Musical Notation, Music Performance and Technology: A Long Term Synergistic Relationship

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It is the intent of this paper to render a historical narrative that demonstrates the dynamics of the coexistence of music performance and musical notation, how they have influenced and stimulated one another in Western music beginning in Greek and Jewish traditions known as antiquity, proceeding to contemporary situations. They have evolved together countering discrepancies via adaptation in order to meet the musical demands of each period. Throughout the centuries technical notational devices have been developed that refined the capabilities of specificity and enabled the dissemination of music repertoire on a mass scale which has greatly impacted society. Interactions between communication practices such as musical performance and technology are related to institutions, cultural values, social practices, and economic conditions. Musical notation has created both access and barriers to musicianship for people and musical identities/genres have been defined by the use (or not) of written music. For the purpose of this paper the advent of recorded music will be assessed for its impact on performance practices, performance opportunities, and archival potential and the legal issues concerning ownership of music in any format will not be included.

Synergistic is often used to describe the effects of drugs working together – where one drug increases the other's effectiveness. It can also refer to various parts working together to produce enhanced results. Music performance is a complex composite of many interactive components which is more than simply the sum of its parts. Musical performance is a step in the musical process during which musical ideas (humanly organized sounds) are realized and transmitted to a listener. Hearing music involves the aural process while performing music can be thought of as involving the oral process. Musical notation is a system used to visually represent aurally perceived music through the use of written symbols. It could be regarded as

one of the earliest codes of communication, and as a technology that provides a tangibility to the ephemeral world of music. "The genealogy of modern notation, now some three hundred years old, reaches back almost three thousand years to the *letter notation* of ancient Greece" and early Hebraic liturgical chant. [1]

Generally speaking there are two classes of musical notation. Notation can be either phonetic "in which sounds are represented by letters, numbers or other signs" or diastematic, also called intervallic "in which sounds are represented graphically". Ancient Greek and Chinese music are based on phonetic music notation while Western music is a diastematic music notation. [2] Scholars concur that the pre-Christian Greeks had at least four different systems of musical notation, all derived from the letters of the alphabet and they employed one type of system for vocal music and a completely different system for instrumental music.[3] In Jewish cantillation notation was used to complement the letter and vowel points of chanted Biblical text known as accents and the musical motifs associated with the signs are known as troupe in English. Another device known as cheironomy consisted of hand gestures that aided in both the memorization and execution of chant. All of these ancient modes of notation were adjuncts to their current oral tradition of performance and although from our modern vantage point may seem very simplistic, they were an effective system of music notation that facilitated successful performances in their own respective contexts. Scrolls, music theory essays, and fragments of

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[1] Gardner Read, Music Notation: A Manual of Modern Practice (London: G. Bells and Sons, 1979) 3.

[2] Hope Strayer, "From Neumes to Notes: The Evolution of Music Notation", Musical Offerings 4, no.1 (2013) 1-14.

[3] Read, Music Notation: A Manual of Modern Practice, 4.

papyrus scores provide hand written artifacts that provide a sparse glimpse into the beginnings of the relationship between notation and performance.

Early Christian churches by way of the repetitive use of chants and plainsong throughout the liturgical calendar created a need for "a form of writing that would demonstrate a chant's pitch, duration, loudness, and articulation to the scholars and monks of the church." [4]"The use of neumes to notate melodies which emerged in the ninth century first began as symbols placed above the text to indicate the melodic gesture for that syllable" mimicking the Jewish cantillation tradition. According to Leo Treitler the word "neumes" is derived from the Greek word *neuma* which means "a sign". There is a strong scholarly consensus that these accent signs can be credited to the classical literature of Aristophanes of Byzantium (ca. 180 B.C.) [5] The early Middle Ages was a time of general illiteracy where only the clergy, royalty, and those from privileged classes were able to read and write.

