5-2024

Digital Orchestration in Media Compositions

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DIGITAL ORCHESTRATION IN MEDIA COMPOSITION
Creating an Ideal Sound

By

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Presented to the Faculty of the Graduate School of

Stephen F. Austin State University

In Partial Fulfillment

Of the Requirements

For the Degree of

Master of Music

STEPHEN F. AUSTIN STATE UNIVERSITY
May 2024

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ABSTRACT

As composers gain access to better tools, digital mockups have increasingly grown in popularity. Composers often aim to emulate an idealized orchestral sound in their mockups. By understanding the nature of acoustic orchestration and instrumentation, specific techniques and approaches for virtual instruments and sample libraries, and methods to process and manipulate MIDI audio, composers can achieve this idealized sound. This thesis will focus on the common techniques and methods that composers can use to achieve this in digital mockups. Concluding the thesis is an original work that combines digital and live instruments while exploring different techniques to achieve an ideal sound.

ACKNOWLEDGEMENTS

I want to thank Lance Trevino, Dr. Benjamin Morris, Mason Lieberman, Zach Heyde, and Arne Wallender for allowing me to interview them to deepen my understanding and provide insight into this topic. I also want to thank Anne-Kathrin Dern, Zach Heyde, and David Kurdell for their continued efforts to further education in this area with their YouTube channels and informative videos. Finally, I want to thank the TEAMMATES Discord server for providing invaluable insight, information, inspiration, and support as I worked on this thesis.

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CHAPTER 1 – GENERAL CONSIDERATIONS OF DIGITAL MOCKUPS

Digital mockups are emulations of live performances that composers create using digital audio workstations (DAWs) and sample libraries. When composers gain a deeper understanding of digital audio workstations (DAWs), audio software and hardware, and audio processing, the quality of their mockups will improve.

Chapter 1 will define goal of digital mockups and the ideal sound. It will summarize the similarities and differences between digital mockups and music composed with notation software. The chapter will then explore the common software and hardware (DAWs, sample libraries, templates, and recording and playback devices). It will explain the use of effects (reverb, delay, equalization, compression, panning, and mic placement). It will then explore ways composers counteract latency and conclude with a description of the importance and uses of automation (modulation, volume, expression) and velocity.

Goal of Mockups

Most traditional music theory and composition analysis focus on notated music, which contains information about pitch, rhythm, timbre, and harmony — the traditional building blocks of music. To learn how to achieve the ideal sound with a mockup, a

composer must dive deeper into "un-notatable" elements that are innately performed by musicians.

Notation software provides composers with the tools to create readable music that conveys the composer's intent to musicians. A successfully notated score looks professional and is easily understood by the performer. Well- engraved scores follow many of the engraving principles outlined in resources such as Elaine Gould's *Behind Bars*.[1] When composing acoustic music in notation software such as Finale Sibelius and Dorico, composers often prioritize professional-looking notation over the quality of the audio playback. Arne Wallander of Wallander Instruments (creator of the MIDI playback plugin NotePerformer) states, "Most composers want their notes performed predictably, e.g., mezzo-forte should always produce the same dynamic."[2] The purpose of notation software and DAWs are different. In a DAW, a composer is freed from the limitations of traditional notation and can concentrate exclusively on the sound of the mockup. Composers writing music for live musicians generally use notation software, while composers writing for virtual instruments will use a DAW. As composer and educator Zach Heyde explains, mockups aim to "…create an accurate representation of [a

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[1]Elaine Gould, *Behind Bars: The Definitive Guide to Music Notation* (La Vergne: Faber Music Limited, 2016).

[2] Arne Wallander, personal interview, January 6, 2024.

composer's] music."[3] Most composers using notation software aim to communicate their musical ideas clearly to the performers so they can effectively execute the composer's desired sound. Composers aim to communicate their ideas through their DAW so listeners can ***hear*** their desired sound.

The Ideal Sound

While there is not a singular "correct" way to create a mockup, composers have, over time, developed a standard based on the mixes of prominent film composers like John Williams or Jerry Goldsmith. It is not possible to emulate the experience of every individual sitting in a concert hall listening to an orchestra simultaneously. Instead, when creating a mockup, a composer creates a mix that is based on idealized version of the sound of an orchestra, designed for a theatre speaker system or headphones. This thesis aims to explore the techniques and concepts used to achieve this ideal sound.

While this idealized sound has become standard in the industry, not all pieces aspire to sound like the standard orchestral scores of Williams or Goldsmith. In many media scoring projects across multiple genres, a less ideal sound may be preferred. For example, film and video game directors might prefer composers to write music that

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[3] Zach Heyde, "Basic Terms & Tools | Before You Start," July 31, 2023, YouTube video, 5:40, https://www.youtube.com/watch?time_continue=26&v=rWpajIYR9qo&embeds_referring_euri=https%3A%2F%2Fpayhip.com%2F&source_ve_path=MjM4NTE&feature=emb_title.

sounds "otherworldly" for sci-fi films that take place off-world, such as Hans Zimmer's "*Dune* Soundtrack",[4] Ben Prunty's music for *Subnautica: Below Zero,*[5] and sections of Andrew Prahlow's music for *Outer Wilds*.[6] Composers may deviate from the ideal sound through synthesized sounds as in Thomas Bergersen and Nick Phoenix's piece "Impossible."[7] They may use uncommon extended techniques, layer samples to create strange sounds, or manipulate waveforms to create phenomena such as Shepard Tones—a feeling of the music endlessly ascending or descending in pitch.[8] However, certain rules of achieving the ideal sound and digital orchestration must still be followed. While these composers may not emulate an acoustic orchestra in their works, they demonstrate an understanding of how to manipulate digital instruments to create music and achieve a pleasing, balanced, and well-orchestrated sound.

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[4] Hans Zimmer, *Dune: Original Motion Picture Soundtrack,* WaterTower Music Inc., 2021.

[5] Ben Prunty, *Subnautica Below Zero (Original Soundtrack),* Ben Prunty, 2021.

[6] Andrew Prahlow, *Outer Wilds* (*Original Soundtrack*), Annapurna Interactive, 2019.

[7] Two Steps from Hell, "Impossible," September 23, 2017, YouTube video, 8:54, https://www.youtube.com/watch?v=6qTghUgMOeY.

[8] Eleonora Rapan, "Shepard Tones and Production of Meaning in Recent Films: Lucrecia Martel's *Zama* and Christopher Nolan's *Dunkirk*," *The New Soundtrack* 8, no. 2 (September 2018): 135–44.

Software and Hardware

A composer has a plethora of tools at their disposal when creating a mockup. Composers will closer emulate the ideal sound in their mockups if they understand how to use the most common software and hardware (DAWs, sample libraries, templates, and playback and MIDI devices).

One of the most crucial pieces of software a composer needs is a digital audio workstation (DAW) which serves as the creative hub. DAWs house the composer's samples, templates, plug-ins, effects, audio, and Musical Instrument Digital Interface (MIDI) data, which is then read and converted into musical language and produces sound, to playback, edit, or export.[9] The most common DAWs used today are Steinberg's Cubase, Apple's Logic and Garage Band, Cocko's Reaper, Image-Line's Fruity Loops (FL) Studio, Ableton's Ableton Live, and Avid's Pro Tools.

Another tool vital to media composition and digital orchestration is the sample library. Sample libraries contain virtual instruments that composers use to realize MIDI data written within a DAW. These can range from one instrument with a single articulation (such as a legato violin or staccato trumpet) to one with a full articulation set, a section, a full instrument family, or even a full orchestra. Libraries help composers'

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[9] Marrington, Mark, "Experiencing Musical Composition in the DAW: The Software Interface as Mediator of the Musical Idea" (paper presented at Proceedings of the 2010 Art of Record Production Conference, Leeds, UK, December 2–4, 2011), https://www.academia.edu/download/37668471/MARRINGTON_M_ARP2010.pdf.

complete specific tasks, such as imitating a virtuosic solo line or blending samples to emulate a realistic orchestral sound. While some composers choose to sample instruments themselves, commercially available sample libraries are available from a host of companies including Spitfire, CineSamples, Native Instruments, Steinberg, Cinematic Studio Series, 8dio, and Kontakt. Libraries are commonly created by recording musicians in a concert hall, a process known as sampling.[10] Another common technique is modeling in which audio engineers use complex computer systems to create instrument sounds from scratch and manipulate the results to create a desired sound. The library companies Acoustic Samples and Samplemodeling use this technique.

After composers develop a preferred list of virtual instruments, they create a template in their DAW of choice. A template is an empty session that will pre-load all their samples with the effects, plug-ins, and other musical elements input by the composer. This process helps composers save time by setting up their sessions in advance. Each instrument is loaded into a specific track inside the DAW as shown in **Figure 1.1**. Composers may also choose to include routing information in their templates. Routing, also commonly called bussing, is the pathway a sampled sound takes before reaching the final stereo output for playback or exportation as a stem—an exported audio file of a group of tracks—or as a final "Audio Out" mix as shown in **Figure 1.2**. This

[10] Wallander, interview.

allows composers to add multiple effects to one, or multiple, samples without having to replicate the effect or instrument each time.

Figure 1.1: An Orchestral Template in Cubase

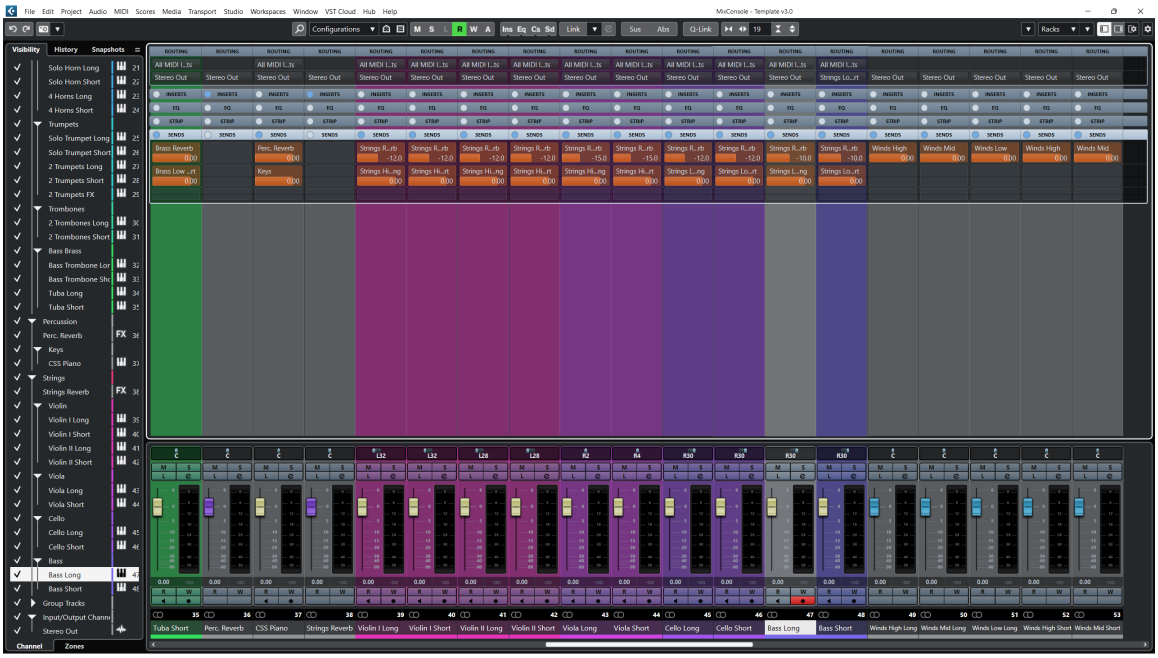

Figure 1.2: Routing Information for Instruments

Composers also need quality studio monitors or professional headphones. These allow composers to hear the entire frequency spectrum required in digital music. They also need an audio interface, which connects audio input and output devices to a computer via USB. Finally, they need a MIDI controller/keyboard, which bridges the gap between the composer and the DAW. MIDI controllers range from keyless controllers to keyboards with up to eighty-eight keys as well as faders and knobs.

Composers can achieve the ideal sound in their works by understanding the common hardware and software they routinely use when creating. As composers develop preferences for certain tools, effects, and samples they create a template to act as a

starting point for each new mockup. These tools, combined with the hardware the composer uses for inputting MIDI and hearing the playback, are the basis of all mockups.

Audio Effects

The advancement of technology and recording equipment has made samples sound more lifelike, but to further emulate the ideal sound of their mockups, composers manipulate the sounds produced through a wide array of effects, plugins, and other forms of audio manipulation. To achieve the ideal sound, composers may use effects that are built into their DAW of choice or use third-party plugins from other companies. Plugins act as a virtual counterpart to physical hardware to process the output on a mixer.[11] Like a guitarist's pedalboard, plugins allow composers to chain effects together, known as an FX-chain, to create a pathway the sound travels through before reaching the final output. While there are an almost endless number of effects at a composer's disposal, the most common and most important ones are reverb, delay, equalization (EQ), compression, panning, and mic placement.

Because samples are recorded in many different venues, every sample will sound different. This is further underlined by the library engineer's decision to add or remove any ambient sounds in the library. Many composers opt to use multiple libraries for the

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[11] Vincent Goudard and Remy Muller, Real-Time Audio Plugin Architectures," IRCAM, September 8, 2023, http://recherche.ircam.fr/equipes/temps-reel/movement/muller/xspif/pluginarch.pdf.

same instrument in their templates, as they need to create the illusion that all instruments are being performed in the same place. To achieve this, composers use reverb and EQ. Reverbs are split into two types: convolution and algorithmic. Convolution reverb uses mics placed within a specific room or concert space such as the LA Scoring Stage and Studio One, to record impulse responses to determine the levels of pre-delay, decay, depth, and other parameters. While convolution reverbs require less work for composers, they generally require more CPU power and give composers less control over the parameters of the reverb. Generally, they only allow control over the mix level—the balance between the reverb and the unprocessed sound. The mix level determines how wet/dry the sound is; the wetter a sound the more reverb is added. The dryer the sound the "purer" the sampled sound is heard. [12] Algorithmic reverb, on the other hand, allows composers to take control over all aspects of the reverb; the plug-in then creates the reverb using complex mathematical processes. This requires the composer to spend more time building the reverb and is much harder to create a reverb that sounds the same as a convolution reverb, but it gives composers more liberty to create their desired sound.[13]

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[12] Anne-Kathrin Dern, ... "...And How I Use Them," October 12, 2022, YouTube video, 48:46, https://www.youtube.com/watch?v=s8qRLWPTHr8&t=843s.

[13] Jonah Westling, "Evaluation of Reverb with Eq as a Tool for Egocentric Distance Perception in Games" (Bachelor's thesis, Luleå University of Technology, 2016), 7, https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1019924&dswid=-8695.

Even if a composer uses reverb to make samples sound as if they were recorded together, differences in recording equipment, positioning, and instrumental timbre may cause the samples to have higher or lower frequencies than other samples and may provide static feedback at certain frequencies. Composers use equalizers to create a seamless frequency between samples, composers use equalizers. Equalizers, commonly known as EQ, are audio processors that change the volume of different frequencies. EQs can increase and decrease frequency regions to bring out or lower the different frequencies.[14] When two instruments play together in an acoustic space, the sympathetic resonance produces a different timbre than if those instruments were recorded in separate spaces.[15] Equalizing instruments in a mockup allows composers to create these timbral perceptions synthetically to achieve a sound closer to the desired final product.

Another challenge composers face in creating a mockup mix is ensuring that the loudest sections do not peak the audio, creating static in the sound or clipping the audio completely, and that the softest sections do not become imperceptible to a listener. Dynamic compression allows composers to raise the lowest volumes, guaranteeing audio, and lower the maximum volume in a mix, preventing the volume from clipping.

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[14] SlateDigitalTV, "When to Use Additive vs Subtractive EQ," March 30, 2018, YouTube video, 5:59, https://www.youtube.com/watch?v=0TqRw1ZuH_c&t=289s.

[15] Stefanos Ioannou et al., "ODESSA: An Interdisciplinary Symphonic Recording for the Study of Orchestral Sound Blending" (paper presented at the Audio Engineering Society Convention 149 [online], October 22, 2020), https://www.aes.org/e-lib/browse.cfm?elib=20982.

Another way composers can create a sense of space in a mockup is by panning the orchestral instruments. Panning, which changes how much audio output goes to a specific speaker, is vital to creating the ideal sounding mockup. The values are generally between -64 (completely left) and 64 (completely right) or a percentage with 0% being centered and increasing to 100% the more an instrument is panned left or right. There are many speaker setups, including a single (mono) output, 360° surround sound, and newer setups such as Dolby Atmos which uses spatial audio to allow "filmmakers, sound designers, and music creatives [to] precisely place individual sounds anywhere around the room to create an immersive soundscape. The result is a spatial sound experience that fills up the room, putting you inside your entertainment, and sounds more like the way we hear things in real life."[16] In most cases, however, the mix output is a simple L/R setup with one speaker on the left of the listener and one speaker on the right. The more an instrument is panned to one side the more it is heard from that speaker and the less it is heard through the other speaker. While this will be further discussed in Chapter 3, composers generally pan their instruments to follow a standard orchestra setup as shown in **Figure 1.3**. While many setups are available, a composer should decide which they prefer and aim to pan instruments to adhere to their setup of choice. Some samples come

[16] Dolby, "What Is Spatial Audio? How It Works and How to Use It,"accessed March 8, 2024, https://www.dolby.com/experience/home-entertainment/articles/what-is-spatial-audio/#whatisspatialaudio.

pre-panned; however, many of the library companies allow composers to pan the instruments themselves through their DAWs.

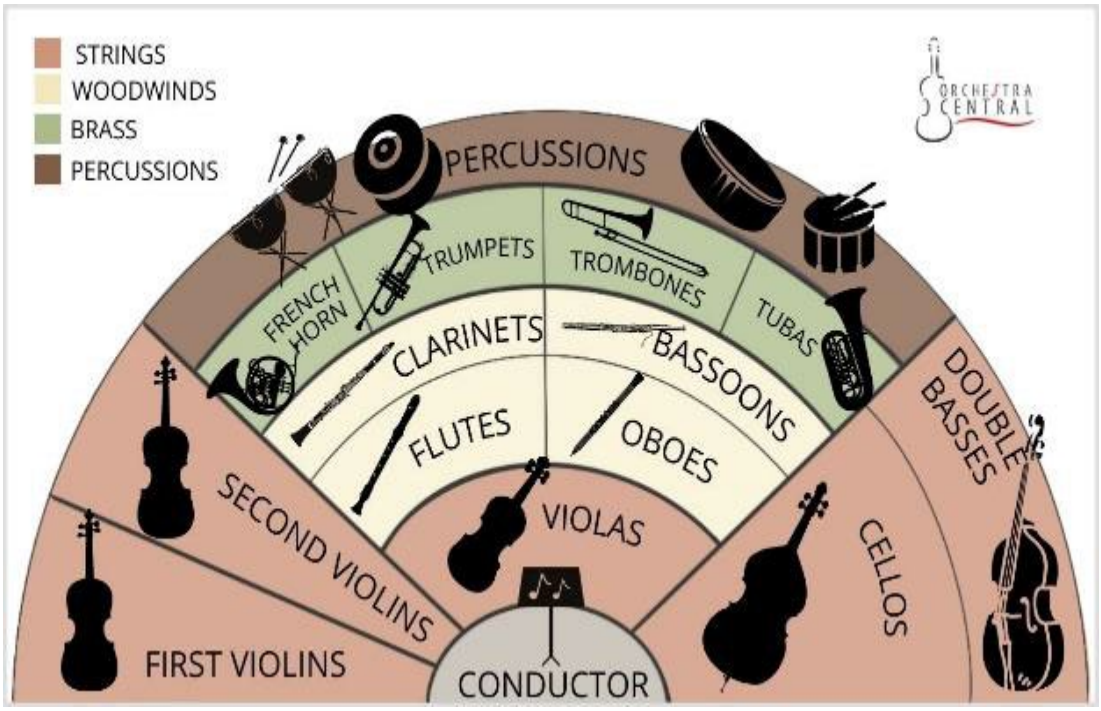

Figure 1.3: One Standard Orchestral Setup[17]

Another effect composers can use to achieve the ideal sound is mic placement. Mic placement is a vital part of the recording process for samples. The placement of a mic during a recording session completely alters the sound produced from the recording.

[17] Hannah Gee, "Orchestra Arrangement: How Is It Arranged?" Orchestra Central, published September 13, 2021, https://orchestracentral.com/orchestra-arrangement-how-is-it-arranged/.

There are numerous mic options composers can use depending on their chosen library. The most common mic positions in libraries are close, room/far, and mixed. Close records by placing the mic above, closely in front of, or on the instrument. This allows for more attack and crisper sounds; however, it negates much of the ambient sound. Furthermore, it can make a section or player "stick out" of the sample. Room micing allows more room reverb to penetrate the sample by setting up mics further away from the section, sometimes even in the middle of a hall. This allows for a lusher sound as more of the room's ambient reverb is included in the sample. This mic placement does sacrifice some of the crisp articulations, especially for short articulations such as staccato and staccatissimo. Furthermore, articulations can sometimes become lost in the sound of a mockup as the reverb may take over the sample. A mixed-mic setup allows a composer to combine the two mic positions to get a specific sound; they may give up some of the room sound to make a crisper articulation during faster passages let in more reverb during long, legato sections.[18] Most mockups use the mix position entirely, which is preferred over using both a room and close mic position because it saves RAM. Room micing allows the samples to have a crisper attack while leaving ambient room for overtones and the full note to be heard. Depending on the style of the section within the mockup, composers may increase the close mic position to bring out the attacks of an instrument,

[18] Zach Heyde, "Using MIC Positions in Orchestral Mockups," September 24, 2021, YouTube video, 15:55, https://www.youtube.com/watch?v=e8QKScXYzI0.

such as the trumpet line during the end credits of *Star Wars Episode III: Revenge of the Sith* by John Williams,[19] while they may lower the close mic sound and raise the room mic sound during more ambient, slow, and lyrical sections.

Combining reverb, delay, equalizer (EQ), compression, panning, and mic placement helps composers emulate the sounds of a live orchestra. Combining these effects helps the music sound like it is being performed inside a concert hall with the proper arrangement of instruments and without the unwanted static, popping, or crackling noise that can come from speakers. These also enhance certain expressions acoustic instruments can create and samples may lack.

Note Lengths

In addition to adding audio effects and setting up their template, the composer must also manipulate the MIDI data to ensure the sampled instruments sound as desired. When a performer plays an instrument, the time between the start of playing a note and the start of sound is almost instantaneous. In digital mockups, the time between the MIDI being read, and the sound being heard is greater. The MIDI pathway begins with a MIDI controller before going to a computer. In the computer, the MIDI goes into the DAW through a channel to a track with a MIDI device connected to a VST before reaching the

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[19] Blake Robinson, "Abbey Road One | Walkthrough and Thoughts," November 5, 2020, YouTube video, 24:11, https://www.youtube.com/watch?v=KTve55dg bY0&t=698s.

output device for a composer to hear (see **Figure 1.4**). This long pathway creates latency, which is the amount of time it takes for a sample create sound after the start of MIDI or pressing a key, which is further exacerbated by slower computers. Although the delay is only milliseconds at worst, the latency can cause composers serious issues if they are scoring to picture or composing over existing samples. Furthermore, every sample is different, so while one sample may take 30ms to be heard, another, even by the same company, can take 150ms or more. Because this phenomenon is common in almost every sample, composers strive to counteract latency in their workflow. They may start MIDI data early, add pre-delay to the tracks, and use quantization tools to help achieve realistic playback.

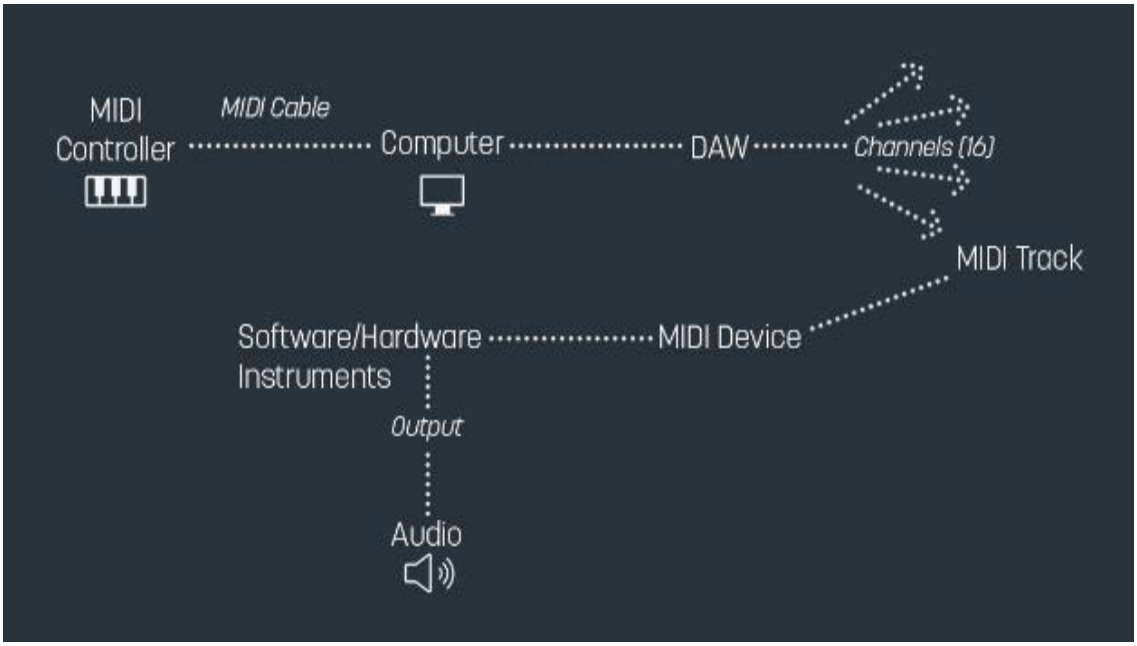

Figure 1.4: Pathway Between a MIDI Controller and the Playback[20]

One of the most common ways to counteract latency is to start the MIDI data slightly before the beat one wants to be heard, around 50–200ms early, allowing the computer and DAW extra time to read the MIDI and send the sound to the output so it can be heard at the correct time. While this approach works, many composers opt for a different method because if the mockup is sent to an orchestrator to convert into notated sheet music for performers, they may struggle to fully understand the desired rhythms

[20] Erin Barra, "MIDI Data: What It Is and How to Use It," iZotope, November 18, 2019, https://www.izotope.com/en/learn/midi-data-what-it-is-and-how-to-use-it.html.

given the early input of each MIDI note. This can also create problems because the pre-entrance length must be almost exact to prevent the note from starting early or late.

Another common way to control latency is by setting up pre-delay in the DAW for each sample. Pre-delay has the DAW "read ahead" to determine what is coming next and relay that information early. Setting the pre-delay for each sample to read ahead by the number of milliseconds the sample takes to be heard allows the sample to be heard at the right time. Composers may choose a different method because this does not allow multiple articulations on the same track as each articulation may have different latencies, or because they do not have a template of samples they regularly use, so they do not want to spend the time before each piece determining the latency time for each sample in each work.[21]

Most composers choose to record their MIDI into their DAW via a MIDI controller, most commonly a keyboard, although some prefer to use a mouse and keyboard for input. This allows composers considerable control over the start and end points of the notes, which can create a problem. Because of latency, human reaction speed, and DAWs allowing notes to start and stop at any point, MIDI data that has been input can vary in accuracy and is rarely perfect in length. DAWs have a way to help composers handle this inevitable hurdle: quantization. Quantization lets composers round

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[21] David Kudell, "Why You Should Quantize + Negative Track Delays Explained," May 10, 2022, YouTube video, 11:12, https://www.youtube.com/watch?v=Cd8KOOm_Ktk.

the start and end of notes to the nearest note value (quarter, eighth, sixteenth, and smaller divisions) they choose.

Dynamic Writing for MIDI

While all the previously discussed topics involve inputting MIDI and using samples, none delve into dynamics, timbre, or volume. Each sample can produce a range of dynamic and timbral sounds. Composers use automation to change the dynamics and timbre and to manually set the parameters of different aspects within a sample to automatically adjust during playback. A DAW will read the information programmed by the composer, and translate it into sound manipulations, such as increasing the volume or changing timbres, automatically within a playback. Most of the properties a composer edits within automation come from control change (CC). These values control the changes the automation reads and range from 0 to 127. While VSTs can assign whichever function they desire on any CC value, most choose to have the commonest control changes (modulation, volume, and expression) and non-CC values such as velocity function similarly.

Table 1.1: MIDI Standard CC Values and Usage

CC Value	Usage
0	Bank Select
1	Modulation
2	Breath
3	Undefined
4	Foot Controller (Pedal)
5	Portamento Rate
6	Data Entry
7	Volume
8	Balance
9	Undefined
10	Pan
11	Expression
12	Effect Controller 1
13	Effect Controller 2
14–15	Undefined
16–19	General Purpose
20–31	Undefined
32–63	Controller 0–31
64	Sustain Pedal
65	Portamento On/Off
66	Sostenuto On/Off
67	Soft Pedal On/Off
68	Legato On/Off
69	Hold 2 Pedal

Table 1.1 continued

70–79	Sound Controller 1–10
80–83	General Purpose 1–4
84	Portamento Amount
85–90	Undefined
91–95	Effect 1–5 Level
96	Data Increase
97	Data Decrease
98–99	Non–registered Parameter
100–101	Registered Parameter
102–119	Undefined
120	All Sound Off
121	All Controllers Off
122	Local Keyboard On/Off
123	All notes Off
124	Omni Mode Off
125	Omni Mode On
126	Mono Mode
127	Poly Mode

Modulation, known as CC1, is one of the most common automations in a composer's arsenal, especially for longer notes and brass. While modulation can affect different parameters, its most common use is for timbral shifts and the number of samples being performed within a VST. When a composer uses a sample library, each sample is composed of numerous recorded performances across a wide range of volumes and

timbres. These samples are placed together and repeated, sometimes reaching 100+ copies, on a single sample that the composer uses. When a composer wishes to change the number of samples they use, they change the modulation. The higher the modulation, the more samples that are used. Furthermore, for brass, the higher the modulation the brighter and more intense the sound. While modulation affects volume, it cannot silence a track, as a modulation value of 0 plays the softest sample at its lowest recorded volume.

Volume, CC7, controls the overall loudness of the track. This does not affect the samples themselves but adjusts how an individual track dynamically relates to the other tracks in the mockup. This CC value is one of the least commonly used during the compositional process to allow for its use during the when balancing the final mix. This automation is most effective when used after other automations and within the mixing process.

CC 11, more commonly known as expression, affects the volume dynamics of a sample without affecting the timbre or changing the selected sample. Each sample instance described in modulation has a dynamic range within itself, so “soft” sounds can go from no volume to some volume, whereas the highest modulation sounds can become even louder than their initial sound. This is how expression manipulates the sound. While modulation tends to have more ebb and flow within a sample, expression tends to remain smoother, but the overall value range is greater than modulation, as shown in **Figure 1.5**. This can allow the sound to enter from silence and push the dynamics even more at impact hits. CC 11 is very close to CC 7, volume, in that it controls many of the same

parameters. However, because volume is more of a permanent change, many composers opt instead to use volume as a helpful balancing tool to ensure certain instruments do not overtake others.

Figure 1.5: Double Bass Line with Modulation and Expression

Although velocity does not have a CC value, it works cohesively with other automations. Velocity is used in place of modulation for short articulations, percussive instruments, and keyboards. Velocity, generally, determines how strong of an attack a note has, although it can be used for many other aspects, especially with percussion. It is impacted by how hard a key is depressed on a keyboard; the higher the velocity the stronger the attack and the louder the instrument. **Figure 1.6** shows the same phrase as

Figure 1.5, with staccato articulations for the string bass, velocity, and expression used instead of legato, modulation, and expression.

