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ENGLISH TRANSLATION

Ten-thousand notes going under the skin

By OLIVER GEORGI

An enormous effort is underway for the acoustics in the Hamburg Elbphilharmonie concert hall. It is supposed to become one of the ten best concert halls in the world one day, largely due to uniquely designed gypsumfiber boards.

As the conductor raises his baton for the first time in the Hamburg concert hall on January 10th, 2017, Benjamin Samuel Koren from Frankfurt will be sitting in the audience, nervous as never before in his life. Are the acoustics as muffled as they are in other highly decorated, but lousy sounding concert halls? Will the sound of the violas even be noticeable past the first balconies? Will you hear the first violins distinctly in the front row, but only muddled further back? The developers' intention for the Elbphilharmonie is for it to become one of the ten best concert halls in the world, not despite but because of its acoustics. Benjamin Samuel Koren, computer scientist and musician, architect as well as a fine spirit has also worked hard to help achieve this ambitious goal.

An eccentric project such as the €789 million-building on the river Elbe, which was designed by the world-renowned Basel architects Herzog & de Meuron does not automatically mean its

acoustics will be good. Especially the Great Concert Hall, which will accommodate a large audience of 2150 members, is twisted and angled like no other. Unlike classical halls, the stage is located in the center, surrounded by an audience sitting on nested balconies, the highest one being located 17 meters (approx. 55 feet) above the stage. "Vineyard" style, as it is called, a system of terraces that will allow each viewer an unobstructed view of the stage. Every viewer will be seated at a maximum of 30 meters (approx. 100 feet) away from the conductor and hence closer to the musicians than in any other concert hall in the world.

Construction work of the Great Concert hall in early February. A special wall covering, the so-called "white skin" is intended to ensure good acoustics. © dpa

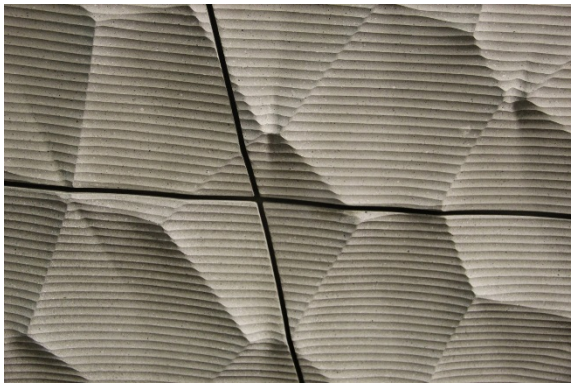
The 10,000 gypsum fiber panels, each having a unique structure for an optimal distribution of sound. © Peuckert

Each panel was manufactured on a milling-machine according to Benjamin Samuel Koren's input. © Peuckert

Each panel is unique and has been manufactured to fit precisely at its location in the hall. © One to One

The panels being examined in a warehouse before being shipped to an installed in Hamburg © Peuckert GmbH

The Bavarian company Peuckert manufactured the panels according to the specifications coming from Frankfurt - 10,000 files for 10,000 panels. © Peuckert GmbH



Unique surface depressions and grooves: The panels are to diffuse the sound at any point of the room. © Peuckert GmbH

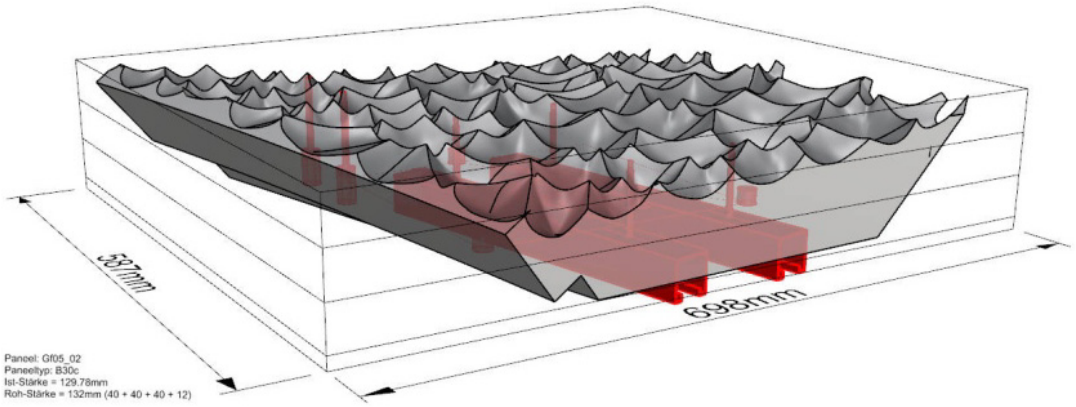
The only problem is: Every corner and every angle is an acoustician's nightmare, because the sound, which is essentially a wave, will break and get redirected back into the room at angles impossible to predict. Perfect sound is such a complex web of physical dependencies that entire generations of architects have failed to achieve it. In the past, more often than not, aesthetic design ambitions also competed with acoustic requirements: a room might look great but sound miserable.