> As a result, most of the music notation from this time period has been found in highly decorative manuscripts called illuminated manuscripts. These manuscripts were written and decorated by hand in either Gothic or Roman notation. Manuscripts that contained text were sometimes left blank or only the staff lines were drawn where the music was to be added later. The most common color for the staff lines was red, but sometimes black was used. The notes were then written in black ink. The paper on which the music was written was mainly vellum made from animal hide. [6](Reyna)

At the onset of the Middle Ages, neumes only conveyed general information about the melodic contour which meant that the singers (vocal music dominated musical life until the Baroque era) learned the songs by ear. The forms of written musical notation and traditional

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[4] David Mann, The Birth of a Written Musical Language: Literacy in music and its effect on musicians and music throughout history. http://www.jmu.edu/mwa/docs/2011/mann.pdf

[5] Strayer,"From Neumes to Notes: The Evolution of Music Notation", 2.

[6] Rosenda Reyna. Music Printing History. http://www.musicprintinghistory.org/

orality "were not mutually exclusive; they worked together to create an optimum form of musical practice."[7] Exact pitches could not be established nor could the intervallic distance between them and their rhythmic durations could not be precisely conveyed. Alterations to this form of notation emerged to address these deficiencies by the end of the ninth century and continued to evolve in a responsive manner throughout the Renaissance period. Initially imaginary lines were mentally inserted into the manuscript and Italian and French scribes placed notes higher and lower in relationship to this imaginary line as well as elongated parts of the symbols of some notes to express even more distance. Later on an actual line was carved into the manuscript itself, colorless it served as an organizational point of reference and can be regarded as the emergence of a more distinctive diastematic notation.[8] The precursor of the musical staff ensued by filling in the carved line with ink which was red and designated as *F*. This was followed by an additional line in yellow designated as *C*. These innovations were generated by the dynamic interplay between the growing needs experienced in performance and liturgical requirements dictated from the Catholic Church. Monks provided the theoretical frameworks which often included developing musical writing practices.

Musical notation greatly impacted the manner in which music was learned. Guido of Arezzo has been considered as the inventor of the musical staff. He wrote about it many times and his text, the *Micrologus*, was a widely distributed treatise on music in the Middle Ages. He developed new techniques for teaching music by including staff notation, solmization which is assigning syllables to pitches, and most famously by a widely used mnemonic system where note

[7] Stayer, "From Neumes to Notes: The Evolution of Music Notation", 3.

[8] Ibid.

names are mapped to parts of the human hand. Music could now possibly be learned without hearing it first. However orality was still the chosen method of memorizing music where notation served as an aide to remembering what had already been memorized. Most singers had over eighty hours of liturgical music memorized. Musical notation impacted literacy, eased the task of memorization and now written music could be transported to other places and more readily learned which created performance experiences that initiated a direction towards a more unified canon of repertoire and performance practice. It would become the cornerstone of West art music.

Rhythmic notation had been largely neglected. Liturgical vocal music was becoming more harmonically and rhythmically complex. "The first standard form of rhythmic notation occurred with Notre Dame polyphony." [9]Clearer notation was needed so that performers could distinguish their moving individual musical lines amidst many competing ones. Leoninus and Perotinus are honored as important contributors to the systematization and organization of polyphonic repertoire. In 1280 "Franco of Cologne developed the next rhythmic innovation by building on the established modal system" known as "mensuration signs" and most impressively he created a formal symbolic definition for a rest or silence.[10]The modal system consisted of groups of notes and Franco liberated each note by extracting it and assigning it a specific length of duration. One of his innovations eventually would become modern time signatures that allow musicians to successfully perform complex works involving many individual parts. During the *Ars Nova* period, circa 1310-1370, music notation continued to allow a more rhythmic independence for notes and secular music gained in sophistication as well. The *Ars Subtilor* period was regarded as an endnote to the entire Middle Ages in the late fourteenth century. Coloration was a technique

[9] Ibid. 6.
[10] Ibid. 8.

used where notes that were printed in red ink indicated a specific intervallic alteration in performance. The music was very complex, difficult to sing and hence the visual complexity of notation dually matched it creating some of the most elaborate scores in unusually expressive shapes such as a heart, an eye, or triangle.

