

# MODULAR HOUSE BUILDING



## **Modular House Building**

The purpose of this paper is to set out a brief definition of a type of modular build, consider lessons learned and to generate options for delivery with summary risks and rewards.

### **Definition**

There are a confusing range of build methods applied to the term modular, so it is important for this paper to be clear on the method and house type. For the purposes of this paper, modular is defined as complete volumetric units built and fitted out in a factory environment, delivered to site and installed with minimal construction works on site other than the ground works and connections and jointing finishes. In addition, modular as defined above can, and is, easily utilised in apartment style development but again, for the purpose of this paper, the analysis is for a low rise house, either bungalow or 2/3 storey detached, semi detached or terraced/town house design.

There are 5 critical and interlinked stages in the development of a modular house. Each stage is described below together with some fundamental lessons learned from trying to develop and deliver a modular build housing solution.

### **A) Site choice, planning and design.**

As with any housing development, land to build on is a fundamental requirement. Many of the attributes applied to housing land will apply to modular i.e. planning status, flood risk, topography ground conditions, road access etc. However, there are two key additional attributes which need to be checked out before any decision is made, road access for the completed units to be transported to site and crane space for lifting the units off the transport and into place. Trees, overhead cables etc can either make a modular system impossible to deliver on a site at the very least add cost in removing obstacles either permanently or temporarily during installation.

#### **Lesson 1; Ensure potential sites are surveyed by the logistics team or by surveyors experienced in modular for any access issues prior to any further work.**

In order to maximise cost efficiency in manufacture whilst at the same time producing a design which is acceptable to the local planning authority and the consumer, it is important that the designer is engaged as early as possible and is able to maximise the layout and efficiency of the site specifically for modular units. Retro fitting a modular solution to a traditional build planning approval will not deliver an efficient process. Equally the designer will also need to work with the manufacturer to understand the most efficient way the units can be manufactured. The designer will then need to work with the client and the planning authority in order to balance the production cost efficiency with good design that will meet local expectations without pushing costs too high. It is vital that the designer and manufacturer develop a good relationship and mutual understanding of each other's constraints and the client's objectives.

#### **Lesson 2; Appoint a designer with experience of modular build at an early stage and engage with manufacturers early to optimise design and build cost.**

External finishes and design such as roof lines vary from client to client, local planning authority and the site location. The addition of a traditional pitched roof can add significant cost and there are good alternatives which maximise the modular benefits.



**Lesson 3; Enter preplanning discussions with the planning authority at the earliest stage in order to gauge appetite for innovation ie is it a brick external finish with pitched roof or something different**

## **B) Manufacturing**

There are two basic manufacturing process which can be described at the opposite ends of a spectrum and with variations in between. The first is a highly automated process with use of robotics and computerised automation. The second is a manually based production which essentially builds a house in a factory using parts delivered to a production line. Both processes require a pipeline, and many have referred to at least 500 units in front of production. Automation perhaps requires a bigger pipeline.

Automation gives the production capacity to deliver large volumes but is constrained by the very need to deliver large volumes to be able to amortise the initial high set up costs. It also has less capacity to be flexible in design changes although this is not impossible.

A manually based operation is more flexible in that factories can increase or decrease build capacity with shift working. However, until a greater pipeline can be assured, economies from supply chains cannot be achieved.

The reality is that production, similar to car manufacturing will lie between the two, with the basic frame and structure being automated and mass produced whilst the fitting out will remain largely manual. Examples already exist of panelised production delivering the pre cut panels to a factory for assembly into the volumetric units

Most manufacturers currently in the market use either a steel frame design with panels or a laminated timber panel system. In all cases this produces a very strong rigid 'box' which is able to be transported, craned, stacked and joined without any additional reinforcement. The strength also allows all the internal fittings to be installed without risk of movement during transit and installation.

All manufacturers will advise on the basic dimensions of 'the box' as it is constrained by the ability to transport by road larger units without the need for a police escort or road closures. However, most manufacturers will be willing to design within that constraint pretty much anything a client wants. This is the important part that requires a client and their designer to work with the manufacturer to optimise the design for manufacturing. Compromises in this process will lead either to higher manufacturing costs as the client specification pushes up build cost or to disappointment from the client when the manufactured process delivers a standard product.

