Stage for music visualisation

The Stage for Music Visualisation is a forum for the visual interpretation of Beethoven’s works.

Music research related, dramaturgic, reception-aesthetical and historic structures of Beethoven’s works are reviewed, tested and presented to the audience in a virtual environment which provides the use of three-dimensional image and sound reproduction as well as interactive devices.

The basic idea here is to bring together presentation, analysis and interpretation.

“Fidelio, 21st century” and “Presto 126/4” are the first two works produced for the Beethoven-Haus.
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Music visualisation

The genre “music visualisation” represents a new form of music and theatre, combining traditional and experimental means of expression. The question of how new technology can be employed to communicate content has been answered clearly: Three-dimensional computer visualisation enables us to experience Beethoven’s music in a new and different way. The new medium “Virtual World” offers the opportunity to explore spatial-scenic, aesthetic and interactive strategies.

The first two Beethoven pieces that were transferred into the visual 3D medium are the opera “Fidelio” and the piano bagatelle op. 126, no. 4.

The music visualisation of these two compositions is not based on subjective synaesthetic models. Nor does it illustrate feelings or colour frequency curves. Instead cutting-edge hardware and software (amplifiers, projectors, screen, interactive devices, programming and data) is used to create an entirely novel effect of three-dimensional sound, space and image for the audience. Hereby the basic idea is the following: Music is a flow (process in time) consisting of sounds which, in turn, creates a flow of image data. The image data flow is controlled and can be shaped by programming code.
Fidelio, 21st century

The Stage for Music Visualisation was inaugurated with the performance of “Fidelio, 21st Century” (production: Fraunhofer Institute for Media Communication; director Johanna Dombois; realisation: Vertigo Systems GmbH and rmh new media gmbh). Behind this performance stands the most modern interpretation of the historic material which Ludwig van Beethoven used for the third and last version of his only opera “Fidelio”, performed for the first time in 1814.

With regard to the fact that stage productions convey their message mainly by their performance and that their survival depends on questioning the message over and over again, an opera like “Fidelio” particularly demands a modern interpretation. Beethoven himself edited his “Fidelio” numerous times. The subject matter had to be adapted to changing historic and organisational conditions. So, the discrepancy between old and new is a vital characteristic of this work.

From this standpoint, it seems to be a naturally grown desire to perform Beethoven’s “Fidelio” in a way also applicable to the new 21st century. “Fidelio, 21st Century” is the attempt to confront a classical piece with new media. And this attempt alone triggers a lot of tension and thrills at the Beethoven-House: As is generally known, Beethoven’s “Fidelio” takes place in a vault. And so, “Fidelio, 21st Century” is performed in the historic vault of the Beethoven-House which accommodates the Stage for Music Visualisation.

Old and new at one place, that means in particular: Through “3D virtual reality technology”, the opera is performed as a vivid interactive theatre play. Standard singers are replaced by a cooperative group interaction. “3D-Virtual Reality Technology” and 3D image sources offer new scenic possibilities. Using a tape and a cut version, the first “3D sound projection” for a standard opera piece was created. In brief, the opera (once again) becomes an area of sound. Still, the technology for virtuality does not question the authenticity of the music but sharpens the audience’s awareness and consciousness for the music.

Altogether, the genre of music visualisation can be regarded as a form of vivid theatre. In a virtual environment, programme code controls the flow of images whereas the flow of notes, essential for music, can be presented with more than just images. Thus, by means of virtual environment, the opera can realise its traditional demand, namely the equitable unity of sound and image.
Summary

Like other classical operas “Fidelio” consists of main and subplots, main and auxiliary characters and consequently a complex mesh of relations. Simultaneously, an opera performance in a virtual environment must also deal with elaborate technical structures. Therefore, the opera’s own complex structure in a novel production environment is exposed to new limits.

Depending on the technical requirements and in accordance with the direction concept, “Fidelio 21st Century” is based on a cut version. The shortened version does not want to reduce the original work but aims at concentrating the plot. The following is a summary of the resulting “Fidelio”:

During the introduction the previous history of Florestan and Pizarro is illustrated in fast motion. The audience witnesses a dispute between the two opponents. In the end, Florestan is defeated by Pizarro and a prison is constructed around him. Held prisoner in a dark dungeon, Florestan patiently awaits his end which he cannot avoid under his own steam. But suddenly, a vision of his wife Leonore as an angel gives hope that his pathetic situation can be changed and he be released from prison. But the vision fades away quickly.

Its disappearance is accompanied by a shrill whistling signal from Rocco, the prison guard, who then opens the dungeon entrance. From the dark where he has hidden all the time Pizarro now emerges. He is still yearning for revenge and comes disguised to kill Florestan. Florestan can only defend himself with words. Pizarro then discloses his identity and pushes forward to Florestan, the dagger in his hand.

All of a sudden and completely unexpected, screaming Fidelio throws himself between Florestan and Pizarro, protecting him with his body from Pizarro’s attack. In the ensuing melee Fidelio discloses his real identity as Leonore, Florestan’s wife. Consternation gives way to confusion. Pizarro then pushes forward towards Leonore and Florestan, trying to kill them both. He pulls the dagger, aims and raises his arm for the final attack. But Leonore fends it off. With her last power, she pulls a weapon of her own against Pizarro. Simultaneously, the first trumpet signal resounds, announcing liberation through a higher power.

