

Revised Selected Papers

Accademia Musicale Studio Musica
Michele Della Ventura, *editor*

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Accademia Musicale Studio Musica
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Editor

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Preface

This volume of proceedings from the conference provides an opportunity for readers to engage with a selection of refereed papers that were presented during the International Conference on New Music Concepts and Inspired Education. The reader will sample here reports of research on topics ranging from mathematical models in music to pattern recognition in music; symbolic music processing; music synthesis and transformation; learning and conceptual change; teaching strategies; e-learning and innovative learning. This book is meant to be a *textbook* that is suitable for courses at the advanced undergraduate and beginning master level. By mixing theory and practice, the book provides both profound technological knowledge as well as a comprehensive treatment of music processing applications.

The goals of the Conference are to foster international research collaborations in the fields of Music Studies and Education as well as to provide a forum to present current research results in the forms of technical sessions, round table discussions during the conference period in a relax and enjoyable atmosphere.

36 papers from 16 countries were received. All the submissions were reviewed on the basis of their significance, novelty, technical quality, and practical impact. After careful reviews by at least three experts in the relevant areas for each paper, 12 papers from 10 countries were accepted for presentation or poster display at the conference.

I want to take this opportunity to thank all participants who have worked hard to make this conference a success. Thanks are also due to the staff of “Studio Musica” for their help with producing the proceedings. I am also grateful to all members of Organizing Committee, Local Arrangement Committee and Program Committee as well as all participants who have worked hard to make this conference a success.

Finally I want to appreciate all authors for their excellent papers to this conference.

April 2019

Michele Della Ventura

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The use of virtual instruments in the process of creating a soundtrack with film music. Is this the twilight of film music played by man?

Adrian Robak (Ph.D.), Wojciech Wieczorek (M.A.)

Krzysztof Kieślowski Faculty of Radio and Television University of Silesia
Department of Philology, University of Silesia
adrian.robak@us.edu.pl

Abstract. The authors want to examine the use of virtual instruments in the process of creating a soundtrack with film music on the example of the carried out research and experiments. The research focuses on the issue of substituting live orchestras with virtual instruments and whether it affects the emotions of the audience and their perception of the audio-visual narrative in the scene. During the research four research hypotheses were formulated and an experimental method and questionnaires were used. Survey questions were created in the context of the researched hypotheses. Experiments were carried out on two subgroups consisting of students. During the experiments the subgroups watched video clips with the same music but with soundtracks created with different production methods. One of them was the original soundtrack performed by the orchestra, the second one was the soundtrack created with virtual instruments. The results based on the numerical quantities, their verbal definitions, medians and means confirmed three of the four formulated hypotheses. The main conclusions are that virtual instruments produced in 21st century are able to replace acoustic instruments in creating film music soundtracks, allowing for an immersion in the world of film equally well as the acoustic instruments and strongly affect the emotions of the audience of the film. It can be assumed that the phenomenon described in the research is possible only with the combination of film and music.

Keywords. Film and Music. Film. Virtual instruments. Acoustics. Music composition. Music Perception. Music and Psychology. Music synthesis and transformation. Psychoacoustics.

1 Introduction

As described by Anahid Kassabian in his book *Hearing Film. Tracking Identifications in Contemporary Hollywood Film Music: ...Music became the foremost example of autonomous art, art for art's sake. Communication of meanings came to be considered outside the realm of music's task's; western instrumental art music is called „absolute”* [1].

About modern film music and history of the application of electronic music.

Modern film scoring differs greatly from its early days in the silent film era, not to mention the so-called “Golden Age of Hollywood”. Modern film music not only includes an eclectic mix of classical, jazz, rock and popular music influences, but above all, a variety of electronic music. In the 80’s, one could distinct two opposite tendencies in film scoring: the first tendency was writing neo-romantic scores large orchestras; the other one was a strictly electronic music, sometimes mixed with rock and pop influences, such as *Black Rain* (1989), *Blade Runner* (1982), or horror films franchises such as *Nightmare on Elm Street* or *Evil Dead*. Among many main or part time film composers who became prominent during that era, such as Harold Faltermeyer (*Top Gun*), Giorgio Moroder (*Midnight Express*), or Vangelis (*Blade Runner*, *Chariots of Fire*), Hans Zimmer seems to be a figure of the biggest importance with regards to the modern film scoring. Zimmer started as a rock musician playing keyboard in the band *The Buggles*. He eventually transitioned to film scoring and established a characteristics style due to a heavy use of synthesizers mixed with orchestra. His style has evolved through the years, but these two components remained constant, however, they varied on a degree of use. For example. in the late 90’s and early noughties he often used electronic instruments to imitate the orchestra, while in 2010’s *Inception* he wanted to do something completely opposite – to imitate electronic sounds with the orchestra [2]. Hans Zimmer is also a creator of Media Ventures Entertainment Group, later changed name to Remote Control Productions, associating composers working in the film industry. Their style is an extension of Zimmer’s – a mix of electronic and live instruments and frequent usage of VSTi instruments [3] imitating the orchestra, which has become gradually more and more prominent since the *Pirate of the Caribbeans* soundtracks. Their success in Hollywood is perhaps one of the contributing factors for the omnipresence of VSTi instruments. Another key factor are the budgetary issues – while in their early days the synthesizers were a very expansive device, nowadays it is a lot cheaper to use electronic mock-ups instead of the live orchestra, especially in TV shows, where the recording of hours of music required for every season would cost much more than a piece created on a computer. One might compare soundtracks for *Star Wars* films, recorded with a live orchestra and *Star Wars* animated TV shows, which are made almost entirely with VSTi instruments, even if they re-use original John Williams’ cues written for the films.