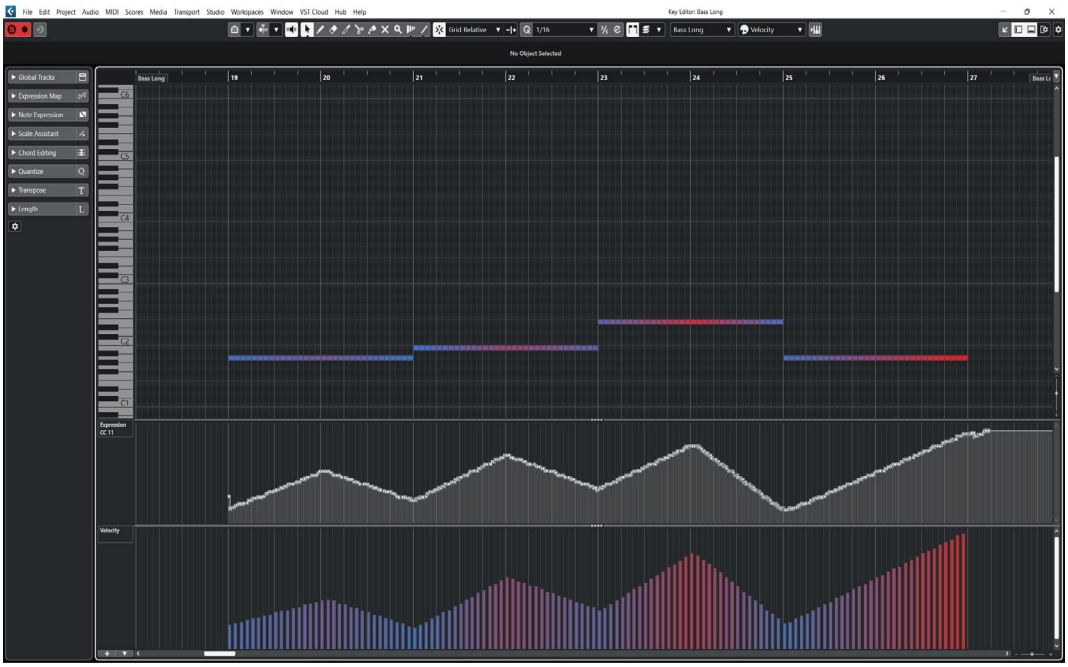

Figure 1.6: Double Bass Line with Expression and Velocity

Understanding how to write dynamically within a mockup helps composers achieve a higher quality sound. Automation techniques such as modulation, expression, velocity, and volume help composers create realistic-sounding phrases and emulate micro-phrasing techniques that many professional musicians naturally create in their performances.

CHAPTER 2 –SPECIAL CONSIDERATIONS FOR INSTRUMENT FAMILIES

When writing orchestral music, a composer must understand the tendencies of each orchestral section—the strings, winds, brass, and percussion. The composer must understand the mechanics of each instrument to compose idiomatic music for those instruments, but they do not necessarily need to know how to play them. Because composers serve as both the composer and "performer" of VSTs when creating digital mockups, they must make all the decisions themselves and include interpretive details like phrasing, articulation, and other factors. While this thesis does not aim to encompass all of the acoustic orchestration techniques helpful to composers (composers aiming to gain such knowledge should study acoustic orchestration textbooks) understanding some specific considerations for each instrument family can help composers achieve a more idealized mockup.

Considerations for Strings

One of the most versatile instrument families, the strings have a wide range of techniques and sounds. Many string techniques, while similar across instruments, are handled differently with each instrument. Many considerations apply similarly

throughout the string families, and learning how to approach these compositional aspects will help composers create ideal mockups.

When writing for strings all notes fall under two major categories, open and fingered notes. The open notes are notes that are played without fingering any note on the string. Alternatively, apart from the lowest open note, all open notes can be played by fingering a fourth on the string just below the open note desired, called closed fingerings. This allows the notes to have two distinct sounds; a fingered and vibrato sound that blends with the other notes and an open, vibrato-less sound. The decision between open and closed is dependent on a variety of factors: style, time period of the piece/performance, performer and composer preference, musical context, and more. For instance, when striving for historical accuracy, performers should play seventeenth- and eighteenth-century music with the open strings, [22] as shown in Arthur Grumiaux's performance of "Bach's Violin Partita No. 3 in E major, BWV 1006."[23] Modern performances, however, prefer to use stopped strings whenever possible[24] such as in

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[22] Rônez Marianne, "Violine," in *Die Musik in Geschichte und Gegenwart*, ed. Ludwig Finscher (Kassel: Bärenreiter, 1998), 1638.

[23] Johann Sebastian Bach, "Bach - Violin Partita No. 3 in E Major, BWV 1006 {Grumiaux}," Bartje Bartmans, July 1, 2015, YouTube video, 14:54, https://www.youtube.com/watch?v=5tjl07RmEQg.

[24] William Drabkin, "Beethoven and The Open String," *Music Analysis* 4, no. 1/2 (March 1985): 15–28, https://doi.org/10.2307/854233.

music by John Williams, including Itzhak Perlman's performance of "Theme from *Schindler's List*."[25]

Many libraries struggle to tackle the phenomenon of opened vs. stopped notes. A few choose to ignore this issue entirely. Some libraries, such as Cinesamples Taylor Davis Solo Violin, feature a separate articulation, as shown in **Table 2.1** for open strings that allow the composer to switch between a vibrato and a non-vibrato sound for the notes. Others, including Cinematic Studio Series' Strings, and Spitfire's Studio Strings Professional, allow composers to control vibrato for every note; this functionality is usually connected to CC2 (breath). Not only does this allow composers control over the vibrato level for each note to create a more realistic playback, because, as with live performances, composers and performers may not opt to have the same level of vibrato for every note. While this may not sound as "open" as an open-stringed note it emulates the non-vibrato sound that open notes have.

Another important and varied aspect of strings is their numerous articulations. In a sample library, the "articulation" refers to a specific type of recorded sample, including acoustic articulations like staccato or legato, extended techniques like harmonics or col legno, and some specific effects such as cluster chords. Composers and most sample

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[25] John Williams, "John Williams: Schindler´s List Theme - Itzhak Perlman," CMajorEntertainment, October 16, 2019, YouTube video, 3:31, https://www.youtube.com/watch?v=cLgJQ8Zj3AA.

libraries split these articulations into three categories: longs, shorts, and effects. Each of these categories must be considered differently due to their distinct sounds.

Table 2.1: shows common articulations for strings and which libraries host those articulations

	Libraries with the Articulation	Sustain	Legato	Staccato	Staccatissimo	Spiccato	Marcato	Tremolo	Harmonics	Pizzicato	Col Legno	Con Sordino	Trills	Detache
Cinematic Studio Strings		X	X	X	X	X	X	X	X	X	X	X	X	
EastWest Hollywood Opus		X	X	X	X	X	X	X		X	X		X	X
Berlin Strings		X	X	X		X		X		X	X		X	
CineStrings Core		X	X	X		X	X	X	X	X	X		X	
Cinestrings Pro		X		X								X		
Cinesamples Quartre		X		X		X		X		X	X			
Benjamin Wallfisch Strings		X	X	X		X	X	X		X			X	
Spitfire Symphony Orchestra			X	X		X	X	X	X		X		X	
Abbey Road Orchestra			X	X		X	X	X	X	X	X		X	X
BBC Symphony Orchestra Core			X			X		X		X				

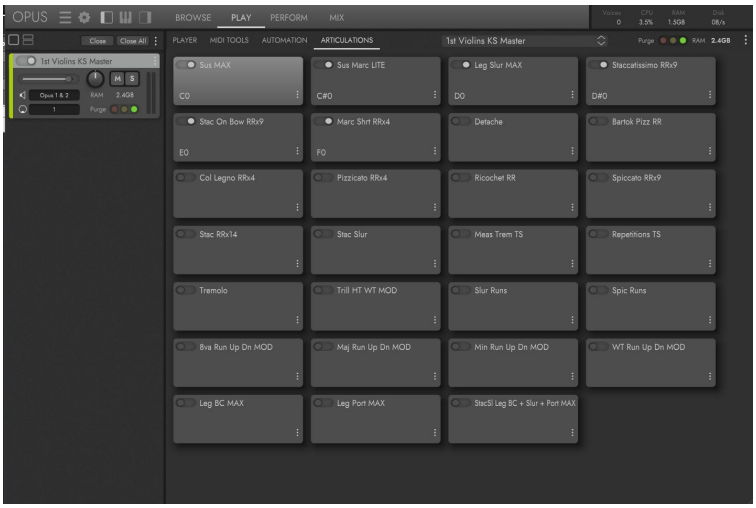

Figure 2.1: Violin I Articulations for EastWest's Hollywood Opus

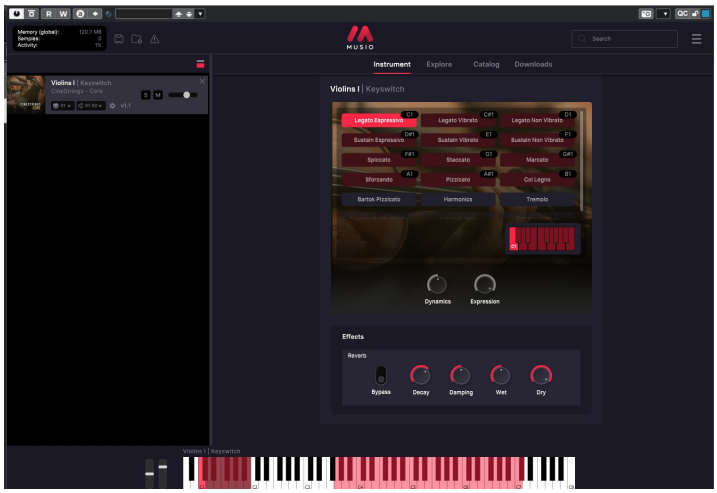

Figure 2.2: Violin I Articulations for CineSamples CineStrings Core

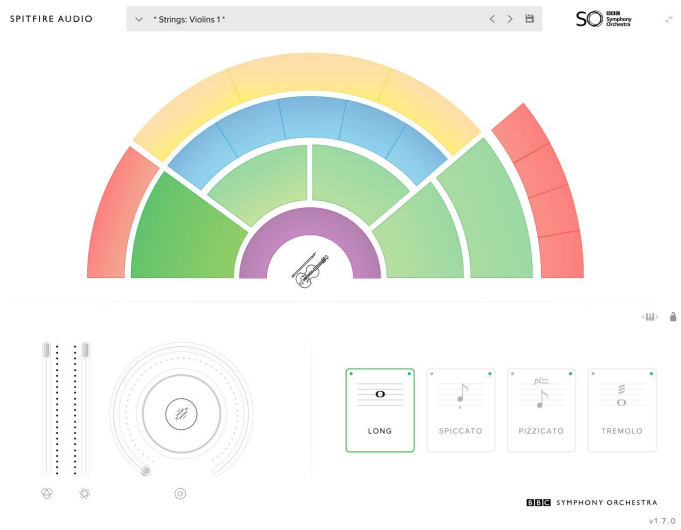

Figure 2.4: Articulations for BBC Symphony Orchestra Core Violins

Figure 2.4: Articulations for Cinematic Studio Strings 1st Violins

Longs are made up of two articulations: legato and sustain. Sustain is created by having a loop repeat itself endlessly. While this allows the composer to have extra control for single note lines with minimal note changes and allows notes to continue forever, it causes serious problems when trying to perform runs, including notes cutting out, large space between sounds, and extra latency between notes.[26] Legatos, on the other hand, excel at smooth melodies and playing multiple notes simultaneously. Like a slur in acoustic writing, legatos allow notes to connect seamlessly as well as the use of double, triple, and quadruple stops. The change between legato notes can be fingered

[26] Juho Salmi, "Using Sample-Based Virtual Instruments to Produce Orchestral Strings in Film Music" (Bachelor's thesis, Tampere University of Applied Sciences, 2018), https://www.theseus.fi/handle/10024/148222.

(portamento), bowed, or include a slide between each note, as outlined in Spitfire Audio's video "What is a Legato."[27] Guy Michelmore's YouTube video "Orchestral Samples - *The RIGHT way to use legato"* dives into the difference between legato and sustains.[28]

There are several different short articulations with a variety of names depending on the sample library**.** Generally, the articulation depends on the length of a note, from detaché to staccatissimo (with and without accents). Unlike longs, these articulations have a defined length and release. No matter how long the MIDI note is held, the note will only play for the predetermined length.

In conjunction with longs and shorts, most sample libraries also include effects. Because of the versatility of stringed instruments, each sample library is unique in the number and types of extended techniques provided. **S**ome of the most common are harmonics and tremolos; however, libraries can also include special articulations and effects, such as octave runs, short and long crescendos, and clusters. The best way to determine the different articulations in each sample is to watch the sample walkthrough created by each library company such as EastWest, Cinematic Studio Series, Native Instruments, and Spitfire Audio.

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[27] Spitfire Audio, "What Is a Legato?" July 15, 2018, YouTube video, 1:35, https://www.youtube.com/watch?v=vmca5qUEX8Q.

[28] Guy Michelmore, "Orchestral Samples - the Right Way to Use Legato," March 21, 2021, YouTube video, 8:11, https://www.youtube.com/watch?v=EPJs8EKwLdk.

Table 2.2: Uncommon Techniques in Libraries.

	Bartok Pizzicato	Runs	Portamento	Sul Ponticello	Sul Tasto	Detuned	Cluster Chords	(De)Crescendo	Flautando
Cinematic Studio Strings	X	X		X	X				
EW Hollywood Opus	X	X	X						
CineStrings Core	X								
Spitfire Symphony Orchestra	X			X	X				X
Berlin Strings		X	X					X	
CineStrings Pro		X							
Abbey Road Orchestra		X	X						X
CineSamples Quartre						X	X		

Another vital consideration is the difference between solo and ensemble patches. Unlike the other sections which require one instrument per part, the strings have between eight and eighteen instruments per part. Many string libraries are considered section patches because they use multiple instruments in the recording, as they would be in an orchestral setting. If a composer needs to use a solo stringed instrument, they must find a different solo patch. These are sold by most sample libraries including Cinematic Studio Series and Spitfire.

A less commonly used sample patch is an ensemble patch. An ensemble patch consists of multiple instruments, ranging from chamber-sized to string and full orchestra, all within the same library. While many composers prefer to use these libraries for sketches, many reject using ensemble libraries within mockups because of the lack of

control over which instruments are played. Since instruments such as the upper register of the cello and the lower register of the viola, share the same notes, ensemble patches may automatically choose one, or both, of the instruments to playback, regardless of the composer's desire.[29]

Instrument Ranges

Given the flexible nature of stringed instruments, there are three different "types" of ranges: the practical range, the real range of the instrument, and the range of the instrument's harmonics. The practical range of the instrument is defined as the range that a performer can comfortably and consistently play. The real range extends further and includes all the possible notes for each instrument. Sample libraries do not distinguish between real and practical ranges in their playback and may not allow composers to reach beyond the practical range; nevertheless, composers must understand the difference between the two. Finally, the harmonic range, which will be discussed in more detail later, is the range of notes that string players can create using an extended technique.

The highest-pitched stringed instrument in an orchestral setting, the violin can reach notes as high as C7 if not higher. Realistically, it is better for composers not to reach this high unless they are writing a virtuosic solo line. Some orchestration books, such as Samuel Adler's *The Study of Orchestration*, advise against writing higher than

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[29] Benjamin Morris, personal interview, March 4, 2024.

E7,[30] while others, including Andrea Pejrolo and Richard Derosa's *Acoustic and MIDI Orchestration for the Contemporary Composer*, push the practical range slightly further to G7.[31]

Although performers have access to this wide range of notes, sample libraries must restrict the range within their virtual instruments. Because the range of the stringed instruments differs in orchestration textbooks, samples have different upper ranges depending on the library, although most samples have the lower range end at the open string G3. Many libraries choose D6 as the highest programmable note including Berlin Strings, Cinematic Studio Strings Violins, and EastWest Hollywood Strings, while others, such as the BBC Symphonic Orchestra, raise the highest note to C7.

Violin I and Violin II

As with modern orchestras, many sample companies split their violins into a violin I and a violin II patch. While this may seem useless, separating violin patches allows for a greater sense of an ideal orchestral sound. As most orchestras have slightly

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[30] Samuel Adler and Peter Hesteraan, *The Study of Orchestration* (New York: W.W. Norton, 2002), 58.

[31] Andrea Pejrolo and Rich DeRosa, *Acoustic and MIDI Orchestration for the Contemporary Composer* (Amsterdam: Focal, 2007), 120.

more first violins (sixteen-eighteen) than second (fourteen-sixteen),[32] if someone used the same number of instruments at the same volume for violin I and II, they would create an unrealistic sound further from the ideal sound. One way samples distinguish between violin I and II is by having more performers in violin I samples than in violin II. Some libraries, such as Spitfire's BBC Symphony Orchestra Professional (BBCSOP) and Symphonic Strings Professional, use a standard number of instrumentalists, sixteen first violins and fourteen second violins, while many others do not use a standard number of instruments. Cinematic Studio Series Strings uses ten first violins and seven second violins, Cinematic Studio Strings 2.0 uses twelve first violins and eight second violins, Spitfire Chamber Strings has four firsts and three seconds, and Orchestral Tool's Berlin Strings uses eight firsts and six seconds. Alternatively, sample libraries such as 8Dio's Magestica and Audio Bros' LA Scoring Strings use the same number of first and second strings (twenty of each for Magestica and sixteen of each for LA Scoring Strings). These samples rely on mic placement and panning to differentiate between first and second violins, although samples that have an unequal split between violin I and violin II should also have these elements to emulate an ideal sound.

As shown in **Figure 1.3**, the first violins are the farthest instruments in the orchestra to stage right with the second violins right next to them. Because of this, the

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[32] Russ Hepworth-Sawyer et al., *Innovation in Music: Performance, Production, Technology, and Business* (New York, NY: Routledge, 2019), 227.

second strings do not sound as loud, or as close, to the listener. Sample libraries help composers achieve this an ideal orchestral sound by changing the mic positions when recording. Generally, the first violins are recorded with the mics closer to the performers, as the listener would hear them more clearly, while the second violins will have more room mics located further away. Having slightly more reverb on second violins creates a more realistic effect, as will be explored in Chapter 3, as listeners hear more ambient noise from second violins than their first counterparts due to their greater distance from the listener. Finally, panning the first violins slightly further left than the seconds is common in creating digital mockups due to their different seating locations in a live orchestra.

Strings as Orchestral Instruments

The string section has the largest number of musicians in an orchestra. As shown in **Figure 1.3**, they consist of the closest instruments to the conductor and the listener, the leftmost, rightmost, and centermost players. Because of this, if the strings do not sound accurate in a digital mockup, it is difficult for the mockup to create the ideal sound. Composers should prioritize the strings before focusing on the other instruments as they are the bulk of the orchestra.

Composers generally discuss the panning in two different ways. The first way composers describe panning is with a percentage value between 0 and 100 and a direction. For instance, if a composer states that something is panned L75, then the

instrument is panned 75% to the left; a 0 pan would indicate a central pan with no panning in either direction. The other common way composers discuss panning is with a value between -64 and 64 with -64 being fully panned left, 64 being fully panned right, and 0 being centered.

Being the outermost sections on the stage, panning the strings correctly is one of the first steps to creating an ideal sound. Some libraries, such as CineSample's CineStrings when performed through Musio, pre-pan instruments so composers are not required to do so, although composers may prefer to adjust the default settings. While the amount of panning can vary based on the tastes of the composer and the limitations of the sample library, there is a common range of panning for each instrument. String basses and celli follow the same pan levels respectively; however, these are panned to the right. Many digital composers decide not to pan violas due to their location at the center of the orchestra, although some may opt to pan the instruments slightly, between 4L and 4R, to either the left or the right if one side of the stereo mix is not as full as the other side. Many composers decide to pan the double basses and celli separately, with the double basses panned more than the celli, despite them sitting at the same degree to the right of the podium because it allows for an even spread between the left and right sides of the mix**.** It is extremely helpful in creating an ideal sound for composers to have an even spread across the mix because it creates a more balanced stereo image. For instance, if violins I and II are panned 30 and 15 to the left, then the basses and celli should be panned 30 and 15 to the right to balance the stereo spread.

Reverb can enhance the sonic uniformity and realism of a mockup. As described in Chapter 1, digital instruments work cohesively as a unit when they sound as if they were performed and recorded in the same venue. Because of the wide range of reverbs, samples, and pre-mixed reverb settings in sample libraries, it is difficult to define specific mix levels for reverb. However, there are some consistent characteristics for composers to pay attention to when adding reverb to sampled instruments. Given a string section's proximity to the listener as the forwardmost instruments in the orchestra, listeners hear a dryer sound less impacted by the room than the brass, winds, and percussion. As such, these instruments should have the least amount of reverb.

An important and specific technique for strings in orchestral writing is the use of divisi within a section. When writing music for acoustic performances, divisi sections split the section in half, making each note sound quieter. Unfortunately, this does not translate to digital mockups as the sound doesn't split (although some sample libraries have created a separate divisi feature), so each note sounds twice as loud as it would in an orchestral setting. To counteract this, some libraries, such as 8dio's Adagio Violins 2.0, include an instrument library that has about half the number of instruments as their full-sized patches, from eleven to six in the case of Adagio Violins, while others, including Spitfire's Albion NEO, have a specific divisi patch. Many sample libraries, however, do not have these helpful resources, leaving composers to pay attention to the volume of divisi sections and lower the volume of each note to showcase the acoustic difference between the divisi and tutti sections.

Considerations for Brass

The brass section creates unique colors through its versatile dynamics, timbres, and techniques, and can add dynamic power and timbral variation to the orchestra. Libraries approach these characteristics differently, and understanding specific considerations for individual brass instruments and how to write cohesively for the brass helps composers create an ideal sounding mockup.

Writing with Mutes

One of the biggest textural characteristics of brass instruments is the difference between an open and muted sound. Some instruments, such as trumpet and trombone, have numerous mutes that change their sound. Because many unique items can fit into, or around, the bell of an instrument, there is a vast array of mutes at a performer's disposal.[33] Due to this versatility, many sample libraries have unique approaches to mutes. Some libraries, such as Aaron Venture's Infinite Brass, have multiple mutes. Other libraries, such as Cinematic Studio Brass, are restricted to a single straight mute while some companies, such as Orchestral Tools, prefer to create a separate library for muted sounds. Because of their effects on volume, many libraries automatically lower the volume of muted samples. If samples do not lower the volume automatically, composers

[33] Clifford Bevan and Alyn Shipton, "Mute," *Oxford Music Online*, 2003, https://doi.org/10.1093/gmo/9781561592630.article.j320300.

need to lower the volume to emulate the effect. Alternatively, companies such as Libre Wave have created plugins like Sordina that affect the frequencies and sound of samples to emulate the effects of a plethora of mutes. While these plugins require more work for the composer, many prefer them because they can affect the sound on almost any library and can create the muted sound of most mutes.

Table 2.3: Available Mute Options in Common Libraries

	Straight	Cup	Bucket	Harmon	Harmon (Half-Stem)	Harmon (Stem Out)	Plunger	Stopped Horn
Infinite Brass	X	X	X			X		
Orchestral Tools Muted Brass	X			X	X			X
Cinematic Studio Brass	X							
Acoustic Samples VHorns	X	X	X				X	
EW Hollywood Industry Brass	X			X				X

When writing digital mockups that use mutes, composers should pay attention to three important factors in achieving an ideal sound: volume, range, and physical movement. Because mutes affect the sound in numerous ways, it is physically harder for performers to play in the upper and lower registers of the instrument's range and

dynamics.[34] To further emulate an ideal sound in mockups, composers should strive to write parts that range from *p* to *f* and should not write extremely long muted sections, as many live performers can not play through a mute for extended periods easily.[35] Furthermore, because of the physical limitations created by muting an instrument, the range of an instrument is condensed. Generally, trumpets can play from B*b*3–B*b*5 comfortably, depending on the mute, while trombones can play from B*b*2–B*b*4.[36] Although some samples extend outside of this range, keeping most of the muted sections within this range emulates a realistic performance from a live musician. Finally, although sample libraries allow samples to switch instantaneously between muted and unmuted sounds, it is important in creating an ideal sounding mockup that composers think about the time it would take for a live performer to switch between unmuted and muted sections. These one to four measures of rest, depending on the tempo, allow performers the time to insert or remove a mute from their instrument and get set up to play. To emulate the ideal sound in a digital mockup, composers should consider this time a necessary component of using mutes.

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[34] William Russo, *Jazz Composition and Orchestration* (Chicago, IL: University of Chicago Press, 1998).

[35] Elliot Deutsch, "How to Arrange for Trumpet Mutes, Pt. 1 - Big Band Arranging Secrets Revealed," August 20, 2021, YouTube video, 13:51, https://www.youtube.com/watch?v=c4whKtdOTnE.

[36] Dick Lowell, Ken Pullig, and Michael J. Gold, *Arranging for Large Jazz Ensemble* (Boston, MA: Berklee Press, 2016), 120-121.

Sound Considerations for Brass

One of the greatest assets of brass instruments is their timbral versatility, ranging from warm, dark, and mellow to brassy, bright, and piercing timbres. In acoustic performances, composers create different timbres by changing the dynamics; as the ensemble plays louder, they transition to a brassier sound. Composers emulate this through expression (CC11). As a composer increases the expression, the timbre changes. Using expression to change the timbre in conjunction with modulation, velocity, and volume changes helps create an ideal orchestral sound in digital mockups.

Sections and Solo

As with string libraries, brass libraries come in two variations: section and solo. Unlike strings, the variation between section libraries is greater and many composers use solo, section, or a combination of both libraries in their digital mockups. Section patches range from two to three for trombone and trumpet libraries while horn libraries can be two, four, six, or even twelve horns. Generally, most libraries only have solo tuba samples because having a single tuba in an orchestra is common, although two to three is not a rarity.

Some composers prefer using solo instruments for brass because it is easier to balance the instruments among themselves since each instrument has its own automation and velocity amounts. Furthermore, composers have more control over instrument

doubling. If they wanted to have two horns doubling a specific note, it is easier to create when using four separate solo horn libraries as opposed to one sample with four horns.

Conversely, most composers prefer to use section patches. While it is slightly more difficult to get a proper balance within the section, it is easier to blend. Because section patches are recorded with multiple musicians, the natural blend, harmonics, and sympathetic resonances are recorded and emulated in the library. [37] Composers can circumvent these issues within their mockups by splitting their ensemble patches. For instance, if a composer wants to double a specific note, they can compose the section in two separate two-horn libraries as opposed to a single four-horn library. This allows the blend that comes from playing with a section as well as the ability to split the parts out to balance more easily.

When striving for the ideal sound in digital mockups, using a mix of the two library types allows for an improved-sounding mockup. Reserving solo libraries for virtuosic materials helps composers further exemplify these moments because of the sound differences. In contrast, while using section libraries for the remainder allows composers to hear a more realistic and clearer blend and overtone production and still maintain a balanced mockup using smaller section libraries.[38] Finally, if a single line is

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[37] Sven-Amin Lembke et al., "Acoustical Correlates of Perceptual Blend in Timbre Dyads and Triads," *Musicae Scientiae* 23, no. 2 (October 31, 2017): 250–274, https://doi.org/10.1177/1029864917731806.

[38] Lance Trevino, personal interview, February 21, 2024.

written in a section patch, it will emulate the note being played by the number of instruments in the library, such as four horns. If a composer prefers one instrument to play the line, using a solo library will emulate a single instrument better than a section patch.

Table 2.4: Common Brass Articulations and Libraries

	Sustain	Legato	Staccato	Staccatissimo	Marcato	Trills	Flutter
BBC Symphony Orchestra		X		X			
Berlin Brass	X	X	X	X	X	X	
Spitfire Symphony Orchestra	X	X	X	X	X	X	X
Albion Colossus	X	X	X	X	X		
Talos Audio Imperia	X	X	X	X	X		
EW Hollywood Opus	X						
Century Brass	X	X		X		X	X
Cinematic Studio Brass	X	X	X	X	X	X	X

Table 2.5 Uncommon Brass Techniques

	Swells	Runs	(De)Crescendo	Fortepiano	Horn Bells Up	Zampano Trumpet	Stopped (Horn)	Rips	Cuivre	Pitch Bend
Berlin Brass	X	X	X	X	X	X				
Talos Audio Imperia	X		X					X		X
Albion Colossus			X							
Century Brass			X							
Spitfire Symphony Orchestra					X		X	X	X	
Cinematic Studio Brass								X		

Woodwind Considerations

The woodwind family provides countless textures, sounds, and timbres within an orchestral section.[39] The woodwinds provide charismatic solo and soli material in orchestral music. Understanding how to effectively write for woodwinds can elevate the digital mockup performance.

The most crucial aspect when writing for woodwinds is their dynamic relation to the entire orchestra. Although the woodwinds can overtake a string section, as shown in Tchaikovsky *Suite No. 1 in D Minor*, Op. 43 Mvt. IV Marche Miniature or "Mercury, The Winged Messenger" from Gustav Holst's *The Planets*, especially when the other families are muted, as is the case in Ravel's "Ma mère l'Oye," they can struggle to outplay the brass section dynamically. When the orchestra is playing at a low volume or the orchestration is thinned, the woodwind section can still be heard, as is the case in John William's "Princess Leia's Theme;" however, when playing at the upper dynamics, the brass and strings can easily overtake the woodwinds.[40]

The most realistic way a composer can emulate this disparity in dynamic range from woodwinds is by following standard orchestration techniques to allow listeners to

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[39] Henry Mancini, *Sounds and Scores* (Greenwich: Northridge Music Inc., 1986), 93.

[40] Andrea Pejrolo and Rich DeRosa, *Acoustic and MIDI Orchestration for the Contemporary Composer* (Amsterdam: Focal, 2007), 192.

hear the woodwind family. Composers can bring out woodwind lines by thinning out the accompanying orchestration to very soft brass or limiting the use of strings during a woodwind solo or soli. This allows the woodwinds to come through the texture naturally. One example of this is Colin Stetson's track "All Aboard" from the film *The Menu*. In the track, when the flute duet is introduced, Stetson lowers the ensemble to high-string sustains and pizzicato low strings. This allows the flute duet to overtake the ensemble as the primary voice to listeners.[41] Similarly, in Laura Karpman's piece "What If... The Avengers Assembled in 1602" from Marvel's *What If* begins with no brass, allowing the woodwind melodies to be heard.[42] While some composers opt to use volume to raise the decibels of the woodwinds, or lower the decibels of other instruments, to allow the woodwinds to sit above a full orchestral sound dynamically, this does not emulate an ideal sound as closely as woodwinds would naturally blend into full orchestral textures.

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[41] Colin Stetson, "Colin Stetson - All Aboard | the Menu (Original Motion Picture Soundtrack)," October 19, 2022, YouTube video, 4:25, https://www.youtube.com/watch?v=6yKCFjoYUbE.

[42] Karpman, Laura Anne, and Nora Kroll-Rosenbaum. *Soundtrack of What If... the Avengers Assembled in 1602?* (Marvel Music Incorporated, 2024).

Table 2.6: Common Woodwind Techniques and Libraries

	Sustain	Legato	Staccato	Staccatissimo	Marcato	Trills	Flutter
Berlin Woodwinds	X	X	X		X	X	
Spitfire Symphony Orchestra	X		X	X	X	X	X
Cinematic Studio Winds	X	X	X	X	X	X	X
BBC Symphony Orchestra		X		X			
Berlin Woodwinds SFX							X

Table 2.7: Uncommon Woodwind Articulations in Sample Libraries

	Clusters	Runs	Bends	Wind Through Instrument	Tongue Slaps	Multiphonics	Overblow	Harmonics	Key Noise
8Dio Symphonic Shadows	X								
Native Instruments Symphony Series Woodwinds	X	X	X						X
CineSamples Hollywoodwinds	X		X						
Berlin Woodwinds		X							
Berlin Woodwinds SFX		X	X	X	X	X			
Spitfire Studio Woodwinds Professional		X		X					X
Spitfire Symphony Orchestra							X	X	

CHAPTER 3 – PRE-COMPOSITION SETUP

Composers must ensure that their DAW, instruments, and effects are properly set up to achieve an ideal sounding mockup. Setting up the DAW and tracks before any MIDI is input into the mockup will provide a smooth, efficient setup from which composers can work. Composers create templates so they do not have to spend time recreating these parameters at the start of each composition. Creating a template helps composers begin work faster, be more creative, and have a central starting point for each new mockup.[43] Setting up the DAW (splitting articulations, routing the tracks, and balancing track volumes) and setting up virtual instruments (determining how to switch between articulations, panning, setting pre-delay levels, and adding FX) before a composer begins writing their mockup helps them save time, diagnose problems earlier, and analyze minor corrections throughout the mockup more easily.