The persons involved freeze, both in horror and relief, as if a miracle has just happened. The crisis seems over. A second trumpet signal can be heard from high above and order returns. Leonore and Florestan consider themselves liberated, Pizarro found guilty and Rocco duped.

Florestan and Leonore set the seal on the end and celebrate their rescue, reunion, liberation and Pizarro’s disempowerment.

Only scenes taken from the second act of “Fidelio” were used for this cut version. The strangely sad humorous couple of Marzelline and Jaquino, whose tale dominates
the first act, was left out. Also Rocco’s solo sections, the (second) great finale at the end of the second act as well as all dialogue scenes were omitted.
The scenes

The following list of the staged plot knots shows how profoundly traditional stage direction and new media have become merged in “Fidelio 21st Century”.

1. Plot knot: “Duel” [Introduction]
The orchestra introduction of the second act gives “Fidelio’s” previous history in fast motion. The plot’s framework is established by introducing the main characters, Florestan and Pizarro, both separately and opposing each other. The conflict of principles, a central characteristic of “Fidelio” is expressed in two ways: Artistically by the animation of the figures and technically through the way these figures are created.

2. Plot knot: “Prison” [Introduction]
The creation of the stage setting emphasises the duel between Florestan and Pizarro: With Pizarro’s help the audience can build the prison interactively during the introduction. In this regard, the correspondence between figure and architecture is substantial. Pizarro, who is represented with bars, does not only support the prison construction but is the prison himself. Therefore, Florestan is not just captured by a person but by the prison itself. As Pizarro is closely linked with the prison, the stage setting can always react dynamically or statically according to the plot or Pizarro’s movements.

3. Plot knot: “Sound area/surround sound” (recitative Florestan)
Florestan’s recitative describes his desolate state in the dungeon. To interpret his feelings with the correct scenes and acoustics, camera apertures were used for the first time in a virtual environment. The prison’s size, width and depth can then be seen from various perspectives. Each aperture was exactly adapted to the music’s course and generates an individually different listening angle. Thus, the musical apertures constitute the music which has turned into space. The natural surround sound of the scene can be influenced by the audience’s interaction and becomes a vivid area of sound.

4. Plot knot: “Epicycles” (Florestan’s aria)
The second relevant key scene besides the prison construction is the moment when Florestan has a vision of his wife Leonore. This scene serves as an indication of Leonore’s later appearance and Florestan’s liberation. Florestan’s basic figure is represented by a chain spiral. During the vision, the spiral unchains and its radius increases. Florestan literally outgrows himself. By means of so-called epicycles - specific forms of spiral creation that can be moved on three-dimensional orbits - he bursts his shackles and overcomes gravity. The dungeon extends. “Yet shines for me a rainbow, which bright on the darkening clouds rests” - what Leonore has just sung has become true for a precious moment thanks to Florestan’s power of imagination.

5. Plot knot: “Whistling Rocco” (transition to quartet)
The whistling signals that Rocco and Pizarro use as a code for the conspiracy murder
were staged in a special way for “Fidelio 21st Century”. These signals are given not only at the beginning of “Fidelio’s” key scene but together with the trumpets they can be regarded as an acoustic frame around the famous murder quartet. Insofar, two details are decisive: On the one hand, Rocco does not only give these whistling signals but the entire figure of Rocco that was already pinned down to the role of a negotiator in the libretto is made up of these signals. At this point, acoustic and optical information overlap each other exactly. On the other hand, the dramaturgic whistling signals are used to outline Rocco’s character. For example, the third signal indicates the melody that always precedes Pizarro’s appearance.

6. Plot knot: “Uncovering Pizarro” (quartet)
The fact that Fidelio’s libretto not only features an uncovering scene for Leonore but also for Pizarro has been ignored in most Fidelio performances. As this proves to be an interesting factor for the balance of all characters, “Fidelio 21st Century” includes a change of appearance for Pizarro as well. When he reveals his role as avenger and his motivations, he loses his toughness - dialectical moment of weakness in the moment of strength. Pizarro, the resistant figure made of bars, who entrenched himself behind the prison bars, is deprived of his armour. It softens and its rigid movements melt away. At the peak of its power, the figure Pizarro is deprived of its influence scenically and technically (all of a sudden the figure animation is overlaid with particle effects). The plot Pizarro has driven so far starts to turn against him.

7. Plot knot: “Leonore’s appearance” (quartet)
The positive shock triggered by Leonore’s appearance as well as her rescue mission belong to the strong moments of the classical opera literature. In the moment of the most imminent danger when Florestan’s life is threatened by Pizarro, Leonore appears as an incarnation of protection and defence. From high above she falls down right in the centre of the scene as a staggered wall. Martially and without being affected by the fluent movements of the music, she separates assailant from victim. Pizarro’s murder attempts do not only recoil off Leonore emotionally but also scenically.

8. Plot knot: “Leonore’s uncovering” (quartet)
The evil uncovering of Pizarro is opposed to the good uncovering of Leonore: At the peak of the general confusion, she reveals herself as a woman and as Florestan’s saviour. In “Fidelio 21st Century” this moment is not expressed through a cultural historic or even feminist interpretation but through Leonore, who in the form of a staggered and well-fortified wall suddenly warps and becomes affected by the music’s energy when the famous line “Yes, see here, Leonore!” is sung. Leonore’s double character (the weapon bearing peaceful woman) constitutes a conflict and shows as a soft wall. In the end the music itself is staged as an element of catharsis - the music’s influence on Leonore’s figure indicates the beginning of a happy end channelled by the music.

