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Das Chesa Futura Appartmenthaus in St. Moritz

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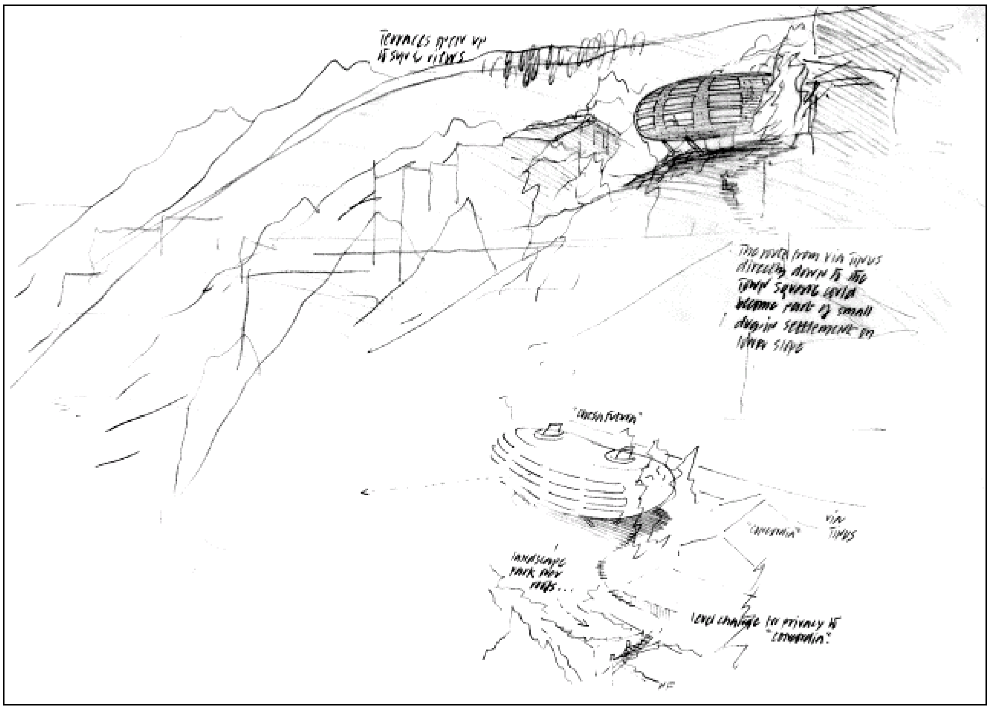
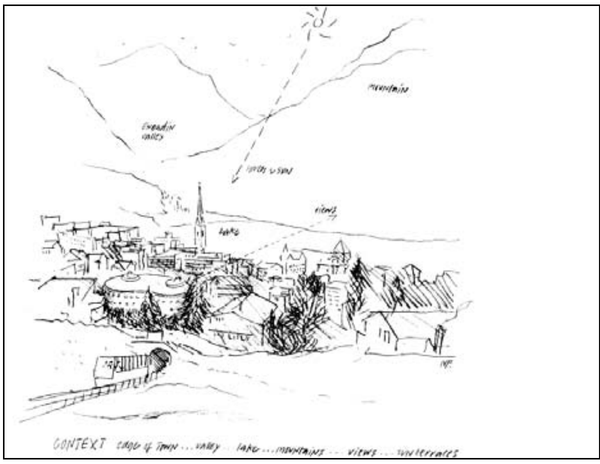
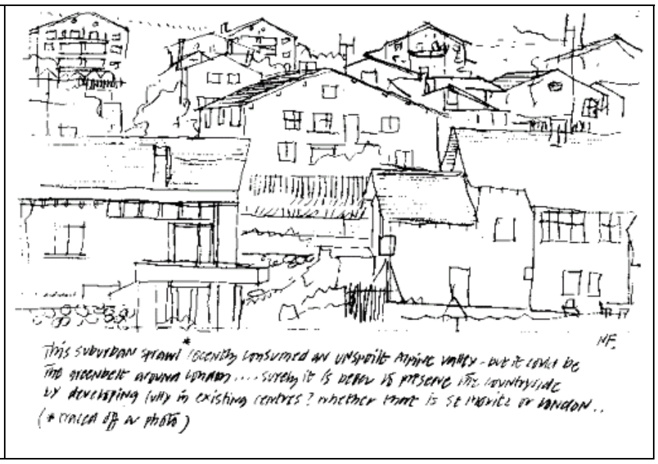
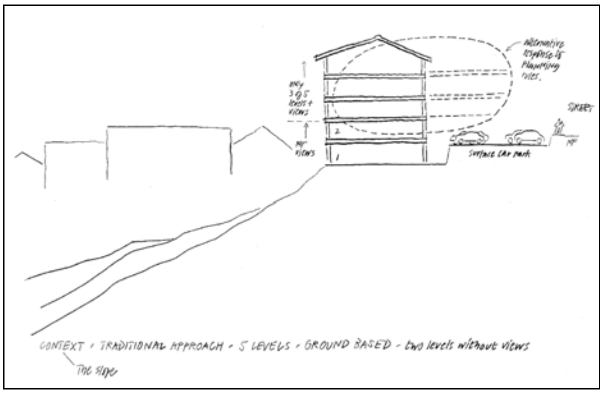
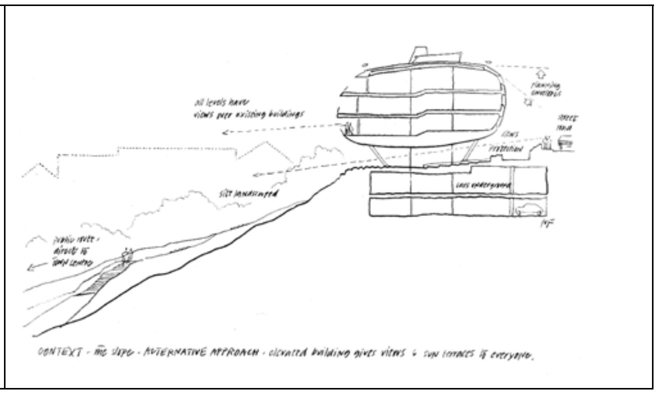
St Moritz is a popular skiing resort in the Engadin Valley in Switzerland. It is situated amongst dramatic landscape at 1800 metres above sea level. Its small population of 5,000 swells to 50,000 during the peak seasons when it hosts downhill skiing championships, cross-country skiing marathons and hang-gliding. Its frozen lake is the venue for motor-racing and polo competitions. The town is densely built, with buildings concentrated in a relatively small area. The Chesa Futura apartment building fills a gap in the town centre rather than building on the unspoiled surrounding alpine meadows. It fuses state-of-the-art computer design tools and traditional, indigenous building techniques to create an environmentally sensitive building. It combines a novel form with traditional timber construction - one of the oldest, most environmentally benign and sustainable forms of building. The building is raised off the ground on eight legs and has an unusual bubble-like form. This is a creative response to the site, the local weather conditions and the planning regulations. The site has a height restriction of 15.5 metres above its sloping contours. If the building were built directly on its sloping site the first two levels would not have views over the existing buildings. Elevating the building provides views for all apartments and maintains the view of the village from the road behind the building. Raised buildings have a long architectural tradition in Switzerland - where snow lies on the ground for many months of the year - avoiding the danger of wood rotting due to prolonged exposure to moisture.





