HOUSE PLANNING HELP

Episode 274

An innovative cork house, designed for disassembly – with Matthew Barnett Howland

The show notes: www.houseplanninghelp.com/274

Matt: I am the director of research and development at CSK Architects on the High Street here in Eton. I was educated at Cambridge, followed by The Bartlett and always been interested in making things as well as designing things.

After working for various architectural practices, in 2013 decided I wanted to undertake this project. Together with industry and academic partners, I put together a research team and spent the next five or six years developing the solid cork construction kit, as we call it, and the Cork House which is the first pilot for that construction kit.

Ben: I'm assuming cork must have come first. You must've had a love for it, or an interest or an intrigue?

Matt: No, cork strangely didn't really come first. It came shortly after the main driver which is probably a slightly grumpy dissatisfaction with what we typically build with, especially in modern house construction here in the UK.

I've designed and built many buildings using this type of construction where it's a very layered form of construction using a whole range of products, materials and systems that make this a very complex assembly.

When you actually analyse what you end up with in one of those constructions, it's not a particularly attractive prospect in a number of ways. Most importantly for me, it introduces a complexity across almost every stage of the building's lifecycle right from the resource stage and landscaping packs; through to even the design stage, specifying different materials with different properties and so on; through to on-site sequencing of trades, interfacing between trades; through to the performance gap that you almost always get in houses where they always perform less well than they're predicted; right through, particularly most importantly probably, to the end of life scenario where you have a destructive demolition.

That's one of the main motivations behind the project also, was this idea of designing a building with respect to its material ecology if you like and not designing a building and then thinking about its material ecology; thinking about the material ecology and then developing an architecture out of that, if you see what I mean. It's reversing that idea slightly.

Ben: I was just going to say, that can be one of the challenges. You start focusing on one area and it dictates the others.

Matt: Yes. Typically, the process of designing and making buildings is quite a granular process by which I mean that you might start with a client having a site that has particular characteristics that you need to respond to. Then they will have a brief. So, you develop a design and then that's got to go through planning. The planners might have certain ideas about what they want it to look like externally and the client probably has some ideas about what they want it to look like internally. Then the engineer gets involved in terms of what the structure is made of. Then you want to make a construction that passes building regulations. Then it goes through the pricing process and some value engineering, shall we say.

Before you know it, you have this thing that sure enough works and ticks all the boxes but the way you've got there is not through a very holistic approach. That's what this project allowed me to do, unusually, I guess as the client initiator, researcher, designer and in the end builder as well. It allowed a sort of single minded and holistic approach to the project.

Ben: I'm still intrigued a little bit about this research side of things. You've gone through a number of different aspects of the project but what came first?

Matt: Obviously, there's a whole aspect to the building which is a response to the specific characteristic of the site and what we wanted to achieve with the building and so on, which I can talk about if you want.

Ben: Yes. We want as much detail as possible.

Matt: At the back of our existing house, there are two gardens that go down to a bottleneck between them. Next to the riverbank, a slightly awkward junction and geometry. We weren't really using the most rear garden that much. So, we placed the house in such a way to create a house and garden setup in this rear garden but also the end bay of the house creates a threshold space between the two gardens that sort of articulates that junction between the two and is

an antechamber to the house itself and is also an outdoor living space for the house.

It was very specifically sited and designed in that respect.

Ben: What was on the brief for this project?

Matt: The brief was driven by that dissatisfaction with the complex wall that I was describing. We had the question, if you like, with a thesis, could we make a building envelope, walls and roof, out of a single bio-renewable material to fulfil all the functions of the modern building envelope, to modern performance requirements. That in a way became the brief. Could we develop this solid cork building envelope? That's where the research kicked in.

So, with that concept in mind, I applied for research to Innovate UK and EPSRC and that's when we put together this team of industry and academic partners and between us over two-and-a-half years, we tested and prototyped and developed the proof of concept for this solid cork building envelope. And then the house is the first pilot application of that new system that we had researched and developed.

Ben: Before we get ahead of ourselves, just a bit of background on cork. Where does it come from?

