Documenting the Sound Projection of
aus LICHT

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2017–2019

The Royal Conservatoire, The Hague,
Netherlands

**MASTER'S PROGRAMME
AUS LICHT**

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1.0 Introduction

In May and June 2019, the most complete production to date of the opera cycle *LICHT* by Karlheinz Stockhausen (1928–2007) has taken place in Amsterdam, Netherlands. This production, called *aus LICHT,* was a collaboration between The Royal Conservatoire in The Hague, the Holland Festival and the Dutch National Opera. A master's programme called *Master aus LICHT* was developed at the Royal Conservatoire to train a new generation of musicians, including sound projectionists, who were taught to perform the works from the opera *LICHT* in the performance tradition of Karlheinz Stockhausen.

The aim of the master's programme was to allow a new generation of students to work on the *aus LICHT* production with, and learn from longtime Stockhausen collaborators with experience in previous productions of the *LICHT* opera. More importantly, it was an opportunity to document information gathered during the extensive rehearsal period from all parties involved in the production of the musical aspects of this opera. Since the musicians and sound projectionists were taught Stockhausen's *LICHT* opera cycle almost from the ground up, we as sound projectionists could witness the entire process, from preparation to performance, from the musical rehearsals where we could learn the music and search for the proper solutions to realise our role, to the final public performances.

This opportunity also presented a challenge, since there has not been much research done on ways of documenting sound projection in great detail. Finding a way to document and structure this knowledge became the research question for the sound-projection students. The initial approach was to collect as much information as possible, in order to update the information in the scores that have been collected by Stockhausen during the premieres and performances and to add details and information from this production. This did not only concern elements that came to light once the pieces had been performed multiple times and at different locations, with different musicians, but also differences occurring due to the changed technology since the original performances. Because of the enormous scale of the *aus LICHT* project, the scope of the research was limited to three works, although with the aim of emphasising information that is applicable to other works in the entire opera as well.

This research took place between September 2017 and July 2019, during the extensive rehearsal periods for *aus LICHT* as well as the actual performances. From November 2017 to April 2019, the rehearsals took place in The Hague, at the studio Licht aan Zee, as well as at the Royal Conservatoire in The Hague. From the beginning of May 2019, the rehearsals continued at the location of the performance, the Gashouder in the Westergasfabriek complex in Amsterdam.

This research has been conducted as a collaborative effort by Arne Bock and Marko Uzunovski, two of the master's students involved in the sound projection of several parts of the *aus LICHT* production.

1.1 Abstract

This thesis is the outcome of the research component of our master's study *aus LICHT - Sound Projection*.

The aim of this research was to document the available information that would come to the foreground while working with a group of experienced Stockhausen collaborators, each of them a specialist in sound reinforcement and/or sound-system engineering.

This information is captured in three case studies, which contextualise a set of keywords that were collected and defined during the 20 months of preparations and rehearsals (September 2017 to May 2019 in the "Licht aan Zee Studio" in The Hague), as well as the concert period (May 2019 to June 2019 in the Gashouder in Amsterdam).

One case study was written collaboratively, whereas two case studies were written individually by each of the sound projectionists involved in this research project. Each case study details one work or part of the whole programme. The thesis is concluded by reflective statements by each of the collaborators.

1.2 Relevance

Sound projectionists play an important role in the realisation of Stockhausen's works. According to Stockhausen, the role of the sound projectionists include:

> …*adjusting the loudspeakers using the loudspeaker test tape; positioning the cable microphones for piano and percussion; positioning the transmitter lavalier microphones on the instruments (sometimes with holders specially developed by Stockhausen over the years for optimal pick-up) and singers; following the movements of the performers onstage with pan-pots so that the amplified sound of their playing always comes from their position on stage; configuring the mixing console; and even lighting (which is part of the responsibility of the sound projectionist in most works).*[1]

He considered the role of the sound projectionist a musical one, rather than technical:

> …*a good musician, who can hear extremely well and who knows the works and how they should sound is just as qualified – or even more so in many respects – than someone with a general musical-technical training, provided they have a professional sound technician to assist them.*[2]

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1 Stockhausen Stiftung (2008), Sound Projection Course Basics. Hand-out Stockhausen Kurse, Kürten

2 Ibid.

There are a number of sound projectionists such as Kathinka Pasveer, Brian Wolf, Paul Jeukendrup, Jan Panis, André Richard, who have worked directly with Stockhausen and acquired the knowledge and experience to be able to project his works. After the composer's death they continue to perform his works, and when possible pass on knowledge to other sound projectionists.

Previously, this kind of knowledge was formalised at the premiere of these pieces, subsequent performances on productions around the world or at the Stockhausen Courses in Kürten. After the composer's death, such transfers of knowledge became less possible. In Kürten, Stockhausen's closest collaborators Kathinka Pasveer, Brian Wolf and Igor Kavulek organised a course in sound projection and gave an introduction to each piece before it was rehearsed and performed, explaining the challenges for the sound projectionist(s).

> *Kathinka Pasveer, who, for 25 years assisted Stockhausen in all realisations of his music in the Studio for Electronic Music of the WDR, at IRCAM, and in private studios; assisted in all mix-downs of his music; assisted him with the sound projection of all of his concerts world-wide.*
>
> *Bryan J. Wolf, who, since 1998, acted as Stockhausen's sound projection assistant in numerous concerts in Europe (including those of the Stockhausen Courses Kürten). He has travelled world-wide as sound projectionist of selected Stockhausen works and to help others learn the authentic sound projection performance practice of these works.*
>
> *Igor Kavulek, who, since 1998, has been Stockhausen's personal sound technician and who has travelled worldwide for concerts with Stockhausen. Making sure that the correct equipment was set up correctly and in time was always Igor's responsibility.*[3]

With this research we wanted to collect, organise and document the knowledge we gained from this project by producing a document that could form a basis of information for other sound projectionists, who would be interested in learning to project these particular compositions. This document could be seen as an update and an extension to the information already given in the scores. Even though this research project and the outcome of it focuses on Stockhausen's music, the way of collecting and organising this information, its interpretations and the reason to work in such a way, could also be useful to sound projectionists or sound engineers in general.

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[3] Ibid.

2.0 Main Research Questions

How to document the sound projection of *aus LICHT* beyond the score? What information to collect, how to interpret, organise, structure and present the knowledge so that it could be useful to future sound projectionists and other performers of Stockhausen's works?

2.1 Sub Questions

How can one collect information regarding sound projection, while also being required to fulfil his/her own role in the preparation of the performance?

What is the most relevant information for a sound projectionist when preparing a piece by Stockhausen?

How to get to the essence of the information acquired and to deliver this in a way that could be relevant for future productions in different venues and different musicians?

Can the information be documented in a way that is relevant for future productions of Stockhausen's music? Is it relevant for works by other composers?

3.0 Methodology

Compiling and defining a set of keywords is the main method in this research project. These keywords, and more specifically their definition, are derived during the rehearsal and performance period, whilst gathering information regarding the sound projection of Stockhausen's music.

The necessity of organising the information in a way that it could be shared made us look for solutions to classify the comments. Keywords turned out to be a good solution because we could use them to express what the comments were referring to.

The idea behind the keywords is that through collaboration and discussion between sound projectionists, an agreement can be made about their interpretation. In this way, their objectivity has been given more sense and context, and more subjective data can be obtained out of the project.

Information was gathered from the score from previous productions, from comments, from remarks, and from ideas that were discussed during this period. These discussions involved the sound projection students, their mentors Jan Panis and Paul Jeukendrup, the musical director Kathinka Pasveer as well as other people involved with the sound projection in the *aus LICHT* production such as Reinhard Klose, the system engineer.

This information was systematically collected, and while doing so, keywords were created and attached to each comment, remark or idea. Later on, the keywords needed their own structure and they were grouped into three categories, based on which part of the realisation of the performance they were referring to: technical, musical, or a combination of both.

Case studies were made in order to test how the keywords could be used in context. In these case studies, the knowledge collected is being presented through the use of the keywords relevant to the piece it's dealing with, whilst trying to capture the main essence about its sound projection.

A collection of technical information, technical drawings, equipment information etc. that were used for these performances are included in the "SP Master Files" documents attached in the appendices. Comments, remarks, ideas are collected in "Comments Sheets" documents that are also in the appendices. Short interviews were conducted with the above-mentioned supervisors. The interpretation of the keywords by the supervisors can be found in the appendices while the interpretation by the sound projectionists involved in this research project is shown in the following chapter.

4.0 Keywords

What follows is a list of keywords that we used to classify the comments. The keywords in this list were either used by our supervisors or colleagues to express a musical or technical remark, idea or note, or came to exist from our own questions.

After each keyword there is a short definition that came about as a result of lengthy discussions between the sound projectionists involved in this research, trying to specify what kind of situations these are applying to. As a further investigation of their meanings we asked some of the supervisors to give us their interpretation of the keywords without seeing our own or each other's definition of them.

The interpretation of keywords in the **sound reinforcement** category where generally agreed upon as well as the ones from **sound quality.** The keywords in the **sound balance** category were more easily misinterpreted.

For instance, the keyword **sound-source localisation,** which in our own words is defined as: "localising the amplified sound source at the origin of the sound-source position" was interpreted by Reinhard Klose as: "localisation of sound source according to visual" (hearing the sound from the player's position), by Kathinka Pasveer as: "hearing the sound from the spot where it is produced" and by Jan Panis as: "normally from the direction of the source". These wordings are close enough to make this a useful keyword for this particular situation. Also for **sound-source spatialisation** there was consensus by everyone. Our definition of it is: "placing the sound source at any given point in the listening space", the one from Pasveer: "moving sound sources in the space", Klose: "moving sound sources through the room" and the one from Panis: "putting sound sources (natural and amplified) in a 3D (actually, left/right, up/down, front/back) sound picture".

For **sound colour** there was an agreement as well with Klose: "changing sound by adding or remove special frequency ranges" and Panis: "balancing sub-low/low-mid/hi-mid/hi right". The same goes for **blend**, **direct/indirect**, **sound image / Klangbild.** Pasveer and Klose interpreted **sound detail** and **natural sounding amplification** as intended in this research project. The keywords like **blend** and **sound balancing** were confusing, and their interpretations were swapped by some. Other keywords were understood differently or not at all by everyone, such as: **intimacy**, **immersive metaphors, sound theatre, ensemble** or **sound size.**

This proved that some keywords are more commonly understandable, while others remain vague or misinterpreted if not used in the right context. This also highlights the importance of discussing the keywords as a way to make sure that all collaborators are talking about the same thing. Possibly, more research should be made in the future in order to standardise these terms when talking about sound. For the case studies we used the following interpretations of the keywords.

4.1 Keyword List

SOUND BALANCE (DRAMA)

- Sound Levelling: Create a consistent balance between the loudspeaker sound and the acoustic sound of the performers.
- Sound Detail: Ensure that precisely prescribed details in the score stand out in the balance.
- Sound Dramaturgy: Realise global volume movements, global dynamics changes or specific individual cues that need changes in dynamics.
- Sound Theatre: Use specific amplification techniques (such as filtering, reverb, etc.) to achieve or enhance a certain sound effect.
- Sound World: Types of sounds used, instrumentation.
- Sound Priority: Emphasise formulas, moments and solos, as indicated in the score.
- Sound Presence: Dynamic relationship between one or multiple sources and others.
- Intimacy: The feeling of proximity through the interplay of timbral and dynamic balance.
- Immersive Metaphors (terms that relate to the notion of being immersed in sound):
    - Image: The listener is surrounded with clearly spatialised sounds.
    - Curtain: Essential, localised sound events.
    - Carpet: Underlying sound/drone
    - Shower: Immersion without any clear localisation.
- Ensemble: How well the musicians can hear themselves within the entire performance space, good 'Ensemble' is obtained when the musicians can hear themselves well.
- Blend: Perceived as a mix between instruments and/or tapes.
- Timbral Polyphony: The ability to hear harmony regardless of timbre.
- Natural/Artificial Room Information: placing the sound source in a simulated acoustic environment that is different from the performance space.

SOUND REINFORCEMENT (SYSTEM)

- Natural Sounding Amplification: Use adequate equipment and mixing strategies to deliver the most accurate representation of the sound source relevant to the performance space.
- Sound Colour: The ability to realise the required timbral representation of a sound.
- Direct/Indirect: Place the listener in or outside of the sound-field propagation of the loudspeakers.
- Sound-Source Localisation: Localising the amplified sound source at the origin of the sound-source position.
- Spatialisation: Placing the sound source at any given point in the listening space.

SOUND QUALITY (GLUE) – WHEN DRAMA AND SYSTEM WORK TOGETHER

- Klangbild: Create the intended musical experience (Sound Levelling, Natural Sound Amplification, Sound-Source Localisation work together).
- Sound Size: Truthful representation of the instrument by means of amplification (Sound-Source Localisation, Sound Colour and Sound Level work together).
- Sound Layers: Foreground – Background, distribution of sound sources (Presence, Priority, Detail and Levelling work together).

5.0 Case Studies

As a prelude to the case studies, below follows a description of the sound reinforcement infrastructure for all pieces performed in the *aus LICHT* opera marathon as well as some more information about the space where it was rehearsed and performed. This information is necessary in order to get familiar with the environment in which this opera marathon has evolved so that the reader could have more context to understand the case studies, which are dealt with later on in this chapter.

5.0.1 Technical Setup

The main rehearsal period of the *aus LICHT* production took part between January and June 2019. Between January and April 2019, rehearsals where conducted in The Hague and from the beginning of May 2019, the production and rehearsals moved to the Gashouder in Amsterdam, which was also the performance location.

In the *aus LICHT* production we worked with two main stage areas, a front stage with a stage height of 1.20 m (this stage was referred to as the "Michael Stage") and a backstage, whereupon a staircase was built for Luzifer (this stage was referred to as the "Luzifer Stage"). Furthermore there are several sections where the performers move around in between the audience's seating area. This meant that audience chairs needed to be flexible and could be turned either towards the Luzifer Stage or facing the Michael Stage, and different aisles could be created through the audience's seating area.

The Gashouder is a historical building in Amsterdam. It was built in 1902 to store gas for the city's street lightning. The interior space is cylindrical and has a diameter of about 53 m and a height of about 15 m. In addition to the large volume, many reflective surfaces such as a concrete floor, a half-side brick wall and a ceiling constructed of steel, create a very reverberant space. As preparation for the performances, 25 cm thick sheets of *doscha*[4] wool were placed along the walls on advice of Jan Panis, who gained experience from many previous Holland Festival and DNO productions at the the Gashouder. Due to the doscha wool and other masking curtains, the reverb time became very low (approximately 1 sec.) and with the audience in the hall we had very few problematic reflections.

To accommodate for the many different works performed in *aus LICHT,* a sound system had to be designed that allowed for good intelligibility for the whole audience area as well as the flexibility to accommodate for the many different requirements of staging and surround sound that come with each work (see fig. 1).