Motivation for the research, Hypotheses and research methods

The intensified participation of virtual instruments in the production and post-production of sound in film is one of the strongest motivators for carrying out the research about the influence of film music on the perception of art recipients depending on how it is made. There is a research gap due to the fact that so far there has been no research regarding the perception of film music performed by the virtual instruments. Therefore, the purpose of the research is verifying the hypotheses and describing the results in the articles. The hypotheses concern two areas. First area is concerned with acoustic instruments and the hypotheses are as follows:

1. The film music performed by acoustic instruments allows for a better immersion into the presented world of film (hypothesis no 1.).
2. The film music performed by acoustic instruments has a strong impact on the emotions of recipients (hypothesis no 2.).

Second area is concerned with virtual instruments and the hypotheses are as follows:

1. The film music performed by virtual instruments has a strong impact on the emotions of recipients (hypothesis no 3.).
2. The film music performed on virtual instrument has a destructive effect on the illusion of the film (hypothesis no 4.).

Two of hypotheses are similarly formulated (hypothesis no 2. and no. 3) because researchers want to examine the same element and make a comparative analysis. The research method was based on the questionnaire method and closed questions combined with the experiments.

2 State of art

Types of film music

Two types of film music can be distinguished:

1. Transcendent type (non diegetic, score music),
2. Immanent type (diegetic, source music) [4].
 - a. synchronous (the music is linked with the film; the recipient sees the source of music in the film),
 - b. asynchronous (the film music is a counterpoint to the film, the source of the film music exists in the world created in the film and it is located in the area of the action; the recipient does not see film music's source) [5].

The transcendent type of the film music can be explained as a musical illustration that is not simply linked with the world created in the film and this type of film music does not create a logical element in common with film's action (for example: the music used during main titles or the music which is used for emotional illustration). The task of transcendent music is complementing the emotional atmosphere in the film, summarizing the action of the film and announcing the characters and situations from the film.

The immanent type of film music is directly or indirectly linked with the film's scene and this kind of film music makes a logical whole (coherence) with the film scene. Source of this music is seen on screen or it results from the film's action, even though we do not see it. According to one of the French film music composers, Maurice Jaubert, a film music has a servile role. He said: "We don't go to the cinema to listen to film music. We demand from film music only to deepen our visual experience" [6].

Film music is also divided due to various factors. The geographical factor in film music is noticeable when characteristic elements for a given culture appear in it (e.g. regional instruments in film music) [7]. The historical factor in film music is noticeable when a composer wants to apply past composers' techniques or pristine musical forms which correspond with the historical/fantastic time of the action of the film and their pieces reinforce the content of the film (e.g. simple film song based on modal scales, modern

modes) [8]. Film type factor is the most common. The last factor is the style of a composer. James Horner's soundtracks from various films have a similar emotional fluctuation, melody and harmony. His music from *Star Trek II: The Wrath of Khan* sounds very similar to *A Beautiful Mind*. [9]

Collaboration of the composer and the director. Film song as a director's tool

In many films, musical fragments are composed by a composer in accordance with the director's idea and vision. This practice allows the viewers to understand what kind of film or scene they are dealing with. Horror films use high, long, shrill and squeaking sounds of the violins [10] or the waterphone [11]. The final crime in thriller films is preceded by silence or low sounds of bowed string instruments [12]. In fantasy films, composers often create epic melodies performed by French horns with a string orchestra accompaniment [13]. The music ends when the gun fires in gangster films [14]. Science fiction films are often illustrated with huge symphony orchestra (in neo-romantic composers' style) [15] or electronic music played by synthesizers [16]. A variety of benefits arise from a cooperation of the composer and the director arranged by a conscious producer [17]. Repetitive musical patterns are noticeable in many films. Film music is rarely combined with a moving picture on the basis of emotional opposites. If this happens, film music is supposed to emphasize the absurdity of the film's stage, situation, character or event.

One of the most important types of film music is a film song. In the American film industry, directors and composers very often choose a song with lyrics that have a value that explains the origin of a character much more convincingly than the dialogue and image [18]. A well-chosen film song can also influence the creative process and for many directors it is a rudimental element without which they cannot continue working on the next scene of the film.