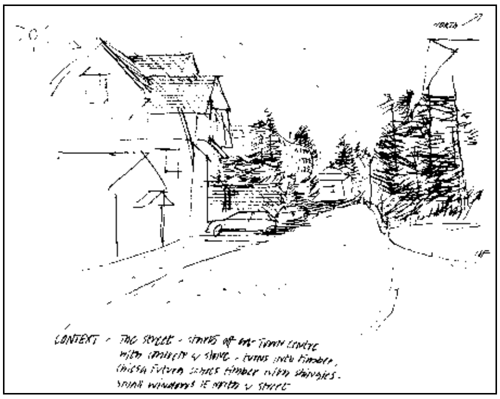




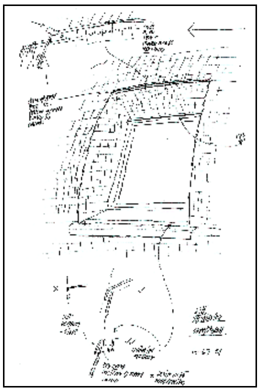


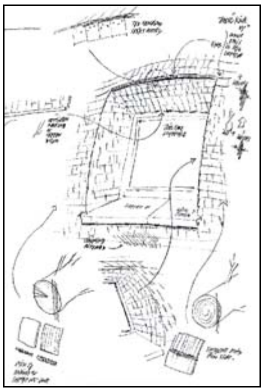
By sculpting the building into a rounded form, it responds to the planning regulations. A conventional rectilinear building would protrude over the specified height. Because the ground and first floor levels are not utilised, the three elevated storeys are widened to achieve the desired overall floor area, but do not appear bulky due to the building's rounded form. The curved form allows windows to wrap around the facade, providing panoramic views of the town and the lake.

