Arup was enlisted in 2004 by the City of Metz as part of the architectural competition team formed with architects Shigeru Ban and Jean de Gastines, as well as Philip Gumuchdjian for the competition design, delivering structural, mechanical, electrical, and public health design.

Having helped bring to life the design of the original and highly successful Centre Pompidou in Paris, Arup has again succeeded with Centre Pompidou Metz through the innovative structural design of the galleries and the spectacular timber roof protecting them.

Complex and free-form roof
The Centre Pompidou Metz’s unique and captivating roof is a focal point. Although the complex stacked-timber mesh, with spans of up to 50m, appears to drape effortlessly over the three galleries, achieving the roof’s bespoke geometries was an intense and complicated design project in itself.

Arup’s form finding software was used to develop the roof’s geometry and our structural software and methods were used to model, investigate and predict the behaviour of the roof structure. The timber hexagonal mesh is clad by a translucent prestressed PTFE membrane.

“The Centre Pompidou Metz is a fantastic showcase for the potential timber has to create organic curved forms,” says Andrew Laurence, Arup’s timber specialist. “Unlike other materials, the wonderful thing about working with timber is that by looking closely you can work out just how each piece has been constructed and how the parts fit together to create the overall structure.”

The building structure, which partly supports and stabilises the roof, presented structural challenges of its own. Three 80m-long concrete galleries, the ‘tubes’, are stacked at 45 degree angles and stabilised by the central steel hexagonal tower. The restriction on the location of support points resulted in large cantilevers up to 22m and spans up to 45m.

The structure of the polycarbonate facade enveloping the forum, cantilevering from the ground up to 35m, was also technically complex, needing to interact delicately with the surrounding and interpenetrating structures, without attracting any loads from them. “Although it encounters a range of different conditions, the structure has to read as a single entity,” explains Arup’s project leader, Sophie Le Bourva.

The unusual geometry of the building required wind tunnel testing. Models of Centre Pompidou were tested in the CSTB wind tunnels in Nantes as well as pounded with snow. Arup scoped and supervised these loading studies. Wind tunnel testing enabled a significant reduction in the loadings previously assumed during the design, resulting in significant savings on materials, sizes and cost at construction.

Discreet environmental control
Designing the mechanical services involved integrating the large elements of a state-of-the-art air displacement system within the fabric of the building, whilst keeping them outside the galleries to avoid their presence competing with the artworks. The system feeds air discreetly through a multitude of small perforations in the floor of the exhibition spaces, with all the large ducting located outside, confined to one side of the ‘tubes’. The exposed ducts remind us briefly of the Centre’s predecessor in Paris – famed for its exoskeleton of mechanical services.

“It is one of the first projects where we used services 3D modelling extensively to coordinate ductwork routes and location of air handling unit plant with the complex geometry of the roof and the concrete gallery tubes,” explains Arup services engineer, Emmanuelle Danisi.

Interactive design
The unusual interaction of the steel, concrete, timber structures and the PTFE membrane added a degree of complexity to the project that could only be achieved through a truly integrated design approach.
Extensive sensitivity studies and structural integrated modelling was needed, which required Arup to pool together multidisciplinary skills and experience from across the firm.

“As testament to the diverse skills of the project team, I recall being impressed watching a colleague conduct a meeting in French for the client’s benefit, whilst at the same time translating into German and English for the benefit of the contractor and the design team”, Andrew comments. “No easy feat!”

“Returning to see the completed structure gives the team sense of satisfaction for a job well done,” says David Gration (Arup ATG’s structural engineer in charge of the roof analysis). “The building is a spectacle in its own right, a lovely space to experience art and a portal to Metz.”

Ben Lewis, the roof structural engineer, has not worked on anything so difficult before. “Pompidou was a whole other level of complexity, everything from the derivation of the geometry, to the analysis, and the design of the connections involved going back to the first principle of structural engineering design. Seeing the finished building was amazing, there is truly nothing else quite like it on the planet. Being part of the team that created this is superb.”

Engineering succession
Sophie Le Bourva has worked at Arup in London for over 20 years. Despite having worked on a portfolio of high-end design driven projects, she describes the Centre Pompidou Metz as one of her most complex projects to date. “Designing the Centre Pompidou Metz was technically extremely sophisticated and required careful management of strategic issues within the design team,” Sophie explains.

Andrew shares Sophie’s views on the project’s complexity. “Despite claims that the design of the building looks complicated but is actually very simple, I personally found this to be one of the most challenging projects I’ve ever worked on. After all, there aren’t many structures that manage to work in shell, catenary and bending action, all at the same time.”

Although Sophie joined Arup long after the original Centre Pompidou Paris was complete, she was fortunate enough to have worked with the late Peter Rice, Arup’s primary structural engineer on the project during the 1970s. “One of the great rewards of working on the Centre Pompidou Metz was to follow in the footsteps of an engineering master like Peter,” Sophie explains. “And to be able to draw upon the lessons learned from him in bringing to life the ambitious successor to his original Centre Pompidou.”