INDEX:

This CPD module will you take you about one hour to go through. It contains:
1. CASPAR characteristics. Detail of the developer's criteria.
2. Development examplar - an overview of CASPAR 2 was written by journalist David Birkbeck.
3. A short history of housing prefabrication - by architect David Levitt.
4. Citycore System used for CASPAR - a summary of the design challenges facing the architect on CASPAR2 using modularisation, by David Levitt.
5. Design philosophy
6. Design, massing and materials
7. Layout, circulation and security
8. Private and Communal Open Space
9. Schedule of Accommodation
10. Capital costs
11. Financial projections

CASPAR characteristics

A market research exercise conducted by Joseph Rowntree Foundation identified characteristics that were likely to lead to CASPAR developments being well received. All CASPAR schemes are planned to have the following:

- Locations within walking distance to commercial, cultural and leisure heart of the city, as well as a mainline railway station.
- Choice of leading practice of architects to create contemporary, award-winning design.
- Larger-than-usual one-bedroom apartments of about 50 square metres.
- One secure parking space per apartment. Rents reduced by £45-50 per month for those without cars.
- Fixtures and fittings include cooker, fridge, washer/dryer and carpets and curtains.
- Apartments meet the Police's Secure by Design criteria.

All apartments served by lifts. Space standards meet Lifetime Homes standards for accessibility and adaptability to make them suitable for large proportion of disable people.

Rents of about £100 per week - apartments with best aspects let at up to 30% more while those with least attractive let for less than £100.

Development examplar

Joseph Rowntree Foundation's new scheme in Leeds is set to prove that it is possible to develop an award-winning apartment block for the private-rented sector, then let it at below market rents and still make an attractive return on investment without any subsidy. The scheme is the second in a development blueprint programme called CASPAR – City-Centre Apartments for Single People at Affordable Rents. The JRF is committed to using its own funds to illustrate the financial viability of such development in the belief that city regeneration depends on increasing the number of young single residents whose appetite for social interaction and disposable income underpin urban life in the evenings and at weekends.

JRF currently projects that it makes about 2.9% on equities in its £270m investment portfolio whereas it will make a 6.2% yield in Leeds, despite offering such competitive rents. It is letting units at £100-130 per week against total development costs of £68 600 each for the forty-five 51 m2 flats. Each has generously specified bathroom, kitchen, entrance hall, living room, double-bedroom plus additional room for use as second or occasional bedroom/home office.

Pioneering design and construction

JRF's achievement owes much to its procurement route, picking architects Levitt Bernstein and contractor Kajima UK through a competition for a design that pioneers hotel construction methods in UK homebuilding. The result: time from site possession to project completion slashed from an anticipated 78 weeks to just 36. In fact, once the foundations and ground beams were in place, it took 13 working days within a period of just 18 calendar days to erect the three-, four- and five-tiered structure.

Here it is necessary to clarify terms used to describe construction making this possible: "volumetric" describes building assembly from square, rectangular or assymetrical blocks with internal and external traditional building finishes and fenestration, electrics, plumbing, tiling and joinery pre-prepared in a factory; semi-volumetric describes when half the building is built as "volumetric" units, and the other half delivered flatpacked as six panels for site workers to fix together. Leeds is semivolumetric and, to confuse matters, the supplier is Volumetric Ltd, part of Potton Group of Bedfordshire. The location of its plant at the other end of the M1 was one reason for flatpack delivery - to avoid transporting cubic metre after cubic metre of air 250 miles – but the 55 m2 apartments supplied as a single completed pod would have been too wide for a normal 3.6 m-wide load and so more costly.

At Caspar the factory assembled pod contains the kitchen and bathroom because of the preference for factory-controlled finishes for works typically otherwise troubled by programming of various trades such as plumbing, tiling and electrics, and by quality management or maintenance. All M&E in the completed pod was fitted before delivery to site, except the ring main for the whole apartment and the pod was delivered wholly complete except for the kitchen's white goods, supplied separately later. The flat-packed half of each apartment, containing the main bedroom and living area, was delivered to site finished except a final coat of paint and carpet. The project team is generally of the view that the decision to go semi-volumetric proved a false economy, as the challenge of tight, steeply sloping site, large overhanging roof

and semi-circular plan combined to exert unmanageable pressure on the assembly of flat packs to keep up with the pace of pod delivery.
All pods were craned into place floor by floor, and are self supporting to five storeys, having the capacity to take the superimposed load of aluminium monopitched roof and galvanised steel courtyard balcony and access gallery systems. The integrity of the system, proven in hotel building, uses elements familiar to UK timber-frame housing - 89 x 38 mm vertical timber studs with a sheathing of bitumen impregnated fibreboard enclosing rigid panel insulation. The performance specification for the structure is to a nominal 60 years, as for most new houses.