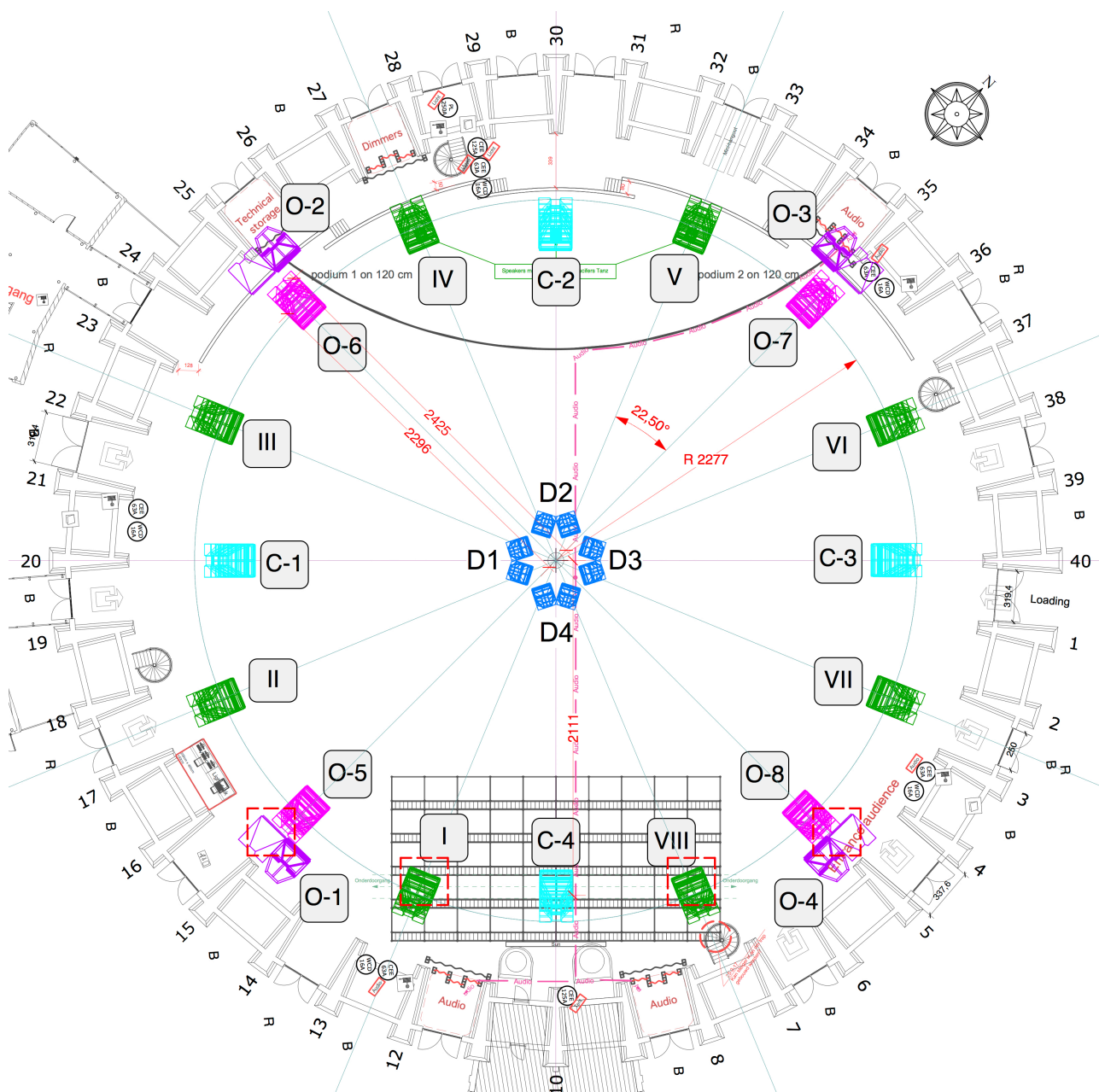[4] http://www.doscha.nl/blog/toepassing/akoestiek/, accessed May–June 2019

Fig. 1

Stockhausen has specified detailed information about the amplification of the acoustic and electronic instruments in most of his works. There is information in the score about microphones used for each instrument, their position, their arrangement in the mixer as well as the mixing and spatialisation techniques he used. Furthermore, there are also instructions on how to design the speaker system to better suit the sound he was looking for. Stockhausen worked with several sound engineers such as Brian J. Wolf, Igor Kavulek, Reinhard Klose and others, with whom he would make visits to each venue in order to determine the right speaker plan.

In the *aus LICHT* production at the the Gashouder in Amsterdam, a sound design was conceived by Igor Kavulek using a line-array loudspeaker system. This is not at all a common solution for Stockhausen's works, however, it was considered as a necessary solution because of the size of the space. All of Stockhausen's works were premiered, as indicated in the scores, using traditional 'point-source' loudspeakers such as the Meyer Sound UPA-1P. Because of ill health, Kavulek, who passed away in 2018, could not continue this project and the sound design was carried on and further developed by Reinhard Klose (see fig. 1).

As a basis, Igor Kavulek designed a system consisting of a circle of eight line arrays, hung at a height of 10.80 m and spaced evenly around the audience. Those were referred to with roman numerals and named speakers I – VIII (coloured light-green in fig.1). For pieces needing Stockhausen's octophonic speaker setup, additionally four 'corner' arrays where hung at a height of 13.70 m referred to as O5 – O8 and four 'corner' arrays that where stacked on the ground referred to as O1 – O4 (coloured purple in fig.1).

Later on, Reinhard Klose added four centre arrays, which were referred to as C-1 – C-4 (coloured green in fig.1). These were added for better clarity and flexibility.

Each array of speakers consisted of: 1 x d&b V-SUB[5], 3 x d&b V-8[6], 2 x d&b V-12[7].

Initially, a delay system consisting of six point-source speakers was also planned. After the first listening test in the Gashouder it was clear that these were not necessary, so they were changed into a centre octagon cluster aiming outwards, containing of 4 x 2 speakers, to be used for supporting sound sources when located in the centre of the hall. These speakers are d&b V7P[8], referred to as D-1 – D-4.

In The Hague, the rehearsals were conducted in the Zuiderstrandtheater's office building, which apart from office rooms also has a large rehearsal space. The rehearsal space was nicknamed *Licht aan Zee* and mostly referred to as LaZ. For convenience, from now on, in this document this rehearsal space will be referred to as LaZ.

LaZ is a shoebox-type hall but with a rather low ceiling, and significantly different from the Gashouder. The dimensions of the room are: length 29.5 m, width 18 m, height 7.5 m (approximate measurements). Sidewalls were covered with black theatre curtain, resulting in a

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[5] https://www.dbaudio.com/global/en/products/series/v-series/v-sub/, accessed May–June 2019

[6] https://www.dbaudio.com/global/en/products/series/v-series/v8/, accessed May–June 2019

[7] https://www.dbaudio.com/global/en/products/series/v-series/v12/, accessed May–June 2019

[8] https://www.dbaudio.com/global/en/products/series/v-series/v7p/, accessed May–June 2019

short reverb time, however, the space did have a considerable buildup of frequencies in the lower range.

To minimise the transition difficulties from LaZ to the Gashouder it was decided to use the same equipment for both rehearsals and performances, except for the loudspeaker systems. A loudspeaker system was designed for LaZ mirroring the loudspeaker setup in the Gashouder. Instead of speaker arrays, point-source speakers where selected (L-Acoustics X12[9]). A truss structure was placed in LaZ wherein the speakers could be hung at a height of 5.5 m. The subwoofers (L-Acoustics SB15[10]) could not be hung and were placed on the ground.

The size of the performance space in the Gashouder is significantly larger than LaZ. In LaZ we had problems with the buildup of low frequencies resulting in, at times, difficulty to hear details in the music. Furthermore, due to the small space and low ceiling, the sound level was in general too high. Many instruments were loud enough without amplification whilst other, softer instruments were easily covered and needed support. Those were problems not present in the Gashouder. In the Gashouder, depending on the lay-out of each work, the mixing desk was about 35 m away from the musicians and every instrument now needed considerably more amplification. Due to the acoustical damping of the Gashouder we had a lot of tonal and volume control, however, at times the space seemed almost too dry and more acoustical reverberation could have been helpful in some works.

Considerable time was needed, not only to adjust to the different sound environment, but also for adjusting the staging, due to the much larger performance space in the Gashouder.

In the Gashouder, Klose was the system designer. It was his task to do the primary system tuning: he took care of delays and equalised the system, which gave the sound projectionists a very balanced sound system and freedom to colour for artistic purpose.

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[9] https://www.l-acoustics.com/en/product/x12/, accessed May–June 2019

[10] Â https://www.l-acoustics.com/en/product/sb15m/, accessed May–June 2019

5.1 Case Study I – *Invasion-Explosion mit Abschied*

For octophonic electronic music, 6 trumpets, 6 trombones, 2 synthesizers (1 so-called Synthi FOU[11]), 2 percussionists, 1 flugelhorn and 3 vocal soloists (soprano, tenor, bass)

Act 2 of *Dienstag aus LICHT*   1990–1991 (74')

Fig. ©Foto Ruth & Martin Walz

5.1.1 Introduction

The personae in a staged performance according to the score are:

MICHAEL troop:
Tenor
Three trumpeters (The first also plays quarter-tone flugelhorn)
Six tutti trumpeters (ad lib.)
One synthesizer player
One percussionist

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[11] In *LICHT*, the name Synthi-FOU is used for a character, a musical instrument or a section. In this text, Synthi-FOU is written in double quotation marks only when there is a reference to the section.

LUCIFER troop:
Bass
Three trombonists
Six tutti trombonists (ad lib.)
One synthesizer player
One percussionist

EVE Soprano

Synhti-FOU

Sound projectionist (in the centre of the hall)
Electronic Music (8-track tape)

The structure of *Invasion-Explosion mit Abschied* is as follows:

Order	Part	Elements
1	1st AIR DEFENSE (Luftabwehr)	Tape
2	1st INVASION	Musical battle between two troops
3	Calm (Ruhe)	Tape
4	2nd AIR DEFENSE	Tape
5	2nd INVASION	Musical battle between two troops
6	Casualty (Verwundung)	Tape
7	PIETÀ	Soprano and Trumpet Duo
8	3rd INVASION	Musical battle between two troops
9	EXPLOSION	Musical battle between two troops
10	BEYOND (JENSEITS)	Synth Solo
11	SYNTHI-FOU as KLAVIERSTÜCK XV	Synth Solo
12	FAREWELL (ABSCHIED)	Synth Solo

The two troops of musicians are moving on stage and within the audience while performing.

During the entire performance, an eight-channel tape is being played through Stockhausen's octophonic speaker setup, which was first developed for his electronic composition *Oktophonie*.

Between the second and third Invasion there is one duet with soprano and flugelhorn and after the third Invasion there is a solo with a synthesizer player called Synthi FOU.

According to the score, amplification is necessary for two electronic percussion instruments, two synths, bass, tenor, flugelhorn, soprano, a synthesizer solo Synthi FOU and of course the tape playback.

5.1.2 List of Keywords Relevant for this Piece

SOUND BALANCE (DRAMA)

- Sound Levelling: Create a consistent balance between the loudspeaker sound and the acoustic sound of the performers.
- Sound Detail: Ensure that precisely prescribed details in the score stand out in the balance.
- Sound Dramaturgy: Realise global volume movements, global dynamics changes or specific individual cues that need changes in dynamics.
- Sound Theatre: Use specific amplification techniques (such as filtering, reverb, etc.) to achieve or enhance a certain sound effect.
- Sound Priority: Emphasise formulas, moments and solos as indicated in the score.
- Sound Presence: Dynamic relationship between one or multiple sources and others.
- Intimacy: Create a feeling of proximity through the interplay of timbral and dynamic balance.
- Immersive metaphors (Terms that relate to the notion of being immersed in sound):
    - Image: The listener is surrounded with clearly spatialised sounds
    - Curtain: Essential localised sound events
    - Carpet: Underlying sound/drone
    - Shower: Immersion without any clear localisation
- Ensemble: How well the musicians can hear themselves within the entire performance space, good 'Ensemble' is obtained when the musicians can hear themselves well
- Blend: Perceived as mix between instruments and/or tapes.
- Timbral Polyphony: The ability to hear harmony regardless of timbre.
- Natural/Artificial Room Information: placing the sound source in a simulated acoustic environment that is different from the performance space.

SOUND REINFORCEMENT (SYSTEM)

- Natural Sounding Amplification: Use adequate equipment and mixing strategies to deliver the most accurate representation of the sound-source relevant to the performance space.
- Sound Colour: The ability to realise the required timbral representation of a sound.
- Direct/Indirect: Place the listener in or outside of the sound-field propagation of the speaker.
- Sound-Source Localisation: Localising the amplified sound-source at the origin of the sound-source position.
- Spatialisation: Placing the sound-source at any given point in the listening space.

SOUND QUALITY (GLUE) - WHEN DRAMA AND SYSTEM WORK TOGETHER

- Klangbild: Create the intended musical experience (Sound Levelling, Natural sound amplification, Sound-Source Localisation work together).
- Sound Size: Truthful representation of the instrument by means of amplification (Sound-Source Localisation, Sound Colour, Sound Level work together).
- Sound Layers: Foreground – Background, distribution of sound sources (Presence, Priority, Detail and Levelling work together).

5.1.3 Tape Playback

For playing back the tapes during performances we used the computer program Qlab[12] because of its stability and reliability, however, during the rehearsal period it was more useful to have markers that relate to the tracks in the score in order to start anywhere in the score. For this reason the computer program Logic Pro X was used during the rehearsals instead.

The score for *Invasion-Explosion mit Abschied* contains two eight-channel tape playback files as well as one two-channel tape playback file for the part that is called "Brücke". These needed to be triggered (i.e. started, paused or stopped) by the sound projectionist or co-pilot (assistant operator). The first eight-channel tape runs from the very beginning, while the stereo tape is used as a bridge during "Pietà". The second part of the eight-channel tape is also started by the sound projectionist during "Pietà" while the stereo tape is being faded out. The tape was projected over the designated *Oktophonie* speakers O1–O8 as well as subwoofers S-O-1–S-O-8.

It is worth noting that during rehearsals, the stereo tape file with the click track / counting was also used for practicing with the musicians. The sound projectionists need to be able to switch between the *Oktophonie* and the stereo click track as well as having markers for the track numbers to facilitate the rehearsals.

5.1.4 Instrument Design

This piece had not been performed since it was premiered in the Leipzig Opera in 1993, so the instruments used were hardly available and furthermore, an update of the setup was necessary with a more recent technological solution in order to give freedom to the synth and percussion players to move without them being wired to the mixer or power. Hence for this performance new instruments were designed. New sounds were created from scratch for the two synthesizer and percussion players who performed on mobile instruments: two keyboards and two modified marching snare drums.

