Osaka Expo ’70

OSAKA EXPO 70: THE PROMISE AND REALITY OF A SPHERICAL SOUND STAGE

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ABSTRACT

The West German pavilion at the 1970 Worlds Fair in Osaka included a spherical auditorium with sound and lighting technology designed at the TU Berlin. Stockhausen's music was played live by a group of musicians every day of the Expo, alongside pre-recorded music of Boris Blacher, Erhard Großkopf, Eberhard Schoener, Gerd Zacher and Bernd Alois Zimmermann.

This paper uses technical designs, interviews, sketches, and correspondence to illuminate the experiences of this project from different perspectives and to connect Stockhausens theory and practice of using space as a compositional element with the practical realities afforded by the auditorium and the technology used in its design.

1. INTRODUCTION

Although the spherical auditorium of the West German pavilion at the 1970 World's Fair in Osaka was designed by architect Fritz Bornemann, three integral elements of the project were the architect, composer, and technicians. Broadly speaking, the composer Karlheinz Stockhausen decided what was to be done, the technicians from the TU Berlin and Siemens decided how it could be done, and the architect decided where it would be done. These three areas clearly influence one another, and with a large and complicated project such as a World Expo, the interactions between elements are not always harmonious. Because of the scale and need for innovation in such a project, testing, evaluation, and adjustments were virtually impossible. I will address each of the three components in order and draw some conclusions at the end.

2. THE COMPOSER

Osaka Expo 70 is firmly associated with Karlheinz Stockhausen, and although he was involved in consultation in the design process and had many of his works performed there on a daily basis, there were other composers involved with different areas of the production. Stockhausen's incorporation of space as a compositional element since the mid 1950s was a significant factor in the design of the West German pavilion. In *Gesang der Jünglinge* (1955-6), composed for 5 channels, he had already entertained the idea of raising the height of one loudspeaker to disrupt the horizontal plain; in *Kontakte* (1958-60) he had developed the rotation table - a device for dynamic panning of a single sound source across four channels; and throughout the 1960s we see evidence of his insistence of positioning loudspeakers for his electronic pieces higher and higher to improve the quality of sound projection for the audience. He first suggests a spherical auditorium in the essay "Musik im Raum" (1958) [1, pp.152-175] in which he cites spatial location as a fifth compositional parameter after pitch, duration, timbre, and dynamics.

The end of the 1960s saw the development of the 8-track tape machine, although such technology was extremely expensive, and as early as 1968 we start to see Stockhausen proposing ideas for a "Rotationsmühle" (rotation mill) which is a device that can be rotated by hand, like a coffee mill, in order to direct a signal to 8 different loudspeakers. Coincidentally the idea for a rotary switch for loudspeakers appears in a document by TU Berlin technician Heinz Friedrich Hartig, dated between 1959-61. [2]

There is substantial correspondence between Stockhausen and Leonhard Electronics in Switzerland about developing such a device that carries on until 1975, but without any device eventually being made. This technology is incorporated into compositional practice in 1968 with the sketches for a piece specifically designed for the Expo entitled *Hinab-Hinauf* described as "Licht-Raum-Musik" [3] (see Fig.1). This piece is to use film projection, automated sound and lighting control, and to allow the audience to move through the space, and seems to have a clear historical link to Xenakis and Varèse's work in the Philips Pavilion at the 1958 Brussels World's Fair which Stockhausen had attended.

The sketches show 7 rings of 7 loudspeakers (1-7), with seven corresponding vertical alignments (I-VII). The output of 7 channels of an 8-track tape machine are routed to corresponding vertical groups I-VII, thus giving a lateral distribution of audio tracks in a 360° area, with track 8 dedicated to control signals for the projectors. The most interesting proposition, however, is the inclusion of two live instrument inputs, one contact mic, and one condenser mic, routed via W49 bandpass filters and faders to two rotation mills. The 8 outputs of each rotation mill can then be patched into any of the individual loudspeaker inputs, with Stockhausen providing

This research was made possible by the generosity of the Deutsche Akademische Austauschdienst (DAAD), and the Leverhulme Trust.

