History: Murray Grove, n. London- 2000
Raines Court, Hackney, 2003
Modular Supply in the UK

- Approximately 6000 modules per year manufactured in the UK per year
- 7 Major suppliers in the UK
- Main markets are: Student residences, Military accommodation, Hotels, Social housing, Hospitals and Schools
- Building heights 4 to 12 storeys generally
- Module sizes of 2.7 to 4m width
Housing in Harlow
Hotel, Southwark
Residential Buildings- Modules on a Concrete Podium
Modules for Schools
Medical buildings, Colchester
Modules in Finland
Types of Modules

- 4 –Sided Modules with Load-bearing Walls
  - mainly used for cellular-type spaces
- Open –sided Modules with Corner Posts
  - mainly used for large open plan spaces
- Stair and Lift Modules
- Non-load Bearing Modules
  - Bathroom Modules
  - Specialist Modules, such as Balconies
Light Steel Framework of a Module
Open sided Modules – Used for Larger Spaces in Schools and Hospitals
Modules with Corner Posts
Modular Stairs
High-rise Buildings using Modules

- The modules support vertical loads
- Stability is provided by braced steelwork or concrete core
- Modules are ‘clustered’ around the core
- Fire resistance of 2 hours – provided by 3 layers of plasterboard
- Dimensional accuracy in installation is important
Paragon Project, Brentford, 17 storeys, 2007
Paragon-Typical Floor Plan
Paragon - Installation of Modules
Tallest Modular Building, Wolverhampton - 25 storeys
High-rise Modular Building, Wembley
Modular Hotel, Wembley
Modules Placed Around a Core
Mixed Constructional Systems

- Modules maybe be supported by a steel or concrete podium
- Stability is provided by separate structure
- Steel ‘exo-skeleton’ surrounds the modules
- Additional steelwork for walkways and balconies
- Supporting steel framework for high rise buildings
Modules on a Steel Framed Podium

- Modules
- Core for stairs/lifts
- Cellular beams supporting a composite slab
- Span of 12 to 16.5 m
MOHO Manchester-
External Steel Frames Support Modules
Mixed Modular – Frame Construction
Open House System in Malmo, Sweden
Constructional Features

- Fast construction—6 to 8 modules a day
- Two modules for one single bedroom apartment and three for 2 or 3 bedrooms
- 45 to 55% of the value of the building fabric is constructed in factory conditions
- Excellent acoustic insulation due to the double layer construction
- Modules are individually fire resistant using multiple layers of boards
Installation of Modules
2 Module Apartment
Double Walls and Floors in Modular Construction
Breakdown of Costs of Modular and Site-Intensive Construction

Site-intensive construction:
- Site overheads: 15%
- Materials and Waste: 30%
- Transport and equipment: 15%
- Site personnel costs: 40%

Modular construction:
- Site overheads: 8%
- Materials and Waste: 20%
- Non modular components: 20%
- Transport and craneage: 5%
- Site personnel costs: 20%
- Factory personnel costs: 15%
- Factory overheads: 20%
Cost of Modular Residential Building

- Manufactured cost of modules (25 to 35m² area) = 45 to 55% of total building cost
- Installation, transport and craneage +3%
- Non-modular components eg corridor, services, cladding, lifts, roof +25 to 35%
- Site management and facilities +8 to 10%
- Foundations and site preparation +5 to 10%
Modular Project, Wolverhampton

- 825 modules installed in 6 months
- Construction period reduced by an estimated 12 months
- Waste reduced by an estimated 90%
- Transport reduced by 60%
- Productivity increased by 50%
Construction Programme for Modular Building

- Foundations & Concrete Core
- Module Installation
- Cladding Installation
- Finishes & Services
- External work
- Client Fit-out
Economic Benefits of Modular Building

- Speed of Construction – savings in bank charges and earlier return on investment
  - 1% saving per month reduction in programme.
- Reduced site management and facilities cost
  - 4 to 6% saving due to faster construction
- Improved quality and reliability - fewer problems in hand-over -1 to 2% saving
- Economy of scale in manufacture – can be 10% reduction in cost for 500 module building
- Improved productivity in manufacture and installation (built into costs)
Sustainability Benefits of Modular Construction

- Speed of construction – reduced impact on locality; important for schools and hospitals.
- Reduced waste on site, and factory waste is re-cycled.
- Improved quality and reliability- better energy performance and acoustic insulation.
- Modules can be refurbished and re-used.
- Lower embodied carbon in light weight materials
Tests on Modular Construction
Bracing in Corridors for Stability
Restraint to 12 storey Building by Concrete Core
Brickwork Cladding

- Brickwork
- Insulated sheathing board
- 1 or 2 layers of plasterboard
- Mineral wool
- Light steel frame
- Wall ties
- Low lamb
- Merit legs tripig
- Brick ventilated plasterboard
- Brick
Metallic cladding panels

- Metallic cladding panels
- 2 layers of plasterboard
- Mineral wool insulation
- Rigid insulation board
- Vertical rail fixed to stud
- Light steel frame
Metallic Cladding to Modules
Future Trends in Modular Construction

- Mixed use buildings - ‘Open building systems’
- Greater standardisation in modular dimensions and connectivity
- High-rise modular construction, often with an additional supporting structure
- Greater emphasis on adaptability and re-use
- Pre-attachment of cladding for highly accurate construction