TAMPERE UNIVERSITY
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USING SAMPLE-BASED VIRTUAL INSTRUMENTS TO PRODUCE ORCHESTRAL STRINGS IN FILM MUSIC

Juho Salmi

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Music Production Study Path

ABSTRACT

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JUHO SALMI:
Using Sample-Based Virtual Instruments to Produce Orchestral Strings in Film Music

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As the music production technology has developed, the usability and availability of virtual and software instruments has increased substantially. This has affected also the production environment of film music production, where virtual instruments are widely used to create wide range of timbres, including traditional orchestral sounds.

The purpose of this study was to gather information regarding the use of sample-based virtual instruments to produce orchestral strings in film music. The aim was to study that what is the historic perspective for the use of sample-based virtual instruments in film music production, how are these instruments utilised in modern film music production and is it possible to produce convincing and realistic orchestral strings with these instruments.

This qualitative study is based on the information mainly gathered from various literal sources that includes books, articles and researches written by professionals in this field.

It was found that sample-based virtual instruments can be utilised to produce professional sounding orchestral strings in film music. Especially in the case of TV and low-budget film productions, there are many scores created exclusively with virtual instruments. To produce musically convincing orchestral strings with sample-based virtual instruments, it is needed from the composer to understand the fundamentals of the real acoustical instruments and to have the skills to program the virtual instruments to match the use of live instruments.

The utilisation of virtual instruments for orchestral strings will likely continue to increase in the film music production. The main reasons are the availability of high-quality software and the economic considerations regarding the production costs. This creates demand for composers and audio engineers that are able to provide quality orchestrations with these instruments.

Key words: virtual instruments, orchestra sample libraries, orchestral strings, film music, music production

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1 INTRODUCTION

As the music production technology has developed, the usability and availability of virtual and software instruments has increased substantially. Nowadays a film composer can create a professional sounding score with only a computer and software (Davis 2010, 62). This creates many possibilities for modern-day composers as the production can be executed with lesser budget and fewer people working with the film score project. Of course this also increases the pressure for the composer to produce professional sounding scores independently. As there are enormous amount of possibilities with the modern virtual instruments, there are still many limitations to them. Virtual instruments can be great tools for writing phase of music, but my interest is in the abilities of these instruments as professional music production tools and their use in creating the final musical product.

This thesis is about the use of sample-based virtual instruments (SBVIs) and how they can be used to produce orchestral strings in film music. I will briefly cover the history of both film music and virtual instruments, the film scoring technology, the role of orchestral strings in film music and operational principles of SBVIs in general. Then I will go deeper with the sample-based virtual instruments for orchestral strings. I am using EastWest's Hollywood String virtual instrument as an example for a SBVI for orchestral strings. With the historical perspective I am aiming to create understanding of the development of the film music and the music production methods, especially the development of the virtual and electronic instruments and their effect on the film music production methods.

> "For today's computer-literate composer, it is important to understand the development and the use of technology in scoring - important not just from a historical standpoint, but to understand how technology works and how it impacts one's compositional process" (Davis 2010, 55).

In the film music part of the thesis, I will mostly concentrate on the film music scores and film music production of the Hollywood films as it has been the forerunner in the technological sense and it has such an influential role in the film industry worldwide. Also the available source material is really heavily Hollywood-centred. The main focus will be on the full-length, large-budget feature films, because the same principles apply to television shows and movies, low-budget films, documentaries, short films and even student films (Davis 2010, 86). I will not discuss about the songs in the films (e.g. end-

title songs, source music, theme songs or other music outside the main score) and in this thesis the term “film music” will refer only to the original scores composed especially for the films. The traditional film score “can be defined as an institutional practice for the regulation of non-diegetic music in film”, which means that “it is the music heard by the spectators, but not experienced by the characters” (Kalinak 1992, xiv).

The orchestral strings are one of the key elements in the film music and they have been used since the early days of cinema. They are present in the majority of the film scores as orchestral strings are one of the most effective and expressive instruments in a film composer’s arsenal (Maddocks 2010). They can be utilised in lyrical, emotional lines, but also in grandeur Hollywood action sequences (Maddocks 2010). I also wanted to learn more about the use and possibilities of virtual instruments for orchestral strings and that is why I chose them as my main interest.

As a composer and a music producer myself, the development of the virtual instruments and other digital music production tools is very fascinating. My musical background is mostly from rock and pop genres, but I have an emerging interest in the film music composing. For a composer like me, these modern virtual tools offer a great opportunity to create competent compositional works and to produce them independently

Here are the research questions for this thesis:

- What is the role of sample-based virtual instruments for orchestral strings in modern film music production?
- Are the sample-based virtual instruments for orchestral strings convenient for producing orchestral strings in professional film music compositions?
- Is it possible to produce the orchestral strings in a film score using exclusively sample-based virtual instruments?
- What are the main operational principles for sample-based virtual instruments for orchestral strings and especially for EastWest’s Hollywood Strings?
- When aiming for a convincing and realistic performance, what is required for the use of sample-based virtual instruments for orchestral strings?

This qualitative study is based on diverse source material that has been written and provided by professionals in this field. The main sources have been a book by Richard Davis called Complete Guide to Film Scoring – The Art and Business of Writing Music

for Movies and TV (2010, 2nd edition), a book by Martin Russ called Sound Synthesis and Sampling (2008, 3rd edition), Users' Manual for EastWest's Hollywood Strings (2011) and articles written by Dave Stewart for Sound On Sound about virtual instruments for orchestral strings (2012-2017). A study by Reinhard Kopiez, Anna Wolf, Friedrich Platz and Jan Mons called Replacing the Orchestra? - The Discernibility of Sample Library and Live Orchestra Sounds (2016) provided important insight and research results on the credibility of the sound of SBVIs for orchestral strings.

I want to say special thanks to the main library of Tampere, Metso, for offering a great environment for focused working and to Tampere University of Applied Sciences and University of Salford for high-class education on the music production and related subjects.

2 FILM MUSIC

Film music is music that is either directly composed or expressly chosen to accompany a motion picture. Music has been part of the cinematic experience almost from the beginning of the cinematic history. It has been performed live and it has been recorded. The power of film music is in its ability to define meaning and express emotion as it guides our responses and connects us with the film in emotional level. It connects the narrative of the film into unified entity, so that the audience feels the sequence is inevitable. Acclaimed film composer Bernard Herrmann describes the meaning of film music: "Film music must supply what actors cannot say – it must convey to an audience their feelings. It must really convey what the word cannot do. The strange thing about cinema is that nobody really knows why music is needed – after a lifetime, I'm not sure – but it is not complete without it." (Kalinak 2010, xiii; Smith 2016.)

The original music composed to accompany a film is called the score. A typical feature film contains from around 30 minutes to over 120 minutes of music (Davis 2010, 79). The score is part of the film's soundtrack, which usually includes also pre-existing (e.g. pop music) music, dialogue and sound effects. The score comprises of individual pieces of music called cues (Davis 2010, 79). The length of the cues can be anywhere from a few seconds to several minutes. A score is usually composed by a single composer, but it can also be a team effort of many composers. The music is usually composed in collaboration with the director and/or the producer of the film.

In the this chapter I will go through the history of the film music, how the music and the production methods have evolved over the years and what is the role of orchestral strings in film music.

2.1 The history of film music in brief

The artistic expression and the technological development have always been very closely connected in the film music and in the film industry in general. The modern-day movies result from both the stylistic and artistic development that has occurred during the cinematic history and immeasurable amount of technological innovations. It has been a long way from the early days of cinema to the modern, digital film production tools and Dolby Cinema theatres with Dolby Atmos surround sound systems (Waniata

2016.) There has been significant evolution in the roles, styles and techniques of the film music during the cinematic history.

2.1.1 The early cinema

The first documented incidents, where film had musical accompaniments, happened in the 1885 and 1886, when the Lumiére family screened some of their early films in Paris and London (Davis 2010, 5). The early film screenings had musicians (e.g. pianist of small orchestras) that played along the film. They played mostly compositions from music fake books that contained many different classical pieces of music with different moods that covered almost any dramatic situation (Davis 2010, 6). There was no significant sound effects or voice acting in films until the 1920s, when the first talkies appeared. These films had synchronized music, sound effects and speech, and the first real box-office success was the film Jazz Singer starring singer Al Jonson. The film was released in the 1927 and it had the sound recorded in sync with the shooting of the film, which was the common procedure with the other talkies also. These first talkies were mostly musicals for both commercial and technical reasons. (Davis 2010, 14.)

The technology, which allowed the so-called re-recorded music to be added anywhere in the film, was adapted for commercial use in the early 1930s. This also created the process now called “dubbing”, where the music, dialogue and sound effects are mixed together. This new technology to produce music for film made the process of adding the music in films significantly more flexible and affordable. This first resulted to some naïve and strange experiments with music (e.g. thinking that the music source should always be visible on screen or use of the constant music), but by the early 1930s, directors and producers began to think that the film’s score was nevertheless a crucial component in movies. (Davis 2010, 15-17.)

Starting in the late 1920s, the major film studios in Hollywood had music departments that allowed every stage of the music to be produced in-house. The music department staff included composers, orchestrators, songwriters, rehearsal pianists, orchestra musicians, conductors, choreographers, music copyists, proofreaders, music editors and music executives to oversee the process. These people usually worked in a same building (the music building) that also contained a music library and a recording studio. This was the most productive time in the history of the Hollywood film business in

terms of the number of films produced. There was a great and constant need for new films in the 1930s, because approximately 65% of the population went to the movies for once a week (the same numbers nowadays is under 10% of the population). That is why they created this assembly line resembling, very efficient and streamlined style of producing film and film music. They could produce the music for a whole film in such time as in five days, including the composing, recording and dubbing. By the mid 1930s, most of the films made in the US were produced under what has become known at the "studio system". It refers to a situation, where the whole moviemaking personnel had been placed under contract to the film studio. (MacDonald 2013, 40-41; Davis 2010, 20-24.)

2.1.2 The Golden Age of Hollywood

The Golden Age of Hollywood is the time from the mid 1930s until the early 1950s. During those years an average of 500 films were produced every year. It was an exiting time for film industry and also for film music both in technical and creative manner. Film music's language and techniques developed, which created a foundation that is still valid today. Some of the most important film composers of that era include Max Steiner (1888-1971), Dimitri Tiomkin, (1894 – 1979), Erich Korngold (1897 – 1957), Alfred Newman (1901 – 1970), Branislau Kaper (1902 – 1983), Miklos Rozsa (1907 – 1995) and Franz Waxman (1906 – 1967). They were all European born immigrants (except Newman, whose parents immigrated from Russia to US) and many of them had fled the political upheaval and prosecution in Austria, Germany and Eastern Europe. They had in-depth knowledge of the music of the 18th and 19th centuries, which was exactly the style the film producers wanted for their films. The music from this same era had been used with the silent films and the audience was familiar with the style. These composers from the Golden Age of Hollywood drew their influences from such classical composers as Verdi, Wagner, Strauss, Puccini, Beethoven, Mozart, Brahms, Mahler, Schubert, Berlioz and many others, and they were very highly and classically trained professionals, who had great achievements before and during their Hollywood careers. They had excellent abilities in harmony, melodic development and other compositional techniques (e.g. leitmotifs). They set the bar really high in the film music. (MacDonald 2013, 27-28, 36; Davis 2010, 27-30.)

PICTURE 1. Dimitri Tiomkin working on the score for Duel In The Sun in 1946. (Photo: Russian Art and Culture 2012)

During the 1940s, some new musical ideas for film music, like jazz, contemporary 20th century music and other modern compositional techniques (e.g. twelve-tone rows), were introduced by Bernard Herrmann (1911 – 1975) and David Raksin (1912 – 2004). (Davis 2010, 32-33.) Raksin makes an interesting notion considering the audiences ability to accept some more contemporary or dissonant music in films:

> If you have a really violent sequence and you write something that is really dissonant, they wouldn't like to hear that as a [concert] piece of music. But they will accept it, if it is the right music for a film sequence. (Raksin as cited in Davis 2010.)

The new generation of film composers began to arise in the early 1950s. These were conservatory-trained American musicians that included for example aforementioned Herrmann and Raksin, Alex North (1910 -1991), George Antheil (1900 -1959), Aaron Copland (1900 – 1990), Leonard Rosenman (1924 – 2008), Elmer Bernstein (1922 – 2004), André Pervin (1929 -) and Jerry Goldsmith (1929 – 2004). This new generation of composers were influenced by the music of Bartók, Schoenberg and Stravinsky, but many of them also had a good knowledge of jazz styles. They composed raw and edgy scores with also dissonant elements. Of course there was still need for the more conservative score for example in big epics based on biblical stories. (Davis 2010, 36, 39)

2.1.3 Movement towards the popular style

In the 1960s, the film music changed remarkably from the traditional symphonic style to a more modernistic, popular style. The film music was heavily weighted towards jazz-influenced scores and using pop and rock songs in the films. The composers such as Henry Mancini (1924 – 1994), John Barry (1933 – 2011) and Michel Legrand (1932 -) were the leading trendsetters of the 1960s in the film scoring. The turbulent political times in the US (Vietnam war, assassinations of political and religious leaders) and the arrival of the television affected the whole entertainment industry. By the 1970s, the old studio system with big in-house music departments had finished. The people did not go to the movie theaters as frequently as they used to, and the antitrust law from the 1948 also affected this development as it had required the studios to break up their chains of self-owned theaters. The major film studios had to lay off many employees. This change meant that also the composers became independent, and they now could move from studio to studio as the projects required. The television impacted the film music so that it enhanced the rise of jazz, pop, rock and atonal and dissonant methods in film scoring. (MacDonald 2013, 259, 325; Davis 2010, 36, 38-39, 45.)

There was a decade, from 1960s to early 1970s, when the orchestral and symphonic film scores were not that popular. In the 1970s, at the same time that the last godfathers and pioneers of the film music were ending their careers, the symphonic scores were experiencing a revival. In the 1974 the Stephen Spielberg film Jaws was released with a more traditional and orchestral score by John Williams (1932 -), and it returned the appreciation for the orchestral scores. After Jaws, Williams' work with Spielberg (Close Encounters of the Third Kind, E.T. the Extra-Terrestial, Jurassic Park, Schindler's List) and George Lucas (Star Wars series, Indiana Jones series) has made him one of the acclaimed contemporary film composers, who has made some of most popular and recognizable film scores in the cinematic history. He is still composing at the age of 86, although in the recent years he has mostly concentrated on the new Star Wars films. (MacDonald 2013, 329, 398; Davis 2010, 46-45.)

PICTURE 2. John Williams at the 2016 AFI Life Achievement Award Gala (Photo: Chris Pizzello 2016)

2.1.4 The rising of the electronic instruments

The use of electronic instruments in film scores had started even before the 1970s, but it was in the 1980s that the electronic scores really drew the audience's and the film producers' attention. The score of the 1981 film Chariots of Fire was a milestone for the use of electronic instruments in film scores. It was composed by a Greek composer Vangelis (1943 -), and the score was made entirely with electronic instruments and synthesizers, which at that time were still primitive compared to today. This score was a great success both artistically and commercially. It showed that the electronic instruments could be used in a very musical and lyrical manner. (Davis 2010, 49.) This was a great achievement as electronic music had been frequently dismissed as a style of music that equates to "dehumanization", the "final victory of the machine over man" and "the triumph of noise over music" (Schwartz 1973, 3, as cited in Barron 2014, 91). The synthesizers and other electronic instruments (e.g. theremin) were previously used mostly in high intensity dramatic situations or in science fiction films. (Barron 2014, 85; Davis 2010, 49.)