Layout

The scheme occupies a central Leeds site off North Street enclosed on three sides by a semi-circular slip road accessing the city centre's urban motorway-class circulation. Architects Levitt Bernstein traces the slip road with a crescent layout , buffering traffic noise with an outer perimeter of timber-rain-screened access galleries to apartments. Occupants are further shielded from disturbance from traffic or tenants traipsing home late to their flats or even the sound of the elements five storeys up in north Yorkshire by internal layouts which place kitchens, lobbies and bathrooms between the outer northern face and the living and principal sleeping accommodation which faces southward onto the sheltered courtyard.

There is a steep fall throughout the 0.345 hectare site, descending from three storeys on the west, through four storeys on the north to five on the east of the crescent. This transition from west to east end of the crescent is punctuated into four segments by three lifts and stairways, each shared by either 15 or 18 apartments. The access gallery is laid out so that there are typically two and never more than three flats on either side of the lift and stairwell. This configuration makes most apartments overlooked by passers-by, but no single flat is passed by traffic to more than two other flats, enough to discourage crime, while generally held to be too few to create a nuisance. The study/dining room/ occasional second bedroom is the only room in each apartment to have views to the north, revealed through cut outs in the rain screen.

Security

Every element of the scheme addresses the Police's Secure by Design guidelines for security of both individuals and property, which Joseph Rowntree Foundation research discovered were key criteria for potential tenants - women citing personal safety and men secure parking. The scheme can only be accessed through a single entrance in the south east corner, controlled by a gate with a tenant-operated remote entryphone system.

Building performance

Target cost for each apartment is £2/week for heat, light and power throughout the year. Factory fitted insulation standards are high and the total building performance of 110 far exceeds the rating required by Building Regulations in its Standard Assessment Procedure, while also outperforming requirements for the prevention of sound penetration. 2 plus 1 acoustic windows and front doors without letter boxes on the road side of the building stem traffic noise, leaving the ear to pick up the hum of a heat recovery, extract and ventilation system designed by engineers Max Fordham & Partners. When back up warmth is required, it draws warm moist air from the kitchen and bathroom and transfers the heat to incoming fresh air, distributed through ducts to each room. Winter heating is provided by individual gas boilers circulating hot water through a coil in the recycled air flow, although it is hoped that the energy efficient structure will mean that heat generated by lighting and equipment will be sufficient for space heating most of the time.

A short history of housing prefabrication
By David Levitt

Prefabrication of housing is very much a current preoccupation, not only for architects but also for government and housing producers. Its origins stretch back from even before the 2nd World War, when systems for the framing of houses were first experimented upon, to the immediate post-war period when “prefabs” were used as a serious attempt to solve the post-war housing crisis.

These early “prefabs” were the first attempt to use volumetric construction – the complete assembly of homes in a factory environment for transportation by road to their eventual destination. Although considered successful at the time, prefabs were always received by the public as an economy measure to solve a crisis until other preferable alternatives became available. They were always associated with publicly subsided “council housing” and they were not overwhelmingly cheap either. Being essentially freestanding, single storey structures – caravans without wheels – their contribution in terms of urban design was necessarily limited.

However, the concept became a preoccupation for architects who, throughout the 1950s, 1960s and into the 1970s experimented with different forms of prefabricated housing both in Europe and in the USA. Philosophically architects seemed to believe that a building produced in a factory needed to present certain characteristics which demonstrated, once complete, their industrial origins by means of expressed joints showing the use of materials more associated with industrial processes.

