The *Gashouder* tamed

'We have a new concert hall'

Last June, people were ecstatic about the sound in the *Gashouder*, a former gas tank on the *Westergasfabriek* premises in Amsterdam. During the Holland Festival, the French composer Edgar Varèse's complete works were performed here. Nobody had expected the sound to be so beautiful in that enormous barrel, but sound designer Jan Panis managed it.

After the concerts, called *Varèse 360°*, Jan Panis was congratulated by the most critical people you could meet in the music industry: musicians, conductors and composers. Everybody was much impressed by the phenomenal acoustics in the Gashouder. The press, too, was enthusiastic. 'We have a new concert hall', was people's reaction. Jan himself was also pleased with the results, although he later admitted that a slight panic had swept over him once he had realised the kind of commission he had received from Pierre Audi, artistic director of the festival. After all, performing Edgar Varèse in the Gashouder, wasn't that asking for trouble?

Jan Panis: 'That gasholder has an enormous reverberation. One stroke on a kettledrum echoes for ten to twelve seconds in the lower regions. A fantastic effect. But when you play fast, punctuated music there, the sound turns into an impenetrable mash.' And fast music with much percussion, that simply is Varèse. He is well-known for his smaller electronic works but his bigger pieces tend to border on the megalomaniac. His symphony orchestra is 130 musicians strong, too many for normal proscenia. The violins literally play second fiddle, with tens of percussionists and brass players running the show. In the Gashouder, this huge and loud orchestra was to be placed on a proscenium in front of a semi-circular grandstand with an audience of thousands. For that same audience, Varèse's work for ensembles was also to be played with only 8 to 30 musicians. There was a male choir, a piano solo, and a flute player playing a flute solo in the middle of the hall. And, last but not least: his electronic works. A surround system was needed for the famed *Poème Electronique* from 1958 and the freshly orchestrated *Étude pour Espace*, for the sound to move in spirals.
It was as if someone had decided to have both extremely expansive orchestral and the smallest possible chamber music performed in an immense, resonating cathedral. As well as electronic music in surround. All this had to sound immaculate.
Jan Panis realised he would have to do three things. He would have to confine the resonance to do justice to the expansive orchestral sound. He would have to find a way in which to amplify the ensembles, choir and flute solos without contrasting sharply with that enormous orchestra. And he would have to design a surround system. Under the circumstances this was the least of his tasks, that is, if the reverberation were short enough. So, his first and foremost challenge were the acoustics and then he would have to produce inaudible amplification.

[caption:
During the Varèse concert, video artist Gary Hill's images were shown. Some people found them far too dominant and even called: 'No video'. A few mobile screens hung in front of the loudspeakers, but hardly disturbed their amplification. Photo: Ruud Jonkers]

From gasholder to concert hall
Jan Panis: 'I wanted to try and tackle the reverberation in a natural way'. That is why he did not begin his acoustic design with either loudspeakers or microphones, but with a plan to tame the reverberation. He had to fit the gasholder with an enormous quantity of muffling and he managed to convince artistic coordinator Lieven Bertels that its success would be crucial to the whole project. Without that muffling the hall would be totally unsuitable for Varèse. This resulted in a budget being made available, albeit that it represented only a very small amount of the total.
What Jan Panis had in mind were the baffles of Txlnt, a fairly new concept of mobile muffling material specially designed for varying locations. Their muffling qualities are good across the entire frequency range. Unfortunately, the whole stock was needed in the Amsterdam ArenA for a Toppers concert. In consultation with the supplier an alternative was found >

[table 1. Absorption value of Doscha wool and Txlnt]

Frequency in Hz	Doscha wool	Texlnt
63	0,33	0,47
125	0,5	0,99
250	0,88	1,1
500	0,91	1
1000	0,95	0,98
2000	0,98	0,98
4000	0,99	0,99
8000	0,99	0,99
16000	0,99	0,99

in Doscha sheep's wool. The Txlnt baffles use that same wool because it does not itch, is environmentally friendly, acts as a fire retardant and is reusable. Only, Txlnt has a much better absorption in the lower regions (table 1). This meant that 50 to 60 per cent more Doscha wool would be needed to reach the same effect as with Txlnt. Eventually, over 500 m2 of wool, 100 mm thick, in strips

of 1.5 x 7 metres, were hung up between the pillars of the gasholder, in 18 sections behind the grandstand, but not behind the orchestra. In front of the Doscha strips, woollen fabric was hung in thick folds, which gave it a festive look.
All in all, it did not take much more than half a day to hang up the material. Jan Panis: 'When I entered and clapped my hands, I knew it was fine. Acoustics were great during rehearsals as well. We had used less wool than our calculations had indicated and it turned out to be very agreeable indeed. On the opening night, with the audience, it was even a bit too dry. The second night I compensated this by introducing a slight concert hall reverberation with the Altiverb on the rear surround loudspeakers, and this improved the sound just that little bit.' Anyone who has ever been in the Gashouder understands how strange this sounds: the gasholder needing *more* reverberation.