Fig. 2

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[12] https://figure53.com/qlab/, accessed May–June 2019

The synthesizers where made mobile by adding a battery loudspeaker to amplify them locally and using 10" MacBook Air laptop computers that could fit under the speakers. Roli Seaboards[13] were chosen for the synthesizer players to get a better realisation of the score than in earlier performances, using the five-dimension touch-control possibilities of the Roli Seaboard. To be able to use this feature of the Seaboards, new sounds had to be created and these were done using Roli's Equator synthesizer running on the MacBook Air computers (see fig. 2).

The percussion players, who also had a battery-powered speaker, used two Keith McMillen Bob Pad controllers to trigger samples. These controllers were connected to two Raspberry Pi mini computers that had a custom-developed sampler in Pure Data software to deal with the samples (see fig. 3). Each Raspberry Pi was powered by a power bank, and an Arduino microcontroller board was used to show the number of the section where the percussionists were in. All of this was hidden in a modified marching snare drum. The new presets and sounds for all four instruments were designed based on the score and the sounds needed.

Fig. 3

For "Synthi FOU", a new set of controllers and synthesis methods were used as well. For the solo synth part, another Roli Seaboard keyboard was used together with Arturia 61 and Arturia 88 MIDI keyboards as well as two Bob Pad controllers for sample triggering (see fig. 4). Pedals were used to change patches, and in these patches, different configurations of the keyboards were used to control various synths in Apple's MainStage software. A lot of sounds were multi-layered by using multiple virtual synths.

5.1.5 Sound Equipment

Following the score, amplification is necessary for the following performers: bass, tenor, flugelhorn, soprano, Synthi FOU and tape playback.

The two electronic percussion instruments and two synthesizers were originally amplified only locally. During the rehearsal period, it was decided that these instruments should also be amplified on the PA, as well as locally through the portable loudspeakers.

Fig. 4

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[13] https://roli.com/products/seaboard, accessed May–June 2019

5.1.6 Spatialisation of Sound Sources

A solution was needed to accommodate the **spatialisation** and **sound-source localisation** of the musicians in the "Invasions", in particular the bass and tenor singer. Later this turned out to be necessary for the percussionists and synth players as well. It was decided to use the SPAT Revolution[14] software developed at IRCAM[15]. A drawing of the loudspeaker system was made in SPAT Revolution that could be adapted between rehearsal space and performance space with the specific dimensions. It allowed us to move sources horizontally or vertically sent from the mixer (signals from the microphones) using the Open Sound Control (OSC) protocol. We used an iPad with an app called Lemur[16] to move the signals of the tenor, bass, percussionists, synths and Synthi FOU and send them back to the mixer as a number of discrete signals, depending on the speaker setup in SPAT Revolution. During the rehearsals in LaZ we designed a system based on the speaker setup and we used eight discrete channels to go to the eight speakers of the *Oktophonie* cube setup. In De Gashouder a new design was made for SPAT Revolution, including all the 16 line-arrays in the upper circle of speakers. In this way we had a more precisely defined spatialisation of the sound sources.

5.1.7 Transforming *Invasion-Explosion mit Abschied* from Rehearsing in LaZ to the Gashouder

As mentioned previously, the acoustical and staging area properties between LaZ and the Gashouder where very different.

Due to the smaller staging area in LaZ, the effect of indirect projections of the brass instruments did not have a huge influence on the total **blend** and **timbral polyphony** of the piece. Also the overall volume with so many acoustic sources soon became rather high, which also resulted in an undefined sound picture, where **ensemble** would become problematic. The sound projectionists had to be very aware not to raise the general dynamics either by amplifying singers or tape too much, resulting in long and ear-tiring rehearsals.

Upon moving to the Gashouder, we found ourselves in a rather different situation where the overall volume was a lot quieter and indirectness had a big influence on **ensemble** and **timbral polyphony.** We were not sure how the brass would sound acoustically in such a large performance space, but after considering amplification it was decided by Pasveer that no amplification was necessary for the instruments. Although the sound was **direct** for parts of the audience whilst

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[14] https://www.flux.audio/project/spat-revolution/, accessed May–June 2019

[15] https://www.ircam.fr/innovations/collections-de-logiciels-et-de-bibliotheques-dechantillons/, accessed May–June 2019

[16] https://liine.net/en/products/lemur/, accessed May–June 2019

being **indirect** for others**,** and the **timbral polyphony** was not always stable, this was an acceptable compromise.

However, several sources that did not need amplification in LaZ now always needed a minimum of support in the Gashouder. While in LaZ we only amplified synth and percussion in their respective solos, in the Gashouder we always had to have some support in order for them not to become inaudible.

There was a big difference between the sound system used at the two locations. As explained before, rather than point-source speakers pointed not directly at the audience as we had in LaZ, in the Gashouder we had a line-array system that did not only have much more presence and added clarity, but also had a more even coverage throughout the entire audience area. In this way we had better projection possibilities for the tape material as well as for the instrument amplification. The tape had more clarity and a lot of detail, which was important for the musicians since they needed to hear the cues. We had more headroom for the voice amplification and we could improve the **sound-source localisation.** The only compromise was, since the staging area was so large, that the voices needed extra support on the centre octagon cluster or *D-1–D4*, which compromised the **sound-source localisation** but improved **sound detail**.

Invasion-Explosion mit Abschied had an advantage compared to some other pieces in *aus LICHT*, since it was already performed in the Dutch National Opera and Ballet in 2018 during the *aus LICHT Preview*. Fortunately, musicians knew the piece well by then and despite being in an acoustically different environment that presented more challenges in getting the cues from the tape or each other, they still managed to keep the performance on a good level since they were used to perform in acoustically different spaces.

The staging of *Invasion-Explosion mit Abschied* places the performance space in the audience area. The musicians are performing by moving through designated paths through the audience. This has posed the first and most important question regarding amplification: what should and shouldn't be amplified? The score informs us that for the premiere, the bass, tenor, flugelhorn, soprano, Synthi FOU and tape were amplified. This was also our departure point. Additionally, the preface of the score informs us that the synthesizer and percussion players may be amplified not only locally but through the PA system as well. This proved to be necessary in our case in order to attain better **blend** with the brass players, which acoustically had a better projection.

The score of *Invasion-Explosion mit Abschied* is

Fig. 5

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organised in 'signal numbers' (attack sounds from each player group) rather than in bar numbers. Furthermore, there are indications of the track numbers that relate to the tape part of *Oktophonie* (see fig. 5).

In the score there are many indications for **sound detail**. For instance at signal #1, at the very beginning, one can already see the symbol indicating plus (see fig. 6). This is an important resource for the sound projectionists, since these are crucial moments in the score where the sound projectionists need to take these indications into consideration and make sure that the part that is indicated is audible at the dynamic levels indicated. At signal #10 the bass singer should be in the centre so that he is heard from all loudspeakers; he needs a lot of amplification to stand out in this signal.
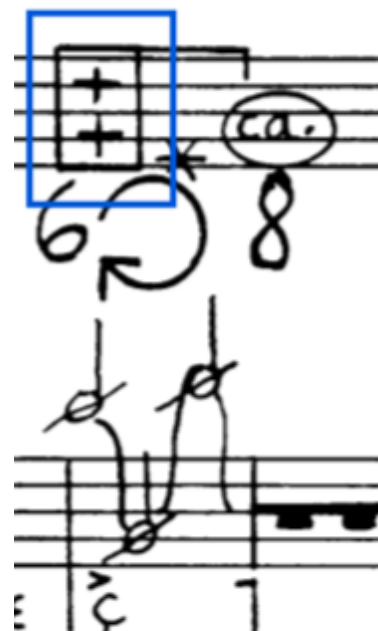
Fig. 6

As mentioned in the instrument-design chapter earlier, new sounds and presets were created for synths and percussion players. Although these was prepared meticulously and with a constant volume output on their local speakers, a lot of time was spent on modifying sample and preset volumes per signal to obtain good **blend** and **ensemble** throughout the piece. However, during rehearsals in The Hague it was decided to give them additional support during their solos (see appendix "comments sheet *Invasion - Explosion mit Abschied*" - comment #2).

The singers, synth and percussion instruments were projected using SPAT for **spatialisation** in the upper circle of speakers I to VIII, C-1 to C-4, O-V to O-VIII, following their exact position during the performances to realise an optimal **sound-source localisation**. Initially, for the synths and percussion instruments, amplification support was given only in their solo parts. This decision was supported by Kathinka Pasveer (see appendix "comments sheet *Invasion - Explosion mit Abschied*" - comment #1).

Because the **spatialisation** was more complicated and required more continuous control by the sound projectionist it was decided that an assistant sound projectionist would help by following the movement of the performers who were amplified in the "Invasions". Additionally, the assistant did the rotations of the bass and tenor singers indicated in the score as well as **spatialising** the sources of the Synthi FOU signals.
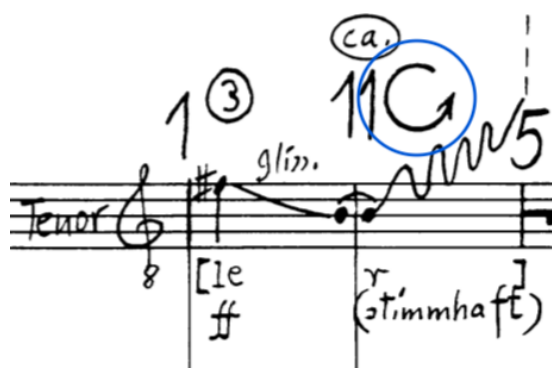

Fig. 7

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However, this situation needed to change after moving from the rehearsal space to the much larger Gashouder. It was soon decided that it was necessary to constantly amplify both percussion players and both synth players through the SPAT revolution software, while still adding additional support for their solos to maintain good **sound priority**.

Also, in the score, indications for **spatialisation** can be found for the bass and tenor singers (see fig. 7), in particular with the parts of the tenor and bass singers where their sound needs to rotate in the hall.

Upon moving to the Gashouder, another remark by Kathinka was about the fact that the **sound detail** of the singers was weakened, so we needed to add their signals also to the centre cluster. This improved **sound detail** but compromised slightly the **sound-source localisation** and **spatialisation** (see appendix "comments sheet *Invasion - Explosion mit Abschied*" - comment #9 & #10).

For optimal **sound levelling,** the produced dynamics of the tenor, bass, synths and percussion had to be followed continuously by correcting them on the faders (see appendix "comments sheet *Invasion - Explosion mit Abschied - comment #7*). It's quite important that all the musicians can hear the voices of the tenor and bass. To achieve good **sound theatre,** during the rotation/ **spatialisation** of the bass and tenor voices, extra support was necessary on the system as the amplified sound was rotating instead of being localised where the acoustic sound was. Because the tape was to be played quite loud in the hall, they are to be amplified at a level at which they are always audible, as well as giving extra accent to enhance **sound detail** where indicated in the score. Good **blend** for this must be found during the rehearsal period, supporting good **sound priority** between singers, synths and tape. This is also essential for achieving good **ensemble**, considering that some musicians have to cue others as well as listen for cues in the tape.

In "Pietà", amplification of the flugelhorn and soprano needs constant and precise **sound levelling** to bring about the proper **Klangbild.** In "Pietà", **intimacy** is an important part of the desired **Klangbild**: the listener should get a closely intimate connection with the music. This is achieved when the sound of the flugelhorn and soprano are reproduced as accurately as the sound source. The **natural sound amplification** and the **sound size** of the duet should be as truthful as possible, so they don't appear too big or too small. As a consequence thereof, a choice was made not to use any **artificial room information.** If reverb was to be used it would create distance, and **intimacy** would have been reduced or lost. In terms of **sound-source localisation,** the amplified sound of the flugelhorn and soprano should appear as if it was coming from the same point of the acoustic source and not spread too wide. When all this is achieved we would get the desired **Klangbild (**see appendix "comments sheet *Invasion - Explosion mit Abschied*" - comment #6).

Other indications in the score listed that the channels 5 – 8 from the tape, going to the upper four speakers O-5 – O-8 (in the octophonic cube), were to be played louder by 6 dB. This was tested and it was decided to leave it this way. This comes as no surprise since the upper speakers are further away from the audience compared to the lower speakers. The tape is to be played quite

loud in the hall in order for the audience to feel immersed in the sounds of the bombs, airplanes and other, electronic sounds. Since the brass does not need to be amplified, a good balance needs to be found between the non-amplified sounds and the tape. The musicians need quite some cues that come from sounds from the tape but they also need to cue and hear each other, so this needs to be taken into account.

The octophonic tape in *Invasion-Explosion mit Abschied* is particular in the sense that its role, as well as its different immersive characters, change throughout the whole piece. Preceding the "First Invasion", the tape opens the performance with "First Air Defence", with an **immersive carpet** character transforming into an **immersive curtain** that is moving closer to the audience. Soon after, the listeners find themselves immersed in a more **immersive picture**. This effect is achieved by starting the octophonic tape on a sufficient, somewhat louder **sound level.** Throughout the "First Invasion", "Second Invasion" and "Third Invasion", the sound projectionist should closely be aware of the **sound layers**. For example the 'bombs' in the tape (see fig. 7), as specified in the score, should be brought out to create a better **sound dramaturgy**. However, the **sound presence** of the tape needs to be brought back after these accentuated parts, after which the tape returns to an **immersive curtain** character to leave room for the un-amplified musicians performing their solos. Pasveer additionally highlighted this during rehearsals in The Hague (see appendix "comments sheet *Invasion - Explosion mit Abschied"* - comment #4). These accentuated parts furthermore serve as cues for the musicians, who are performing by heart.

After the "Second Invasion", in order to realise the **sound dramaturgy,** the tape is faded out to create room for the flugelhorn and soprano and it remains in the background as an **immersive carpet**. In "Pietà" bar number 32, the "Brücke" stereo tape is started and layered on top of the other tape, while still acting as an **immersive carpet** and not disturbing the duet. As Kathinka mentioned, the tape should fill the room and immerse the hall in sound but not cover the soprano and flugelhorn (see appendix "comments sheet *Invasion - Explosion mit Abschied"*- comment #5). At the end of "Pietà" bar number 85 the second part of *Oktophonie* is started with more **sound presence,** and the **immersive carpet** character of the tape turns into one of an **immersive picture**.