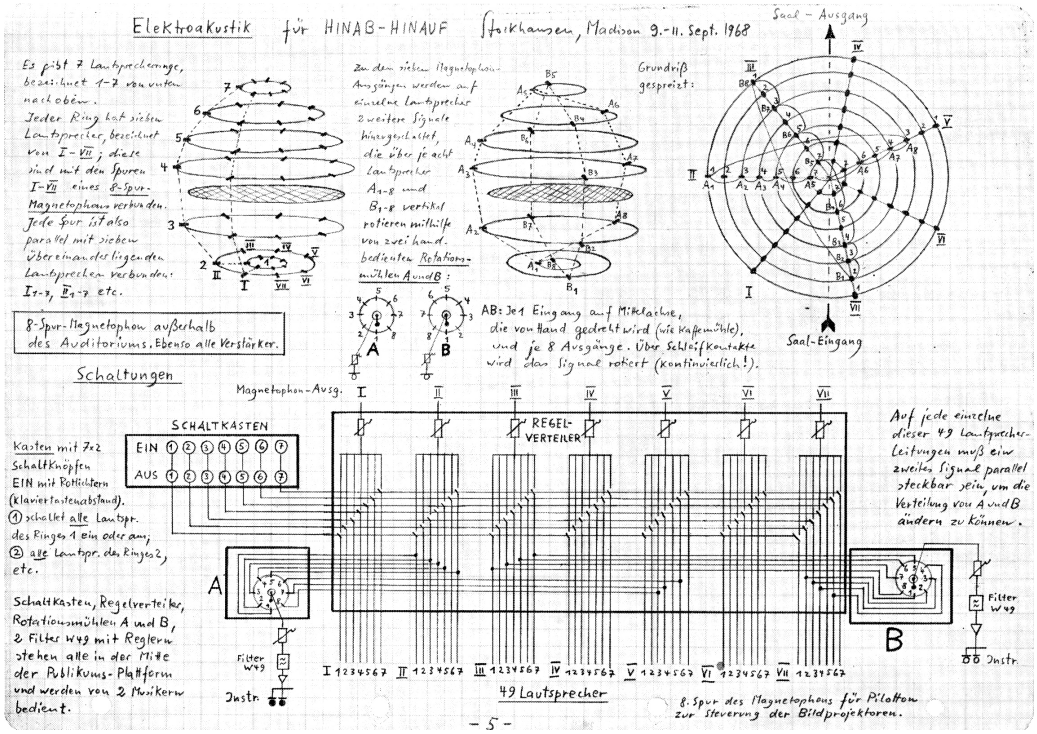

Figure 1: Texte III, p. 163 Sketches for *Hinab-Hinauf* (9-11 September 1968)[3, pp.155-169].

two example patches which allow the signal to be rotated in a vertical circle. This piece was never realised, and instead much of the programme of Stockhausen's works included structured improvisations such as *Kürzwellen*, *Spiral*, and *Pole*, which all use +/- notation and can be quite flexible in length and use of instruments.

3. THE TECHNICIANS

The contract for the technical infrastructure was awarded to Siemens after strong competition with Philips [4], and the design and construction of the light and sound control system was awarded to the Technical University, Berlin. Many features from Stockhausen's sketches are found in the eventual design, particularly the use of 7 main output channels, and loudspeakers arranged in 7 horizontal rings. However, instead of 7 speakers in each ring, the top and bottom two rings had 5 speakers with the middle 3 rings having 10 speakers each (see Fig.2). The net result gives more like 5 vertical channels rather than 7. The main floor was a metal grid, in theory acoustically transparent, but this was situated below the middle of the sphere so that the third ring of loudspeakers was very close to its circumference. Given Bornemann's use of a geodesic plan, the loudspeaker arrays were built as triangles to fit into the corresponding locations, with one octagonal sub-woofer array situated in the centre at the bottom of the sphere.[5]

The mixing desk was designed by Siemens and had 14 input channels (7 microphone channels and 7 line input channels) each switchable between multiple input sources, with 7 output busses, each with a high-pass filter and master fader, and an additional output bus with a low-pass filter and fader for the sub. The signal routing was done via a really flexible patchbay designed by the TU Berlin team comprised of Fritz Winckel, Manfred Krause and Claus Amberg, with several students from the TU working alongside them. Each of the 7 output groups could be patched to any combination of the 50 loudspeakers, either directly or via one of 10 groups of 5 "Tonmodulators". These Modulators were controllable either by signals recorded onto track 8 of the 8-channel tape machine, or by the Sensor-sphere built by the TU team which had a button representing each loudspeaker arranged on a small sphere. This meant that full remote control of audio was possible, either on playback of fixed media material or during live performance, or both at once. In addition to this, there was a so-called "Rotationsmühle" which was a rotary switch with one input and 10 outputs. This was wired up in parallel with the Sensor-sphere with each output controlling one of the 10 groups of 5 Tonmodulators. The Sensor-sphere allowed continuous control of volume by using a photocell and a button with 6 mm of travel, whilst the rotation mill simply switched the Tonmodulator on or off with one of two preset lag times of either 0.2 or 5 seconds to prevent clicks.[6]