PICTURE 3. Vangelis won an Academy Award for Best Original Score in 1982 for his score to the film Chariots Of Fire (IMDb.com, Inc. 2018). (Photo: Encyclotronic 2017)

In the mid-1980s, as synthesizers became more affordable, accessible and easier to use, many composer began to incorporate electronic sounds into the film scores. These composers include for example Jerry Goldsmith, Elmer Bernstein, Maurice Jarre (1924 – 2009), James Horner (1953 – 2015), Basil Poledouris (1945 – 2006) and Alan Silvestri (1950 -). Composers found that with electronic instruments they could create new kind of textures, sounds and soundscapes. Other emerging composers in 1980s include Danny Elfman (1953 -), Michael Kamen (1948 – 2003), Randy Newman (1943 -), Howard Shore (1946 -), Bruce Broughton (1945 -), James Newton Howard (1951 -), David Newman (1954 -), Thomas Newman (1955 -) and Carter Burwell (1954 -). (MacDonald 2013, 406; Davis 2010, 49-50.)

There is an interesting example showing the juxtaposition of the traditional sound and the new electronic sound with the Ridley Scott fantasy film The Legend (1985) and the scoring of that film. The film was initially scored by Jerry Goldsmith with a traditional orchestrated music (that actually also utilised synthesizer), but after the poor reception of the film from the audience in the US, the film studio thought that the score should be done again. They thought that “more accessible sound was needed to attract the youth audience” (Kermode 1995, 19, as cited in Barron 2014, 84). They then commissioned

the score from a German electronic band called Tangerine Dream, who were set out to do more ‘new age’ –type of music with synthesizer-laden sound. This became the new score for the film’s abbreviated US version, although the longer international version has the original Goldsmith score. The score by Tangerine Dream can be seen well-suited for a Ridley Scott film as he has the history of movies with machinic quality (e.g. Alien and Blade Runner), but still the director ultimately preferred the original score by Goldsmith. (Barron 2014, 84, 92.)

2.1.5 The digital age

The next big shift in the music technology was from analogue to digital, which increased the possibilities with electronic music production even more. Actually, the whole world of commercial music was altered forever by the arrival of synthesizers and computers. There was a need for a new kind of expertise to master this new technology. Some composers now oriented themselves heavily towards electronic and synthesizer scores. These composers became experts in synthesizer sounds, sampling, MIDI technology and sequencing. One of the most well-known and established composers in this field is a German-born Hans Zimmer (1957 –), who has written successful scores (The Lion King, Pirates of the Caribbean series, The Thin Red Line, Gladiator and The Dark Knight trilogy) using either entirely electronically generated music or a combination of electronic and acoustic sounds. He started his career in Hollywood in the late 1980s and he is still one of the most popular composers in the film industry. Although he started with electronic scores, he began writing scores that incorporated a full live orchestra as did many of those, who started as synthesizer specialists. (Davis 2010, 49-50.)

In the 1990s, the more affordable personal computers were being manufactured by the IBM and the Apple Company. Also the World Wide Web developed then and the importance of the Internet started to grow. This also had impact on the music production as the significance of physical distances started to have a lesser importance and the digital production tools (e.g. DAWs and virtual instruments) also became more available to the aspiring composers. The orchestrated and symphonic film scores were quite popular in the 1990s, although there were scores that abandoned the orchestral music altogether. Some of the emerging film composers of the era include Alan Menken

(1949 -), Patrick Doyle (1953 -), Elliot Goldenthal (1954 -), Cliff Martinez (1954 -) and Rachel Portman (1960 -). (MacDonald 2013, 478; Paris 2018.)

In the 2000s and 2010s, the importance of the Internet and the constantly evolving digital production technology are two big factors affecting the operational environment. As there has been emerging traditional, classical-oriented composers, for example Alexandre Desplat (1961 -) and Dario Marianelli (1963 -), there is growing number of musicians from non-classical backgrounds making their mark in the film industry, including Clint Mansell (1963 -), Jon Brion (1963 -), Trent Reznor (1965 -), Jonny Greenwood (1971 -), Steven Price (1977 -), Michael Giacchino (1967 -) and Jóhann Jóhannsson (1969 – 2018). Many of these composers have background in pop or rock music, which affects their stylistic approach among the film music. (Chitwood 106; Paris 2018.)

The film music today is richer than ever because of the technological and stylistic evolution that has happened from the early days of the cinema until today. The digital technology has become a necessary tool for today's film composers (Davis 2010, 51). It is a logical development as film production in general is done mostly in the digital environment nowadays. The new technology also creates new possibilities for composers that are not classically trained, do not orchestrate or cannot read music, and this, on the other hand, creates stylistic richness to the film music in general.

2.2 The film scoring technology

As described above, the technological evolution has had a significant impact on the stylistic matters in film music and also impact on the ways it has been made. In the days of so-called studio system, the composer's only composing tools were musical instruments, pen and score paper. They had a large group of people with different responsibilities working with the same film score. The composers today have access on very efficient composing tools, such as computers, digital audio workstations (DAWs, such as Pro Tools, Logic Pro X, Cubase and Ableton Live), sample libraries, virtual instruments, notation software and so on. This creates many possibilities for composers, but it also moves more responsibilities to composer's direction. The utilising of the Internet as a working environment and as a social platform is commonplace.

Nowadays the composers are expected to produce high-quality demos, mock-ups (a rough version of the cue recorded with synths and samples) and final scores. This means that professional audio production skills are needed. Many low budget films and TV productions use music that is created with only computer, sample libraries, virtual instruments and other digital tools, i.e. 'in the box'. Composers need to have the expertise, but also access to the hardware, the software and the sample libraries. Still, there are composers today that relay on the old method of working with pen and paper. (Davis 2010, 55, 148.)

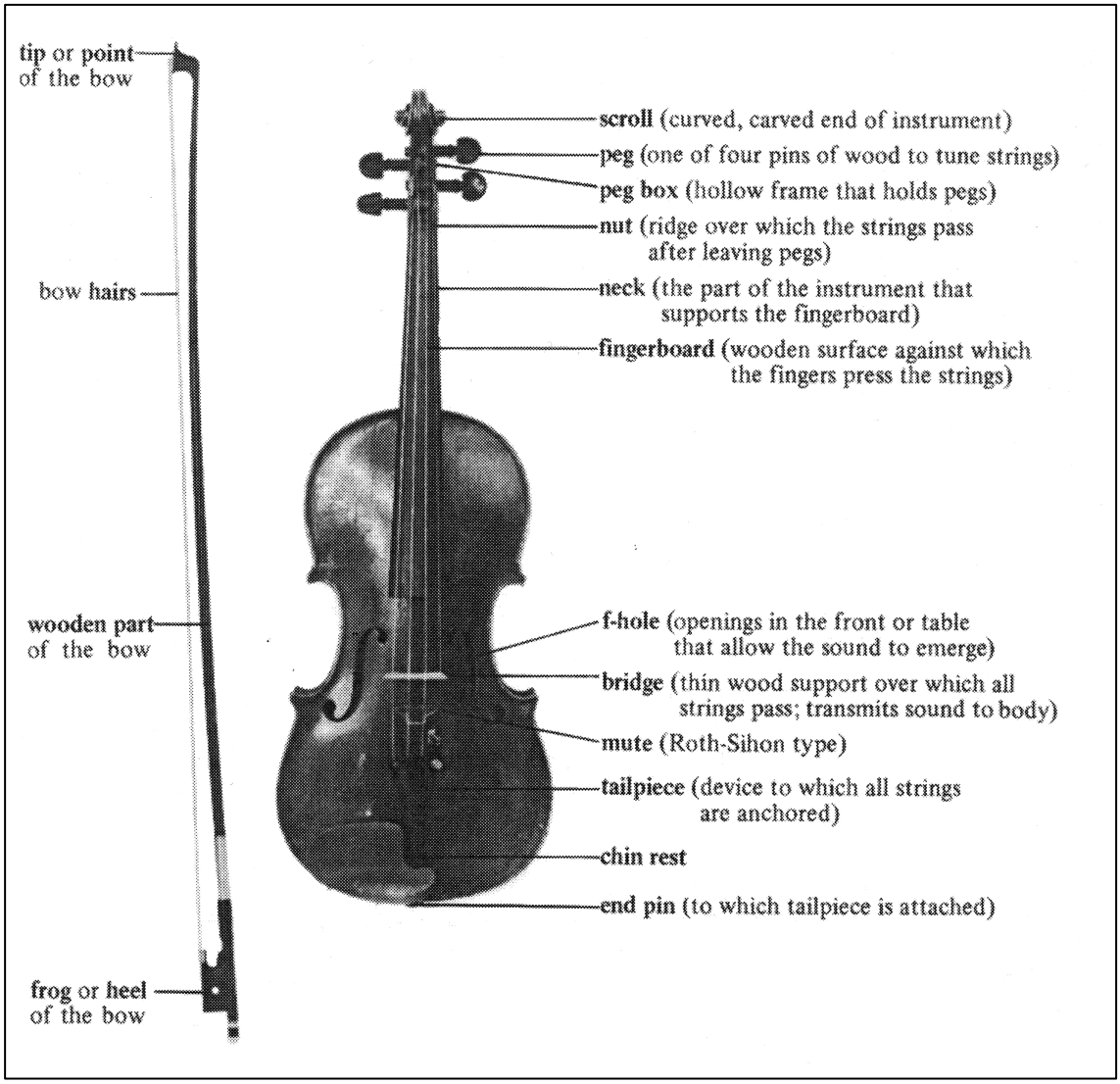
PICTURE 4. Hans Zimmer working in his studio at Santa Monica, California.
(Photo: Eric Charbonneau 2014)

One of the main advantages of using a DAW is that the work can be done faster and more efficiently. The composer can play the ideas along the video and at the same time record and notate it. Also if the composer is not trained in music notation, it is much easier to realize the musical ideas with a keyboard. In some cases the film score needs some sounds that cannot be made or are really hard to make (e.g. unusual and exotic instruments) without electronic instruments or sample libraries. If the final score is created with a DAW, then the syncing of the music to the picture is fairly simple, which potentially saves time on the production. (Davis 2010, 149.)

2.3 Orchestral strings in film music

2.3.1 Orchestral strings

The four principal instrument families of the symphony orchestra are woodwinds, brass, percussion and strings. They can be augmented with piano and occasionally a choir. The stringed instruments that are commonly associated with the symphony orchestra and often referred to as the orchestral strings include the violin (divided into first and second violin players), viola, violoncello (i.e. cello) and contrabass (i.e. double bass). All of these instruments share a similar physical structure including most of the parts, although they are different in size. It is valuable to know the construction and the parts of these instruments as it creates understanding of the ways in which string instruments are played and produce sounds. (Blatter 1997, 26; Stewart 2017.)



PICTURE 5. The parts of the violin. (Blatter 1997)

PICTURE 6. The orchestral strings instruments and their relative sizes (from smallest to largest, these are the violin, viola, cello and contrabass). (Blatter 1997)

Here is a short description of the strings on an orchestral string instrument and its basic sound production manner:

> The strings on the instruments are identified both by letter name and by number, usually expressed as Roman numerals. From high to low (right to left in Pic. 5) the strings are numbered I, II, III and IV. The vibration of the strings is transferred through the bridge to the front or table of the instrument. From there the sounds are transmitted to the back by means of the sound post, a small wooden rod inside the instrument and perpendicular to the front and back. It is located at the number I sting end of the bridge. (Blatter 1997, 26.)

The string can be set into vibration in three ways, which are plucking, striking and bowing. Plucking is usually done with fingers, but for some special effects a pick may be used. The instruction to pluck is *pizzicato*. When striking the string, it can be done for example with the wooden part of the bow, percussion mallets or the performer's hand. The most common way is the bowing that utilises the bow and its hairs (made of horsehair or similar substance). The use of the bow is assumed in the case of modern orchestral strings, but if there might be some doubt as to how a particular passage should be played or if a composer wishes the performer to return to bowed playing after a pizzicato passage, the instruction *arco* is used to indicate that a particular part should be played with a bow. Different articulations for different playing styles are discussed more in the chapter 4. (Blatter 1997, 27.)

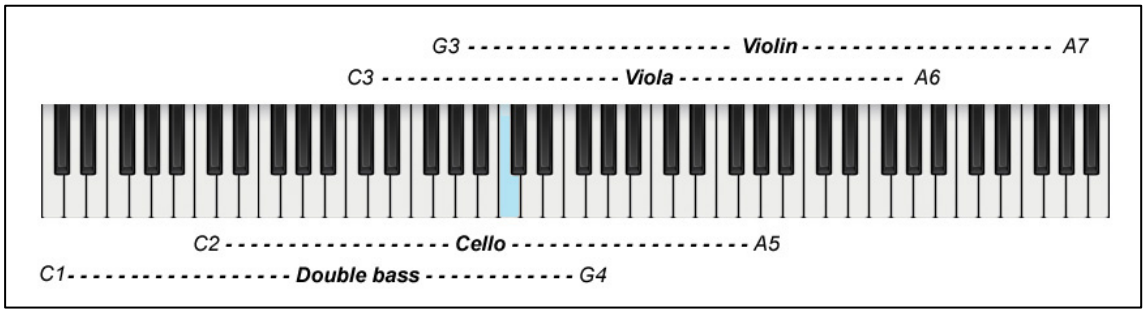
The violin is the highest pitched instrument of orchestral strings and it operates in the soprano and alto range in string ensemble writing. Due to its small size, the violin is the most responsive and most agile of all the string instruments. Virtuoso performance skills are often associated with this expressive instrument. For professional performer there are very few performance limitations, but novice composers and orchestrators tend to underestimate the ability of string performers. With the violin, it is possible to perform very complex lines and it has excellent solo and ensemble qualities. Like the other modern orchestral string instruments, the violin has four strings. (Blatter 1997, 49-50.)

The viola operates in the alto and tenor range, and it is pitched a perfect fifth below the violin. The body of the viola is longer and deeper than that of the violin. Due to its lower tone, the viola sounds a bit heavier than the violin, although in the hands of a great performer, the virtuosity and agility of the viola is very near that of the violin. The viola can be used as an associate of the violins, doubling melodic lines, and as associate of the celli, reinforcing and doubling the cello lines. Along with the second violin, the viola is usually given major responsibility for the inner voices, accompaniments, rhythmic figurations, and the harmonic underpinnings of a score, which means that it often reduces the melodic opportunities for the instrument. (Blatter 1997, 56-57.)

The cello operates primarily in the bass range, but also in the alto, tenor and even soprano range. It is pitched an octave below the viola. The sound of the cello is rich, warm and clear, which makes it an excellent bass, harmonic and melodic instrument.