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[43] Virtual Orchestration, "Basic Template Creation - Save Valuable Time ⏳ - Feat. Max Blomgren," February 6, 2023, YouTube video, 5:53, https://www.youtube.com/watch?v=emNM51pC2eA.

Setting up the DAW

To set up a DAW for orchestral mockups, composers must load all the instruments they will need into tracks. Some composers, such as Anne Katherin-Dern and John Powell, prefer to have tracks divided by articulations, which creates multiple tracks of the same instrument to capture all articulations. Other composers, such as Lance Trevino and Zach Heyde, prefer to combine some articulations, breaking up the tracks into long articulations (sustains, legatos, marcatos), short articulations (staccato, pizzicato, spiccato, staccatissimo), and FXs (harmonics, bends, rips, clusters.) Templates can range from tens to hundreds of tracks in one mockup. To aid in clarity within the vast number of tracks, composers prefer to group tracks into folders. These folders generally consist of instruments and families. For example, all the horn tracks may be placed into a folder for horns, which is then placed inside a folder for all brass instruments, as shown in **Figure 3.3**.

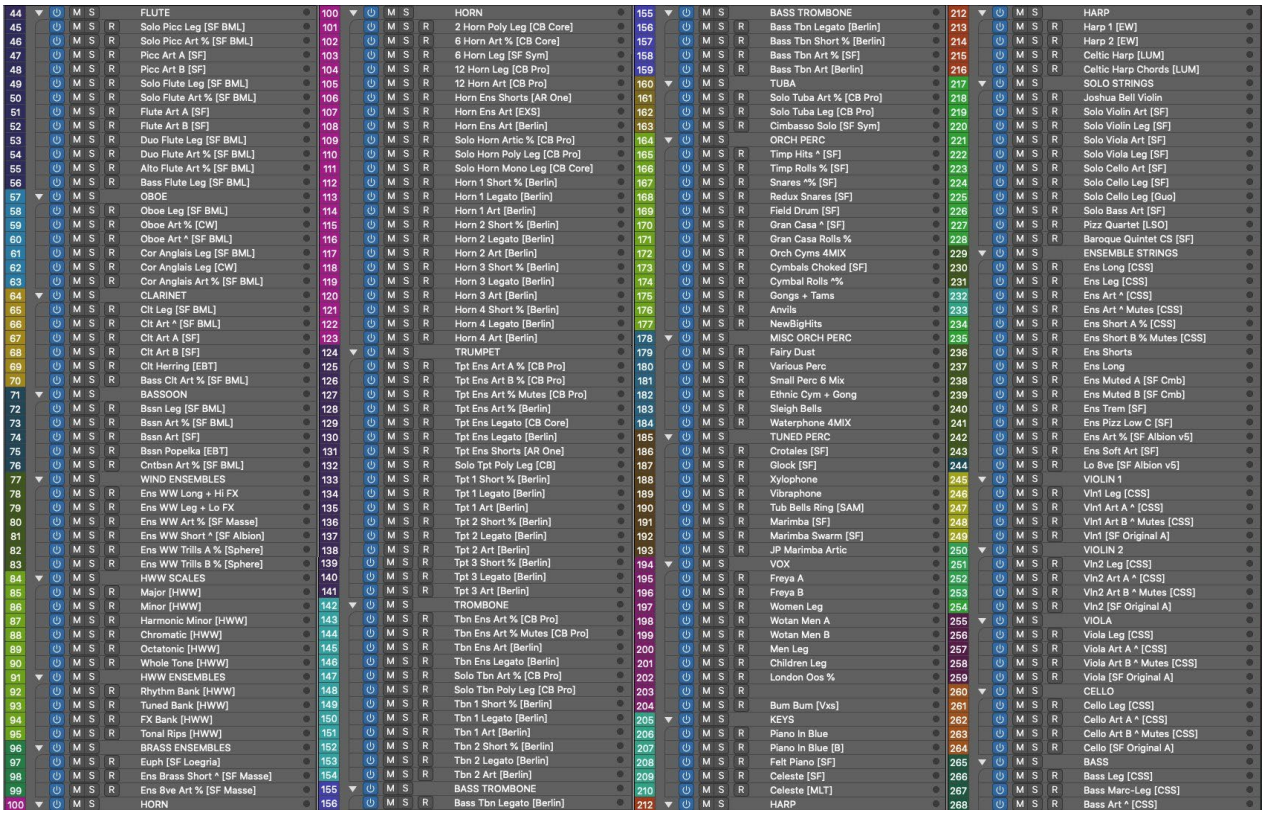

Figure 3.1: Composer John Powell's Orchestral Template[44]

[44] John Powell, "Here's a look at my current orchestral template! Thanks to Spitfire Audio, Cinesamples, Orchestral Tools, Strezov Sampling, #cinematicstudiostrings and more," Facebook, April 8, 2021. https://www.facebook.com/johnpowellmusic/photos/a.1690234244533204/2843904155832868/?type=3.

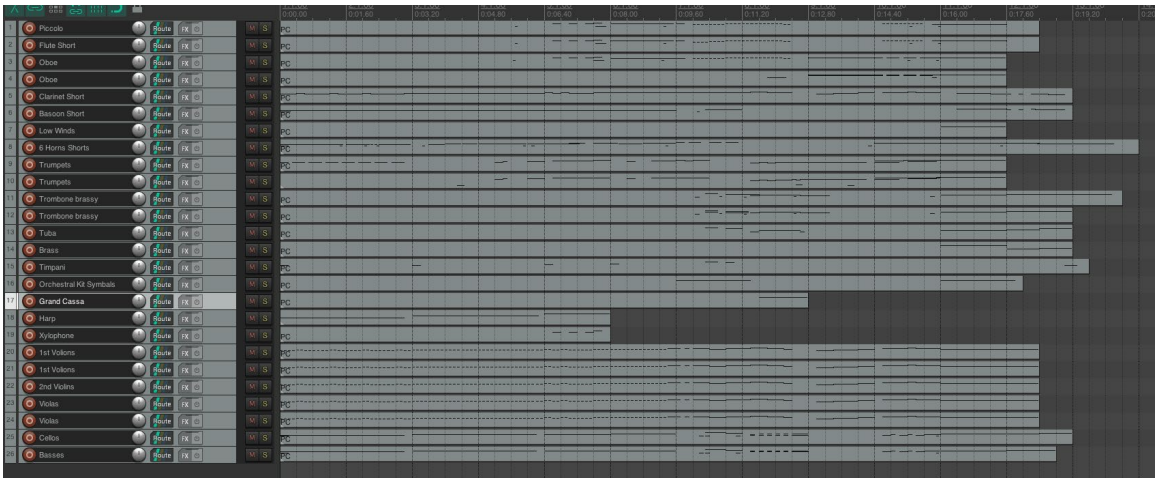

Figure 3.2: Simple Orchestral Template[45]

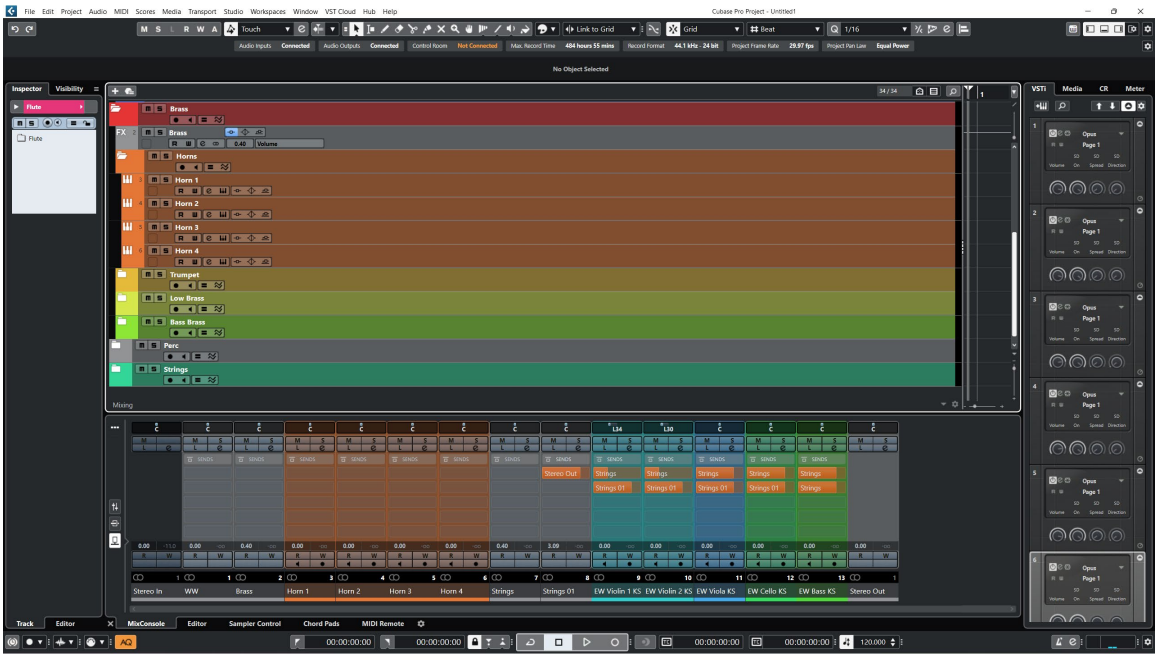

Figure 3.3: Horn Tracks within a Horn Folder within a Brass Folder

The next step in preparing the DAW is to set up the routing signals. Routing, as previously described in Chapter 1, is the pathway a sampled sound takes before reaching the final stereo output for playback or export as a stem—an exported audio file of a single track or a group of tracks. While all tracks will reach the final "Audio Out", routing determines a track's pathway to reach the final mix. While some composers may not have to send broken-down stems to other people, such as audio engineers for mixing or a dubbing stage, having a well-routed DAW will allow composers to hear instruments and FX clearer. When building a routing setup, many composers begin with specific routes and become broader with each new level of stems. The stem routing is broken down into five levels. Level one, the most specific level, would be each track separated into its own stem; each track automatically creates this. Level two consists of combining the soprano and alto instruments in each family together based on articulations and the tenor and bass instruments in a separate stem, for instance, strings high longs, strings low longs, and strings high shorts. Level three combines the articulations based on instrument family and range, i.e. brass highs and brass lows. Many composers, especially those in media scoring, choose to reserve reverb until this level because media composers will often

[45] Wojciech Usarzewicz, "Mojo Madness by Thomas Bergersen—Mockup and MIDI (and Tips for Orchestral Mockups from Score)," Orchestral Music School, published January 29, 2020, https://orchestralmusicschool.com/mojo-madness-by-thomas-bergersen-mockup-and-midi-and-tips-for-orchestral-mockups-from-score/562.

have to send a "dry mix," or a mix with no reverb, to audio engineers.[46] The fourth level combines instruments into their respective families — strings, brass, woodwinds, and percussion — with the final level being the "Audio Out" which is colloquially known as a full mix or stereo out.

The next step in creating an ideal-sounding mockup is to balance the volume of the libraries to an even level. Because libraries are recorded in different studios, with different mics and mic positions, and with differently sized instruments (if they are not modeled libraries), each has a different volume, which can lead to an unbalanced orchestra.[47] To fix this, composers must balance the tracks to an equal volume. Using the DAWs track volume for this purpose allows CC7 to remain open for use within the mockup. Selecting a track that represents a good baseline volume that the composer likes, they must go through and raise or lower each track volume to a level that is equal to the reference track; more experienced composers gain the ability to do this by ear.[48] This, combined with EQ, allows samples from different libraries to blend into the same sound

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[46] Anne-Kathrin Elisabeth Dern, "Template Pt 3: Mix Setup," February 7, 2021, YouTube video, 20:40, https://www.youtube.com/watch?v=5-oGP8DbON4.

[47]Anne-Kathrin Elisabeth Dern, "Template Pt 2: Daw Setup," January 26, 2021, YouTube video, 18:00, https://www.youtube.com/watch?v=AznRiT9o1pM.

[48] Zach Heyde, "How to Make an Orchestral Template for Logic Pro X in One Hour," January 10, 2022, YouTube video, 47:41, https://www.youtube.com/watch?v=_2oT2U1kwDs.

world. Composers can also use the stem levels to check the volume of each track when played together.

Setting up the Instruments

Once the DAW has been set up, composers begin to change the parameters of their virtual instruments. Each track in the DAW has a few options that composers can manipulate to create a mockup that sounds closer to an ideal sound including mic positions, outlined in Chapter 1, switching between articulations, panning, pre-delay, and FX.

Composers must select how to switch between articulations. As stated previously, libraries can be loaded with all articulations on one track, broken down with one articulation per track, or between the two extremes. Once a composer decides on how to structure their tracks they must decide how to transition between the articulations if there is more than one articulation within a track. One common way to switch between articulations is key switching. Key switching allows composers to switch articulations by activating certain keys via MIDI input. Key switches are generally one to two octaves above or below the performance range of an instrument, and attach each articulation to a specific note. Whenever that note is pressed, the track switches articulations to the articulation connected to that specified key. This allows composers to perform and record MIDI with multiple articulations in a single recording. Expression maps, also known as articulation maps depending on the DAW, are another common way that composers

switch between articulations. These maps free composers from needing to press a key to activate new articulations. A composer maps the articulation within their DAW by creating a title for each articulation and the corresponding key that they would normally press to activate that articulation via key switches. After setting up the map, composers can select the articulation they desire within the DAW negating the need to press the correct key switch live during the performance of MIDI data.[49] This is especially helpful for lines that require multiple articulations in quick succession, as the composers would have to press multiple key switches while performing simultaneously. Finally, another common way to switch between articulations is by using UACC. UACC, the Universal Articulation Control Channel was created by Spitfire to allow composers to change articulations via CC value.[50] To use UACC, composers must select a CC, generally one that is undefined such as those between 20 and 63. Once a CC is selected, each note is assigned a numerical value between 1 and 127 within the CC. To switch between articulations, composers only need to select the CC value connected with the articulation. Although UACC was created for use in Spitfire libraries, it is possible to create UACC values for every sample player. Many composers prefer UACC over expression maps and

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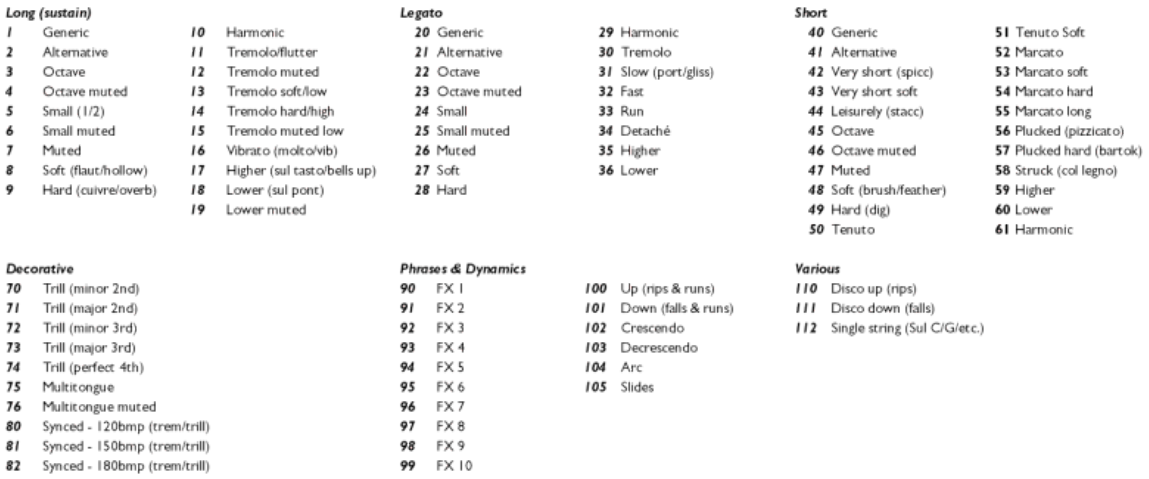
[49]Steinberg.help, "Expression Maps (Cubase Pro Only)," accessed March 8, 2024, https://steinberg.help/cubase_pro_artist/v9.5/en/cubase_nuendo/topics/expression_maps/expression_maps_c.html.

[50] Spitfire Audio, "What Is UACC and How Do I Use It?" Support Centre, published September 26, 2020, https://spitfireaudio.zendesk.com/hc/en-us/articles/115002450966-What-is-UACC-and-how-do-I-use-it.

key switching because they can set up a standard map for every instrument, library, and articulation at their disposal. For instance, legato can always be CC37 value 1 regardless of the instrument being a flute, violin, horn, or percussion whether the library is from 8Dio, Spitfire, Native Instruments, Performance Samples, or another library.



Long (sustain)

1	Generic	10	Harmonic
2	Alternative	11	Tremolo/flutter
3	Octave	12	Tremolo muted
4	Octave muted	13	Tremolo soft/low
5	Small (1/2)	14	Tremolo hard/high
6	Small muted	15	Tremolo muted low
7	Muted	16	Vibrato (molto/vib)
8	Soft (flaut/hollow)	17	Higher (sul tasto/bells up)
9	Hard (cuivre/overb)	18	Lower (sul pont)
		19	Lower muted

Legato

20	Generic	29	Harmonic
21	Alternative	30	Tremolo
22	Octave	31	Slow (port/gliss)
23	Octave muted	32	Fast
24	Small	33	Run
25	Small muted	34	Detaché
26	Muted	35	Higher
27	Soft	36	Lower
28	Hard		

Short

40	Generic	51	Tenuto Soft
41	Alternative	52	Marcato
42	Very short (spicc)	53	Marcato soft
43	Very short soft	54	Marcato hard
44	Leisurely (stacc)	55	Marcato long
45	Octave	56	Plucked (pizzicato)
46	Octave muted	57	Plucked hard (bartok)
47	Muted	58	Struck (col legno)
48	Soft (brush/feather)	59	Higher
49	Hard (dig)	60	Lower
50	Tenuto	61	Harmonic

Decorative

70	Trill (minor 2nd)
71	Trill (major 2nd)
72	Trill (minor 3rd)
73	Trill (major 3rd)
74	Trill (perfect 4th)
75	Multitongue
76	Multitongue muted
80	Synced - 120bmp (trem/trill)
81	Synced - 150bmp (trem/trill)
82	Synced - 180bmp (trem/trill)

Phrases & Dynamics

90	FX 1	100	Up (rips & runs)
91	FX 2	101	Down (falls & runs)
92	FX 3	102	Crescendo
93	FX 4	103	Decrescendo
94	FX 5	104	Arc
95	FX 6	105	Slides
96	FX 7		
97	FX 8		
98	FX 9		
99	FX 10		

Various

110	Disco up (rips)
111	Disco down (falls)
112	Single string (Sul C/G/etc.)

Figure 3.4: UACC Values for Spitfire Libraries.

The next stage is to set up instrument panning. Generally, when libraries are created and loaded by the composer, the pan is set to center, also known as 0. Some libraries, such as CineBrass, CineWinds, and CineStrings pre-pan instruments when played through Musio; however, these may not be panned at a composer's preferred level. Panning not only creates a realistic sound, but many film and media composers pan instruments to leave the center of the mix open for audio. While the degree of panning may differ depending on the composer, size of the ensemble, and library, there are a few general characteristics to keep in mind. One important concept is the structure of the

standard orchestra. Because composers aim to create an ideal orchestral mockup sound, their instruments must be on the correct side. While the actual pan level is subjective (for instance, some prefer to pan the horns 25%[51] while others pan them 5%[52]), composers should still aim for equality across the mockup. If violins I are panned a certain percentage to the right, then the basses should be panned about the same percentage to the left. When adding up the pan levels between left and right, the sum of the levels should be as close to 0 as possible.

As outlined in Chapter 1, many composers aim to determine each instrument's negative delay, or pre-delay. While some composers, especially those that put long and short articulations on the same track, prefer not to use pre-delay, many composers favor them as it can make the workflow smoother, and composing easier. The pre-delay amounts vary from library to library; however, the values can usually be found in each library's manual. For instance, Cinematic Studio Strings has a delay of 60ms for their staccato articulations.[53] If the library does not explain the delay amounts, composers can

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[51] Emerson Maningo, "Symphony Orchestra Panning and Reverb Settings," Audio Recording.me, published July 9, 2011, https://www.audiorecording.me/symphony-orchestra-panning-and-reverb-settings.html.

[52] Wojciech Usarzewicz, "How to Mix Orchestral Music for Beginners – Part 1," Orchestral Music School, published August 26, 2019, https://orchestralmusicschool.com/how-to-mix-orchestral-music-for-beginners-part-1/437.

[53] Cinematic Studio Series, *Cinematic Studio Strings: User Manual* (version 1.7), n.d.

experiment with their own tracks. The easiest way to achieve this is by recording a note onto a track. By playing the note back, composers can slowly adjust the pre-delay to determine the needed amount. When the note starts sounding at the exact moment the beat hits, the pre-delay amount has been found. Doing this for every track makes transferring MIDI data between instruments easier and can aid in ensuring audio lines up across tracks.[54] While negative track delays can enhance a workflow, composers opting to use key switching, UACC, or expression maps cannot effectively use pre-delays because the delay time for articulations is different.

The effects are the last step composers should set up before beginning their project. Once a composer decides the FX they will use, they should decide where to place them, either as an insert or a send FX. Insert FX are placed directly onto a track. These FX, generally compression and EQ, affect the entire track. Furthermore, inserts can only affect the track on which they are placed. Send FX are FX that some, or all, of the track is sent through before reaching the final output. These FX are placed on their own track so

[54] Dern, "Template Pt 2: Daw Setup."

multiple tracks can pass through them. These work better for RAM-heavy FX and FX that are used similarly throughout the mockup such as reverb.[55]

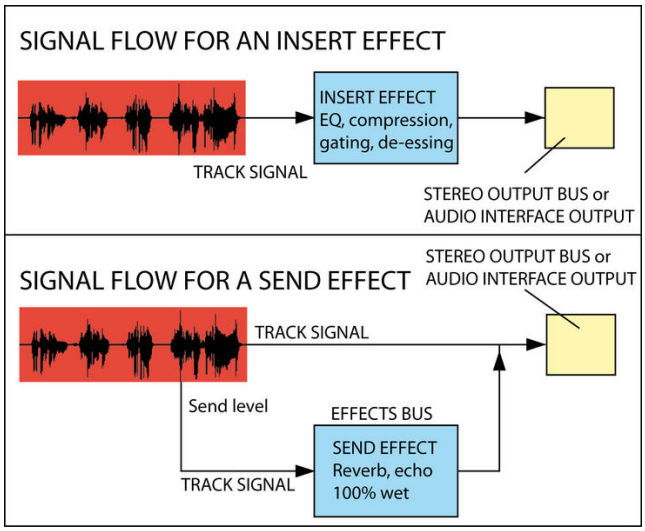

Figure 3.5: Insert vs Send FX Pathways[56]

Rather than changing the FX for each track, each track can only change the mix level—the amount of the track sound sent to the FX. For instance, if the horns had a reverb send mix level of 50% then 50% of the sound would go through the reverb track

[55] Robert Ciesla, *Sound and Music for Games: Basics of Digital Audio for Video Games* (New York: Apress, 2023), 90.

[56] Emerson College, "Inserts & Sends," Emerson Support, accessed March 8, 2024, https://postproduction.emerson.edu/hc/en-us/articles/4904812446611-Inserts-Sends.

before reaching the audio out while the other 50% would go straight to the audio out creating a combination of wet and dry sound within the same track.

Composers can have more than one FX as an insert or a send. The combination of FX is known as an FX chain. FX chains are similar to guitar pedal boards in that the goes through one before going to the next in a sequential link. For instance, **Figure 3.6** shows a potential pedalboard setup for a guitarist. This FX chain has the sound going through the tuner into the volume pedal before reaching the compressor, then through the octave pedal into overdrive, and other pedals until reaching the amp. Similarly, **Figure 3.7** shows the FX chain within a DAW. The Break Hits and Break Fill tracks have the sound go through the overdrive into the chain EQ before finally passing through the space FX.

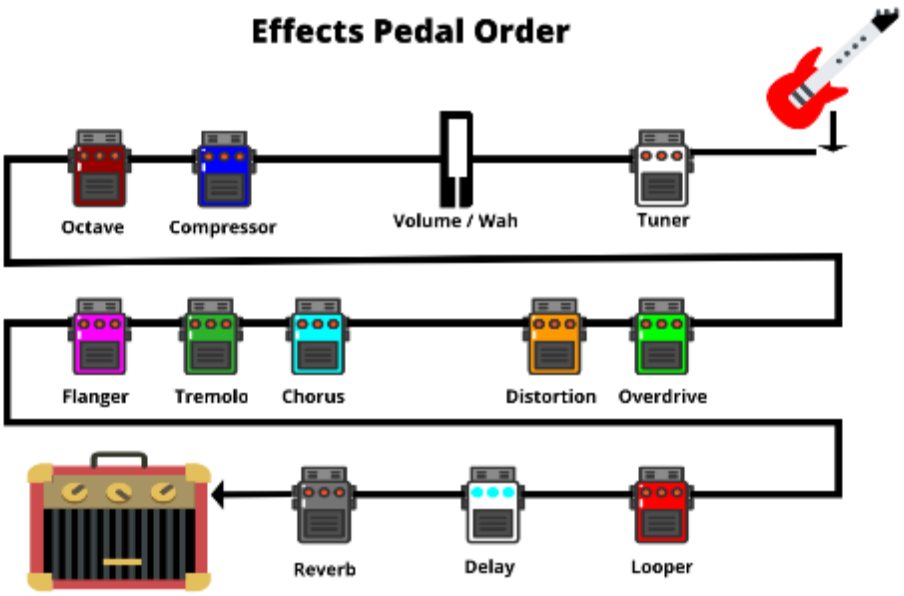

Figure 3.6: The Pathway from Guitar to Amp through a Pedal Board[57]

[57] James Wray, "Pedalboard Signal Chain: A Simple (but Complete) Guide," Guitar Jive, last modified October 10, 2022, https://guitarjive.com/pedalboard-signal-chain/.

Figure 3.7: FX Chain in Logic Pro[58]

FX chains inside DAWs can become very complex. Because composers have control over the amount of sound that goes to each FX within the sends, they can send a track through multiple FX chains, as shown in **Figure 3.8**.

[58] Ric Baker, "Understanding Signal Flow Basics in Logic Pro X," *Splice Blog* (blog), May 23, 2023, https://splice.com/blog/exploring-signal-flow-logic-pro-x/.

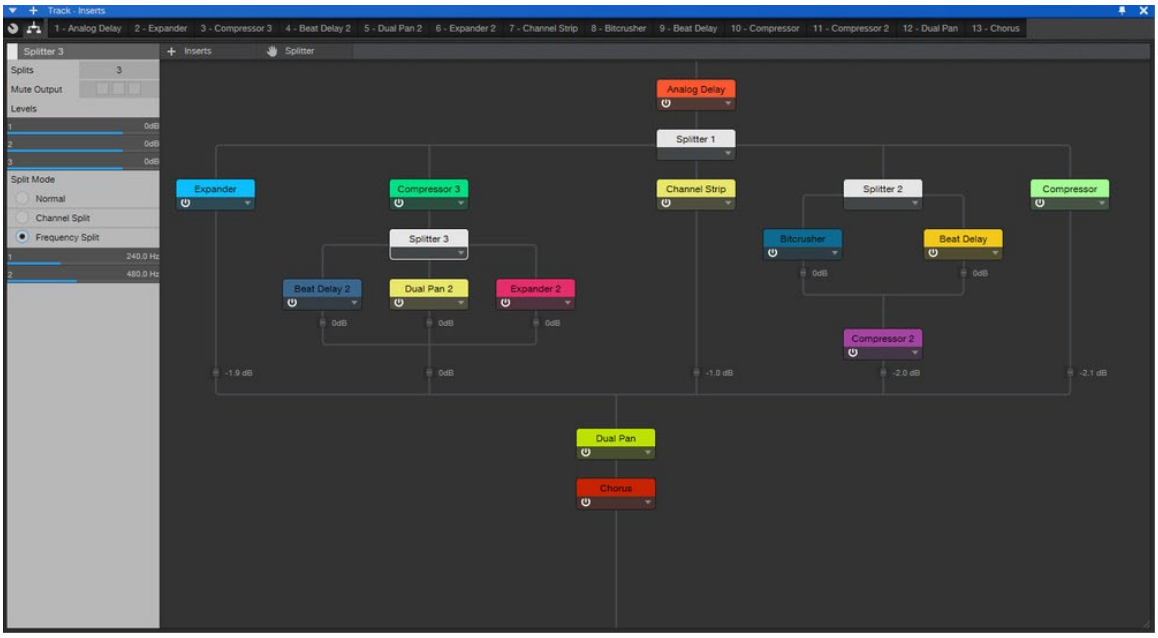

Figure 3.8: Complex FX Chain Sequence in Studio One[59]

One of the most common FX used in digital mockups is equalization (EQ) which allows composers to raise and lower specific frequencies to remove unnecessary digital sounds such as static and create a unified sound between different libraries. The two main EQ methods are called additive EQ and subtractive EQ. Additive EQ is the process of raising the desired frequencies. This makes them louder and more easily heard but does not cut out the unwanted frequencies. Subtractive EQ allows composers to remove unwanted frequencies. Effective EQ combines both additive and subtractive EQ because

[59] Robin Vincent, "Studio One: FX Chains," Sound on Sound, last modified September, 2024, https://www.soundonsound.com/techniques/studio-one-fx-chains.

subtractive EQ prevents quicker listening fatigue while also preventing the track from clipping by going over the max global volume,[60] and additive EQ because it enhances the desired frequencies within a mockup.[61]

Another common effect is reverb. To enhance the depth created by reverb, many composers prefer to use a mix of both convolution and algorithmic reverb. Convolution reverbs can create a unified sound within a mix, giving the impression that all instruments were recorded in the same hall, while algorithmic reverbs can provide extra color and texture within a mockup.[62] Likewise, the further back an instrument is on stage the more reverb mix level it should have.[63] This closer emulates an ideal sound as listeners hear more ambient sound the further back an instrument is and hear more of the actual instrument sounds the closer to the listener a section is.

While some of these setup ideas may not directly create an ideal sound in a mockup, setting these parameters up before writing any MIDI will make creating

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[60] Earl Vickers, "The Loudness War: Background, Speculation, and Recommendations," Audio Engineering Society, last modified November 4, 2010, https://www.aes.org/e-lib/browse.cfm?elib=15598.

[61] Mixing Lessons, "Subtractive EQ vs. Additive EQ: Cutting Frequencies versus Boosting Them," accessed November 16, 2020, https://www.mixinglessons.com/subtractive-eq-vs-additive-eq/.

[62] Dern, "Template Pt 3: Mix Setup."

[63] Andrea Pejrolo and Rich DeRosa, *Acoustic and MIDI Orchestration for the Contemporary Composer* (Amsterdam: Focal, 2007), 332.

mockups easier, more efficient, and more enjoyable. Furthermore, while many of these things are time-consuming at first, they can be set up once and saved in a template so composers only need to make minor adjustments between each mockup.

CHAPTER 4 – ORCHESTRATING THE MOCKUP

Setting the Tempo

One of the first things composers generally set up within their mockup is the tempo of a piece. As with all music software, if a tempo is not specified, the playback will be at the software's default tempo. DAWs represent tempo changes (either immediate or gradual) on a separate tempo track. These sudden changes will look like steps without any curve or bend, as shown in **Figures 4.1** and **4.2**. To create gradual tempo changes, composers must switch to the correct setting. Labeled "Ramp" in Cubase and "Gradual Tempo Shift" in Reaper, this setting will continuously speed up or slow down between the last point at the old tempo and the first point at the new tempo. If composers want to start a tempo shift at a certain measure, they must place another marker at the initial start point to indicate the start of the change, as shown in **Figures 4.1** and **4.3**. Alternatively, **Figure 4.3** also shows a manually written ritardando, which some composers opt for if they prefer to have more control over the speed of the tempo change.