Eye music is a term that describes graphical features of scores that when performed are unnoticeable to the listener. A type of eye music occurs when the device of writing with absurdly small note values as well as ridiculously large ones is used to match the words of a song. "The score is made difficult "unnecessarily," is eye-catching for its graphics, and has a clever external reference, all unnoticeable to the listener."[11] Music had become objectified and although this style of notation was in vogue for a short time and relatively few people participated in it, it altered how Western culture perceived music. It would be revived in the twentieth century. The visual aspect had competed with the primacy of orality as the norm. Performance/oral tradition complemented early forms of notation by supplementing information that notation did not contain. By enabling exact recall music notation now complemented the performance/oral tradition and changed the ways that memorization and performance were implemented.[12]Literate audience members of this period were very few. Performing church musicians who typically where also composers were trained to develop the ability to hear what was seen and to see what was heard. This cloistered privilege would soon become within reach of the secular population of musicians with the invention of the printing press by Guttenberg in 1450.

The immense complexity of printing music due to its vast number and variety of symbols and graphic nature presented many technical problems and demanded innovative solutions. "By the

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[11] Thurston Dart, "Eye Music", Grove Music Online, (Stanley Sadie, editor. London: Macmillan, 1980)

[12] Strayer, "From Neumes to Notes: The Evolution of Music Notation", 11.

late fifteenth century a technique evolved for printing music called woodblock printing." It entailed writing or drawing the music on a piece of wood in reverse enabling the printing of a mirror image. The symbols were elevated by cutting the wood out around them. The entire woodcut was inked, pressed on paper or vellum and left to dry. *Opusculum Musices* (1487) by Nicolaus Burtius is cited as the earliest known book of music printed by woodblock.[13] Early music printing relied on the highly decorative and elaborate manuscripts that had been hand copied by monks for models to emulate. Staff lines were printed first in one color and followed by notes and words in contrasting colors. This was tedious work and expensive. Multiple colors were abandoned which was a significant visual change that impacted how musicians were stimulated to recognize notes and spatially relate to the page. Individual pitches have long been associated with colors and emotions in a semiotic fashion which fuel a performer's interpretative palette.

Another important consequence for performers in relation to the standardization of type setting was the established custom of stem placement. A stem in musical notation is the vertical line that interlocks with a circle or notehead, similar to how a flower blossom is supported. When written by hand they had been drawn on either the left or the right according to personal taste and in early printing they were aligned directly in the middle of the notehead. The printers placed them in the middle in order to be able to make the note invertible or reusable however this representation made the notes seem to "float" and made reading patterns awkward. This was resolved by the printer's decision to uniformly attach stems on the left side going down and on the right side going up which altered how people wrote manuscript by hand and it has defined multiple aspects of "reading" expectations for performers. An important side-effect of the

[13] Rosenda Reyna. Music Printing History, http://www.musicprintinghistory.org/

invention of musical printing was to slow down the evolutionary process of notation. The burgeoning accuracy of notation standardized performances and actually constricted the artistry of individual musicians. Personal interpretation of the musical experience began to be micromanaged in a way not previously possible.

Instrumental music was gaining traction at this time. The fast note runs of the harpsichord and violin needed something different from what the letter press style of printing provided. "Because moveable type was unable to duplicate many of the details of hand-written manuscripts, more elaborate methods of printing music were adopted. Engraving was the next technique used to print music."[14] Skilled engraving required a long apprenticeship and someone with substantial musical skills. It was followed by lithography which was invented by the playwright, Alois Senefelder in 1796. [15] Photography changed music printing and "photolithography became a practical process to copy music". The Halstan Process was a method that involved drawing with blue pencil initially and black ink was added around the penciling. A photo was taken where the pencil marks didn't show and the proof was used to duplicate the music. [16]Stencils, stamps, and transfers were other options for copying and writing music.