Matt: Cork comes from the Mediterranean rim. I think roughly fifty percent of the world's cork is produced by Portugal and we worked in this project with the cork supplier called Amorim who are the world's biggest cork manufacturer and supplier.

It's the bark of the cork oak tree. It's called Quercus suber. Suber relates to the unusual material that's in the cork that gives it its funny combination of characteristics, which is called suberin.

Most of the value from the cork harvest is used obviously for cork stoppers, wine stoppers. Then there's a whole agglomerated cork industry which is granulated cork mixed with polyurethane glue to make a whole range of industrial technical furniture products and so on.

But then in a way the waste from the forestry and from those previous industries, they end up in what's called the expanded cork industry which is a very important distinction in that the cork is granulated, put into large fixed volume ovens, if you like, saucepans, and it's cooked at a very high temperature, about three-hundred-and-sixty degrees centigrade with dry steam passed through it. Under this heat and steam the granules expand and they

also release a natural resin inside the cork, the suberin, which then melts and as it cools it re-bonds the expanded granules of cork back together again.

So, blocks of expanded cork that we've used throughout this project is in fact a one-hundred percent pure bio-renewable and biodegradable product.

Ben: Why do they sometimes do something differently? It would seem natural, as with many things in life whatever the material is, but why are they adding other things to it?

Matt: Typically, if it was something like what they call agglomerated white cork, which is say if you buy a cork coaster from Ikea that's typically agglomerated cork – it's sort of beige coloured stuff – the reason you would introduce polyurethane binders into that is for performance reasons. You can make it very thin, it's hard wearing, it's an industrial performance product in a way.

This expanded cork is a slightly more rougher agricultural process. Obviously, in terms of impact, it isn't quite as good, and in terms of other mechanical properties, but it was adequate for what we required and more importantly had this purity that was very important to the lifecycle considerations of using it in the building.

Ben: How have you considered that lifecycle? Let's say it gets to the end of life of this building. Do you anticipate that it could go straight into another building?

Matt: First of all, it's important to say that just because the house is designed with an awareness of the fact that it at some point in the future may come to the end of its useful life, I'm not looking to hasten that moment.

Ben: Quite understandably.

Matt: It's like timber buildings. If they're detailed well and looked after then they should be able to last for why not several hundreds of years as you will find all around Scandinavia.

Having said that, buildings often do come to the end of their useful life or people need to get rid of buildings for redevelopment or for whatever reason and I think it's important to consider the end of life scenario.

I don't want to make out that they're consumables, as it were, in the same way that maybe a plastic knife and fork are. But nonetheless I think it's important to consider that as part of the building lifecycle.

So, we design the entire house without any mortar or glue between the cork blocks. All the timber elements, the connections between them, are bolted and screwed, whether that's the windows into the cork or the beams to the structural wardrobes, or the floorboards to the solid CLT timber floor which are screwed. Everything is accessible and demountable.

That obviously then makes it easy in terms of recovering materials or elements of the construction either for reuse if possible, or if not for reuse then for recycling back into the manufacturing chain. And failing those two options then of course the cork being pure cork, it can actually be granulated and go straight into the soil to biodegrade and generate new growth, which is in fact one of the uses of granulated expanded cork already. It is used as an aerating soil improver.

Ben: I know there are many benefits. The obvious one that I know is about insulation. But what else? What can you tell us about the benefits of cork?

Matt: I think the benefits of cork in this instance are that it enabled that initial primary objective. In other words, its unique range of properties means that it could fulfil all the roles of a building envelope that are normally fulfilled by a range of different materials. In other words, structure, rain-tightness, airtightness, insulation, internal finish, external finish, the enclosure that it gives you and so on. That's all done by the cork in this instance. That was the benefit of the cork, the range of applications it allowed.

Ben: So, getting to this stage, it was obviously a research project. What else did you need to find out about it before you started building?

Matt: We did a range of tests on prototypes that we made, smaller constructions. The cork casket, which is like a sort of dog kennel almost, and then a slightly larger cork cabin were the two main prototypes. We tested those in-situ, on site in terms of weather. We had them tested for airtightness and they were obviously very useful in terms of the construction process. They taught us a lot about that as well. And obviously, lots of little bits and pieces where they gave us feedback on what we were trying to achieve.