**Lesson 4; Talk to manufacturers and view a range of manufactured modular homes before opting to work with any specific one. It is unlikely that there is an 'off the shelf' design from any manufacturer that will meet all requirements.**

## **C) Logistics**

Transporting the units from the factory to any given site and then craning them onto the site is another key part of the process which on the face of it seems fairly simple and straight forward. However, it requires very careful planning to ensure that completed units are not having to be stored at the factory or off site, waiting for the logistics or the site to be ready. Equally a crane waiting for late units to arrive is expensive. It has already been mentioned above, but the

dimensions of any unit are important to ensure that they can be transported by road without the need for a police escort or road closures which all add significant cost.

The weight of the units may also be a consideration as lighter units may be able to be craned into position using a heavy weight Hiab type vehicle whereas heavier units will need a separate crane.

**Lesson 5; It is critical that the logistics are planned in with the manufacturer and ground worker and that there is a good relationship and evidence of experience. Some contingency should be allowed for unavoidable delays e.g. traffic hold ups.**

#### **D) Groundwork and utilities**

The design of the site layout has already been mentioned above and it is critical that accurate and precise plans are drawn up for the ground worker to be able to install the foundations, order utility connections and complete all other infrastructure works such as the roads, driveways and surface finishes including landscaping. As far as possible, the site works should all be completed prior to installation. This is completely the opposite to traditional build where landscaping is the final activity.

Utility connections have proved problematic in some earlier modular developments and so a discussion at very early stages is recommended to identify where, if any, problems or delays may lie. For example one utility company would not log a connection job onto its system until the house existed on site. Only then would they log it into a system which then generated a date several weeks away for the connection work. This led to the frustrating position of houses being completed and ready for handover but without power for several weeks and unable to hand over.

**Lesson 6; Ensure an early discussion with utility providers in order to identify any potential delays in connections.**

**Lesson 7; Either appoint a ground worker with modular experience or ensure early connections with the manufacturer and the logistics provider**

#### **General**

It is probably worth at the outset tempering beliefs that modular will be cheaper than traditional build. All the examples to date have cost more and, in some cases, prevented schemes proceeding. The best examples have managed to deliver at a broadly comparable cost. What modular volumetric does produce is a very quality controlled product with absolute detail of every wiring run, pipe installation and ducting, all logged through BIM. Its air tightness and the performance of all elements is assured. This gives confidence that the building will perform as designed and where future repairs, replacements or improvements are carried out, contractors will know to the millimetre where everything is in the building.

As in traditional construction, it is essential that a client employs the right technical advice from an early stage. This will help the client get both the best design but also help achieve assurance on cost control.

**Lesson 8; Consider appointing an Employers Agent early on in the process in order to ensure that all the above elements join together, and all variables are tied down prior to any contracts being let.**

It is very tempting to work solely with a manufacturer and be persuaded of the cost efficiency of the manufactured product. What experience has demonstrated is that much of the cost lies with the



three other elements, design, logistics and ground works. Modular is a relatively new concept and contractors will add margin to cover their untested risks, especially if they are to be held to account for any failings. A number of manufacturers are now starting to offer a 'turnkey' product where they take responsibility for managing all the elements of the process. However, until a level of understanding and expertise develops, there is still likely to be a higher degree of risk pricing.

**Lesson 9; Do not focus solely on the modular manufacturer. All four elements are integral to the cost-effective delivery and a focus on manufacturing may appear to achieve a cost-effective solution but it will only lead to higher delivery costs and frustration.**

### Delivery options

Modular units lend themselves to a rental product, either market or affordable. This is because once committed to an order, all the units will be delivered and installed in a relatively short time frame fully commissioned and with no snags. Lettings can be signed up with confidence for tenants to move in the day after planned completion, meaning income is generated immediately from completion and final payment.

Conversely, modular as an open market sale product is riskier. It is unlikely that the manufacturer will be able to provide a show house on the sales site and purchasers would need to commit off plan for the units that are programmed to be delivered without seeing one built. This can be mitigated by taking clients to visit other sites or the factory, but it adds risk until modular becomes the norm and consumers can see, feel and touch the new homes. Any unsold units on a site will still arrive and be installed for which payment will need to be made. Depending on the number of unsold units in the pipeline, this could be very expensive. Traditional builders will simply slow down or stop building in this sort of situation. Again, this could be mitigated by having several sites over which the sales product can be delivered

Another way of mitigating this risk could be a flexible approach to tenure with units being either for sale or rent. If this were to be the case, the management of the whole estate would need to be clearly set out and high standards maintained for estate management of both the tenanted and owner occupied properties in order to give assurance to those considering owner occupation. There are good examples of this tenure blind mixed approach and it does not appear to have put off purchasers knowing that other homes are for rent.