9. Plot knot: “Overgrowing” (quartet)
After Leonore’s uncovering the plot approaches its inevitable crisis. Both the music
and the scenes describe the loss of orientation. In “Fidelio 21st Century” this tremendous congestion and cross-fading of individual and group dynamical actions is shown by the so-called “overgrowing” of the particle systems. Florestan, Leonore, Pizarro and Rocco, all made of particle systems, flow over. Their particle units become unchained and in a sense, they transpire particles while an unrestrained particle acceleration takes possession of the stage. The loss of order becomes visible and optical stress is the outcome of emotional involvement.

10. Plot knot: “Stab of a dagger” (quartet)
Pizarro’s attempt to kill not only Florestan but also Leonore leads to several strings of actions merging at one point. When Pizarro grabs his dagger, Leonore fends him off and suddenly draws a pistol. All this is then overlaid by the rescuing first trumpet signal. Therefore, it became an imperative for “Fidelio 21st Century” to depict this enormous depth of actions. In addition, the performance was to show that many stagings of “Fidelio” distinguish between Pizarro’s “evil weapon” and Leonore’s “good weapon”. The scenic resolution of “Fidelio 21st Century” is characterised by the “change of arms” and the compression of scenic media: Pizarro’s dagger is aimed at Leonore who does not react with a weapon of her own but deftly takes Pizarro’s dagger away and directs it towards him. The weapon recoils off Leonore’s wall and is returned to its owner, Pizarro, who is quite surprised by the attack. It seems as if the air flow of the trumpet signal gave rise to Leonore’s defence mechanism and even guided the dagger. The plot’s core is the movement of the dagger whose trajectory is a visualisation of the trumpet’s melody.

11. Plot knot: “Breeze” (intermezzo)
Whereas the exacerbation of the murder quartet creates optical stress expressed through the overgrowing of the particle systems, the present breeze stands for a desire for order. As the intermezzo already indicates the wonderful rescue initiated by the trumpet signal, the breeze effect represents the literal “atomisation” of the scenic disorder: Suddenly, the particles are swept away by a gust of wind and disappear like a bad dream upon awakening. The stage becomes clear again and an invisible force re-establishes the order.

12. Plot knot: “2nd Trumpet signal” (intermezzo)
While the first trumpet signal in “Fidelio” is followed by Catharsis, the second signal announces the wonderful effect of that Catharsis. Thus, the symbols of rescue are of major importance in “Fidelio 21st Century”. With regard to the fact that the music itself serves as a means of rescue, the first trumpet signal controls the dagger’s trajectory between Pizarro and Leonore. The second signal recapitulates this event but not from the audience’s but the weapon’s perspective. A camera panning upwards repeats with other means what was earlier shown as a sequence of attack and defence. The scene depicts the dagger’s perspective as it is controlled by the music. At large, this is a comment about the authorial perspective of the trumpet sound which has always been interpreted as an unearthly moment or associated with a divine power.
13. Plot knot: “Reversal - Prison” (recapitulation)
During Florestan’s vision the dungeon already started opening through the power of imagination. At the end, it will disappear completely. After the second trumpet signal the fronts turn and the party of Leonore and Florestan increases its power while Pizarro’s influence dwindles. In this sense, the prison loses its relevance in the characters’ minds whereas the idea of liberty becomes almost tangible. In “Fidelio 21st Century” the process of liberation is marked with the effect of turning the prison upside down at the end of the recapitulation. By means of a Moebius transformation the virtual stage setting turns from an internal to an external space. Not only in a mathematical context this process is identical with the reinterpretation of space definitions. Florestan, the prisoner, is free, Pizarro, the capturer, is captured. Leonore’s power of love has turned the static environment into a dynamic one. In theatre history this fortunate liberation and unleashing is equivalent to the development from a raree show stage into a full stage.

14. Plot knot: “Magnetic point” (duet)
The love duet between Florestan and Leonore is the finale of “Fidelio 21st Century”. The idea that love can reunite what has been separated is technically expressed by means of a magnetic point. Still individually moveable through audience interaction, Florestan and Leonore are magnetically drawn to each other. They are automatically oriented to each other and always come back together despite the greatest distance. The magnetic power exceeds the [interactive] idiosyncratic forces. That means that in the world of liberty, Florestan and Leonore depend on each other in an equal and friendly way. In programming this state is achieved by using so-called “affection functions”.

15. Plot knot: “Entries and exits”
The considerations for entries and exits of the involved characters are a scenic unit. For example, Leonore’s entry does not accidentally come from above, the same direction that the trumpet signal came from, but clearly indicates the “divine” or supernatural perspective from which rescue will come. Florestan’s entry is from the front, the only open direction for seeing the events (in three-dimensional space the fourth wall dissolves). Then, Florestan is pulled toward the front left centre. Pizarro, the omniscient negative power appears ghostlike out of the dark and moves toward the front right centre, away from his opponent. Rocco appears from behind, his hiding place, where the back prison wall is located [zoom technique]. Upon exiting, he is pulled back there [reverse zoom technique]. While fleeing, Pizarro is frozen: He remains stuck between front and back and is neither granted redemption nor an exit from the plot. Florestan and Leonore stay. Their strength came, comes and will come from their presence.