Perception of sound and theories of perceptual processing of sound sensation. Principles of spatial hearing

Hearing is a human sense which distorts received sounds in comparison to electroacoustic devices such as microphones. This phenomenon is manifested more strongly especially (1) when the volume of very high and very low pitch sounds changes, (2) in sounds out of the area of audibility range or (3) when the organ of hearing is altered by an illness [19]. There exist multiple theories about perceptual processing of sound sensation. One of them is Hermann von Helmholtz's "Resonance theory" (also known as Place theory) [20]-[21]. Another one is Georg Bekesy's "Hypothesis of migratory waves" [22]. "Frequency theory of hearing" (also known as Telephone theory) created by Williams Rutherford compares the ear functions to a microphone and it transmits signals to the brain [23]. Charles Bray and Ernest Wever declared the "Volley theory" [24]. One of the most famous theories is the Weber-Fechner law [25]. The process of receiving sounds by a human is significantly different than the recording process of the same sound by electronic devices. The subjective features of sound such as hearing pitch, level of hearing intensity, hearing loudness, directional hearing, sound colour or tinge, tonality,

clarity and even sound duration and spaciousness were created due to this reason [26]. Sensory or psychological dimensions of sound have been described by Krystyna Danecka-Szopowa [27]. Among objective features of sound (possible to be measured physically) can be enumerated as follows: frequency, amplitude (sound intensity), wavelength, sound pressure, acoustic density, acoustic power [28], time structure, panorama, spectrum, wave impedance, and propagation speed of the sound wave. One of the most significant relationships between the frequency (measured in Hz), sound intensity (measured in dB) and the impression of volume perceived by human are isophonic curves also known as equal-loudness contours for the human ear, which were developed by the Fletcher-Munson duo [29]-[30].

It is worth mentioning that musicians have a greater ability of sound perception. They perceive sounds at the same time as a complete whole phenomenon and whole phenomenon compounded of several factors. Musicians are able to focus on the selected factor e.g. pitch, and they perceive several coefficients simultaneously, e.g. pitch, sound colour and dynamics level. Husson believes that “in every musical experience, the impression layer exerts some influence on the listener: it accelerates or slows down the breath and the pulse, evokes the tension or muscle relaxation, changes in blood pressure and speed, shivering” [31]. In the acoustic system created from three elements such as the source of the sound (a), environment (b) and listener (c) it is possible to perceive spatial information readable from sounds experience. These are:

1. The distance of the source of sound to the listener,
2. The direction of the sound source in relation to the listener,
3. The type of environment where source of sound is located,
4. The type of environment where the listener is located [32].

Meaning of music and meaning of film in culture

The meaning of music was described in Leonard B. Meyer dissertation “Emotion and Meaning of Music”. One of the theories (*Theory of emotions*) introduced a psychological explanation of a human emotional experience and claimed that emotions appear when the tendency to react is inhibited [33]. Theorists explained that emotion is a temporary inability to react to a stimulus. L. B. Meyer specifies the musical experience with three different features:

1. Musical stimuli are non-referent, that is not burdened by meanings, non-conceptual,
2. In music, the tendencies to react are solved and brought to conclusions, because the continuation of the musical piece meets expectations and brings explanations.
3. In music, one and the same stimulus activates, inhibits and resolves tendencies, for example: one and the same musical motif is at the same time the announcement of *continuum* and the conclusion of the previous phase. As a result, it activates listeners, raises their expectations, but also explains what the listeners had previously expected [34].

The cinema started more as a technical curiosity and entertainment, similar to a circus or a vaudeville show, but quickly became a new genre of art. As the cinematic techniques developed and expanded ways of storytelling, the film provided an escapist function for many people, allowing for entering another world for a several hours. But eventually, the

world of film rose to an entirely new level: not only was the cinema considered a new art form, but it became a source of a new mythology. As Bill Moyer put it:

After our youngest son had seen Star Wars for the twelfth or thirteenth time, I said, "Why do you go so often?" He said, "For the same reason you have been reading the Old Testament all of your life." He was in a new world of myth." [35]

The development of the different cinematic techniques and special effects allowed for telling stories of a grander scale, such as *Star Wars* or *Willow*, which dealt with the mythological issues put in a science-fiction or fantasy context. One might argue that the scores of those films largely contribute to building the mythical qualities and narratives.

Film music tasks and description of the clip used in the research

The role of music in the film has been a subject of research of the great philosophers of music aesthetics. Hans Heinrich Eggebrecht believed that film music is similar to chamber hall music [36] because this kind of music achieves goal of meeting people's expectations when they meet together to listen to the music [37]. Defining this goal can be started by stating that film music must express the image of the film frame and information contained in the film is transmitted through sounds of music. Music is the most powerful and the most emphatic form of art [38]. The music in John Williams' film was often composed as if this soundtrack was supposed to be a rival of sound effects [39]. Perhaps the conflict between the sound effects and the music was intentional and the idea behind it was to underline the conflict between the realm of the myth, mystical powers and tradition and the technology which served the evil Galactic Empire [40]. This conflict is even stronger due to the "organic" sound of the music – George Lucas had always wanted the music to be written in a classical, operatic idiom and for a while he even considered using pre-existing classical music, as did Stanley Kubrick in *2001: A Space Odyssey* [41]. Eventually, Lucas decided on John Williams due to recommendation of his friend, who was also a director – Steven Spielberg. The director structured *Star Wars* after fairy tales, legends and ancient myths, as he wanted it to be a sort of new mythology for the young generation [42]. The music reflects this idea – Williams used different classical pieces as a source of inspiration, however the structure of the score itself is modelled after Richard Wagner's 19th century operas and his biggest invention, which is the use of the *Leitmotif* – a leading motif or motifs, that are assigned to certain characters or concepts and guide the listener through the story. Wagner's operas also dealt with mythology, since his *Ring Cycle* was largely inspired by the Norse mythology and self-consciously mythical [43]. For the first film of the entire saga, Williams wrote six recurring themes and motifs, the most important being the one assigned to the main protagonist – Luke Skywalker (the theme also serves as a main theme for the entire saga), the main female lead – Princess Leia's theme and the theme of the Force. The Force is a mystical energy field that gives the Jedi Knights, an ancient order of the guardians of the Republic and democracy their powers, but it also serves as a some sort of deity and fate, guiding and influencing the fate of the heroes and of the galaxy. In the scene chosen for the experiment, the latter theme is used. In the scene, the main hero, Luke Skywalker, watches the sunset on his home planet dreaming of a bigger life than the one he has on a farm. The scene uses no sound effects or dialogue, and it is driven only through the image

