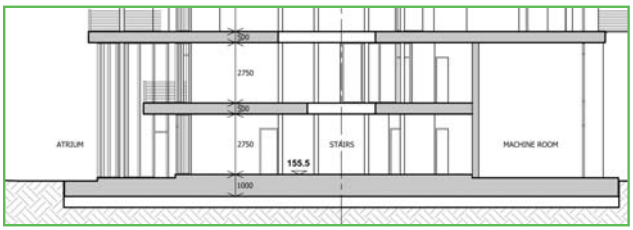
Dumble Key Design and Construction Features

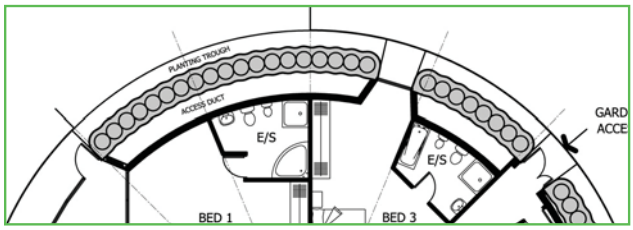


Circular track with low ground pressure - A major feature of the Dumble is its ability to rotate, which creates interesting practical and engineering challenges considering its size: the base diameter is 25 metres and the building weighs approximately 650 tons.

A rail track system supports the building and allows it to rotate. The outer circular track supports the majority of the building weight under the outer walls and the inner circular track supports the centre of the building. This design allows uniform distribution of weight over a large area, resulting in a low ground pressure and eliminating the need for complex foundations.

House mounted on revolving base - the base of the building is similar to a railway engine turntable. A large number of rollers on the track system support the steel structure and allow it to rotate. The whole house is built up directly from this structure. Connections for services between the rotating building and surrounding ground are made through rotary couplings contained within a service void on the ground floor, underneath the central spiral staircase.

'Wheel' design - the structural members for the base of the building (the ground floor), the first floor, the second floor and the roof resemble the layout of a horizontal wheel. The 'hub' surrounds the central spiral staircase, carrying central vertical loads. 'Spokes' radiating out to the 'rim' carry the vertical floor/roof loads and the rim carries the outer circumferential vertical loads down through the wall plate to the walls. The spokes provide a strong and well-braced structure.



Engineered timber - The base is a combination of steel and structural timber sections. The spokes for the roof, first and second floors are engineered timber trusses, and the lower sections of these trusses are left exposed below the ceilings as a visible structural feature.

Plastic pipe walls – Robin Hamilton was closely involved with waste and recycling machinery and the general handling and processing of materials in one of his previous companies. As the disposal of some items such as used vehicle tyres and plastic presented major problems, the Dumble now sets about finding a useful role for them, utilising their characteristics in a positive way.

The project uses redundant heavy-duty plastic pipes within the wall structure. The walls are built up in vertical columns, with each column containing a large bore air duct. The columns are tied together and built up in increments; stone slurry is poured into the void spaces and vibrated down to form a dense and rigid solid stone core.

The curved walls that are formed are inherently stable and when completed one metre thick. The sheer mass of compacted stone slurry provides further rigidity.

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The total 'R' value of the completed wall is 13.23, providing a 'U' value of only 0.08. The total insulation value of the entire wall section, including pipe wall, service duct and inner wall is even better. A combination of cladding and a UV coating protects the outer surface of the walls.

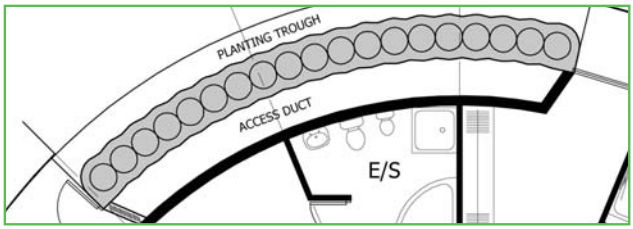
If the same or similar design concepts and materials are used in other buildings, some problematic waste materials will be converted into beneficial contributors to the reduction of energy consumption. The required new embedded energy in the construction of the overall wall is also exceptionally low when compared to conventional building techniques. Since buildings are the main users of energy, the resulting improvements in their insulation could play a valuable role whilst eliminating the actual problem of disposal.

It is recommended however, that others should not adopt the pipe wall design in isolation at this stage, as it is integrated into the overall building design. The wall materials are also flammable and special consideration has been given to this, including special coatings and a fire suppression system within the inner service ducts. Sprayed foam coatings are energy intensive in their formulation, but it is generally accepted that the energy savings they provide through their insulation properties hugely offset this.