After "Pietà", in the "Third Invasion" the tape takes the same role as in the first two "Invasions". At the end of the "Third Invasion", a synthesizer player, referred to as Synthi FOU, starts his solo and plays in the following two sections "Jenseits" and "Synthi FOU". During these two sections, the tape is not so much in the background anymore but is again, together with the synthesiser sounds, turning into an **immersive picture.**

The sounds of the synthesizer during "Jenseits" and "Synthi FOU" are also **spatialised**. During the rehearsal period it was pointed out by Pasveer that the stereo signal from Synthi FOU should be **spatialised** in SPAT as two mono sources separately, (see appendix "comments sheet *Invasion - Explosion mit Abschied"*- comment #11). The **spatialisation** of the two mono sources was improvised as it was done in the premiere (see fig. 8) and practiced during the rehearsal period. We had control over the left and right channel (left and right hand in the score) to be able to **spatialise** the synth sounds within the upper circle of line arrays. In "Jenseits" this was done

slowly in circular movements in one direction only, with one hand localised at the opposite of the other, while in "Synthi FOU" this was done in a more free and improvised way. The left and the right channels were still opposite to each other most of the time, but also changing speed and direction of rotation. Other free movements were used rather than just rotations, moving in any direction in the performance space.
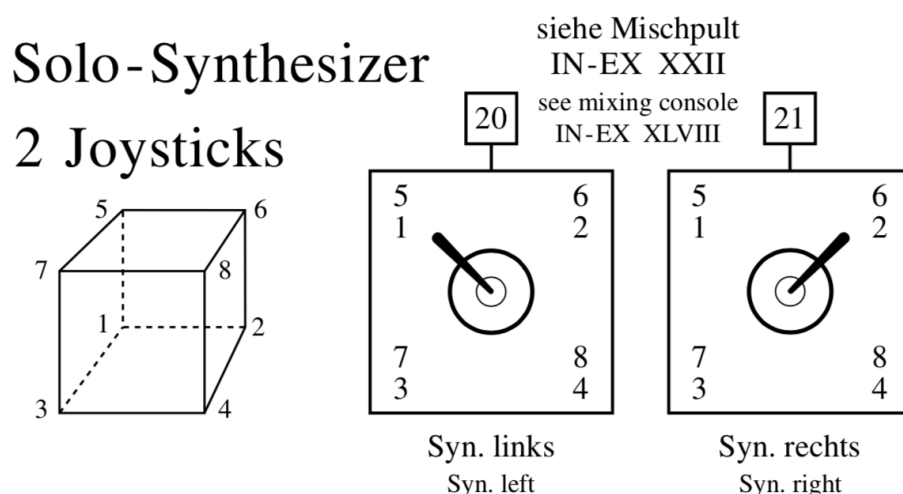

Fig. 8

5.1.8 Reflections

Invasion-Explosion mit Abschied gives a very **immersive** experience to the audience, since the players are performing within the audience, eliminating the boundary between stage and auditorium. The tape is crucial to the **immersive** experience and, as mentioned earlier, takes different **immersive** roles.

The stage settings present a challenge in terms of amplification: due to the lack of possibility of **levelling** of the acoustic instruments, sometimes **sound presence** is sacrificed. However, we achieved a very successful musical theatre experience.

The role of the sound projectionist is to find the right **blend** between the tape, amplified signals and acoustic instruments while not compromising the **immersive** character of the piece. The right **sound priority** should be maintained to realise the **sound dramaturgy**. Musicians should be able to hear the tape clearly as to always maintain good **ensemble.**

Due to the extensive rehearsing of this piece, the performers were very stable upon entering the actual performance space, the Gashouder in Amsterdam. In the rehearsal period in LaZ we were constantly faced with dynamic issues due to the restricted size of the rehearsal area and the low ceiling. The acoustic sound of the many brass instruments was very loud, even when they played piano, which influenced the quality of **ensemble, blend** and **sound detail.** As sound projectionists we were left with little dynamic room to create **sound dramaturgy,** and at times the tape would

lose its **immersive** character. This was very predictable and it was to be expected that we would encounter a very different acoustical situation upon starting rehearsals in the Gashouder.

De Gashouder brought other challenges along: general loudness was no longer a problem, but due to the immense performance space, and since not every instrument was amplified, **sound indirectness** and **presence** had a big influence on **ensemble**, **blend** and **timbral polyphony.** Since *Invasion-Explosion mit Abschied* has a very large **dramaturgy** with many moving sound sources, much time was spent for the performers to accommodate to this new situation.

Those are compromises that were accepted due to the **immersive** character of the performance. Also the sound system was very different in the Gashouder compared to LaZ. The line-array system in the Gashouder could accommodate much better for the sound character and quality of the tape, as well as for the amplification of instruments. This resulted in better **natural sounding amplification,** improved **direct amplification** and heightened **sound-source localisation**. As sound projectionists we felt we had to re-find levels for **sound dramaturgy** and **sound levelling** in the Gashouder. Being familiar with the music and artistic vision from previous rehearsals gave us better insight in the **sound quality** needed for *Invasion-Explosion mit Abschied* and prepared us for this task.

Despite previously mentioned compromises, **Klangbild** was hugely improved in the Gashouder compared to LaZ and the performance in the Gashouder as a whole was a big success.

Arne Bock, Marko Uzunovski

5.2 Case Study II – *Kathinkas Gesang als Luzifers Requiem*

For Flute solo and 6 Percussionists

2nd Scene from *Samstag aus LICHT*

1982–1983 (33')

© Foto Ruth & Martin Walz

5.2.1 Introduction

In *Kathinkas Gesang* (Kathinka's chant), a flute player masked as a cat performs 24 stages as a ritual to Lucifer's dead body. These 24 stages are made out of 22 exercises and 2 pauses that are based on fragments from the "Lucifer formula" and their attributes such as rhythmic modulation, toneless pitches, tremolo rhythms and melodic movement. The exercises have various lengths, ranging from 22 seconds to 4.5 minutes.

Six percussionists accompany the flute player and represent the six mortal senses: Sight, Hearing, Smell, Taste, Touch and Thinking. The percussionists play sound plates, whistles and 'magical' instruments made out of various percussion elements or found objects, which mostly hang on their bodies or costumes. They develop these instruments during the rehearsal period to find
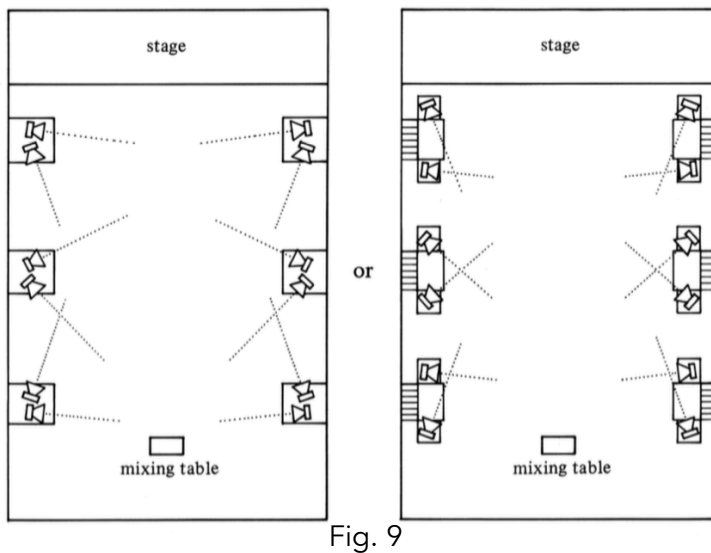
Fig. 9

appropriate sounds according to the instructions in the score.

The flute part contains extended timbral flute techniques including toneless blowing, flutter-tonguing, double-or triple-tonguing, vocalisation, microtonal fingering, and dynamic accents and figures. The flute performs on stage in front of the audience while the percussionists are distributed three and three on both sides of the audience (see fig. 9). On stage there are two big circular mandalas, each containing twelve exercises (see fig. 10). After playing a short "Salut" in the centre, the flute player walks to the left mandala where she plays exercises one to twelve. When done with the twelfth exercise, a part called "Vertauschung der Sinne" follows, where she leaves her flute in the middle of the stage and walks to the percussionists and changes some of their plates. During this event, the percussionists play their whistles. Next, the remaining twelve exercises at the right mandala take place. These are followed by a part called "Die Entlassung der Sinne" where the flute player releases each of the senses/percussionists, one by one. They walk from their positions to the front stage where they release their sound plates and disappear. The scene continues to an "Ausweg" where the flautist uses her voice while playing, and this is followed by "Die 11 Posaunentöne" when she is supposed to play trombone-like sounds and ending with "Der Schrei" or the final scream.
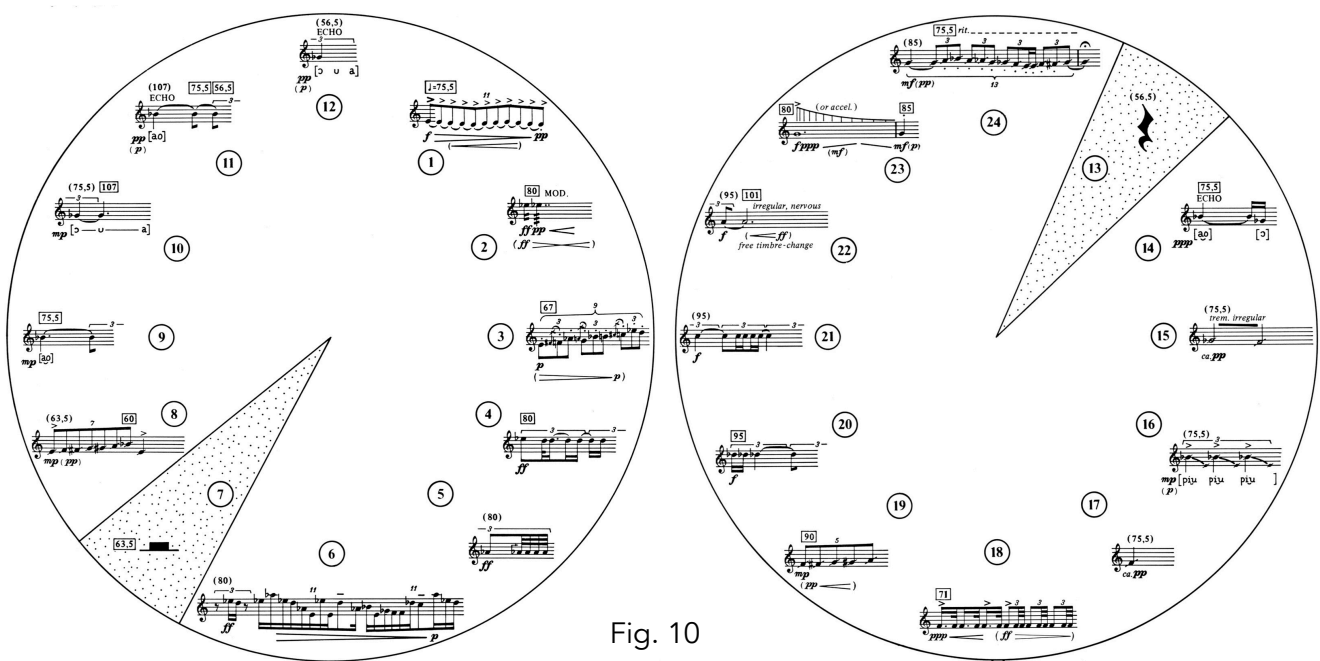

Fig. 10

5.2.2 List of Keywords Relevant for this Piece

SOUND BALANCE (DRAMA)

- Sound Levelling: Create a consistent balance between the loudspeaker sound and the acoustic sound of the performers.
- Sound Detail: Ensure that precisely prescribed details in the score stand out in the balance.
- Sound Dramaturgy: Realise global volume movements, global dynamics changes or specific individual cues that need changes in dynamics.
- Sound Theatre: Use specific amplification techniques (such as filtering, reverb etc) to achieve or enhance a certain sound effect.
- Sound World: Types of sounds used, instrumentation.
- Sound Priority: Emphasise formulas, moments and solos as indicated in the score.
- Sound Presence: Dynamic relationship between one or multiple sources and others.
- Immersive Metaphors (terms that relate to the notion of being immersed in sound):
    - Image: Listener is surrounded with clearly spatialised sounds
- Ensemble[17]: How well the musicians can hear themselves within the entire performance space, good 'Ensemble' is obtained when the musicians can hear themselves well
- Blend[18]: Perceived as a mix between instruments and/or tapes.
- Natural/Artificial Room Information: placing the sound source in a simulated acoustic environment that is different from the performance space.

SOUND REINFORCEMENT (SYSTEM)

- Natural Sounding Amplification: Use adequate equipment and mixing strategies to deliver the most accurate representation of the sound-source relevant to the performance space.
- Sound Colour: The ability to realise the required timbral representation of a sound.
- Direct/Indirect: Place the listener in or outside of the sound-field propagation of the loudspeakers.
- Sound-Source Localisation: Localising the amplified sound source at the origin of the sound-source position.
- Spatialisation: Placing the sound source at any given point in the listening space.

SOUND QUALITY (GLUE) - WHEN DRAMA AND SYSTEM WORK TOGETHER

- Klangbild: Create the intended musical experience (Sound Levelling, Natural Sound Amplification, Sound-Source Localisation work together).
- Sound Size: Truthful representation of the instrument by means of amplification (Sound-Source Localisation, Sound Colour and Sound Level work together)
- Sound Layers: Foreground – Background, distribution of sound sources (Presence, Priority, Detail and Levelling work together)

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[17] McCarthy, Bob. 2007. Sound systems: design and optimization: modern techniques and tools for sound system design and alignment. 1st ed. Oxford; Burlington, MA: Focal.

[18] Ibid.

