

# FIRST IMPRESSIONS

Computer modelling tools are an essential part of the design and construction of modern-day stadia

Computer modelling for sports facilities has dramatically changed the process for delivering MEP (mechanical, electrical, plumbing) design. These programmes allow engineers to design better systems by predicting how the system will function and detailing how the system should be constructed. As building systems engineers, we must fully utilise these new tools during the design process, from early conceptual design through the construction process. This article looks at several programmes that US-based mechanical and electrical consulting engineering firm M-E Engineers has found useful in designing state-of-the-art facilities around the world: Revit modelling with Navisworks coordination, sports lighting modelling using AGi32, and CFD (computational fluid dynamics) modelling using Fluent software.

## Revit model

Revit MEP is a three-dimensional building information model (BIM) software for mechanical, electrical and plumbing engineering. Revit offers a single database environment for MEP design, analysis and documentation. Engineers work with the architectural model, laying out systems and providing construction information for contractors. Any change made to the model automatically updates all model views and drawing sheets, allowing for accurate and coordinated designs. Ultimately, a better coordinated, more detailed design means streamlined schedules and reduced building costs for owners.

Coordination of all disciplines is achieved by exporting Revit drawings to a third-party software called Navisworks. Navisworks is a collaboration programme designed to quickly integrate each discipline's files from Revit, Autocad, or other programmes, to give a complete picture of the design. Reports are generated comparing one discipline to another, allowing the engineers to find interference problems and clashes between trades.

Using Navisworks, designers are able to detect these issues and alter the design as needed before they become problems during construction. These coordinated files are also useful after construction, giving facility managers a complete building model to track systems and coordinate upgrades or repairs.

## Navisworks collision detection

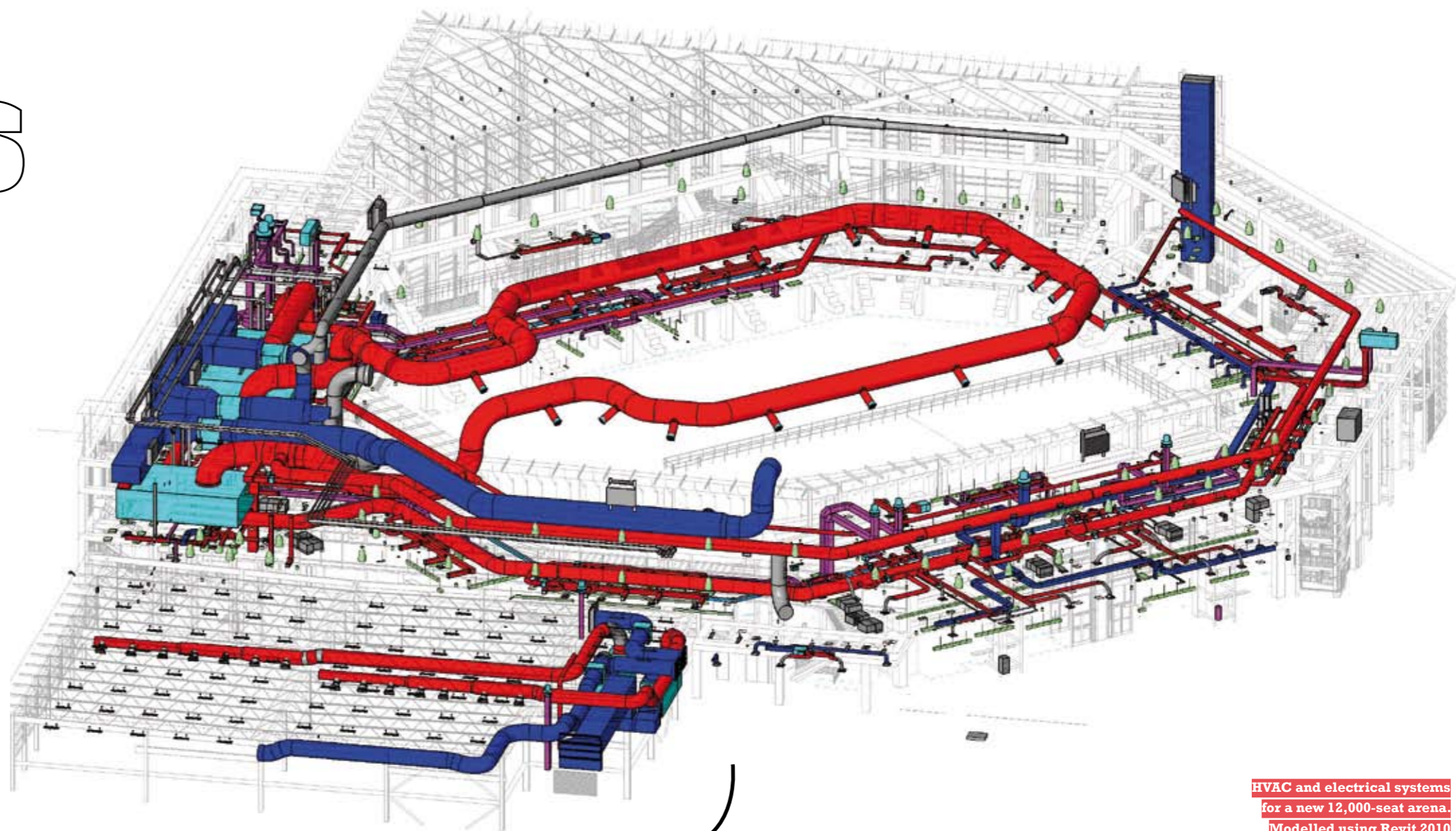
Revit Mechanical includes tools that allow users to calculate system needs and size duct and pipe mains, branches or the whole system at a time. For example, ASHRAE duct fitting pressure loss information is built in to Revit, allowing engineers to update the size and layout of ducts without using other programmes.