As well as the tests on the prototypes, we also undertook a range of lab tests as well. For example, we tested wind-driven rain at the BRE, we did some fire tests for the roof classification at BRE. Pete Walker at the University of Bath, in a way, they're the leading national researchers in terms of bio-renewable materials in construction, they tested for compression, creep, sheer, there was

all sorts of interesting structural tests that characterised the material, which then ARUP, the engineers, were able to extrapolate for the design of the house, as it were.

Ben: Tell us about that then. You mentioned that cork is a structural material but then is that what has informed the building and how it's developed?

Matt: Yes. The architecture, the spaces and the forms, are a result of the properties of the material, of the consideration of each stage of the building's lifecycle.

For example, the pyramidal corbeled roofs, we didn't draw pyramidal roofs at the start and then think, 'what shall we make them out of? Let's try cork.' The pyramids come out of a whole series of decisions about deciding to use cork. It works best in compression, we don't want to use glue and mortar for disassembly reasons, and the wall works with the tongue and groove system so a logical consequence of that is for the roof is rather than introducing a new set of materials and systems that would introduce complexity, you offset this wall system using these solid blocks of cork to take the load through them. So, the form is a result of those considerations and those factors.

Ben: What's the challenge then on site? I love that expression.

Matt: Well, obviously it's the first load-bearing cork house in the world as far as we're aware. So, I guess for any system with that level of innovation built into it, it's obviously not going to be always a good day on site.

Ben: Was it easier for just building up to roof height and then when you're dealing with that roof, that to me looks to be the tricky part? You've made it look very neat though. I will say that.

Matt: Obviously, the foundations are removable steel screw piles. There's no cement whatsoever in the building.

Ben: Tell me about this because I've heard this a few times. People say that this is sustainable because you can take it out and use it again afterwards. Was that the full…?

Matt: No, probably the motivation was more that when you did take the building down and took it away, it would become a virgin site again almost. You wouldn't have known there'd even been a building there, which obviously you can't do with huge amounts of concrete piles or foundations.

Ben: But there's a bit more cost involved in that, having screw piles?

Matt: I don't think there was much more cost involved in that necessarily. Probably a little bit in terms of, say, doing a simple strip or raft foundation, yes. But not a lot. Not that made it prohibitive.

Again, it was on message with the narrative. It was a dry form of construction. The subcontractor came on site, two days on site, foundations done, which ended up with little steel discs on the surface of the ground.

Then you put your little two-hundred millimetre high steel feet on top of that, bolt down to that, and then little steel T-brackets bolt on to the top of that foot, and then this accoya ring beam spans from foot to foot and that makes a nice, big, simple three-hundred by one-hundred timber beam all the way around the perimeter.

Then with a contractor assisting us, we dropped large CLT floor plates that spanned between that ring beam. That gave us a nice, solid timber deck with cork insulation underneath the timber to insulate it.

From that point, I guess there was a nice, easy bit in that the cork blocks are literally, you pick one up, you put it on top of the previous block, it friction fits down, you tap it to make sure it's gone home as it were with a rubber mallet, and then you do the next one. You tap that down and it literally goes at about the speed I'm describing it. Then the next one and so on.

That was very swift in terms of building the walls. Where it's not so easy is where it interfaces with the timber ring beam and valley beams which are at eaves level.

All the cork works in pure compression and takes all vertical load. All of the vertical load in this house is taken down to the timber slab via the cork. Almost all of the lateral load and sheer loads of the house to stop it folding over as it were in the wind is taken through this almost like a timber ladder beam, if you drew it, at eaves level. That ladder beam is tied down in two places to the structural wardrobes – literally structural timber wardrobes – and that stops the whole building falling over. Anyway, the point being that the interface between the prefabricated timber elements and the prefabricated cork elements, as you can imagine at that level when you're trying to get the cork into a certain shape so that you can fit the timber together and screw it and bolt it, that took some effort.

There are some very funny photographs of me trying to ratchet strap and clamp an eighteen metre long wall of cork into exactly the

right shape so that the timber at eaves level fits in. That was complicated.