4. PROBLEMS

Stockhausen kept copies of almost every letter he wrote and received, and these show good communication with Bornemann, and also with Siemens, who even provided him with a 1:1 scale blueprint of the mixing desk and patchbay. I was able to find very little correspondence at all with any members of the TU team, and this helps to explain some of the problems that arose during the Expo

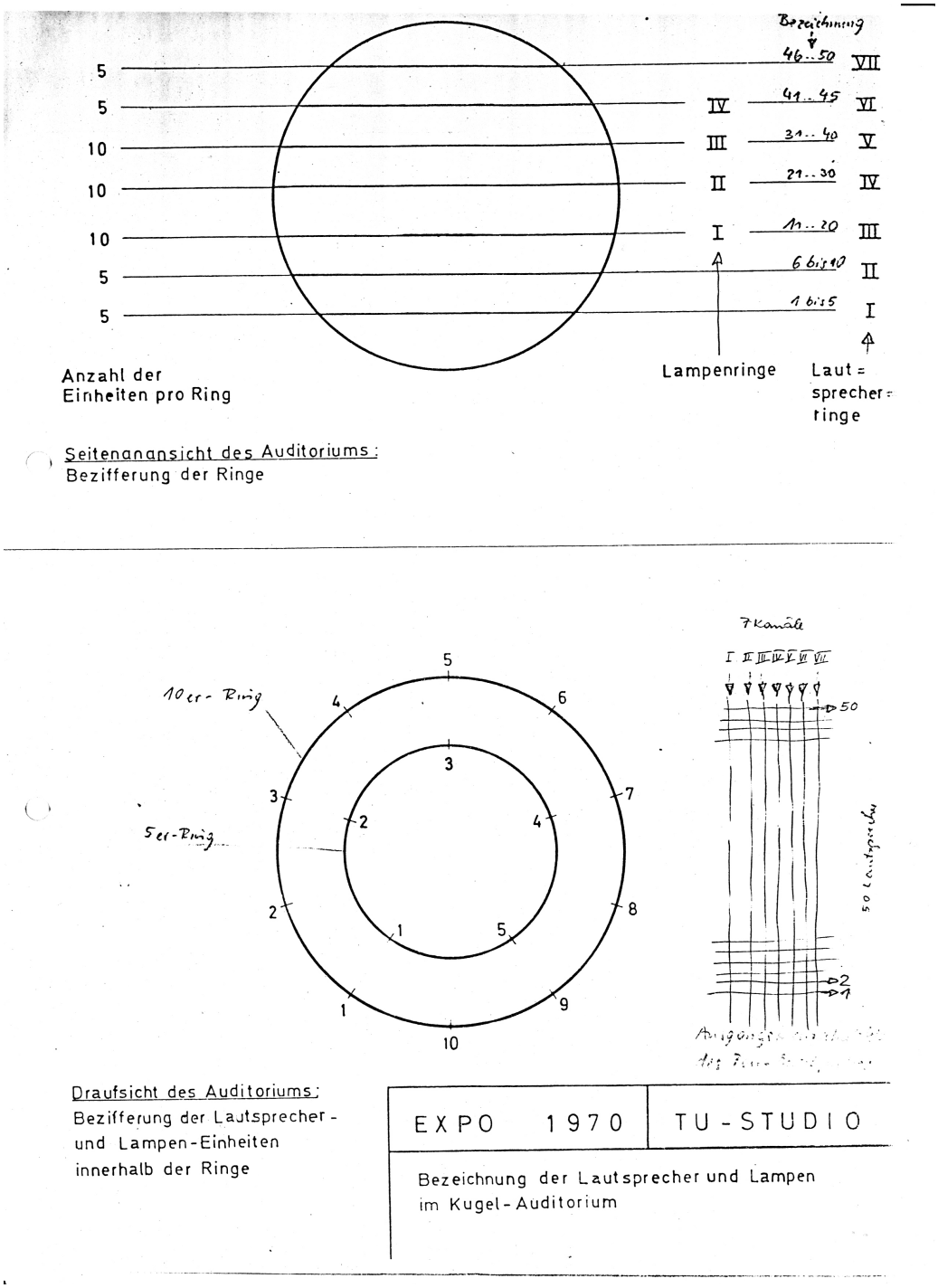

Figure 2: Technical document showing loudspeaker arrangement[6].

in Osaka. There is a document entitled *Technische Universität Berlin, Gruppe "Studiotechnik"* dated 23/6/69 and stamped with Fritz Winckel's stamp which contains a summary of Stockhausen's suggestions including the rotation mill,[7] so the TU group was aware of this at the same time as they were developing their Sensor-sphere. The significant factor is that the TU team seemed to develop the Sensor-sphere idea without any discussion with Stockhausen or the musicians who would be using the system for 6 months in 1970. No member of Stockhausen's ensemble appears in the photographs of the testing sessions or is referred to in any of the documentation.