Despite its quite big size, the cello is a very agile instrument. It is good for variety of expressive melodic line, arpeggios and complex figures, but also for doubling other instruments. It is common to find the cello used as a solo voice or scored above the viola, because it plays well in that range. Because the cello has significantly longer strings than smaller string instrument, pitches are farther apart. This means that melodic leaps may require more time to execute. (Blatter 1997, 61-62.)

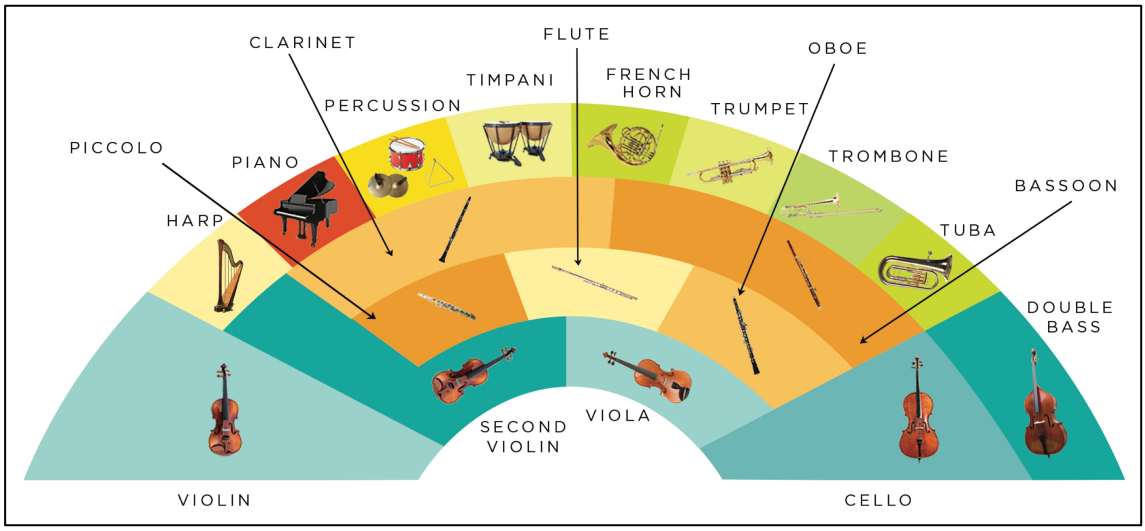
The contrabass (i.e. double bass, bass viol, bass or string bass) is a large instrument that operates in the bass register, and it is the lowest voice of orchestral strings. The contrabass is a descendent of the viols, not the violins as the other orchestral strings. It differs from the other orchestral string instruments by its body shape and tuning system. As the violin, viola and cello are tuned in fourths, the contrabass is tuned in fifths. Quite often there are parts written for contrabass that include notes that are below the E string (E1), and to play these notes, there are five-string contrabasses and contrabasses with a low C (C1) extension available. The most common function for the contrabass is to play the bass line or to double the bass an octave lower than the other instruments. (Blatter 1997, 67-69.)



PICTURE 7. Playing ranges of stringed instruments - the double bass range includes a low C extension. (Sound On Sound 2017)

There is a variety of different kind of string orchestra ensembles and sections. The chamber orchestras can vary from a string quartet consisting of four players (2 violins, viola and cello) to bigger ensembles that include up to 21 players (6 first violins, 5 second violins, 4 violas, 4 cellos and 2 contrabasses). A full symphonic string section or a string orchestra usually features 16 first violins, 14 second violins, 12 violas, 10 cellos and 8 contrabasses, which makes 60 players all together. The use of certain ensemble or orchestra type depends on the composer's or orchestrator's decisions, and it is always related to the style of the music and the desirable musical atmosphere. There is a certain

tradition to the seating positions of the orchestral string players in the symphonic orchestra set up. The positions for different instrument families and sections in a modern symphonic orchestra can be seen below. (Blatter 1997, 359, 417.)



PICTURE 8. The orchestra seating chart for modern symphonic orchestra. (Dallas Symphony Orchestra 2018)

PICTURE 9. London Symphony Orchestra - one of the world's leading orchestras that has also performed many film scores and worked with composers such as John Williams and Alexandre Desplat. (Summit Records 2018)

2.3.2 The role of orchestral strings in film music

From the beginning of the cinematic history, the classical music has had a huge influence on the film music, and the orchestral instruments have been used to

accompany films since the early days of the cinema. The size of the orchestras used has been increasing through the years, and nowadays the 100-strong symphonic ensembles are heard in Hollywood film soundtracks. Orchestral strings are vital, established and biggest part of the traditional symphonic orchestra, so it is logical that they have become one of the key elements in film music too. They are present in the majority of the film scores, because they are one of the most effective, expressive and versatile instruments to be used in composing for films. Orchestral strings can be utilised for example in lyrical and emotional scenes (e.g. love scenes), but also in grandeur Hollywood action sequences and in various other occasions. (Maddocks 2010; Smith 2016; Stewart 2017.)

The strings have ability to move and engage the audience and to cut to the emotional core of the storyline. They bring humanity to the score, as the composer James Murphy states (Smith 2016). British composer Patrick Doyle has one explanation on why the strings are so effective:

> The violin is so similar to a human voice, it touches us all instantly. Strings are so evocative – they immediately create a visceral, emotional response. The combination of harmony and strings can have quite a devastating emotional impact. (Doyle as cited in Smith 2016)

The ability of strings to remain in the background, under the dialogue, and then to add the needed tension, emotion and soundscape without interrupting the dialogue and the storyline, is especially important. Some other instruments do not have this ability, as for example flute's high-pitched sound can be too piercing with the dialogue. The dynamic and harmonic range of the string orchestra is very wide and it is well equipped to convey a whole range of human feelings. Different playing techniques can be used to make the strings more viable and interesting, and to avoid the blandness. The different orchestral ensembles (e.g. string quartet or full string orchestra) can be used to create different musical and emotional effects. One technical advantage with strings compared to other orchestral instruments is that string players can sustain notes indefinitely by means of a continuous alternating bowing and they are able to play two or three notes at a time. (Smith 2016; Stewart 2017.)

Although the orchestral strings might be first associated with the romantic scenes, they have had a crucial role in many films containing raw terror, horror and apocalyptic atmosphere. One of the most well-known examples is the use of strings in Spielberg's

blockbuster movie Jaws (1975) that has been covered earlier in this chapter. Other famous example is the Alfred Hitchcock's horror movie Psycho (1960) and especially its 'shower scene', which was initially planned by Hitchcock to contain no music, but the composer Bernard Herrmann thought otherwise. The score of Psycho is done purely with strings. (Smith 2016.)

Although the stylistic spectrum of film music has widened notably in the last fifty years, covering for example rock, pop, electronic and experimental music, the orchestral strings have retained their importance, and the situation is not likely to change in the near future. The importance of the orchestral strings in modern film music, and in modern music production in general, can be noticed for example in the investments that different manufacturers have made to develop and manufacture comprehensive and realistic virtual instruments for orchestral strings.

3 SAMPLE-BASED VIRTUAL INSTRUMENTS (SBVIs)

Here is a good definition and short description of virtual instruments by Vienna Symphonic Library (2018):

> A virtual instrument is a software application that enables the user to produce or play sounds on a computer…. There are two kinds of virtual instruments. The first type generates sounds by creating and modulating waveforms – similar to traditional hardware-based synthesizers. The second type are sample-based [virtual instruments], i.e. they trigger recorded audio tones, loops, and phrases performed by musicians. These "samples" are edited and assembled for use in a sample library, which can be accessed in real-time by the software instrument. In the case of an orchestral sample library, single notes and tone sequences (phrases) are recorded with various expressions, tempos and articulations. These variations cover the capabilities of each instrument or ensemble. Finally, the recordings are edited in the studio and processed for use in a sample library or virtual instrument.

The focus of this thesis is on the sample-based virtual instruments (SBVIs) for orchestral strings, which are also called orchestral sample libraries (OSL). "The invention of pre-recorded orchestra sample libraries (OSL), as a modern approach to sound synthesis, can be regarded as a minor music-industrial revolution, which enables the recording of music without the presence of live musicians" (Kopiez, Wolf, Platz & Mons 2016). Nowadays, the use of SBVIs for orchestral strings is indispensable to the modern production of various musical genres, and these tools can liberate music producers from the constraints of a professional recording studio or expensive digital equipment (Kopiez, Wolf, Platz & Mons 2016).

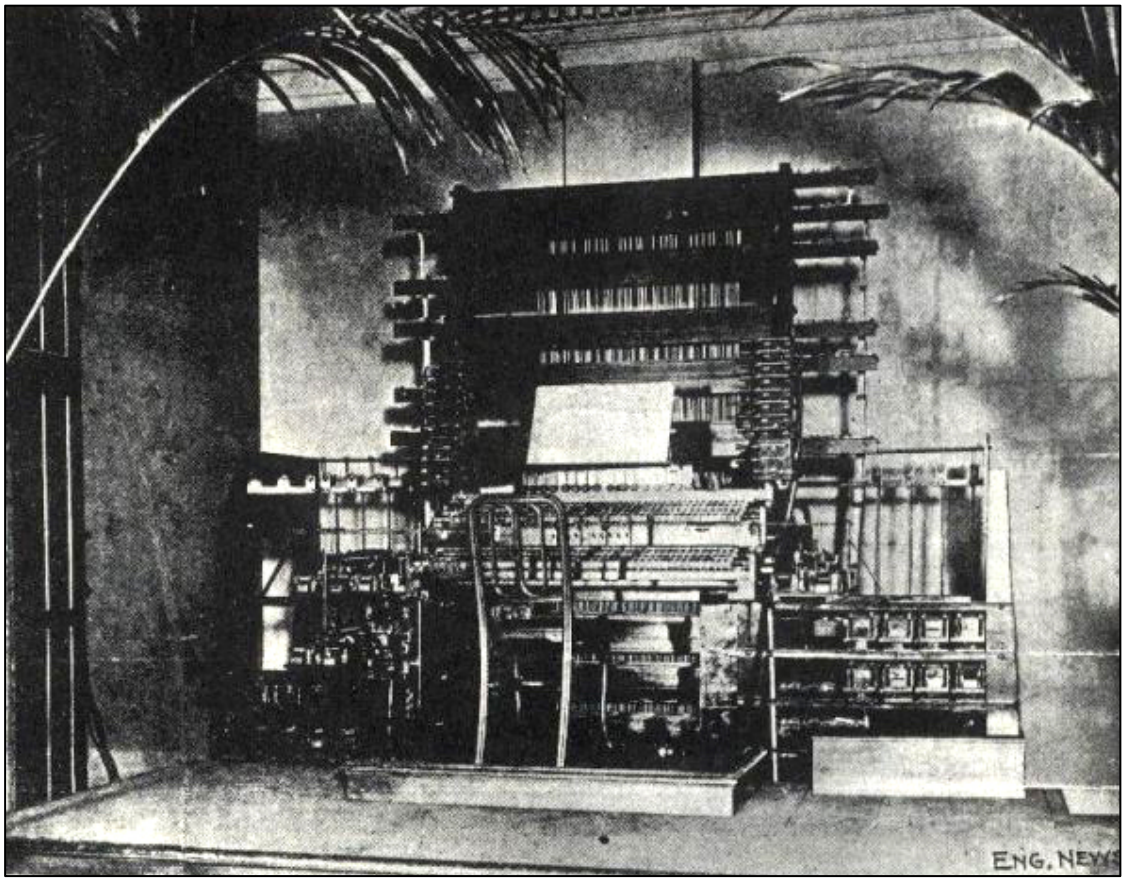
In this chapter I go through the history of electronic and virtual instruments, the operational principle of the SBVIs, SBVIs for orchestral strings, the operational principles of EastWest's Hollywood Strings virtual instrument, the use of SBVIs for orchestral strings in film music production and the credibility of the sound of SBVIs for orchestral strings.

3.1 The history of electronic and virtual instruments in brief

3.1.1 Early electronic instruments and analogue synthesizers

The first instrument to create music by an electrical process was the 'Dynamophone' or 'Telharmonium' exhibited in 1906. It was manufactured by Thaddeus Cahill from

Holyoke, Massachusetts, US. Other early electronic instruments include for example Theremin By Lev Theremin in 1920, Ondes Martenot by Maurice Martenot in 1928 and Trautonium by Friedrich Trautwein in 1930. In 1948 electronic music became a recognizable genre with Pierre Schaeffer's concert that consisted of his compositions created from existing sound recordings. The genre called musique concrète had been born, and it was created by processes of "subjecting natural, pre-recorded sounds to any number of recording techniques, like speed changes, playing the sounds backwards or tape reversal, and overdubbing" (Ernst 1977, 3, as cited in Barron 2014, 85). The pure electronic music was established in Germany in the beginning of the 1950s with the composers such as Karlheinz Stockhausen (1928 – 2007). They utilised electronic sound generators and modifiers instead of manipulating natural sounds. (Barron 2014, 85; Russ 2008, 79-80; Gamer & Moog, 1998.)



PICTURE 10. Telharmonium. (Photo: Public Domain / Wikipedia 2010)

The word 'synthesis' is defined in the Oxford Dictionaries (2018) as "the combination of components or elements to form a connected whole", which implies that the process of synthesis is more than just a random assembly. It is a creative process that includes the human element of controlling and choosing. The process of producing sounds is

called ‘sound synthesis’, which can reuse existing sounds by processing them or it can generate sounds electronically or mechanically. It can be thought that the only ‘natural’ instrument is the human voice and anything that produces sounds by any other method can be considered ‘synthetic’. However, the word ‘synthesizer’ has come to mean only an electronic instrument that is capable of producing a wide range of different sounds from traditional acoustic musical timbre to completely new and original sounds that have been designed and composed (or programmed) by a musician or by another skilled individual. (Russ 2008, 3-5, 31-32; Gamer & Moog, 1998.)

PICTURE 11. The RCA Mark II Sound Synthesizer (1957), a follow-up to the Olson-Belar Sound Synthesizer released in 1955. (Photo: Public Domain / Encyclotronic 2017)

In 1955 RCA demonstrated the Olson-Belar Sound Synthesizer, which represented a “multi-function machine, possessing sound generators, modifiers, and mixers” (Ernst 1977, 49, as cited in Barron 2014, 85). However, the important development of the electronic music occurred, when the smaller, voltage-controlled synthesizers, principally the commercially marketed Buchla and the Moog were released in the mid 1960s. The basic components of this kind of analogue synthesizer for creating and shaping the sounds include oscillators (for generating repetitive waveforms), mixers (for combining waveforms), filters (for increasing the strength of some overtones while reducing the strength of others) and amplifiers (for shaping the loudness contours of the sounds). Analogue synthesis methods can be divided into three basic categories, which

are subtractive, additive and wavetable synthesis. Most of the synthesizers designed before the 1980s are analogue synthesizers, because their circuits directly produce electric waveforms that are analogous to the sound waveforms of acoustic instruments. In the 1960s, the sampling in an analogue environment also gained some popularity with the release of the sample-replay musical instrument called Mellotron. The default sounds of Mellotron included for example sampled strings, woodwinds, organs, brass and choir. (Russ 2008, 3-5, 8, 31-32, 186-187; Barron 2014, 85; Gamer & Moog, 1998.)