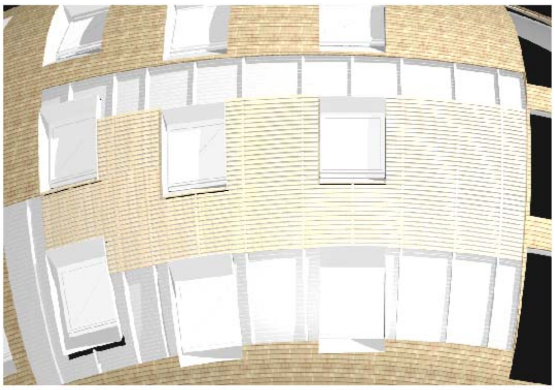
The building's sculptural curved form has been refined using a specially written computer programme that has fused the building's plan and section to create a three-dimensional volume. The computer model acts like a conventional spreadsheet, enabling any part of the building to be altered and instantly generating a new overall form. This facilitates numerous design studies to be tested within a fraction of the time required for conven-tional modelling techniques. The computer model can be cut through any section to produce drawings of any part of the building. The digital information can also be directly exported to cutting tools to build physical models and ultimately to the machines that will make the timber building components.

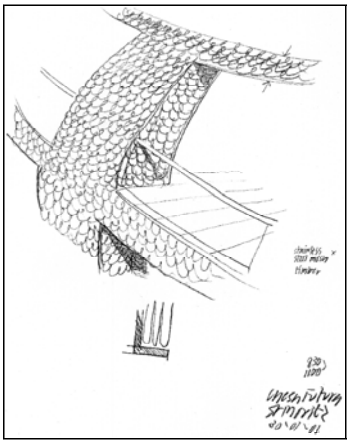


The building has large windows with balconies to the south, to allow generous amounts of sunlight into the apartments and to exploit the views. The building is more closed to the north where it faces the mountains and the coldest weather, providing insulation through its thermal mass - the structural frame creates a 40cm-wide cavity that is filled with insulating material. Small windows are punched into the northern facade. These echo traditional Engadin windows, which allow the most amount of light through the smallest aperture by chamfering the window surround.