(All information on scenes and music dramaturgy taken from the direction notes by Johanna Dombois.)
Music and sound

Contrary to traditional staging techniques, staging music in a virtual environment requires tapes. Consequently, a recording was used for the production of “Fidelio 21st Century”.

Because only a multi-track recording could serve as basis, not only questions about the interpretation, legal availability, performances of the singers and opportunities for a cut version had to be answered when choosing the recording but also questions regarding the recording technique. Finally, the “Fidelio” recording of the Vienna Philharmonics under Leonard Bernstein from 1978 was selected. The solo singers are René Kollo (Florestan), Gundula Janowitz (Leonore), Hans Sotin (Pizarro) and Manfred Jungwirth (Rocco).

In the virtual environment the recording is the foundation of the direction concept which is used to transfer the music into plausible figure movements.

Besides the opportunity to involve the audience and move the characters independently of the notes, the figures should not only interpret the music but also display it in line with the score. By enhancing the capacities of the opera characters, the figures themselves should become music - music transposed in images.

To achieve these aims, “Fidelio 21st Century” had to be analysed following new rules. Three basic parameters were selected (“energy parameter”, “adrenaline parameter” and “breathing parameter”), converted to numeric values, transformed into curves and fed into the figures by means of a curve editor. In line with Beethoven’s musical directions the figures are now able to move with the utmost exactitude.

It is important to note that working with the parameters in detail has given rise to a different understanding of music analysis and stage direction. On the one hand, it is still unusual in music science to analyse classical music as a continuous flow beyond its motive-related structure. On the other hand, a new feeling for material has developed in the field of stage direction. When instead of incarnate singers abstract curves can be guided with a maximum of exactitude and when digital instead of analogue relationships can be plumbed, the technical requirements enable us to generate poetic moments in new environments. All in all, both disciplines experienced the exactitude and meticulousness necessary for working digitally as a debatable form of faithfulness towards the original.

Furthermore, “Fidelio 21st Century” sets great store by sound quality. Similar to the 3D images an innovative sound engineering approach was followed when setting the notes in a three-dimensional context. Thus, the virtual space could be plastically shaped (spatial sound projection.) The sound sources now move together with their figures - an acoustic event that bears a great psychological value of insight for an opera staging.
Direction concept

The direction concept for “Fidelio 21st Century” is based on the idea that new media provide technical opportunities applicable to operas but are still met with suspicion. (Taken from Johanna Dombois’s direction notes)

Technical progress has substantially changed our everyday life - cell phones have changed our way to talk, e-mail our way to write, videos our way to watch, computers our way to think. But in the field of operas we are still satisfied when new costumes are made for an old piece. However, this is no more than updating the surface. Any attempt to modernise an opera and adapt it to our everyday life results in the reproach of destroying the poetic content of the music theatre. Could it not be that this reproach itself is based on helplessness and yearns for refreshment?

The use of new technologies does not automatically mean to disenchant or betray the original. Particularly in the field of opera new media might be ideal to guarantee an utmost faithfulness towards the piece. This is like in fine arts where only radio-carbon dating delivers the exact age of some panel paintings. And even our desire for valid images could be satisfied through a plain number code if this code had been generated yearningly.

Therefore, “Fidelio 21st Century” mostly aims at reconciling the technical and artistic content. Both new media and the genre of opera are put to test: How strong is the mutual influence? How can one profit from the other in the future? Do methods overlap? The virtual environment is an ideal basis to answer these questions: Both the fields of scenes and acoustics as well as interaction offer the opportunity to find and test new strategies.

The fact that Beethoven’s “Fidelio” is politically motivated and has always lead to political interpretation shall not be neglected. Quite the opposite is the case. But the direction concept for “Fidelio 21st Century” assumes that a political comment does not always have to describe a political situation. In a larger sense “political” can also mean anything that makes modern techniques and technologies be more than just serve a mechanical purpose. The messages alone are not enough. We also need to develop an attitude.
Sound projection

The sound projection at the Stage for Music Visualisation of the Beethoven-House uses advanced technological developments of the multi-channel real-time processing for sounds to generate an immersive and interactive sound environment for Beethoven’s music. The recording of an original performance during which the individual sound components are recorded on separate tapes serves as a basis. For the production of a CD these components are then carefully edited at a mixer until the desired sound characteristics are achieved. In contrast, the virtual stage at the Beethoven-House uses technologies that combine these sound components to an interactive spatial sound environment in real-time.

In addition, “Fidelio 21st Century” gives the visitors an opportunity to influence the performance and express their own interpretation to a certain extent. The result is an environment of sounds that can be adapted in terms of spatial impression, positioning and distance and that coincides with the three-dimensional figures presented by the virtual staging. To position the four mobile sound sources (i.e. the four singing voices) in the virtual space, several technical levels of the sound editing are combined:

1) The sound source is placed into the 17 loudspeakers according to its scale (VBAP technology). This results in a high degree of sound fidelity and a clear position.

2) The sound sources are simulated in a three-dimensional acoustic space. This simulation consists of a dynamic real-time reproduction of sound reflections at the walls of a virtual concert hall and a diffuse echo. Both are then projected into the room and enclose the audience from all sides.

3) Beyond the real-time simulation of the acoustic environment the figures and sound sources move through a spatial topology of sound parameters. In this layer the sound setting parameters used for the possible locations of the sound source are fixed. The same applies to the figures parameters used for the chronological process of the plot. Thus, impressions for distance, proximity, size etc. of the sound source can be associated in the virtual space.
Scene and setting

Because “Fidelio 21st Century” takes place on a virtual and not a traditional opera stage, the direction concept had to arrange for scenic settings that applied to these new conditions.