and the music. The director and the composer decided on illustrating the scene with the Force theme, although at this point of the film the viewer has not been introduced to its concept – in this role it serves more as a “destiny theme”, hinting the fate of the hero, who will soon join the rebellion and become a Jedi Knight. Williams’ score is an equal counterpart for the image in telling the story, and creating the narrative and the aura of myth.

Virtual instruments in the service of composers

Mel Lewis said that if the music generated by electronic devices really was to arouse emotions, it would require more effort and a significant amount of corrections. As a result of the process, very sophisticated and well-designed compositions are created [44]. One of the increasingly popular film soundtracks recording method is creating an electronic demo or mock-up. It is often required for editing the scenes. Although virtual instruments are widely used in the film and computer game industries, there exists only a scarce number of publications regarding their subject.

3 Methodology of the research

The process of preparations for the research

The process of preparations can be divided into several actions, which had been undertaken before the first viewers saw two clips with the same, albeit differently performed music.

The process of selecting a film clip

The first undertaken action was selecting fragments of a film in which music is the key factor of building the emotional layer of the scene. The next step was to choose one scene from the selected fragments, taking into consideration the following factors: (1) the chosen scene does not contain any sound effects except for the music, (2) the music is an integral part of the moving image and the film and the music are an inseparable whole, (3) the music from the chosen fragment is considered iconic and is already recognizable, (4) the composer of the music from the chosen scene is an esteemed film composer, (5) the music in the selected scene is performed by a symphony orchestra without the use of electric or electronic instruments, (6) the score for the music in the selected scene is available. The chosen film clip, and simultaneously the soundtrack fragment selected on the basis of the previously stated criteria, is the famous scene known as “Binary Sunset” with the legendary musical motif called *The Force Theme* from a science-fiction film “*Star Wars Episode IV: A New Hope*”, directed by George Lucas. The music for the film was written by John Williams.

Description of the research group (university students and high school students)

The test group consists of two subgroups. In the first subgroup there were university students of the second and third year of Organization of Film and Television Production speciality of the Krzysztof Kieślowski Faculty of Radio and Television University of Silesia in Katowice. In the second subgroup there were students of the second and the third year of Techniques of Recording and Sound Realisation speciality of High School: Piotr Latoska Upper-secondary School no. 4 in Ruda Śląska (Zespół Szkół Ponadgimnazjalnych nr 4 im. P. Latoski w Rudzie Śląskiej). The test groups consisted of 52 people.

The choice of the subgroup was not random: the first subgroup was composed of people who train their sensibility of the perception of an art of film, furthermore they acquire skills and abilities that are required in the process of production and post-production of films. Also, they are often aficionados of cinema, capable of a professional judgment of a result of an artistic work in the field of their profession. People placed in the first subgroup are between twenty and twenty four years old. The second subgroup consists of the students who are learning the techniques of sound recording and amplification. They acquire their knowledge from a highly educated faculty, by working with a professional sound recording equipment, they learn acoustics and electroacoustics, the history of music with a suitable literature and they participate in ear training courses, learn the principles of music and professional Digital Audio Workstation (DAW) software. The group is between sixteen and nineteen years old.

Survey questions for research hypotheses

The next undertaken action was to create survey questions in the context of the researched hypotheses. The first hypothesis was formulated as follows: **Music performed by acoustic instruments allows for an immersion in to the world of film.** To examine the hypothesis, the following question was formulated and placed in the survey: *Was the music in the clips coherent or incoherent with the film?*

The second and the third hypotheses are as follows: **Music performed by acoustic instruments strongly affects emotions of the audience** and **Music performed by virtual instruments strongly affects emotions of the audience.** To examine the hypotheses, the following questions were formulated and placed in the survey: *Does the music in the clips sound more lyrical or heroic? Does the music in the clips sound more nostalgic or disturbing?*

The fourth research hypothesis is as follows: **The music performed by virtual instruments has a destructive impact on the illusion of the film.** To test this hypothesis, a following question was placed in the survey: *Did the instruments in the track sound real or inauthentic?*

All test questions were as follows:

1. *Does the music in the clips sound more lyrical or heroic? (1 - lyrical, 5 - heroic),*

2. *Did you hear the music performed in the same recording studio or in different studios?* (1 - in the same recording studio, 5 - in different studios) - the question is not described in the article,
3. *Did the instruments in the track sound real or inauthentic?* (1 - real, 5 - inauthentic),
4. *Was the music in the clips performed in incoherent acoustic space or coherent acoustic space?* (1 - in incoherent acoustic space, 5 - in coherent acoustic space) - the question is not described in the article,
5. *Was the music in the clips coherent or incoherent with the film?* (1 - coherent with the film, 5 - incoherent with the film),
6. *Does the music in the clips sound more nostalgic or disturbing?* (1 - nostalgic, 5 - disturbing).