Unique skin made of 10,000 panels

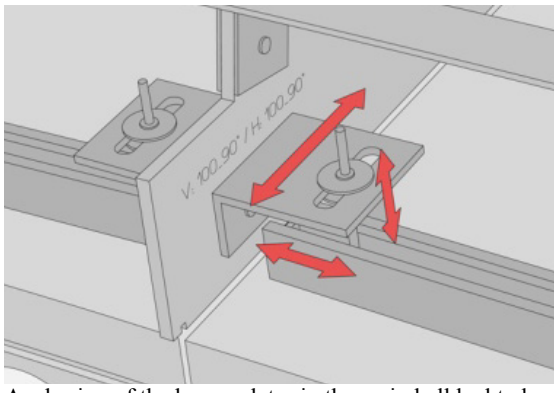
In order to minimize this discrepancy between aesthetics and acoustics for the Elbphilharmonie concert hall, the world-renowned Japanese acoustician Yasuhisa Toyata was commissioned to run computer-based calculations and simulations of the acoustics using complex 3-D models. Toyota even had the entire concert hall built, in meticulous detail, as a physical model at scale 1:10, in order to test and simulate the acoustics using miniature microphones. However, all these advanced methods and technologies cannot change the fact that the concert hall's beautiful design does not necessarily offer the best conditions for exceptional acoustics. For that reason, Toyata developed a unique surface treatment for its walls and ceiling, the so-called "white skin". It consists of 10,000 gypsum fiber boards, each one individually machined with a unique surface pattern consisting of depressions, grooves and pyramidal cones that will break and scatter the sound at each location in the concert hall. This is where Benjamin Samuel Koren comes into play.

Universal creative mind: Benjamin Samuel Koren is an architect, musician and computer scientist. He calculated the surfaced treatment of 10,000 panels in the computer. © One to One

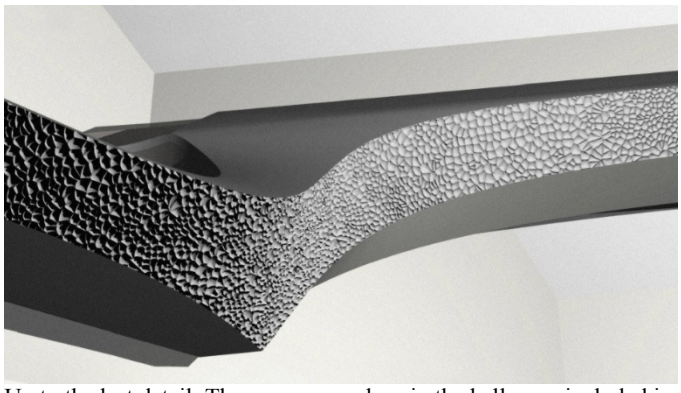
As you visit Koren at his small firm "One to One", located in an inconspicuous backyard building near Frankfurt's central train station, the universal, sophisticated nature of his character manifests itself quickly within the spacious old studio space. The furniture, predominantly Art Nouveau, is of exquisite noblesse. An upright piano and a vintage Hammond organ reveal the experienced jazz pianist, who was born in Frankfurt, grew up in the United States and studied architecture, film and music in Miami. It is no surprise that the soft spoken and discreetly courteous Koren prefers to listen to the music of Bach: No other compositions reveal a more apparent link between music and mathematics.



The computer model of a single panel, as Benjamin Samuel Koren has created it at his company One to One. © One to One



Anchoring of the heavy plates in the main hall had to be meticulously planned: The 10,000 panels hang on a specially designed steel frame. © One to One



Up to the last detail: The numerous edges in the hall were included in the calculations.
© One to One

An architectural model in a glass case hints at the Elbphilharmonie concert hall, which Koren has worked and lived for since he was commissioned by the architectural firm Herzog & de Meuron to calculate the panel surfaces for the "white skin" in 2009. At the time, he had finished his studies at the prestigious Architectural Association in London and just established his company. As it turns out, one of his first projects happened to become one for which others work towards their entire life: a godsend, which Koren is well aware of. "There is no concert hall in Germany, which was built with an even remotely comparable effort," says the young man, "contributing to a project like this one, is truly an honor." He then points to an inconspicuous gypsum board leaning against the glass case which might decide one day whether the Elbphilharmonie will in fact become an exceptional hall.

