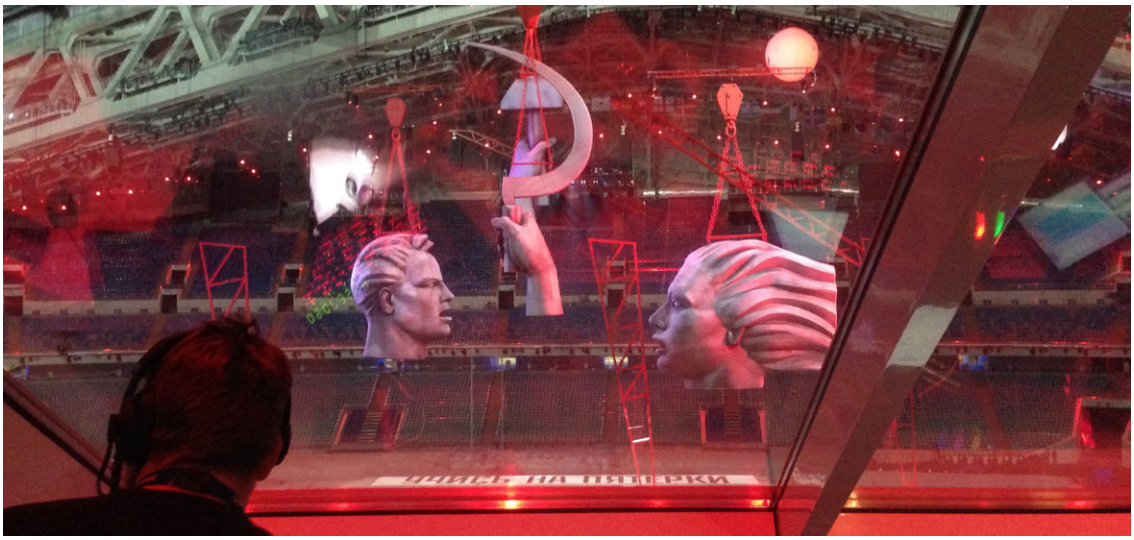
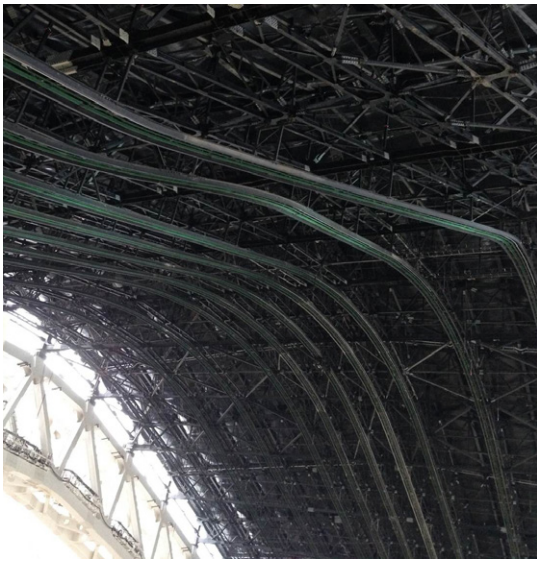
Sochi 2014 Winter Olympics Track System



Sochi 2014 Winter Olympic Ceremonies - Aerial Track System

In order to deliver the ceremonies for all four of the Sochi 2014 Winter Games, we developed a comprehensive aerial track and carriage system capable of accurately flying multiple performers and large scenic elements through Sochi's Fisht Stadium. Our ground breaking system delivered over 400 axes of movement for the ceremonies which were on an unprecedented scale both creatively and technically.



The system consisted of nine 420 metre long multi-gradient tracks, each carrying up to nine carriages. Each carriage carried large capacity winches capable of lifting up to 1200kg, whilst traversing at high speed and performing to an exceptionally high degree of accuracy. In addition to this, the tracks followed the curved geometry of the stadium's roof structure, with each one incorporating severe gradients and tight curves for the carriages to negotiate. Above the field of play, the middle five tracks rose from their starting height of 35m, up to to a height of 70m, while the outer four tracks incorporated both vertical and tight horizontal curves.

Prototyping and Testing

In developing the system, we carried out extensive research and development, building a full scale test rig designed to mirror the worst case gradients and track radiuses. The rig consisted of a full scale test track and a number of test carriage modules, enabling numerous traction tests to be carried out, as well as allowing for an analysis of the ability of the carriages to steer around the gradients and curves. The ability to articulate and pivot around the carriage's central axis was also assessed - an important factor as during use, the carriage units transitioned from a flat area of track, through a curve and then on to a steep gradient. Four test units were built in total, with both differential drive and direct drive systems, each being thoroughly tested and assessed for suitability.