But neither the simulation of people nor the digitalisation of historic events would have served the purpose. Both would have been totally anachronistic. Instead there are a number of reasons that imply that Beethoven himself favoured people as a medium for abstract ideas instead of historic characters for his “Fidelio”. The motto the composer chose for his sixth symphony could also apply to “Fidelio”: “Expression of emotion rather than painting.”

For these reasons “Fidelio 21st Century” is based on abstract figures. The futuristic quality of the virtual environment is used to make the complexities of Beethoven’s music visible. “Abstract forms for the opera stage: The conviction that the main criticism of the opera, namely that it is not realistic, is its very element. (Taken from Johanna Dombois’s direction notes.)

It is through the use of particle systems that the abstract representatives of the four main characters Florestan, Leonore, Pizarro and Rocco look like energy fields and have the ability to react. Thus two basic conditions were met:

First, the figures can now be employed beyond a naturalistic designation as forces with and against each other. Their hidden motivations already contact each other through their external appearance.

Second, the energetic principle allows to go beyond a plain illustration of the opera and its historic interpretation. If an opera depends on a continuous flow of music, it also needs figures capable of expression anytime during the plot. It seemed to be in line with digital music visualisation to create characters that continuously merge into each other just like the data flow that evokes them and the music that generates them.

Altogether two impulses are responsible for moving the figures of “Fidelio 21st Century”: Firstly through the music that is fed into the figures by means of music scientific parameters and secondly through interaction. The viewers are given the opportunity to test the energy fields’ individual degrees of strength and weakness, an activity equal to a form of stage direction. Everybody can take on the role of director and test which figure combinations and positions are visually and acoustically intriguing.
Supertitles

During the past few years it has become common to use supertitles even in operas and enrich the performance with the text material.

Typically, opera performances are significantly influenced by the speed at which the music is performed. And this speed in turn depends on the conductor. Therefore, it is impossible to give the full supertitle or show them exactly on time with the current scene. They are just a compromise.

The musical plot in "Fidelio 21st Century", however, is based on a recording. Speed directions are not subject to change but can be reproduced. Insofar, it is possible to display the supertitles with an exactitude that is not only unique but also renders the performance more aesthetic and interesting.

Detailed supertitles provide an optimum of orientation in a virtual environment. As the supertitles for "Fidelio 21st Century" exactly follow the music, an absolute congruence between the opera characters and their respective singing can be achieved, resulting in conducting engagements of the text material "Fidelio" is based on. The written word itself becomes music and is given the scenic relevance it describes.

In addition, "Fidelio 21st Century" features multi-lingual supertitles. Apart from German, the text material is also available in English, French and Japanese.

The foreign language versions were written especially for “Fidelio 21st Century” (English and French by Joachim Kalka, Japanese by Tomonari Maeda). They are new interpretations of the common libretto translations.
The figures

Florestan is represented by two converging spirals irreversibly winding downwards. They stand for thread of life, chain, rope and shackle, all prototypical forms to create various levels of connection and unleashing. High music or scenic energy increases the diameter and the elastic tension between Florestan’s spirals. Temporarily, the figure overcomes gravity. During the vision, the so-called epicycles generate a special form of spiral creation that can be moved on three-dimensional orbits - an expression of how Florestan’s bursts his shackles.

Leonore builds a staggered wall, meaning protection and defence. During the uncovering Leonore’s wall segments contract and are suddenly gripped by the music. She turns into a movable wall, a productive contradiction the figure has always used to express itself.

Pizarro defines himself by means of seven different bars. Their movements follow a specific choreography and are recomposed into various groupings over and over again. Thus, Pizarro represents the prison. It is important that Pizarro not only becomes identical with the prison but that his bars and prison bars also symbolise lance and dagger and thus an aggressive and indicative gesture expressing the thought of murder. All in all, Pizarro is comprised of figurative, physical and architectural metaphors.

Rocco is represented by two balls lying within each other and rotating in different directions, an expression of the clumsiness and poor sound-proofing symbolised by this figure. The ball as the only closed geometric figure in “Fidelio 21st Century” expresses Rocco’s lack of emotional movement and his restricted inclination to be self-focused and not look beyond. In addition, Rocco’s figure includes three tentacles spreading from the balls’ centre, symbolising the (uninterrupted) relations to Florestan, Leonore and Pizarro. Rocco has a catalytic character which is often underestimated. He is the one who establishes contact between the other figures and keeps it up. Without Rocco, there would not be any confrontation. He has the key for the prison and thus for the core of the plot.

The interactive devices were adjusted to the respective opera characters. A scenic basic situation is created even in the auditorium.

The interactive device for Florestan consists of two closed rope loops. They symbolise his captivity, his altering freedom of movement and optically represent his flexible spiral form.

The device to control Leonore features four sensors. It uses Theremin technology and works without touch. Leonore’s interactive device expresses the transcendent quality of her character, her nervous desire to be entirely free from all given control.
mechanisms. The device’s technical dynamics are taken into account to enable its figure to withdraw from any dictatorial use.

The interactive device for Rocco is a large and heavy ball that can be turned in any direction. It symbolises Rocco’s catalytic and yet clumsy character, represented on stage by a ball circulating in itself.