Low loadings - the thickness and solid stone core of the pipe walls provides a very large load bearing surface area that is capable of supporting the vertical load imposed by roof and floors with a safety factor of several 100%. Point loads and pressures are therefore kept low.

Uniform loadings – as the house is round, loads are carried uniformly around the structure. The roof weight is completely supported by the pipe walls and a circular plate sitting on the top of the pipe walls distributes this evenly.

Suspended floors – the 'hub' and 'rim' of the first and second floors is suspended from the roof 'spokes' on tension cables.



Service duct – a one metre wide service duct runs round the inside diameter of the pipe wall, with a conventional studded and plasterboard inner wall separating it from the internal living space.

This void creates a firewall, provides further insulation benefits and allows easy access around the building to connections for water, electricity, drainage etc., which are positioned wherever they are required and routed through the duct to the machine room at the rear of the building. The duct also allows airflow from the front atrium to the machine room for energy management and control.

Flexible internal layout – as vertical loads are directed through the outer walls and the 'rim', full internal design flexibility is possible for the internal non load bearing partitions, which can be easily moved to provide a flexible internal layout.

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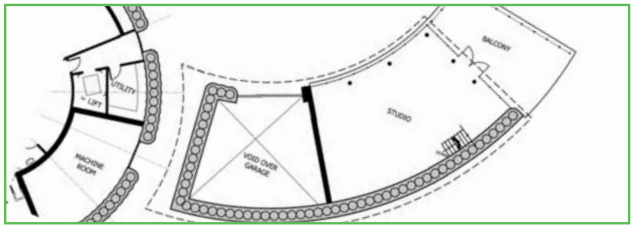
Visible structural elements - the outer cables or columns supporting the floor 'rims' are positioned within the service duct (between inner and outer walls), but the inner columns supporting the 'hub' are visible interior design features. This follows the theme created by the visible engineered timber trusses for the floors, and is continued in the atrium. Wherever possible the structural elements are exposed and designed to become key visible design features

Self-contained Atrium - the large front-facing glazed atrium (double floor height), sits within its own rigid steel frame. Together with internal columns, this supports the roof loads in the absence of pipe walls in this area. The Atrium is a self-supporting module sitting within the structure of the house. It features double-glazed curtain walling to both the outside of the building and the inside living space, providing an insulated barrier and reducing heat transfer to or from the living space as required.

Balconies – the atrium features an internal balcony at the first floor level. A further balcony also sits above the roof of the atrium, on the second floor outside the building and is partly protected by overhanging sections of the roof.

Garage / Workshop – the Dumble features a separate garage/workshop and studio building, constructed using the same outer pipe wall technique. The base is at the quarry floor level and the roof is at the top of the quarry, forming the entrance platform to the upper main entrance of the house. The overall design compliments the house and is constructed in an arc shape, with its concave front following the convex side of the house.

Access - a revolving building generates unusual access requirements. Ground floor access is provided via a clear path surrounding the building at ground level (the bottom of the quarry) and the front and rear ground floor entrances can be accessed in any position from this path.



The main entrance to the rotating house is through the top/second floor level (which is also at the top of the quarry level and the same level as the garage roof). Access to this entrance is provided by a circular collar/walkway - a design feature that is part of the building and rotates with it. Access to this walkway is in turn provided from the top of the quarry and across the garage/studio forming a "docking bay" of "landing stage" An internal lift connects all floors; and this combined with the level main entrance makes the house wheelchair accessible too.

Rotation speed - normal rotation speed is very slow. A typical requirement for the atrium to follow the sun (or avoid it when the sun is intense) equates to a speed on the outer edge of the house of about 5cms/minute or 0.002 mph, which is virtually indiscernible and significantly slower than a modern revolving restaurant. It is possible to increase the speed to provide a more rapid response when required, but the word rapid is relative!

'Green' roof – the house roof and part of the garage roof features a sedum covering.

External wall appearance - although the walls are constructed in an arc, once these are covered and insulated with rigid foam and weather proofing coatings, the depressions between each column of pipes are largely filled.

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The exterior surface therefore gently undulates where not covered with cladding.

When completed, the walls are sprayed with a rigid setting foam, thicker on the outer face. This completely seals the pipes, provides a more uniform external surface (and further increases their insulation value). A UV coating finally protects the outer surface and plants and flowers are encouraged to grow up and over it. Planters are provided on the protruding rotating base of the building and similarly on the top floor collar/walkway.

