Castro Mello Pioneers Green Building Design in World Cup Stadium with NVIDIA Maximus

When Brazil was awarded the 2014 Soccer World Cup and 2016 Olympics, many of the country's existing stadiums were in varying states of disrepair, with poor conditions punctuated by the tragic death of seven fans when a section at the Fonte Nova stadium in Salvador, Bahia collapsed. Vicente Castro Mello, the third-generation owner of leading Brazilian sports architecture firm Castro Mello Architects, had just completed a detailed study of his country's existing stadiums, highlighting shortcomings related to design and hazards in structural integrity. Armed with that data, he joined forces with Ian McKee, founder of the EcoArenas green building sports consultancy, to co-write the CopaVerde Plan calling for the largest coordinated green building effort to date leading up to the 2014 World Cup.

"We knew we had an opportunity in Brazil with the World Cup in 2014, the Copa America in 2015 and the Olympics in 2016, to reset the standard for more efficient, green stadium building around the world—we also knew we wouldn't be able to do this credibly without complying with a reputable, international global standard, which is why we are pursuing LEED[1] certification," explained McKee. "The boost in computing power afforded by NVIDIA Maximus workstations has been a critical factor in our success thus far."

NVIDIA® Maximus™ -powered workstations played a significant role in enabling high-quality design iterations and reviews to help Castro Mello Architects and EcoArenas reach for its goal of designing the first Platinum LEED certifiable stadium in the world, located in Brazil's capital city, Brasilia.

[1] Leadership in Energy and Environmental Design designation defined by the U.S. Green Building Council

Challenge

Hundreds of sports architectural design firms around the world competed to win a bid for one of Brazil's many new stadiums. Castro Mello Architects was awarded the design of the coveted 'Estádio Nacional de Brasilia'. Determined to show the world that high performance stadiums could be profitable examples of green building success, the team needed to devise inventive ways to create building efficiencies in the areas of energy consumption, water usage, waste and transportation, among others.

In order to improve the stadium's overall design, spectator experience and environmental performance; several lighting, climate, airflow and material tests had to be conducted from the earliest design phases. This testing required compute-intensive rendering of hundreds of computer generated (CG) images.

When Castro Mello Architects began developing their designs, the initial workstations used were Dell Precision T7500s with consumer grade GPUs running Autodesk Revit for design, and Autodesk 3ds Max for producing rendered stills. One architect would start by creating 3D structure designs in Revit. Then, a second architect on a separate workstation would take those designs and run real-world light studies using Autodesk 3ds Max, and render them out on the CPU to determine how to build the stadium to get the most out of natural lighting, which is essential for LEED certification.

"There was simply not enough computing power with this system to create images from our designs with any efficiency," said Castro Mello. "It was taking us 8 hours to generate a single frame and we didn't have a practical way to view changes that could meet the demands of our schedule. If there was something flawed in our design, we would often have to waste an entire overnight render run before we became aware of the problem—only to have to start over the next day."

Solution

When approaching the stadium design, Castro Mello and EcoArenas began conducting bio-climactic studies to analyze the weather in Brasilia and align the results with optimal building and roof designs.

"When I was in the climate research phase, I learned that some meteorologists and scientists working with heavy processing demands were using NVIDIA Tesla GPUs. Already armed with Quadro cards on our workstations, we added Tesla cards bringing the workstations up to the Maximus-powered configuration to see how it would improve our render times " explained Castro Mello. "The results were dramatic. Working in 3ds Max and leveraging the GPU based renderer, iray, we were able to generate test renders of design revisions in as fast as 30 seconds, a process that was previously taking us up to eight hours on the CPU."

This opened up an incredible opportunity for Castro Mello architects, three of whom immediately started working on Maximus-enabled workstations. "We had to do extensive testing of varying sun positions and lighting conditions. Next we analyzed that information which was then translated into different design permutations to assess how best to maximize

natural resources. This process helped significantly reduce the overall energy load of the stadium," continued Castro Mello.

Adopting Maximus-enabled workstations also allowed Castro Mello Architects to run both Revit and 3ds Max with iray simultaneously on a single workstation, significantly boosting workflow speed and efficiency. With the ability to run both programs on one system, designers could conduct real-world lighting tests in 3ds Max or analysis of energy impact in Ecotect, and then instantly make necessary design changes in Revit, streamlining the design process and providing the enhanced speed necessary to complete the project on time and with as many green features as possible.

In addition to extensive light studies, this computer analysis and the rendered images were used to demonstrate how the stadium could capture and reuse rainwater, improve airflow and ventilation, reduce waste, and enable explorations to determine overall color, pattern and material choices for stadium seating.

Impact

At the front end of the project, the CopaVerde Plan helped sway FIFA to require some form of green building certification to be included in all submitted designs; to date, ten of the twelve new stadiums are pursuing LEED certification, with Castro Mello's Estádio Nacional de Brasilia (slated for completion in February of 2013) going for the highest—Platinum—designation.

With the help of NVIDIA Maximus technology, Castro Mello Architects made some unanticipated changes to their original stadium designs. "After running sunlight and reflection studies to figure out exactly where the sun's heat was impacting the building, we discovered that by simply drawing back the glass façade of the VIP boxes, and creating patios instead, we could significantly limit solar heat gain, reducing internal air conditioning demands," explained Castro Mello.

Their research and use of a Maximus workstation also enabled the team to develop a system to collect rainwater runoff from the entire site, treating the captured water and redirecting it for use in restrooms, field irrigation and general stadium cleaning. The result is a dramatic reduction in potable water use. Other eco-friendly components include the largest stadium solar photovoltaic system in the world at 2.544 MW.

With these building efficiencies, EcoArenas, LLC estimates that the Brasilia Stadium will realize approximate energy savings of up to 120% per year becoming the first Net Zero Energy stadium in the world and reduce potable water consumption by more than 80%.

"Speed and being able to preview and revise our designs in real-time on the same workstation were essential on this project. That's really where we were able to benefit from the boost in computing power—being able to solve design decisions in one sitting," concluded Castro Mello. "We are a relatively small team, only six architects, and armed with the best technology, we're able to compete on a global scale. The playing field has been leveled where small, but highly qualified teams, can compete with much larger architectural firms. The ability to turn around design iterations so quickly with a Maximus workstation was essential in designing what we hope will be the greenest stadium in the world."