5.2.3 Stage Setup

Following the stage setup prescribed in the score by Stockhausen, a stage design was made for the *aus LICHT* Production with the flute soloist playing on the front central stage and the percussionists each on their own elevated stage on the left and the right side of the audience (see fig. 11). Large structures made out of scaffolding were made for the mandalas and the percussion stages, including staircases on the sides for the mandalas and on the back for the percussionists. In the middle of the front stage there was an opening that led to a staircase leading under the stage. This was used as an entrance and exit for the flute player.
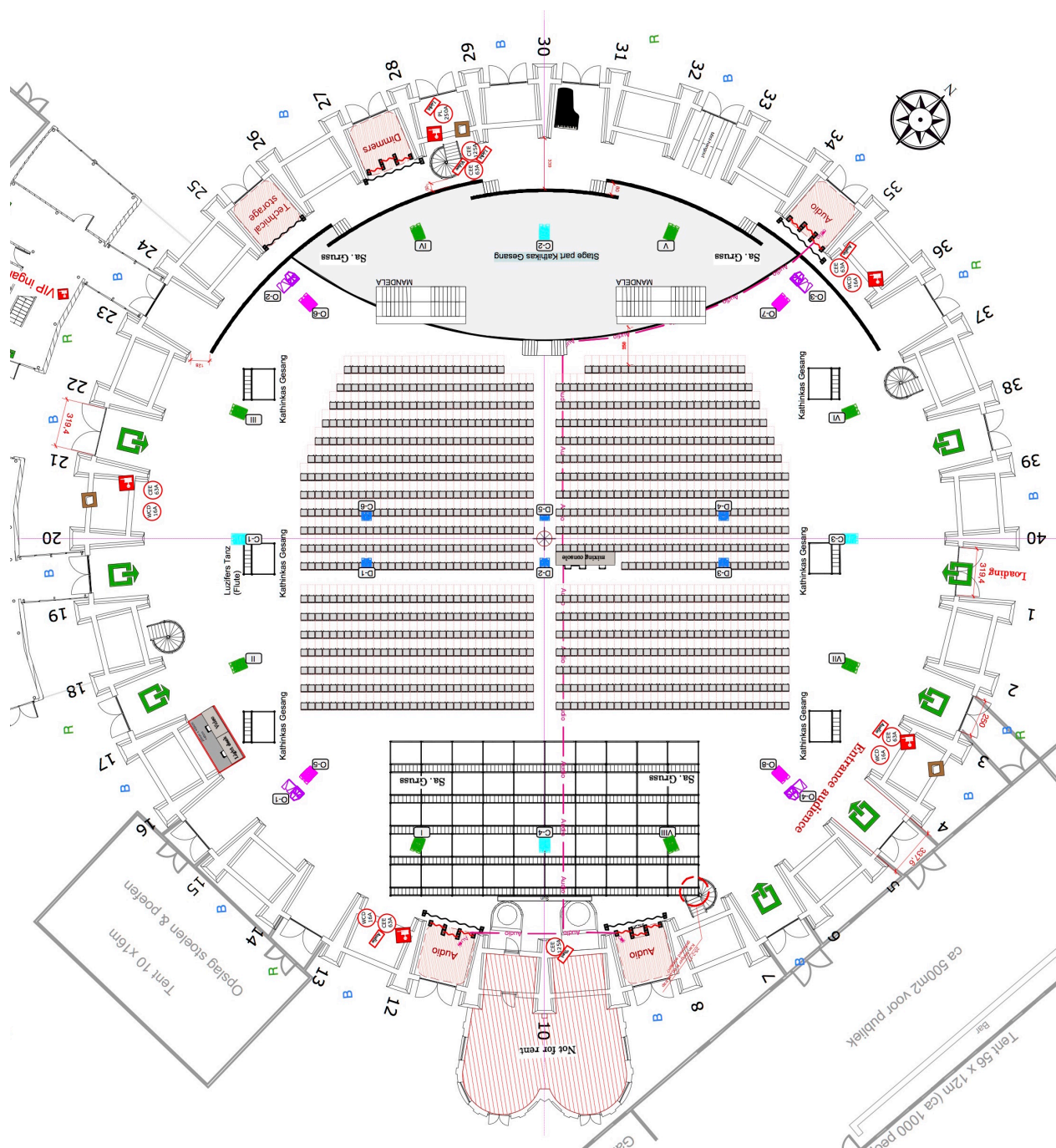
Fig. 11

5.2.4 Instruments

The flute player plays a B-Foot[19] flute. The percussionists play 'magical' instruments, sound plates and whistles. Percussionists I–V have two sound plates on each side, positioned on the left and right side of their faces, while percussionist VI has only one sound plate. The flute player has also one sound plate that she takes to percussionist III in Section 13, where she also exchanges other sound plates between the other percussion players.

Besides the sound plates, each percussionist assembles the magical instruments that are then hung or strapped to their body: on the head, chest, arms, thighs or belly. They are supposed to create a wide pallet of sounds: sound noises or noises through striking, rubbing, rattling, shaking and blowing. The sounds coming from these instruments should be strange, mysterious and should have a 'magical' effect. The **sound world** should be the one of fairy tales, sounds that enchant beings, sounds of a 'magical' forest.

There are a few suggestions in the score about what kind of objects should be used and these were taken into consideration, so the instruments from the percussionists were made out of toys for small children, squeeze toys, chimes, rubber or wooden sticks being rubbed on various surfaces, children's instruments (violin, trombone, harp, ocarina, drums, accordion etc.), music box, wine glass, gongs, wooden sticks, metal plates etc. (see fig. 12).

Fig. 12

According to the score, during the performance the percussionists should have a whistle in their mouth or several ones mounted close to their mouth. The types of whistles can be chosen from referee whistles, police whistles, children's whistles or various bird-sounding whistles. In our case they had also several types of whistles, either attached to their arms or mounted close to their mouths, producing various types of sounds, various intensities, intervals or noises. With these whistles the percussion players have 'conversations' or create a 'mysterious' or 'magical' atmosphere, as explained in the score.

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[19] The B-Foot extends the range of the flute down half a tone, making the lowest note available B. Therefore the foot is lengthened by about an inch.

5.2.5 Sound Equipment

According to the score's introduction, in the sound-equipment part, during the premiere Stockhausen initially tried to amplify the flute with wired microphones, but very soon he realised that the flute sound was compromised in this way and that a wireless microphone is necessary for the flute in order to keep the **natural sound amplification** and the consistent **sound levelling,** as well as having enough headroom to avoid feedback**.** Not only did it look and sound better without having microphone stands on stage, it also allowed the flute player to move freely.

The score was obviously our starting point for the amplification of the flute. As specified, the best option is to amplify the flute by means of a small wireless microphone. We used two radio transmitters with two DPA 4060 microphones on each transmitter. These were attached to the costume of the flute player as this was – according to Kathinka Pasveer, who premiered the piece – the least distracting for the flute player (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #1). The flute was amplified with the first microphone only, the second microphone was only to be used in case of failure of the first one.

The score specifies that if a concert performance is being held in a large venue, the percussion should be amplified as well. Since the Gashouder is a relatively large venue we did take this into consideration in the early stage of rehearsals and we did amplify the percussion instruments throughout the entire period of rehearsals and performances, using two DPA 4099 microphones and one DPA 4060 microphone on each percussionist to be able to cover all the instruments that they had. All the microphones for the percussionists were wireless. The DPA 4099 microphones were chosen because they made changeovers easier, while the DPA 4060 microphones were also used during "Die Entlassung der Sinne" when the percussionists walk to the front stage, when they needed to be wireless in the first place.

In terms of the speaker setup used we had the entire speaker setup for *aus LICHT* at our disposal, which gave us a lot of options to amplify the flute and percussion instruments. This will be dealt with more extensively in the case study further on.

5.2.6 Realisation

The performance of *Kathinkas Gesang* takes place both on and off stage. The flute is performing on the main stage in front of the audience and the percussionists most of the time on their own six stages, three on the left and three on the right sides of the audience, except during "Die Entlassung der Sinne" when the percussionists leave their stages, and while taking different paths, they reach to the front stage to join the flute and later disappear behind it.

The flute is the main soloist in this piece. As mentioned before, the flautist plays many extended techniques such as toneless blowing, flutter-tonguing, double- or triple-tonguing, vocalisation, microtonal fingerings. The part of the flute in the score has large ranges, both in terms of intervals as well as dynamics.

The flute should have very **natural sound amplification,** as well as clear **sound-source localisation**. This means a good position for the microphone(s) should be found, so that the flautist can be free to move and not be annoyed by technical solutions, while the sound stays uncompromised. The right **sound colour** should be established during rehearsals that would work for all types of sounds that the flute makes. The flute should be constantly followed in order to obtain the right **sound presence** and **sound detail** (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #3).

During the rehearsals in LaZ, Pasveer suggested to give the flute a boost in the frequency range of 200–250 Hz in order to help her voice have more **sound presence** (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #12). Another range worth considering is 5–8 KHz that in our case needed attention in order to find the right **sound colour** and balance between the more windy sounds (made by blowing extra air to the flute) and clean flute sounds for the sections where this was required. This became more apparent in the Gashouder where line arrays were used, as opposed to the situation in LaZ where point-source speakers were used, aimed less directly to the audience area. In LaZ we had more acoustic sound present at the listening position while the amplified sound was more **indirect.** In the Gashouder we had more **direct** amplification.

Other differences that we experienced after moving to the Gashouder were the **sound size** and the **sound-source localisation** of the flute. While in LaZ she was less amplified and the area that she covered horizontally and vertically on stage was quite small, in the Gashouder these distances got a lot larger. The stage itself was wider and new mandalas were built for the Gashouder that did not fit at LaZ previously. This provided the necessity of **spatialising** the flute when she moves horizontally from left to right, and vertically when she climbs higher or descents lower down the stairs, in order to achieve the right **sound-source localisation** (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #18). Initially an LCR bus was used, using speakers IV – C-2 – V (see fig. 3), but after noticing that the flute moved even more to the extremes of the stage a 5.1 surround bus was made, adding O-6 as Ls and O-7 as Rs**,** so the flute could be **spatialised** using the joystick on the Digico SD7 mixing desk[20], which was more practical and hands on when mixing alone. (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #19). The width of the 5.1 surround bus was carefully chosen during the rehearsals in the Gashouder in order to reach the right **sound size** of the flute. If this was too wide it would compromise the **sound-source localisation** and the **sound size** (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #15). To obtain the right vertical **sound-source localisation**, another stereo output was used on the flute channel that was routed to speakers O-4 and O-5. This was constantly followed as the flute player was climbing or descending the stairs at the mandalas. Lastly we also added the flute to the front fills, which were added later on, not to lose the flute sound on the opposite side of the one she is located at when playing at the extreme sides of the stage. Only after taking all these steps did we get the most **natural sound amplification** and the **Klangbild** of the flute that was necessary. For this piece SPAT was not considered, since a more narrow **sound-source localisation** for the flute and especially for the percussionists was preferred. Having the sound

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[20] https://digico.biz/consoles/sd7/, accessed May–June 2019

come from only one of the speakers turned out to be difficult to do in SPAT and this is what was necessary when we wanted to **localise** the percussionists at their stages.

As mentioned before, in the preface of the score, amplification for the percussionists is prescribed if the performance is taking place at large venues. For the Gashouder this was necessary in order to achieve the right **sound presence.** Because of the nature of the percussion instruments, each percussionist initially had to find the right dynamics to play with the instruments designed by them. As these were not common instruments, the sound produced varied quite a bit dynamically, so firstly a good balance was necessary between their instruments so that when amplification was applied, good **sound levelling** could be achieved. Once the balance was achieved, we looked at the position of these instruments on the costume to determine the right microphone position. We used two DPA 4099 microphones to pick up most of the sounds: one positioned in the centre in front of them in order to amplify the instruments on and around their belts, while the other DPA 4099 microphone was in the centre but positioned higher to pick up the instruments on their heads and their torso. Furthermore there was one more DPA 4060 microphone taped on their cheeks to amplify the whistles and the sound plates. Of course this added some general amplification of the entire percussionist setup, since it was an omni-directional microphone. However, this worked in our advantage, adding a bit of **natural room information** that made the sound more **natural** in contrast to the DPA 4099 microphones.

The sound of the percussionists is of an **immersive image** character. It should be amplified at a decent level so that it is audible in the entire hall as well as to be **direct** enough (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #20). Their sound should **blend** well together, especially when they play the sound plates that need to be **present** to achieve the right **sound detail** (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #6). To be able to play as an **ensemble**, in-ear monitoring was given to all percussionists. They received the flute sound so they could always hear the flute well and be on time with it.

During most of the piece, very little **artificial room information,** in this case reverberation, was used on the percussionists, except in "Vertauschung der Sinne" (Section 13) and "Die Entlassung der Sinne" where a lot of reverb was used to create the "magical forest of bird sounds" (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #7). In these sections, the signals from the DPA 4099 microphones were omitted and only the signals of the DPA 4060 microphones were used and sent to quite an extreme level to achieve the right **sound theatre.** The whistles should sound **indirect** and as an **immersive shower**.

To realise convincing **sound-source localisation** during the entire piece and to be able to **spatialise** the sound of the percussionists, each percussionist had its own LCR bus output. The following routing was used for the percussionists:

Percussionist/ Speaker	L	C	R
Percussionist I	C-2	VI & O-7	VII
Percussionist II	C-2	O-7	C-3
Percussionist III	C-2	V	VII
Percussionist IV	III	IV	C-2
Percussionist V	C-1	O-6	C-2
Percussionist VI	II	III & O-6	C-2

When all percussionists on the left side of the audience were panned to the left extreme and all percussionists on the right side were panned to the right extreme, the optimal **sound-source localisation** and proper **sound levelling** could be achieved, since the percussionists could be localised where their stages were positioned (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #4).

During "Die Entlassung der Sinne", the sound of the DPA 4099 microphones were muted and the sounds of the DPA 4060 microphones were **spatialised** by panning the microphone signals to the opposite sides of their bus slowly, so that the percussionists could be followed when they move towards the stage, ending in a nice **blend** of 'magical' sounds surrounding the flute sound on the front speakers IV – C-2 – V (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #14). Since these microphone signals in this section had a lot of **artificial room information**, the **sound-source localisation** was not that crucial to achieve the right **sound theatre.** Although proper **blend** should be kept constantly as the different tones of the whistle sounds need a constant **sound presence** (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #10).

As a reverb, the Altiverb 7 plugin[21] was used. Three instances of Altiverb 7 with the "Kammermusik Berlin" impulse response were used and one with "Notre Dame"**.** All of them were surround reverbs with a stereo input and a quad output, so that the reverb could be localised where the sources are. The first Kammermusik preset was used for the flute in general, routed to speakers O-5 – O-8. The second and third were used for the percussion in general. The second one was routed to speakers II – III – VII – VI and the third to VI – VII – II – III. The former was used for the percussionists IV – V – VI while the latter for percussionists I – II – III. The Notre Dame reverb preset was only used for the very last scream of the flute.

As mentioned before, the flute is the main soloist in this piece. Between the flute and the percussionists the appropriate **sound layers** should be established (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #2). This does not mean that the percussionists are just in

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[21] Altiverb 7 - https://www.audioease.com/altiverb/, accessed May–June 2019

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the background layer, but enough room should be kept to maintain the **presence** and the **detail** of the flute (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #5).

There are moments in the score (listed below) where the percussionists or the flute need more attention to bring about the right **sound priority** and **sound detail.** These will be discussed in order of appearance in the score and they relate to the setup (audio, stage and instrument) in the Gashouder.

At the very start of the score, in the "Salut", the flute plays alone as she climbs up the stairs on the centre of the stage. The flute sound should be almost acoustic, and as she climbs up, the amplified sound should be added until the required **sound level** is reached (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #8).

In Section 1 the percussionists join in so the **sound layers** need to be adapted. Right at the transition between each section, the flute plays high pitches that often need to be **levelled** down to keep a good **blend.**

In each section further, different combinations of percussionists play together with the flute as specified in the score. They have instructions for the number of events and type of sounds they should produce. As mentioned before, they are finding these sounds during the rehearsals. Some of these sounds they play often in duet with the flute, so the right amount of **sound detail** is important, such as in Section 5 where percussionist V plays a duet with the flute and in Section 8, where the flute is joined in making more noisy sounds together with percussionists III and I (see appendix "Comments Sheet Kathinkas Gesang" - comment #16).

In Section 5, all percussionists are joining the flute while she plays low tones. Here, a boost on the flute sound and less volume on the percussionists was necessary to keep the right **blend** and **sound layers.** In Section 7, on the contrary, the flute was playing high tones while no percussionists were playing, so the level of the flute should be taken down to keep the **amplification sound natural** and the **sound size** correct (see appendix "Comments Sheet Kathinkas Gesang" - comment #3).