But the move to factory prefabrication never caught on, because in the public’s eye prefabs were already firmly associated with crisis solutions in public “council” housing. It also had one other overwhelming disadvantage, that of cost. Every attempt to develop a system for volumetric prefabrication meant higher initial costs which would only be reduced once orders were secured for subsequent substantial repeat orders, which never some how came. This was partly due to the fact that architects felt that to use a product that had been designed by somebody else for such a substantial part of any housing commission placed limited restrictions on their freedom of architectural expression and dimensional restrictions on many urban sites.

Citycore System used for CASPAR
David Levitt, of Levitt Bernstein looks at the challenge facing architects specifying modularisation in apartment construction.

When embarking on the Leeds and Birmingham competitions we decided to attempt a volumetric solution as an “add-on” to other features of the design entries and also because we felt it might eventually lead to lower prices than traditional construction, if successive projects could be guaranteed. But we knew that neither competition entry would succeed unless it offered a fixed price for the design that fitted within the cost parameter laid down in the brief. Therefore each relatively small scheme of 45 flats had to be built at a cost of equivalent to traditional construction. We looked at:

a) steel volumetric systems – the ‘Portacabin’ principle
b) lightweight steel frame, as offered by Britspace
c) timber volumetric developed by Volumetric Limited for budget hotels and motels.

After comparing all three we selected the timber volumetric system as being the most likely to respond to a custom made brief at a cost competitive with traditional construction on an extremely limited first production run.

Early studies showed that putting all the complicated bits of a flat in a single module – the completely fitted bathroom, the entrance hall with heat recovery and water heating system, the fitted kitchen, virtually all the electrics, all of the plumbing, all of the installed storage and all of the doors except that leading out onto the balcony, meant that the rest of the flat consisting of the living room and bedroom could more economically be supplied as a series of flat panels. The essential structural stability of the building is provided by these core modules, piled one on top of each other and supplied sealed and waterproofed from the factory, complete with internal wall and floor finishes. Once these had been assembled simultaneously with the conventional flat pack timber frame the intention had been to quickly install the main front to back roof beams and the roof finish which projected over a metre beyond the front and rear walls of the building. It had been intended to suspend the access gallery system from the cantilevered end of the roof beams on one side, and the private balconies from the cantilevered ends of the roof beam on the other. Unfortunately the main contractor had been unable to agree a price with the volumetric supplier for the external timber rainscreen to be applied in the factory and the design of the balconies and access galleries was not sufficiently advanced for the steelwork simply to be craned into position and suspended from the roof beams. As the programme shows this meant that the erection of the main timber structure was extremely quick. However, the subsequent steelwork sub-contract and the need for a complete scaffold to the inside elevation of the building and partial scaffold to the external elevation to apply the external rainscreen, slowed the contract down in its later stages to the equivalent of a conventional contract. In prefabricated volumetric buildings there is clearly a Health and Safety issue to be addressed in which conventional views about scaffolding will need to be modified, in order to save unnecessary cost. Throughout this period the design team was looking at alternative methods of detailing and fixing the rainscreen, suspending the access gallery system and closing the gap between the top surface of the upper flats and the underside of the single pitch roof. Originally it had been hoped to leave this space open and for any ventilation ducts to finish in this roof void without having to perforate the stainless steel profiled roof. This proposal was unacceptable to Building Control and there was also a fear associated with keeping birds and vermin out of the roof void. Similarly, the intention to suspend the rear access gallery system proved impossible once the main contractor had decided to use the access gallery structure in lieu of scaffolding. The steelwork programme therefore had to be accelerated and the gallery themselves supported on thin steel columns, with what has been intended as steel hangers only acting as restraint at the top.

Using pressure impregnated timber as a cladding material on an escape route is expensive when it has to become effectively non-combustible, using a method of treatment that achieves Class ‘O’ fire resistance. Even so the external cladding seems true to the spirit of a timber frame building and is much more economical per square metre than even cheap traditional external skins such as brick, tile or aluminium.

The follow-on scheme from Leeds will be fully volumetric, although the external skin will still be applied on site. It is obviously desirable to deliver the units complete with their external rainscreen but it does pose problems both for tolerances and protection during transit especially of exposed edges.

