refurbishment**

- Refurbishment of Victoria Theatre and Concert Hall, Singapore

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**Major Refurbishment**

- Refurbishment theatre building of Start Vista
### Medium Refurbishment

**Purpose**  
Renew the existing fabric and services of a building to present day standards

**Duration**  
The investment timeframe is typically 15 years

**Scope of Works**
- Fittings, finishes and elements of building services will be replaced or upgraded, taking advantage of technological advances
- Limited structural alterations

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### Medium Refurbishment

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

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### 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)

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### Medium Refurbishment

- 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**
- Confining 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.

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Minor Refurbishment

**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

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

- Enviromental:
  - Adaptation countermeasure environmental issue, i.e. noise and pollution

Stages of Refurbishment

1. Building Investigation
2. Recommendations for Refurbishment
3. 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

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

Construction

- 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.

• 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

Tutorial Questions

1. Refurbishment of one office building is requested by the client. **Describe 3 different change concept in refurbishment. State and explain 3 ranges on refurbishment.**

2. Student housing in university requires major adaptation works. **Describe briefly 3 stages of refurbishment works. Explain 2 phasing of adaptation works.**
Lecture 5.2 - Sustainable Buildings – Energy Efficiency

Energy Consumption

Energy Consumption in the 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).

Energy 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 3.12% 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)

Energy Efficiency with respect to Building Envelope Design

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
2. Energy Efficiency Index

- Energy efficiency index (EEI) should be used to assess the energy consumption of building 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

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 with EEI less than 150 kWh/m²/yr

Nanyang Polytechnic
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 → 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

Port Singapore Authority (PSA) building

Roof Top Garden as Insulation

Thermal properties of green roof
- Evapo-transpiration
- Shading by plants
- Thermal insulation
- Thermal mass storage

Insulating property

Light Color Building Material

Reflects 20% Reflects 80%

Dark Roof Cool Roof
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 Efficient - Daylighting

Solar panel roof at Singapore’s sportshub
**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 Efficient – Natural Ventilation**

HDB car park, Singapore

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**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**

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 → < 0.56 kW/ton
  - Screw → < 0.64 kW/ton
  - Reciprocating → < 0.92 kW/ton

Variable Speed Drive (VSD)

- Saving in chiller plant power

Variable Air Volume (VAV)

- Control air distribution for better zone temperature control → saving up to 15% energy consumption
Zoning

Fan coil unit for small areas

Zoning

Inverter-controlled variable refrigerant volume (VRV) packaged unit for room with 24 hours operation

Motion Sensors

Energy Labels
3. Building is classified to have efficient energy if it is associated with low ETTV and low EEI. **What is ETTV and EEI?** How to define the criteria for low ETTV and low EEI? Explain 3 other factors need to be considered for designing building with respect to energy efficiency.

4. In Singapore, air-conditioning consumption make out almost 50% of energy usage. **Describe briefly 5 methods to reduce the consumption of energy from air-conditioning.**

THANK YOU