PICTURE 12. An early Minimoog Model D (1970) by R. A. Moog.
(Photo: glacial23 2010)

The first major success for electronic music composer was the Walter Carlos' Switched-On Bach album that included recordings of classical Bach by using a Moog modular synthesizer. Later Carlos also composed music and arranged existing classical works for the Stanley Kubrick's classic film A Clockwork Orange (1971) using the signature approach with electronic sounds. In the 1970s many well-known artists started to fully utilise the electronic instrumentation and effects in a wider scale. Artists and bands that employed synthesizers were such as Brian Eno, The Tubes, Todd Rundgren, King Crimson, Yes, Rick Wakeman, Patrick Moraz, Keith Emerson, Jean-Michel Jarre, Vangelis, Kraftwerk, Tangerine Dream and Gary Numan. Some of these artists and bands used synths with traditional instruments (e.g. guitars, bass and drums), but some of them were fully founded upon the use of electronic instruments and synthesizers. (Barron 2014, 85-86; Russ 2008, 27; Gamer & Moog, 1998.)

3.1.2 Digital synthesizers and sampling

Digital synthesizers and music systems contain circuits, which produce series of numbers that must then be converted to analogue waveforms in order to be created as a sound. Here is the operation principle of the digital sound synthesis explained by Gamer and Moog (1998):

> Computer [digital] sound synthesis involves the description of a sound waveform as a sequence of numbers representing the instantaneous amplitudes of the wave over very small successive intervals of time. The waveform itself is then generated by the process of digital-to-analog conversion, in which first the numbers are converted to voltage steps in sequence and then the steps are smoothed to produce the final waveform…. Computer-based music composition systems are capable of performing any function that can be described as a computational procedure, or algorithm. The algorithm is written by a composer or programmer as a series of instructions that are stored in digital media and "loaded" into the computer when the music is to be realized. The composer then also writes a score that specifies properties of the individual sound events that make up the composition.

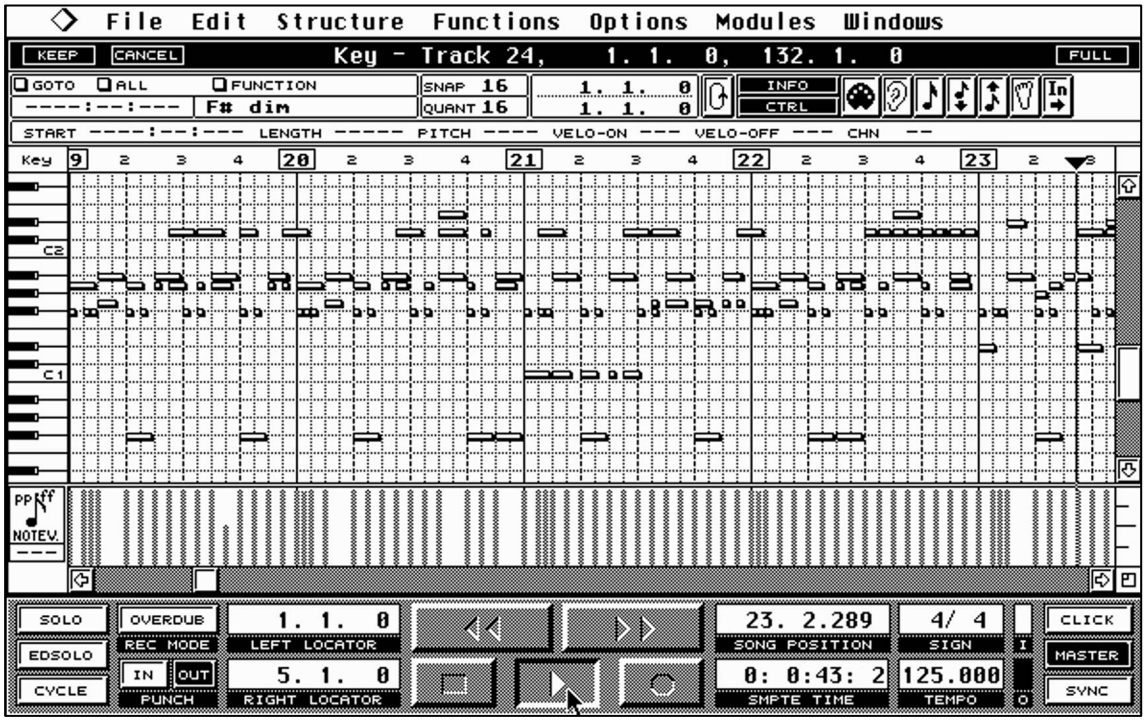
Digital signal processor (DSP) is a specialised microprocessor chip that is used for carrying out the complex numerical calculations. It was invented in the 1970s to enable audio coding algorithms to be developed and to enable the development of many types of digital synthesizers. DSPs are still used today, but the powerful processing capability of modern computers has reduced the need for this kind of specialised microprocessor. The first widely successful synthesizer that used digital technology was Yamaha DX7, which used frequency modulation (FM) synthesis. It was released in the late 1982 with two other models, DX1 and DX9. Many other manufacturers, including Casio and Roland, followed with their digital synthesizers and by the end of the 1980s, digital music systems surpassed tape studio techniques and analogue synthesizers as the most popular electronic composition medium among modern and experimental music composers. In the 1990s first successful synthesizers using physical modelling techniques were released, including Yamaha's VL1. (Russ 2008, 16, 28-29; Gamer & Moog 1998)

PICTURE 13. Yamaha DX7, a digital synthesizer released in 1982.
(Photo: Public Domain / Wikipedia 2017)

Pulse code modulation (PCM) is a technique for digitizing or sampling sound and converting the sound into digital form. It was developed by Bell Telephone Laboratories in the 1950s and 1960s. In this technique an audio signal is sampled at regular intervals and a sound waveform is converted to a sequence of numbers that is a digital representation of that waveform. PCM forms the basis of sampling. The musical applications of sampling allow a musician to digitize a sound waveform and then process it and play it back under musical control. Commercial use of sampling began in the late 1970s and the early 1980s with the products such as Fairlight Computer Musical Instrument (CMI), Ensoniq Mirage, Emulator, LinnDrum and Kurzweil 250, which was one of the first synthesizers that contained digitally encoded (i.e. sampled) representations of grand piano, strings and other orchestral instruments. By the end of the 1980s, numerous instrument manufacturers had combined the technologies of the digital computer, digital sound synthesis and sampling into integrated composition, sound-processing and performance systems called music workstations. (Barron 2014, 85-86; Russ 2008, 16, 29; Gamer & Moog 1998.)

3.1.3 Using computers for music making

With the rise of the personal computer in the 1980s and 1990s, the possibilities for musicians and composers to use computers for creating music also started to grow significantly faster. The launching of the Musical Instrument Digital Interface (MIDI) in 1983 was a really important point in bringing the electronic musical instruments and computers together. MIDI is an interface for exchange of information between electronic musical instruments and computers. This protocol was created through an agreement made by several commercial instrument manufacturers. MIDI is used for transmitting commands that tell for example which notes are being played, what timbre is desired and what nuances are being produced. The pinnacle of traditional MIDI's popularity was in the 1980s and 1990s, but it is still an existing connection medium. Nowadays the physical connection between an instrument and a computer is usually made with an USB (Universal Serial Bus), but the MIDI information is still being used for the communication between the devices and to control the virtual instruments. (Russ 2008, 66-67; Gamer & Moog 1998.)



PICTURE 14. Cubase was first released for Atari computers in 1989.
(E.P.S.S. and Cubase on Atari STe, YouTube 2012)

Commodore 64, released in 1982, was the first successful home computer that people could make music with. It was an 8-bit device and had the SID (Sound Interface

Device) sound chip, which enabled users to create music using three channels of sound synthesis. In 1985 Atari ST was released. It was a 16-bit device and it included MIDI ports to connect the eternal hardware and it became very popular computer among the musicians. Another 16-bit home computer from that time, Commodore Amiga 500 released in 1987, was the first computer to have music tracker software, which is a type of sequencer software that was widely used for creating video game music. In 1989 Steinberg released Cubase for Atari computers, and it was the first sequencer software that included the so-called arrange page that had a vertical list of tracks and horizontal timeline. It is a design still used in modern DAWs, including Digidesign's Pro Tools, which was originally released in the early 1990s and which became an industry standard DAW that is still used widely today. (MusicRadar, 2008; MusicRadar 2011.)

In the 1990s the IBM-compatible PC computers started to gain popularity as they became more affordable. Those PCs had interface slots, which were an accessible way to add audio features, for example MIDI breakout box, called the MPU-401, or different types of soundcards (e.g. Adlib, Sound Blaster and Gravis Ultrasound). With the new software (e.g. Pro Tools, Cubase and Logic) the ever evolving and more powerful computers were turned into multi-track audio recording and manipulation devices. Modern 64-bit computers have the audio input and output of CD quality and built-in support for MIDI. With separate audio interface it is possible to gain for example a higher sample and bit rates, more line level inputs and outputs, and better noise floor. These can be connected through USB, Firewire and Thunderbolt or through specialized interfaces that connect into bus inside the computer for more demanding applications. There are three operating systems that are most used: Windows, Mac OSX and Linux. For all of them, there are professional DAWs and other audio software available. (Russ 2008, 380, 383; MusicRadar, 2008.)

Here is a brief summary of the role of computers in modern music production by Russ (2008, 382):

> Computers have almost integrated music totally…. It is remarkably easy to buy and install a piece of software that has a sequencer, sampler, analogue and digital synthesizers, effects units, mixer, samples of real instruments and drum sounds, and tutorials on how to use it, and which costs a fraction of what exactly the same equipment in real physical form would have cost 10 years ago. This is an astonishing achievement.

3.1.4 Plug-ins and virtual instruments

A big step in the computer based music making was the invention of Virtual Studio Technology (VST) by Steinberg in 1996. This technology allowed software based audio plug-ins (e.g. effects plug-ins) to be used in the host software, typically a computer sequencer (in this case, Cubase). The follow-up version VST2 was released in 1999 and it allowed MIDI processing and thus the use of simple sample replay and synthesizer plug-ins in the sequencers. It also came with the first VST instrument called Neon, which was a virtual analogue synthesizer. In the mid-2000s the first physical modelling plug-ins were released. They could produce realistic sounding classical instruments like pianos and strings. With completely rewritten code, the VST 3 was released in 2008. It added a number of new features, including dynamic processing, sample-accurate parameter automation, multiple MIDI ins and outs and more advanced integration with the host software. Other sequencer manufacturers have also developed their own plug-in formats as for example Audio Units (AU) from Apple and Real Time AudioSuite (RTAS) from Digidesign. The most of the plug-ins are an operating system specific, and the main host software platforms for the plug-ins are the DAWs. (Russ 2008, 381, 385-387, 413; MusicRadar 2008.)

PICTURE 15. Steinberg's Neon was the first VST instrument released in 1999. (Photo: KVR Audio, Inc. 2018)

The amount of different types of plug-ins is ever-growing and while it is impossible to list all of these categories, here are some of the most typical:

- Reverb and other time delay with feedback-based effects
- Chorus and other modulated time delay effects
- Analogue synthesizers using modelling technology
- Physical modelling based synthesizers

- Sample, DLS/SoundFont and other players
- Sample rate converters
- Granular, FOF, formant, FM and many other types of synthesis
- Arpeggiators, step sequencers and other accompaniment functions
  (Russ 2008, 391.)

As the hardware (e.g. computers and digital devices) and software (e.g. DAWs, virtual instruments and effect plug-ins) have evolved with tremendous pace, the software has become increasingly responsible for the operation and facilities that are offered for music production. This creates more flexibility and connectivity among the music production tools that was ever possible with the assembled hardware. With plug-ins, the users are allowed to customize the selection of sounds, functions and effects rather than use just what the host software provides. This has also created a whole new market, and the development of the third-party plug-ins has been immense both in quality and in quantity. Nowadays the music is often produced 'in the box' with no other hardware than the computer and possibly the audio interface and a midi keyboard. One practical advantage with these virtual tools is that the settings and sounds can be usually easily saved and recalled. (Russ 2008, 29, 389-390, 392, 394.)

3.2 The operational principle of the SBVIs

As explained in the beginning of this chapter, the sample-based virtual instruments use samples of different instruments to produce the sounds. The manufacturer of a virtual instrument is usually responsible for recording these samples. With the virtual instruments for orchestral strings, the amount of samples they contain can be enormous. For example a virtual instrument called Hollywood Strings (Diamond Edition) by EastWest includes over 800 000 sample files (East West Sounds 2011, 12). In orchestral SBVIs these sample files include samples from different orchestral instruments with articulations and multiple dynamic layers.

As with the analogue synthesizers, digital synthesizers and other electronic instruments (or with even most of the conventional acoustic instruments), virtual instruments have the side that is seen by the user and the side that is hidden from the user. This is how Russ (2008, 4) describes these two sides (blocks):

> Synthesizers have two basic functional blocks: a ‘control interface’, which is how the parameters that define the end product are set; and a ‘synthesis engine’, which interprets the parameter values and produces the output. In most cases there is a degree of abstraction involved between the control interface and the synthesis engine itself. This is because the complexity of the synthesis process is often very high, and it is often necessary to reduce the apparent complexity of the control by using some sort of simpler conceptual model. This enables the user of the synthesizer to use it without requiring a detailed knowledge of the inner workings. (Russ 2008, 4)

With virtual instruments, the synthesis engine is the code of the software and the control interface is the graphical user interface (GUI). Usually virtual instruments provide users with the access to audio input and output streams and/or MIDI input and output streams. Virtual instruments are based on the software versions of the techniques that have been developed with the analogue and digital instruments, for example, virtual analogue synthesizer use analogue modelling techniques and virtual FM synthesizers express the FM formulas in software. Same principle can be applied also to the sample replay techniques, which sample-based virtual instruments (SBVIs) and most of the orchestral virtual instruments are based on. Sample replay instrument replays complete samples of sounds with a loop for the sustained section of the sound. (Russ 2008, 10, 392.)

Virtual instruments typically use a software sample player or a sample engine (e.g. Kontakt by Native Instruments, Play by EastWest, Vienna Instruments by Vienna Symphonic Library), which works as platform that enables the use of a plug-in or a virtual instrument within a DAW or as a standalone application. The biggest virtual instrument manufacturers use their own sample players, but some sample players, for example Kontakt, are widely used by third-party sample library manufacturers also. Each of these sample players has their own user interface, but the main functions are usually the same.

To have some insight on how the orchestral SBVIs have evolved over, here is one example from the EastWest’s Hollywood Strings Users’ Manual (East West Sounds 2011, 11-12.):

> For over 20 years libraries have been [created from] recording[s of] multiple dynamics for each articulation and layering them to capture the different timbres heard at different dynamic levels. These libraries usually used the MIDI Velocity parameter to select, which layer to play back. While this approach achieved excellent results, it meant that typically 2 to 5 distinct layers were available, and timbre could not change mid-note.