The flautist uses also her voice to produce sounds such as in Section 9**.** As we mentioned before, Pasveer suggested to give a boost to the flute in the low-mid frequencies to give the voice the right **sound priority.** This continues up until Section 13 and needs constant **sound levelling** to give the flute sound enough **sound presence** when the percussionists are playing.

Other examples of **sound detail** are a duet that percussionist V has with the flute in Section 11, and in Section 12 where the flute is joined by percussionists I, II and III, which together with the flute make a crescendo right before the end of the section. This needs to be supported in order to create a **sound dramaturgy** moment before the start of Section 13, "Entlassung der Sinne" (see appendix "Comments Sheet Kathinkas Gesang" - comment #26).

In Section 13, *"Entlassung der Sinne"*, as mentioned before, the signal of some microphones is omitted while the signal from the head-worn DPA 4060 microphones needs to be boosted and a lot of **artificial room information** should be added in order to create the desired **sound theatre**, that of a "forest of magical sounds" (see appendix "Comments Sheet Kathinkas Gesang" - comment #7). There are additional moments of **sound detail** in this section. At the beginning of the section, the flautist leaves her instrument at the centre of the stage. Then she walks to the percussionists to change their plates. As soon as she gives the percussionist a new plate, the receiving percussionist has a solo moment with whistle sounds to show his excitement of receiving the sound plate. Accordingly, this moment of **sound detail** needs to be **present** enough (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #24). Once all the plates are distributed, the flautist comes back on stage and picks up her instrument. Here, there are two moments of **sound dramaturgy** that were added by the director Pierre Audi. Namely when the flautist picks up her instrument the whistling should be louder as well as when she lifts the flute high with her hands. In order to achieve this, the percussionists' level should be boosted to create the required **sound dramaturgy** (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #25).

The **sound theatre** moment ends before the start of Section 14**.** It is important that the correct **Klangbild** is set for this section on time and that the **artificial room information** is faded out before the first note of the flute. During this section, the flute comes back playing and using her voice in a pianissimo part, so in this part the flute sound needs enough boost to keep the right **presence.** Also, percussionist III has one event in this section where she played on a wine glass that needed a lot of boost to get the **sound detail.**

Section 15 is a duet of the flute and percussionist I. A precise **blend** between these two instruments, which produce wind-like sounds, is necessary. The same goes for Section 16 and Section 18, but this time, percussionist VI plays along with the flute.

The flautist uses her voice again in Section 19 and Section 20 so here, her **presence** needs to be maintained again.

Section 21 and Section 22 have a few specific moments of **sound detail** and **priority**. The flautist plays notes that resemble the Sunday part of "Michael's formula". In Section 22, percussionist I plays a very quiet music box that needed to have a good **blend** with the flute, so it required a strong boost (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #11). A **sound dramaturgy** moment was created at the end of this section after a last-minute suggestion by Pasveer (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #9). Feedback delay and reverb were added to the sound of percussionist III who plays a shaker. Pasveer's suggestion was to **spatialise** this sound and make it circle above the audience. This was **spatialised** live using the joystick of the Digico SD7 mixing desk.

A moment of **sound detail** in Section 22 requiring good **sound levelling** is almost at the end of that section, when the percussionists reply to the "aha" sung by the flautist (see fig. 13). This is

not supposed to be extremely **present** but not lost either, so it requires always to be followed by the sound projectionist in order to **blend** well together.

Fig. 13

The section "Die Entlassung der Sinne" starts off with a crescendo of the flute that is followed by a pianissimo part, where she also plays low notes (see fig. 14). This part requires quite some boost on the flute signal in order not to get covered by the percussion (see appendix "Comments Sheet *Kathinkas Gesang" - comment #21*). In this section, as mentioned before, the same **sound theatre** from Section 13 needs to be recreated. Only the signals from the head-worn microphones from the percussionists are used with a generous level of reverb to create the **Klangbild** required. In addition to the reverb, their sound is **spatialised** and moves towards the front stage as they walk and climb on stage as well. The resulting sound should be that of an **immersive curtain** that is moved towards the front, and while maintaining good **presence** it should not be drowning out the flute at any moment, even when each percussionist has a solo moment on stage. After their solo moment, the percussionists disappear behind the stage and they should be faded out up to the point where the flautist starts with the "Ausweg" section (see appendix "Comments Sheet *Kathinkas Gesang" - comment #13*).

Fig. 14

In "Ausweg", the flute needs to maintain quite a lot of **presence,** even though she is playing alone. Pasveer wanted to create a moment of **sound dramaturgy** by having the flute sound loud

and hysterical as she was walking down the stairs under the stage (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #23). Even more **presence** was required during "Die 11 Posaunentöne" since the **sound levelling** was lost once the flute was under the stage, and the **sound theatre** required large trombone-like sounds (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #22) (see fig. 15). In the beginning of the last line of the score, there is a sudden change in dynamics after the 14-beat legato tone. Since the level of the flute needs to be raised a lot to get the sound presence and sound size for "Die 11 Posaunentöne", a fast reaction is necessary to bring the flute level back after the 11th tone.

Fig. 15

The very last scream of the flute player in "Der Schrei" is a big **theatrical** moment. This is where the "Notre Dame" reverb preset was used as well as enough boost of the flute sound to make the scream larger and more **dramatic** (see appendix "Comments Sheet *Kathinkas Gesang*" - comment #17).

5.2.7 Reflections

Kathinkas Gesang offers the audience quite a specific **sound world**. Not only is the flute part very original and virtuosic;, the palette of the percussion sounds and the fact that they play around the audience makes it full of extraordinary sounds and immersive layers of events.

The performance of the piece depends very much on the skills of the flautist, whose part and the techniques required make it quite complex to play, especially since she does this from memory.

There is also a strong dependence on the creativity, imagination and virtuosity of the percussion players. For this performance, the percussionists did a very good job in designing their instruments as well as finding the right way to play them, and to create very interesting duets with the flute. What really emerges from this case study is that the sound projectionist also needs to be across all the details of the work, to make sure that the flute and the percussion instrumentation always have the right blend and sound layers.

It goes without saying that it is up to the sound projectionist to deliver the **Klangbild** to the audience in the right way. It is his task to assert **natural sounding amplification,** maintain the **sound layers** properly through the exercises and make sure all **sound details** are heard. Even though there are not a large number of performers, this piece requires a lot of **sound levelling** of each instrument and especially at this production the flute needed constant **sound levelling** and **spatialisation** horizontally and vertically to maintain the right **sound-source localisation.** *Kathinkas Gesang* requires that the sound projectionists become very familiar with the score and with the instruments of the percussionists in order to maintain the **blend** throughout the piece. What makes it additionally interesting to mix is the fact that different **theatrical** moments needed to be realised in specific parts of the piece that create 'magical' and 'abstract' scenes.

The fact that it was performed in such a large space did not disperse the sounds too much, on the contrary: it gave enough room for them, especially to create the "forest of magical sounds". The sound system used in the Gashouder gave us a lot of flexibility to achieve the proper **sound-source localisation**, **spatialisation** and **sound theatre.** Furthermore, the coverage of the line arrays made it possible that all **sound details** from the percussion instruments were well audible through the listening space.

Kathinkas Gesang turned out to be one of my favourite pieces of the *aus LICHT* production. It is a unique part of the *LICHT* opera, which, depending on the percussion instrument design can give a very original performance each time. The musicians did a great job performing the piece in this production and I was very happy to be part of the result. I was also very lucky and grateful to be able to work and learn from Kathinka Pasveer, who could provide precious insights since this composition was dedicated to her and she was the one who premiered it.

Marko Uzunovski

5.3 Case Study III – *Michaels Reise*

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5.3.1 Introduction

Michaels Reise forms part of the *Donnerstag* (Thursday) opera. It depicts Michael's travels on earth, passing through seven specific places, which in the score are named as 'Stations'. Each Station is a specific known place on earth, such as New York, Africa, Bali or Japan. Each main character maintains its main musical 'formula', and the formulas also appear entwined in the orchestra's musical content. However, at each Station the musical content and atmosphere change dramatically to suit the Station and place. Halfway through, Michael suddenly hears the formula of Eve, represented by the basset horn. Eventually, *Michaels Reise* ends with the movement called "Himmelfahrt" (Ascension), where Michael and Eva lift off and fly away together.

Michaels Reise's first staged performance took place at the Teatro alla Scala in Milan in 1981, as part of the premiere staging of *Donnerstag aus LICHT*. It is an iconic piece in many aspects, not the least since it specifies a complicated surround routing of the fully amplified orchestra, and a loudspeaker array is to be placed around the audience seating, encapsulating the audience in the amplified sound, which is controlled by the sound projectionist.

Stockhausen's own musical synopsis of a staged performance (as published in the score) is as follows:

> *The "Journey round the Earth" takes place purely musically. MICHAEL's instrument is the trumpet. The orchestra is "the world".*
>
> *Musicians, as penguins, are seated around the globe at the South Pole. MICHAEL appears as trumpeter, dressed in blue and with the "Michael sign". He plays his formula as farewell, and climbs into the globe, which begins to rotate eastwards. At each of the "7 Stations" which follow, a different window (balcony) opens, out of which MICHAEL leans and "converses" with the musicians.*
> *Two clarinettists – a clownesque cross between swallow and penguin – whizz through the orchestra several times while playing.*
> *At the 6th Station MICHAEL hears a basset-horn in the distance and gives a sign to turn back. The Earth starts rotating backwards. At the end of the 7th Station, on hearing the basset-horn again, he stops the Earth, climbs out, calls in vain for an answer, and is consoled by the double-bass.*
>
> *Again the call sounds and comes nearer. EVE appears as a beautiful, seductive basset-horn player. She plays with him, enchants him, and finally, dancingly, takes him away with her.*
>
> *During this, two clowns with clarinet and basset-horn slink in, mock the couple, climb into the globe, play on a balcony, are attacked by the trombones and engaged in a fierce argument.*
> *The long held notes of MICHAEL and EVE can be heard in the distance. Finally they approach and end in a loud, lamenting, falling melody which fills the entire space while the light slowly fades out and all becomes still.*
>
> *In the darkness the melodies of the trumpet and the basset-horn calmly fly in the sky, accompanied by increasingly sparse droplets of sound from the orchestra.*
> *Both unite in an artfully intricate trill, which very gradually slows down.[22]*

In *aus LICHT*, *Michaels Reise* was performed in the quasi concert version. The trumpet soloist could walk around but was mainly situated on a round podium placed at the middle of the stage (see fig. 16).

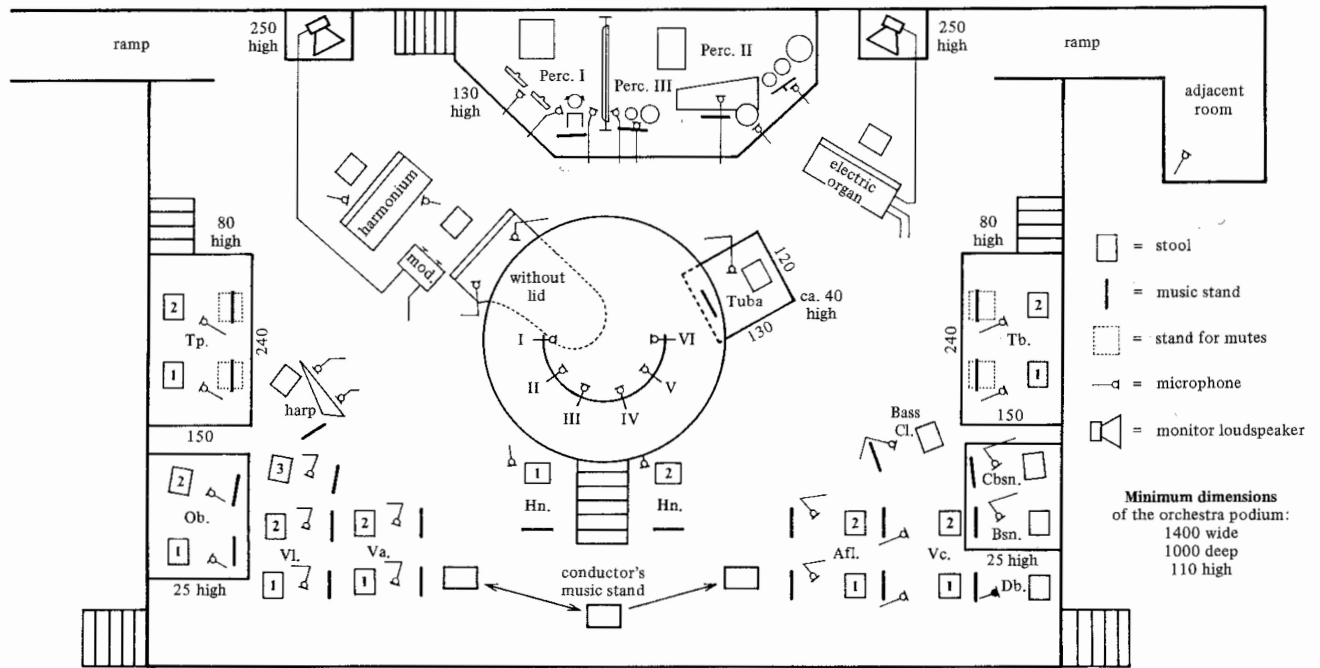22 Stockhausen, Karlheinz. 1980. Michaels Reise Score. Stockhausen-Verlag : Work No.50

Fig. 16

According to the score, amplification is necessary for all instruments.

The Michael, Eve and Lucifer formulas include melodies as well as gestural elements that could fall under the category of extended techniques, such as dynamic modulation, harmonics, vocalising, tongue clicks, etc. Throughout *Michaels Reise* and throughout the different sections of the orchestra, the different formulas reoccur.

5.3.2 List of Keywords Relevant for this Piece

SOUND BALANCE (DRAMA)

- Sound Levelling: Create a consistent balance between the loudspeaker sound and the acoustic sound of the performers.
- Sound Detail: Ensure that precisely prescribed details in the score stand out in the balance.
- Sound Dramaturgie: Realise global volume movements, global dynamics changes or specific individual cues that need changes in dynamics.
- Sound Theatre: Use specific amplification techniques (such as filtering, reverb etc) to achieve or enhance a certain sound effect.
- Sound Priority: Emphasise formulas, moments and solos as indicated in the score.
- Sound Presence: Dynamics relationship between one or multiple sources and others.
- Intimacy: The feeling of proximity through the interplay of timbral and dynamic balance.