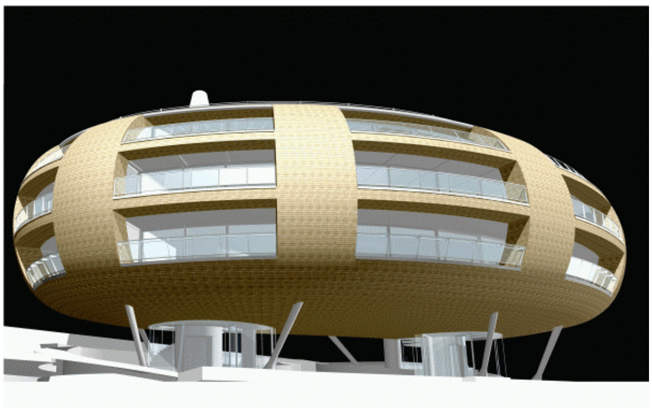


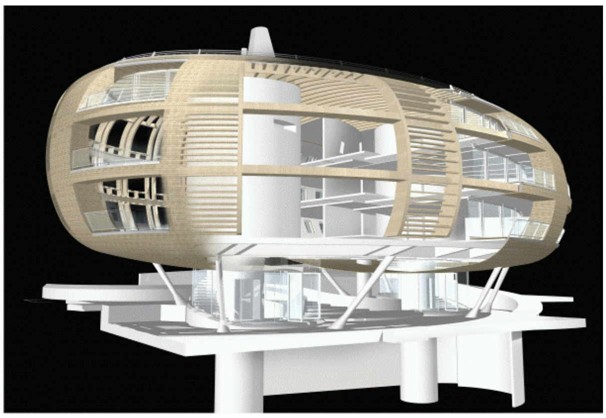






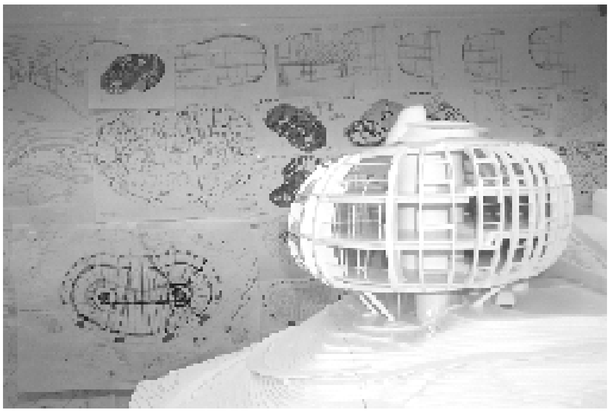
The larch shingles that make up the building's skin are culturally sympathetic, reflecting local architectural traditions. They will respond to weather, change colour over time, and appear as an organic part of the landscape. They are cut by hand by a local family that has practised the craft for generations. By cutting the timber laterally and radially, the most efficient use is made of the wood - only eighty trees will provide the required 240 cubic metres of shingles. The two different cuts combine the benefits of water-draining characteristics of one cut and structural strength of the other and provide a variegated visual appearance.