Using the Integrated Environmental Solutions (IES) virtual environment, Revit can perform calculations of heating and cooling loads, daylighting values and thermal energy analysis. For more detailed analysis, Revit models can be exported to third-party programmes such as Trane Trace. Energy and load analysis calculated in Trace can then be imported back into the model. These calculated values can also be exported to an Excel spreadsheet for those without access to the Revit software.

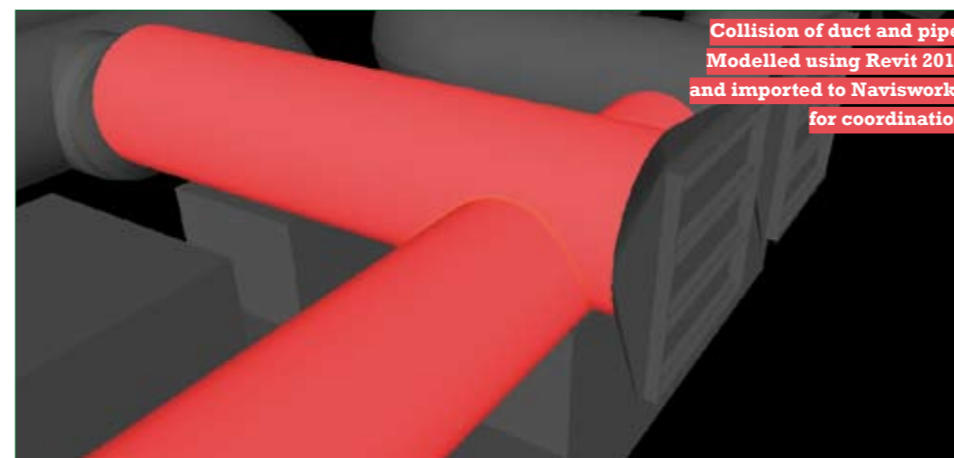
Revit modelling presents engineering solutions in three dimensions that can be coordinated and integrated with the architectural and structural design. Revit allows a more detailed design to be presented for construction, reducing conflicts with other trades and costly construction change orders.

## Pitch lighting modelling

Pitch lighting is one of the most critical systems in stadium design. To sell events to the public, high definition digital quality and 3D video are now required. These broadcasts are impossible without appropriate lighting. In fact, illumination values are now approaching studio stage levels. M-E Engineers offers exceptional lighting expertise to professional facilities such as Wimbledon and



HVAC and electrical systems for a new 12,000-seat arena. Modelled using Revit 2010



Collision of duct and pipe. Modelled using Revit 2010 and imported to Navisworks for coordination

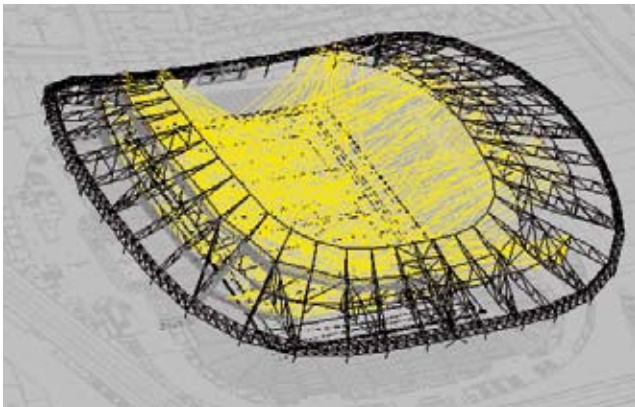
sports organisations such as FIFA worldwide. M-E has successfully used AGI software to help with its lighting designs. This modelling programme allows the designer to customise sport lighting aiming strategies to provide ideal lighting on the pitch for broadcast media, spectators and players. The programme helps the designer to analyse each camera position, player position and sightline to ensure adequate lighting is achieved, while not creating glare for the participants.