Pizarro’s interactive device uses an icon of computer games: the joystick. On the one hand, the joystick, often associated with power and dynamics, represents Pizarro’s attacks. On the other hand, it represents Pizarro’s basic form of crossing bars that also symbolise dagger and prison bar.
Synergy of Disciplines

Although artists consider the genre of opera as the interdisciplinary genre par excellence, “Fidelio 21st Century” is much more than this. The four year long production of Beethoven’s “Fidelio” and “Presto 126/4” in a new technical medium brought together a number of experts in art, music and technology and the following disciplines:

Opera direction, dramaturgy, cultural studies, musicology, dramatics, virtual reality, informatics, modelling, animation, sound engineering, acoustics, mathematics, computer graphics, media art, visual arts, translation, architecture, air conditioning technology, marketing etc.

In order to allow for high-definition work, all these people with their different skills and characters had to be joined and production processes had to be designed to make sure that everybody involved could contribute to the common goal.

All in all, this interdisciplinary effort can be illustrated by an example where stage direction, musicology, visual effects and sound technique were required in various ways:

By using scenic, musicology and dramatics-related aspects, the stage characters for “Fidelio 21st Century” were assigned to abstract forms consisting of so-called particle systems. Parameter curves describing the time behaviour of form-building forces are used to move and control these particle systems.

To set these parameters the music first had to be converted into continuous curves which delivered sensible values at any point of time. For this purpose a new musicological approach was developed by the director and musicologist to transfer the characteristics of Beethoven’s music into numerical values.

At the same time, the director of visual effects implemented the approach of a time-based parameter control into the virtual reality environment so that several curves could be controlled simultaneously for several particle systems. At that point, a problem became apparent: absolute time without noticeable fluctuations. Together with the director for sound a synchronisation routine was developed and programmed to pass the “clock” of the sound files to the image generating computer as a general time value.

Next, the curves resulting from the music analysis had to be entered. The measures taken from the score were converted into seconds and entered into a specifically-programmed curve editor offering the following features: Orientation in form of a coordinate system, editing of curve points with different interpolation modes, playing and displaying sound files (in time and frequency domain), parallel processing of several curves.
After matching the values to the music with utmost exactitude the curves were applied to the particle systems of the figures. At that point, corrections were necessary for each particle system. The 16 control curves of all figures had to be corrected to one hundredth of a second so that the visual effect became visible in line with the music. Even the smallest musical unit was reviewed and interpreted.

The curves' interaction was then enhanced and merged by the artistic and technical assistants for image and sound.

**Presto 126/4- a bagatelle**

Despite the literal meaning of "trifle", a bagatelle in Beethoven's work is far more than just that. As a musical aphorism this bagatelle captivates the audience through its brevity and rightly has been called "modern". Beethoven composed the piece around 1823/24 as part of his third Bagatelle Cycle, op. 126, which he himself described in the following way: "6 bagatelles [...] for piano only, [which] are likely the best of this type I have ever written...".

The piece is ideal for a visualisation in a virtual environment (VE). It is short - storytelling productions in a VE can hardly finance more than five minutes - and clearly divided into four main parts with a lot of repetitions. For the optical performance of the piece on the Stage for Music Visualisation (production: [Fraunhofer Institute for Media Communication](https://www.fh-usable.de)) two types of visualisation were combined:

In a classical sense, visualisations go in line with the musical structure and illustrate more or less the notes. Opposed to this approach, a new type of music visualisation has been established during the last years: Computer applications such as “iTunes” or “Windows Media Player” offer not only music but also generate coloured images by means of the music’s physical data.

“Presto 126/4“ transfers such a visualisation software to a VE for the first time. Through a scientific approach to music, precision for all frequency ranges can be established in a three-dimensional and interactive way. Using a music interpretation typical for humanities, the anonymous data flow is divided into units to create a clear competition between technical and musical experience.
Recording

For the visualisation of the piano bagatelle in B minor, opus 126, No. 4, bearing the movement designation “Presto”, the recording on a pianoforte of the Beethoven-House was chosen. The pedals of the instrument built in 1824, the same year the bagatelle was written, express the sound shading of “moderato” and the postponement better than modern grand pianos. On this instrument not only parts of the form and the musical characters Beethoven opposed so strongly in this piece are expressed better but also the visible physical level benefits. The recording with Paul Komen, one of the best pianoforte pianists of our time is from 2003.
Visualisation

The visualisation of “Presto 126/4” brings together two entirely different worlds of experience in music, a music scientific world and an acoustic technical world.

1) The semantic analyses of music science educate our hearing for musical structures and compositional architecture. The historic music visualisations, from Castel’s “Clavecin oculaire” of the 18th century to Walt Disney’s “Fantasia” of the 20th century, follow this logic. They simulate the melody, emphasise opposing topics or stress harmonic extremes. In this sense, the music scientific structure is visible in “Presto 126/4”.

2) At the same time, physical music visualisation follows the original’s frequency spectrum and volume. Although such visualisations do not pay attention to musical structures, harmonies and disharmonies, they are very exact when it comes to the acoustic moment. Every overtone and detail of the sound spectrum is reproduced with the utmost fidelity even beyond the scope of human hearing. In “Presto 126/4” the frequency spectrum is divided into four tapes which control four differently coloured dot flows. Using four interactive devices, visitors can set the location where the dot flows emerge and are thereby directly involved in generating the colour plays.