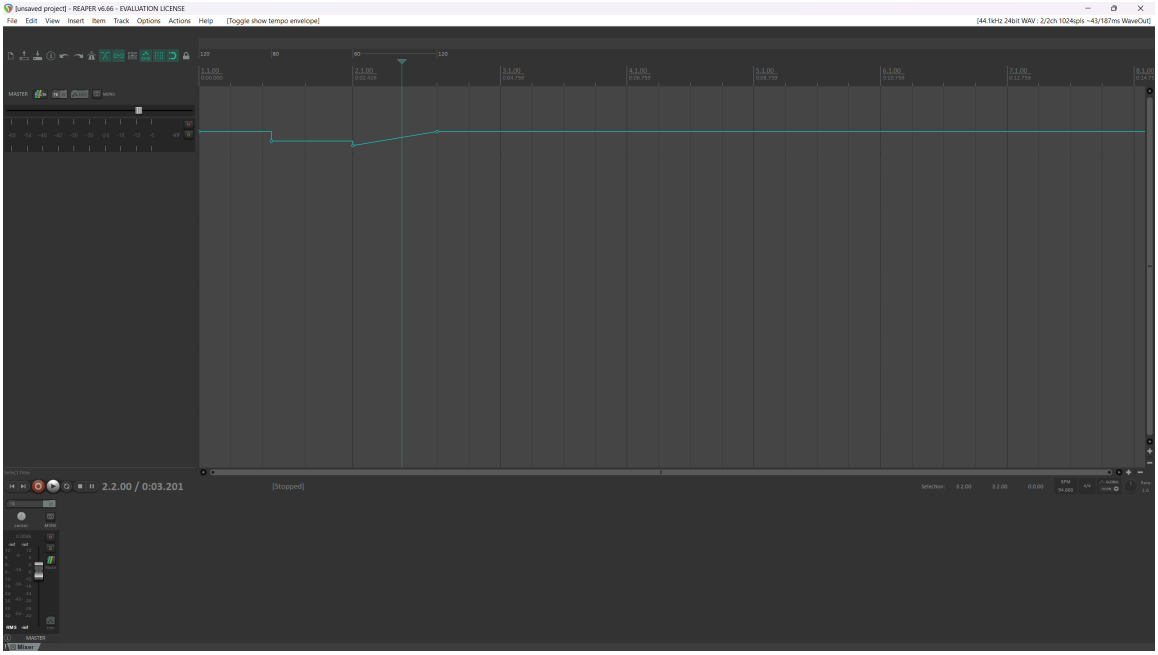

Figure 4.1: Sudden and Gradual Tempo Change in Reaper.

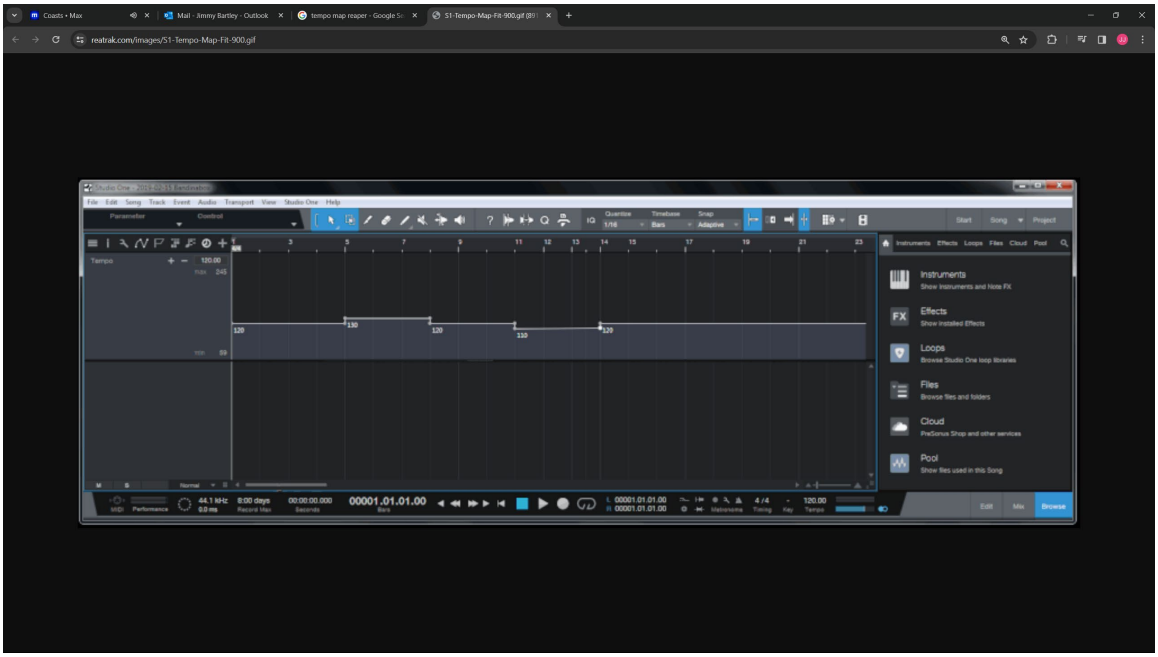

Figure 4.2: Sudden Tempo Changes in Cubase

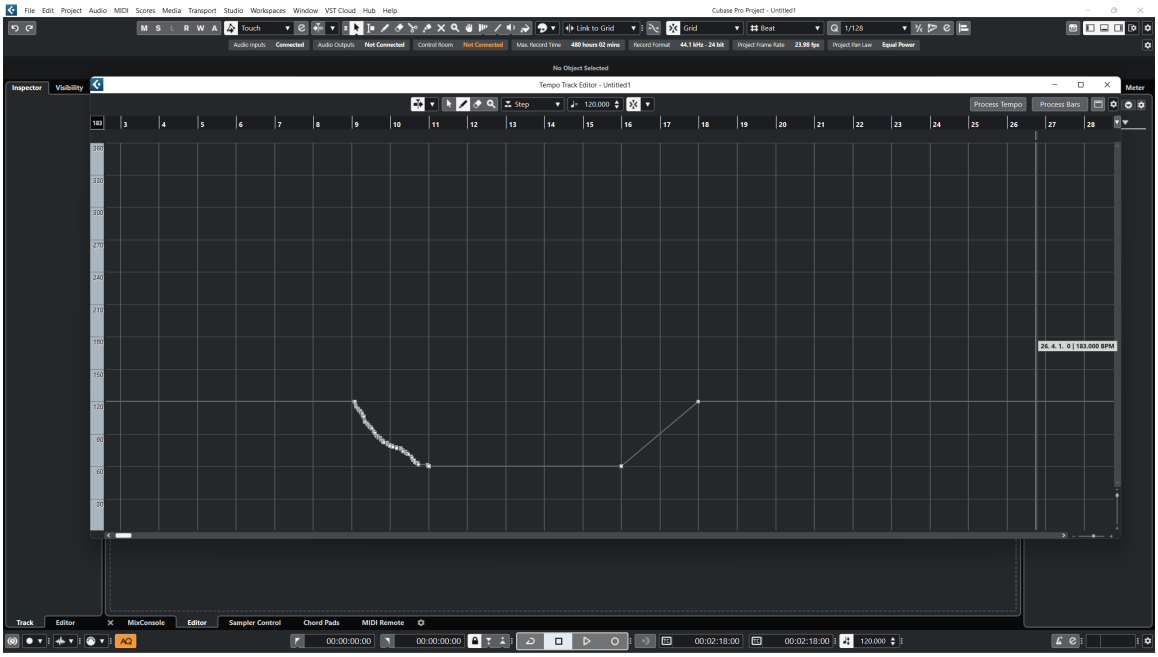

Figure 4.3: Written Ritardando and Ramped Accelerando.

Tempo mapping is vital to creating an ideal sound within a mockup because it allows composers to capture the subtle deviations that occur in live music. Tempo is relative, especially in slow, lyrical pieces. As a piece is performed, the tempo ebbs and flows to further impact the emotions of the music. For instance, John Williams' "Theme

from Schindler's List," has only eight tempo markings in the entire piece as shown in **Figure 4.4**.[64]

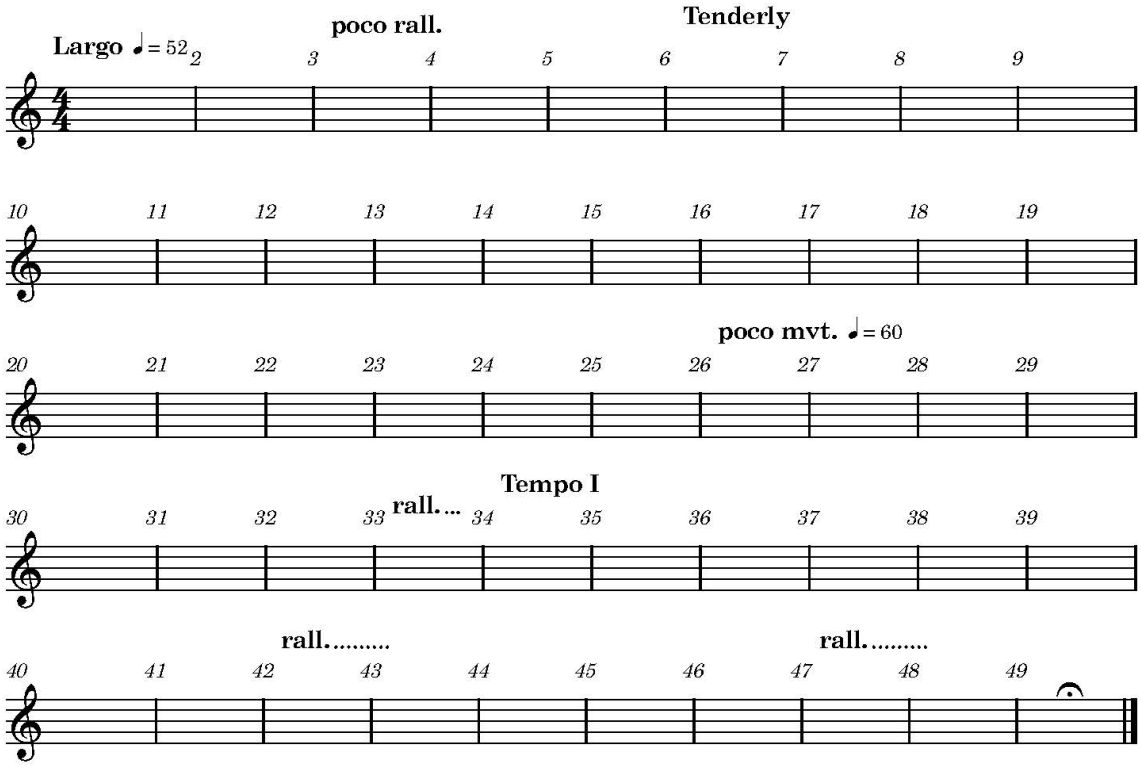

Figure 4.4: Tempo Markings in John Williams' "Theme from Schindler's List"

However, in the LA Philharmonic performance with Itzhak Perlman as the solo violinist, there are closer to 25 tempo changes as the ensemble performs the piece, some with less than 5BPM difference (**Figure 4.5**).[65]

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[64] John Williams, "Theme from Schindler's List [Study Score]," recorded 1993, Sony Pictures Studios, 1994.

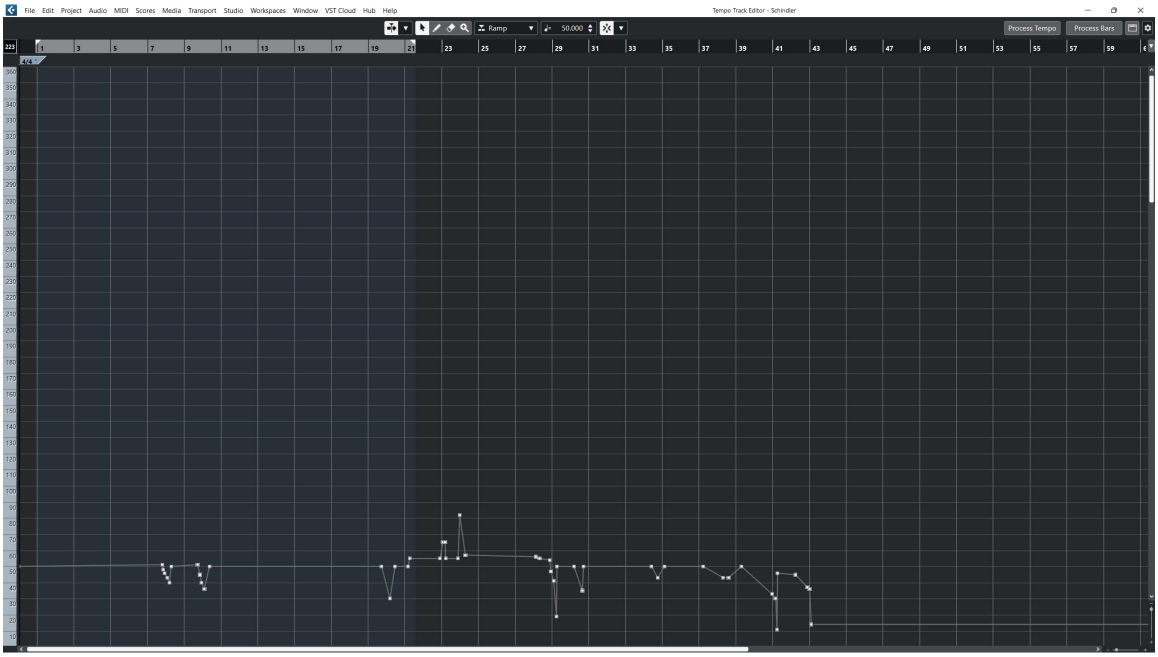

Figure 4.5: Tempo Map Interpretation of LA Phil's Performance of Williams "Theme from Schindler's List"

Because ritardandos and accelerandos are not even throughout the tempo change, the last three beats may slow down much more than the first part of a ritardando or conductors may reach a tempo under the desired tempo for the last few beats of a ritardando before returning to the desired tempo. Learning how to effectively draw these

[65] Williams, "John Williams: Schindler's List Theme - Itzhak Perlman."

tempo changes enhances the sound of a mockup. [66] Using tempo maps, composers create these subtle changes throughout the piece to emulate a live performance. This gives the music a realistic effect as listeners hear the varied tempos which makes the music sound more lifelike and less metronomic.

Phrasing, on both a micro and macro level, is an important consideration for composers when aiming to achieve an ideal sound. When a professional musician is performing a piece, they make many decisions that are not written into the music. Many of these involve micro-phrasing techniques, such as a crescendo through long sustains or repeated notes similar to mm. 39—46 in Joan Tower's "Fanfare for the Uncommon Women," crescendos during melodic rises and slight decrescendos into the falls, or a crescendo through a section to prepare for large leaps in parts as is the case for many performances of the horn solo in Grainger's "Irish Tune from County Derry". Furthermore, the relativeness of dynamics means that a *ff* is not always the same volume even within the same piece such as the volume difference between mm. 32 and 128 in John Adam's "Short Ride in a Fast Machine" which are both labeled *ff*. [67] Composers create these aspects of realistic phrasing by using automation within their DAW. Because

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[66] Dong-In Danny Choi, "Perfect Rit/Accel in Logic pro While Maintaining Hit Points, Bonus Tip: Rubato," February 15, 2022, YouTube video, 14:11, https://www.youtube.com/watch?v=pasipjg-t_Q.

[67] LA Phil, "Short Ride in a Fast Machine, John Adams," accessed March 8, 2024, https://www.laphil.com/musicdb/pieces/3291/short-ride-in-a-fast-machine.

automation has a value between 0 and 127, composers differentiate dynamic contrasts, even within the same dynamic marking, easily by changing the values of each automation. For instance, m. 32 of Adam's piece may have an automation level of 110 for expression and 100 for modulation, while measure 128 may have an automation level of 120 for expression and 110 for modulation. Furthermore, because expression changes the volume slightly while not changing the sample being performed, many composers prefer to use expression for micro-phrasing reserving modulation for macro-phrasing.[68]

Finally, understanding how to balance and blend the mockup further emulates an ideal sound. In acoustic performances, musicians blend within their section and balance within the ensemble. While most sample libraries blend themselves, especially if the library has multiple instruments playing on the same library, composers must create balance within the mockup themselves through the mixing process. This is the final stage in the process of creating a mockup, and it is where composers ensure the instruments are balanced together.[69] The concept of foreground, middle-ground, and background commonly used in acoustic orchestration, as detailed in Samuel Adler's *The Study of*

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[68] Spitfire Audio, "The Secret to Orchestral Programming," November 21, 2020, YouTube video, 29:57, https://www.youtube.com/watch?v=7Vxj4ghJHtY&t=542s.

[69] Daniel James, "Mixing and Mastering," in *Crafting Digital Media*, ed. Daniel James, (New York: Apress, 2009), 285–316, https://doi.org/10.1007/978-1-4302-1888-3.

Orchestration,[70] is equally helpful in digital mockups.[71] If a composer takes the time before starting the mockup to set up the parameters in Chapter 3, such as EQ and panning, then part of the mixing process is already completed.[72] The next step is to categorize each instrument in each phrase as foreground, middle-ground, and background. Following traditional orchestration techniques, the foreground and bass background should be the two most important and heard sections. To achieve this in a DAW, composers can raise the CC7 level of those instruments or lower the CC7 level of the other instruments. Furthermore, composers should consider the natural volume of each instrument, as outlined in Chapter 2. If the mockup contains a melody that is only played by a single flute, with the middle and background performed by the rest of the orchestra, a composer could raise the mix level of the flute; however, that would create a less-ideal sound, which is why concepts such as doubling[73] are used similarly with

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[70] Adler and Hesteraan, *The Study of Orchestration.*

[71] Steve Savage, *Mixing and Mastering in the Box: The Guide to Making Great Mixes and Final Masters on Your Computer* (Oxford: Oxford University Press, 2014), 63.

[72] Jeff Strong, *Home Recording for Dummies* (Hoboken, NJ: John Wiley & Sons, Inc., 2021).

[73] Zach Heyde, "Quick Orchestral Combos You Can Use Instantly," December 12, 2022, YouTube video, 11:25, https://www.youtube.com/watch?v=3EOgJXxjDLc.

acoustic orchestration.[74] Combining these techniques with the common acoustic orchestration considerations outlined in books by Rimsky-Korsakov, Adler, Piston, Strauss, and others helps composers create an ideal sound in mockups.

[74] Paul Mathews, *Orchestration: An Anthology of Writings* (New York: Routledge, 2006), 82.

[A]Biotic Worlds

For Virtual instruments and
Live performers

JJ Bartley

[A]Biotic Worlds

Live Instruments

Flute

English Horn

F Horn

C Trumpet

Trombone

Violin I

Violin II

Viola

Cello

Double Bass

Virtual Instruments

Flute

Oboe

B*b* Clarinet

Bassoon

F horn I, II

C trumpet I, II

Trombone I, II

Tuba

Violin I, II

Viola

Cello

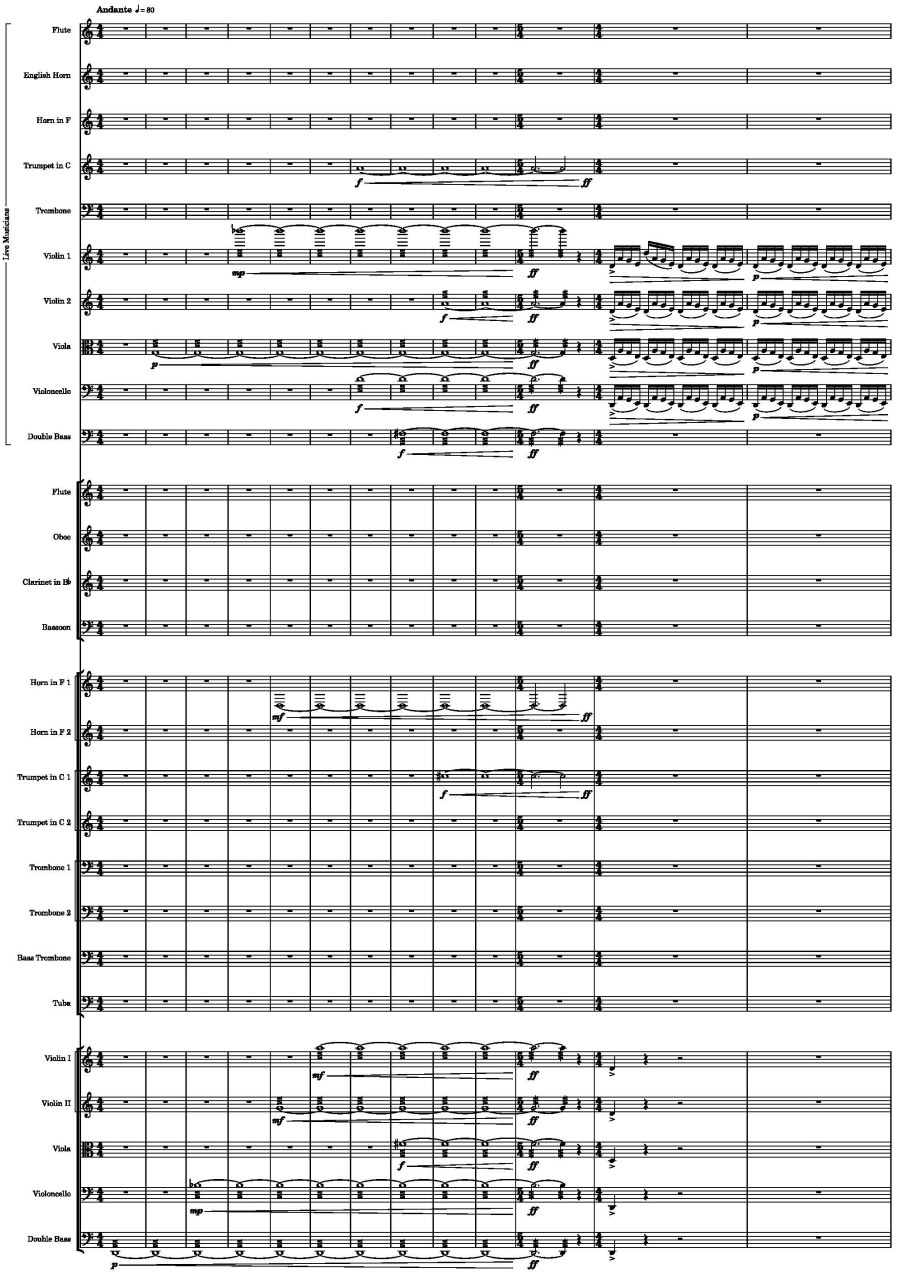
Double Bass

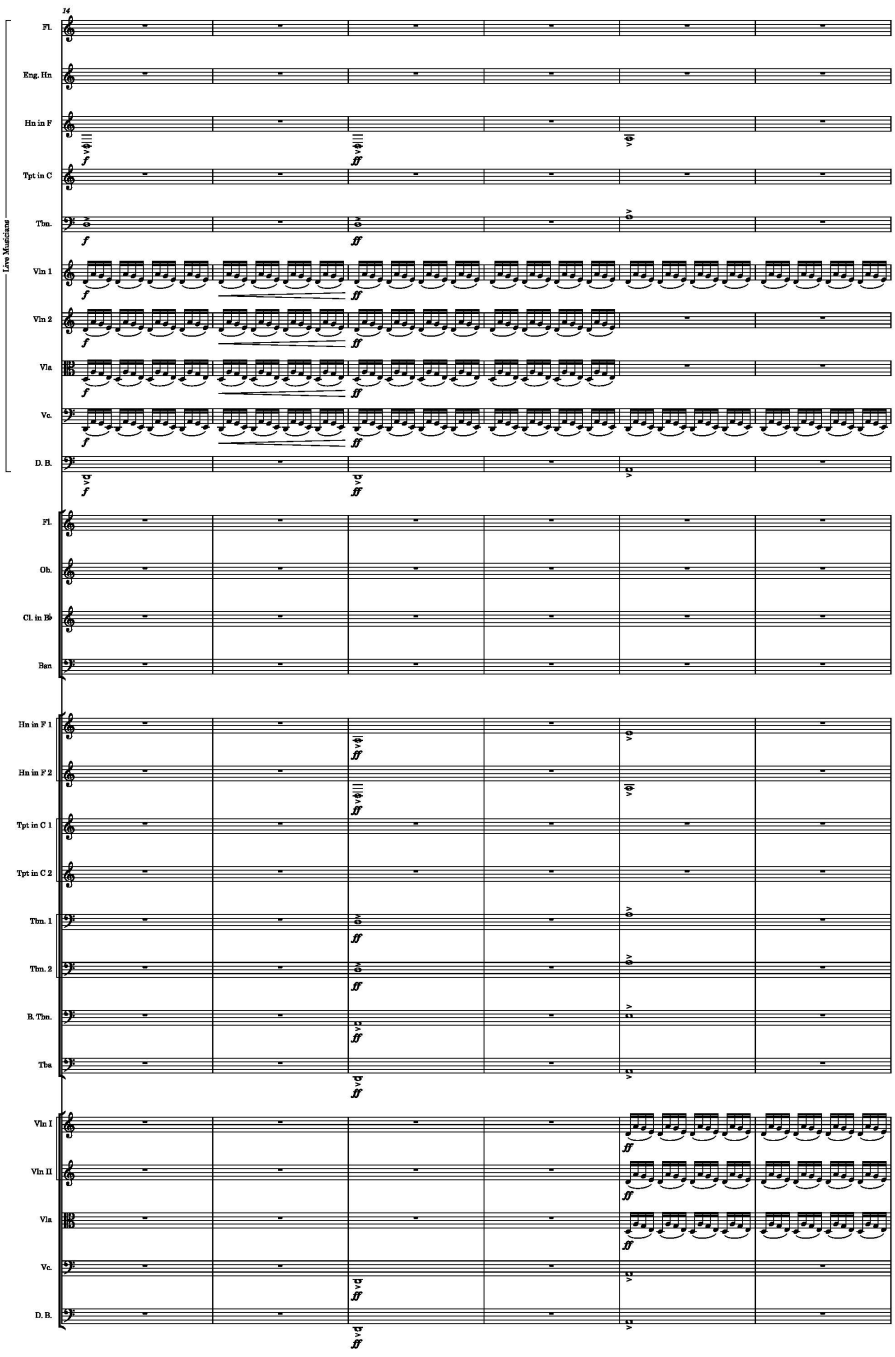
Program Notes

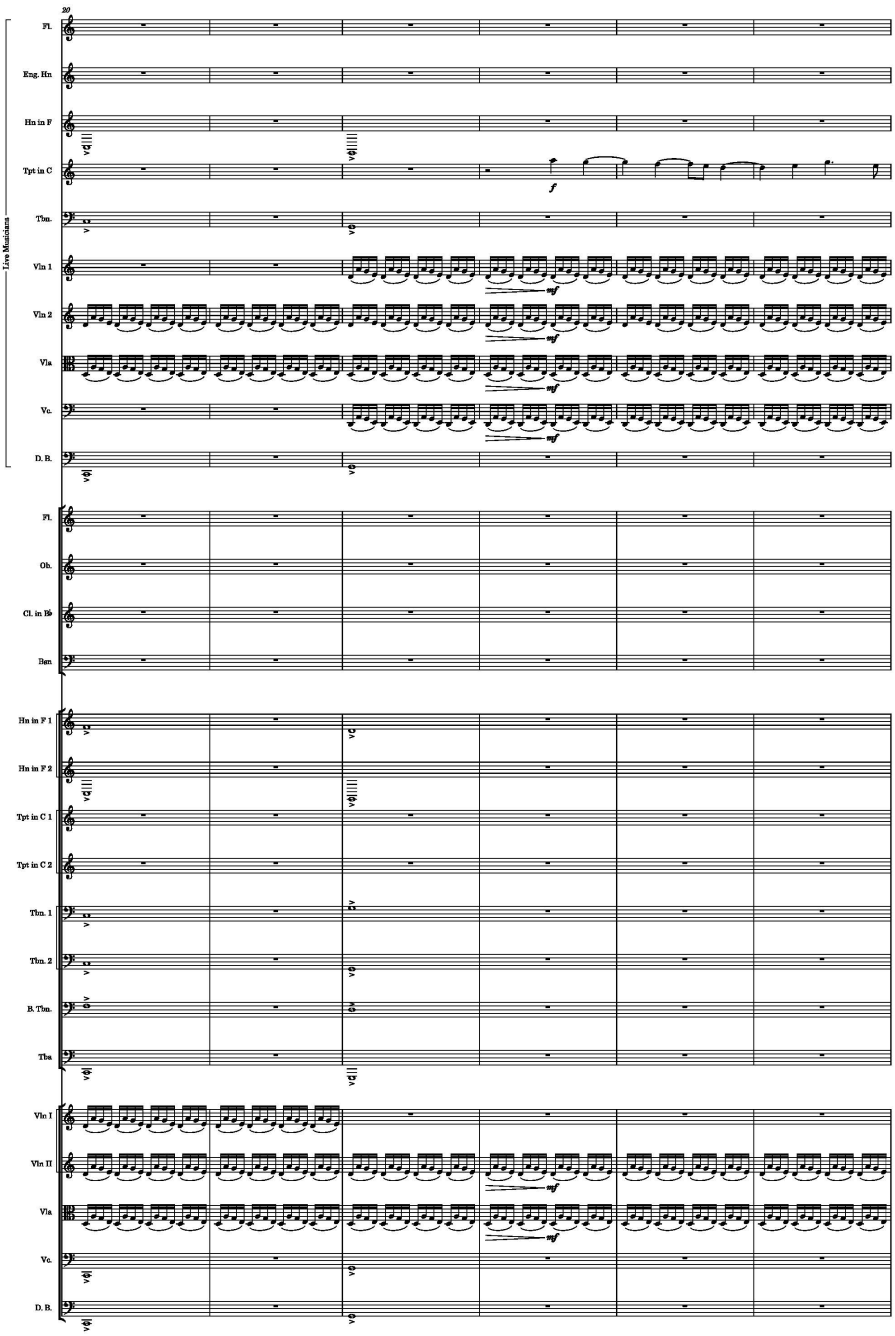
[A]Biotic Worlds is derivative of the idea that live and virtual instruments live in separate realms, serving two separate purposes. The piece encapsulates different styles, or “worlds,” that endeavors to show how different and how similar these two groups are. As the piece begins, the virtual instruments act as a support for the live instruments. Continuing, the piece slowly morphs as the audience enters the world of virtual instruments. The piece concludes harmoniously as the two groups combine to create a harmonious community of live and virtual worlds.

