Manipulating micro-rhythm and micro-timing in digital music creation, with a focus on mixing music: three general perspectives

Jan-Olof Gullö
Royal College of Music, Stockholm, Sweden. jan-olof.gullo@kmh.se

Gary Bromham
Queen Mary University of London
g.bromham@qmul.ac.uk

ABSTRACT
Our research project, "Searching for Sophia [Wisdom] in Music Production," explores the critical factors contributing to successful music production by examining it across music education, musicology, psychology, and sociology. This ongoing sub-project focuses on micro-rhythm and micro-timing manipulation in digital music production, particularly during mixing and post-production. Micro-timing adjustments, which involve small temporal shifts of audio tracks, enhance phase coherency and alter groove perception, impacting the listener's experience. Drawing on the Haas effect, we conducted experiments using micro-timing strategies in drum recordings and other instruments, revealing the influence of micro-timing on groove and sound unity. Future studies will explore the influence of micro-timing on audiovisual productions and listener perception.

Author Keywords
Music Production, Micro-timing, Haas-effect, Groove, Lip-sync

CCS Concepts
Applied computing → **Sound and music computing**; Performing arts.

1. INTRODUCTION
Our research project, "Searching for Sophia [Wisdom] in Music Production," aims to uncover some of the critical factors contributing to successful music production. We seek to comprehensively understand facets of music production by exploring it in the academic fields of music education, musicology, psychology, and sociology. Our goal is to understand better what leads to success among listeners and the music industry. This ongoing sub-project focuses on the significance of micro rhythm and micro timing manipulation in digital music creation, particularly in music production and, specifically, in mixing music.

In music production, the actual production process is often divided into different stages. This can be simplified in three stages [1,2,3]. The first stage is pre-production, during which the recording work is planned. The actual recording takes place in the production phase. Once all the recordings are completed, they are edited and compiled during the post-production process. This last phase includes mixing and mastering, which are used to create the final versions, then submitted for streaming on platforms such as YouTube or Spotify, or for traditional media such as radio, television, or film. Various aspects of the music recording are altered in various ways during such editing and mixing. In today's music production, there is often an overlap between these three stages: pre-production, production, and post-production. Pre-production involves working with recordings to prepare for the upcoming production; this includes tasks such as testing the appropriate key for the singer, trying out different arrangement ideas and preparing score material, for example. If these preparatory recordings are of high musical, artistic, and technical quality, they can be kept and used in the production. Many music producers today work in teams, especially when producing popular music. Team participants often have different roles, and specialised team members work on tasks such as mixing, which involves blending different recorded parts and balancing the sound of different instruments to create the desired soundscape. When mixing music, which usually takes place in a DAW (Digital Audio Workstation), several tools are used to manipulate the recorded music [4]. In most cases, the music is recorded on several tracks, and the volume level of these tracks is carefully balanced during the mixing process. Other important aspects include panning, dynamics, and manipulating timbre, amongst other tasks.

2nd Audiovisual Symposium 2024, December 6, 2024, Dalarna Audiovisual Academy (DAVA), Dalarna University, Falun, Sweden.

2. MICRO-TIMING
An element that has yet to receive much attention in previous research is micro-timing in mixing music. This involves adjusting the timing of different audio tracks in a mix against one another to manipulate the overall feel. Usually, such micro-timing manipulation is done with minimal adjustments of just a few microseconds but sometimes in significantly longer intervals, such as 50 milliseconds or more. There are two main reasons for such micro-timing manipulation. First, it effectively creates a clearer sense of phase coherency when a sound source, such as a drum kit, has been recorded with multiple microphones [5]. Second, micro-timing manipulation can be used to create a different Groove or Feel. It is not uncommon for music producers, usually during mixing but also during earlier stages of a project, to try moving audio tracks horizontally to change the perceived interplay between musicians [6,7]. For example, adding a slight time difference of 20 milliseconds to a recorded electric bass in relation to the drums can effectively give the drums a more prominent groove. Furthermore, a third important perspective involving micro-timing in music production is when the music, one way or another, is embedded in an audio-visual presentation.

The theoretical background for this study is mainly based on the Haas effect, described by Helmut Haas in his PhD thesis in 1949 [8,9]. This phenomenon, also known as the precedence effect, relates to the law of the first wavefront [10] and involves how humans interpret sound reflections and echoes. It occurs when a listener hears two similar sounds that are close enough in timing to be regarded as a single auditory event. When the sounds originate from different directions, the listener's perception of where the sound comes from is primarily based on the first arriving sound. If two identical sounds reach the listener with a slight delay that remains below the threshold of perceiving an

source of this event is largely determined by the initial sound wave, which arrives first, while the role of the delayed sound in determining location is considerably weaker. The precedence effect is observed when the second and subsequent wavefronts reach the listener 2 to 50 milliseconds after the initial wavefront. Haas notes in his study that this effect can still be detected even if the delayed sound is up to 10 decibels louder than the first wavefront, particularly for delays ranging from 10 to 30 milliseconds. However, when multiple microphones are used or delays are applied to multiple sources in auditory material, a comb-filtering effect may occur [11, 12]. Comb filtering is an audio phenomenon that occurs when two identical sounds reach a listener's ears, or a microphone, with slight timing variations. This timing difference, described as delay, can range from a single sample to several milliseconds. Such a delay produces a subtle interference pattern that modifies the tonal quality of the sound. However, if the delay is extended and exceeds 20 milliseconds, the auditory system often perceives the sound instead as a distinct echo, resulting in a clearer, separate repetition of the original sound. This effect can significantly affect sound clarity and spatial perception in music and acoustics. The Haas effect provides an opportunity to enhance and enhance a primary sound while preserving its directional characteristics, provided that the duration of the delay remains within a moderate range and the amplitude of the delayed signal does not exceed a reasonable level. Conversely, if the delay duration is excessively prolonged or the delayed signal is overly pronounced, it may begin to be perceived as a distinct echo.