Creation of a mock-up containing virtual instruments soundtrack version

The next stage of the preparations was creating the sound mock-up using excerpts from the original soundtrack score. A thorough analysis of the tempo of the original recording was conducted. Originally, the score was created in scorewriter software, where all of the orchestral voices were implemented. Orchestral voices that shaped the chosen musical excerpt are:

1. From the group of woodwind instruments
 - a. embouchure wind instruments - flute;
 - b. double-reed wind instruments - bassoon;
2. From the group of brass wind instruments
 - a. organic, reed and embouchure - French horn 1, French horn 2, French horn 3, French horn 4, trombone 1, trombone 2, trombone 3, tuba;
3. From the group of strings
 - a. plucked string instruments - harp;
 - b. bowed string instruments - violins 1, violins 2, violas, cellos, double-basses.

The score contained dynamic, agogic, articulation and expression marks. Instruments were exported at separate MIDI files from a scorewriter program. In MIDI sequencer software MIDI files were imported to a new created session. The original soundtrack tempo was insightfully analysed and the tempo curve was drawn in MIDI sequencer afterwards. It was noticed that in the original soundtrack the first French horn's part was performed in *tempo rubato*. It was necessary to faithfully reproduce the tempo curve in virtual instruments soundtrack version so that the individual notes of the first French horn's part corresponded with the picture as in the original soundtrack. After implementing virtual instruments every sound parameter assigned to each individual note in all instrumental parts was set. They had the following parameters: (1) dynamic curve, (2) velocity, (3) expression curve, (4), vibrato curve (to bowed string instruments), (5) bow pressure on the strings (to bowed string instruments), (6) speed of legato (to bowed string instruments). WAV file of each instrumental part was exported MIDI sequencer software as a separate file (sample rate 48 kHz, bit rate 24 Mbit/s). The next step in creating virtual instruments soundtrack version was mixing and mastering separate audio files in Digital Audio Workstation program. Imported audio files (WAV files) were juxtaposed with the video clip. A comparative analysis based on the original soundtrack

version and virtual instruments soundtrack version of the same video clip was performed. Finally, one mastered virtual instruments soundtrack, which contained all of the previous instruments tracks (in stereo and 5.1 format) was created. Last step of preparing the experiments was creating two short video clips: the first one containing the original soundtrack, the second one containing virtual instruments version of the soundtrack.

Description of the research and experiment

The experiments (perception tests) were conducted at the screening room at the Krzysztof Kieślowski Faculty of Radio and Television of Silesian University in Katowice and Sound Laboratory in Piotr Latoska Upper-secondary School no. 4 in Ruda Śląska (Zespół Szkół Ponadgimnazjalnych nr 4 im. P. Latoski w Rudzie Śląskiej). Two film clips were identical in terms of the moving picture, but used two different soundtracks. The first of those soundtracks contained the original track which was recorded by the London Symphony Orchestra during the sound post-production stage of making *“Star Wars Episode IV: A New Hope”*. The second track used the recording prepared with the virtual instruments. The famous 40 seconds long scene was presented twice during the test is known as “Binary Sunset”. Test were conducted:

- 9th of January 2019 (First the video clip with the original soundtrack, then the clip with the soundtrack created with virtual instruments),
- 16th of January 2019 (First the video clip created with virtual instruments, then the clip with the original soundtrack),
- 23th of January 2019 (Both video clips with the original soundtrack),
- 30th of January 2019 (Both video clips with the soundtrack created with virtual instruments).

The screening schedule of the clips is shown in Table number I:

TABLE I: SCREENING SCHEDULE OF CLIPS

	Video clip no. 1	Video clip no. 2
The First Experiment	original soundtrack	soundtrack created with virtual instruments
The Second Experiment	soundtrack created with virtual instruments	original soundtrack
The Third Experiment	original soundtrack	original soundtrack
The Fourth Experiment	soundtrack created with virtual instruments	soundtrack created with virtual instruments

After watching the first video clip, the participants of research filled the survey answering the six questions. Subsequently, after watching the second video clip, they answered the same six questions. The time for completing the survey was unlimited.

4 Results of the research

Results of research for hypothesis no. 1

Hypothesis no. 1: **Music performed by the acoustic instruments allows for an immersion in the world of film.**

Test question no. 1: *Was the music in the clips coherent or incoherent with the film?*

The following definitions were assigned to the numerical quantities: 1 - the music in the video clip is coherent with the picture, 2 - the music in the video clip is almost coherent with the picture, 3 - the music in the video clip is neither coherent, nor incoherent with the picture, 4 - the music in the video clip is almost incoherent with the picture, 5 - the music in the video clip is incoherent with the picture.

Results of the answers to test question no. 1 in first hypothesis are shown in Table II and III.