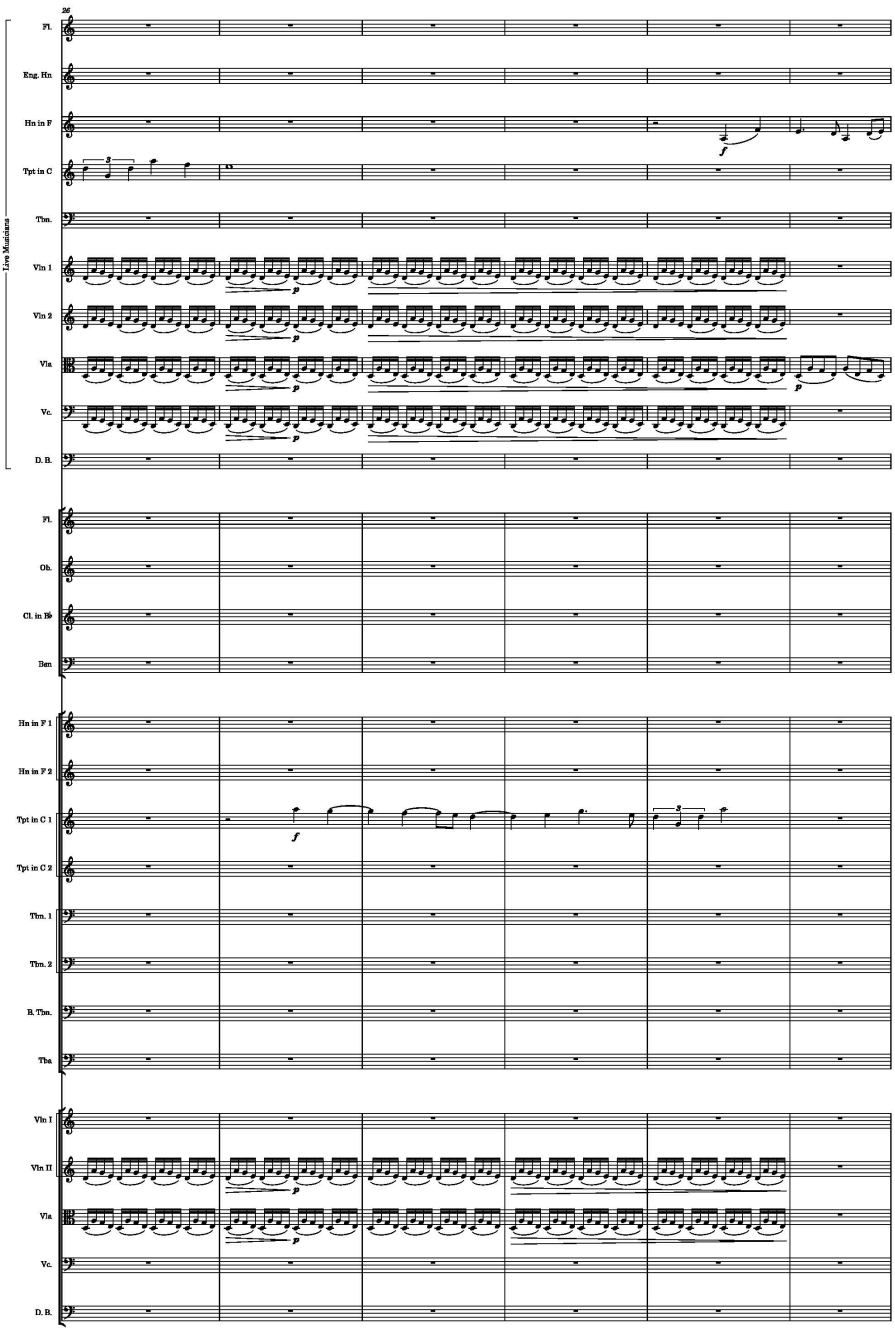
[A]Biotic Worlds

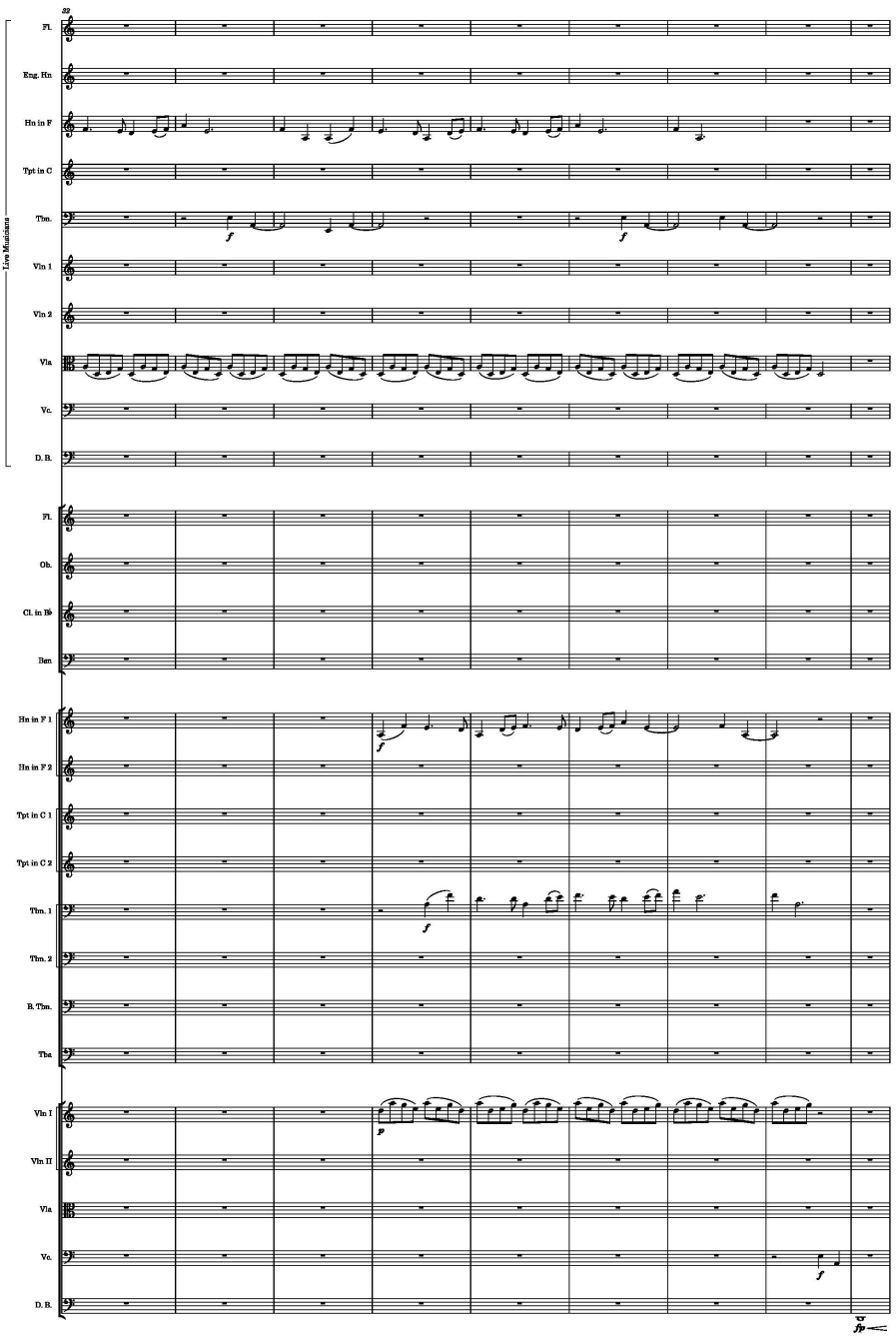
JJ Bartley

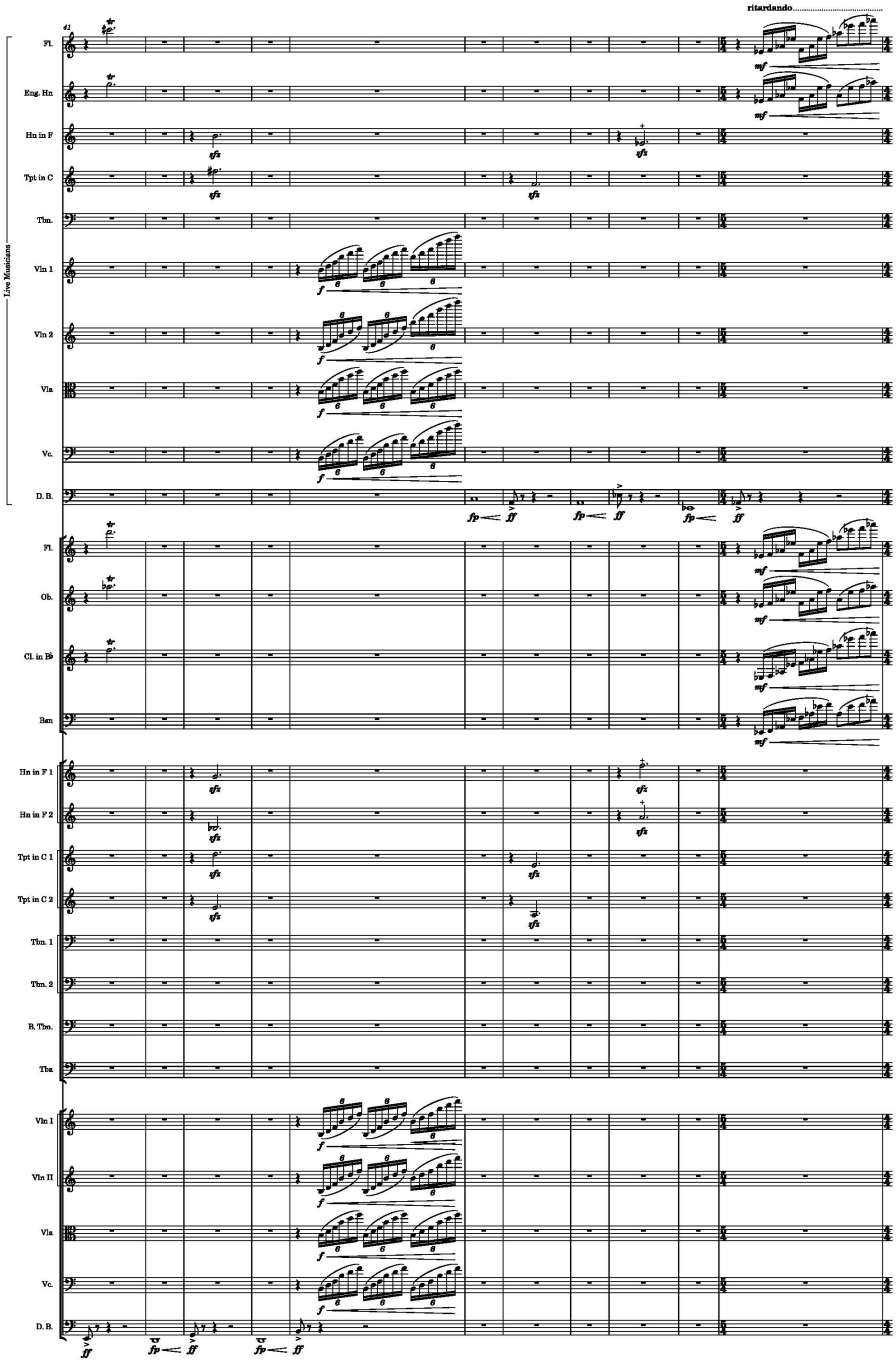


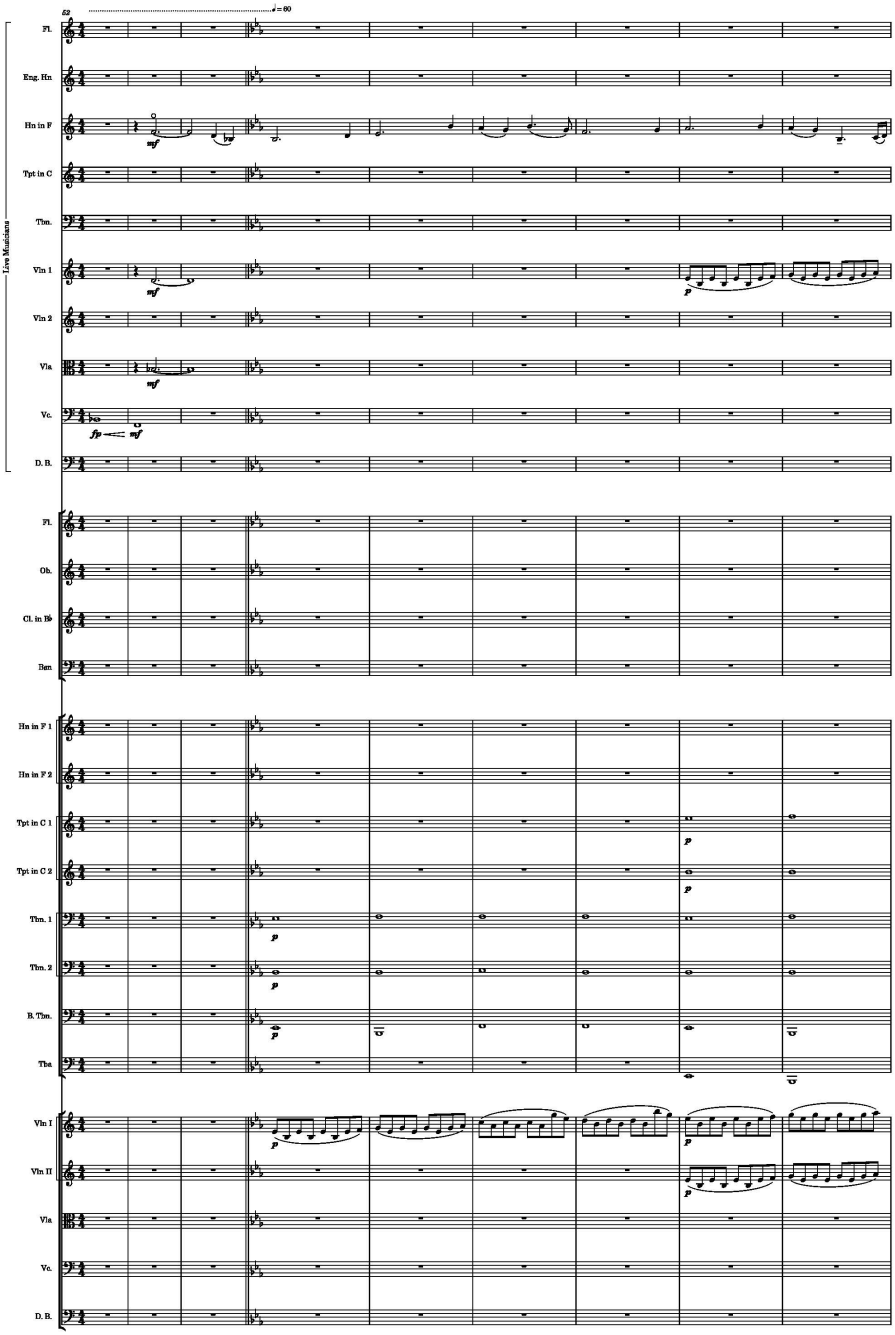

14
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.

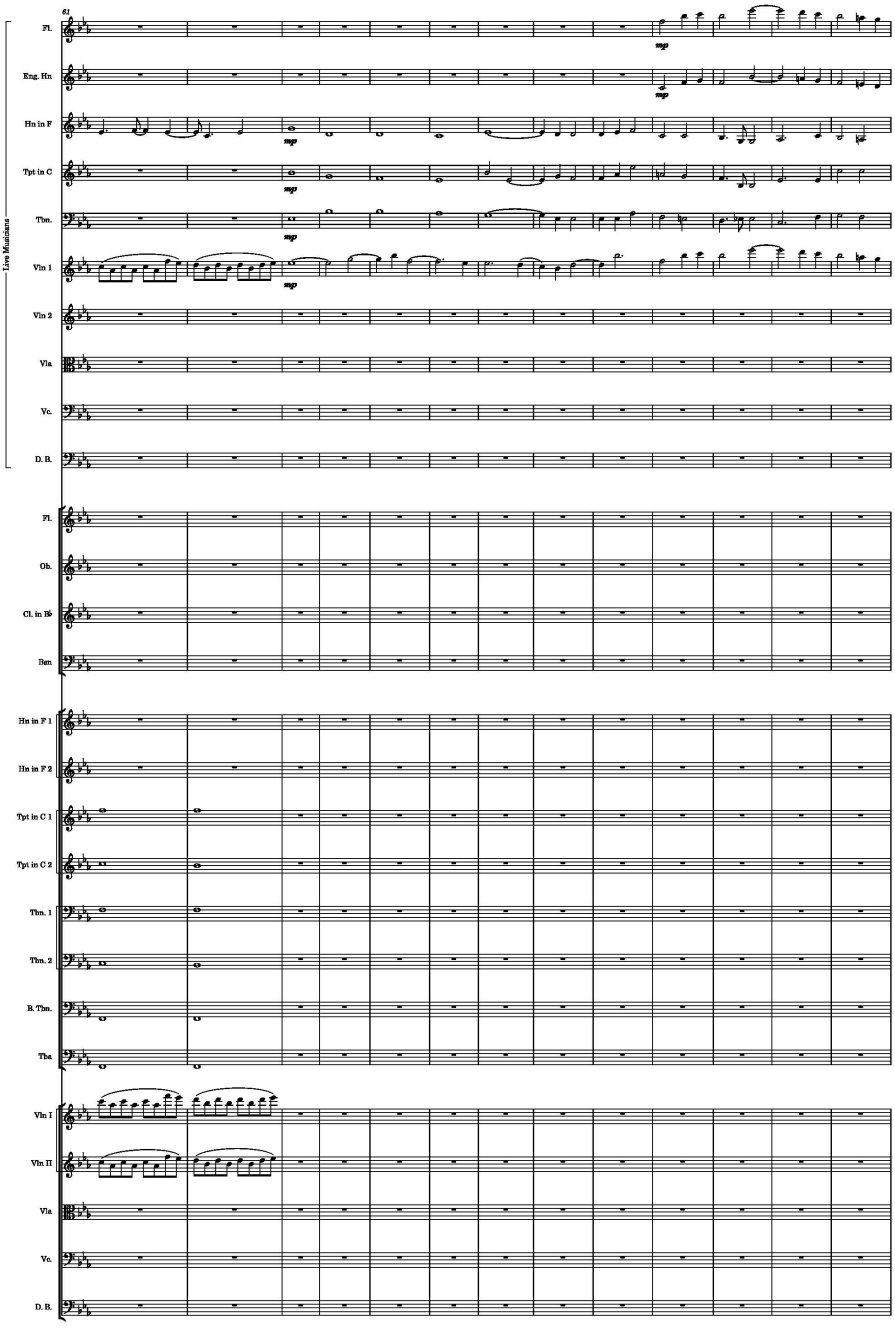

20
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn.
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.
f
mf
mf
mf
mf
mf
mf

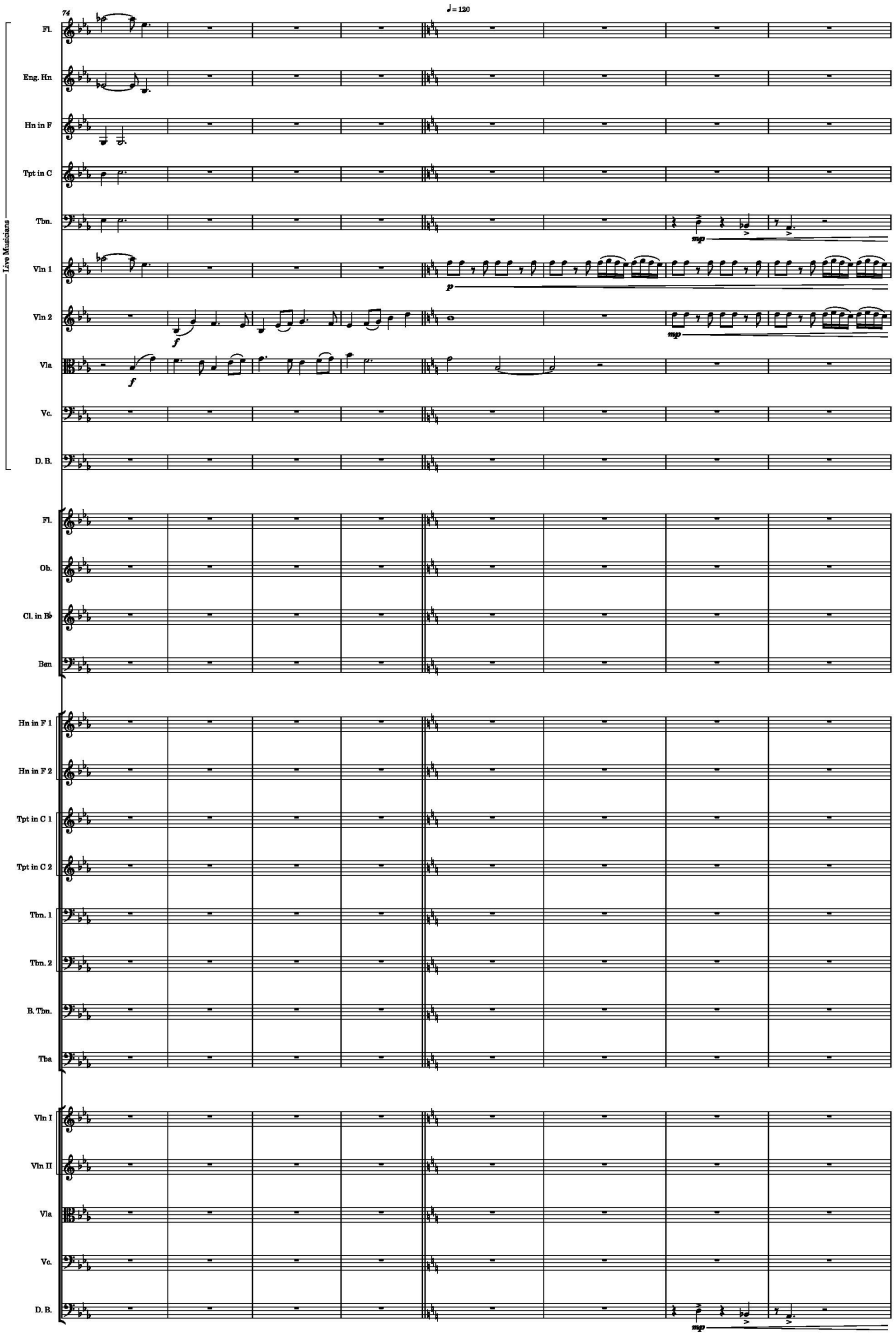

26
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla
Vc.
D. B.

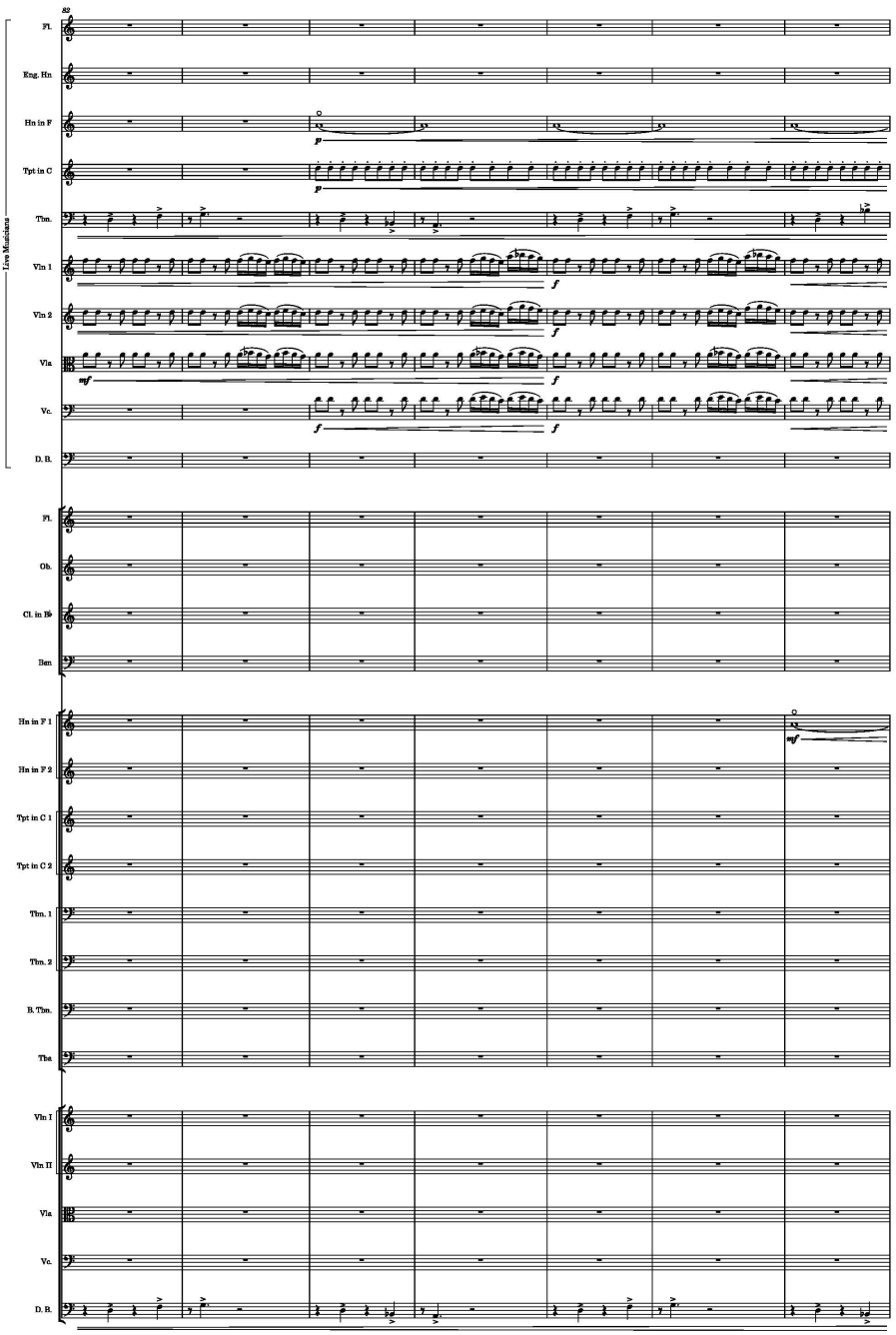

32
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.

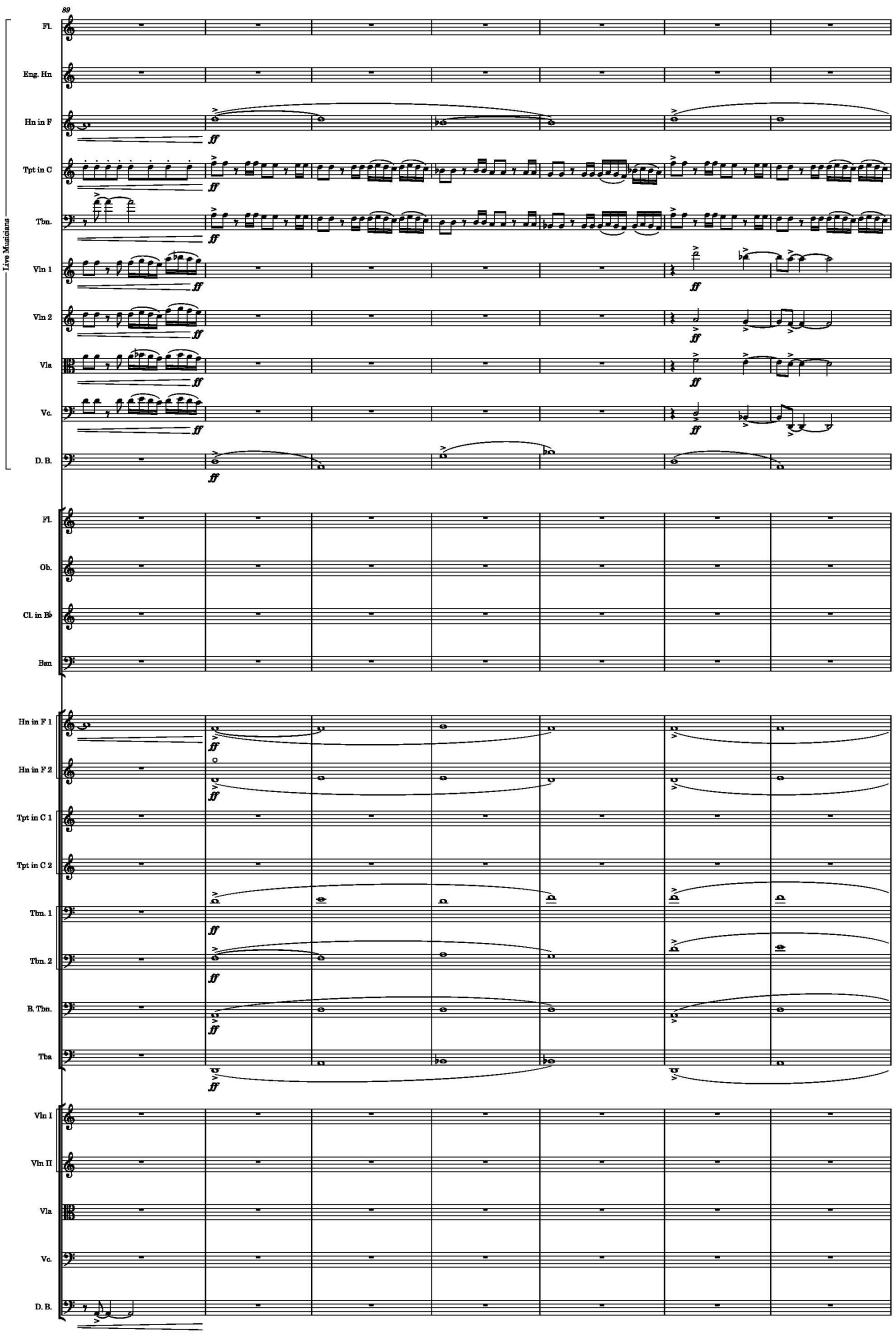

ritardando
41
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln 1
Vln II
Vla
Vc.
D. B.

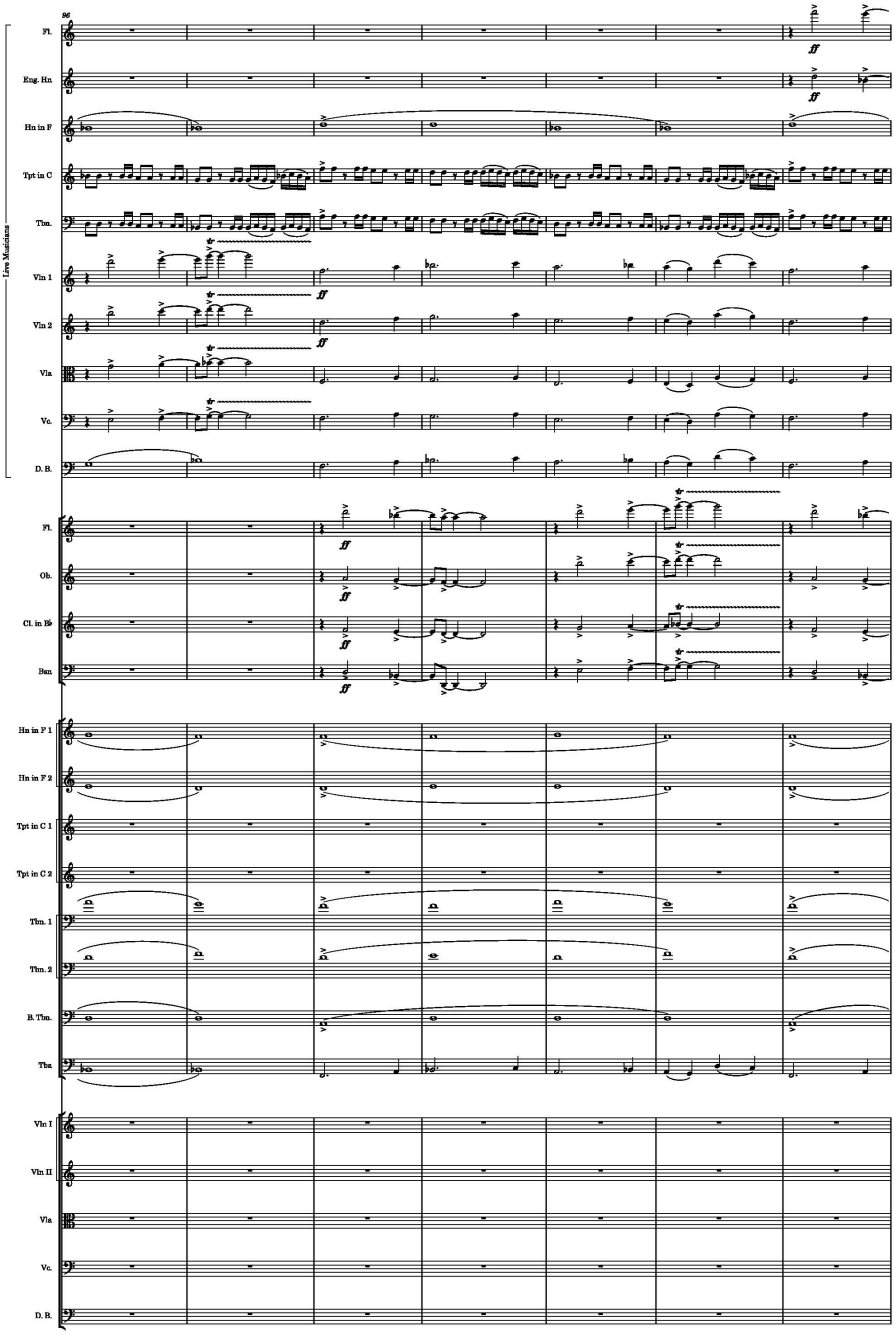

52
♩ = 60
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.