Musical typewriters were developed in the 1800s but did not become popular until the mid - 1950s. They used musical symbols instead of letters and the Keaton Music Typewriter had two keyboards (one stationary and one moveable). [17]In 1946 the Musicwriter was invented and was used worldwide. An electronic version, Musicwriter II, was developed in 1988 that was capable of typing both alpha-numeric symbols and musical symbols. [18] These technical advances in the

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14 Ibid
15 Ibid.
16 Ibid.
17 Ibid.
18 Ibid.

printing of, copying, and mass dissemination of sheet music were innovative responses to market demands. Musical notation had remained stable for centuries but much had changed in musical repertoire and in the world of sound production itself.

Western art music had evolved and expanded artistically to include many forms, styles, and instrumental configurations. Secular music had established itself independently from sacred music and was embedded in educational curriculums. The advent of the phonograph and radio transformed everyone's relationship to sound. New performance experiences were generated from the popularity of live radio shows, theatre, cinema, and the business demands propelling the recording industry. Sheet music in standardized notation had become widely available and a growing middle class embraced piano playing in their homes. Popular songs unified societies and innovative composition flourished. Stable pedagogical methodologies developed which molded generations of professional and non-professional musicians. Twentieth century musical aesthetics were directly impacted by the presence of these phenomena.

Twentieth century Western art music embraced multiple styles and created hybrid genres. Composers were no longer held captive by labels that locked them into a solitary musical identity; they were free to seriously dabble. There was much experimentation with non-western musical traditions, instrumentation selection, exploitation of instrumental capabilities, mixed media presentations, defying conventional musical syntaxes, and improvisation. Explicit notational markings began to be fabricated and implemented that conveyed detailed instructions for the performer. In juxtaposition to this controlling approach, the written scores for aleatory or chance music contained vague or loose descriptions of the composer's intent. There was a resurgence of eye music where scores could look like abstract modern art drawings rather than as functional guides for musical performance. The presence of the composer during rehearsal was

essential for some of these compositions. Experiments in technologically created and produced music were conducted in a few expensively equipped studios. As equipment became more affordable many more composers began to work with computers and synthesizers. These pioneering musical compositions were constructed of sounds and sound effects that had not previously existed and thus notating them was literally uncharted territory. "A computer generated visual representation of an audio file shows purely sound quality as it relates to (its) frequency. This entirely new and different way of visualizing music (could) be the precursor to a new era of musical notation." [19]

Computer software provided unprecedented opportunities to represent music notation. During the early 1960s the first two programs were developed: Plaine and Easie Code and DARMS (Digital Alternate Representation of Musical Scores). Another program, ILLIAC, was developed that incorporated the Musicwriter keyboard and punched out coded paper.[20]

> In 1977, Armando dal Molin developed the Musicomp. The Musicomp was a computer used specifically for notating music. It consisted of two keyboards. The left keyboard set the pitch while the right keyboard contained music symbols and letters. The music appeared on the screen, and the machine could store up to 30 pages of music in a microcassette. The Musicomp was used to provide ready-to-publish scores for several publishing companies. [21] Reyna

Several programs were developed for desktop computers and in the 1980s the MIDI (Musical Instrument Digital Interface) was pivotal in that it allowed musicians to input music into a computer. The Mockingbird was a program that "was capable of playing the music back and printing with a laser printer". [22] However this was not the very first time that a keyboard

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[19] Gabriella F. Scelta, The History and Evolution of the Musical Symbol. http://www.thisisgabes.com/images/docs/musicsymbol.pdf

[20] Rosenda Reyna. Music Printing History, http://www.musicprintinghistory.org/

[21] Ibid.