TABLE II: RESULTS OF THE ANSWERS TO TEST QUESTION NO. 1 (UNIVERSITY STUDENTS SUBGROUP) IN THE FIRST HYPOTHESIS

<u>Subgroup of University Students</u> Hypothesis no. 1: Music performed by the acoustic instruments allows for an immersion in to the world of film. Test question no. 1: <i>Was the music in the clips coherent or incoherent with the film?</i>				
	<i>Median</i>	<i>Mean</i>	<i>Result</i>	<i>Comparison to virtual instruments soundtrack version</i>
The first experiment (first clip)	1,00	1,83	coherent	almost incoherent
The second experiment (second clip)	1,50	1,90	coherent	almost incoherent
The third experiment (first and second clip)	2,00 2,00	2,05 2,05	almost coherent	-
The fourth experiment (none)	-	-	-	almost coherent

TABLE III: RESULTS OF THE ANSWERS TO TEST QUESTION NO. 1 (HIGH SCHOOL STUDENTS SUBGROUP) IN THE FIRST HYPOTHESIS

<u>Subgroup of High School Students</u> Hypothesis no. 1: Music performed by the acoustic instruments allows for an immersion in to the world of film. Test question no. 1: <i>Was the music in the clips coherent or incoherent with the film?</i>				
	<i>Median</i>	<i>Mean</i>	<i>Result</i>	<i>Comparison to virtual instruments soundtrack version</i>
The first experiment (first clip)	1,00	2,20	coherent	coherent

The second experiment (second clip)	2,00	1,77	almost coherent	almost coherent
The third experiment (first and second clip)	2,50 2,50	2,43 2,43	neither coherent, nor incoherent	-
The fourth experiment (none)	-	-	-	almost coherent

Results of research for hypothesis no. 2

Hypothesis no. 2: **Music performed by acoustic instruments strongly affects emotions of the audience**

Test question no. 1: *Does the music in the clips sound more lyrical or heroic?*

The following definitions were assigned to the numerical quantities: 1 - the music in the video clip was lyrical, 2 - the music in the video clip was almost lyrical, 3 - the music in the video clip was neither lyrical, nor heroic, 4 - the music in the video clip was almost heroic, 5 - the music in the video clip was heroic. Results of the answers to test question no. 1 in second hypothesis are shown in Table IV and V:

TABLE IV: RESULTS OF THE ANSWERS TO TEST QUESTION NO. 1 (UNIVERSITY STUDENTS SUBGROUP) IN THE SECOND HYPOTHESIS

Subgroup of University Students Hypothesis no. 2: Music performed by acoustic instruments strongly affects emotions of the audience Test question no. 1: <i>Does the music in the clips sound more lyrical or heroic?</i>				
	<i>Median</i>	<i>Mean</i>	<i>Result</i>	<i>Comparison to virtual instruments soundtrack version</i>
The first experiment (first clip)	3,00	2,86	neither lyrical, nor heroic	neither lyrical, nor heroic
The second experiment (second clip)	3,00	2,75	neither lyrical, nor heroic	neither lyrical, nor heroic
The third experiment (first and second clip)	2,00 2,50	2,20 2,55	almost lyrical	-
The fourth experiment (none)	-	-	-	almost lyrical

TABLE V: RESULTS OF THE ANSWERS TO TEST QUESTION NO. 1 (HIGH SCHOOL STUDENTS SUBGROUP) IN THE SECOND HYPOTHESIS

<u>Subgroup of High School Students</u> Hypothesis no. 2: Music performed by acoustic instruments strongly affects emotions of the audience Test question no. 1: <i>Does the music in the clips sound more lyrical or heroic?</i>				
	<i>Median</i>	<i>Mean</i>	<i>Result</i>	<i>Comparison to virtual instruments soundtrack version</i>
The first experiment (first clip)	3,00	3,00	neither lyrical, nor heroic	almost lyrical
The second experiment (second clip)	3,00	2,46	neither lyrical, nor heroic	neither lyrical, nor heroic
The third experiment (first and second clip)	2,00 2,50	2,36 2,36	almost lyrical	-
The fourth experiment (none)	-	-	-	almost lyrical

Test question no. 2: *Does the music in the clips sound more nostalgic or disturbing?*

The following definitions were introduced to the numerical quantities: 1 - the music in the video clip was nostalgic, 2 - the music in the video clip was almost nostalgic, 3 - the music in the video clip was almost neither nostalgic, nor disturbing, 4 - the music in the video clip was almost disturbing, 5 - the music in the video clip was disturbing. Results of the answers to test question no. 2 in second hypothesis are shown in Table VI and VII:

TABLE VI: RESULTS OF THE ANSWERS TO TEST QUESTION NO. 2 (UNIVERSITY STUDENTS SUBGROUP) IN THE SECOND HYPOTHESIS

<u>Subgroup of University Students</u> Hypothesis no. 2: Music performed by acoustic instruments strongly affects emotions of the audience Test question no. 2: <i>Does the music in the clips sound more nostalgic or disturbing?</i>				
	<i>Median</i>	<i>Mean</i>	<i>Result</i>	<i>Comparison to virtual instruments soundtrack version</i>
The first experiment (first clip)	1,00	1,97	nostalgic	almost disturbing
The second experiment (second clip)	2,00	2,30	almost nostalgic	almost nostalgic
The third experiment (first and second clip)	2,00 2,00	1,80 2,00	almost nostalgic	-
The fourth experiment (none)	-	-	-	almost nostalgic