The interdisciplinary approach brings together the physical data flow and music scientific analysis. Physics-educated visitors learn the measured result semantically structured by the optical classification. Music-educated visitors see what elements their hearing event consists of. Two realities and thus two sides of the same medal are established.
Musical parameters

At first glance Beethoven’s bagatelle 126/4 is characterised by the contrast between pianistic rage and melodic simplicity. When taking a closer look a clear schematic structure becomes obvious. Therefore it seemed to appropriate to stage exactly this structural revelation as the core of the composition.

A form and motive analysis on several levels was the starting point: From the general form with its common structure to the microform where even the smallest motive and every single measure is deemed an individual part of the form. One of the middle form levels is then displayed on screen through movement and direction changes. It becomes a structuring force itself for the basic scenic forms which are composed of the music’s physical characteristics.

Splinter-like reflexes taken from the sforzati (sudden accents often opposed to the measure) Beethoven noted down interrupt the scene. The bagatelle’s simplicity and its block-like construction are thus counterpointed (and undermined). Wasn’t Beethoven’s appearance in music history not a sforzato itself?
**Physical parameters**

Physical parameters control the form of the four particle systems. Some of these parameters are taken from the frequency spectrum and the absorbed sound characteristics. Others are independently defined forces such as gravity and magnetism. Every particle, that means every visible dot, comprises inherent and invariant characteristics such as speed, direction, colour and duration.

In a virtual environment gravity can be set as desired. Direction and intensity are set for each system individually. Thus, gravity in a virtual environment does not necessarily comply with gravitational force in reality. The same applies to magnetism which in a virtual environment is determined independently by a fictive metallic character inherent to the particles.

The parameters that result from the sound characteristics are based on a frequency analysis done with the so-called “Fast Fourier Transformation”. The computer analyses the digital audio signal while it is played. During this process the frequency spectrum is divided into four significant frequency tapes.

**Tape 1**: 80 - 400 Hz  
**Tape 2**: 400 - 850 Hz  
**Tape 3**: 850 - 1,350 Hz  
**Tape 4**: 1,350 - 2,000 Hz

Each particle system is assigned one frequency tape. During the performance the tape is played using several characteristics.

**Tape 1**: “Blue”  
**Tape 2**: “Red”  
**Tape 3**: “Green”  
**Tape 4**: “Yellow”

The degree of use and the resulting visual form differ for each particle system.

Examples for characteristics that depend on the sound characteristics are the number of particles, their size, the area they cover and their acceleration. For example, a loud bass sound results in a brief visual intensification of the blue dots by creating more particles with a higher initial speed on a greater area. High sounds lead to an intensification of green and yellow.

The particle systems can be moved over the screen through the connected interactive devices. The systems can collide and transfer impulses. So they act like elements in reality, featuring inertia and friction.
Technical equipment

Interactive devices

The auditorium of the Stage for Music Visualisation features four different interaction columns that were specifically built for the Beethoven-House. Several viewers can use the columns simultaneously. When the virtual objects can be controlled, the columns are illuminated.

1) Ropes: Two closed rope loops (so-called Grummet loops) are crosswisely attached to a column. Reels transfer the movement of the ropes to a right-left and front-back control which steers the virtual objects. The device was patented under the name “Florestometer” (patent see DE 103 225 90.0-53, 20.5.2003) as it controls Florestan.

2) Ball: A large ball rests on several rollers and can be moved in any direction. The movements of the ball are transferred to the virtual figures and control them. The technique is similar to how a computer mouse works.

3) Theremin: This interactive device works without touch. Four sensors based on the Theremin column record any hand movement above the column. The hand’s position determines the direction whereas the distance between hand and column determines the speed of virtual movements. The device is robust in manufacture but sensitive for temperature changes.

4) Joystick: The joystick is an icon of computer games. Here it is used as a simple device for two-dimensional control.

In “Fidelio, 21st Century” the construction and form of the interactive devices match the character of the four figures involved. Florestan is controlled by means of the ropes, Rocco through the ball, Leonore through the Theremin and Pizarro can be moved with the joystick.

In “Presto 126/4” the four interactive devices steer the virtual representatives of the four frequency tapes (tape 1: 80-400 Hz; tape 2: 400-850 Hz; tape 3: 850-1,350 Hz; tape 4: 1,350-2000 Hz). Their respective forms act in relation to each other.
Interaction

For an opera like “Fidelio” interaction is not a new concept. A stage piece is written for the audience and therefore also depends on the audience. As long as there are operas, the audience will always have a variety of opportunities to shout encouragement or otherwise influence the performance.

In digital arts, however, the term “interaction” has a special meaning. When virtual figures are involved, the vivid principle of the stage shifts to the audience. It is the viewers who control movements and give meaning to the scenes. By means of interactive devices viewers can adapt the development of the plot which in turn depends on how deftly these devices are used.

If, however, music is staged in a virtual environment, a contradiction arises. If the figures are to represent the music a composer wrote, they cannot be changed without also changing the music. And this would be an illegitimate interference. Even just altering the volume of a Beethoven aria in a playful way through interaction would affect the piece’s foundations. The viewer would need the knowledge of a conductor to produce a suitable interaction.

Therefore, one of the main challenges for “Fidelio 21st Century” was to combine audience interaction with music visualisation.