Lifespan - The predicted lifespan of the Dumble is many generations, and although maintenance will be required as for any building, the design, build techniques and materials used will provide a life in excess of 100 years. The project may be regarded as a trend-setting advance, and may even become an object of historical interest many centuries from now.

Innovation and value engineering – the 'wow' factor is the combined result of the innovation in overall concept, design, construction and integration of 'off the shelf' low cost standard components and systems, rather than bespoke, expensive materials and components that typically require a large budget.

For example, the atrium is constructed with flat segments of glass forming an arc, rather than bespoke curved glass. Similarly, the design and construction of the building aims to minimise the need for specialised skills, or specialist sub contractors and also tries to avoid the need for specialist equipment or heavy lifting gear. This helps to makes it possible and practical for others to adopt some or all of the techniques and features used.

Modular build - in keeping with value engineering, the main components such as the base, floors and roof are modular. For example, the floors feature a sectioned inner ring, a sectioned outer ring, and radial spokes. Flooring sections can therefore be assembled and dropped into place in segments. No single component need weigh a substantial amount.

Size - the diameter of the outer wall is 24 metres and the volume of the building is encouragingly large in relation to its footprint. The house may at first sight appear over-sized compared to the needs of its occupants, but its scale is due to several factors.

(1)Part of the volume is used for energy capture and generation and the majority of the systems, equipment and features described above are incorporated within the building.
(2)The building is designed to be light and airy, with a large climate-controlled atrium incorporating water features, plants and flowers.
(3)To incorporate so many special features into a smaller building would produce a negative balance between the space they use and the living space.
(4)A smaller building of conventional house size may not convince others that the concept and energy capture/control could be scaled up for larger buildings and commercial applications.
(5)The size is harmonious with its setting, the scale of the quarry, and the differing ground levels – the design would not 'flow' if made smaller.
(6)A major challenge is to complete this project cost effectively, where the build and running costs are impressively low in comparison to the useable space, the features provided, and the desirability factor. This is easier to demonstrate in a larger building.

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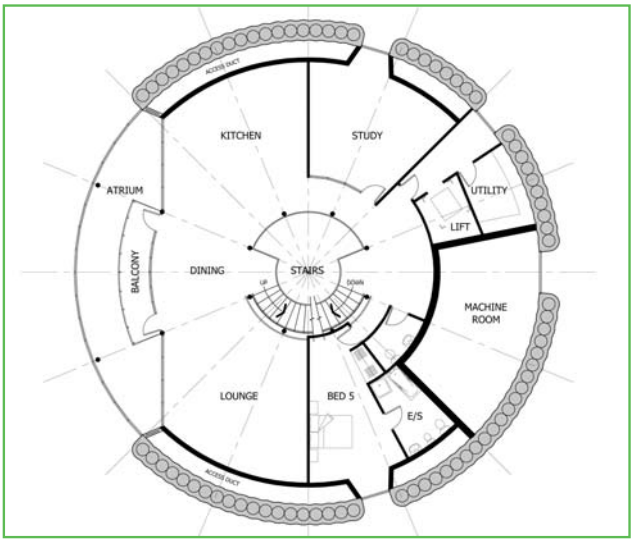
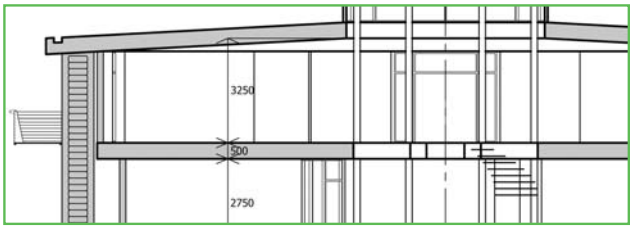
Adaptability - as the house is a self-contained structure, it can be adapted to provide variants elsewhere. For example, its design and construction (allowing flexibility within constraints) should provide a largely earthquake-proof structure. It is also mobile as it is mounted on a platform. This also enables a 'hull' to be incorporated so that the house can float with rising sea levels. Depending on ground conditions, there is no need for extensive foundations. The walls and structural components can be made from a variety of materials depending on local availability, and modular construction techniques allow off site manufacture of many items.

Ongoing development – The project will continue to develop after it is built. The shape and external appearance will not significantly change, but the internal machinery, equipment and control systems will become fully integrated, with all functions, including movement of the house, automatic and computer controlled.