> Those libraries would use cross-fades for a small number of patches where mid-note changes were beneficial. But they kept the number of those cross-fades small to prevent their greater use of the computer's memory from becoming overwhelming. In Hollywood Strings, the producers greatly expanded the use of crossfades, both in their numbers and in how many concurrent voices participate in the cross-fades within a given patch.
>
> This approach results in instruments that capture the way string instruments can vary the sound during a crescendo or swell, or as the depth of vibrato changes, like a live musician playing an acoustic instrument.

Virtual instruments (VIs) are constantly evolving and their amount is increasing enormously. The constant development of the software means also that the updating of the plug-ins is very important because of the bug fixes, compatibility fixes or other improvements available (Russ 2008, 387). Because there are so many different virtual instruments to choose from (e.g. the different options for orchestral VIs named in the next section), it is important to find the ones that suit the productional purposes and to learn the operation principles of them.

Here is a good listing by Russ (2008, 393) about the general principals of using plug-ins that can be extended to the SBVIs and actually, for many other things in life too:

- Understand what the device does - a good mental model is ideal
- Explore the limits of what the device can do - go beyond the manual
- Understand how the device works in its environment - so that you can exploit it effectively
- Use and misuse the device and the environment - if you are told that you cannot do something, find a way to do it
- Do not just collect - compare, contrast and choose the one that suits you, and then learn about it in depth
- Do not bloat - if you try a plug-in and do not like it, remove it

4 SBVIs FOR ORCHESTRAL STRINGS

In the case of sample-based virtual instruments for orchestral strings, the samples that these instruments use are recorded samples of the orchestral string instruments. These kind of virtual instruments are also called orchestral (or orchestra) sample libraries (OSL). The history of orchestral sample libraries date back to the year 1993 and the release of the Symphonic Orchestra Samples CDs by Miroslav Vitous (Stewart 2015). After that, there was a steady flow of orchestral libraries, but in the 2000s along with the Tascam's Gigastudio sampler software, the amount of these libraries increased notably (Stewart 2015). By the year 2018, there are a large number of quality sample libraries and virtual instruments to choose from. Vienna Symphonic Library and EastWest are possibly the two biggest pioneering companies in this field. Vienna Symphonic Library (2018) states on their website that "music professionals can accurately and authentically recreate orchestral pieces on their computers" and that "they (virtual instruments) enable the user to arrange his or her composition on the computer so that, in many cases, the results cannot be distinguished from a live orchestral recording". These are presumably the objectives for all the high-end SBVIs for orchestral strings.

Here is a list of some of the most popular manufacturers and products of SBVIs for orchestral strings (contains both ensemble and solo instruments):

- EastWest: "Hollywood Strings", "Symphonic Orchestra", "Hollywood Solo Violin", "Hollywood Solo Cello" etc.
- Vienna Symphonic Library (VSL): "Orchestral Strings I & II", "Chamber Strings I & II", "Solo Strings I & II", Appassionata Strings I & II" etc.
- Native Instruments (NI): "String Ensemble", "Session Strings Pro" etc.
- Spitfire: "Hans Zimmer Strings", "Albion One", "Spitfire Symphonic Strings", "Solo Strings", "Alternative Solo Strings" etc.
- Orchestral Tools: "Metropolis Ark 1, 2 & 3", "Berlin Strings", "Nocturne Violin" and "Nocturne Cello"
- Sonokinetic: "Sotto", "Noir", "Expressivo", "Maximo" etc.
- Garritan: "Personal Orchestra" and "Instant Orchestra"

PICTURE 16. The basic view of the Vienna Symphonic Library's Vienna Instruments sample player. (Photo: KVR Audio, Inc. 2018)

These SBVIs for orchestral strings differ from each other for example in these factors:

- **Included instruments** - Some of these include only strings, but others include other symphonic orchestra instruments too
- **Playing styles, techniques and articulations** - For example some are created for production of more delicate sounds, but others are made for mode grandeur expression - there are also sample libraries for more experimental take on the orchestral strings
- **Instrument section size** - How many players are used per instrument section
- **Number of microphone positions** - How many microphone positions there are available to use in the SBVI – These usually vary from the close mics, where the room ambience is minimized, to the main mics that are placed further away and thus the sound includes more room ambience
- **Sample player software** - Some manufacturers use their of sample player software (e.g. EastWest and VSL) and some use a third-party software like NI's Kontakt (e.g. Orchestral Tools and Sonokinetic)
- **Price** - The price range of SBVIs for orchestral strings start from around 100 euros, but the most expensive ones cost over 1000 euros - There are also monthly subscription services (e.g. EastWest's ComposerCloud) that can give

the user the access to the whole range of manufacturer's virtual instrument collection

Each type of virtual instrument group (i.e. analogue synthesizers, orchestral strings and acoustic drums) has similar type of controls in the user interface that are related to the nature of the instrument in question. The controls are used for modifying and selecting the desirable sounds. With acoustic drums, for example, these controls might affect the size of the kick drum. With orchestral strings, the user interfaces may include following controls:

- Instrument type: Violin, viola, cello, bass (plus different combinations)
- Articulation type: Sustain, legato, staccato, detaché, pizzicato, tremolo etc.
- Expression control: Vibrato, velocity
- Performance control: Round robin settings, legato, portamento etc.
- Reverb settings
- Envelope: Attack, decay, sustain, release (ADSR) or equivalent
- Keyboard roll
- Mixer: Volume control of different microphone positions and panning
- Main volume control
- MIDI controls

Although these are some of the most common features in the SBVIs for orchestral strings, all the virtual instruments are somewhat different. In this thesis I am concentrating especially on the use and operational principles of one SBVI for orchestral strings, which is EastWest's Hollywood Strings and especially its Gold and GoldX (adds the close microphone position) versions.

4.1 Hollywood Strings (Gold and GoldX) by EastWest

Hollywood Strings, first released in 2010, is a sample-based virtual instrument for orchestral strings by EastWest. The Gold edition is reduced version of the full Diamond edition. The GoldX edition adds the possibility to use also the close microphone position as the basic Gold version includes the mid position. With Hollywood Strings, EastWest were aiming to manufacture the most detailed collection of string orchestra instruments ever assembled. As the name implies, this SBVI is designed to create string

orchestrations that are heard in movie soundtracks. That is one of the reasons, why it is appropriate to have it as an example of a virtual instrument that can be used to produce orchestral strings particularly in the film music production. (East West Sounds 2011, 31, 73.)

PICTURE 17. The recording setup at EastWest Studios. (Photo: Sound On Sound 2010)

Hollywood Strings is an acknowledged and widely used virtual instrument that has been developed with expertise and precision: “The combination of the right producers, an actual Hollywood recording studio, the best mics and other recording hardware available, and string players familiar with the Hollywood sound all came together to capture the authentic sound you can hear in this virtual instrument” (East West Sounds 2011, 11). It was recorded with 7 microphone positions and with 57 string players in total (Stewart 2015). Pejrolo & DeRosa (2016) describe it as a versatile and complete orchestral library with string sections that is very playable and easy to mix with comprehensive sounds and articulations. It has a rich, full and opulent sound, which is can be described as wet in the overall sense of reverberation (Stewart 2015; Pejrolo & DeRosa 2016). It includes a comprehensive selection of long and short note articulations and also pre-recorded and playable runs. The Play system, which is a sample player that is runs on, includes a large selection of convolution reverb presets that are capable of transforming the library’s large-room acoustic into a concert hall

sound (Stewart 2015). As some articulations utilise as many as 13 velocity layers, HS can put a heavy load on the computers processing resources and use great amounts of RAM (random access memory).

The size of the Hollywood Strings Gold and GoldX sample libraries is over 80 gigabytes in total (Diamond edition is over 300 gigabytes). HS Gold and GoldX include hundredths of thousands of 16-bit, 44.1 kHz sample files. Hollywood Strings uses the EastWest's sample player software called Play (the current version number is 5.0), which is also used by other EastWest virtual instruments. Here are the minimum and recommended system specifications for Hollywood Strings: (EastWest Sounds 2011, 13; Sounds Online 2018.)

Mac computers, minimum requirements:

- Intel Core 2 Duo Processor 2.1GHz or higher
- 8 GB RAM
- Mac OSX 10.7 or later
- 7200 RPM or faster (non energy saving) hard drive for sample streaming

Mac computers, recommended system:

- Mac Pro Late 2013 edition
- 16GB RAM or more
- SSD (Solid State Drive) for sample streaming

PC computers, minimum requirements:

- Intel Core 2 Duo or AMD Dual Core 2.1GHz or higher
- 8 GB RAM
- Windows XP SP2, Vista or Windows 7
- Sound card with ASIO drivers
- 7200 RPM or faster (non energy saving) hard drive for sample streaming

PC computer, recommended system:

- Intel Core 2 Quad or AMD Quad Core 2.66GHz or higher
- 16GB RAM or more
- 64-bit Windows/Host Sequencer
- SSD for sample streaming

4.1.1 The graphical user interface

Here is a picture of the graphical user interface (GUI) of Hollywood Strings (HS):

PICTURE 18. The graphical user interface for Hollywood Strings by EastWest. (Salmi 2018)

The GUI for HS includes following controls (from top left to bottom right):

- Main Menu knob: Basic menu controls including options such as open, save, about Play and check for updates
- Settings knob: Includes more detailed audio and other settings
- Mixer knob: Go to mixer view
- Browser knob: Go to browser view, where it is possible to load and control the instruments
- MIDI and audio settings: MIDI port, channel, transpose, vel. min, vel. Max, voice limit, bit depth and sensitivity (graphical control)

- Performance: Round robin reset, portamento, legato, con sordino, repetition, other and finger position knob
- Envelope: Attack, hold, decay, sustain and release controls
- Articulation: The controls to adjust different available articulations for different instruments
- Stereo double: Gives the user the option of using exclusively the left or the right stereo signal and determine the spread of the stereo signal
- Reverb settings: Type of the reverb, pre-delay, volume, master
- Microphones: Used for selecting the desired microphone positions and to control their volume and panning, includes four different mic positions that are close, mid, main (available only in Diamond Edition) and surround (available only in Diamond Edition)
- Master output controls: Channel source, tune, pan
- Keyboard roll
- Meters: CPU usage, disk usage, voices (currently active voices), RAM usage

Some of these controls are part of the EastWest's Play sample player software, and they are common to all Play System libraries. These include for example main menu, settings, mixer and browser knobs as well as graphical envelope, reverb controls, MIDI and audio controls, master output controls, keyboard roll and meters. Other controls and features are specific to the Hollywood Strings virtual instrument and from this on I will concentrate solely on those (including Keyboard Roll).

Performance section is a group of six buttons and the Finger Position knob. These controls affect the performance of the chosen instruments. Here are the short descriptions of each button and the knob:

- **Round Robin Reset**: Round robin is a technique used to bring life and perception of a so-called real performance. Several different samples are recorded with the same parameters (e.g. volume and speed of attack) to have multiple similar samples with just slight natural changes. The aim of this technique is to avoid the "machine gun effect", in which playing of the same sample repeatedly causes an unnatural sound of consecutive notes being identical. In Hollywood Strings Round Robin is used with the instruments that hold the "RR" in their name. This Round Robin Reset button is used to reset the

so-called Round Robin loop, which consists of the similar samples played one after another. This could lead to inconsistent playback of the composition as the Play engine remembers and plays the next sample in line. With the reset button, the user is able so reset the Round Robin loop for example in the beginning of the composition or in the beginning of different parts of the composition. This way every playback is identical even though an instrument uses Round Robin technique. (EastWest Sounds 2011, 24.)

- **Portamento**: Portamento is the technique of a continuous slide in pitch from one note to the next note in the phrase. With this button the portamento is available as a script-based effect that creates a short movement between the pitches of two subsequent notes. This script-based effect is separate from the actual portamento instruments included in HS. (EastWest Sounds 2011, 17.)
- **Legato**: Legato is the style of playing notes in a phrase with no significant silence between them. This creates a smooth and flowing melodic line. With this button the legato is available as a script-based effect, which is separate from the actual legato instruments included in HS. (EastWest Sounds 2011, 17.)
- **Con Sordino**: The term "con sordino" means "with mute". A mute attaches to the strings near the bridge and dampens the vibration, which creates a sound with its higher overtones reduced. With this button the "con sordino" is available as an effect. (EastWest Sounds 2011, 18.)
- **Repetition**: Repetition refers to the playing subsequent notes of a single pitch for more than once with no different notes played between them in the same phrase. With this button the repetition effect is turned on, which causes repeating notes to sound slightly different, avoiding the sense of mechanical repetition. (EastWest Sounds 2011, 18.)
- **Other**: This button controls whether a hidden script is turned on or off. This script manages some important features of a wide variety of articulations. It should not be turned off, when it is lit. Turning it on when an instrument contains no script has no effect. (EastWest Sounds 2011, 18.)
- **Finger Position knob**: The Finger Position knob controls the string on which a note will be played on. The lowest notes of an instrument, such as Middle C on a violin, can be played only one way, but when going higher up the scale, the number of ways to play a note rises, and then decreases again for the highest notes. The 4 values available with this knob correspond to the hand positions that a string player uses during a real performance. With this knob it is possible

> to approximate the same position-related change in sound that can be achieved on a real instrument. The entered Finger Position value is only a guideline of the sought-after sound, because not all the notes can be played on all the 4 strings. In general, notes played with the finger position closer to the bridge have a warmer and more emotional sound. The finger position settings do not apply to all articulations, only those in which the bow moves across the string in a long movement. (EastWest Sounds 2011, 18-19.)

These performance scripts are not modifiable by the user, but the important parameters can be adjusted with the MIDI control codes and partly with MIDI Keyswitches, which are MIDI notes assigned to control certain functions and performance features. With MIDI control codes (and is some cases with Keyswitches) it is possible to control for example vibrato, velocity, volume and expression.

Articulations section in the middle of the GUI shows the articulations available with the currently active instrument. Often this list is short, containing only the one articulation given in the instrument name and perhaps its release trails ("RT") on a separate line.
When the current instrument file includes a keyswitch, the list of articulations is much longer. Each of the main articulations includes the name of the keyswitch note at the beginning. The checkboxes at the left of the section allow you to deactivate and activate any articulation or to unload and load the samples from the computer's memory. The small knobs in the third column allow the user to adjust the loudness of each articulation without affecting the loudness of the others. (EastWest Sounds 2011, 28.)

There is a Keyboard Roll at the bottom of the GUI. It shows the notes that are being played and also the playing range of a selected instrument. The active keys are shown as white (and black) and the inactive keys are shown with a darker tone. Like all the other SBVIs for orchestral strings, HS is usually played with a MIDI keyboard. The notes and other MIDI related commands can be also entered with other MIDI devices and they can be drawn in a sequencer.