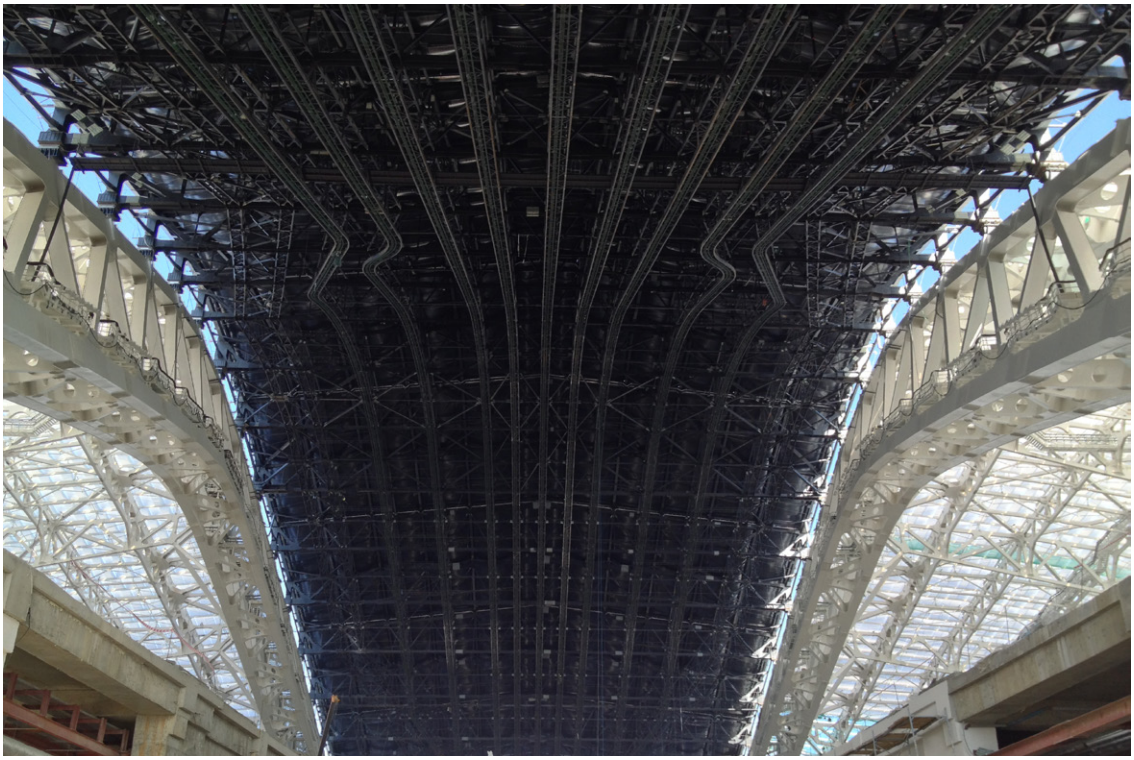
The successes and failures of these tests gave us a wealth of data on factors such as wheel slippage, traction and steering capacity. A final design that addressed all the test data and conclusions was built and once commissioned, was submitted for Client approval and ultimately production.

Predicting Uncertainty

With complex choreographed sequences playing out at height and speed during the shows, it was essential that we could accurately predict the ability of each carriage to successfully traverse the gradients and curves of the track, while lifting and tracking scenic elements. In order to meet the theatrical demands of the show, the carriages not only functioned individually, but could also be synchronised to work reciprocally with any number of other carriages on any number of other tracks.

Generating and uploading the motion and positional data paths to each carriage had the potential to cause problems for the Sochi shows, due to the unusually great distances over which the large packets of data had to be transmitted. This was recognised early on however and addressed.

The system we devised enabled us to accurately fly some extremely large and complex scenic elements, including those that synchronised with projection; along with multiple aerial performers.



Winch Mechanism R&D

Once the carriage prototype had been developed, the same principle of design development and R&D was applied to the winch mechanism. Numerous design criteria had to be addressed; however, the main issue was with the change of gradient. This had a direct impact on the angle that the winch wire had to achieve in order to successfully deploy off and onto the winch drum assembly. This was overcome with some ingenious design development and research into various mechanical devices.

The positional data and power distribution was also a complex technical issue as no products existed that could successfully transmit both power and data down a bus bar rail system. The test rig was fitted with various types of data and power distribution systems, alongside optical positional control systems. Due to the high speed movement and positional accuracy required, a new data stream product had to be designed and developed to overcome the problem. Further development and testing was then required to integrate the new hardware and software into existing motion control equipment.

It was vital to the realisation of the project that each carriage would be able to operate independently, be moved under positional control and be able to lift to a high degree of accuracy. No trailing wires could be employed and more conventional wireless control systems would not work due to the show's complexity and the great distances of traverse required.

Spot Hoists

During development, it became apparent that further hoisting applications were required to deliver the show's narrative. To facilitate this, we installed 40 spot hoists into the temporary roof structure of the stadium, reconfiguring the drop positions for each ceremony as required. The spot hoists were used to deliver key scenic moments such as raising the columns for the Tolstoy ballroom scene, as well as accurately facilitating the deployment of screens and scenic surfaces used for projection. For the Paralympics, the hoists were repurposed for the LED forest.

The site at Sochi posed numerous problems, however, working in collaboration with the temporary roofing contractor, we managed to complete the installation of the track system in time, enabling the rehearsals to commence prior to Christmas 2013.