- Immersive Metaphors (terms that relate to the notion of being immersed in sound):
  - Image: The listener is surrounded with clearly spatialised sounds.
  - Carpet: Underlying sound/drone
  - Shower: Immersion without any clear localisation.
- Ensemble: How well the musicians can hear themselves, good 'Ensemble' is obtained when the musicians can hear themselves well
- Blend: Perceived as a mix between instruments and/or tapes.
- Timbral Polyphony: The ability to hear harmony regardless of timbre.
- Natural/Artificial Room Information: placing the sound-source in a simulated acoustic environment that is different from the performance space.

SOUND REINFORCEMENT (SYSTEM)

- Natural Sounding Amplification: Use adequate equipment and mixing strategies to deliver the most accurate representation of the sound-source relevant to the performance space.
- Sound Colour: The ability to realise the required timbral representation of a sound.
- Direct/Indirect: Place the listener in or outside of the sound-field propagation of the loudspeakers.
- Sound Source Localisation: Localising the amplified sound-source at the origin of the sound-source position.
- Spatialisation: Placing the sound-source at any given point in the listening space.

SOUND QUALITY (GLUE) - WHEN DRAMA AND SYSTEM WORK TOGETHER

- Klangbild: Create the intended musical experience (Sound Levelling, Natural sound Amplification, Sound-Source Localisation work together).
- Sound Size: Truthful representation of the instrument by means of amplification (Sound-source Localisation, Sound Colour, Sound Level work together).
- Sound Layers: Foreground – Background, distribution of sound-sources (Presence, Priority, Detail and Levelling work together).

5.3.3 Transforming *Michaels Reise* from rehearsing in LaZ to the Gashouder

The main objective of the sound projectionist during the rehearsal period was to facilitate the rehearsal for the musicians with the most **natural sounding amplification** possible. Furthermore, this meant learning the music and the **sound priorities** of the score and finding the best technical solution to realise the piece. LaZ is a relatively small rehearsal space for such large setup, and as was already mentioned, has a low ceiling. As a result, acoustically, instruments like tuba and percussion would easily get dominant. Low frequencies build up easily, resulting in an undefined and muffled sound picture. Due to these acoustical limitations it was difficult to find good balances, both dynamically and tonally for *Michaels Reise* in LaZ. Upon applying amplification, we

generally needed to cut most of the low frequencies in order to maintain clarity. Many sound sources in LaZ remained almost un-amplified since they were acoustically already too loud.

Upon moving to the Gashouder we found that first of all, we needed to find a new timbral balance for almost all channels of amplified instruments: we now worked with a much fuller and evenly sounding sound system and, as mentioned earlier, the Gashouder had been dampened with wool. Despite some strong early reflections, the general reverb time (T60) was now under one second and thus considerably less than many large concert halls (usually greater than two seconds). Acoustically we now found that none of the instruments were loud enough and therefore needed much more amplification. The ring-speaker system in the Gashouder had a very natural sound and was well-suited for getting a **natural sounding amplification** without extreme timbral colouring. In comparison with our input setting in LaZ, a big difference was that we now needed to amplify the full frequency range of the instruments to achieve the most **natural sounding amplification**.

5.3.4 Amplification

As mentioned earlier, every sound source in *Michaels Reise* is supposed to be amplified. We had the fortune to be working with state-of-the-art equipment, operated by expert sound engineers. In contrast to the world premiere of *Michaels Reise*, we had at our disposal a large amount of reliable wireless microphones. By using more wireless microphones we had less staging complications and at the same time improved the stability of the amplification of certain sound sources. Here follows a short description of microphone changes compared to Stockhausen's original choice;

- All strings where amplified with clip-on DPA 4099 microphones, allowing for more physical movement and a more visually clean stage.
- Trombones where wirelessly amplified with DPA 4099 microphones that allowed the players to stand-up in certain solos, not bound by a fixed microphone position.
- Trombones each had a wireless microphone taped to their chin to amplify their voices at moments of calling out numbers.
- Trumpet-ring microphones where changed from Shure SM58 microphones to DPA 2011 microphones (condenser microphones). Initially this change came about as a visual request from stage director Pierre Audi; eventually we found that this allowed the trumpet soloists to have more distance from the microphones and **sound detail** was improved significantly by this change.
- Double basses had a DPA 4099 microphone in the bridge and a contact microphone on the body.

To obtain good **ensemble**, it was necessary to place audio-monitor wedges for several musicians in the orchestra. Violins and violas needed to hear the flutes better, while flutes needed to better hear the strings. Trumpets, trombones, piano and percussion needed to hear the trumpet soloists well.

5.3.5 Spatialisation of Sound Sources

For the amplification of *Michaels Reise* in the Gashouder, the speaker arrays I – VIII + C1 – C4 with their subs S-I – S-VIII were used, while the top speakers of the *Oktophonie* speaker arrays (O5 – O8) where added to complete the whole circle of speaker arrays around the audience. This complete system will from here on be referred to as 'ring speakers'. In the preface of the score, Stockhausen explains how he used six loudspeakers placed around the audience to amplify and spatialise the sound sources see (see fig. 17).

The table below explains our adaptation to a larger circle of speakers, which allowed for a more consistent **sound-source localisation** for a larger part of the audience.

6 loudspeaker groups
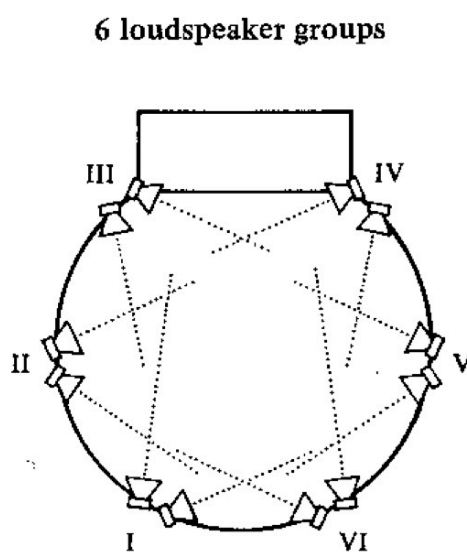
Original Speaker:	Projected to:
I	I+II
II	C1
III	IV
IV	V
V	C3
VI	VII+VIII

Fig. 17

Stockhausen originally used stereo groups to route and project the input sources over different speakers. Upon preparing for *Michaels Reise* we took a similar approach, but following advice from Paul Jeukendrup, who had previously mixed this piece, we decided to use stereo aux busses that we routed through the mixer's matrix. Therefore we could split and balance one side of the stereo aux between several outputs: this gave us the freedom to broaden the sound-projection area to better accommodate for the large audience area in the Gashouder, creating an overall more even **Klangbild**.

Another adaptation we made was changing from a front Left/Right system to a Left/Center/Right (LCR) system:, this gave us the freedom to pan very evenly with improved **sound-source localisation** for a larger part of the audience. Trumpet, basset horn and the two clarinets positions on stage needed to be followed very precisely for a good **sound-source localisation**, which resulted in the right **sound size, natural sounding amplification** and thereby achieving a correct **Klangbild**.

In the last movement, "Himmelfahrt" (Ascension), the score indicates that the sound of the trumpet and basset horn should rotate around the audience. To accomplish this, their microphones where projected using the ring speakers. SPAT revolution software was used for this circular projection and we used the iPad with the Lemur app to control SPAT.

5.3.6 Realisation

Michaels Reise is a groundbreaking piece in its approach to placing the listener in an **immersive** sound experience. With clear indications in the score's preface, the orchestra is amplified over speakers placed around the audience creating an **immersive image**. *Michaels Reise* as a composition is build up around the main character's leitmotifs and **sound priority** is of utmost importance.

Due to the many extended playing techniques used by the performers, constant **sound levelling** of soloists is very important. In the preface of the score, Stockhausen states the following:

> *The sound projectionist sets the input level of each channel during the first rehearsals that, with the faders all in the same position, the instruments are balanced when they all play the same dynamic. He must ensure that everything in the score is audible working together with the conductor to achieve this.*

A very **natural amplification** with very good **spatialisation** is sought for *Michaels Reise*. Throughout the piece, the sound projectionist must pay extreme attention to **sound priority, sound detail** and **sound levelling. Sound priority** changes between different sections in the orchestra, and the **immersive** character is therefore changed throughout the piece. Only when correct **sound priority** and **sound levelling** are obtained, a good and appropriate **Klangbild** will be created.

Ensemble amplification

The orchestra in *Michaels Reise* is projected on the ring speakers around the audience, creating an **immersive Klangbild**. However, throughout the piece different sections in the orchestra change between playing underlying parts where **timbral polyphony** is very important and at times various instruments have solo or soli sections. This results in various changes of the desired **immersive sound picture** throughout the piece. *Michaels Reise* starts with a battle between the solo trumpet and first trombone clearly 'attacking' each other, **sound presence** and **sound levelling** for both players are very important in this part. Setting an **immersive carpet** character, the harmonium plays a long cluster chord drone, meanwhile the orchestra starts to play; in the score, each player (see fig. 18) is instructed to play in their own timing and a bit by themselves as if there was no **ensemble**. The sound projectionist is to make **sound dramaturgy** by slowly adding amplification to the orchestra, resulting in an **immersive shower** character that also has clear **sound-source localisation.**

Fig. 18

Below follow a few examples of how the **immersive** characters are developed throughout the piece, resulting from the different **sound priorities** and **sound levellings**.

In the end of several movements the two horns play signals to indicate a next transition. The sound projectionist is here to create further **sound dramaturgy** by amplifying the two horns with clear **sound priority.** An interesting example of **spatialisation** and **immersive character** is also in bar 20 (see fig. 19).

Fig. 19

The extreme panning (horn 1 on speaker array IV, horn 2 on speaker array V) enhances the **spatialisation** and sets off a more **immersive image** character. Clear comments were made about making sure this would be a very audible effect (see appendix "comments sheet *Michaels Reise*" - comment #3).

An interesting indication of **sound levelling** that also resulted in **sound theatre** is found in bar 40. Stockhausen here uses the + symbol, indicating a change in amplification for the tamtam. The tamtam amplification should here be set loud enough so that the tamtam itself starts to work as a reverberating plate for the long, sustained notes played by the horns at this moment, which enhances **sound theatre**. Horns are amplified on front speakers Left and Right (speaker arrays IV and V), their resulting reverb tail from the tamtam is projected in the middle over the audience using speaker arrays C1 and C3. The resulting listening experience is that of an **immersive** character, the listener hears **direct sound** from the front, but an **immersive shower** character is created, hearing the tamtam 'reverb' amplification.

In bar 44 we had to create a new **immersive Klangbild**. Flutes, violas, vibraphone and harp are now fully amplified. They are **spatialised** around the audience and they freely play the Eve nuclear formula, adding formula notes at each repetition (see fig. 20). We where to give and maintain **sound priority** for this group of players, furthermore this is supported as Stockhausen states in the score they should all be evenly loud (see fig. 20), thus good and constant **levelling** is essential. It is important to have a **natural sound amplification** and we are to obtain an **immersive image** with several **sound layers** creating a full **Klangbild**.


Fig. 20

In bar 68 we move into the 1st Station. Here, the **immersive** character of the piece again changes. All orchestra except brass plays long notes, creating a very steady **immersive carpet**. **Sound priority** is given to the solo trumpet playing a low Michael formula and also **stop** two alto flutes playing a low Eve formula supported by the viola. The two alto flutes should be followed for **sound detail** since they at times play very low and soft notes, furthermore in the same section they use various extended playing techniques needing **levelling** to create a **natural sounding amplification**. The added **sound priority** to the alto flutes creates a very clear **spatialisation** and produces a clear **immersive image.** The experience of clear trumpet localisation and spatialisation over either **Klangbild** is that of an **immersive carpet** and **immersive image** results in clear **sound layers.**

To underline the importance of the alto flutes in this section and help the sound projectionist, Stockhausen has here used an additional notation technique for the dynamics of the alto flutes. On an additional staff In between the two alto flutes, Stockhausen draws a line indicating the **sound detail** and **sound levelling** needed (see fig. 21).

Fig. 21

Trumpet soloist's amplification

The trumpet soloists were amplified via the ring of six microphones placed on the podium, hereafter referred to as 'ring microphones' (see fig. 22).
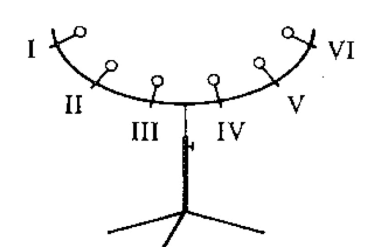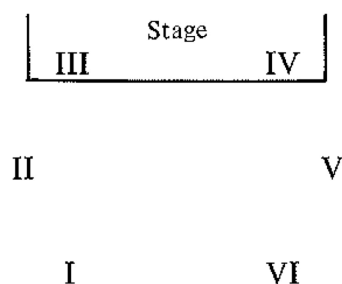

Fig. 22

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However, the trumpet soloist's staging asks him to play at various positions, so he was also equipped with a wireless transmitter and microphone. Each of the 6 microphones were routed to individual speakers from Left to Right (see fig. 22).

The trumpet soloist was instructed to use different microphones from the ring for different phrases. This creates a very **spatial** and **immersive image** to the piece. Furthermore, the trumpet soloist is to change between different trumpet mutes throughout the piece, ranging from rather loud cup mutes to very soft whisper mutes; ongoing **sound levelling** is therefore needed to bring out the **sound details** and maintain the **sound priority.** Changes of the mutes are indicated throughout the score above the trumpet soloist's part. The explanation of the trumpet mute signs are found in the preface of the score.

Ring Microphone:	Projected to:
I	I+II
II	C1
III	IV
IV	V
V	C3
VI	VII+VIII

Stockhausen helps the sound projectionist by using a special notation to indicate the needed **sound levelling** and supporting **sound detail**. (see fig. 23). An extra staff is placed below the trumpet soloist's staff, indicating approximate **sound levelling.**

Fig. 23

As a starting point, when the trumpet soloist was positioned behind the ring microphones, we tried to only use the ring microphones to amplify him, maintaining a big **spatial** effect, but we often needed to add the wireless transmitter for optimal **levelling** and **sound detail**. This would also occur when the trumpet soloist would accidentally be too far away or too far off one of the ring microphones, which would result in a lack of **sound priority** (see appendix "comments sheet *Michaels Reise*" - comment #6).

Due to the extended playing techniques, **sound levelling** was needed to bring out **sound detail,** which could not be picked up by the ring microphones.

