

# Modern classic

A centuries-long tradition of ceramics production was the inspiration for innovative acoustic design in China's new Fuzhou Strait Culture and Art Centre

Set on the waterfront of the Minjiang River in the Chinese city of Fuzhou, the Fuzhou Strait Culture and Art Centre (SCAC) opened its doors to audiences and artists in October 2018. The center is composed of an intriguing cluster of seven individual buildings resembling a fleet of sailboats, each housing one venue, including

a 1,600-seat opera hall, a 1,000-seat symphony hall, a 700-seat multifunction hall, an exhibition hall for visual arts and a cinema.

Due to its proximity to the Taiwan Strait, Fuzhou was historically a gateway for international trade along the Maritime Silk Road, enabling the city to develop a centuries-long tradition of high-quality porcelain and ceramics production. PES Architects renewed and extended this tradition by making innovative use of ceramics throughout the building, ranging from baguette-shaped shading louvers on the façades to acoustically shaped ceramic tiles in the two larger performance halls:

white porcelain with an abstract pattern for the symphony hall and smaller, darker tiles forming a floral pattern inspired by jasmine branches for the opera hall. The Taiwanese ceramist artist Samuel Hsuan-yu Shih designed the tiles using new technology to pattern the China White material.



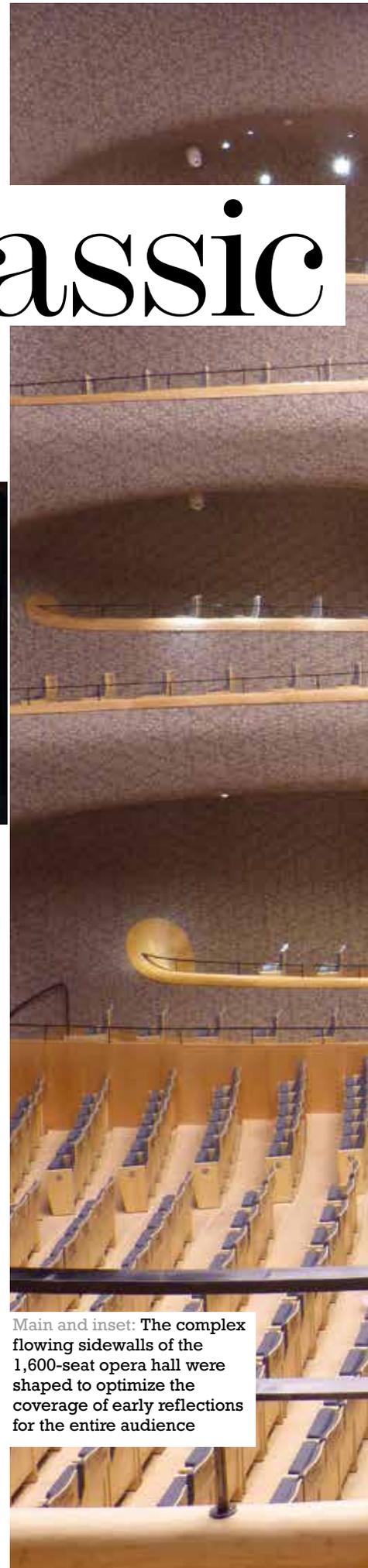
The 1,600-seat opera hall features a freeform interior, the complex surface geometry of which is the result of close collaboration between the architects and the acousticians. To achieve excellent vocal and musical clarity and presence, combined with rich reverberation, Kahle Acoustics optimized the shaping of the hall interior to generate early acoustic reflections for all audience zones.

In many respects, the opera hall with its three balconies can be seen as a contemporary reinterpretation of the horseshoe paradigm, in which the walls, balcony fronts, soffits and columns, as well as the proscenium zone, have been blended together

into a coherent, flowing 3D sculpture. The curvature of this complex, double-curved and acoustically reflective sculpture is highly variable, including large portions of acoustically focusing concave surfaces.

Through an iterative design process that included many cycles of acoustic

Flower-shaped tiles create a warm sound, avoiding the harshness that could arise from using flat ceramic surfaces



Main and inset: The complex flowing sidewalls of the 1,600-seat opera hall were shaped to optimize the coverage of early reflections for the entire audience



## ACOUSTICS



analysis directly within the architectural 3D computer model, the curved sculpture was acoustically optimized. The entire surface was analyzed to identify areas of acoustically positive focusing and those areas that generated focusing problems for certain combinations of stage/pit sources and audience zones. After quantifying the strength of the focusing, the shape was optimized either by reorienting the surface or by 'ironing out' and 'inflating' certain areas until optimized reflection coverage was obtained.