TABLE VII: RESULTS OF THE ANSWERS TO TEST QUESTION NO. 2 (HIGH SCHOOL STUDENTS SUBGROUP) IN THE SECOND HYPOTHESIS

<u>Subgroup of High School Students</u> Hypothesis no. 2: Music performed by acoustic instruments strongly affects emotions of the audience Test question no. 2: <i>Does the music in the clips sound more nostalgic or disturbing?</i>				
	<i>Median</i>	<i>Mean</i>	<i>Result</i>	<i>Comparison to virtual instruments soundtrack version</i>
The first experiment (first clip)	2,00	2,87	almost nostalgic	neither nostalgic, nor disturbing
The second experiment (second clip)	2,00	1,92	almost nostalgic	almost nostalgic
The third experiment (first and second clip)	2,50 3,00	2,50 2,57	almost nostalgic or neither nostalgic, nor disturbing	-
The fourth experiment (none)	-	-	-	almost nostalgic

Results of research for hypothesis no. 3

Hypothesis no. 3: **Music performed by virtual instruments strongly affects emotions of the audience**

Test question no. 1: *Does the music in the clips sound more lyrical or heroic?*

The following definitions were assigned to the numerical quantities: 1 - the music in the video clip was lyrical, 2 - the music in the video clip was almost lyrical, 3 - the music in the video clip was neither lyrical, nor heroic, 4 - the music in the video clip was almost heroic, 5 - the music in the video clip was heroic. Results of the answers to test question no. 1 in third hypothesis are shown Table in VIII and IX:

TABLE VIII: RESULTS OF THE ANSWERS TO TEST QUESTION NO. 1 (UNIVERSITY STUDENTS SUBGROUP) IN THE THIRD HYPOTHESIS

<u>Subgroup of University Students</u> Hypothesis no. 3: Music performed by virtual instruments strongly affects emotions of the audience Test question no. 1: <i>Does the music in the clips sound more lyrical or heroic?</i>				
	<i>Median</i>	<i>Mean</i>	<i>Result</i>	<i>Comparison to original soundtrack version</i>
The first experiment (second clip)	3,00	2,26	almost lyrical	neither lyrical, nor heroic
The second experiment (first clip)	3,50	3,05	neither lyrical, nor heroic	neither lyrical, nor heroic
The third experiment (none)	-	-	-	almost lyrical

The fourth experiment (first and second clip)	2,00 2,00	2,73 2,40	almost lyrical	-
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TABLE IX: RESULTS OF THE ANSWERS TO TEST QUESTION NO. 1 (HIGH SCHOOL STUDENTS SUBGROUP) IN THE THIRD HYPOTHESIS

<u>Subgroup of High School Students</u> Hypothesis no. 3: Music performed by virtual instruments strongly affects emotions of the audience Test question no. 1: <i>Does the music in the clips sound more lyrical or heroic?</i>				
	<i>Median</i>	<i>Mean</i>	<i>Result</i>	<i>Comparison to original soundtrack version</i>
The first experiment (second clip)	2,00	2,07	almost lyrical	neither lyrical, nor heroic
The second experiment (first clip)	3,00	2,69	neither lyrical, nor heroic	neither lyrical, nor heroic
The third experiment (none)	-	-	-	almost lyrical
The fourth experiment (first and second clip)	2,00 2,00	2,57 2,42	almost lyrical	-

Test question no. 2: *Does the music in the clips sound more nostalgic or disturbing?*

The following definitions were assigned to the numerical quantities: 1 - the music in the video clip was nostalgic, 2 - the music in the video clip was almost nostalgic, 3 - the music in the video clip was almost neither nostalgic, nor disturbing, 4 - the music in the video clip was almost disturbing, 5 - the music in the video clip was disturbing. Results of the answers to test question no. 2 in third hypothesis are shown in Table X and XI.

TABLE X: RESULTS OF THE ANSWERS TO TEST QUESTION NO. 2 (UNIVERSITY STUDENTS SUBGROUP) IN THE THIRD HYPOTHESIS

<u>Subgroup of University Students</u> Hypothesis no. 3: Music performed by virtual instruments strongly affects emotions of the audience Test question no. 2: <i>Does the music in the clips sound more nostalgic or disturbing?</i>				
	<i>Median</i>	<i>Mean</i>	<i>Result</i>	<i>Comparison to original soundtrack version</i>
The first experiment (second clip)	4,00	3,20	almost disturbing	nostalgic
The second experiment (first clip)	2,00	2,30	almost nostalgic	almost nostalgic
The third experiment (none)	-	-	-	almost nostalgic

The fourth experiment (first and second clip)	2,00 2,00	2,27 2,47	almost nostalgic	-
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TABLE XI: RESULTS OF THE ANSWERS TO TEST QUESTION NO. 2 (HIGH SCHOOL STUDENTS SUBGROUP) IN THE THIRD HYPOTHESIS

<u>Subgroup of High School Students</u> Hypothesis no. 3: Music performed by virtual instruments strongly affects emotions of the audience Test question no. 2: <i>Does the music in the clips sound more nostalgic or disturbing?</i>				
	<i>Median</i>	<i>Mean</i>	<i>Result</i>	<i>Comparison to original soundtrack version</i>
The first experiment (second clip)	3,00	2,67	neither nostalgic, nor disturbing	almost nostalgic
The second experiment (first clip)	2,00	2,08	almost nostalgic	almost nostalgic
The third experiment (none)	-	-	-	almost nostalgic or neither nostalgic, nor disturbing
The fourth experiment (first and second clip)	2,00 2,50	2,50 2,50	almost nostalgic	-