[22] Ibid.

instrument was entangled with mechanical devices in a ground breaking manner. The pianola was the first truly musical piano-playing device that was developed by the Aeolian Company in the late 1890s in America. It required the player to use foot pedals that generated the suction required to run it and the pitch was controlled by a perforated music roll where the score, which had not been produced by recording at a keyboard, was displayed visually in a unique marked up notation. The greater the suction at any given moment the louder the note or chord sounded. The keys would move automatically and the player's fingers rode them. [23] In contrast, reproducing-pianos (player pianos) were able to reproduce the nuances of a performance of a piece because their music rolls were produced by using the recordings of prominent pianists. "These music roll recordings form an important historical repertoire of romantic piano music and interpretation, as well as jazz and ragtime." [24]

Interactive software programs are devices that fundamentally make adaptations of musical notation to a new format possible. They permit the expedient transfer of paper transcripts to a more mobile and malleable environment which in turn allows users to compose, arrange, notate and print sheet music. Encore, Sibelius, Finale, and Noteworthy are a few of the most popular software programs. Smart Music is a software program dedicated to interactive practicing which has transformed the learning process for anyone who doesn't have access to live accompaniment. It makes it possible to create "practice loops" by setting up repeating sections and working those parts in isolation, endlessly. The tempo or speed can be set at a fixed rate but the program has the capability to "follow" the sounds the user produces via a microphone and simulate live musical interplay.

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[23] The Pianola Institute. The Pianola Institute Ltd. http://www.pianola.org/index.cfm

[24] Ibid.

Musicians can now generate their own library of printed repertoire and tailor any aspect of it to their personal needs. An array of menu options can serve as a catalyst for musicality to proliferate. Individual score parts can be extracted from full scores and instantaneously transposed to accommodate any particular instrument needed in rehearsal, performance, or instruction. Other genres of programs such as: Ableton Live, Pro Tools, Sonar, and Apple Logic can be used without any knowledge of the language of music notation.[25] Microphones can be introduced into the interface experience and someone could sing or play what they wanted and a score or "lead sheet" can be readily generated. A lack of knowledge is no longer a barrier in the process of musical score production. This ease of access has afforded a deluge of new participants worldwide. The volume of professional and self-produced musical projects in popular music has surged Meanwhile new adaptive reading skills are necessary for performers realizing music on the printed page generated from computer programs because it looks different from non- computerized print spatially. New performance practices and multi-media arenas have emerged where musicians play along with a prerecorded selection of music or with a computer generated soundscape. The prerecorded music could have been performed by a musician earlier and included in a live performance venue. Thus, one can perform a duet with oneself.

In conjunction with oral traditions music notation has intrinsically contributed in the construction of our society's musical archive and cultural memory. Recorded music has claimed an important place in the musical archive. Its repeatability is a powerful tool that sends it deep into the psyche of individual and collective memory. Reading music as part of the performance experience has greatly impacted the narrative of music history. At some points it was a

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[25] Cory Hinton. "Movement in technology spurring movement in musical notation." *James Madison University.* Accessed December 5, 2014http://www4.ncsu.edu/~cdhinton/technology_and_music.pdf

privileged activity of a selection of clergy and upper class musicians who catered to the wealthy. Through technological innovations this is no longer the case although far fewer people can read traditional music notation than text today. The ability to read, interpret, and perform written music well is a marketable skill in many venues. Notational reading defined how Western art music was classified, comprehended, organized, realized, shared and expressed. Music notation became an important component in academic scholarship and contributed to vigorous intellectual discourse.

There has been a persistent stream of proposals to reform traditional notation from composers, professional and non-professional musicians, music theorists, and educators ever since its conception. The printing press with its standardized type created a long pause in the evolutionary flow of notation and musical notation has been accepted by most people as a static entity. Modern composers and performers along with music educators and students must adjust to the global technological milieu that saturates musical production and performance today. There is an innovative momentum growing with the introduction and use of some pragmatic alternative notational systems specifically with guitars and keyboards. Guitarists have in a grass roots manner honed the tablature system which better matches the characteristics of their instrument. "Accordion tablature is very popular in China."[26] Mark Gaare, vice president of the Music Notation Modernization Association (MNMA) in the United States, passionately believes that it may be time to abandon traditional written or printed music and embrace the digital music studio. [27]

Holland has a very popular keyboard tablature system called "Klavar" which is short for

[26] Mark Gaare, "Alternatives to Traditional Notation", Music Educators Journal, Vol. 83, No. 5 (Mar., 1997), pp. 17-23.