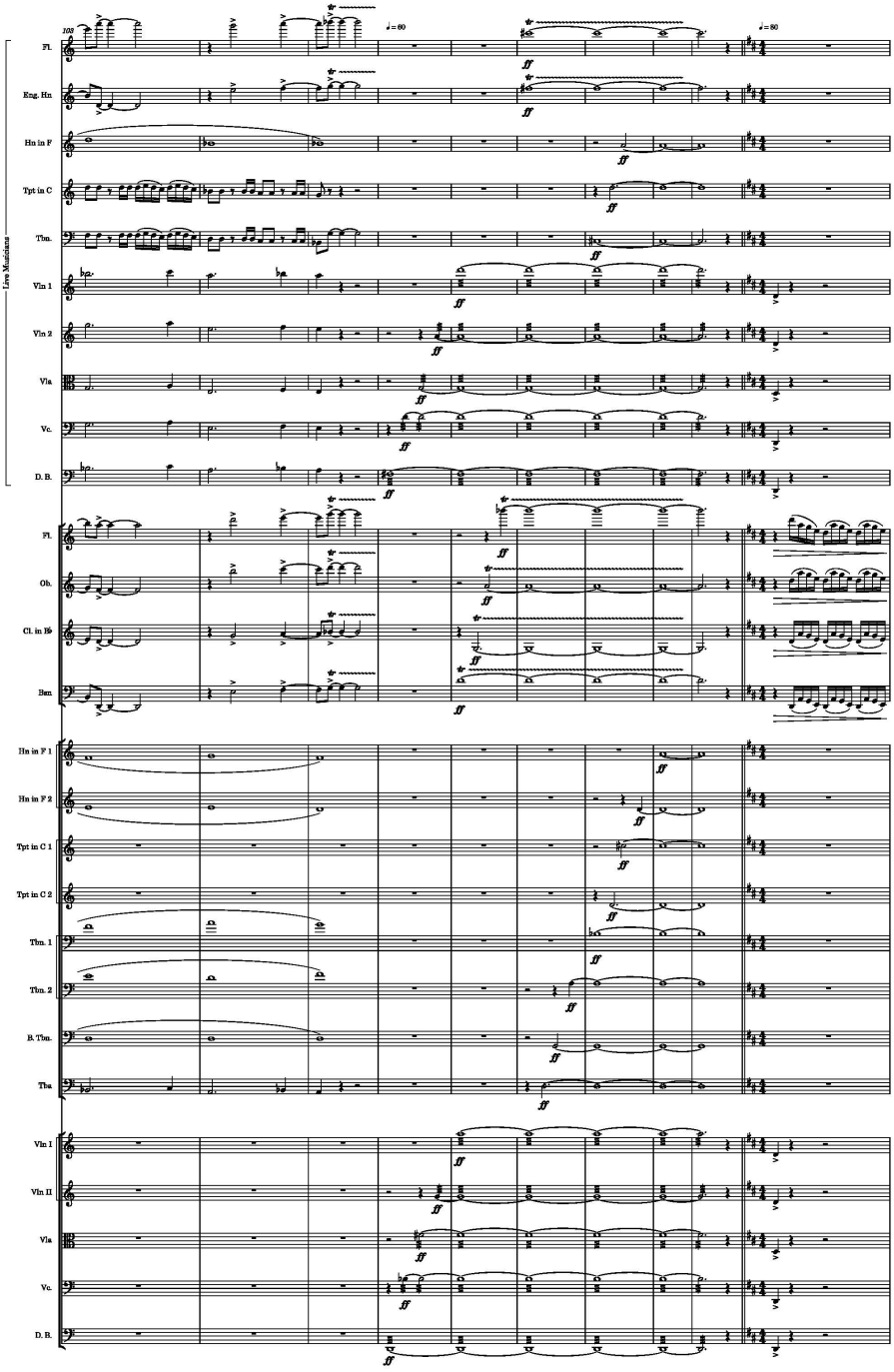

61
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.

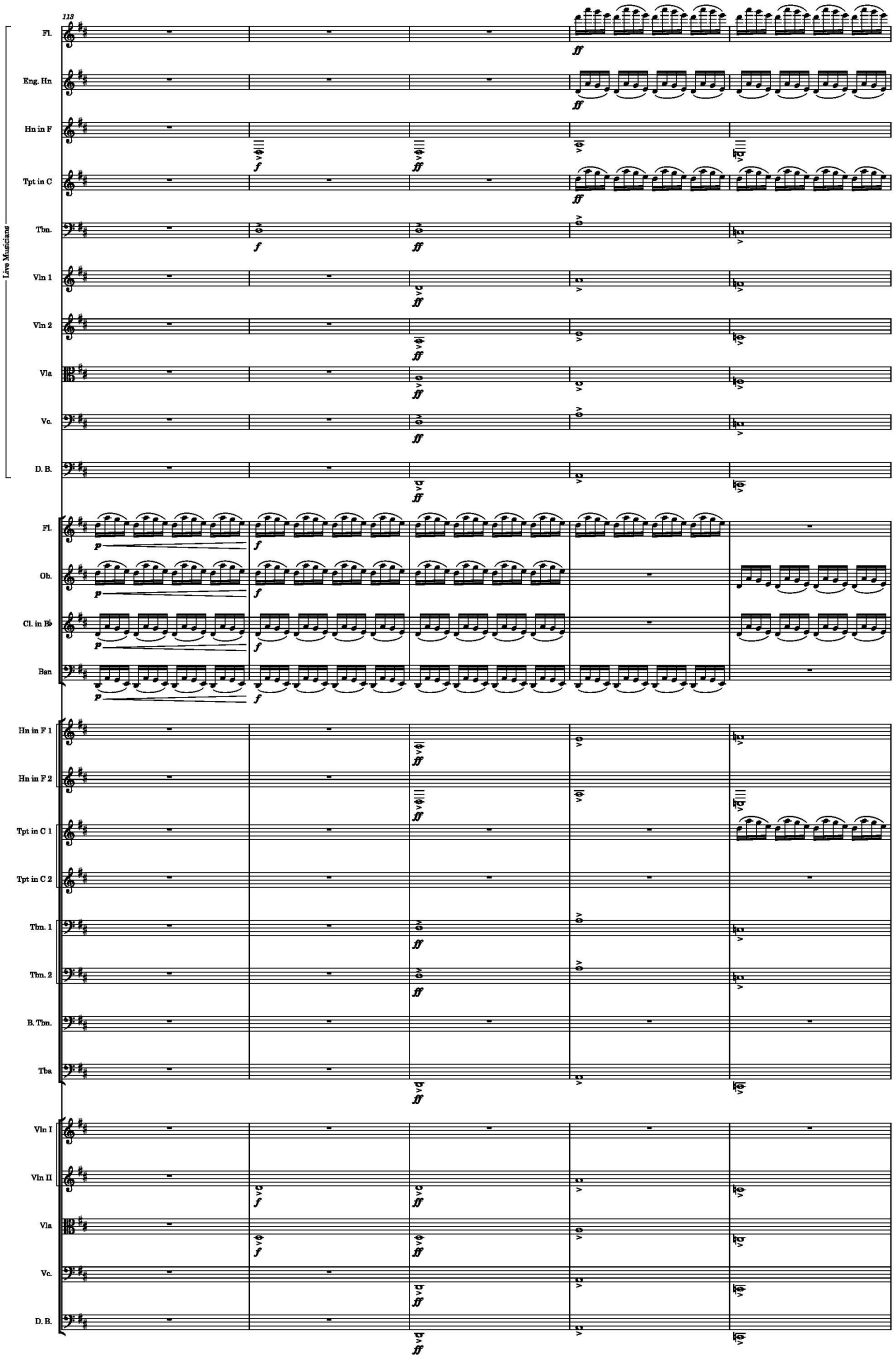

74
♩= 120
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn.
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.

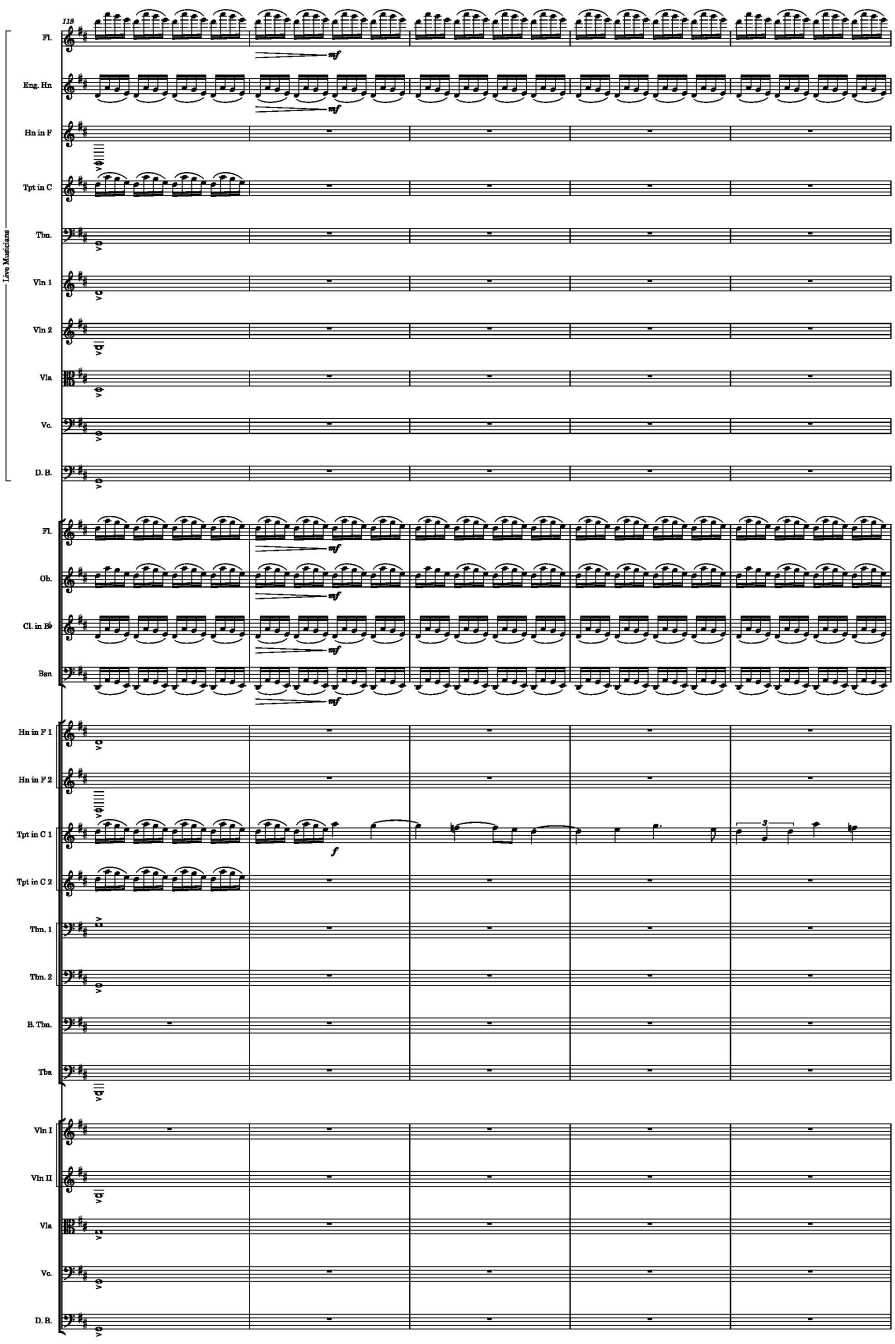

82
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn.
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.

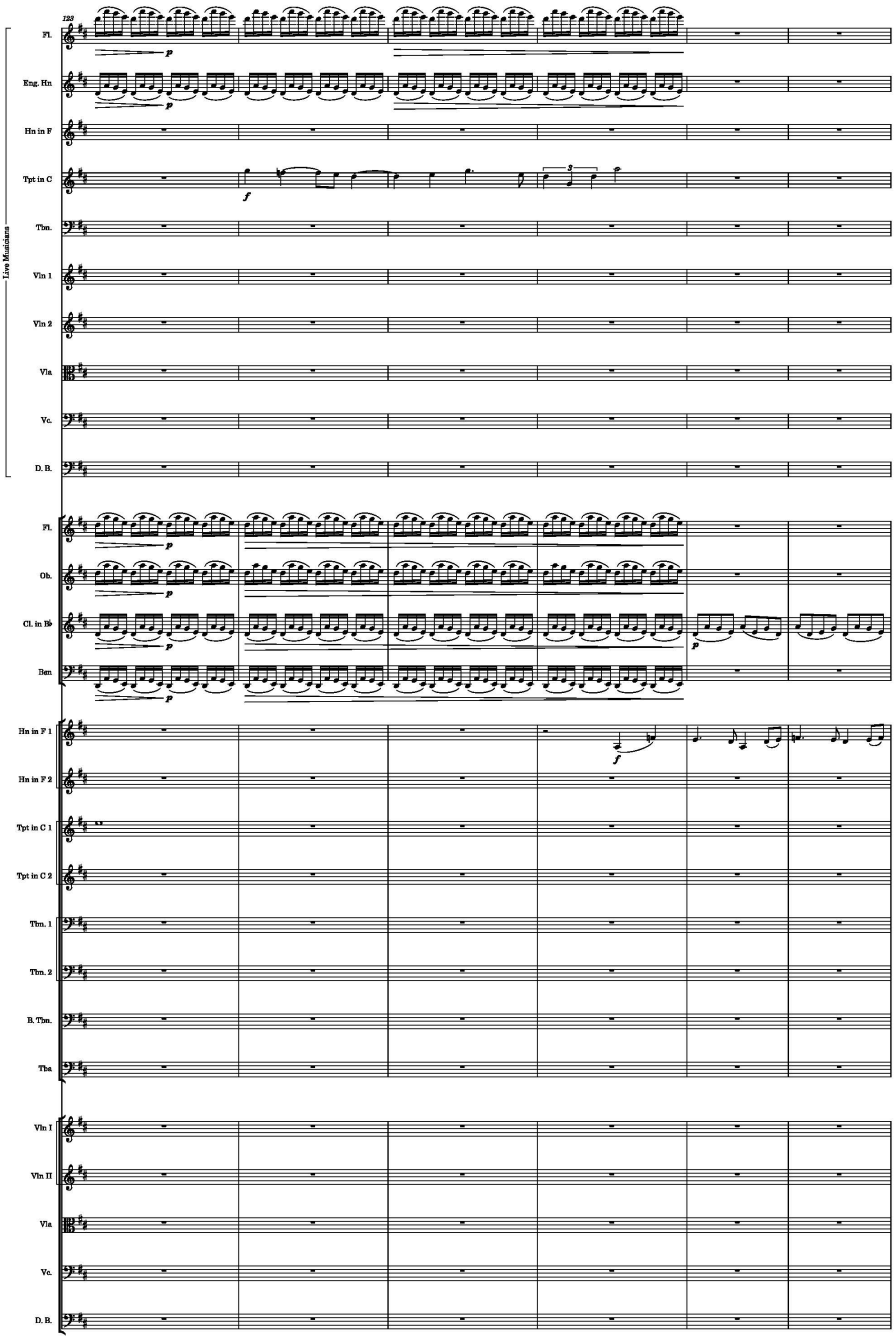

89
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn.
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.

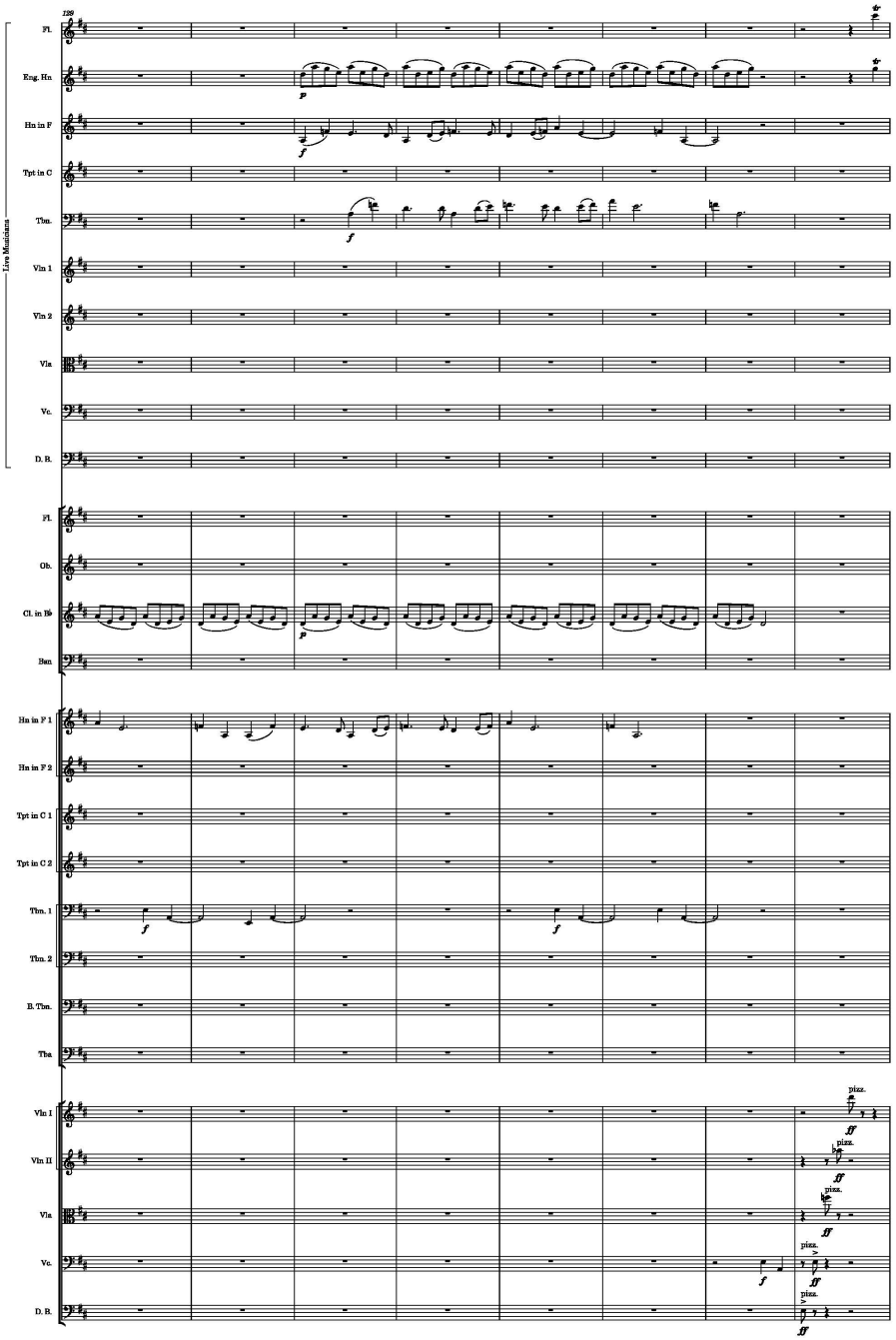

Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn.
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.

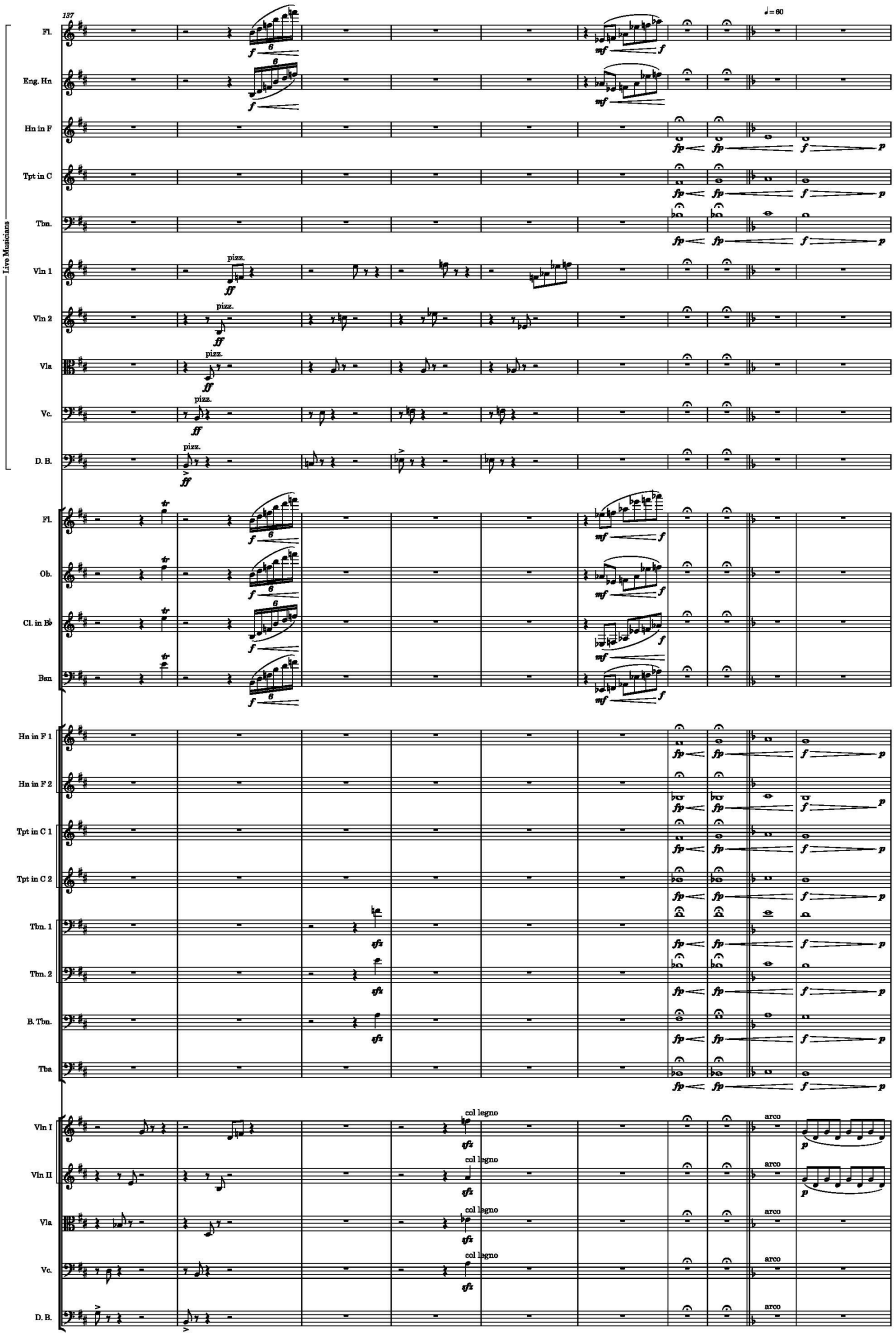

Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn.
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.

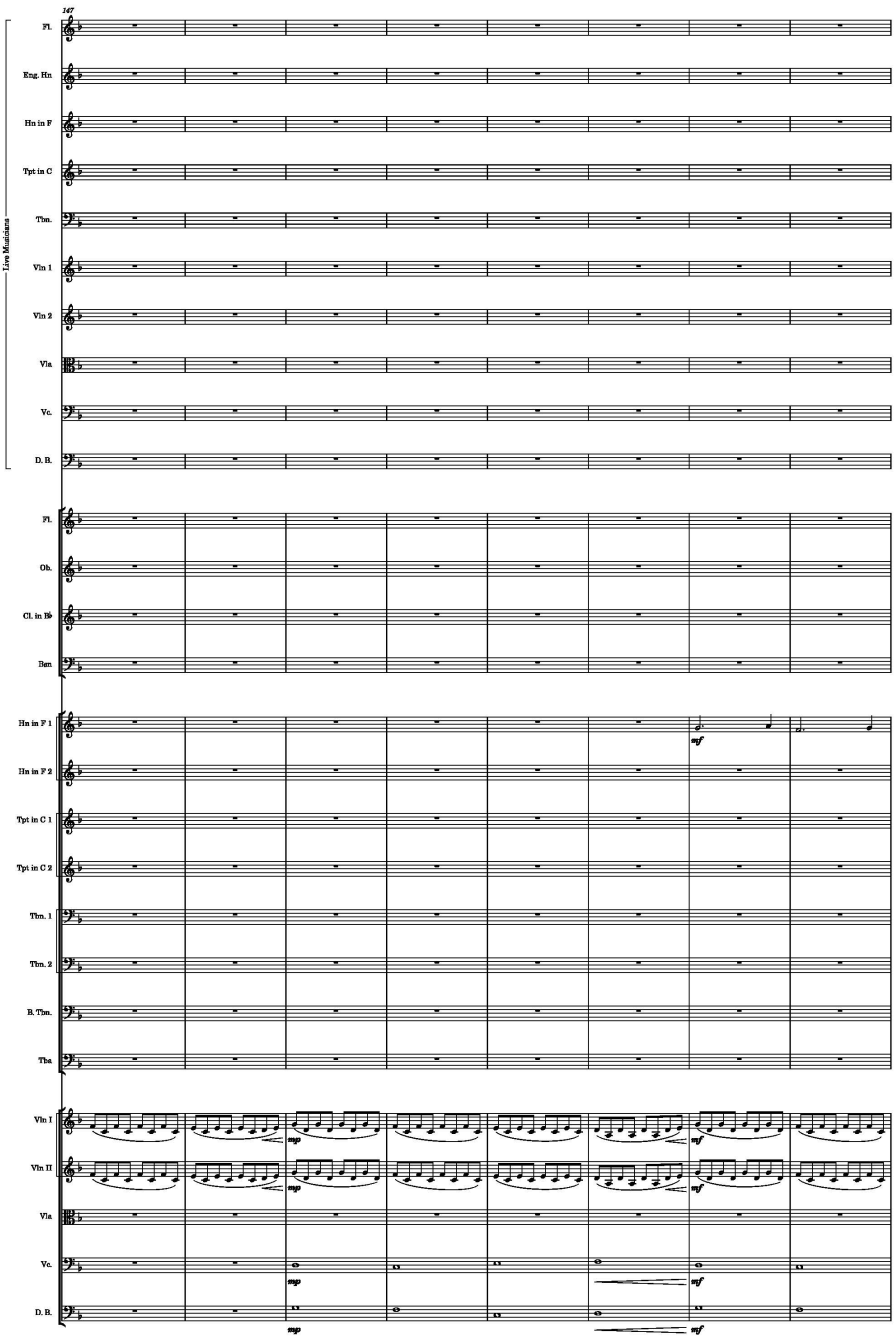

113
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.

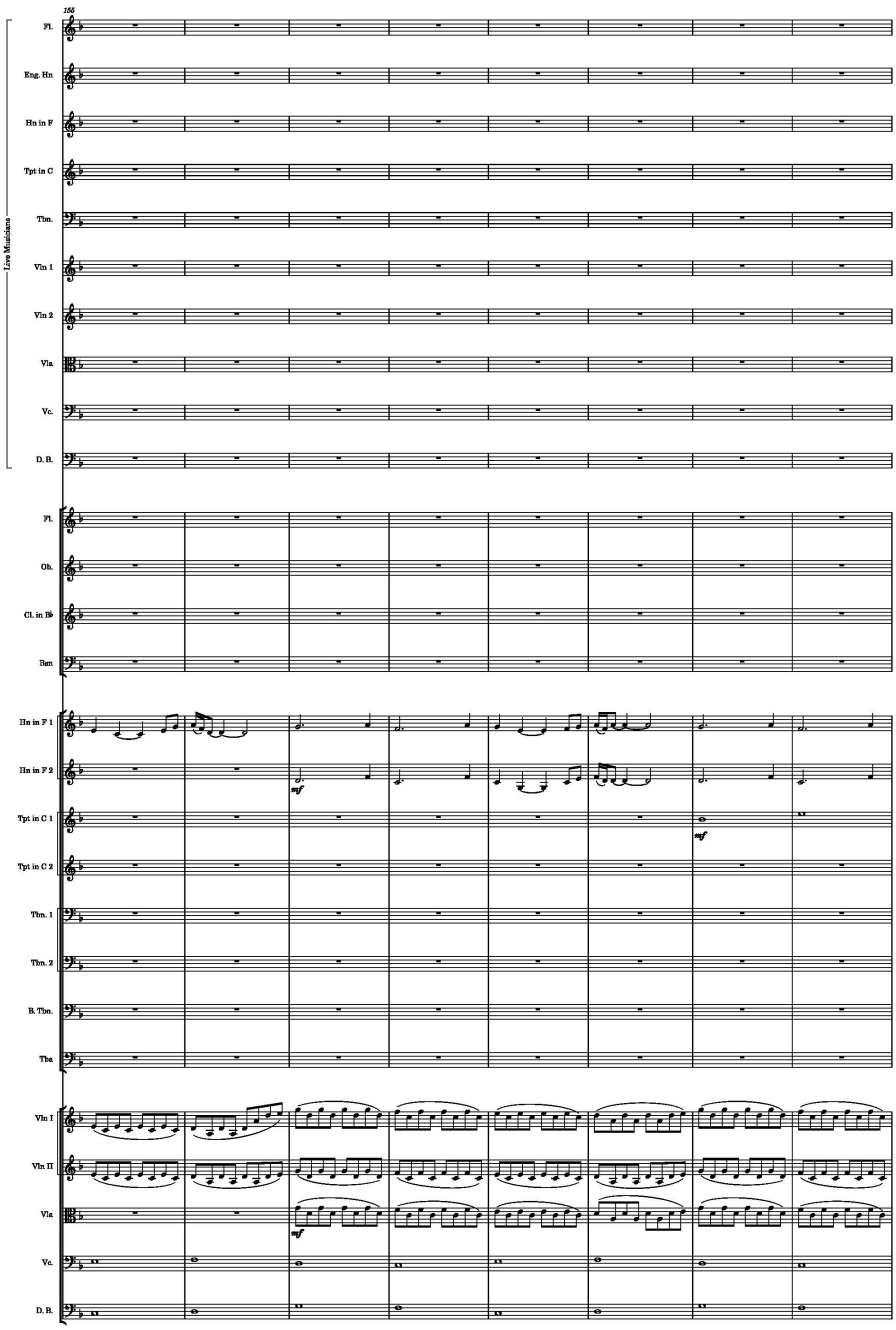

118
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla
Vc.
D. B.

