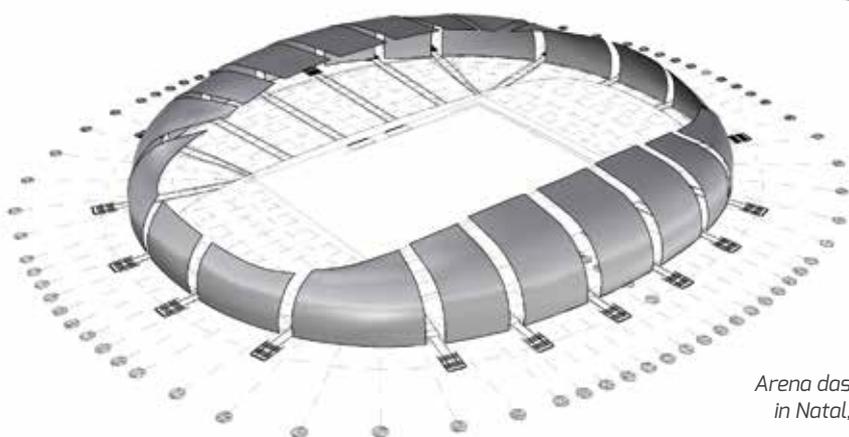


FREE THE FORM

Architect Peter Mehrrens explains parametric design and construction of envelopes for large public venues.

MONRO roll forming machine.



Arena das Dunas in Natal, Brazil.

Key criteria to the functional design of large public venues like stadiums are rather explicit, such as the size and orientation of the field, sightlines, viewing distance, arrangement of aisles or spectator circulation, to name just a few. Of course, to express the full architectural concept there is a lot more to bear in mind, be it the context of the site, the atmosphere to create or a response to climatic conditions.

This applies to one of the new stadiums being erected in Brazil for the FIFA World Cup 2014, the Arena das Dunas in Natal, Brazil (pictured), designed by Christopher Lee of Populous, who explains: “...the structure’s undulating form responds to the climatic conditions of the location, shielding the spectators from direct sunlight, while allowing main stands to catch the prevailing on-shore breezes and air to flow into the seating bowl, creating the stadium’s distinctive dramatic asymmetric form, reminiscent of the sand dunes that form its backdrop.”

(Citation from <http://populous.com/project/estadio-das-dunas/>)

Play ball. At the tip of the high ball line our eyes meet the roof. The arena’s

envelope which the spectators see when approaching the next big event, is a fine-lined, highly-customised metal panelling. The design and construction of such a tailor-made suit encompasses multiple interesting work stages that require rigorous integration to ensure highest quality is achieved.

A parametric model is created that includes surfaces representing the water-bearing layer and the panel layout. The design must match the intent of the architectural design as well as fulfil the obvious functional criteria of a building envelope and comply with local building codes.

Precise and fast mass customisation of large structures leads the construction industry towards innovative technology. The cutting-edge MONRO standing seam panels by BEMO Project Engineering Germany are an application of a digitally-controlled 3d roll forming process (pictured). Independently curved MONRO profiles and specific production machinery were developed ten years ago. The first sports venue exposing itself in such a skin was the Budapest Sports Arena, designed by Közti Architects, completed in 2003.

BEMO, with its worldwide operations, has focused on the design of integrated metal roof solutions, applying these technologies to international construction projects. During the early stages, feasibility studies can be carried out, often already leading to the above-mentioned panel layout. After the supporting structure has been completed, a terrestrial laser scan of the stadium structure is taken. The resulting point cloud is evaluated and used to adapt the parametric model to the as-built state. This ensures that the panels can be installed on the designed substructure and verifies that the building’s overall tolerances are kept.

The pattern of alignment curves divides the smooth surface into smaller patches representing each panel. A 3D CAD model of the bent profiles is abstracted into developable stripes, for automated derivation of production data. Generation of files to drive the CNC machines is done by specialised CAD software extensions.

The production machines, built into shipping containers for portability, can produce standing seam profiles continuously on site straight from the coil. By combining individualised panels with a flexible substructure system and thoughtful engineering, the design and installation of freeform envelopes has become a cost-effective option for construction projects at any scale.

The next world class venue appearing in modern standing seam shell is going to be the Arena das Dunas. Let’s look forward to a great World Cup. ■