In developing the delivery options, the client must consider firstly the route that they intend taking re tenure, potential scale of numbers and therefore the scale and pace of orders that they may be able to place at any one time. This will influence heavily their choice of acting alone, collectively and how they engage with manufacturing. These options are set out briefly below together with a simple reward/risk matrix.

**Option 1; A single organisation procures all 4 elements of the modular build and manages the co-ordination through, for example an Employers Agent.**

Rewards	Risks
<ol style="list-style-type: none"> <li>1. Direct control of the four elements and clarity on price for each element</li> <li>2. Appointment of preferred contractors for each element</li> <li>3. Easier for the client to be clear what</li> </ol>	<ol style="list-style-type: none"> <li>1. Very client intensive process with potentially high legal costs around 4 interlinked contracts</li> <li>2. Contractors may not work together very well and risk blurring responsibilities</li> </ol>

their specification is.	<p>when things go wrong if the contracts are not clear.</p> <ol style="list-style-type: none"> <li>3. risk to a single organisation and inability to commit to a big enough pipeline</li> <li>4. Build costs may still be higher than traditional</li> </ol>
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**Option 2; A consortium of organisations procure as option 1 i.e. 4 separate contractors**

Rewards	Risks
<ol style="list-style-type: none"> <li>1. Rewards 1 and 2 above still apply</li> <li>2. Spreads risk and widens expertise across organisations</li> <li>3. Allows potential for scale of pipeline to be secured</li> </ol>	<ol style="list-style-type: none"> <li>1. risks 1 and 2 still apply but with the added complexity of more than one client signing contracts</li> <li>2. Harder to achieve consensus amongst consortium members, especially on design, legal agreements and funding.</li> <li>3. Build costs may still be higher than traditional</li> </ol>

**Option 3; A consortium client acting on behalf of members procuring a consortium supplier i.e. the bidder manages all the component parts in a single turnkey proposal.**

Rewards	Risks
<ol style="list-style-type: none"> <li>1. 2 and 3 of option 2 apply.</li> <li>2. Simpler contracting point and therefore likely to be less legal costs.</li> <li>3. Single contractor responsible for all issues and sorting out problems and disputes between contractors within their own contract</li> </ol>	<ol style="list-style-type: none"> <li>1. Still very client intensive as the client will need to operate as a single point and will need to agree details of every stage with consortia members.</li> <li>2. Profit margins and costs can be hidden within the bidder consortium</li> <li>3. Contractual arrangements may not be as clear as they seem e.g. PFI contracts</li> <li>4. Build costs may still be higher than traditional</li> </ol>

**Option 4; Creation of a Joint Venture type arrangement with a supplier consortium. Shared investment and risk between the client and the supplier - most likely to be led by a manufacturer.**

Rewards	Risks
<ol style="list-style-type: none"> <li>1. Both client and supplier working collectively to manage efficiency and value for money</li> <li>2. Potential share in profits.</li> <li>3. Allows potential for scale and a long-term relationship</li> <li>4. Encourages innovation and efficiency</li> </ol>	<ol style="list-style-type: none"> <li>1. Challenge in securing the right JV partner and satisfying any procurement rules</li> <li>2. JV agreement could be complex if multiple partners involved</li> <li>3. client and supplier share risk of losing money</li> <li>4. Can JV be open to further partners joining?</li> <li>5. Build costs may still be higher than traditional build</li> </ol>



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**Option 5; client or consortium of clients invest in developing their own manufacturing base either from scratch or by purchasing an existing factory and build their own modular units, selling any surplus to other clients**

Rewards	Risks
<ol style="list-style-type: none"> <li>1. Client has direct control of design of production and product.</li> <li>2. Client receives an investment return if the production is profitable</li> <li>3. Potential to provide services for others</li> <li>4. Potential to introduce greater social impact on the process.</li> </ol>	<ol style="list-style-type: none"> <li>1. Still requires procurement of design, ground works and logistics, all of which will add cost to the manufacturing</li> <li>2. Manufacturing expertise will need to be secured unless purchasing an existing factory</li> <li>3. Clients ability to provide good governance over a new process</li> <li>4. Demand side still uncertain</li> <li>5. up front investment will be substantial circa £10 million.</li> </ol>