Design Philosophy

The objective was to create a typology for housing for single people to rent, to be built without any public subsidy. The design principles can be broken down as:

- economy of construction - the use of 'semi-volumetric' timber-frame construction.
- design, massing and external materials
- layout, circulation and security
- private and communal open spaces
- social exchange
- internal layouts
- use of environmentally-friendly materials
- ease of access/Lifetime Homes standards
- landscape design
- economy of management and maintenance
- the Arts. (Consultants in Wakefield invited five artists to submit proposals. Renn & Thacker of Birmingham were chosen and have developed a lighting installation utilising fibre-optics to create a band of light around the building in changing colours.)

Design, Massing and External Materials

No attempt is made to disguise any of the main components. Three, four and five storey timber-framed flats arranged in a semi circle are clad in timber and non-load-bearing stark-bonded brickwork. Spanning the uppermost storey a series of steel beams, set at 100 to the horizontal, supports the polyester -coated aluminium sheet roof. From the cantilevered ends of these beams 25 mm diameter steel rods are suspended. These in turn support steel private balconies on one side, and tie the roof to the access gallery structure on the other.
Except around the entrance, and the lowest floor of the five-floor section, the use of brick cladding has been avoided. External walls are clad either in organic solvent pressure-treated timber "ship-lap" boarding, durable but, unlike brick, capable of being replaced after 50 or 60 years. The access gallery "rainscreens" are clad in organic solvent pressure-treated timber boarding with open joints (class 0 to escape routes).

By having a roof which overhangs the external walls by at least one and a half metres, weather protection is provided for the suspended steelwork. The access gallery structures are supported partly by steel columns and partly by steel brackets coach screwed to the timber structure.

Layout, Circulation and Security

The 45 flats are arranged in a crescent around a semi-circular open courtyard facing south. There is a single entrance in the south east corner accessed from the street and controlled by a gate with a tenant-operated remote entryphone system.

The central courtyard is arranged as a series of tilted planes, part roadway, part courtyard and part garden. All living rooms and bedrooms face the courtyard, all being protected from motorway noise by the enclosing wall of service rooms - kitchens, bathrooms and entrance lobbies. Only the dining/study/bedroom faces outwards to give extended views beyond the boundaries of the site. However, as these rooms can form part of the living room which has its principal windows facing the internal courtyard, the outward facing windows are designed to be kept shut for acoustic reasons, except for cleaning.

The courtyard faces almost due south so all flats will receive direct sunlight at some time on clear days.
The outside perimeter wall and the entrance corridors are the most exposed parts of the building, even though the roof projects by at least one metre. This wall is therefore to be protected by a timber rainscreen, which is wrapped round the exposed walls of flats and used to shelter the access gallery.

Residents entering on foot, by wheelchair, by car or bicycle have direct access either to a lift, or to one of the three communal stairs up to their flat.

Private and Communal Open Space

All flats have balconies or private patios. Car parking and 'sitting out' space have been separated by level changes. The landscaped courtyard is intended as the social focus for the whole community. The design sets out to avoid the social isolation from which many single people in cities can suffer while, at the same time, providing entirely self-contained homes, each behind its own secure front door. Once inside the main entrance gate, residents reach their flats via a series of visually stimulating ramps, pathways and access galleries. These galleries are protected from rain, but, being open ended, are thus part of the outdoor realm. Passing social encounters on the routes to and from flats are therefore encouraged.

The aim is to satisfy both the need for the privacy and anonymity which many of those who seek city life require, while creating the opportunity for a small scale community to develop within its walls.

The outer rainscreen cladding appears to shelter and protect the community within.

One/two bedroom flats are provided. The flats are arranged facing onto the courtyard.

The flats, although smaller than affordable housing standards, allow for considerable flexibility in terms of usage and furniture arrangements. The smaller bedroom can be used as dining room, study, or to simply provide a larger living room. All the flats have duel aspect, that is to say that their living rooms and bedrooms face away from the entrance side and the motorway which provides privacy for the habitable rooms but allows a view through each small kitchen

window, to the entrance corridors outside.