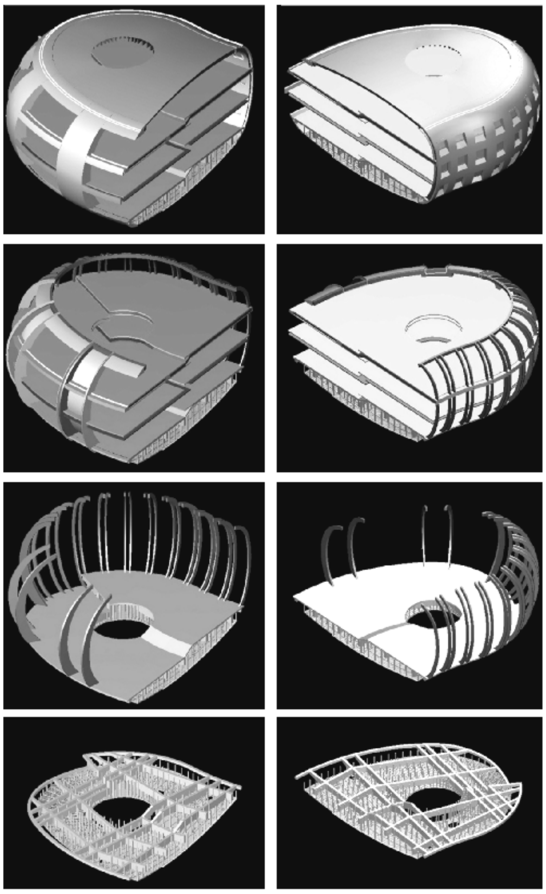


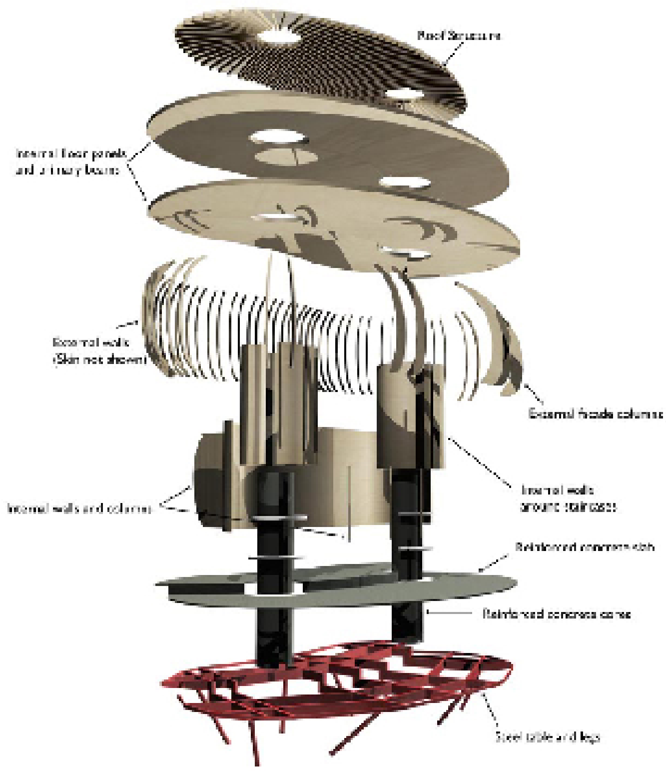


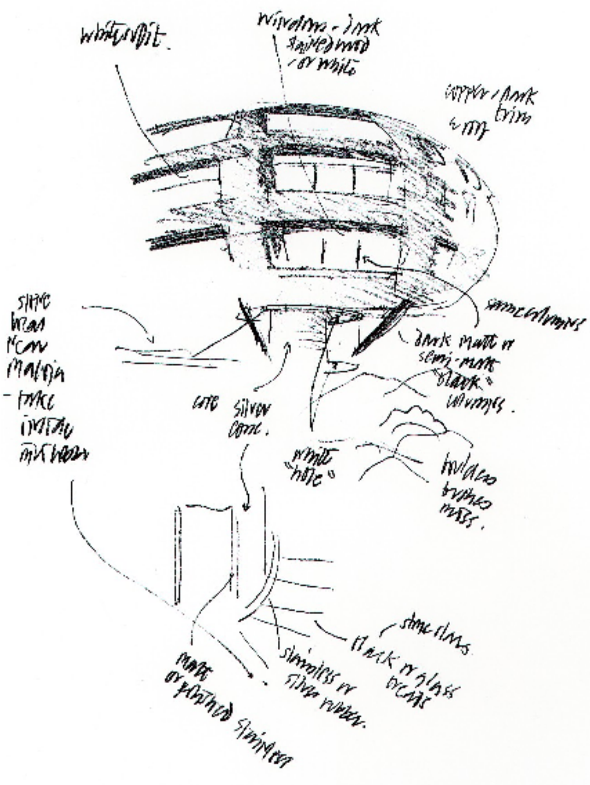
The shingles are cut from trees at the same altitude as the construction site during the winter when the wood is dry and contains no sap, so that they will not shrink. They are applied by hand using nails and will last for eighty years. The roof is made from copper, which has a long local tradition because it is sufficiently malleable to be formed on site when the temperature may drop below twelve degrees.

The building's structure is highly efficient. It has been developed in close collaboration with two engineering firms: Arups in England and Toscano in Switzerland. A high degree of prefabrication is important because the holiday seasons restrict construction to eight months of the year.