4.1.2 The instruments and the articulations

The Hollywood Strings virtual instrument includes five string sections, which are 1st violins, 2nd violins, violas, celli and basses (contrabasses). These sections have been

sampled playing in the multitude of articulations that they are capable of. In the HS virtual instrument these are the included articulations (not all the sections include all the articulations):

- **Bartok pizzicato** - A style of playing in which the string is pulled away from the fingerboard allowing it to snap back forcefully. The sound incorporates pitched as well as non-pitched, percussive elements.
- **Col legno** - The sound of hitting the strings with the wooden stick of the bow, instead of the hair.
- **Détaché** - Refers to notes that do not have a legato connection to the next note in the phrase. They come to a well defined stop before the start of the next note. Longer than staccato notes, but come to a well defined end.
- **Flautando** - A technique when notes are played with no vibrato near the fingerboard with the point of the bow to create an ethereal and flute-like sound.
- **Harmonics** - Harmonics are created when a finger touches lightly a harmonic node on the string and the bow plays close to the bridge. This causes the bowed string to vibrate at a natural harmonic of the fundamental tone.
- **Marcato** - A style of playing where the notes are played with a strong accent at the beginning.
- **Measured tremolo** - The rapid repetition of a note at specific number of strokes per minute or at specific note length. Everyone in the section plays the notes in sync and on the beats.
- **On-the-bow staccato** - Otherwise like staccato, but the end of the note is caused by the stopping of the bow's motion while still on the string (instead of lifting the bow off the string at the end). There is a distinctive, but subtle, noise at the end of each note.
- **Pizzicato** - A style of playing where the string is plucked with the finger.
- **Repetitions** - Notes where the same note was played immediately before it and the string is still vibrating at the time of the new attack, which may affect the sound of the attack.
- **Ricochet** - A technique where the upper third of the bow is thrown onto the string so that it bounces several times and creates multiple notes in quick succession.
- **Spiccato** - A playing style where very short and light notes are created by bouncing the bow so that it is in contact with the string for a very short time.

- **Staccatissimo** - A sound that is a very strong staccato.
- **Staccato** - Notes that are of short duration and not connected to the following note in the phrase. The end of the note may be achieved by lifting the bow from the string.
- **Sul ponticello** - A style of playing with the bow very near the bridge. Achieves a more intense sound that features the higher harmonics of the note.
- **Tremolo** – The rapid repetition of a note without a specific rhythmic frequency, resulting in more continuous sound.
- **Trills** – The rapid alternation between two notes a minor or major second apart.
- **Up & Down patches** – With these patches it is possible to control the playing direction of the bow as it has significant effect on the sound that the instrument is generating. HS includes several patches that automatically alternate between up and down strokes, because that is what string players often do.
  (EastWest Sounds 2011, 31-32, 40, 45, 47.)

For all five instrument sections the list of articulations is divided into 8 main categories:

- **01 Long**
- **02 Long Powerful System**
- **03 Short Tight**
- **04 Short Loose**
- **05 Effects**
- **06 Keyswitches**
- **07 Legato Slur + Portamento**
- **08 Legato Slur + Portamento Powerful System**

01 Long category includes following articulations:

- **Sustain** - All of the sustained instruments continue to play a note audibly as long as the note is held. This is achieved by looping the samples. The Sustain instruments give the user control over several parameters: bow direction (down bow, up bow and round robin), depth of vibrato (non-vibrato, vibrato and molto vibrato), choice of string (affects the finger position) and the number of simultaneous voices.

- **Détaché** - Unlike the Sustain style, this articulation cannot be played indefinitely. The samples work well whether they are played to the end or ended before that.
- **Flautando** - Only the 2nd Violins include a Flautando patch. This instrument does not include control of finger position or vibrato, nor does it include round robin samples.
- **Harmonics** - Only the 2nd Violins include a Harmonics patch. This instrument does not include control of finger position or vibrato, not does it include round robin samples.
- **Marcato sustain** - This instrument type plays a marcato sample in addition to the multiple sustain samples. The marcato sample ends quite quickly and the sustain samples are looped, so they continue to play as long as the note is held. This combination provides extra power at the start of the note.
  (EastWest Sounds 2011, 40-45.)

01 Long and 02 Long Powerful System categories include the similar Sustain instruments and articulations, but the 02 Long Powerful System category includes instruments that use more simultaneous voices (8 to 13) and thus put a heavy load on the computer's resources.

03 Short Tight and 04 Short Loose contain exactly the same instruments, articulations and core samples. The difference between these two categories is that the 03 Short Tight contains versions of the samples that have tighter and a bit faster attack as where as the 04 Short Loose category contains the same samples, but with the entire recorded attack. Tight category samples are more suitable to faster passages as where as Loose category samples have more natural sound for slower passages. (EastWest Sounds 2011, 46.)

03 Short Tight and 04 Short Loose include following articulations:

- **Pizzicato** - All 5 sections include a Pizzicato instrument.
- **Bartók Pizzicato** - All sections except the 2nd Violins include this instrument.
- **Ricochet**
- **Col Legno**
- **Marcato**
- **Spiccato** – In addition to plain Spiccato, there is also Spiccato in which the Mod Wheel can be used to change to Marcato.

- **Staccato** – Staccato articulations include plain Staccato, Staccato On Bow, Staccato in which the Mod Wheel can be used to change to Marcato and Staccatissimo. Staccato On Bow captures the sound of short notes in which the bow does not lift off the string at the end of the bow but comes to a full stop.
- **Repetitions** – With this instrument the section plays the same note repeatedly about a dozen times in quick succession. This sequence of notes is slower than a tremolo. It is more realistic than just playing the same staccato note multiple times, because you get the sound of the bow changing direction between notes. (EastWest Sounds 2011, 46-49.)

All the short articulations are Round Robin instruments (except Repetitions) with 2 to 16 samples for each note depending on the articulation. These categories also include Short MOD SPEED instruments, which allow the user to use the Mod Wheel to move continuously among several short articulations. Short MOD SPEED articulations include Staccatissimo, Staccato, Staccato on Bow and Marcato Short.

05 Effects category includes following instruments:

- **Pre-recorded Runs** - Only 1st Violins, Violas and Celli sections include Pre-recorded Runs. The types of Pre-recorded Runs that HS includes can be grouped into these 3 categories: direction (up, down or both), scale (chromatic, major, minor or whole tone) and control (keyswitch, Mod Wheel, keyboard split or none).
- **Playable Runs** - These instruments allow the user to perform runs by playing the notes. The types of Playable Runs that HS includes can be grouped into these 3 categories: Repetition Runs Script, Slur Runs (generate the sound of a fast-playing scale, only available in 1st and 2nd Violins), Spiccato Runs (Normal and Smooth, intended for playing fast runs with the sound of the spiccato articulation, only available in 2nd Violins).
- **Tremolos** - There is two types of Tremolos: unmeasured (called simply “Tremolo”) and measured. In the unmeasured instruments, each player moves the bow without regard to the tempo, creating a sound with no discernible rhythm. The measured version is aware of the overall piece’s current tempo, allowing the patch to pulse in time with that tempo.

- **Trills** - All the string sections (except the Basses) include an instrument that allows the user to select between a half tone trill and a whole tone trill with a keyswitch. The Trill instrument for the Basses includes only a half tone trill.
- **Repetitions** - This instrument is available for Violas and Basses. The sound is that of a single note played over and over again for a little more than one second. The repetition is slower than a tremolo, but fast enough to fit about a dozen pulses in the note. This sound is more realistic than just repeating the same note over and over from some other patch, because within the sample you hear the continuity of the sound, including the bow reversal.
- **Sul Ponticello** - This articulation is only available in the Viola section.
  (EastWest Sounds 2011, 49-54.)

06 Keyswitch category includes Sustain Keyswitch instruments for each 5 section. With these instruments it is possible for the user to switch between different articulations using Keyswitches, which are specified MIDI notes that are used for controlling the articulation switches. The articulations included in these instruments are Sustain Down Bow, Sustain Up Bow, Détaché Down Bow, Détaché Up Bow, Tremolo, Trill Half Tone, Trill Whole Tone, Flautando, Harmonics and Sul Ponticello. (EastWest Sounds 2011, 54-55.)

07 Legato Slur + Portamento and 08 Legato Slur + Portamento Powerful System categories include instruments with a variety of different types of legato playing. These types include Portamento, Slur, Legato Slur + Portamento and Marcato Legato Slur + Portamento. The last two combine different techniques. These instruments are available as Round Robin versions, but also versions that include only Down Bow or Up Bow samples. All these legato instruments are monophonic, whereas other instruments and articulations are polyphonic. The Portamento and Slur patches include a sampled slide from one note to the next. This slide in pitch between the two notes only occurs to a maximum of one octave. The instruments that include “SM” in their name are so-called smooth instruments as the legato transitions sound more smoothed out, but at the expense of some expressiveness. The instruments that use Legato with Marcato or with Slur Staccato accent the notes that do not have a legato connection to the previous note. The user can use one of these patches, when the first note of each legato phrase is wanted automatically to receive a slightly stronger attack. (EastWest Sounds 2011, 55-58.)

There are also three other folders that use and offer the instruments and articulations described earlier. These folders are following:

- **Full Strings** - In this folder each instrument covers the full range of the string orchestra in a single patch. This is executed by loading four or more instrument types at once (called a "multi-instrument"). This approach allows the user to play the full string orchestra from a single MIDI keyboard, and each instrument type is assigned a range of notes, so that instruments do not overlap. Full String instruments can be useful when composing and creating sketches. Afterwards the notes can be assigned to individual instruments, for more control over musical features. Full String instruments include both long and short articulations. These patches do not give the user as much control over articulations as the individual instruments from the other folders.
- **The Quick Start Instruments** - This is a folder for instruments that are designed to load quickly and use less of the computer resources than the similar patches in the other folders. They can be used with a computer not that powerful or to create quick compositional sketches.
- **The Template PRO Instruments** - This folder includes the recommended articulations for a basic Hollywood Strings template. For those working with HS for the first time, this list of instruments is a good starting point.
  (EastWest Sounds 2011, 59-62.)

For more detailed information and descriptions of articulations, instruments and the use of Hollywood Strings, please study the users' manuals of the Hollywood Strings virtual instrument and the Play sample player software.

4.1.3 The operational principles and orchestral techniques

When using a SBVI for orchestral strings, the aim is usually to achieve the traditional sound of a studio string orchestra. In this section I will go through some of the techniques and methods that are helpful, when creating that orchestral sound and using the Hollywood Strings virtual instrument as efficiently as possible.

The use of computers resources

When using HS, it is recommendable to take into consideration the resources of the computer that is used. HS can be quite a heavy load for the computer, so it is important to find out about the recommended system specifications (e.g. the processing power, the amount of RAM and the speed of the hard drive). The instruments are loaded into the RAM of the computer from the hard drive that the software is installed on. Some of these instruments can load up to 1 GB of samples per microphone position into the computer's memory. Also the central processing unit (CPU) is a crucial factor in the overall processing power of the computer. CPU provides a practical limit to how many virtual instruments and plug-ins can be used in a project. With HS, the CPU load can be divided to multiple cores of the CPU, when multiple instances of Play System are used within a DAW. If multiple instruments would be loaded in one instance of Play, that instance would be using a single core of the CPU, which would not be very efficient in many cases. It is a good practise to open as many instances of play as there are cores in the CPU (quite typically from 2 to 4 cores) and spread the instruments and articulation within these instances. When the computer is resourceful enough, it can prevent distracting and problematic latency (a delay within a system that is caused by the processing of data) from occurring and also prevent different kinds of snaps and cracks from appearing. (EastWest Sounds 2011, 66-67; Russ 2008, 396-397.)

Creating templates

Creating templates for different types of compositional situations and different types of stylistic starting points is usually an effective practise. These templates can include the needed instruments and articulations either in the same instance of Play or multiple instances of Play. Some articulations use the same samples, so it is wise to load these articulations in the same instance of Play as it is more memory efficient, because then different articulations have the access to the same samples. It is also possible to open multiple instances of Play within a DAW or in standalone mode. In many cases, it is better to open multiple instances of Play as described above. It is possible to save a template for a single instance of Play within the Play System, but when the template uses multiple instances of Play, then it should be saved as a template project within the DAW or as a VST host file. (EastWest Sounds 2011, 65.)

Using the MIDI CC data and Keyswitch instruments

MIDI CC (i.e. control codes, control change messages or continuous controllers) data is editable MIDI information that contains 127 different code types per Midi channel. These message types include for example CC1 (modulation), CC7 (volume of the channel) and CC11 (expression). With these control codes, it is possible to control some the features of the instruments in HS and thus make the performance of these instruments sound as authentic as possible. In a DAW it possible to draw an automation curve for MIDI control codes. Lots of musicality and interest can be added to a phrase with a constantly changing curve that corresponds the performance of a real musician. CC values can also be controlled and sent to sequencer with MIDI controller, which can be considered more musical way to do it than just to draw the automation. It can be done while playing the notes into sequencer, but it can also be done afterwards and separately. Combining velocity control, expression, Mod Wheel and volume and learning to shape musical lines the same way a musician does, will give the orchestration much more natural musicality. (EastWest Sounds 2011, 34-35, 66-67, 73.)

The technique that allows these smooth transitions, which can be controlled with the control codes, is based on cross-fades. The basic idea of a cross-fade in this situation is that 2 or more samples of the same instrument, but that differ in some aspect, such as loudness, timbre or vibrato, are played back simultaneously. With the MIDI control codes, the user determines the mix of how much of each sample is heard in the playback. The cross-fades allow a more continuous and gradual change from one sound to another and they modify timbre along with loudness just like an acoustic instrument. This very realistic approach to control the sound is possible because of the recent improvements with hardware and software, but still this technique is quite demanding on the computer's resources, especially the instruments that use more simultaneous voices (located for example in the 02 Long Powerful System folder). Although aiming for the realistic sound has its requirements, it is good to understand that more concurrent voices provide more realistic real-time control over timbre at all dynamic levels and all depths of vibrato. (EastWest Sounds 2011, 44, 73.)

Keyswitches are MIDI notes that are assigned to a certain functions that control the features of the instruments. With Keyswitches, it is possible to control for example Finger Position and articulations with some instruments. By default the Keyswitch notes

are the lowest notes on MIDI keyboard (C0, C#0, D0 etc.), because they are not assigned to any musical use. In each instrument section there are also the Keyswitch instruments that include the feature to switch between different articulations within one instrument using Keyswitches. With Keyswitch instruments, the user is able to write different articulations (e.g. legato and staccato) to the same instrument track in DAW, if one instrument needs to play different articulations within a single phrase, which is many times the case. It is a good practice to use these instruments always, when it is possible, but sometimes there are situations where it is more convenient to break a musical line across separate MIDI channels and assign a different articulation to each track. (EastWest Sounds 2011, 67-68.)

Adjusting the volume and using the dynamics

There are many ways to adjust the volume of instruments with HS. In a DAW, the user can adjust the volume of a track in various ways, but now I am concentrating on the ways to adjust the volume in HS. There are at least three ways to make a sampled instrument sound louder, or at least make the real instrument seem to have been played louder. When creating a realistic orchestration, it is good to know all these different options for their proper use.

Volume is the loudness of the generated sound. Changing the volume can be compared to turning the volume knob in an audio system. Softly played instruments are still played softly, although the volume would be turned really loud. The volume does not affect the timbre. Volume can be adjusted mid-note and the volume of different instruments can be adjusted independently. The MIDI control code that the volume is assigned to is CC7. It is advised in the HS Users' manual that this CC7 (volume) value should be used as a consistent overall volume for each track. This way it would acts as a so-called limiter and it would be easy to change the overall volume of one instrument. (EastWest Sounds 2011, 34, 66, 70.)