Features of the flats include:-

- an entrance lobby serving all rooms
- double doors between living room and small bedroom
- fully fitted kitchens equipped with cooker, washing machine and fridge/ freezer
- bathroom with shower equipment and full height watertight screens around the bath
- welded watertight bathroom floor with drainage gully
- vinyl flooring with coved skirting to bathroom, kitchen and entrance lobby
- timber framed (triple) glazed windows with pivot action and secure night ventilation provision, which can be cleaned from inside or from a balcony
- Storage

Kitchen: Units – Total	1.3 m3
Broom cupboard:	0.7 m3
Wardrobe	1.9 m3

- Automatic heat recovery and extract system. Warm moist air is extracted from the kitchen and bathroom, and the heat is transferred to incoming fresh air, which is distributed through ducts to each room. Heating is provided by individual gas boilers circulating hot water through a coil in the supply air flow.
- Sound reduction in walls and floors exceeds Building Regulations reaching 58 db for party walls and 65 db for airborne and 54 db for impact sound through floors.
- Insulation exceeding Building Regulations contributes to 110 SAP rating.

Service risers on the public (access) side of each flat are contained in fire-resistant riser ducts accessible from outside the dwellings.

Schedule of Accommodation

- Use of Environmentally Friendly Materials
- roof overhang provides crucial shading and weather protection

- shading devices prevent overheating on south-facing balconies
- careful specification of plants which will enrich the soil & sustain the landscape- vital on a brownfield site
- south-facing courtyard contains planting which will provide cooling in summer
- insulation exceeds Building Regulations
- detailing allows for recyclability
- high embodied energy materials have not been specified, unless their performance will result in a long term energy payback
- timber superstructure, factory made minimises material wastage
- softwood structural timber from renewable sources
- softwood external cladding, treated with environmentally friendly, water-based preservatives.
- Lifetime Homes Audit

As many of the 16 headings for Lifetime Homes as are relevant to this project have been met. There is lift access to all upper floor units.

- Economy of Management and Maintenance

The design incorporates certain features to minimise service charges which have to be passed on to residents. These include:-

- single entryphone system
- three 'Schindler' mobile, motor room less lifts
- no internal communal areas
- low maintenance surfaces to entrance corridors and stairs
- landscaping - low maintenance
- caretaker functions - minimal with no communal areas or windows
- communal lighting - use of low-energy light bulbs
- no refuse chutes
- no requirement for communal smoke detectors

The design incorporates features to minimise the costs of cyclical maintenance. Normal painting cycles are required. The roof requires no maintenance.

Outline Specification

<u>Generally</u>

The construction methodology has taken into account both site-specific conditions such as the position and location of the site, and macro issues such as sustainability and economic programming.

The building materials and techniques lend themselves to factory production and simple site

assembly. This promises greater quality with reduced delivery times. It delivers better thermal insulation and more intelligent services using sustainable materials whilst, reducing the need for site plant, especially scaffolding.

Substructure

Mass concrete and/or piling to suit ground conditions. Interlocking timber earth-retaining structures.

Dwelling Construction

Timber-framed 3, 4 and 5-storey construction.
All bathrooms, kitchens and entrance halls are in factory produced units brought to site fitted out, and connected up during erection.
The balance of the construction is in timber-framed panels assembled on site.
Thermal insulation standards are set out in Max Fordham & Partners report.
Party/tenancy separation: twin leaf timber wall to achieve 58 db reduction in airborne sound transmission between dwellings.
Floating timber floors with 25 plasterboard ceilings achieve 65 db for airborne and 54 db for impact sound transmission without carpet.

Doors and Windows

Windows (from Swedish Window Company Ltd are stained treated softwood, high performance triple glazed units:
2 + 1 inward opening side hung acoustic windows to outer perimeter
Double hung to main bedroom
Outward opening side hung to living room

Balcony doors (from Swedish Window Co.) are stained treated softwood glazed doors with triple glazed units, espagnolet locking.

Key locking to all windows except small bed/dining because this is an alternative exit window.

All windows cleanable from within or from a balcony.

Flat entrance doors “Ekodoor” from Swedish Window Co.

External Cladding

1. Organic solvent pressure impregnated “ship-lap” stained timber cladding to flats. (Class 0 to escape routes)
2. Class 0 treated pressure impregnated open jointed “rainscreen” stained timber cladding to access gallery screens.
3. Stack bonded Marshalls Robin Hood Red Smith brickwork.

Note: item 1 + 2 will require recoating with stain at 5+ year intervals depending on exposure and wear.