[27] Ibid. 17.

"Klavarskribo" or "keyboard writing" that was developed in 1931. [28] Its notation is reminiscent of the player piano roll due to the directional manner in which it is read. Synthesizers, samplers, and sequencers all generate unique graphic tableaus. Bob Ezrin (composer and producer of Pink Floyd) said, "In the same way that the telephone revolutionized communication by making it real time, MIDI sequencers have bypassed the old Morse code of notation and rendered musical expression virtually instantaneous." [29] A new kind of musical notation known as the "piano roll" may have already replaced traditional notation as the primary music language for many people in the pop music world. Software developers are melding the best of the old and new worlds with hybrid products. [30] Within this new kind of notation, horizontal bar graphs display multiple tracks that can be viewed simultaneously, *each has its own color*. The display is a direct representation of time and is readable by both computers and humans. These remarkable notational devices are creating new performance experiences and are anchored in electronic music. Acoustic musicians may not embrace any of them because their musical identity and aesthetic is constructed in absence of electronics. However, the implications of potential applications of tablature, Klavar, and piano roll interactive systems are tremendous in scope. The MNMA is an international organization which fosters world-wide cooperation in shepherding the future of music notation. The consequences of notational choices have broad and complex ramifications. There is much iconic cultural currency invested in the lineage of traditional musical notation and therefore much with which to interact.

Historical junctures in the relationship between musical notation, music performance and technological innovations have ultimately been creative and productive ones. Whether or not the

[28] Ibid. 20.
[29] Ibid. 21
[30] Ibid. 21

future of notation exists in a representation that continues to use all of the current system, only select components of it, modified components, or a completely different paradigm that has yet to convincingly emerge is impossible to proclaim. Technology today shows exciting promise of movement into new territory of musical expression by means of notation.

Bibliography

Dart, Thurston. "Eye Music". *Grove Music Online*. Stanley Sadie, editor. London: Macmillan, 1980. Accessed December 5, 2014 http://www.oxfordmusiconline.com.proxy.library.vcu.edu/subscriber/article/grove/music/09152?q=eye+music&search=quick&pos=1&_start=1#firsthit

Gaare, Mark. "Alternatives to Traditional Notation", *Music Educators Journal*, Vol. 83, No. 5 (Mar., 1997), pp. 17-23

Gitelman, Lisa. *Always Already New: Media, History, and the Data of Culture*. Cambridge: MIT Press, 2008.

Hinton, Cory. "Movement in technology spurring movement in musical notation." *North Carolina State University*. Accessed December 5, 2014. http://www4.ncsu.edu/~cdhinton/technology_and_music.pdf

Mann, David. "The Birth of a Written Musical Language: Literacy in music and its effect on musicians and music throughout history." *James Madison University*. Accessed December 5, 2014. http://www.jmu.edu/mwa/docs/2011/mann.pdf

Manovich, Lev. *The Language of New Media.* Cambridge: MIT Press, 2001.

Ong, Walter. *Orality and Literacy.* New York: Routledge, 2012.

Read, Gardner. *Music Notation: A Manual of Modern Practice*. London: Bells and Sons, 1979.

Reyna, Rosenda. "Music Printing History." *Music Printing History*. Accessed December 5, 2014. http://www.musicprintinghistory.org/

Reublin, Richard and Richard Beil. "The Parlor Songs Academy." *The Parlor Songs Academy.* Accessed December 5, 2014. http://parlorsongs.com/insearch/printing/printing.php

Scelta, Gabriella F. "The History and Evolution of the Musical Symbol." *The History and Evolution of the Musical Symbol.* Accessed December 5, 2014. *http://www.thisisgabes.com/images/docs/musicsymbol.pdf*

Strayer, Hope. "From Neumes to Notes: The Evolution of Music Notation", *Musical Offerings* 4, no.1 (2013): 1-14.

"The Pianola Institute." *The Pianola Institute Ltd*. Accessed December 5, 2014. http://www.pianola.org/index.cfm