In sports such as baseball, cricket and tennis, the ball may exceed 140mph in flight. The sports lighting must be able to clearly illuminate the ball in flight for the event player without glare. In addition, cameras must be able to clearly record the ball in

flight for official review and for audiences to follow. With current digital broadcast technology designed for 1,000-1,500 frames per second, proper lighting is essential to achieve the desired results.

In addition to the need to capture the ball in flight, super slow-motion replay is another light intensive demand. Slow-motion replay is becoming the most important video feature of sporting events. Video clips of game highlights are rebroadcast on television and websites worldwide. The demand for high-quality video and changing technologies is requiring lighting design to evolve and improve.

As broadcast media and image capture technologies continue to improve in quality, the sports lighting must continue to improve as well.



The lighting designer must look to new and better tools to ensure the optimum design and make sure the public and players have the best possible experience.

**Sports lighting aiming strategy for a new football stadium. Modelled using AGi32 by lighting analysts**

### **Computational fluid dynamics (CFD) modelling**

Computational fluid dynamics, or CFD, is the use of computers to create a three-dimensional model that simulates air and temperature movement and variations within a space. The model can be used to study steady-state conditions such as the cooling effect of an ice sheet, or dynamic events such as cooling a stadium after the closing of a retractable roof. M-E Engineers has used CFD software in its design and analysis of large-scale seating bowl cooling systems. Use of this tool often points out problems or abnormalities that may otherwise go unnoticed. In large-scale cooling applications, achieving equal temperature distribution and airflow is critical to the comfort of players and spectators.

Many top sports facilities in the world are recognising the benefits of a more comfortable environment, even for sports traditionally played outside. Retractable roofs are one way to control these conditions. The illustration depicts the results of CFD modelling of the temperature gradient in the new Dallas Cowboys Stadium. The goal for the project was to provide comfort cooling within the seating bowl when the retractable roof and large endzone wall doors are closed. Temperature variations within the overall seating area needed to be kept to a minimum. CFD modelling helped M-E Engineers to develop an effective cooling scheme. Given the limited opportunities for intermediate level supply points, M-E chose to model two supply ducts up high below the fixed roof trusses, one to serve the upper seats and another to serve the lower. The CFD model confirmed its expectations that the air volume and temperature from the inner duct ring, serving the lower seats, was adequate. The models also showed that the air velocities and temperature at the upper seats was within the desired range. This allowed the design team and owner to feel confident that their comfort goals would be achieved and costly redesign efforts would be avoided. The end result is a state-of-the-art

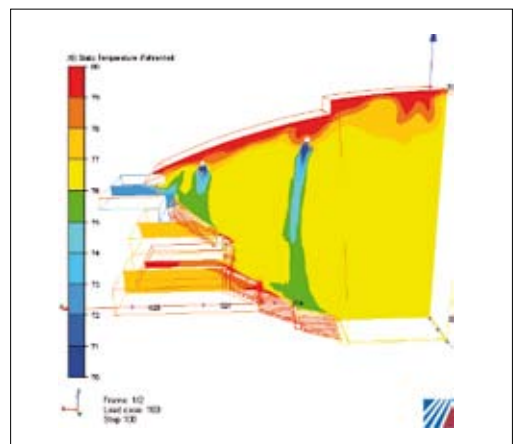
stadium where game-time conditions are equally comfortable for all spectators.

M-E Engineers has used CFD modelling on previous projects as well. For the Arizona Cardinals' retractable roof football stadium and the Arizona Diamondbacks' retractable roof baseball stadium, digital models were used to examine temperatures and air velocities within the seating areas before construction began. The models allowed M-E to develop and examine several design approaches. It was able to choose the best strategies to produce conditions that the design team felt would meet fan expectations.

Knowledgeable application of CFD modelling allows engineers to create accurate models of project conditions. These models are a cost-effective way to experiment with design approaches and determine the best design to meet the client's air conditioning needs.

All the design tools presented help engineers to create the best possible building systems to meet owner and user needs. CFD modelling predicts how an HVAC system will function and helps to optimise the design. Pitch lighting models help to develop aiming strategy and fixture placement for sports stadiums. Revit allows engineers to easily modify their designs, store detailed equipment information, and fully coordinate construction plans with other trades. As technology advances, sports facilities will continue to evolve and new design tools will be needed as well. M-E Engineers has found that these programmes help to create the best possible MEP systems for the benefit of the athletes, media, fans, and ultimately the owners. ■

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**Temperature gradients for a large seating bowl cooling system. Modelled using Fluent software**