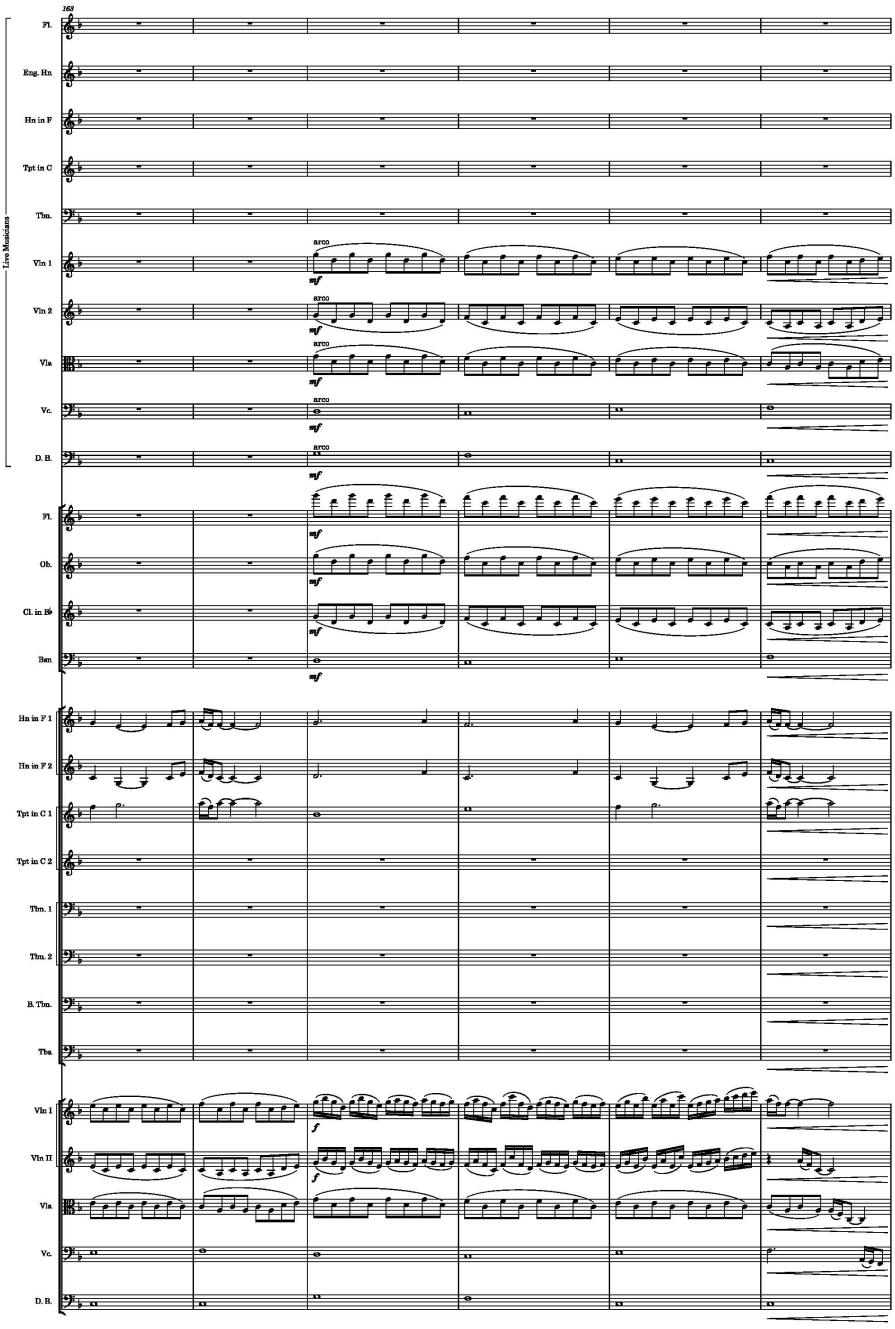

133
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Live Musicians
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.

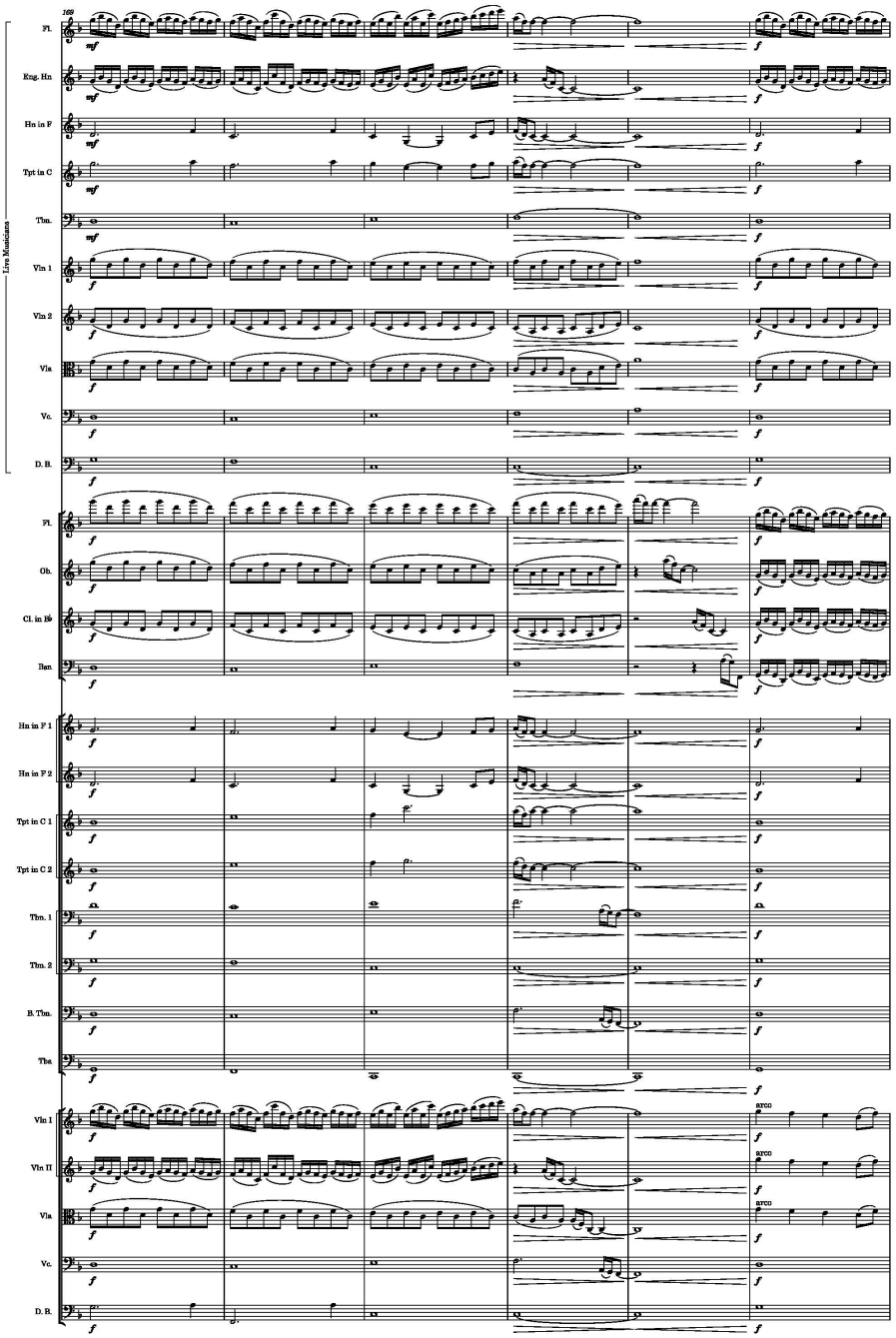

Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.
pizz.

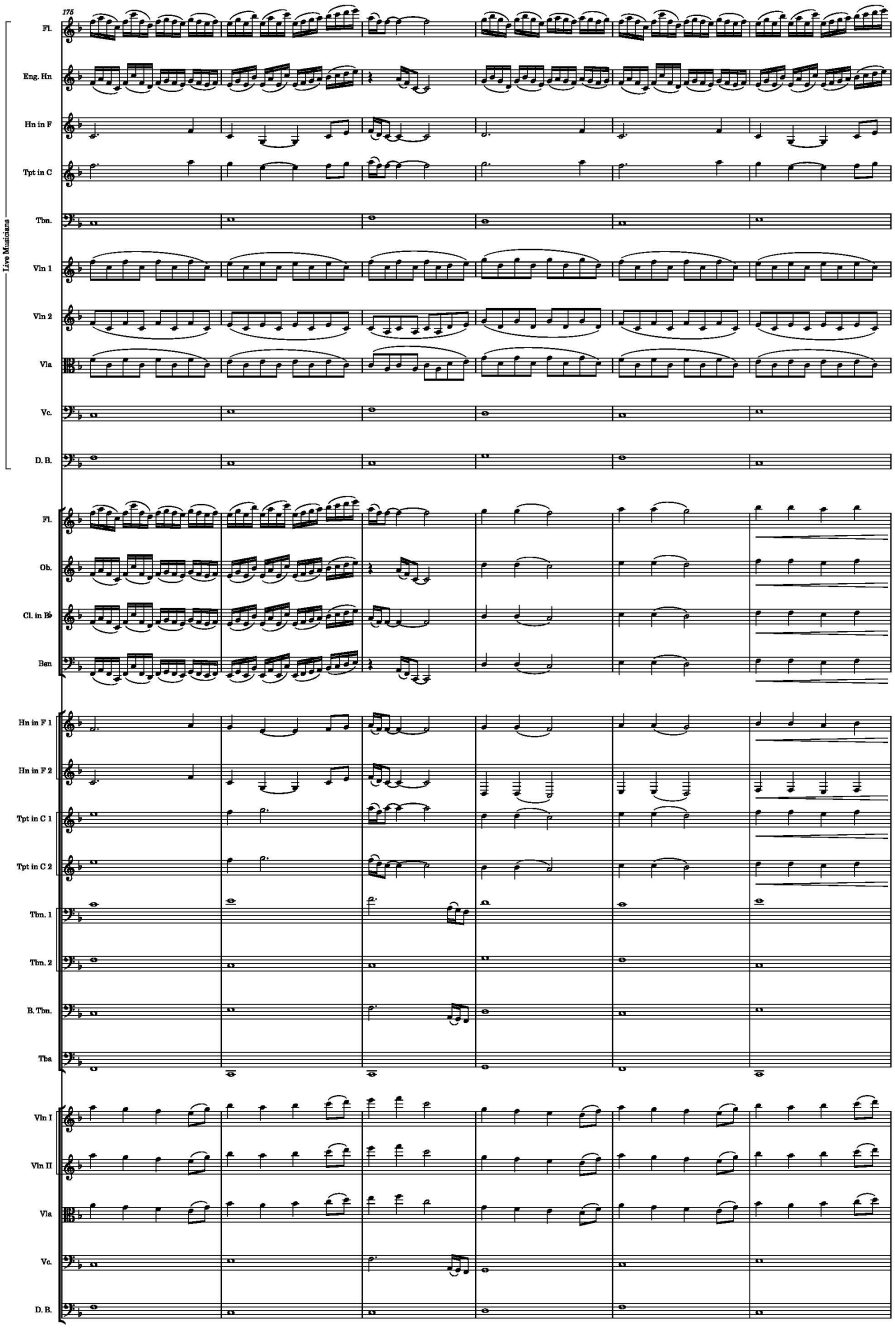

137
♩= 80
Live Musicians
Fl.
Engl. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla
Vc.
D. B.
pizz.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.
col legno
arco

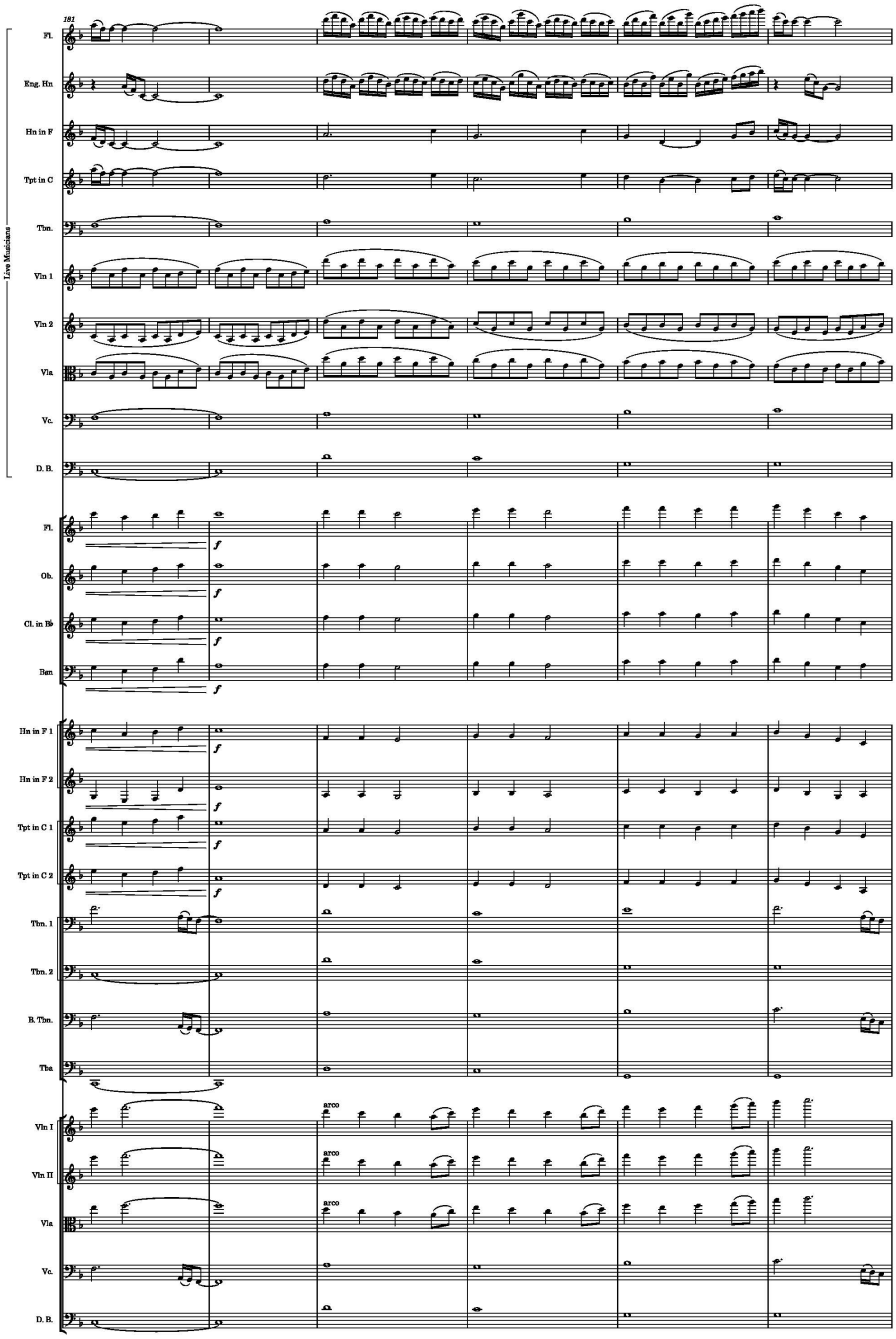

147
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.
mp
mf

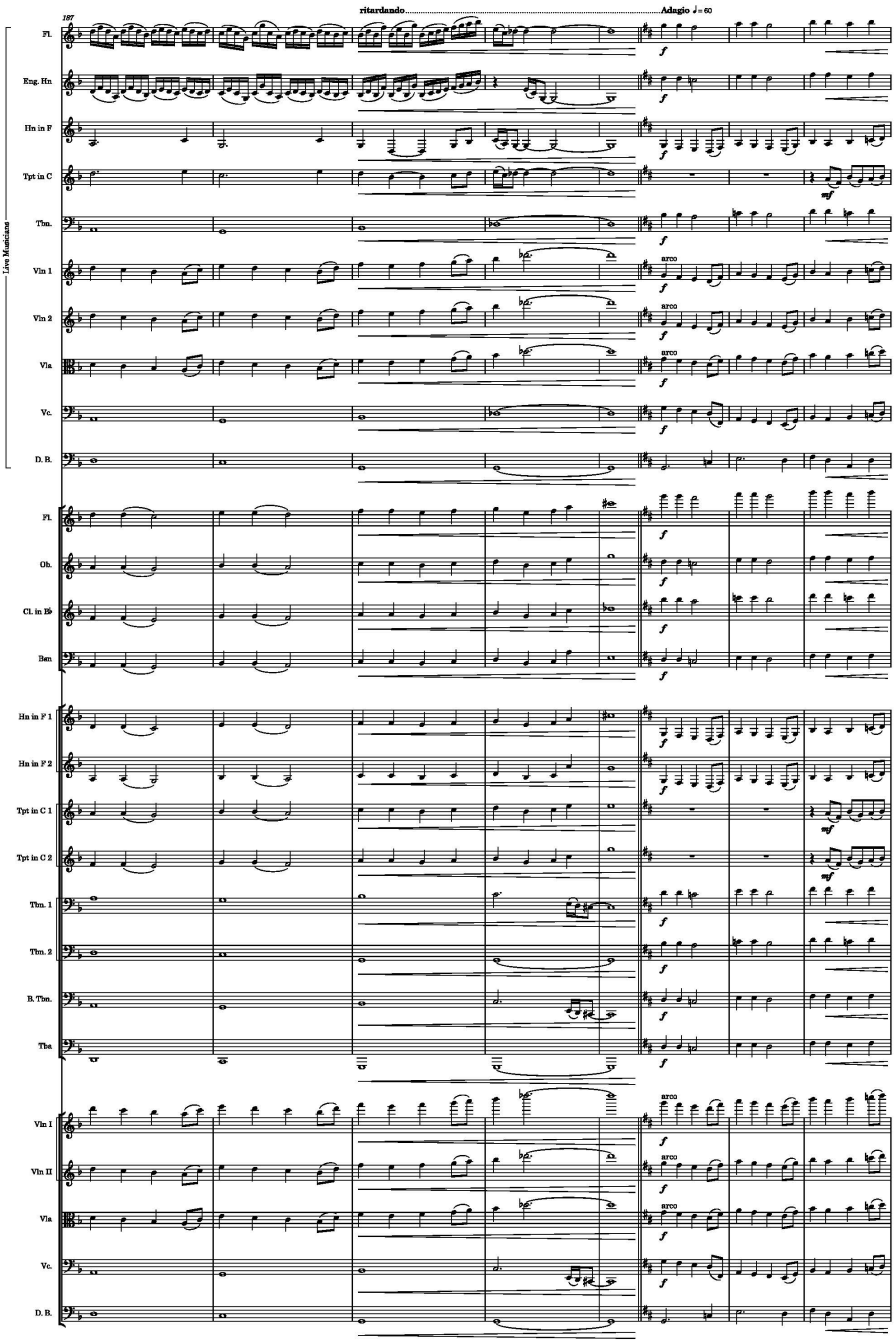

156
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.
mf
mf
mf

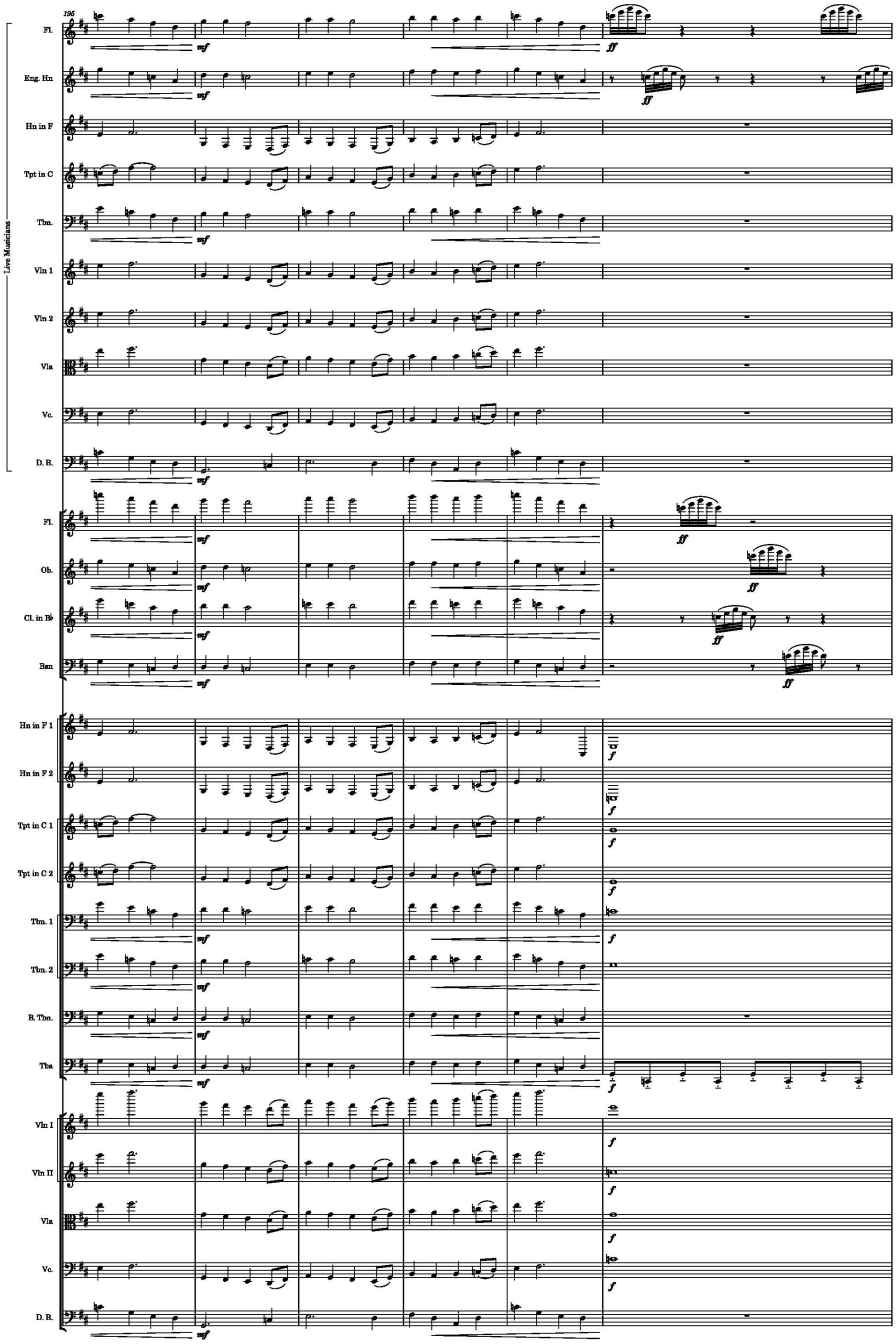

163
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
arco
mf
Fl.
Ob.
Cl. in B♭
Bsn.
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.
f

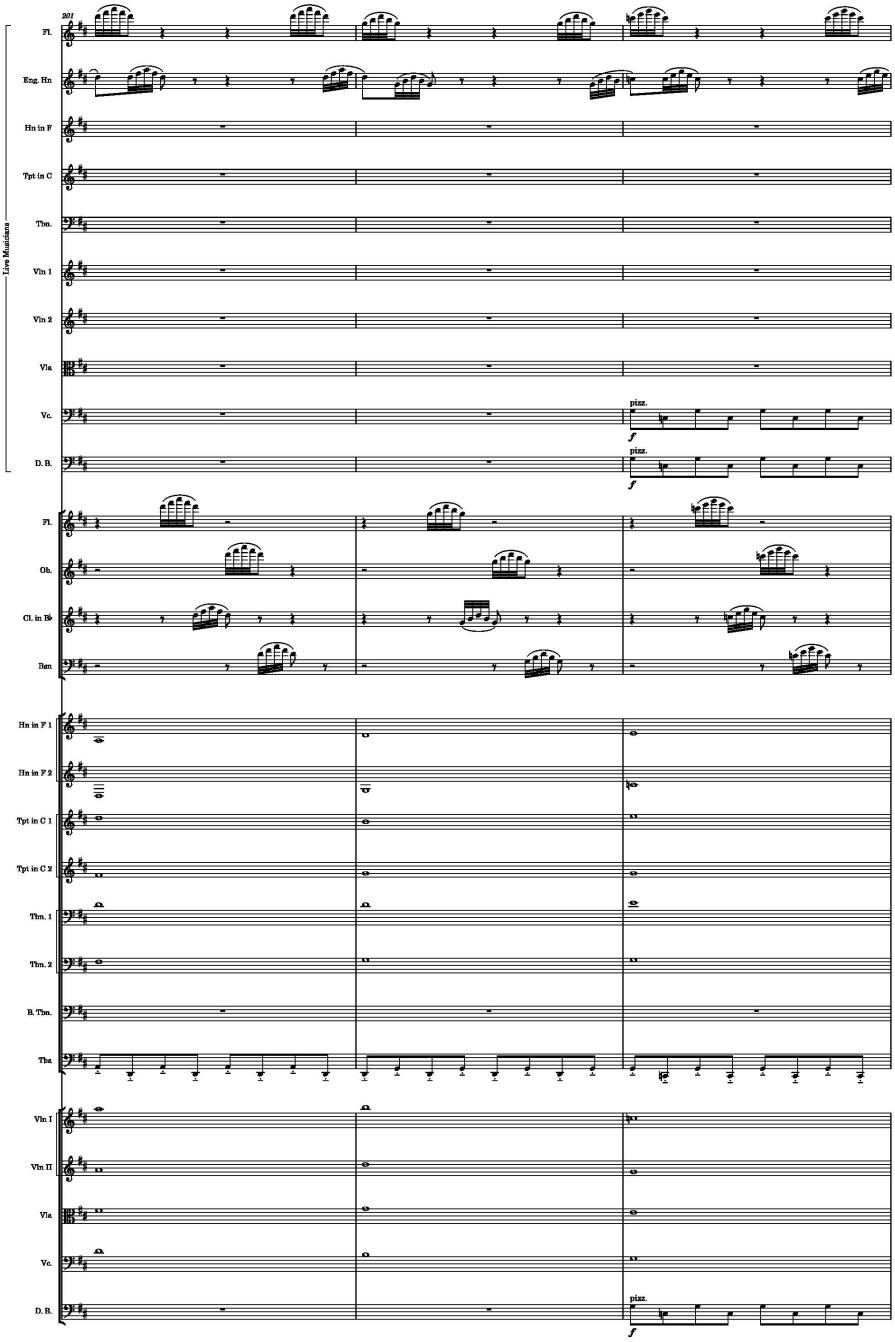

169
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn.
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.
arco

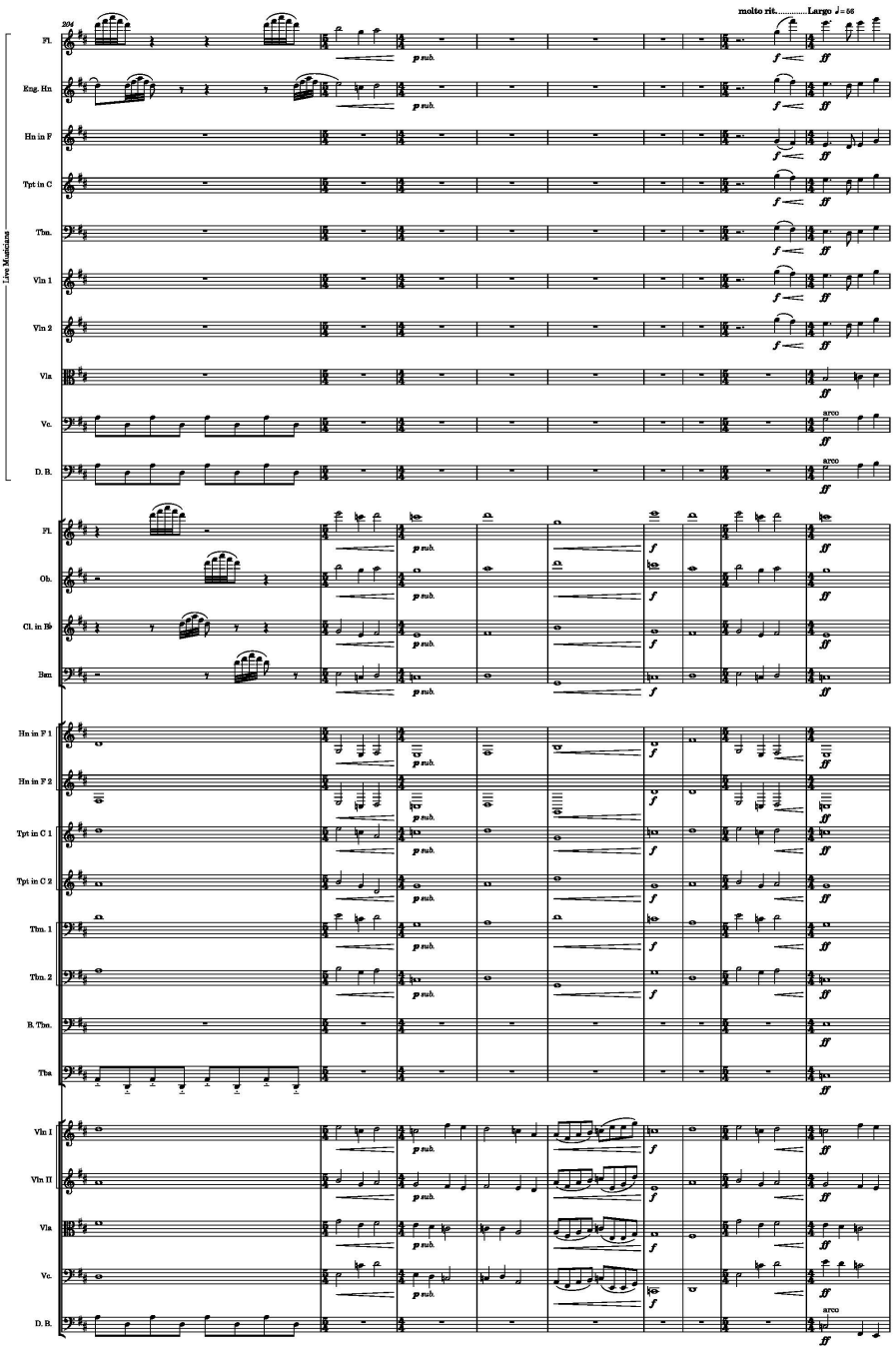

178
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn.
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.