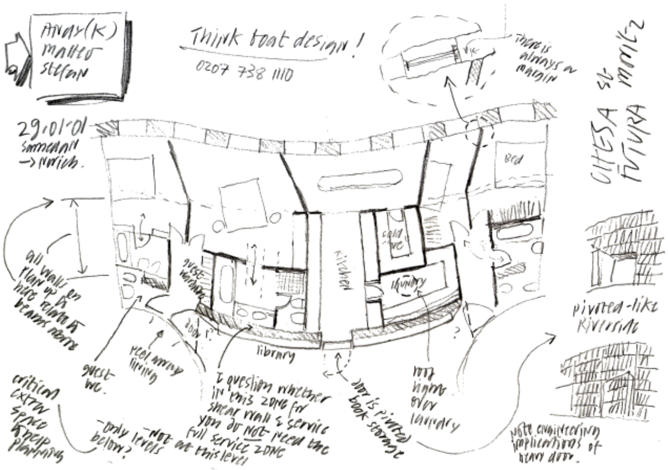




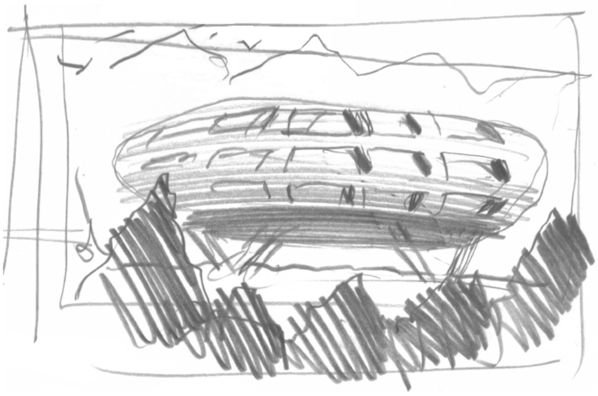


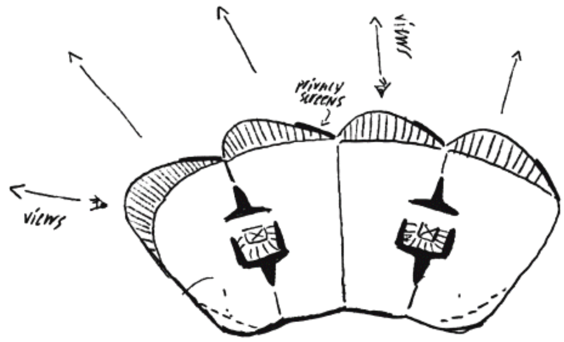
The foundations consist of a sunken concrete box, which houses the plant rooms, car parking and storage spaces. Above ground the building is supported on a lightweight steel 'table' with eight legs. Two concrete cores, housing the lift shafts and stairwells, provide further stability.

The remaining structure is timber. The frame is constructed from prefabricated glue-laminated beams - thin sections of wood glued together - with a skin of plywood sheets. This has many benefits over steel or concrete. The malleability of wood makes it is easier to achieve the building's doubly-curved shape. Because timber is lighter than steel it can more easily be delivered to the site, which is approached by a narrow winding road. Furthermore, in Switzerland, timber construction makes environmental sense -it contributes to the established ecology of felling older trees to facilitate forest regeneration. Wood is an entirely renew-able resource - it absorbs carbon dioxide during its growth cycle. Because local timber is used, little or no energy is expended in its transportation.



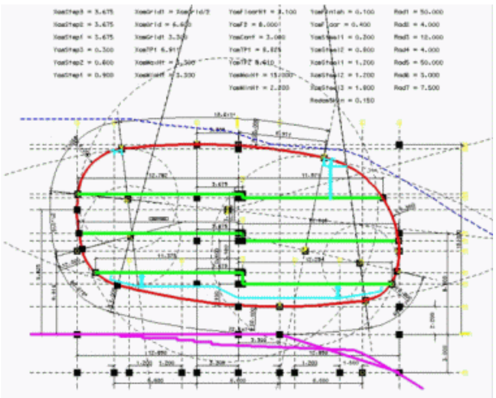
The apartment building has ten apartments. The bedrooms are against the northern facade, which is highly insulated and the living areas are to the south with terraces to benefit from the sunlight and the views. The service areas - the bathrooms and kitchens are located in the middle section of the building where there is less daylight. The interior design is a logical and organic extension of the overall architectural concepts. Because the building's facades curve in two directions the design of the interior elements is similar to boat design. To maintain the curved walls there is no storage against the external walls, only on the internal partitions, which radiate from the cores. All the materials used are high quality, robust and easy to maintain.

