

## A Mathematical Musical: “Dimension Neukölln”

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### Abstract

The project *BeVoice* aims to explore the intersection of science, in particular mathematics, and music theatre. The scientific subject serves as an inspiration for the creative process of making the music, choreography and stage setup. The novel exposure to the scientific subject of the participants and the audience is a welcomed side-effect.

The theme of the musical in 2019 was a mathematical subject: dimensions. About 150 young people from Berlin and the Netherlands rehearsed and performed a music theatre performance piece that was especially written for them. The storyline had no narrative, but instead was conveyed through the geometrical development from dimension zero to a room with infinite dimensions.

### Project Description

The project *BeVoice* is a bilateral youth project, in which a group of about 150 young people from Berlin and the Netherlands rehearse and perform a music theatre performance. The goal is to stimulate international exchange and to bring youths with different backgrounds together and spark an interest in the arts and science. The participants from Berlin (about 120) have a low socioeconomic background. The Dutch guests (about 30) study at a special school for performing arts. During the rehearsal week, the Dutch guests stay with host families in Berlin and an immersive cultural exchange begins.

The project was founded in 2011 and recurs each year with another special theme in the domain of exact sciences. In the most recent, we had four themes based on mathematics: chaos theory, dimensions, binary and infinity. The themes are an inspiration for the lyrics of the songs, the newly developed choreographies and specially composed music. For audio-visual examples, see the project’s homepage [www.bevoice.eu](http://www.bevoice.eu).



(a)



(b)

**Figure 1:** Impressions of the dance Dimensionsreise.

## The Process of Making a Musical

To exemplify the process of putting a mathematical subject on a musical theatre stage, we briefly want to describe the musical “Dimension Neukölln“. The first author, René, is the artistic leader and initiator of the project. In the recent years, he was supported in scientific questions by the second author, Anna.

### Preparation

A year before the rehearsal started, René chose the topic of the next musical to be *dimensions*. In the brainstorming process he met with Anna and her colleagues from the group of Discrete Geometry at Freie Universität Berlin and got familiar with the major ideas of dimensionality. It became clear at this point that the connection and composition of dimensions would be the leitmotiv of the show.

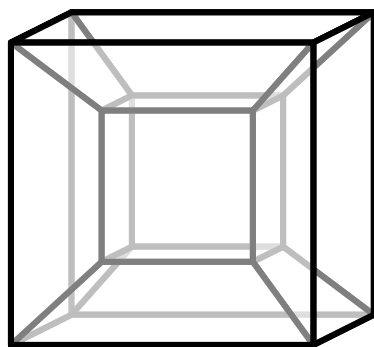
The creative process opened up. Together with a team of choreographers, composers, musicians and the conductor, René developed the music, choreography, costumes, and stage design.

About half a year before the show was performed, we visited the participating young people from the Berlin neighborhood Neukölln, who are about 15-16 years old, to introduce them to the project and the mathematical background. At the end of the lecture a group of volunteers was gathered to collect ideas and write lyrics for the songs.

### The Project Week

During the project week, the whole group of participants worked together for five days. The participants had only one week to rehearse the theatre performance. To motivate the participants, we optimized all conditions and we treated them as professional artists: there were snacks and freshly cooked food, nice costumes and a professional theatre environment. At the beginning of the project week, Anna gave a lecture. She talked about the theme and explained the connections of the show to mathematics.

Because most of the participants have never been on stage before, the Dutch teachers played an important role: they are specialized in working with youths and are able to make one group of the participants who have all different backgrounds. The experienced young dancers from the Netherlands inspired their German peers. However, working under time restriction was new for the Dutch dancers, who are used to striving for perfection. They also had to learn to make concessions and to change plans in order to finish the choreographies.



(a)



(b)

**Figure 2:** (a) A two-projection of the Schlegel diagram of the hypercube, and (b) impression from the choreography of *Kopfüber*.

### The Shows

After one intense week of rehearsals, there were three shows for a full house. The performance started with a public lecture by Anna and René, in which they explained the mathematical theme to the audience.