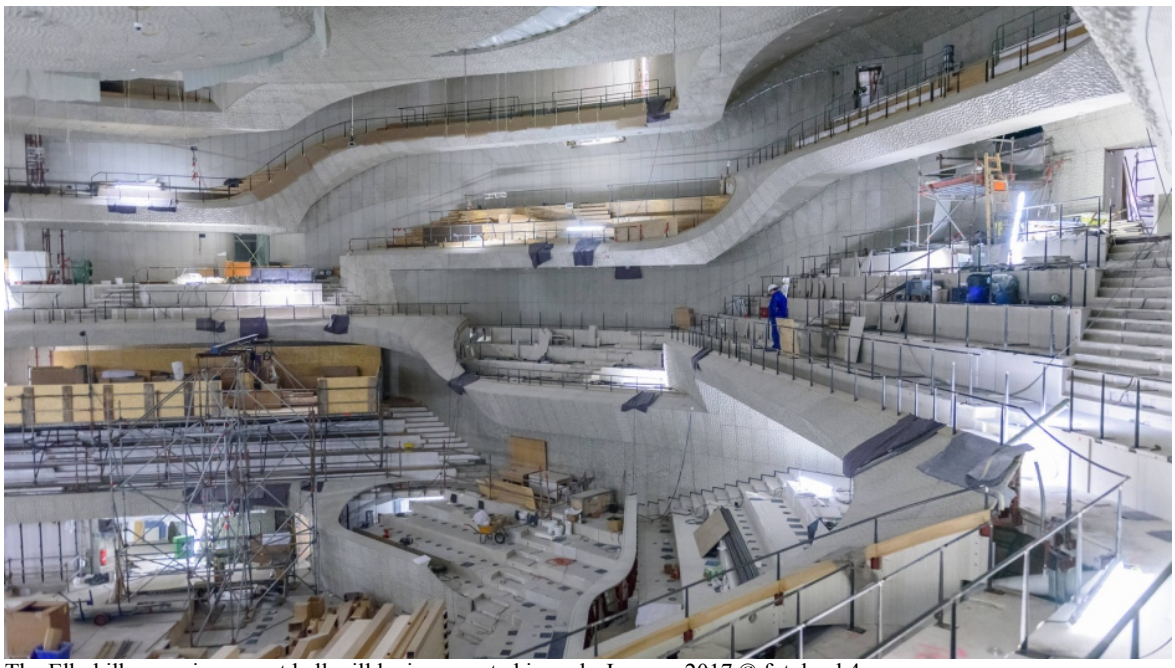
10,000 panels are fastened to the walls and the ceiling of the Great Hall at their backsides to an intricate metal frame, thus forming the "white skin". Each panel's weight of 70-80 kilograms

(approx. 150-175 pounds) was also a technical challenge. As required by the acoustician, Koren developed a computer program that calculated the surface structure individually for each panel: 10,000 panels, 10,000 individual computer files. "Microshaping", as this method was named by the acoustician, is an impenetrable interplay of physical dependencies and mathematical algorithms. Once calculated onto the surface of each of the 10,000 gypsum fiber boards, it allows the incoming sound to perfectly scatter at their respective locations in the hall. Around one million fist-sized, acoustically active cells were calculated by Koren. "The acousticians specifically requested that no surface pattern should repeat itself, in order to avoid interferences." The rules in acoustics are different than in life; the more chaotic, the better.

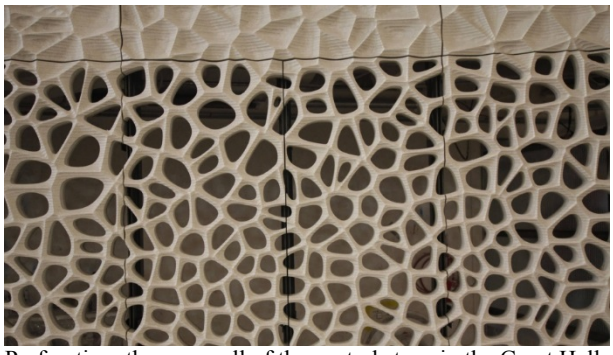
Like a delicate clockwork

Such a complex task requires a lot of team spirit. In 2009, the company Peuckert, located in Mehring, a town East of Munich, was awarded the contract for the realization of the concert hall. Since Peuckert was not only responsible for the production, delivery and installation of the acoustic panels, but also for its plant and assembly planning, a long-standing intensive cooperation between Peuckert and Koren ensued. "Choreographing the complicated logistics in particular was quite a challenge," Koren says in retrospect. "Not only did my work have to be done with the utmost precision, but so did the work of the civil engineers, our colleagues at the CNC machines as well as the technicians of Peuckert. All this interaction had to work seamlessly, like a delicate clockwork."