The acoustic analysis employed a non-uniform rational basis spline-based simulation technique, which enabled both highly time-efficient calculation of the acoustic reflections and a continuous collaboration and exchange by both architects and acousticians throughout the whole process.

To soften the highest frequencies and avoid harshness of tone, the large-scale freeform shape was lined with approximately 1.5 million small ceramic tiles in 13 different shapes and various shades of purple and gray. Crucially, the amplitude of the fine-scale diffusion pattern was limited to 10mm (0.4in), to retain coherent reflections and maintain the acoustic signature of the room. The opera hall is designed to combine excellent clarity and presence with a reverberation time exceeding 1.5 seconds – which can be extended to 1.8 seconds when the orchestra shell is installed in the stage house.

### The symphony hall

In contrast to the freeform shape of the opera hall, the interior of the symphony hall is formed entirely of large segments of spheres. All wall surfaces are convexly curved in the shape of petals and, as in many vineyard-type concert halls, the separating walls



Top: The symphony hall has two levels of convexly curved and inclined walls designed to create early lateral and enveloping reflections

Above: A non-homogenous surface texture was applied to zones that don't provide useful early reflections

In the symphony hall, specific zones are treated with protruding ceramic tiles while smooth areas enhance the coherence of the reflections

between each terrace are vertically inclined to direct early reflections down to the audience. Particular to the Fuzhou concert hall, the outer walls are also vertically inclined to generate additional reflections.

The size of those large outer petals is acoustically advantageous, but they also had to be designed carefully, to avoid undesirable echoes. A special acoustic algorithm was developed, to determine which zones of the acoustic petals were efficient in providing early reflections and which could potentially generate undesirable reflections.

Based on the output of that algorithm, a non-homogeneous surface texture was designed and applied exclusively to those zones that do not provide useful early reflections. This surface texture was obtained by integrating embossed artisanal ceramic tiles of varying shape and pseudo-random arrangement into the smooth curve of the petal.

"Unlike in some recent concert halls, a generalization of this diffusing acoustic treatment to the entire reflector was not allowed, in order to keep the crucial contribution of reflections from these surfaces to the acoustic quality fully intact," says Eckhard Kahle, founder and managing director at Kahle Acoustics.

### Balancing act

The symphony hall has 1,000 seats, including the choir seating behind the orchestra, which can also be used to expand the audience. This relatively small seat count may seem at odds with the large stage platform for a full symphony orchestra of more than 100 musicians and the full concert organ; thus, to avoid the sound becoming overly loud, the acoustic volume was increased much further than the traditionally advised ratio of 10m<sup>3</sup> (353ft<sup>3</sup>) per audience member. The final volume is 17,000m<sup>3</sup>

(600,350ft<sup>3</sup>), similar to that of a medium-sized symphony hall. In addition, absorptive acoustic banners are provided so that the reverberation time can be varied, ranging from 1.75 to 2.45 seconds (without an audience).

### Amplified productions

The multipurpose hall was designed to accommodate all kinds of amplified productions, such as conferences, small-scale theater and music and dance shows. The hall has retractable seating in the parterre, one rear balcony and two side balconies with fixed seating. The basic layout of the space resembles a classic shoebox/horseshoe theater. The acoustics – designed by Akukon – are not variable, as it was agreed with the users that there would be no need to stage unamplified performances in the hall.

The opening concert took place on the evening of October 10, 2018, with the China Philharmonic Orchestra playing Chinese and European classical music in the opera house, which was filled especially for the occasion with the scent of thousands of jasmine flowers.



**Above:** Most of the visible surfaces in the 700-seat multipurpose hall are made of bamboo with an irregular wave pattern, differentiating the hall from the ceramic materials used in the rest of the cultural center

“The sound of the unamplified orchestra combined strong clarity, presence and fullness of tone with warmth and ample reverberation,” says Kahle. “In the months following its inauguration, the Fuzhou Strait Culture and Art Centre was praised by members of international orchestras touring in China, with some declaring it one of the best venues in the country.” ■

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