No. Bedrooms	1
Type	Flats
Size m2 (gross floor area) inc. storage	51
No. Dwellings	45
No. of habitable rooms per flat	3
No. Habitable Rooms	135

Site area 0.345 hectares
Density = 391 HR/hectare
Parking spaces 45 cars

Level 0	3 Flats
Level 1	6 Flats
Level 2	12 Flats
Level 3	12 Flats
Level 4	12 Flats

Room Sizes (m2)
2 bedroom flat

living room	15.7
bedroom 1 (incl.wardrobe)	11.2
bedroom 2/study/dining	7.1
kitchen	5.3
bath	4.5
circulation	4.7

TOTAL = 48.5 m2 net

Roof Construction
Over the dwellings is a monopitch standing seam aluminium single sheet roof by Leestrip supported on steel beams and timber purlins. The open eaves are protected by a continuous external quality ply closer.

External Balconies and Galleries
Access to all upper floor units is via galvanised steel galleries and balustrading supported from the ground. An external quality rubber flooring (Altro Mondo Sportflex) will cover the wearing surface.

Suspended galvanised steel balconies and balustrading are also provided to each flat as private open space. The wearing surface will be slatted treated softwood timber.

Lifts
Schindler machine room less lifts.

Services
Heating and Hot Water by individual wall mounted gas boilers providing instantaneous hot water, and space heating via the heat exchanging ventilation system.

13-A power supplied to all rooms. Low energy lighting fittings. TV and Telecom sockets by cable provider.

External lighting by low energy fittings off landlords supply.

Entry System
KAJIMA to complete

Fittings
Symphony Cambridge kitchen units, inset sink, mixer tap. Space for cooker/hob, fridge freezer and washing machine/drier.

Armitage Shanks sanitary fittings comprising bath with mixer tap, thermostatic shower, wash handbasin, WC and cistern.

Internal Floor Finishes
Vinyl sheet flooring to kitchens and bathrooms. Carpet by Vorwerk elsewhere.

Capital costs per apartment, £	
Build cost	51 100
Land cost	11 700
On-costs	5800
Total cost	68 600
Social housing comparison (higher build costs than TCIs, lower on-costs) £57 300	

Internal Decorations
Generally Emulsion paint on plasterboard to walls and ceilings. Satinwood paint to internal joinery. Internal surfaces of windows to be stained. Full height ceramic wall tiling to bath areas and in splashbacks behind basin and kitchen units.

External Decorations
Treated timer (Class 0 to escape routes) stained with Sadolin: Two coats classic to cladding, l coat classic and 2 coats supercoat to windows, sills and trims. Colours: red pepper and slate grey. Steelwork to be self-finished galvanised.

Hard Landscape
Paving, main car park – block paving/bond gravel
Car park and entrance road - PC concrete setts, 80 mm thick, random coursed bond.
Parking space demarcation – 100 mm diameter ground mounted galvanised stainless steel studs.
Rumble strip - reclaimed granite setts.
Kerbs, including flush trims - PC concrete 'conservation style' kerbs.
Steps as kerbs.
Slab paving - 400 x 400 x 50 mm PC concrete slabs with granite aggregate surface. Colour 'silver grey'.
General footpaths – PC concrete slabs.

Soft Landscape
Planting to perimeter of site.
Existing trees and topsoil protected and retained.
New trees planted in pits backfilled with existing topsoil mixed with tree planting compost.
Internal courtyard.
Trees in car park area planted in trench (minimum cross sectional area 1200 x 1200 mm) Urban tree soil.
Mild steel tree pit edge supports and tree guards.
Other trees planted in trench, minimum depth 1200 mm topsoil to BS 3882.
Turf over 150 mm topsoil over free draining subsoil.

Financial projections, £ 000

Income		
Rents inclusive of service charges	261	(£111.50/week)
Car parking	27	(£11.50/week)
Total	288	
Voids @ 5%	(14)	
Total	274	
Expenditure		
Management charge @ 8%	(26)	
Maintenance	(18)	
Insurance	(3)	
Services		
Cleaning	(3)	
Landscaping/gardening	(1)	
Lifts/communal lighting	(7)	
Carpets/curtains	(10)	
White goods	(10)	
Barriers/entry-exit systems	(3)	
Fire protection	(2)	
Total expenditure	(83)	
Net income	191	
Yield on projected capital cost	6.2%	