3. EXPERIMENTING WITH MICRO-TIMING

In this ongoing project, we performed several sub-studies where we used different micro-timing strategies. Here, we present some examples from our research on micro-rhythm and micro-timing in digital music creation, with a specific focus on the area of mixing music. Primarily, we highlight how such micro-rhythm and micro-timing manipulation can enhance clarity, the groove in a mix, and consequently how listeners may perceive the music. The study is carried out based on the overall research question concerning how micro-rhythm and micro-timing manipulation can be used in music production to contribute to a desired sound and implementation in the aesthetic process.

In several sub-studies, we have tested how micro-timing can be used in the processing of recorded music when several microphones are employed to record a sounding object. This can be most clearly exemplified when mixing recordings, including drums. Typically, multiple microphones are used when recording drums. A drum kit consists of several different instruments. It can be, for example, the bass drum, snare drum, tom-toms, and cymbals of various kinds. In some cases, the producer or sound engineer chooses to place the microphones close to the various instruments in the drum kit and also to use microphones at a greater distance [13,14,15]. It is obvious that it takes different times for the sound to travel from the different sound sources to each microphone, and, in addition, sound leaks in from nearby instruments in the drum kit. It is not uncommon for a dozen or more microphones to be used when recording drum kits. Even if the recording has taken place in isolation from all the other instruments involved in the current music production, mixing the recorded sound into a cohesive unit can be a significant challenge. A method that we have tried is based on the Haas model to determine a sound centre. For example, it could be a microphone placed a few metres above the drum kit. The other sound sources, usually recorded sound from microphones near the various instruments in the drum kit, are then processed with delay. This is what we call micro-timing manipulation. If such a delay occurs in accordance with the Haas model, it is possible to create a unified soundscape with a clear directional character, completely devoid of the phase extinction that is usually a significant concern in multi-microphone technology.

We have also conducted some initial studies in this ongoing project, in which we experimented with altering the timing between different sound sources, such as drums, electric bass, guitar, and vocals, in order to enhance or change the musical groove. An unexpected finding from these timing-altering studies is that changing the rhythm can influence how strong or weak the music or groove is perceived to be, as well as how loud different instruments in the mix are perceived, even when quite short delay times are added. This may be a powerful tool for enhancing static expression that has not been thoroughly explored in previous research and is also not always used to its full extent by many music producers or sound engineers. We have multiple sub-studies pending, and we will share further results on this matter at a later occasion.

Another aspect of our project involves examining how micro-timing can impact the experience of music when combined with other media, such as audiovisual productions. We have additional sub-studies to complete in this area, including studies on lip-sync, and will revisit this topic in the future.

4. REFERENCES

[1] Burgess, R. J. (2013). *The art of music production: The theory and practice*. Oxford University Press.

[2] Hepworth-Sawyer, R., & Golding, C. (2011). *What is music production?: a producer's guide: the role, the people, the process*. Taylor & Francis.

[3] Bourbon, Andrew & Zagorski-Thomas, Simon (eds.), *The Bloomsbury handbook of music production*, Bloomsbury Academic, New York, 2020

[4] Bell, A. P. (2018). *Dawn of the DAW: The studio as musical instrument*. Oxford University Press.

[5] Hepworth-Sawyer, R., & Hodgson, J. (Eds.). (2016). *Mixing music*. Taylor & Francis.

[6] Hellmer, K., & Madison, G. (2015). Quantifying microtiming patterning and variability in drum kit recordings: A method and some data. *Music Perception: An Interdisciplinary Journal*, *33*(2), 147-162.

[7] Danielsen, A. (Ed.). (2010). *Musical rhythm in the age of digital reproduction*. Ashgate

[8] Haas, H. (1951). "Uber den Einfluss eines Einfachechos auf die Horsamkeit von Sprache," *Acustica, 1,* No 2, 49–58.

[9] Katz, Bob (2007). *Mastering Audio: The Art and the Science*. Taylor & Francis. pp. 229–237

[10] Cremer, L. (1948): "Die wissenschaftlichen Grundlagen der Raumakustik", Bd. 1. Hirzel-Verlag Stuttgart.

[11] Meyer, J. (2009). *Acoustics and the performance of music: Manual for acousticians, audio engineers, musicians, architects and musical instrument makers*. Springer Media.

[12] Clifford, A., & Reiss, J. D. (2011). Reducing comb filtering on different musical instruments using time delay estimation. *Journal of the Art of Record Production*, *5*.

[13] Toulson, R. (2021). *Drum sound and drum tuning: Bridging science and creativity*. Focal Press.

[14] Huber, D. M., & Runstein, R. (2013). *Modern recording techniques*. Routledge.

[15] Hodgson, J. (2019). *Understanding records: A field guide to recording practice*. Bloomsbury Publishing US