Koren gradually delivered 10,000 digital files to the Bavarian company which would feed the CNC machines that milled each panel individually. Peuckert CEO Tobias Mueller explains: "The panels are actually floor panels made of gypsum, which we had glued in layers according to the specifications before they were milled. The panels were successively shipped to Hamburg and anchored in place at their respective positions." The last piece was finally installed at the end of January 2016 - a gigantic, intricate puzzle with very little room for error. "In total, we had to correct less than 20 panels," Mueller proudly explains, "it worked out incredibly well."



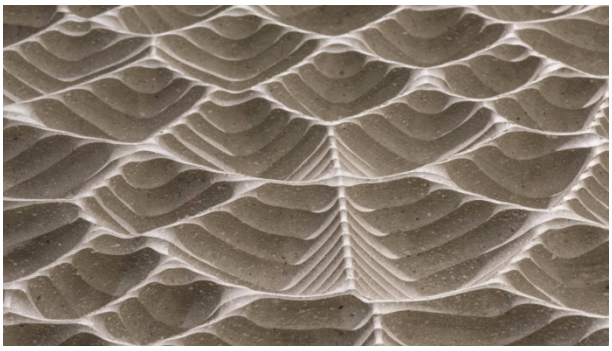
The Elbphilharmonie concert hall will be inaugurated in early January 2017 © fotobuch4you



Perforation: the rear wall of the central stage in the Great Hall © Peuckert GmbH

After its completion, the Elbphilharmonie concert hall shall become one of the ten best concert halls in the world - its builders intend. © Reuters

Fine-tuning the Great Hall: It will hold a total of 2150 listeners. © dpa



Close up of a panel: The unique "white skin". © Johannes Arlt

789 million Euros the Elbphilharmonie will it have cost in total when it opens next January. © Peuckert GmbH

Depending on the position of the wall or ceiling in the Great Hall, the gypsum panels are designed differently; the thickness varies from 35-200 mm (approx. 1.5 - 8 inches), the base areal density being 150 kilograms per square meter (approx. 30 pounds per square foot). Especially

this last factor is immensely important in acoustics: More mass will reflect more sound. The sound of music, the so-called “direct sound”, is radiated concentrically away from the stage. The redirection of the sound directly after this radiation become the first reflections, the ratio of the two should be well balanced. The higher the proportion of undirected reflections, the more the music will envelop the listener, but also become blurred. Higher proportions of direct sound will result in crisp and clear music, but the much wanted spatial impression will be lost altogether. In acoustics, a benchmark for a clear, yet enveloping sound is defined by a reverberation time of about 2 seconds. This is the time it takes a sound in a room to turn completely silent.

The ideal reverberation time is about two seconds

In the Great Hall, the different panels will ensure that this reverberation time is not exceeded even in complicated places such as under the ceiling or on the terraced galleries. The diffusion of sound and the resulting enveloping effect are achieved by the different cells on the gypsum panels, varying in diameter and depth depending on the position of the panel. The acousticians and Benjamin Samuel Koren are convinced that this effort paid off, despite some criticism. The Hamburg expert for acoustics Uwe Stephenson, for example, expressed doubts whether the acoustics in the Elbphilharmonie could really meet expectations due to the ceiling height of 30 meters (approx. 100 feet) being too high to achieve the ideal reverberation time of two seconds.

However, such criticism does not bother Koren nor affect his dedication to the project in the least. Once the Elbphilharmonie opens next year, Koren will have spent seven years working on the project’s geometric shapes, dusty gypsum fiberboards as well as precisely milled peaks and troughs. Seven years in which he not only worked on the project during the day, but also dreamed of it at night. "The Elbphilharmonie was really a dream project," Koren says, and he sounds sincere in his wistfulness when he claims, "a project such as this one, won't happen again."

Koren might take on similar challenges, such as working on the Louvre in Abu Dhabi or the Philharmonie de Paris, for which Koren expressed interest but eventually was not the winning bidder. Perhaps he will also eventually realize his dream to build a concert hall of his own design. It would be a dream appropriate for a multi-talent such as him.

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