Results of research for hypothesis no. 4

Hypothesis no. 4: **The music performed by virtual instruments has a destructive impact on the illusion of the film.**

Test question no. 1: *Did the instruments in the track sound real or inauthentic?*

The following definitions were assigned to the numerical quantities: 1 - instruments in the track sound real, 2 - instruments in the track sound almost real, 3 - instruments in the track sound neither real, nor inauthentic, 4 - instruments in the track sound almost inauthentic, 5 - instruments in the track sound inauthentic. Results of the answers to test question no. 1 in fourth hypothesis are shown in Table XII and XIII:

TABLE XII: RESULTS OF THE ANSWERS TO TEST QUESTION NO. 1 (UNIVERSITY STUDENTS SUBGROUP) IN THE FOURTH HYPOTHESIS

<u>Subgroup of University Students</u> Hypothesis no. 4: The music performed by virtual instruments has a destructive impact on the illusion of the film. Test question no. 1: <i>Did the instruments in the track sound real or inauthentic?</i>				
	<i>Median</i>	<i>Mean</i>	<i>Result</i>	<i>Comparison to original soundtrack version</i>
The first experiment (second clip)	3,00	2,94	neither real, nor inauthentic	real

The second experiment (first clip)	2,00	1,85	almost real	real
The third experiment (none)	-	-	-	almost real
The fourth experiment (first and second clip)	2,00 2,00	2,14 2,27	almost real	-

TABLE XIII: RESULTS OF THE ANSWERS TO TEST QUESTION NO. 1 (HIGH SCHOOL STUDENTS SUBGROUP) IN THE FOURTH HYPOTHESIS

<u>Subgroup of High School Students</u> Hypothesis no. 4: The music performed by virtual instruments has a destructive impact on the illusion of the film. Test question no. 1: <i>Did the instruments in the track sound real or inauthentic?</i>				
	<i>Median</i>	<i>Mean</i>	<i>Result</i>	<i>Comparison to original soundtrack version</i>
The first experiment (second clip)	2,00	1,80	almost real	real
The second experiment (first clip)	2,00	1,77	almost real	almost real
The third experiment (none)	-	-	-	almost real
The fourth experiment (first and second clip)	2,00 2,00	2,00 2,21	almost real	-

5 Conclusions from the research

After obtaining and analysing results from the experiments it was verified that hypothesis no. 1. (*Music performed by the acoustic instruments allows for an immersion in to the world of film*) **is true.**

Furthermore, it was verified that the virtual instruments soundtrack version also allows for an immersion in to the world of film. It was noticed that the equipment used to play the video clips and the order in which these clips were played were significant factors. It was also noticed that there was a substantial difference between the responses given in the individual subgroups during the first experiment.

After obtaining and analysing results from the experiments it was verified that hypothesis no. 2. (*Music performed by acoustic instruments strongly affects emotions of the audience*) **is true.** Answers to the test second question confirmed that both subgroups assessed original soundtrack version as nostalgic. Additionally, both subgroups indicated that music in virtual instruments soundtrack version affected emotions of the audience stronger than music in original soundtrack version.

After obtaining and analysing results from the experiments it was verified that hypothesis no. 3. (*Music performed by virtual instruments strongly affects emotions of the audience*)

is true. Answers to the first and second test questions confirmed that for the both subgroups music in virtual instruments soundtrack version strongly affected emotions as well.

After obtaining and analysing results from the experiments it was verified that hypothesis no. 4. (*The music performed by virtual instruments has a destructive impact on the illusion of the film*) **is false.** Answers to the test question confirmed that for the both subgroups virtual instruments sounded generally almost real. Virtual instruments soundtrack version was rated the worst when audience saw the video clip after the video clip with original soundtrack version. Otherwise, the clip with the virtual instruments soundtrack version was always evaluated as almost real. Described results indicate that the music performed by virtual instruments does not have a destructive impact on the illusion of the film.

In other conclusions, the most important elements during creating soundtrack with application of the virtual instruments are knowledge of acoustic instruments, their construction, articulations and techniques of playing. Next elements are: extensive knowledge of music history, instruments sound color and sound pitch assessment ability, knowledge and skills in the field of classical, romantic and contemporary harmony, knowledge and skills in the field of counterpoint and orchestration, skills of mixing and mastering soundtracks, sense of rhythm and very good harmonic and color hearing.

In summary, this research and carried out experiments confirm that:

1. Music performed by the acoustic instruments allows for an immersion in to the world of film.
2. Music performed by the acoustic instruments strongly affects emotions of the audience.
3. Music performed by the virtual instruments strongly affects emotions of the audience.

This research and carried out experiments did not confirm that:

1. The music performed by the virtual instruments has a destructive impact on the illusion of the film.

Future research plans and research perspectives

This research confirms the need of exploring the subject of virtual instruments application in soundtrack composing and production process. The experiments indicated that this kind of research should be further deepened and continued. It might be useful to carry out a research similar to the one described above only with the symphonic music without the picture on a bigger test group also including professional musicians.

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