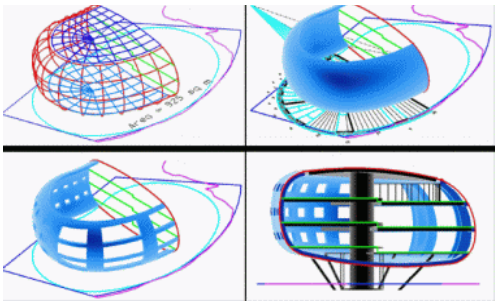


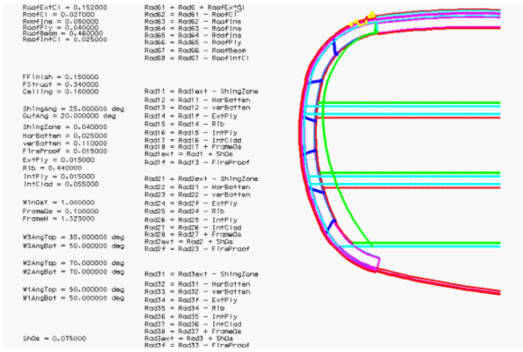


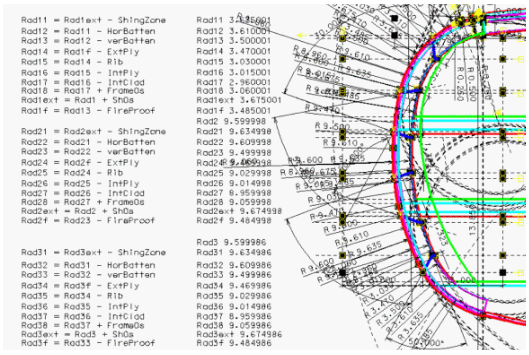
Computer modelling

The Specialist Modelling Group (SMG) was established in 1998. Its brief is to carry out research and development in an environ-ment that is intensely project-driven. This provides a sharp focus for development, while forcing it to examine fundamental or even philosophical questions. For example, it must decide whether geometry is really the essence of form, or just a convenient means of description. Producing a form that can be built requires definition of the relationship between geometry and form in terms of a particular medium. It is therefore significant that designers in the studio work with many different materials and in a wide range of media.

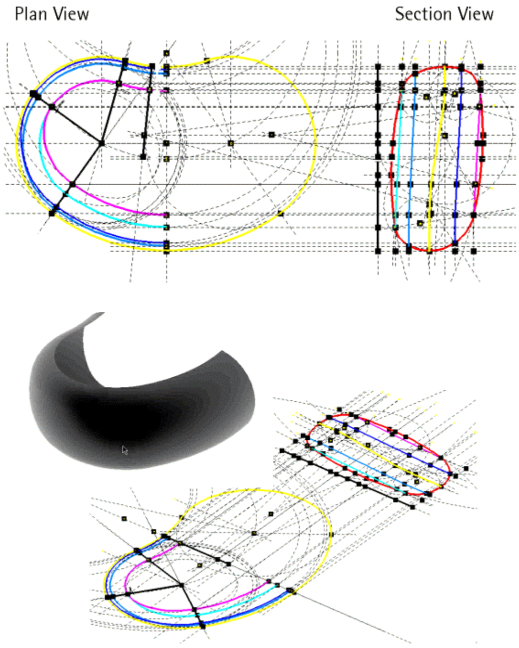


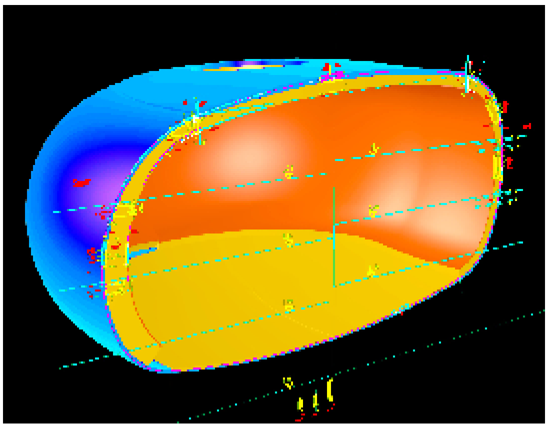






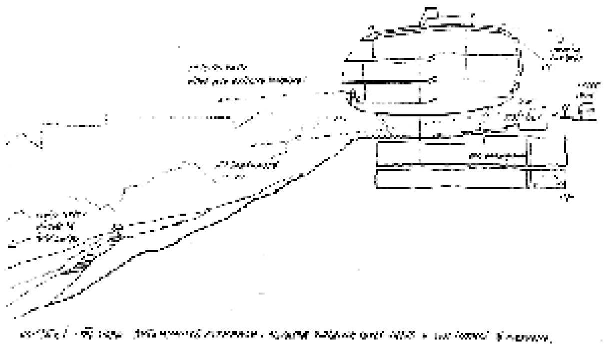
Geometry Method





Development of the Form

The curved form resulted from responding to the potential of the site, while conform-ing to its constraints. The initial design sketches were interpreted and formalised as a parametric mo-del, which the team then referenced so that changes could be tracked in both directions. A parametric version of the section went through many months of changes, which were also informed by simultaneous planning studies. The constraints were such that a 2-degree rotati-on of the plan resulted in a 50 sq.m. loss of floor area, while a 2-degree rotation of the section reduced headroom by 100mm at each level.



Although it appears to be a relatively simple form, for every combination of plan and section, there were endless possible approaches to surfacing techniques. The key to controlling the form was to slice it with two sloping planes at a 3-degree inclination. The idea of using parallel slice planes, which separate the wall element from the roof above and the soffit below, may seem a fairly obvious proposition but it had surprising additional benefits. We started to think of the wall as a shell, which had a polar grid associated with it. The polar grid is an ideal way of locating elements, such as windows, whose positions are based on radial setting out geometry.