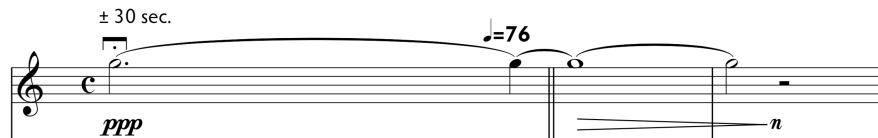
The show started with an overture (in which the audience already recognizes the mathematical ideas), followed by songs and instrumental pieces resulting in a one hour music theatre piece. They were live accompanied by an orchestra of 30 young musicians from the Netherlands and Germany. It was a mixed group of talented young people in different stages of becoming professional musicians. The three performances were viewed by 270 people each.

## Mathematical Themes in the Piece

### *Journey of Dimensions in Choreography and Music*

The piece *Dimensionsreise* (engl.: Journey of Dimensions) started with a group of dancers covered by a large piece of black fabric with holes. When the music started, one dancer put their head through a hole, representing dimension zero. They were joined by some more dancers, resulting in a one dimensional line. As the remaining dancers popped their heads through the black fabric, they completed a plane in two dimensions. The following up and down movements represented the three-dimensional space, see Figure 1.

This journey through the dimensions is also the guiding principle in the musical piece of *Dimensionsreise*. It starts with just one tone, dimension zero.



A melody forms which represents a second degree of freedom.



Now harmonies are added and a three-dimensional space of sounds emerges.

A musical score for a full orchestral ensemble. The instruments listed are Flute (Fl.), Clarinet (Cl.), Tenor Saxophone (Ten. Sax.), Baritone Saxophone (Bari. Sax.), Trumpet I (Tpt. I), and Trumpet II (Tpt. II). The score shows various musical notations including notes, rests, and dynamics like *mf* and *pp*.

### *Dancing the Hypercube*

After the journey through the dimensions from a singular point to the Euclidean space, it was time to leave the realm of the familiar and turn towards the abstract four-dimensional space. In the piece *Kopfüber* (engl.:

Head over Heels), the dancers formed the three-dimensional projection of a hypercube and then let it rotate, see Figure 2.

### **References to the novel *Flatland***

The musical piece *Flächenliebe* (engl.: Flat Love) centers around Abbott's novel *Flatland* [1]. It is a typical musical love-song, which is sung in the form of a duet by a woman and a man, who refer to their respective shapes: a line and a square. Below are the first four verses of the song together with an English translation.

#### **Flächenliebe**

*Frau:*

Du schickst ein Signal,  
Deine Vielseitigkeit kommt gut an.  
Ich bin mir nicht sicher,  
Komm mal näher heran!

Du bist markant.  
Ich taste dich ab.  
Ich mag deine Ecken,  
Die Basis noch knapp.

*Mann:*

Du bringst es auf den Punkt:  
Scharf und spitz.  
Du kommst auf mich zu,  
Es trifft mich wie ein Blitz.

Du bist gefährlich,  
Ein Stich in meinem Herz,  
Durchbohrst meinen Körper,  
Ich schreie laut vor Schmerz.

#### **Flat Love**

*woman:*

You are sending a signal,  
Your many sides are endearing.  
I am not so sure,  
Come closer to me.

You are clear-cut.  
I am testing your shape.  
I like your edges,  
And your basis, just so.

*man:*

You are making a point:  
Sharp and acute.  
You are coming towards me,  
It hits me like lightning.

You are dangerous,  
A stab in my heart,  
Piercing my body,  
I scream out in pain.

*Flatland* gave us even more inspiration. The depiction of women in Abbot's novel is rather misogynist. This caused a discussion about the power of women in the group of young people writing the lyrics. One of them said, that a new dimension for them would be, if women had more power. This idea resulted in the song *Macht Macht* (engl.: Power Power) about the power in any woman.

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### **References**

- [1] *Flatland: A romance of many dimensions – With Illustrations by the Author*, A SQUARE, Abbott, Edwin A., 1884, <http://www.geom.uiuc.edu/~banchoff/Flatland>.