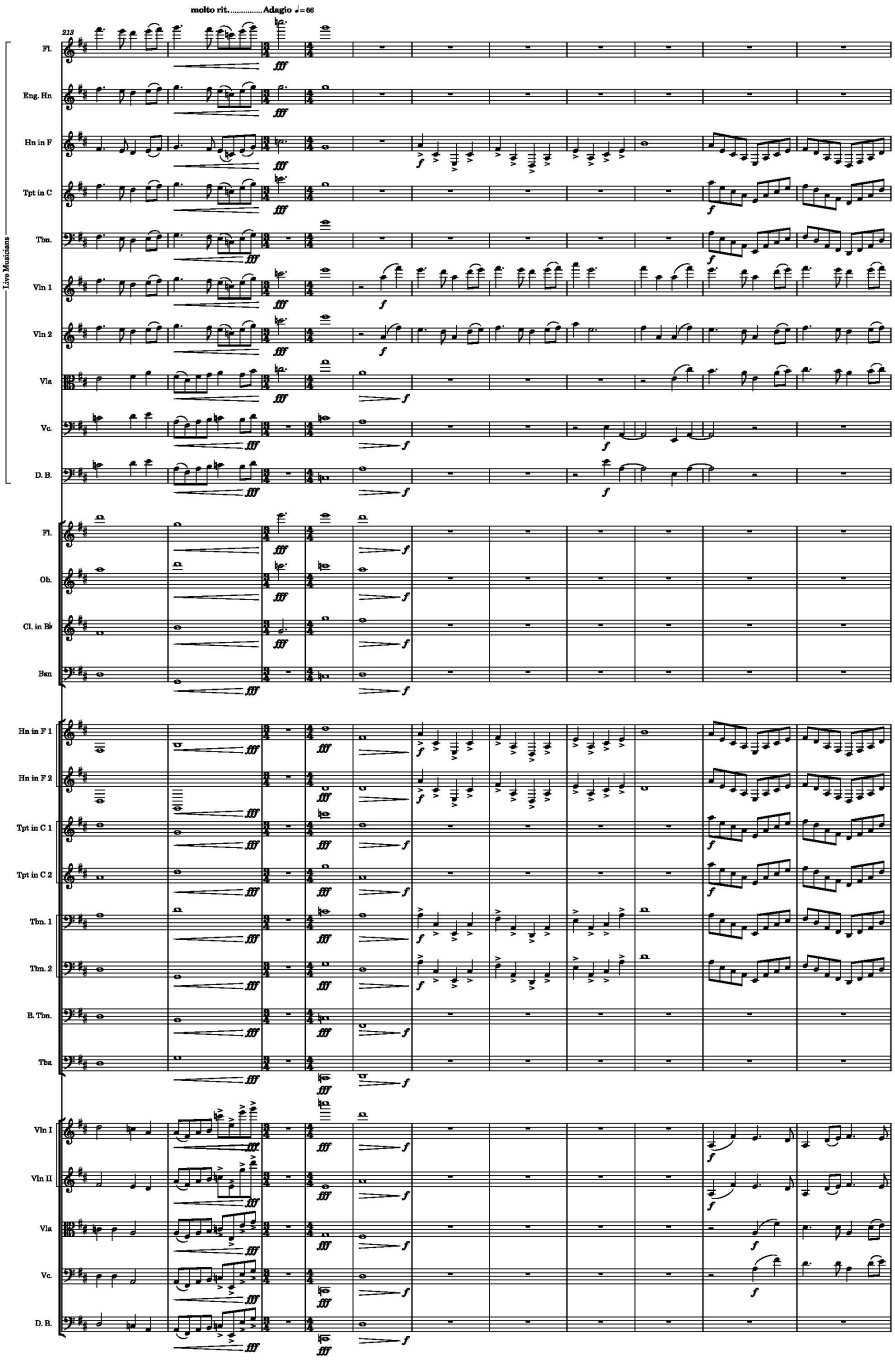

181
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.
arco
arco
arco

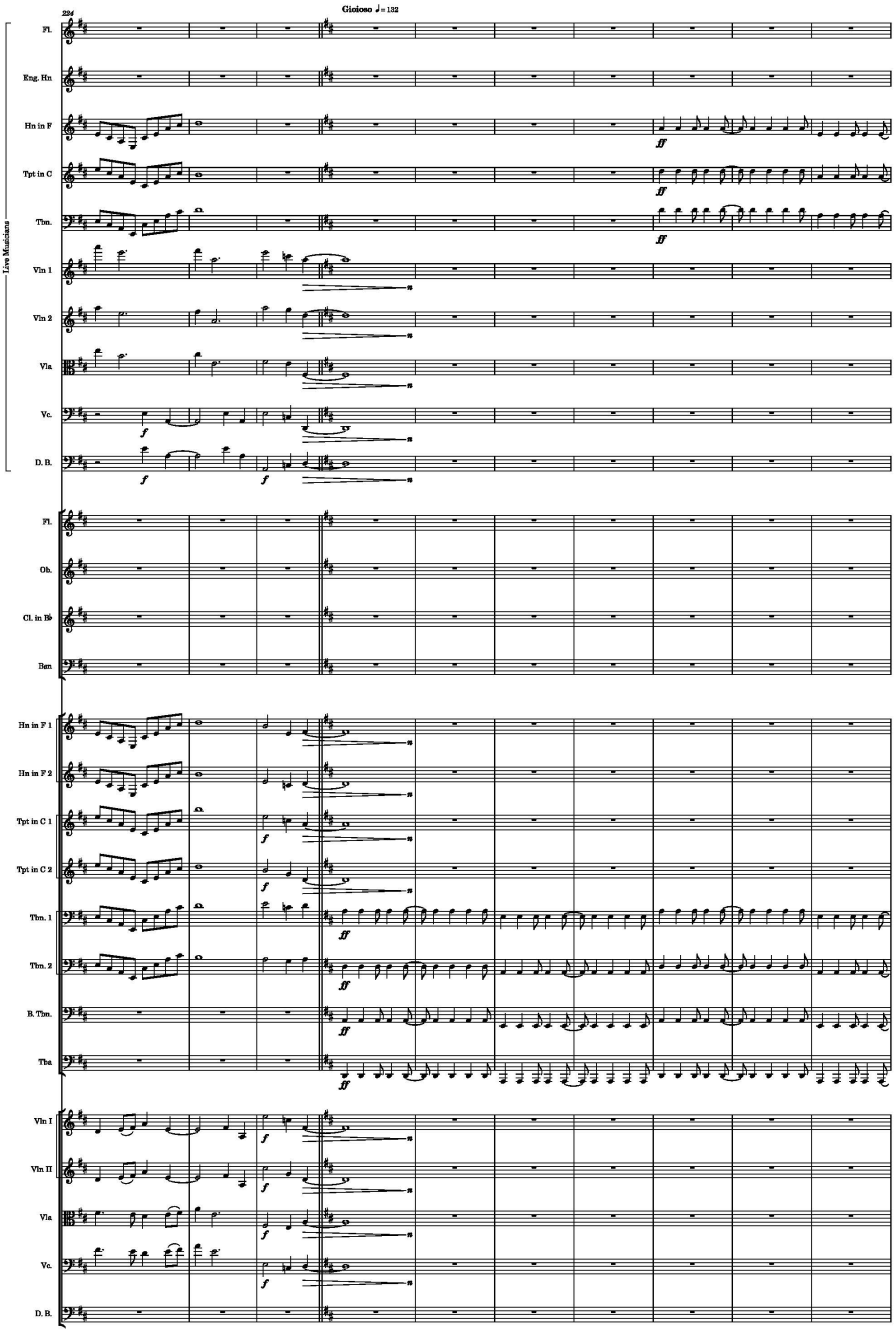

187
ritardando
Adagio ♩= 60
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.
arco

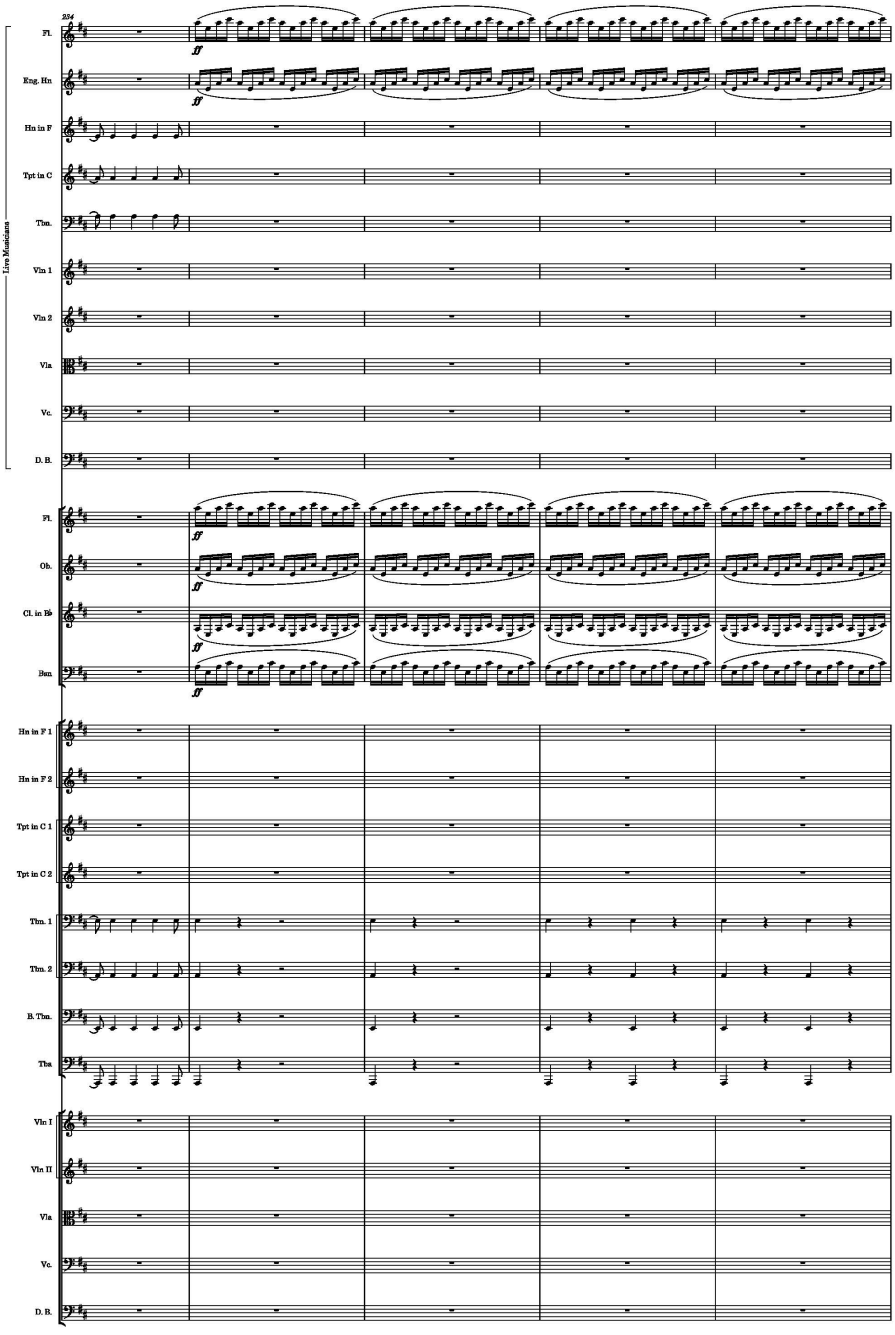

196
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in Bb
Bsn.
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.

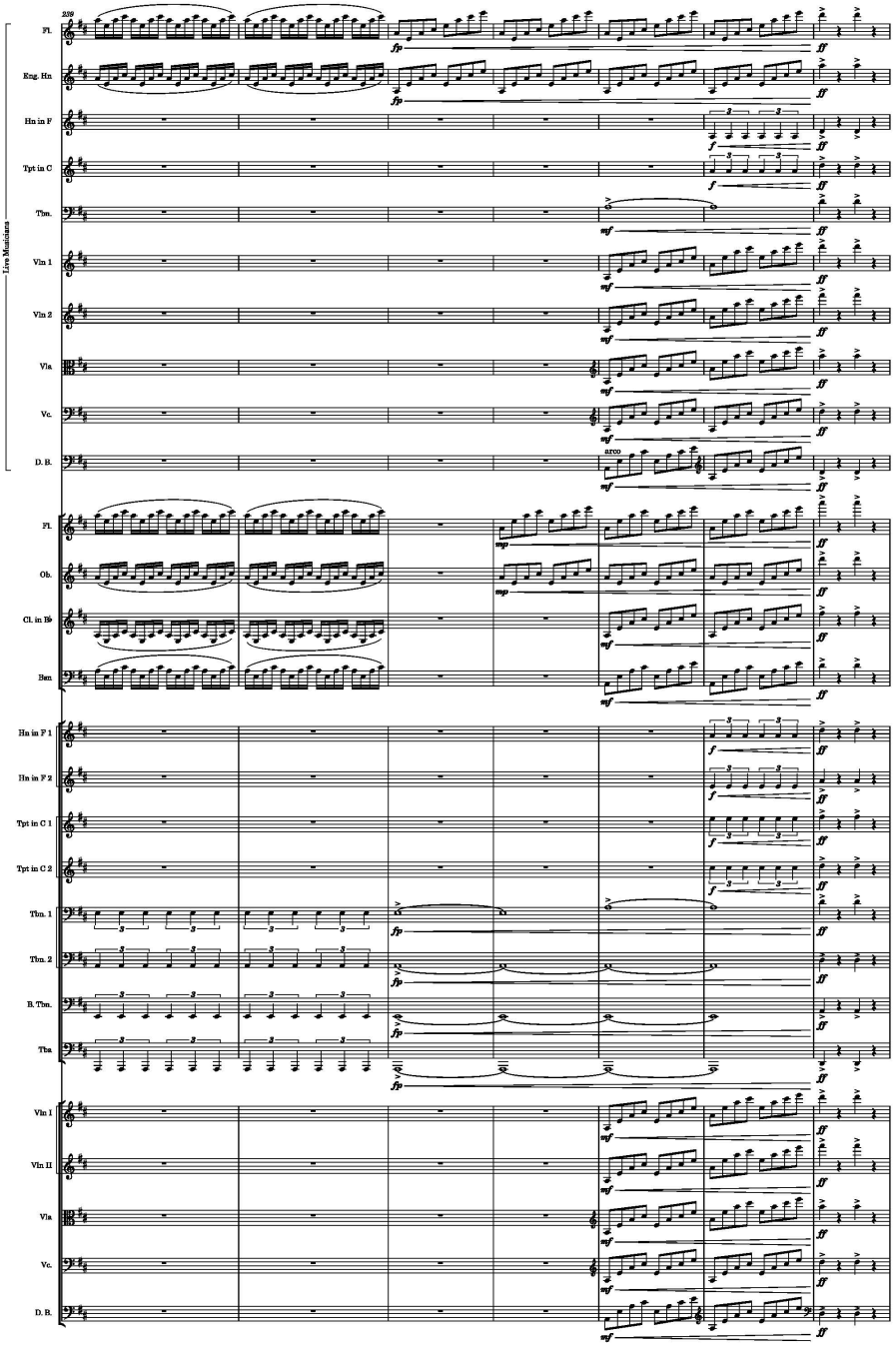

201
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
pizz.
f
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.
pizz.
f

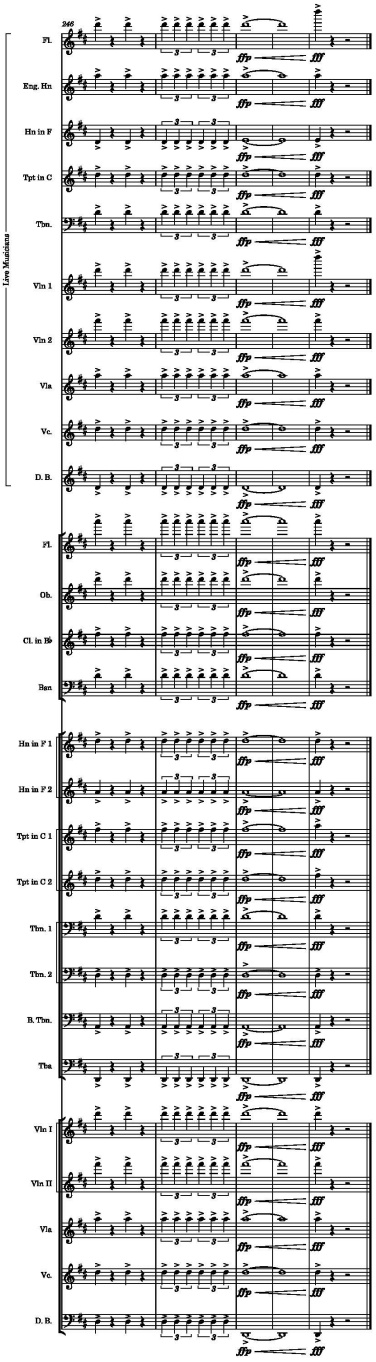

molto rit.....Largo ♩= 66
Live Musicians
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla
Vc.
D. B.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln II
p sub.
f
ff
arco


molto rit. Adagio ♩= 66
213
Fl.
Eng. Hn.
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Live Musicians
Fl.
Ob.
Cl. in B♭
Bsn.
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.


224
Giocoso ♩= 132
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.


234
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
ff
Fl.
Ob.
Cl. in B♭
Bsn.
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba.
Vln I
Vln II
Vla.
Vc.
D. B.


239
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
arco
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.


246
Live Musicians
Fl.
Eng. Hn
Hn in F
Tpt in C
Tbn.
Vln 1
Vln 2
Vla.
Vc.
D. B.
Fl.
Ob.
Cl. in B♭
Bsn
Hn in F 1
Hn in F 2
Tpt in C 1
Tpt in C 2
Tbn. 1
Tbn. 2
B. Tbn.
Tba
Vln I
Vln II
Vla.
Vc.
D. B.

CHAPTER 5 – DIGITAL ORCHESTRATION IN ACTION

To showcase the process of creating a digital mockup, I composed a piece for live musicians and virtual instruments titled "[A]Biotic Worlds." The piece is an experimental work combining live and virtual instruments in a live performance. While recordings of virtual and live instruments combined are common, live performances using VSTs are rarer. The piece is written for the live instruments of flute, English horn, F horn, C trumpet, trombone, violin I and II, viola, cello and double bass and virtual flute, oboe, B*b* clarinet, bassoon, F horn I and II, C trumpet I and II, trombone I and II, tuba, and a full string section of violin I, II, violas, celli, and double basses. This instrumentation showcases each instrument family in both the live and virtual spheres. The smaller orchestral instrumentation prevents the virtual instruments from overpowering the live instruments.

The goal of this piece is to encompass a wide array of articulations in both live and virtual instruments including tremolo, legato, marcato, accents, trills, sustains, staccatos, and pizzicato articulations as well as dynamics ranging from *p* to *fff*. This variety of articulations, dynamics, and tempos allows the virtual instruments to showcase their capabilities across tempos ranging from 56 bpm to 132 bpm. There are multiple

sudden and gradual tempo changes and fermatas. During a successful performance of this piece the audience should be unable to discern what is played acoustically and virtually. Ideally, the instrumentation should be seamless and give the effect of one singular orchestral unit instead of two separate entities performing together.

In "[A]Biotic Worlds" the live and virtual instruments live in separate realms, serving two separate purposes. The piece encapsulates different styles, or "worlds," that show how different and how similar these two groups are. As the piece begins, the virtual instruments act as a support for the live instruments. The piece slowly morphs as the listener enters the world of virtual instruments. The piece concludes as the two groups combine to create a harmonious community of live and virtual worlds.

To emulate an ideal orchestral sound and simulate the standard orchestral setting, the live performers should sit in three rows. The rows should follow the setup shown in **Figure 1.1** with violin I, II, viola, violoncello, and double bass in the first row, followed by flute and English horn in the second row, and horn, trumpet, and trombone in the final row. The performers should sit as close to an orchestral spread as possible: violin I farthest to the left, viola in the center, double bass to the right, and the other performers' windows between these. The piece also requires a stereo system to produce the virtual instrument sound. Ensembles should situate one speaker stage left and one stage right, either outside violin I and double bass or behind the live musicians. Finally, because the

piece has tempo changes, either the ensemble or a conductor must have access to a click track to stay in time with the mockup.

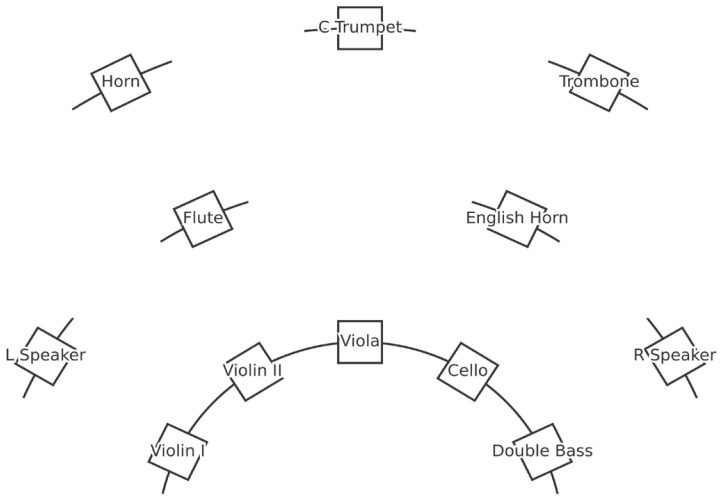


Figure 5.1: Proposed Seating Chart

I first composed "[A]Biotic Worlds" in the notation software Dorico and transferred the MIDI data into the DAW Cubase. I wrote the piece in notation first to

make the score easier for live musicians to read. Furthermore, this allowed me to establish tempos and dynamics to reference in the mockup of the virtual instruments.

One way I showcased an ideal sound of the music is through subtle references to popular orchestral pieces in the work. One of the primary influences of the piece, specifically in section three, is Holst's "Jupiter" from *The Planets*. This piece served as a primary influence because the orchestration during the Andante Maestoso section is crafted extremely well aiding in showcasing different sections with a simple harmonic progression. The piece served as my primary reference, as I attempted to create a mockup of the piece that was as close to the live version as possible. I was influenced by the fast string notes at the beginning of the piece, the simple harmonic progression in the lyrical section, and the trumpet entrance to push the emotive moment at the climax of the lyrical section.[75]

Another way I emulated an ideal sound of the mockup was to include multiple articulations throughout the piece. To show the range of available articulations in the VST plugins in my template I split "[A]Biotic Worlds" into three distinct sections. First, the piece showcases the live musicians with virtual instruments acting as the background, and occasionally middle-ground. Section two presents the inverse with the virtual

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[75] Gustav Holst, "Gustav Holst: 'Jupiter' from 'The Planets' op. 32 with Andrew Manze | NDR Radiophilharmonie," April 19, 2022, YouTube video, 8:39, https://www.youtube.com/watch?app=desktop&v=3aXsQQ-ueBk&embeds_referring_euri=https%3A%2F%2Fwww.mediapia.co.kr%2F&feature=emb_imp_woyt.

instruments reaching the foreground while the live instruments remain in the middle-ground and background. The final section combines live and virtual musicians working cohesively across the spectrum. To further display the capabilities of live and virtual instruments, each section consists of 2–3-minute motivic sections with different styles, tempos, articulations, and dynamic levels.

Section one begins with a cluster played by both live and virtual stringed tremolos and select brass, as shown in **Figure 5.2**. The cluster builds into the subsequent sixteenth-

note section while leaving the listener unable to discern which notes are played virtually and which notes are played acoustically.

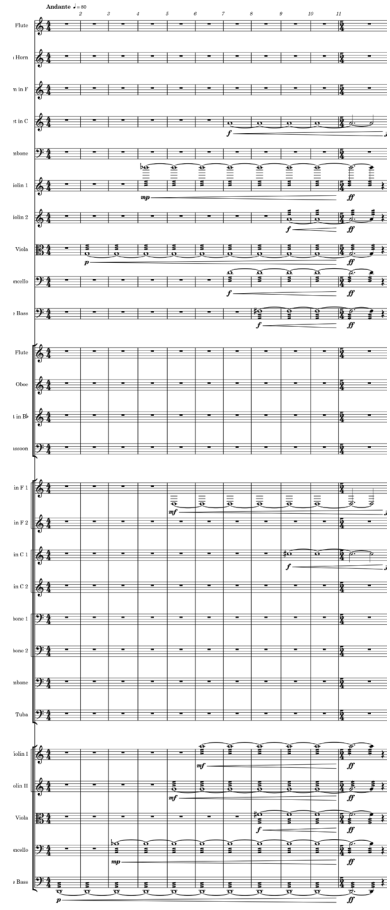

Figure 5.2: Mm. 1—12 Cluster Build

The next section presents an interplay between the live string ensemble and the virtual string orchestra. Having the sixteenth-note line played continuously allows the instruments to swap in and out seamlessly between live and virtual without the listener hearing a distinct change. The section continues with brass instruments presenting a

melody and counter-melody line played with live musicians and echoed by the virtual instruments. Because the instruments are playing simultaneously, it is harder for listeners to discern the live from the virtual lines. The reverb I attached to each track—REverance by Steinberg—creates a cohesive sound between the sampled and live instruments. The reverb makes the virtual instruments sound like they are being performed in the same hall as the live chamber ensemble.

Another important section is mm. 55—62. This section consists of a melodic line in the live, solo horn while the virtual brass play long chords. Rather than breaking up the whole notes into a more "interesting" harmonic line, I used this section to showcase the sustained sounds of libraries. Because sustains work best when there is little movement, having the brass change, at most, every measure allows the library to perform as

intended. The live brass takes over the whole notes in m. 63 to highlight how similar the live and virtual versions sound.

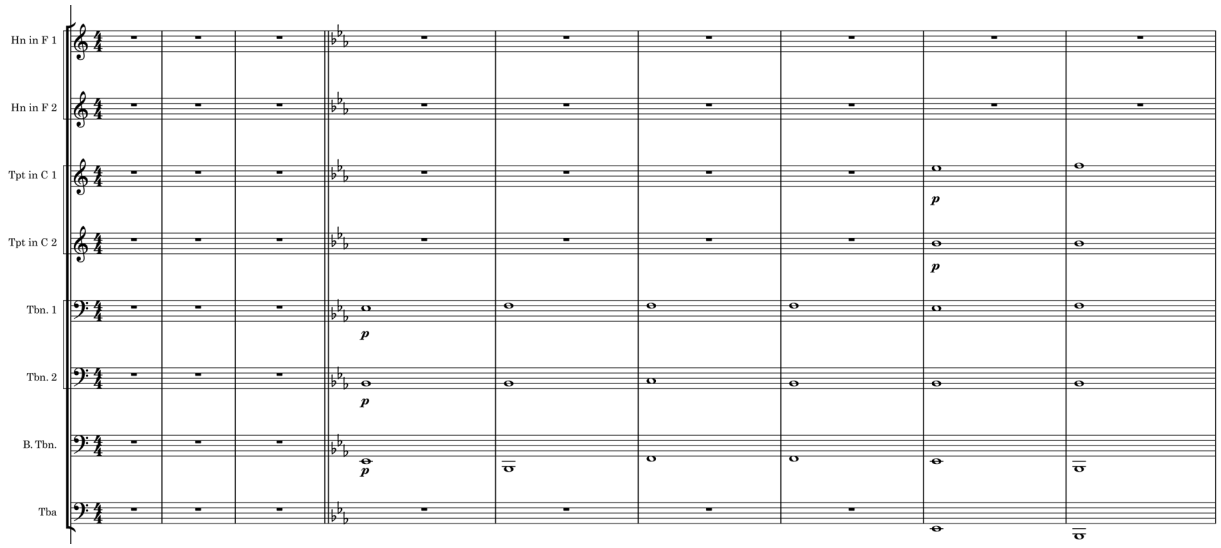

Figure 5.3: Virtual Brass Mm. 52-60

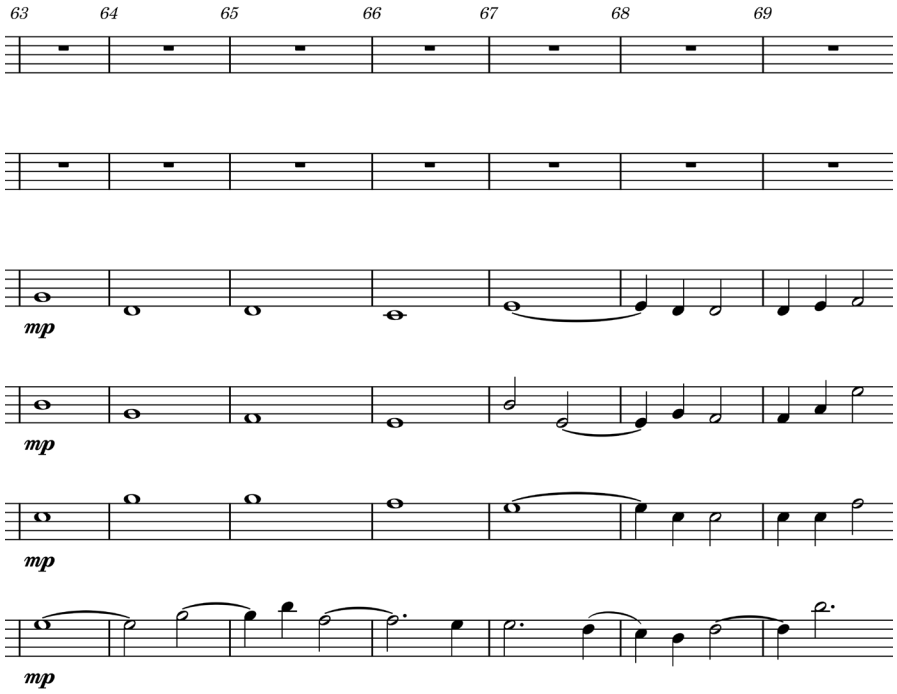

Figure 5.4 Live Brass Response to **Figure 5.2**

Section two of the piece begins similarly to section one with a cluster from m. 106 to m. 112. This serves a similar purpose as the opening cluster but encompasses all the instruments, as shown in **Figure 5.5**. This also shifts the instruments as the virtual

instruments become the foreground, while the live instruments are reserved for the background and middle-ground.

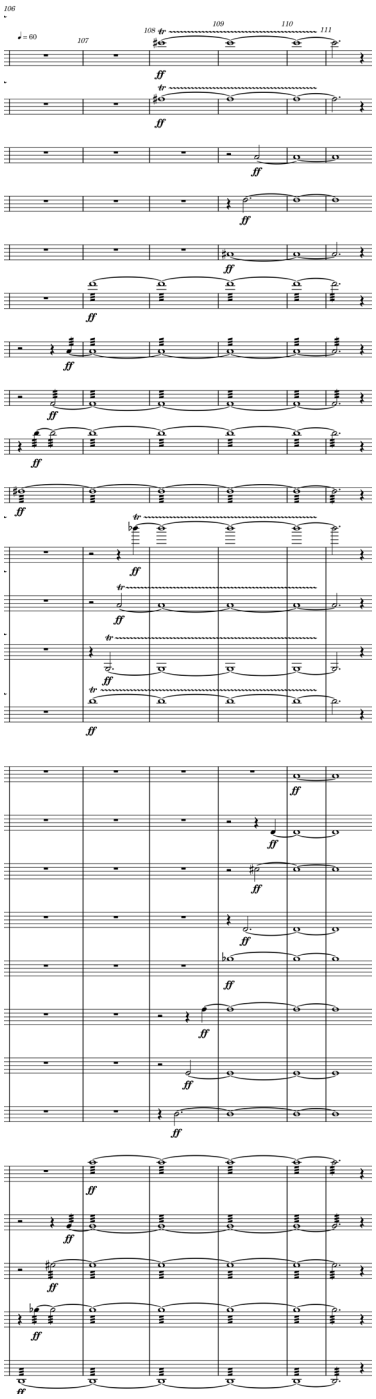

Figure 5.4: Mm. 106—112

The dynamics and orchestration in the piece grow as each phrase adds more instruments beginning in m. 146 and concluding in m. 192. This is the section in which the "worlds" collide and leads into section three which begins at m. 192 and continues until the conclusion of the piece. This section presents the strongest example of an ideal sound within the work. It combines live and virtual instruments in the foreground, middle-ground, and background. Having the instruments serve the same purpose allows each element, live and virtual, to enhance their counterparts. The live instruments enhance the performance with a level of realism with the virtual instruments adding dynamic support to the smaller ensemble. With each section working cohesively, the listener hears a full orchestra being portrayed by nine live musicians. It is also the climax of the theme for the piece, as the two "worlds" become one and work cohesively together.

I split the piece into three sections, each demonstrating a different relationship between the VSTs and the live instruments. In the first, the VSTs color the live instruments. In the second, the live instruments and the VSTs switch roles; the VSTs play the melody and the live instruments color them. In the third, the VSTs and the live instruments work cohesively together in a blended texture. The three sections highlight an ideal-sounding aspects of VSTs as well as their use in concert environments

On finishing the piece within the notation software, I transferred the MIDI file into my template in Cubase, including the tempo, time signatures, and reference automation. The instruments used in my template consist of Cinematic Studio Winds,

Brass, and Strings, EW Hollywood Opus, and Norrland Samples Solo Trumpet largely due to RAM and budget limitations. To separate the sounds of the live musicians, I used NotePerformer for the live instruments in the reference recording.

My template includes all the tracks pre-loaded into Cubase. All of my tracks are routed through three levels before reaching audio out. Each track has a pre-delay time between -80 and -50ms. I applied all reverb to the Level 2 grouping. To further balance the ensemble, I lowered some track volumes to create an equal sound within my mockup. Finally, I lowered the full mix to prevent some clipping issues that had arisen.

A problem arose during the sixteenth-note section for strings in mm. 14-30 and winds in mm.116-126. Cinematic Studio Strings was unable to handle this section without sounding artificial, because CSS did not have an articulation that matched my desired sound. EW Hollywood Opus was able to handle this section due to its repetition articulation.

Another simple correction was needed in the tempo changes. While the DAW did import the tempo changes from the MIDI file, the ritardandos were not dramatic enough for my taste so I increased them toward the end of each gradual change. The tempo during the fermatas in mm. 133-134 was another moment I had to focus on. When the file was imported into Cubase, it did not change the tempo for the fermatas so the notes played as whole notes as opposed to being held longer. The simplest solution to this

problem was to change the tempo to half-speed during the fermata notes before returning to the correct tempo immediately following.

While the first two problems took relatively little time to fix, correcting articulations took significantly longer. Translating articulation markings into VSTs requires extra time because sample libraries do not have the breadth of articulations of live musicians. This required me to go through each articulation to determine the best fit within the VSTs using key switches. Slurs proved to be difficult as CSS does not have a specific articulation for slurs, so I opted to use legatos with each note ending slightly after the beginning of the next note to give the illusion of a slur.

Another issue to deal with in the mockup was the trumpet. The loud volume and dry, brassy timbre of the trumpet make it one of the most challenging instruments in creating the ideal sound. I used Norrland's Solo Trumpet in my piece to enhance the achieve this. While this sample requires a lot of RAM, it sounds closer to the desired sound than the other samples at my disposal. To elevate the trumpet sound further, I added more micro-phrasing elements to the instrument than others, along with modulation, expression and other automations.

As composers gain access to better tools, their ability to emulate the ideal orchestral mockup sound continues to improve. Understanding the nature of acoustic orchestration and instrumentation, specific techniques and approaches for virtual instruments and sample libraries, and methods to process and manipulate MIDI audio allows composers to create mockups that emulate the ideal sound. Furthermore, these

techniques apply to every sample, DAW, and setup regardless of price, quality, or experience.

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The style guide for this document was *A Manual for Writers of Research Papers, Theses, and Dissertations* by Kate L. Turabian (9th Edition).

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