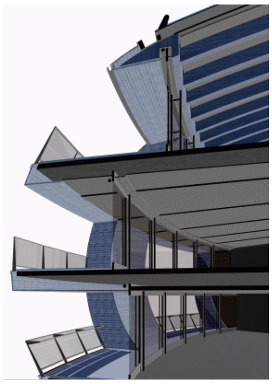
We defined four sectors and a number of subdivisions within each sector, so that every sub-division could be either a window location or a rib position. This gave us great flexibility and control and also provided a convenient coding and referencing system. Having placed the window reveal surfaces as cutters, we then applied Boolean subtractions to create a perforated shell. The insertion of floor plates resulted in a form that related to the section, with a step in each floor plan to maximise the view.

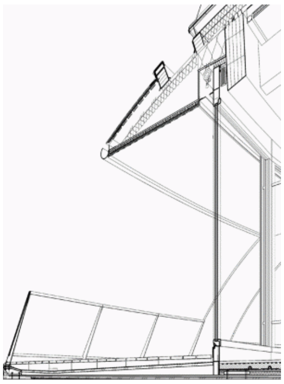
Each generation of digital model led to the next physical model, as increasing levels of detail were explored. At this stage there was a need to study how to control the coursing of the timber shingles in relation to window openings. The coursing lines were produced by software macros as flat patterns, cut by CNC machine and then assembled on the model. To represent timber shingles at this scale of model required a high level of precision and many hours of patient work by the model makers.

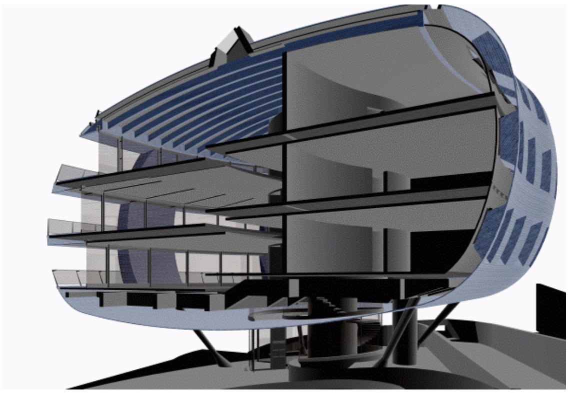
There was a coursing diagram, worked out on the digital model, which showed how the skin was to be battened, because it is the timber battens that control the shingle layout on site. The shingles were modelled in strips of etched brass, which were applied on the course lines and then painted over. Due to the level of detail achieved, this model allowed us to rehearse all the key aspects of the full-scale assem-bly process and to discuss points of detail with the craftsmen involved.

The final generation of building model resolved all the junction details between finishes. At this stage a most useful technique was to illustrate details using hidden-line sectional perspectives. These are cut-away views of the solid model with architectural drawings applied to the cut surface. They successfully communicated process, assembly and final appearance in a single image.

When it came to factory production the full size ribs were CNC fabricated from glue-laminated beams - thin layers of wood glued together under pressure. This is a wonderful material because it has the strength of steel, the malleability of concrete, the lightness of timber, and exceptional fabrication possibilities. The fabricators, Amann, specialise in producing remarkable buildings that use glue-laminated beams. They have a very advanced CADCAM machine with an impressive array of 20 tools, which descend from racks in their prescribed order to cut, drill, rout or bore at any angle, with any curvature (single- or double-curved), on a piece of laminated timber up to 40 metres in length.







An analytical surface is ideal for working with most solid modelling kernels - the software is able to calculate offsets with precision, giving results that are fast, clean and robust, which is particularly important during intensive design development. The ability to make rapid and reliable surface and solid offsets without suffering any CAD problems allowed us to share digital models with our engineers in Switzerland and fabricators in Germany.

Choosing to pre-rationalise the design surface by making it arc-based achieved a degree of control which allowed us to simplify and resolve the many complex issues of design and production. The software macros developed could derive all the arcs from rule-based constructions and then place them in 3-D space, automatically generating shell, frame and rib geometry based on parameter values entered for the offsets. The result was a shell with a precise rational defini-tion, which became the design surface that was signed off to the engineers.