The roof was actually pretty satisfying, strangely. A lot of block types and so on, and a reasonable amount of fiddliness like that. But actually, generally speaking, bar one or two days, quite good fun.

The gutter weirdly, I made a massive mistake. I don't know if this is of any interest. I'd built in the gutter into this sort of layered construction system because that's what the whole thing is. It's characterised in a sense by one thing on top of another. It's really primitive in that sense. It goes back to structures thousands of years old, the really simple dry stone wall and roof construction. You still see them in the south of Italy or the beehive huts in Scotland and Ireland. Lots of cultures have similar architypes. So, although it's quite a high-tech fabrication process for the house in terms of prefabricating the cork and the timber, it's actually a very low-tech on site assembly process.

That's really important to me. In terms of self-build, I find an immense satisfaction in just making anything really. For example, we've often referred to this as a sort of giant organic Lego. It's that same idea. There isn't a massive amount of skill necessarily in how you put these elements together but you still get that satisfaction of having built your own house out of a kit of parts.

Ben: How have you prefabricated this then? Where does it happen?

Matt: It's prefabricated by a company called Wup Doodle in Suffolk who used a five axis CNC machine, but a pretty simple form of technology really. Just using a milling cutter or two or three different cutters on an automatic tool changer.

Literally one face of the block sits on a vacuum bed and is held in place. That allows the other five faces of the block to be machined so that they fit together with a zero-tolerance friction fit on site.

Ben: And these actual connections, they're a technical design that you drew up and wanted for this?

Matt: It's not dissimilar to timber log cabins. They're engineered products and engineered systems that fit together with a sort of interference fit tongue and groove idea. It's a variation on that theme, if you like.

It's just these are quite nice because they're one metre long by half-metre wide by about twenty centimetres high. They're about twelve-and-a-half, thirteen kilograms each for a full sized block, so

manageable by a single person on their own. You can literally build it like a giant form of Lego.

Ben: How are you finding time for all of this?

Matt: It was pretty much full time for about five or six years.

Ben: Full-time? Wow.

Matt: Yes.

Ben: And the construction time?

Matt: If I compressed it all into a single on-site operation like you might do on the third or fourth time you did it with a contractor, it would probably be about a year of work. There were two of us on site for a year in total if I added up all the time between us.

Ben: But you had to slot this into your professional lives?

Matt: No. It was full time for five years.

My dad was an architect. We started to design this together when he was dying. He left us some money and we thought a good thing to do with that money was to… there was a dual motivation for this project; or maybe more than two. One was to obviously build a house that we could use ourselves, but also there is an element of research and development and using our skills in terms of design research to respond to some of the pressing issues of our time.

Ben: What do you think he would have made of the building had he seen it?

Matt: He was pretty competitive and pretty critical generally. No, he really would have liked it. He would. It's probably inevitable that there's quite a lot of him in this building probably in that there's a lot of him architecturally in me.

Ben: How did he influence you as an architect?

Matt: Well, the main way in which we communicated as father and son over the last twenty-five years, I think it would be fair to say, would be through architecture.

Ben: Very interesting.

Matt: Which may be the case for lots of sons of rather obsessed architects. That's where we connected and so this was a nice thing

to work on with him. And he's always been a slightly do it yourself sort of person as well in that if he thinks he can get away with doing a job himself, he'll probably have a go. I guess there's a bit of that going on.

Ben: What did you learn from doing this project?

Matt: Aside from the obvious, that I learnt how to build the world's first solid cork construction system, I enjoy the process of learning about the research really; the way in which you go about these things in terms of conceiving and developing an idea, putting together a team, getting the funding, the lab tests, the prototypes, getting it through building control, how a building design/system takes on a life of its own and you have to systematise it and it becomes more and more rigorous as you go on. That would be something I'd be really interested in taking forward.

So, some of the principles to do with the lifecycle stuff I was talking about. We are taking this forward on another cork project with a client at the moment but aside from more cork, it would be nice to look at the same lifecycle issues maybe through other materials. Low carbon materials, obviously timber but also stone is a very interesting one on that front.