1 Six Bloomline Omniwaves were positioned right in front of the proscenium, with two in the middle position, and five hung right over these from a truss, at approximately 5.5m high. They were controlled by d&b D1 2 amplifiers.
2 In the middle was a cluster of d&b Q7 loudspeakers, 'just in case'. These were hardly used.
3 For the performance of the famous *Poème Electronique* from 1958, originally composed for the Philips pavilion during the World Exhibition in Brussels, a surround system had to be installed to be able to project the sound in 3D above the audience. Jan Panis had loudspeakers suspended in 4 corners, at a height of 8 metres (at pillars 8, 18, 27 and 37). Also a batch of loudspeakers in the middle, turned downwards, at 13 metres above the audience. All these loudspeakers were d&b Q7s. For the freshly orchestrated piece *Étude pour Espace*, which had its world premiere in Amsterdam, Varèse's old dream was realised by adding another four double sets of Q7s on the floor in the same corners, which allowed eight groups of instruments, with the help of MAX/MSP software specially created for the occasion, to spiral up and down, as indicated by the score.
4 The Doscha wool was hung up between pillars 12 and 37.
5 The video screens hung from the green trusses. The blue ones were for the lighting.

The Gashouder (surface 2,500 m2) including proscenium and grandstand. Drawing: Theo Wilschut, Holland Festival

Inaudible amplification

For Jan Panis, specialised in classical and acoustical music, amplifying sound amounts to keeping as close to the original as possible. 'The greatest satisfaction for me is when people have no idea that the sound is amplified.' He knew he would not have to do much for the big orchestra, perhaps enhance a percussion instrument. 'But I had to enlarge the ensembles, because otherwise they would be drowned out by the orchestral pieces. The same applied to the male choir. Also, the flute solo would hardly be audible without amplification.'
For this he needed a loudspeaker system. But loudspeakers have disadvantages. They had to be very accurately positioned and synchronised; if not, the audience would hear the sound coming from the loudspeakers and not from the proscenium. It never sounds the same all over the hall. Moreover, loudspeakers always colour the sound somewhat, whereas Jan Panis wanted as natural an amplification as possible. Earlier, in the small hall of the Amsterdam Concertgebouw, he had worked with the Bloomline loudspeaker system, which has achieved a degree of fame as 'the inaudible loudspeaker'. Colleagues of his had had positive experiences with this fairly revolutionary concept.[1] Jan Panis decided to chance it. What he actually used were eleven small, black loudspeakers: six positioned horizontally on floor tripods, the other five hanging vertically above them, at a height of about 6 metres. That was all. But the impact was inversely proportionate to their not very imposing exterior. Working with these loudspeakers differs totally from working with conventional ones. For one, you do not hear the loudspeaker. The sound is there, in the space, but seemingly without amplification. You hear a piano solo coming from the direction of the piano, no matter where you are seated on the grandstand. Another exceptional characteristic is that there is no acoustic feedback. The flute player played in the middle of the hall without a problem. Jan Panis: 'That was fantastic, also for the flute player, because she was standing within her own sound, owing to the loudspeakers. Everybody expects acoustic feedback, but it simply does not happen'.
Furthermore, this system sounds the same in front and at the back of the loudspeakers. As such, conductor Peter Eötvös also stood in the amplified sound. 'I have seldom heard Varèse in such detail', he remarked; Jan Panis could not get a finer compliment. Panis: 'I don't think he knew the principle of these loudspeakers, but the balance I created was the balance he heard! Usually, the conductor is on the other side of the loudspeakers and totally dependent on what I do. Now we had direct contact about the balance. This is something I have never before experienced. He indicated what had to be louder or softer in a passage and this I noted down in the score. I was able to communicate with him in a unique fashion.'
Initially, he had to get used to the new system. 'With ordinary cone loudspeakers, you're used to hearing an immediate difference (in sound!) when you do something. Now I only needed to create balance, without any delay and hardly any equalising, as the hall in itself sounded magnificent. The big male choir sounded clear and natural. I thought the piano was brilliant. And the beautiful thing was that the audience did not notice where amplification was being used and where not. I was able to completely amplify the concert in my own way, without any noticeable sweet spots for the fanned out audience.' <

[1] Last year, the Bloomline loudspeaker system was used to amplify the orchestra in the performance of *Light is the machine* by *De Veenfabriek*, in a spacious hangar. Further on in this issue Leo de Klerk tells more about his 'inaudible loudspeaker'. He also presented the concept during the VPT special theme day *All about Loudspeakers*.