The fact that “Fidelio” is a theatre work was helpful in this regard as stage characters dispose of free space. And this space offers an opportunity for scenic action. Thus, a singer can always sing the same part of a music score in the same way and in accordance with history. But he does not have to remain at a fixed point on the stage.

In this regard, the term “interaction” was interpreted in two ways:

As the figures are not simulated people but individual force fields moving in relation with each other, their force relations can be tested through interaction. This testing
is identical with testing mental figure motivations - a typical task in regular stage direction. But Beethoven’s compositional guidelines remain untouched.

On the other hand, “Fidelio 21st Century” offers for the first time the opportunity to evaluate the scenic frame of action through acoustics (spatial sound projection). Each figure movement triggered by the audience changes the figures’ position on stage. When a singer moves to the back of the stage, his voice dies away. Returning to the front of the stage, he moves to the typical stage position. Such experiences are not only of major importance for the psychological effect of traditional opera performances. When searching for the ideal scene constellation, visitors can now examine the acoustic relations between the characters in the virtual environment. Even the well-known recording that served as a basis for “Fidelio 21st Century” regains the acoustic importance of the stage which had to be neglected for the CD production.

**Image projection**

The projection at the Beethoven-House is a passive 3D stereo projection using two D-ILA projectors from JVC, model DLA-G150CL. Each projector has an SXGA resolution of 1280 x 1024 pixel and a brightness of 1,000 ANSI lumen. Both projectors are housed in a customised sound insulation box. A slightly tilted silver coated Stewart Screen with a width of 9.8 feet and a height of 6.6 feet serves as screen. The installation was carried out by Viscon.

To generate a spatial 3D impression, the software calculates two different images in real-time at a frequency of 30 images per second: One image from the perspective of the left eye and one slightly shifted image from the perspective of the right eye. A frequency of 30 images per second is applied. To make sure that the audience recognises these two different images with the correct eyes, two projectors are used to project separate images for the left and right eye on the screen.

Using a polarisation foil with horizontal and vertical polarisation in front of the respective projector, the image for the left eye is displayed on the screen in horizontally polarized light and the image for the right eye in vertically polarised light. The audience wears special glasses featuring different polarisation foils so that the left eye sees only the image intended for it. The same applies to the right eye respectively. Both images are then composed in the human brain and form a spatial 3D image, making the illusion complete.

The graphics computer is from DELL and features two Intel processors (3.2 GHz) and FX graphics from Nvidia.
Restructuring

During a one-year construction phase the building “Im Mohren” located at Bonngasse 18 was redeveloped and prepared for accommodating the Digital Archive of the Beethoven-Haus. The building includes a mediaeval vault cellar that was reconstructed into the “Stage for Music Visualisation”. The cellar’s brickwork was damp and nitrate-polluted. Before the building could be insulated against dampness from below and on the sides the house above the vault had to be secured extensively. A number of struts had to be installed before the cellar front on the yard side could be excavated. Then a duct was covered with concrete to lay technical wiring and tubing (IT, air conditioning etc.) to the double-floored Stage.

A specific plaster for renovation and acoustics was applied in the vault to enable a rather high exposure to sound without any unwanted reflections. The actual stage room was separated from the forum with a wall on which sound-swallowing slabs containing micropores were installed. The forum is the place where visitors wait for the next performance.
What is new

As a project the “Digital Beethoven-House” has brought together artist and scientists from all kinds of disciplines: Stage direction and mathematics, music science and computer science, cultural studies and sound engineering and many more. Under the direction of the Fraunhofer Institute for Media Communication (now Fraunhofer Institut Intelligente Analyse- und Informationssysteme, Sankt Augustin), the interdisciplinary gathering provided a procreative forum of a particularly high innovation potential. The most important inventions that were made during the development of “Fidelio 21st Century” and “Presto 126/4” are the following:

- “Fidelio 21st Century” is the first classical opera with a continuous plot to be performed in a virtual environment.

- A new scenic approach and new interpretation methods with new scenic effects for the music theatre were developed for “Fidelio 21st Century”. (See “Direction Concept”, “Plot”, “Scene and Setting” and “Music and Sound”.)

- In addition, a new type of music scientific analysis was established to continuously deliver sensible musical values at any point of the piece. (See “Music and Sound”.)

- The four interactive columns were especially developed for the Stage for Music Visualisation. One of them was patented under the title “Florestometer“ (following the name Florestan of one of the characters). (See “Interactive Devices” and “Interaction Concept”.)

- The Stage for Music Visualisation is the first permanent virtual reality installation to be designed under the primacy of audio elements. An acoustically transparent screen may have been used for the first time in a virtual reality. (See “3D Sound” and “Music and Sound”.)

- A new sound engineering approach was developed for “Fidelio 21st Century” to determine the interactive figure positions with their numerous possible combinations in line with a sound mixture based on a topographic model. (See “3D Sound” and “Music and Sound”.)

- The supertitles for “Fidelio 21st Century” follow the actual music scene exactly by the second and therefore in line with the conducting engagements. (See “Supertitles”.)

- The recording of “Fidelio” under Bernstein and the Vienna Philharmonics was sampled from the original tape at a frequency of 96 kHz in all tracks for the first time by the “Deutsche Grammophon”.

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• Several new software tools were developed to carry the project to fruition. Curve editor, interactive story board and more. [See “Synergy of Disciplines”.

• To establish and shape particle systems in a virtual reality, a new software infrastructure was created.
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