Systems cost-effectiveness and integration – the project cannot yet provide definitive answers on what contribution or percentage of the energy available/used is provided by each of the various integrated components; only practical experience will provide the answers here.





Similarly, the cost effectiveness of each component regarding its generation of power, energy capture and conversion of renewable energy, energy recovery and insulation properties etc. in relation to its capital expense (together with any running and maintenance costs) can only be measured after practical experience. The total energy produced by the systems detailed will however, provide at least as much as the house and garage requires; surplus can be exported back to the National Grid.

Problems – the project features cutting edge techniques, technology and design. Challenges and problems are therefore faced on an ongoing basis. Development is carried out and changes made as necessary to overcome them.

Trials – these are carried out to optimise some of the new techniques, for example the wall building technique incorporating plastic pipes. The building has been designed using these pipe walls as load bearing members, and the work to date indicates they will be completely satisfactory, although different construction and filling techniques may be tried initially before the walls are completed.

Fine tuning of the concept is expected and allowed for, and the goal of a highly insulated wall, with controllable and useable high thermal storage/mass, largely built from waste/redundant materials and local stone, should set a valuable example that others may wish to follow.

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The experience gained and results will all be made available when the project is completed, and advice then offered to others who may wish to adopt similar techniques. The overall building design allows for other wall materials however, such as prefabricated SIPs, straw bales or similar. A conventional internal steel frame can even be inserted if required; none of this excessively compromises the major goals behind this project.

Landscaping - the site is landscaped to provide a natural informal setting within its more dramatic features and location, with natural vegetation and ponds. The whole project is sympathetic to its surroundings and with maturity the building becomes even less noticeable.

Use of materials - The design is still evolving. Steel and concrete are only used where necessary, and the concrete uses a high proportion of recycled material. Consideration is given to all materials used in the construction, to maximise the interior ambience and minimise embodied energy in the production of construction materials. Renewable and natural materials are used extensively; wood is used wherever possible for both surfaces and structure. Where steel is used, reclaimed sections are installed wherever possible. Some of the machinery used is refurbished or adapted from other uses.

Resilience - the whole structure is capable of absorbing and adjusting to what would normally be called settlement, and the combination of the pipe wall construction, suspended floors and appropriate bracing/damping produces a very resilient structure.

Building responsibility - as this project is so innovative, it is more difficult to assess some design features within normal building regulation guidelines and requirements. The Dumble team does not expect or rely on building control officers to answer queries or make judgments on techniques or materials they may not be familiar with, and we therefore carry out all work and research required to satisfy building regulations. The team is confident that it will exceed these, many by impressive margins.

Best Practice - the factors outlined make this project exciting, demanding and worthwhile. The aim is to create an outstanding example of best practice, proven on a cost effective and commercial basis, allowing others to benefit from the techniques used, and taking advantage of the self sustainability and micro power generation capabilities that the project optimizes.

Grand Designs - The TV programme 'Grand Designs' is covering the project; Kevin McCloud and the team are very enthusiastic, several meetings have taken place and filming is underway for broadcast 2009.

A Living Home - The Dumble is designed to provide Robin and Rosy Hamilton's perfect home. It incorporates features they have appreciated in their previous homes and others they have seen elsewhere and admired.

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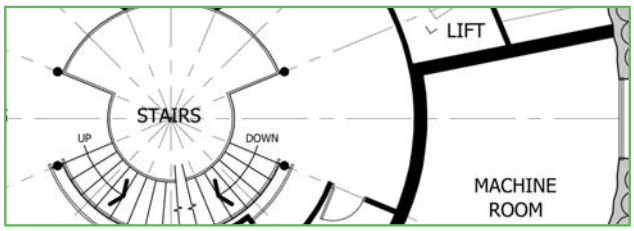

Spanning three floors, the large central spiral staircase plays an integrated role in the overall heating and ventilation system. In particular, the house is light, airy and spacious and predominately open plan. The large atrium is also a main feature and may be treated as a small scale Eden Project. In response to the site and overall setting, the majority of sleeping accommodation is on the ground floor, which is generally the coolest level. The majority of the day-to-day living area is on the first floor/middle level, which enjoys views into the distance. The second floor/top level is the warmest level, enjoys the best views and is used as the reception area and main entrance.

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T: 0845 300 9883
F: 01335 324 008
E: info@home-revolution.com
www.home-revolution.com
Registration No: 6181126
VAT No: 907 5883 90

Home Revolution Limited
The Grange
80 Tamworth Road
Ashby de la Zouch
Leicestershire
LE65 2BW