BY: JOS VAN DE HATERD

The inaudible loudspeaker

In de *Gashouder*, Jan Panis worked with the Bloomline loudspeaker system. The man behind this concept is Leo de Klerk, recording director and studio technician. ‘With stereo you get the best sound when you sit at an equal distance from the loudspeakers’, he says. ‘That is owing to our being two-eared on the horizontal level. Our hearing is binaural. The minimal differences in sound between our left and right ears are sufficient for our brains to determine where the sound comes from. Where two loudspeakers reproduce the same sound, the sound appears to be coming from a point somewhere in between the loudspeakers. It seems to separate from the loudspeakers, that’s where the term phantom sound comes from. This works best in the sweet spot, at an equal distance from both loudspeakers’.
But how about the vertical level? De Klerk: ‘There we don’t have a binaural orientation. On the vertical level we hear the direction of sound with one ear, or monaurally. For that our brains use the angle-dependent colouring of the auricle.’ With monaural hearing, ‘stereo’ or ‘phantom sound’ cannot be heard. Or can it? That question fascinated him and was actually his first step towards the Bloomline concept: was it possible to create a spatially stable phantom sound on a vertical level?

No sweet spot

With an ordinary cone loudspeaker this is impossible. It works as a funnel. Its directional effect is so strong that it is easy for us to locate the loudspeaker with only one ear. De Klerk therefore opted for a design applied in the thirties, among others by Philips: the inverted cone. That was the second step. He built a loudspeaker with a reversed cone and placed a tweeter in it for the high tones. According to De Klerk, the OmniWave, equipped with this two-way chassis, is more coherent over a wider opening angle than ordinary loudspeakers. It does not work like a funnel, but fans out sound all around.[1]
After various experiments and audio tests, De Klerk had a third, decisive inspiration: he placed two OmniWaves at a specific distance above each other at a 90º angle: one horizontally, another vertically. Both were fed the same signal. Surprisingly, we now hear a stable phantom sound between these loudspeakers, seemingly separate from the actual sound sources.
‘The beauty is that when you place two or more of these vertical phantom sources beside each other, there is also no interference on the horizontal level between these phantom sources and the actual loudspeakers’, says De Klerk. You only hear the phantom sources and not the loudspeakers themselves. This enables creation of a stereo or LCR system without sweet spots or colouring. On the Centre channel, you can put the same signal as LR because the vertical phantom sources will not interfere with one another. The sound remains natural no matter what number of channels are used. Jan Panis used five LLCRR channels and simply sent left and right from the mixing table. Incidentally, the OmniWaves do have to be positioned according to the guidelines. They must be placed under a 90º angle. The minimum distance between the top and bottom ones is 1.5 to 2 metres, otherwise the loudspeakers will correlate too much. The maximum distance is 5.5 to 6 metres for them to still connect. On the horizontal level, the distance is no more important than with conventional systems.

No acoustic feedback

Strangely enough this system does not produce acoustic feedback. In the Gashouder the flute player stood in front of the loudspeakers without a problem. Also surprising is that you keep hearing the piano from its actual position wherever you are seated on the grandstand: you hear the instrument, not the loudspeaker. All these characteristics make the Bloomline system appropriate for classical music or the theatre, where a natural sound and optimum interaction with the acoustics in the hall are essential. As the sound on the proscenium is the same as in the hall, monitors are usually unnecessary. The theory behind this phenomenon merits further research. De Klerk suggests that the system might be able to level off the HRIR – the Head Related Impulse Response, the angle-dependent colouring by the auricle with which we localise sound monaurally. That it works in the binaural range is supposedly caused by the fact that we do not localise the actual sound sources because of the vertical phantom effect. That it works is certain, but how precisely is definitely not. <

[1] For experts: the Bloomline Omniwave is handmade from parts that are specially developed by manufacturer KEF. The transfer is optimised on 45{º} off-axis, creating a rotationally symmetrical radiation surface.