Velocity is a term for how fast or hard the MIDI keyboard keys are pressed by the player. Adding force usually changes the loudness of the notes and the notes' timbre. Velocity is usually represented with a number between 0 and 127. Play System can play different samples for different ranges of velocity, which means for example that very soft violin samples could be assigned to velocities 0–25, soft violin samples to

velocities 26–45 and so on. Because each dynamic level of a violin has its own timbre, a note's velocity can affect the loudness and also the timbre. This is why the velocity changes are a much better way to achieve natural-sounding dynamics than volume changes. In HS only the Short articulations use velocity to control which dynamic layer is played. This means that velocity does not affect the volume of Long articulations. Velocity cannot be adjusted mid-note. (EastWest Sounds 2011, 70-71.)

Expression value is a good way to adjust the expressive dynamics and loudness in HS. It is represented by MIDI control code CC11. CC11 controls the dynamic layers (also called "velocity crossfade") of the instrument. This technique can provide the kind of dynamic shaping of notes that give music its expressive life, and it can be used for example for creating crescendos and swells in the middle of a note or a phrase. Expression is often used for controlling cross-fades of samples with different dynamics. This provides the control of loudness and timbre at the same time. With instruments and articulations that use this way of controlling the loudness, velocity information is usually turned off and all the dynamic layers play at once. CC11 controls how much of each dynamic layer to mix into the output. This approach gives a realistic sound for the instrument as the loudness and the timbre change continuously and together. CC11 cross-fades can be found on those HS instruments that can benefit from mid-note changes in dynamics, because they are often held for long times. In a DAW, the CC11 values can be drawn as automation or they can be 'played' with control knobs that are assigned to CC11. It is a matter of personal preference that which approach is more suitable for the user, although using a physical fader or a knob can be considered more musical option. Constant dynamic movement can create a more realistic and human feel for the orchestration. (EastWest Sounds 2011, 71-72; Stewart 2017.)

With some instruments, the modulation wheel (Mod Wheel) is used for controlling the cross-fades and dynamics almost in the same way as with CC11. The only difference is that with those instruments the Mod Wheel controls both loudness and vibrato depth at the same time. This linking of dynamics and vibrato is common in some styles of playing. Mod Wheel is represented by MIDI control code CC1. With instruments that use CC11 for loudness control, the CC1 is used for controlling the depth of vibrato. (EastWest Sounds 2011, 34, 42.)

The sample timing slop

Sample timing slop is a term for the slight delay of the attack of orchestral samples. These samples tend to respond a bit late, because the manufacturers usually want to include the whole attack in the samples. The whole attack of an orchestral instrument played with expressive styles can be quite slow in the nature. In HS the Short sample categories include both Loose (with the whole attack) and Tight (cropped samples with an immediate attack) option, which is one way to solve this problem. There are also other solutions. This problem can be defeated also by quantising the notes and then applying a negative delay effect for the selected region. This will advance the MIDI playback of the region. The amount of negative delay (e.g. 10 - 40 milliseconds) must be tested for example with a click track and by listening how the instrument sits in with the rest of the track. (Stewart 2017.)

Using some of the playing techniques

"**Vibrato** is the rapid fluctuation in the pitch of a note - usually less than a semitone - caused by the instrumentalist moving or rocking the finger that presses the string to the fingerboard" (EastWest Sounds 2011, 74). The timbre is warmer and less flat, when played with vibrato compared to the same not played without vibrato. Those instruments that have ability to play notes with infinite sustain include vibrato in HS. The instruments and articulations with shorter notes are usually so short that vibrato would not be heard. When vibrato is available, it is controlled with Mod Wheel (CC1). CC1 controls the depth of vibrato. When Mod Wheel is turned all the way down (CC1 value is close to 0), the note does not include vibrato, and when Mod Wheel is turned up, the depth of the vibrato increases gradually (with the maximum CC1 value 127 having the strongest vibrato). (EastWest Sounds 2011, 74-75.)

Sometimes string players might change the amount of vibrato over the course of a long-held note. Using the Mod Wheel to vary the vibrato (e.g. waiting a second or two into the sounding of a single note to start the vibrato) can add this kind of realism in to the orchestration. In HS, vibrato is available at three levels that roughly corresponds the bottom, middle and top of the range of Mod Wheel. The instruments that include vibrato all use cross-fades, which enables smooth transitions between different levels of vibrato. (EastWest Sounds 2011, 75.)

Legato can be achieved with Legato instruments in HS. These instruments include Slur legato, Portamento legato and Slur + Portamento legato. With the use of these instruments, the user can create a convincing legato sound. The Legato transitions have been recorded by live musicians and the transitions are available up to an octave, both upwards and downwards. For the legato to work appropriately, the notes must slightly overlap in sequencer. Additionally legato and portamento can be simulate with the Legato and Portamento scripts available in the Performance section of the GUI. Note that the legato and portamento created with these script-based articulations is artificial and not actually played contrary to the Legato instruments. (EastWest Sounds 2011, 75; Stewart 2017.)

The user can utilise different playing techniques with different articulations described earlier. They are more comprehensively explained in the HS' Users' manual.

Creating an orchestral soundscape

There are certain rules and conventions when creating a traditional orchestral soundscape:

> Whether listening to an orchestra live on a stage or from a stereo recording, we're all used to hearing the sounds of the various instruments coming at us from different directions. In a traditional symphonic layout for the strings, we expect the violins to be on our left, and the cellos and basses on our right. There are two reasons we might want to continue this practice. The first is to trick the listener's ear into perceiving a recording of a live performance. Even when everyone understands that the piece was created inside a computer, emulating a traditional sound can have its benefits. The second reason is that it's easier for the human ear to hear two similar sounds as separate when it perceives them as arriving from different locations. If the second violins and the violas are doubled, or even playing an octave apart, they will stand out from each other better when they seem to be in separate locations in the soundscape that surrounds us. (EastWest Sounds 2011, 68.)

In HS, the panning of the various instruments to the traditional locations on the sound stage is built in to the stereo samples of Mid, Main and Surround microphone positions. This means that for example the double basses are louder in the right channel by default. Because the Close microphone position samples were recorded with the stereo microphones directly in front of each instrumental section, they have been panned using the pan control correspondingly with the natural panning of the other microphone

positions. The user does not have to do any panning to achieve the traditional orchestral setting. Still, the user can adjust the panning in the Play interface or in the DAW, if that is needed or wanted. (EastWest Sounds 2011, 68.)

This approach that includes the natural panning in stereo sample files has one special feature. These samples contain the correctly timed reflections from all the surfaces of the space, where the instruments were recorded. To understand this concept, here is a short description about it:

> Consider a double bass player who is 5 meters from the wall to our right and 45 meters from the wall to our left. We are seated half way between the walls. The reflection from the right wall, which will be louder in our right ear, travels 30 meters (5 plus 25); the reflection from the left wall, louder in our left ear, travels 70 meters (45 plus 25). That 40-meter difference means that the reflection arrives in our right ear approximately one-ninth of a second sooner than in our left ear, a significant difference. And the other instruments all have their characteristic left/right delay based on where they sit on the stage. It is impossible for a single digital reverb to achieve that level of realism. (EastWest Sounds 2011, 69.)

Besides panning left and right, there is also the concept of proximity to consider. It is possible to move instrument forward and backward in the soundscape. This can be achieved in three ways:

- **Dynamics relative to timbre** - The timbre of an instrument usually changes depending on how softly or loudly it is played. If the softly played violin is recorded and then the recording is played back loudly, it is still possible to recognise that the instrument was originally played softly (and same vice versa). This idea can be utilised when determining the proximity of instruments. For example, if the cellos seem to be played loud, but the volume level of that instrument compared to others is softer, then the ear assumes the cellos are farther away. (EastWest Sounds 2011, 69.)

- **Delay** - The speed of sound is approximately 340 meter per second. This means that humans determine relative distances based on very small time delays. For example, if two violins play pizzicato notes simultaneously, and one is 15 meters further away, the note from the more distant violin arrives 0.044 seconds later, which is a notable time difference for a human. To achieve this effect, it can be done for example with a delay plug-in or by shifting notes in a sequencer. (EastWest Sounds 2011, 70.)

- **Presence** - The farther away one is from an instrument in a concert hall, the more the natural reverberation of the hall contributes to what is perceived (and vice versa). This presence of the sound is another factor that affects the experience of proximity. When the samples with the Close microphone position are mixed in more, it makes the instrument seem closer to the listener. (EastWest Sounds 2011, 70.)

Arranging for the orchestral strings

The orchestral strings must be well arranged to make them sound convincing, full and musical. All of the instrument sections have their own playing ranges that are described in the chapter 2. The playing ranges of different sections overlap to a considerable degree, which can be confusing for a beginning arranger. It is important to study the sound, the customary musical role and the capabilities of each instrument section and then apply this knowledge into the arrangements. Different sections have to be thought and handled separately, but still there has to be a cohesive view of the music piece as a whole. The style of an arrangement depends on many factors such as the style of music, the instrumentation used and the resources available. (Stewart 2017.)

The size of the orchestra is one key thing in an arrangement. A full symphonic string section features 60 players, a chamber strings section features typically 21 players (6 first violins, 5 second violins, 4 violas, 4 cellos and 2 double basses) and string quartet includes 4 players (1st violin, 2nd violin, viola and cello) (Stewart 2017). These are just examples of different types of traditional orchestral setups, and it is always dependent on the situation and musical needs that which setup is suitable. The bigger orchestra creates a lusher and more grandeur sound, while for example a string quartet creates a more intimate atmosphere and a sound that is more focused and tighter, bringing out the individual character of the instruments (Stewart 2017). Different SBVIs for orchestral strings can have different section sizes for each instrument and usually the solo strings are not included, because there are separate virtual instruments made for them especially.

Using the Full Strings patches might be convenient in the sketching and compositional phase as it makes composing faster, when all the strings are available at the same time. This way it is also possible to use both hands, when playing the orchestra with the MIDI

keyboard. The orchestration details and assigning the notes to the specific instruments and articulations can be done later. Familiarity with a few common articulations is very important for successful MIDI string arranging, and to get started with the arranging, it might be a good idea to concentrate on the most important and common articulations, which are legato, sustain, spiccato, pizzicato and tremolo (Stewart 2017). Keyswitch instruments that contain the most used articulations are sometimes a considerable option, when it is needed to create musical phrases with different articulations.

There is a huge amount of different arrangement techniques to be used with orchestral strings. As an example, here are two simple techniques:

- **Chordal movement** - Introducing melodic movement in a chord progression or in a bass line adds mobility to music. This makes the music more interesting, especially if there is some repetition.
- **Octave doubling** - Doubling an octave is an effective technique to add size and power to the music. The doubling can be done to a melodic line (e.g. with 1st and 2nd violins) or to a bass line (with cellos and double basses). When creating a double line, it might be tempting to just copy-paste the original line, but it is recommended that the double line will also be played. This creates slight offsets in timing, which makes the playing sound more natural and convincing.

For more knowledge about the arranging techniques for orchestral strings, I recommend for example Alfred Blatter's book Instrumentation and Orchestration (1997). The same basic arrangement principles apply for both the live orchestral strings and the SBVIs for orchestral strings.

4.2 The use of SBVIs for orchestral strings in film music production

As the quality and the quantity of SBVIs have increased, they have become more appealing and useful for professionals also in the film music industry.

> The soundtracks (scores) of many films are a complex mixture of conventional orchestration combined with synthesis, but a large number of films have soundtracks that have been produced entirely electronically, with no actual orchestral content at all, although the result sounds like a performance by a real performers. In some cases, although the music may sound 'realistic' to a casual listener, the performance techniques may be well beyond the capability of human performers, and some of the timbres used can be outside of the repertoire of an orchestra. (Russ 2008, 32.)

Here is an excerpt from a marketing text from Vienna Symphonic Library's website that has a similar message than the excerpt above:

> Well-known TV and film music composers such as Danny Elfman, A.R. Rahman, Alan Silvestri, Alexandre Desplat and many others use their "Vienna Libraries" to create mock-ups of their movie scores. Increasingly composers are also combining virtual orchestra sounds with live musicians in the final mix. TV series such as CSI, The Mentalist, Dexter or commercials are almost exclusively created "inside the box". Tight production schedules and limited budgets usually don't allow for recordings of real orchestras, so the sample-based recording isn't just a mock-up, it's the final cue. (Vienna Symphonic Library, 2018)

There are three main approaches on using the SBVIs and other virtual instruments (VIs) in film music production:

- **Creating a cue or a score with VIs**
- **Combining VIs with live musicians**
- **Creating a mock-up with VIs**

Different circumstances affect the approach that is chosen. These circumstances can be some of the following: artistic and stylistic reasons, budget, schedule, habitual behaviour, access to different tools and knowledge to use different tools, which in this case refer to the means of making and actualising the music. They can be for example VIs or a live orchestra.

4.2.1 Creating a cue or a score with VIs

As mentioned above, there are many scores written exclusively with the virtual instruments, which then of course include the SBVIs for orchestral strings also. One of the key things is usually the budget. With the big budgets of the Hollywood films, the composers are likely able to use live orchestras, but with lesser budgets of for example TV series and low-budget films, the use of virtual instruments is often a necessity (Davis 2010, 51). Of course the VIs cost something too, but it is probably much less than what it costs to book a professional orchestra. The use of VIs can also be stylistic and artistic choice, especially when the style of the score is weighted towards an electronic feel. One of the stylistic reasons to use virtual instruments can also be the possibility to realise something that cannot be realised with a traditional orchestra. As Dave Stewart (2017) states, "once we move into the sampled domain, all limitations

vanish". Of course there are also limitations with the virtual instruments, but what Stewart (2017) means, is that with the VIs, it is possible to combine such instruments together (e.g. electronic instruments and rare world music instruments with a traditional orchestra) that would be really hard or impossible with live orchestra. It is also possible have an orchestra as big as what would never be accomplished with live players.

In film music, the schedules are usually very tight whether the score is done with a live orchestra or with virtual instruments. The music is usually created in last phase of the film making process and it is the last creative feature to be added to the film. This highlights the importance of the music as a creative effort, but also the time pressure that is usually present. When the score is created exclusively with VIs, the composer has complete control over all aspects of the final music and it is modifiable until the very end (Russ 2008, 32). This means that changes to the score can be made very rapidly (Russ 2008, 32). This can be both an advantage and disadvantage from the composer's perspective. Compared to setting up a new recording session with a live orchestra, it is very effortless and fast to adjust the MIDI notes and values. There might not be need for a separate final version of the score as the music is created with the same tools from the beginning. On the other hand, if the director or the producer has endless new ideas with the music or difficulties with the decision-making, it may be a painstaking process to modify the score over and over again. Although it is nowadays quite possible to make the virtual orchestral instruments sound realistic and convincing, it can also be very time-consuming to program all the details, which are demanded for this realism (Stewart 2012 & 2017). Giving the music this 'human feel' can be in some cases more difficult than asking an orchestra to interpret the music in a slightly different way (Russ 2008, 32).