4.1. Architectural Issues

In a letter dated 4th April 1970 Stockhausen reports several problems[8]. The inside of the dome was covered in a thick fabric finish which looked wonderful, but no allowance was made for the effect of this fabric when it was used to cover the loudspeakers as well. Naturally it massively attenuated the high frequency response of the speakers, so much so that Stockhausen notes that the only way to combat this problem was to use the EQ on each input channel of the mixing desk. They had to boost the high shelf EQ (fixed at 10 kHz) by 15 dB. The next problem was that the sub-woofers were very loud but focused their energy directly above their location so that people sitting in the middle of the seating area had much louder bass than those around the edges. The mixing desk platform was positioned near the edge of the sphere and consequently monitoring was very difficult. The balconies built for some of the musicians were too small and certain instruments simply could not be played from those positions. The platform for the mixing desk was very wobbly, making it almost impossible to play records without rumble, and it was situated right above the air conditioning system, thus making it very uncomfortable and a little noisy. There was no green room for the performers, and at one point due to heavy rain the basement area was flooded, necessitating the tape machines and other equipment to be raised on blocks.

Amberg observes that the 3rd row of loudspeakers situated just below the metal grating of the floor is so close to the audience that for those sitting near the edge of the space the sound collapses to these speakers immediately. For this reason, he says they should not be used. The first two rows of 5 loudspeakers are attenuated too much by the floor and the seated audience, so he suggests that these are moved closer to the audience to be heard.[6]

4.2. Technical Issues

The biggest compromise in terms of instruments was the choice to use the Siemens Filmton machines instead of a dedicated 8 track tape machine such as the Telefunken, the 3M or the Ampex, all separately suggested in various correspondence. The film sprocket machines were four-track devices and could be mechanically linked to play 8 tracks perfectly in time. However, they were very noisy, were limited to about 20 minutes per reel, took 2-3 minutes to change reels, and the tapes wore out very quickly, only lasting a 1-2 months each. At this time there were very few 8 track tape machines and it would have been necessary to have one in Osaka, and another at the TU in Berlin in order to make new tapes when necessary. At around DM 55,000 each, this was a significant expense that was ultimately not sanctioned. The sound quality was also not as good as the standard Telefunken tape machines. Since these were the machines used to playback music by the other composers (Blacher, Großkopf, Schoener, Zacher and Zimmermann) this gave the live music played by the Stockhausen Ensemble a distinct sonic advantage.

The problem of audio control was partly down to the design of the Sensor-spheres, which needed two hands for operation. If the sound projectionist took their hands off the sphere, for example to make an adjustment on the mixing desk, then the sound would be switched off. Another problem was the terrible grounding in the pavilion which made the switches misbehave, and seemed to significantly reduce the range of volume control.

One result of the problems with speaker placement was that the third ring of speakers (the 10 nearest the audience) were not used for the main audio, but were then available for the output of the Rotationsmühle, allowing the sound projectionist to rotate a sound around the audience. The problem with this was that the built-in lag time of the switch limited the speed at which sounds could be rotated. At the fastest setting of 0.2 seconds, one full rotation would take 2 seconds. Rotating the sound any faster would not allow the Tonmodulator to amplify the signal to unity gain before fading it back out. This also limited the sound projectionist from making any fast moves without the sound simply fading out of one speaker and then fading up in another, instead of moving along the path of adjoining loudspeakers. To vary the trajectory of movement meant re-patching the patchbay which was only practical between pieces.

Whilst Rolf Gehlhaar and David C. Johnson confirm that the Sensor-spheres were not really used, both remember the Rotationsmühle, with Gehlhaar referring to it as the “Kafeemühle”[9]. Unfortunately I have not found a single photograph and the eventual fate of much of the equipment from Osaka is unknown.