At bar 97 in the score we needed to bring out a 'click' sound produced into the mouthpiece of the trumpet (see fig. 24).
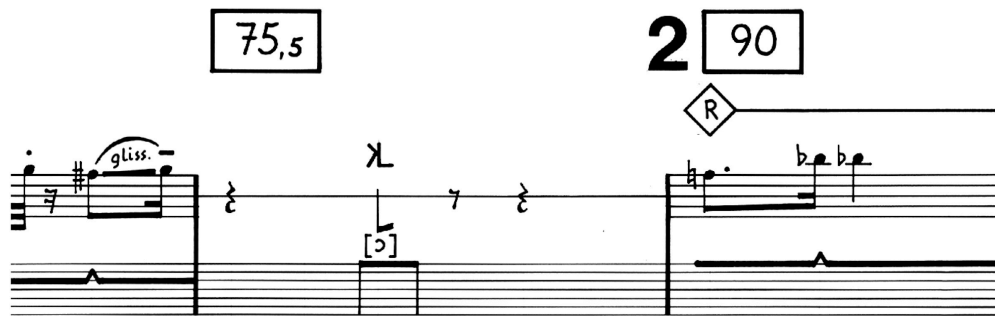

Fig. 24

Again, here we needed to add additional support from the wireless transmitter. There are many 'clicks' like this one and we were instructed to pay special attention to them and make sure they could all be heard. These **sound details** need vigorous **sound levelling**, since they play a big role in **sound theatre** and consequently the forming of the **Klangbild** of *Michaels Reise*.

Pasveer asked us to raise the level of amplification each time the trumpet soloist plays pedal notes. The pedal notes are used throughout the score and form parts of the formula and thus have high **sound priority**; they also help to increase **sound dramaturgy.**

To maintain correct **sound-source localisation** we would at all times follow the trumpet soloist's position on stage as closely as possible, panning the wireless transmitter between front LCR (speakers), this would help to achieve the most **natural sounding amplification**. **Sound colour** is here of utmost importance. However, whenever needing to use the wireless transmitter, it was a compromise to the **immersive image,** which then quickly moves towards an **immersive shower** character regarding the trumpet amplification. This was not desired (see appendix "comments sheet *Michaels Reise*" - comment #14).

In the movement "Halt", the trumpet soloist moves to the right of the stage and plays a duet with the double bass. This is a break in the musical flow and **intimacy** should be achieved here. Both solo trumpet and double bass need to have excellent **sound localisation,** so **spatialisation** and **sound size** were changed for the double bass by means of changing output and panning according to the score (see fig. 25 - bar 414). To achieve a good **Klangbild,** also **sound colour** needed modification to achieve **natural sounding amplification** in this context.
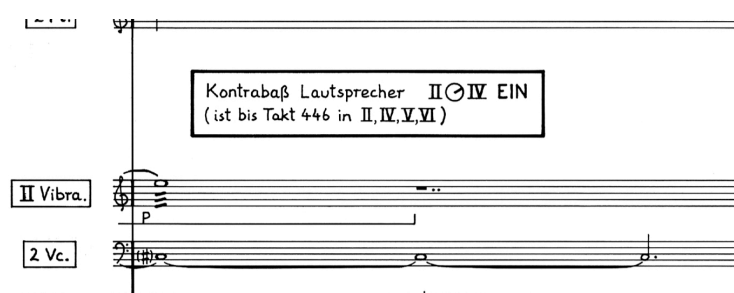

Fig. 25

Basset horn

In the beginning of the movements "Umkehr" and "Halt", the rhythmical flow of the piece is interrupted by the distant sound of a basset horn, taking the attention of Michael (the trumpet soloist). The basset horn at these moments plays the beginning of the Eve formula, and **sound priority** is thus very important here: the basset horn should not be visual and should sound from far away. In the score's preface, Stockhausen explains how the basset horn plays in an adjacent room but we could not realise this in the Gashouder: instead, to create proper **sound theatre**, we had the basset horn player play behind the stage and in the opposite direction of the hall, which increased **indirect sound**. Furthermore, we used an Altiverb convolution reverb preset to create **artificial room information.** An important point here is that we needed to project more **artificial room information** than the sound picked up from the basset horn to achieve good **sound theatre**.

In the following movement, "Mission", the basset -horn now moves from behind stage to play a duet with the solo trumpet on stage. This is a seduction duet and **intimacy** should be obtained. **Artificial room, sound size** and **indirect sound** now need to change to create the most **natural sound amplification.** The basset horn now has a role as important as the solo trumpet, and both should **blend** and have the same **sound priority**.

In the end of "Mission", trumpet and basset horn leave the stage together and throughout the next movement, "Verspottung", they are audible in the distance with slight **sound-source location** changes, achieved through panning, whilst clarinets takes the **sound priority**. Again ,Stockhausen solved this by having the solo trumpet and basset horn play in an adjacent room through the same microphone, with added **artificial room.** As explained earlier, we could not have an adjacent room. We used a snapshot in the mixer to change the settings of solo trumpet and basset horn to be projected through one mono channel into a 5.1 surround bus, routed to the whole speaker ring system, which allowed us to pan the solo trumpet and basset horn together. **Sound detail** changes throughout this part and optimal **blend** had to be maintained. Altiverb was used to create **sound theatre** by adding **artificial room,** making them sound **indirect** and creating the illusion that the instruments sound more distant. By adding **spatialisation**, we slightly moved them between front loudspeakers IV, C2, V, thus creating **sound theatre** and a **Klangbild** that suggests that they start to fly away. In bar 673, Stockhausen indicates a **spatialisation** change, where they need to come loudly out of all loudspeakers. We obtained this by moving the surround panner joystick right to the middle (see appendix "comments sheet *Michaels Reise*" - comment #33). In the following movement, "Himmelfahrt", the sound of the solo trumpet and basset horn now should start to slowly rotate around the whole audience seating; to achieve this **spatialisation** we switched our combined trumpet-solo and basset-horn channel to be projected through SPAT. In SPAT we defined a room according to the specifications of the Gashouder and we used an iPad with the Lemur app to control the input source of the trumpet. With Lemur we could set up an automated rotation, but still with the options of changing direction and doing the rotation entirely manually. This became necessary upon specific request by Kathinka Pasveer and Suzanna Stephens. In order to create **sound theatre,** a change of direction should happen in bar 693 and, also for more **sound theatre,** it was

explained how the rotation should change speed while closely following the rhythmic speed of the trill (bar 708 and 709) until the end of bar 709, where the piece ends on a long note, which again should come out of all ring speakers. For proper **spatialisation** on the last note we changed to our 5.1 bus, addressing all ring speakers and resulting in an **immersive shower** character. A lot of time went into experimenting with SPAT to obtain a correct **sound size**, **localisation**, and the end result was a very good **Klangbild** with clear control over **sound layers** (see appendix "comments sheet *Michaels Reise*" - comment #34).

Clarinets

The two clarinets, which enter fo the first time in bar 124, have a special theatrical function throughout the piece. Stockhausen's description from the score's preface explains: "Two clarinettists – a clownesque cross between swallow and penguin – whizz through the orchestra several times while playing."

They enter playing on top of the rest of the orchestra and soloists. **Sound presence** is important and every note they play should be heard, which means that constant **sound levelling** is needed. They disturb the music played by the other instruments, but this is their function. However, if they become too loud, the overall **sound layer** is destroyed and the complete **Klangbild** will suffer. For proper **sound-source localisation,** the clarinets were mixed into a mono bus that we projected over the front LCR system (speaker arrays IV – C2 – V). Following the clarinets' exact locations on stage ensured good **sound size** and perfect **sound-source localisation.**

5.3.7 Reflections

I chose to write about *Michaels Reise* because it stands as a groundbreaking piece for its time. The way in which Stockhausen managed to write a piece with so many different **immersive** characters and **sound layers,** which makes the piece very relevant and important to study for aspiring sound projectionists, not only for Stockhausen's music but also for working on music from many other modern classical composers.

Rehearsing the piece in LaZ proved to be rather challenging. The less suitable acoustics of LaZ, as earlier described, made it difficult to hear details and therefore, sometimes **sound layers** were not properly realised. This at times created much confusion for all parties involved, musicians as well as sound projectionists and music supervisors. Upon moving to the Gashouder we regained both tonal and dynamic control, and we finally could start to form a good **Klangbild.**

Despite the many sound indications and directions for amplification in the score, the complex immersive nature of this piece makes it challenging to learn and understand the **Klangbild**, and it has been invaluable to have the opportunity to learn this from Kathinka Pasveer, who worked on this piece closely with Stockhausen.

Upon performing the piece, the sound projectionist should only need to look at the indications in the score and follow the score for the essential cues as a reference, but should not need to read

every indication and direction since this would distract from giving his/her full attention to listening to the actual performance and balances. It is therefore essential that the sound projectionist learns the score and understands the **Klangbild** by memory.

Arne Bock

6 Overall Reflections

ABOUT THE PROCESS OF COLLECTING INFORMATION AND FINDING A STRUCTURE

The process of finding a way to document the knowledge required to project Stockhausen's work was quite educational and informative. First of all, an effective way for collecting and organising data systematically had to be found. Initially this was done in so-called Master Files, which were excel sheets containing information from the score and a collection of technical plans, drawings, patch lists and other necessary instructions to prepare the rehearsals.

As the rehearsals started, the need of a way to document the conversations, comments and remarks about the music, the ideas behind it and the expected result, was needed. Simple notations in text-based software were made, as well as audio recordings of the rehearsals. Soon it was realised that a better and more efficient way of organising this guidance was essential. A system of keywords evolved, where we could use one keyword in order to clearly and quickly categorise the given annotated information. In this way we managed to classify the information and the process became more comprehensive and manageable. It was quite important to do this systematically but yet also very hard to complete this, as our full attention was required constantly during the rehearsals. Sometimes there was even no time to document the moments during which we received guidance.

Another complication during the first rehearsals of some of the pieces was that the musicians were performing the pieces for the very first time, meaning they needed to get used to the sound image and find their role in the context of the music. This meant that some of the initial comments directed at the sound projectionists actually needed to be solved by the performing musicians, before a proper mix could be achieved. This made us realise that we needed to filter out some information, while only keeping important and relevant details to realise Stockhausen's ideas behind the score. We tried to interpret the information and document the essential comments regarding the sound projection, from information about specific cues in the score that needed more attention, to the sound image that Stockhausen had imagined.

When it was not possible to make proper documentation during the rehearsals, we found it very useful to reflect upon the rehearsal after it had happened and then document the essential information after all. Since there were several sets of rehearsals, this was still a good method to be better prepared for subsequent rehearsals. This in general proved to be very beneficial since we could then reflect and focus upon what a certain instruction could really mean in the context, sometimes realising we had to take into consideration that other actions were needed to realise the essential idea of the given instructions. The guidance wasn't always straightforward. When reflecting during a more dedicated moment, one could take a step back and contemplate on the entire situation and take all factors into consideration. Only after this process was done did the information start to make sense, and it could eventually make sense to others when trying to understand it too. In this way, a proper transfer of knowledge would occur by trying to make a

comprehensive overview of the general idea behind each work while also focusing on the important details of the music.

Once the information was collected, after the performances, there was time to contemplate on the entire period and write about our experience and knowledge collected. This was when the final organisation of the data was done, interviews were taken and feedback was collected from our supervisors on the keywords. Once we had all this information, we tried to put it together in a context so that it is more comprehensible. The case studies are our attempt to pass on the knowledge collected. We tried to deliver the essence of the music through the use of keywords.

Developing the skills of notating the conversations, ideas, remarks that come from the composer itself or his collaborators, reflecting on how rehearsals had gone, what were the negative and more importantly, positive observations, has proven to be the best tool one could have in this situation. Planning how to follow up on these findings makes every rehearsal count, and together with the musicians you are making progress in getting a better overall performance. This practice of reflection helps sound projectionists to get inside the essence of music and eventually craft the desired mix.

Even though the process of documenting sound projection is very helpful, it is not always possible or easily achievable. Time is normally a big constraint to work in this way. Furthermore we had the luxury to work for a long period with the experienced sound projectionists Pasveer, Jeukendrup, Panis and Klose, who were also our supervisors in our master's programme and we could therefore harvest from their experiences.

ABOUT THE SOUND PROJECTION OF STOCKHAUSEN'S WORKS

As mentioned before, the role of the sound projectionist in the realisation of Stockhausen's works is quite complex. The sound projectionist, together with the conductor and the musicians, is responsible to realise and deliver the composer's ideas. His/her role is as important as for instance the one of a soloist. It is essential to get acquainted with the performance practice of the composer's work and to create a situation where this could be realised.

Having the proper system design and acoustical properties in the performance venue is quite essential. Once rehearsals started in the Gashouder, we found ourselves in a much more controlled environment with better sound detail and a lot more space for the sound to develop. This, as it was concluded in the interviews with our supervisors, was quite an improvement over the situation we had during the rehearsal period and even over previous productions. It made all the details in the tape music very clear while being better suited for instrument amplification as well. It meant, however, that we had to adapt our mix to the new situation. We were expecting a significant change when moving from one rehearsal space to the next, however, the fact that we had prepared the music extensively gave us the possibility to anticipate and quickly adapt to the new situation.

Stockhausen clearly indicated his preference for the use of point-source speakers throughout the prefaces in his scores. Initially it seemed a risky step to work with line-array systems instead, but in this particular situation, as Pasveer and Klose also confirmed in their interviews, the music benefited greatly.

Another important aspect in terms of sound projection is to have a practical mixing setup that will allow the sound projectionist to keep his focus on the music and the mix, rather than being distracted by technicalities. Being familiar with the equipment that is used and organising it in a way that lets you work more efficiently is as essential as knowing the music.

A good balance between the tape music, and the electronic and acoustic instruments is quite important in Stockhausen's work. In some scores there are indications of playback levels for the tape parts. However, these are to be determined based on the performance venue and equipment as well. It is important to find a balance and make sure there is space for the details of the acoustic instruments to come through. This is the reason that in some scores there are indications of fade ins and fade outs. Having some context about the ideas behind the role and function of the tape parts in a particular piece helps to determine the proportions between the instruments and tape sound, as Pasveer mentions in her interview.

In order to project Stockhausen's music it is essential to understand the sound picture that has to be achieved, and this varies a lot from one piece to another. Despite the many sound indications and directions for sound projection in the scores, a clear image can be formed only when one has the chance to work extensively in a live amplification situation with dedicated musicians, as was the situation in *aus LICHT*. As Pasveer mentioned in the interview, indications in the score, specifically plusses, minuses and dB values are not to be followed literally but taken as a reference, and it should be seen in the rehearsals whether these are relevant to that particular situation. These indications were taken from the premiere of the pieces, but even Stockhausen himself made subsequent notes that are not in the score and are only to be found in the archive of the Stockhausen-Verlag. That does not mean that these annotations should not be taken into consideration seriously: the sound projectionists need to know the desired sound picture as to be able to understand how these annotations should be applied. Additionally it is very helpful if one can understand in which context the indications were added.

As Pasveer remarked, the score should be learned and followed for the cues and annotations, whereas the connection with what is happening on stage should always have the main focus in order to have a successful performance.

We are extremely grateful to have had the opportunity to work extensively over such a long period and on several of Stockhausen's works with Kathinka Pasveer. We feel we have had the chance to develop a unique insight into Stockhausen's musical universe.

A special thank you to Kees Tazelaar for proofreading and helping us with finalising this document.

Last but not least we also want to thank the musicians and all the people who were involved with us in this production.