The film music as well as any other part of an artistic expression is tied with the historic perspective. We have certain expectations of what we will experience in each setting, and this is based on the experiences that we have encountered before. These expectations are also present in our experiencing of films and film music. Although the world around us is constantly changing, these conventions can be deeply rooted and people are still quite conservative about many things related to films and film music. This is why habitual behaviour is an important factor, when considering the use of virtual instruments. As Russ (2008, 31) points out, there has been, and still is, certain amount of prejudice and discontent against the use of electronic instruments in some

contexts. “What is wrong with the real instruments?” is a question that is many times used to advocate the use of live orchestral instruments rather than an electronic realization of those instruments. Many people are very familiar with the sounds and timbres (the character or quality of a musical sound or voice as distinct from its pitch and intensity) of traditional orchestral instrumentation. Still, careful use of synthesis can result in musical performances, which are acceptable even to an experienced listener, especially if there are no clues of the synthetic origins (Russ 2008, 31).

The access to different tools can depend largely on the budget. As described earlier, it is really costly to book a live orchestra and make live recordings, and that is why this cannot be done in many productions. When a live orchestra can be utilised with the recording of a score, the composers tend to prefer that over the virtual alternatives (Score 2016). The virtual instruments are in that kind of price range that they are practically available for almost everybody. To run the VIs and to compose the music, a quite resourceful computer and a capable DAW is needed, but still, the overall cost of the software and the hardware is relatively inexpensive compared to live orchestra recordings. The same software is used by both professionals and non-professionals, which means that the so-called ordinary people have also the access to the same tools as the professionals.

The knowledge of the use of different tools or the tools that are available is crucial. The composing for a live orchestra requires expertise on writing for an orchestra (to know its capabilities and possible limitations) and doing orchestral arrangements, preferably knowledge about the music theory and notation, and possibly even skills in conducting the orchestra. Some of the same skills are also needed, when creating film music with the virtual instruments. The professional use of virtual instruments, on the other hand, require expertise in the modern music production techniques and frequent updating of the software, hardware and knowledge about the current developments in that field. When it comes to the VIs, it is not about the availability of the tools, but to have the ability to use those tools effectively. This is not the case of either-or with the virtual and live instruments, because it can be assumed that most of the modern film scores utilise them both.

4.2.2 Combining VIs with live instruments

The use of virtual and other electronic instruments combined with live instrument performance is a very common practice when creating a score.

> Many composers and arrangers make sure to employ the strategic use of at least one or two real instruments and live performances in an arrangement otherwise comprised entirely of virtual sounds. Film and TV music composers have done that for years - their tight time frames and hard deadlines may make it impossible to be able to hire out and record all live tracks, but a score realized mostly in the box but with a few key musical elements provided by live musicians can sound much more natural and organic. (Albano 2017)

For a traditional orchestral score that is recorded with live musicians, virtual or other electronic instruments can provide additional timbres and sounds that add atmosphere, evoke a specific feel or create a certain musical reference (Russ 2008, 32). When creating an orchestral sound, another approach is to have the basic orchestral sound created with virtual instruments and then adding at least one or two live string instruments (e.g. violin, viola or cello) to it. This is a technique that film and TV composers have used for many years, because it suits the tight schedules of the business and it gives the otherwise sequenced music a natural edge and life with additional harmonics and some detuning and noise (Albano 2017; Pejrolo & DeRosa 2016). The live instruments enrich the sound of virtual instruments and the listener's ear is subconsciously drawn to the subtle nuances of the live instrument (Albano 2017). This way it is possible to get really convincing results and close to the sound of a large live string section. The live instrument can be used for example for the solo part of a cue. When aiming for as realistic result as possible, it is recommended to double the highest line of each section with a live instrument (including a few overdubs) (Pejrolo & DeRosa 2016). Hiring a string player for this purpose can be an ideal solution for small budget productions (Pejrolo & DeRosa 2016). In this latter approach, the most of the same basic principles apply as with creating the whole score exclusively with VIs, because the most of the production is done with VIs.

4.2.3 Creating a mock-up with VIs

Mock-up is a term used for an extensive demo version of a cue that is created with virtual instruments (or other mimicking instruments) that will eventually be realised with a live orchestra (Davis 2010, 83). They are frequently used in projects that have

large budgets to record. Mock-ups are usually created for the client (e.g. a film director or a film producer) to have an idea of what the final orchestrated result will sound like with real instruments (Pejrolo & DeRosa 2016). A mock-up allows the director or the producer to approve or alter the project before the budget has been committed to record the actual instruments (Wikipedia 2016). As the replication of acoustic instruments has progressed steadily, there are occasionally situations, where mock-ups are included in the final score of low-budget film projects or projects that have run out of time or money (Wikipedia 2016).

4.3 The credibility of the sound of SBVIs for orchestral strings

The SBVIs that are used in film scores are usually imitative in their nature, like SBVIs for orchestral strings. This means that the timbres and the control techniques are usually intended to mimic the sounds and the limitations of acoustic instruments (Russ 2008, 30). Historically, the first electronic and digital instruments that mimicked the orchestral instruments were not that realistic.

> After the initial rush to use electronic instruments à la Vangelis, many directors and producers began to recognize the cold and sometimes false sounding nature of these instruments. It was one thing to use synthesizers or samplers to create a new and unusual texture, or combine them with orchestral instruments, but the scores that used them to replace orchestral instruments tended to sound dry and phony. For example, if a string section or cello solo is playing beneath an action scene or under dialogue, then a really good sample can sometimes fool the audience. But if the same music in in an exposed place where there is a little in the soundtrack to compete with it, even an inexperienced listener can often hear that it is electronically generated and not real. (Davis 2010, 51.)

The development has been huge since the early heydays of the electronic instruments. Because the modern SBVIs for orchestral strings are based on the recorded high-quality samples of live musicians playing, these SBVIs include so-called real playing by live musicians. With these virtual instruments, the credibility and realism of the achievable sound then depends on the quality of the recordings (e.g. overall sound quality, included articulations, quality of the players that were used and the space in which the samples were recorded) and the user's ability to use the software accordingly. "Libraries such as East West Quantum Leap Hollywood Strings, VSL Appassionata Strings and LA Scoring Strings (to name a few of the big-hitters) contain superb recordings of orchestral string sections, but using them to produce realistic arrangements does involve a fair amount of rather pointillistic and intensive work" (Stewart 2012). Still, to know

how to program the instrument properly and convincingly, it is necessary first to know the basic acoustic and tonal functionality of the instrument in question:

> Even the most extensively programmed or meticulously modelled instrument is likely to sound artificial or disconcerting unless it is handled very carefully. As musicians, we are thoroughly acquainted with the mechanics and physics of the acoustic instruments we play. For instance, a trumpet player fully understands the operation of the valves, the buzzing of the lips, adjustments in embouchure, tonguing methods, and many other specific techniques associated with the instrument. But a composer using a virtual trumpet may find it difficult to execute a believable performance without first becoming knowledgeable in the fundamentals of the instruments in question. A quality sample library for the solo trumpet will provide many different "articulations", which in this context refers to differing playing techniques. A quality virtual trumpet instrument may place these same articulations within the instrument's programming, accessible through the electronic keyboard by virtue of specific MIDI controller messages. All of this is beneficial to us only if we understand when the use of particular trumpet articulation will make logical sense and result in natural-sounding performance. Employing articulations when they wouldn't logically be used will lead to unconvincing results…. In order to use these tools [virtual instruments] to their fullest potential, we must train our sensitive ears to the nuances of acoustic musicianship, and then adjust our simulated performances to reflect those small details that will lend our recordings realism and depth. (Phillips 2014, 224-225.)

There are very few researches made on a direct comparison between natural and emulated instrument sounds, but there is one relatively recent study on the subject that is really interesting and thoroughly executed. In the article "Replacing the Orchestra? - The Discernibility of Sample Library and Live Orchestra Sounds" authors Kopiez, Wolf, Platz & Mons (2016) conducted a research, where they studied people's ability to recognize, which music was created with orchestra sample libraries (same as SBVIs for orchestral strings) and which performed by a live orchestra. There were 602 participants that included both professionals and non-professionals in audio and music field. They used selected phrases from Stravinsky's large and versatile orchestra work The Rite of Spring (1913) that contains numerous acoustical cues. The live orchestra version was taken from an up-to-date recording of the music in question. The sample library version was produced with Vienna Symphonic Library virtual instruments, and it was executed by an objective audio engineer. They used three professional conductors to evaluate this version, so that the result would be as good as possible.

The result of the research was that less experienced listeners (non-musicians, amateur musicians, musicologists and music teachers) did not recognize the difference between the virtual and live performance, while experienced listeners (orchestra musicians, audio

engineers, conductors, composers and arrangers) tended to recognize the sound source. This means that the orchestra sample library (OSL) often generated the impression of a human-controlled sound source for non-professionals, and that "auditory perceptual learning by long-term involvement of sounds can significantly increase the discrimination of sound features" (Kopiez, Wolf, Platz & Mons 2016). The correct response rate (i.e. the percentage of the participants, who could tell the difference between the virtual and the live performance) of the less experienced listeners was 68.6 %, while it was 80 % with the experienced listeners. The overall correct response rate was 72.5 %. While the overall rate slightly exceeds 70 %, which is the upper threshold of Turing's criterion for convincing simulated performance, it "likely overestimates the true discrimination performance of a 'normal' (non-expert) subject listening to musical examples from a less differentiated genre (e.g. a musical or film music)" (Kopiez, Wolf, Platz & Mons 2016). The authors suggest that in the near future, the increasing expertise of audio engineers in creating OSL arrangements will improve the quality of virtually created orchestrations, and the use of high-quality sound libraries will become more common in the music production for economic reasons.

The study does not show for example that how other SBVIs would qualify against a live orchestra, what are the specific timbre cues that make people to discern the virtual instrument from the live performance or which of these is the sound that people prefer. Still, it shows that SBVIs for orchestral strings can convincingly challenge and even match a live performance. In this sense, the text from the Vienna Symphonic Library's website (2018) seems to be correct, when it suggests that with their virtual instruments the user can "arrange his or her composition on the computer so that, in many cases, the results cannot be distinguished from a live orchestral recording". If the SBVIs for orchestral strings and the creative tools that they offer are "used in a musically intelligent way, [they] can help to shape the samples into astonishingly life-like performances" (Stewart 2017). Following excerpt summarises well the basic idea of realism and the significance of the meticulous work with the SBVIs for orchestral strings:

> If you program the different instruments' lines separately and make use of detailed articulations such as true legatos, different note lengths, scale runs, glissandi, and so on, you can narrow the gap between sampled and real strings to the point where the average listener won't be able to tell the difference. However, because of their built-in limitations, even the best samples can't quite capture the delicate, mobile shades of expression of the real thing. (Stewart 2012).

5 DISCUSSION

Orchestral strings are one of the key instruments in film music. It seems quite inevitable that the use of SBVIs for orchestral strings will increasing in the film music production when considering the capabilities of these tools, the nature of film music production and the historic context of development in the film music styles and production means. It can be argued that "the development of sound synthesis can be viewed as being nearly complete" and that "the technology has now reached the point where the quality of the sounds that can be produced is close to the physical limits of the human ear" (Russ 2008). Still, the capabilities of the virtual instruments will continue to evolve and there will be new sound libraries with more advanced algorithms and more detailed sampling, but the most demanding task for the user is to make arrangements and do the programming that utilise these creative features of virtual instruments in musical and natural sounding ways. Most likely the stature of professionals capable of using these virtual instruments diversely and convincingly will rise substantially in the future of film music production.

The SBVIs for orchestral strings include many possibilities to control the expression and playing styles, but it is requiring and time-consuming to program them to sound realistic (like performed by a live musician). The user has to know the characteristics of the instrument (e.g. articulations, arrangement basics, physical possibilities and constraints) in question, which can be very demanding from a non-expert, who might have not even heard the instrument in a real acoustical setting. A musician learns his/her instrument through the years of practice. If we want to create convincing compositions and arrangements, we need to learn the same principles that a musician has absorbed and even study the historical perspective to learn the proper stylistic points and the utilisation of different instruments.

Through the history of film music, the technological advancements have affected the art and the production styles. With virtual instruments, the amount of concurrent voices is unlimited (or limited only by the resources of one's computer) and the sound palette is ever-expanding. This offers endless possibilities for composers, who do not have access or funds to utilise a live orchestra, to create professional film music. It is also a common and often functional practice to combine live instruments and virtual instruments in the film music production, and thus it can be assumed that almost all big budget Hollywood

film scores include virtual instruments. Stewart (2017) calls the modern production environment "The New Hybrid Orchestra", because in the sampled domain, the limitations vanish. Actually the only limitations are the composer's imagination and skills in music production. From an artistic point-of-view, this might also create an illusion that bigger is better, because of all the possibilities that are available. It becomes even more important to have a good artistic vision and to learn to distinguish the essential ideas.

"There's an argument that since a sampled instrument can never sound totally real, it might be better to aim for overall musical expression rather than focus narrowly on realism" (Stewart 2017). It is eventually more about the music sounding 'good' than sounding 'real', and making music that sounds good involves much more than just programming the virtual instruments. Composer Mike Verta addressed this subject in his interview in Film Music Magazine:

> The intent is to have a convincing virtual orchestra and an emotional quality; that is the goal. But there are only so many hours in a day. If you want a truly convincing sound, you're going to spend most of your hours on the performance of the samples, instead of on the music itself – the counterpoint, the orchestration, etc. So given that conflict I will always err on the side of the music – that's where the emotional impact lies. A great piece of music can cure a lot of mediocre sample ills, but not vice-versa. (Verta as cited in Asher 2012.)

Virtual instruments and other modern music production tools allow us to make great sounding scores for a small budget (Davis 2010, 63). Still, when writing film music that may demand any number of styles and genres from a composer, it is essential to have knowledge of these styles and genres, knowledge of their instrumentation and the necessary skills in composition and arranging (Davis 2010, 63).

In the historical context, it is very logical that today's film composers have gone for more and more working independently 'in the box' rather than being an employee of a film studio's in-house music department. The studio systems of the Golden Age of Hollywood started to slowly flag from the end of the 1940s and by the 1970s most of the composer's were working as independent professionals. This point in time, which was almost fifty years ago, can be seen as a push towards the production style of today. The independence of film composers has since deepened because of the technological possibilities of music production and economical constraints of film production.

After studying and processing all the information about the history and the present of film music and sample-based virtual instruments (for orchestral strings), I have really learned a lot. I also learned that it is very useful to read the manuals. Reading the manual for Hollywood Strings gave me new insight on the use of this virtual instrument and I can immediately utilise this valuable information with my composing and production work. So, as dull it may feel like, read the manual.

Also, “love the dots” as Dan Price said. He was my teacher for Creative Composing and Arranging classes at the University of Salford in the spring 2016. With the dots he referred to musical notes. His point was that when you know the modern production techniques and the traditional arranging techniques for orchestral instruments with adequate amount of knowledge about the musical theory, it is an invincible combination when working in the field of music.

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