Ben: Talking about the performance, with all this cork stacking up, there's literally nothing between these blocks other than how they're connected sometimes. Do you feel any drafts? Have you had an airtightness test?

Matt: We had an airtightness test. That was fine. We're mid-range on that.

Two things we had to introduce back into the uber-simplicity of the cork wall and roof, on the walls we had to introduce a rebate on the internal face of the blocks' joints and introduce a ten millimetre wide foam tape to achieve airtightness. It would be nice to find a way of doing that without using a foam based product obviously in the future. And on the roof we found that we had to introduce cedar weatherboarding to help shed the rain off the roof otherwise that roof is not watertight just as a pure cork structure.

Ben: What about around the windows? How are they sealed in?

Matt: Those are also sealed with some Compriband foam tape. As I said, it would be nice to find other methods of doing that but it's quite interesting what it allows. If you want to take the house down or the window out, you literally take out six bolts from each window. The

window literally slides out, the sticky-back foam tape peels off, and it's as simple as that.

Ben: And the cork itself, was it easy to get hold of this much cork? I imagine this might be quite a big order, or not?

Matt: It's a couple of shipping containers of cork. It comes from Portugal, is shipped to Harwich which is near to the workshop in Suffolk. They machine it and because of the way it was done as a gradual project, this one, they would ship it in forty to fifty blocks at a time. There were twelve-hundred-and-sixty-eight in total.

Ben: And other materials in this house? I can see you've used timber in the kitchen and I know there's another section for the bathroom. What other materials exist in the house?

Matt: We tried to be pretty rigorous and consistent as we went through the various parts of the house from the primary structure through to the built-in joinery which is tri-ply or TILLY board. And it's spruce so it's the same as the CLT species.

We made the bed, the sofa and the dining table out of reclaimed spruce CLT forty-four millimetres thick. The kitchen stools are made by a craftsman in Sussex called Bobby Handcrafted. He makes these lovely oak stools out of storm felled oak. The floorboards are also oak, of course because cork is a variation on the oak tree. The floorboards are cross-sawn unplaned timber screwed down to the spruce CLT floor.

So, you can see there's a very limited, consistent palette of materials. The only place where we wandered a bit or introduced some light relief was in the bathroom and the kitchen. The kitchen worktops are five millimetre thick solid brass, unlacquered. And the bath was a bespoke folded solid brass bath as was the basin. And copper for the rainwater goods, gutters, downpipes and so on. So, both brass and copper, all unlacquered, all pure material and can all be recycled back into the manufacturing chain.

Ben: One thing I have noticed in here is that the services are slightly interesting including, are they sprinklers?

Matt: Yes. Obviously, when you're making solid walls with no voids or cavities or any services to hide behind, everything is exposed and on show right down to the sprinkler pipework, sprinkler heads or even how you get a cable up to the top of the rooflight for the motorised rooflights and smoke detectors up there. That was all very carefully thought through.

The bathroom is a self-contained independent solid CLT box structure which acts as a hub for all the services and then the CLT floor panels were pre-routed to accommodate pipe runs underneath the floorboards and all the built-in furniture and the structural wardrobes were also pre-routed for service routes and so on, and then where the pipework comes out into the pyramids, that was really enjoyable working with the subby on that.

Obviously, we did have subcontractors for the electrics, the plumbing and the sprinkler system in fact. And that was nice working with those guys. Obviously, they're really interested because they're doing something different. They'd never worked on a solid cork house before as hadn't I. Just coming up with solutions between us, mocking things up, that was great fun.

Ben: Finally, what does this all mean in your career? You've mentioned that you're hoping to move from the main house out here fairly soon. So, how does this building fit in?

Matt: Obviously, it's scratched a pretty major itch. And I guess it's obviously clarified my overall approach to architecture. We're now lecturing at various big offices in London and at various universities around the country with a lecture called 'Form Follows Lifecycle.' We do that in a discursive way. We're looking to evolve and develop this approach more broadly speaking both with cork and with other materials, as I said.

Ben: Matt, thank you very much for telling us all about the house today. It's great.

Matt: A pleasure.