4.3. Ideological Issues

Despite featuring many fixed media pieces in 4 channels such as *Hymnen*, *Gesang der Jünglinge* and *Kontakte* there was a strong emphasis on live performance. The composed spatial elements of the fixed media pieces were limited to their four channels, albeit with the possibility of additional spatialisation by the sound projectionists - Gehlhaar, Johnson, or Maiguashca. The schedule was so intensive, however, to the extent that Gehlhaar had to change it from the original plan to avoid burnout, that there was little appetite for such additional performance practice when such fixed media pieces already included extremely well crafted spatialisation. The live pieces, however, could benefit from these techniques, and since many of them were structured improvisations, this allowed for a less constrained response from the sound projectionist.

Stockhausen made sketches of layouts and speaker routing for many pieces including *Hymnen*, *Stimmung*, *Telemusik*, *Kürzwellen*, *Aus den Sieben Tagen*, and *Spiral*, but there was little direction regarding the practice of sound projection making use of the potential for movement around the 50 loudspeakers in the dome, except for the instruction to use the Rotationsmühle for sounds routed around the 3rd ring of loudspeakers. The elaborate vertical panning rings from *Hinab-Hinauf* are absent in any of the working sketches for the Expo, and it seems that much of the burden of practice was placed on the musicians themselves.

This was perhaps a contributing factor leading to Fritsch, Gehlhaar and Johnson making the decision in July 1970 to leave the ensemble. The exchange of letters identify the chief problem as being the issues of authorship and creative ownership of the structured improvisations such as *Spiral* and *Aus den Sieben Tagen* (Stockhausen Archive letters REF), and it is telling that the musicians who split from the ensemble were also composers in their own right. Harald Bojè writes to Stockhausen telling him that he is happy to play such pieces in his role of performer/interpreter and does not share the concerns of the others.

From having interviewed Gehlhaar, Johnson and Michael Vetter, it is abundantly clear that Osaka was not an entirely positive experience. The nature of the project meant that the musicians were playing for many hours every day to a transient audience made up of many people simply coming to have a look at the space and to collect the stamp for their Expo book. The musicians had no proper green room and hardly any days off, and with no chance to rehearse and try out new techniques in the space. A comparison with the Philips pavilion in Brussels 1958 shows a similar time period for an audience, with each show lasting about 15 minutes including hearing Xenakis' *Concret PH* in the foyer and Varèse' *Poème Electronique* in the main auditorium. The afternoon session in Osaka featured pieces lasting 15 minutes with 5 minute change overs, and the pressure on the live performers would have been tremendous.

5. CONCLUSIONS

The spherical auditorium was something that Stockhausen had imagined as a perfect forum for his ideas of space music. The practical reality, however, was beset by architectural, technical, and social problems, many of which were impossible to avoid in a project of this scale devised in such a short time period. Despite the enthusiastic sketches for *Hinab-Hinauf*, the failure to realise a piece composed specifically to exploit all the potential of a 50 loudspeaker spherical array - something that he had dreamt of 12 years earlier - was uncharacteristic. Leaving most of the spatial performance practice to his musicians but without fully acknowledging their agency contributed to some less than positive feelings within the group. For Stockhausen, the project was wonderful publicity, representing West Germany on an international stage with the visitor figures cited as over a million[3, p.186], but the cost was high, especially with the break up of the Stockhausen Ensemble. The subsequent controversy about the multi-million Deutschmark cost for relocating the Spherical auditorium to Germany cast a shadow over the affair, and the result was that, like the Philips pavilion in 1958, the building was scrapped and most of the equipment was either lost or destroyed except for a few items that made it back to Germany.

With the move to 8-track and then 16-track tape that followed soon after, Stockhausen limited himself to more standard arrangements of loudspeakers, eventually returning to a 3d sound space by arranging 8 channels at the vertices of a cube. The spherical arrangement with direct sound sources would not be revisited, and it was not until much later in pieces such as *Octophony* (1990-91) and *Cosmic Pulses* (2007) that he would make significant use of mapping multiple trajectories of sounds through many different pathways between loudspeakers. The spherical auditorium was perhaps a step too far all at once, but by observing the varied use of space as a compositional element for both acoustic and electronic sounds throughout the *Licht* cycle, it is clear that the conceptualisation and reality of the spherical auditorium in Osaka had a profound and lasting effect on his practice as a composer.

6. ACKNOWLEDGMENT

The author would like to acknowledge the generosity of Rolf Gehlhaar, David C Johnson, Michael Vetter and Peter Eötvös who agreed to be interviewed; to the Stockhausen Stiftung für Musik, the Technische Universität Berlin, and the Siemens Archive for allowing access to archive material; and the University of Edinburgh which provides a wonderfully supportive research environment for this kind of work.

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