ABSTRACT

Title of Document:	"IT LOOKS LIKE SOUND!" : DRAWING A HISTORY OF "ANIMATED MUSIC" IN THE EARLY TWENTIETH CENTURY
	Emily D. Robertson, MA, 2010
Directed By:	Dr. Barbara Haggh-Huglo, School of Music, Musicology Division

In the early 1930s, film sound technicians created completely synthetic sound by drawing or photographing patterns on the soundtrack area of the filmstrip. Several artists in Germany, Russia, England, and Canada used this innovation to write what came to be called "animated music" or "ornamental sound." It was featured in a few commercial and small artistic productions and was enthusiastically received by the public. It was heralded as the future of musical composition that could eliminate performers, scores, and abstract notation by one system of graphic sound notation and mechanized playback. Its popularity among mainstream filmmaking did not last long, however, due to its limited development. The artists drawing animated sound were dependent entirely upon their technological medium, and when the

sound-on-film system faded from popularity and production, so did their art. By examining from a musicological perspective, for the first time, specific examples of animated music from the work of Norman McLaren, Oskar Fischinger, Rudolph Pfenninger, and several filmmakers in Russia, this thesis enumerates the techniques used in animated sound. It also explores the process of its creation, adaptation, and decline. In doing so, it reveals an important chapter in the little-known early history of modern synthesized sound alongside the futuristic musical ideas it both answered and inspired.

"IT LOOKS LIKE SOUND!" : DRAWING A HISTORY OF "ANIMATED MUSIC" IN THE EARLY TWENTIETH CENTURY

By

Emily D. Robertson

Thesis submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Master of Arts
2010

Advisory Committee:
Dr. Barbara Haggh-Huglo, Chair
Dr. J. Lawrence Witzleben
Dr. Patrick Warfield

Foreword

"It looks like sound!"

      Peter Trosztmer, speaking about current revival performances of Norman McLaren's work (2008).

"The empty vessel makes the greatest sound."

      William Shakespeare, quoting Plato's insult, in the play Henry V (ca. 1599). The quote also oddly describes "empty" machines creating the much-heralded sound of animated music.

"These ornaments are drawn music—they are sound... Now control of every fine gradation and nuance is granted to the music-painting artist."

      Oskar Fischinger, describing his experiments in animated sound and his hopes for their potential impact on musical creation (1932).

"Soon our composers will have to study, not orchestration according to Berlioz or Gevaert, but a certain new art-the art of expressing in the symbols of the soundtrack the most complicated and fantastic timbres, which can be tested then and there, without collecting an orchestra or summoning a conductor. The time is at hand when the musical grammar, if it does not quite disappear, will be practically supplanted by the conventional, phonetic writing of vibrations. We are already at the stage when the composer, if so inclined, can study the art of writing music directly on the track of the sound apparatus, with every variety and every fantastic detail of harmony, timbre, nuance, and tempo, and with choruses and solo voices as well; and what he has written can be made audible to him and others without delay."

      Leonid Sabaneev, depicting the supposed effect of the discovery of animated sound (1934).

      In the fall semester of 2009, I started researching silent film piano reels and the first sound film systems in hopes of finding a term paper and a master's thesis. In a side note on an article about

early sound film, I saw a reference to "animated sound." Following

this curious reference down the rabbit hole, I fell into the brilliant

and quirky land of synthetic sound experiments conducted during

the first half of the twentieth century. This area has not been

widely researched; only a few film historians and analog electronics

enthusiasts have ventured to write about specific moments in the

story of animated sound. For this reason, my study draws mainly

upon the many contemporary publications, interviews, films, and

other archival sources that I could identify.[1] Nevertheless, of the

number of contemporary sources known to exist, only a portion

have been discussed here, due to issues in obtaining access and

copyright permissions and the fact that many sources have not

been well-preserved. Perhaps this study, and the recent revival of

interest in early synthesized sound, will serve as an impetus for

better preservation and increased public availability of documents

and films related to animated music.

　　Because this study is almost entirely based on contemporary

sources, I have maintained the terminology and idioms of the time,

avoiding twenty-first-century academic language. Thus, I use the

adjective "animated" to describe the manipulation of an optical

---

[1] At this time, there is no significant treatment of animated sound in the *New Grove Dictionary, Die Musik in Geschichte und Gegenwart,* or in any other major musicological reference work. I am deeply indebted to the handful of scholars who have published on animated sound in the last decades: Thomas Levin, Andrey Smirnov, and Derek Holzer. Without their findings and suggestions, I would never have gathered enough materialto begin this project.

soundtrack to produce synthetic sound, rather than another term

("ornamental," "graphic," etc.), because it was the most recently

coined and is currently the most widely used. A discussion of the

terminology associated with animated sound is taken up early in

the first chapter. Also, I have tried to relay the more technical

portions of this history in a manner that makes them accessible to

an interdisciplinary readership. I sincerely hope my readers find

this coalescence of early synthetic audio history as fascinating,

inspiring, and amusing as I have. Open your eyes to hear and your

ears to see![2]

---

[2] Norman McLaren, *The Eye Hears, The Ear Sees*, Interview by Gavin Millar
(Montreal: BBC/NFB, 1970).

Acknowledgements

Table of Contents

Title Page and Foreword Credits

Title quote: Peter Trosztmer, speaking of Norman McLaren's work in an interview with Tim Cornwell in "Beyond the Norm," *The Scotsman,* April 17, 2008, p. 48.

Subtitle (Foreword) quote 1: William Shakespeare, quoting Plato's proverb in the play *Henry V*, Act 4, Scene 4, *ca.* 1599.

Subtitle (Foreword) quote 2: Oskar Fischinger, describing animated music in his article "Sounding Ornaments," *Deutsche Allgemeine Zeitung,* July 8, 1932, n.p.

Subtitle (Foreword) quote 3: Leonid Sabaneev, discussing animated sound in his article "Music and the Sound Film," *Music & Letters* 15/2 (April 1934): 147-152

List of Tables

List of Figures

Chapter 1: Historical Background

In the beginning, Edison created the moving picture and the phonograph, and from these two inventions would originate an entire universe of mass media. Prior to that revolution of entertainment, however, there were many years of quiet and often unrewarded experimentation. The much sought-after goal of creating a virtual entertainment reality has never been perfectly achieved, despite each generation of performers and producers who have brought recorded sound and manufactured sight ever closer together to create enveloping entertainment experiences. Today they surround the viewers in imagined worlds full of exotic vistas, pulsing colors, larger-than-life characters, soaring scores, and thrilling speech. Within the last decade, movie theaters have seen the advent of 3-D, surround sound, and HD—each system claiming to bring viewers closer to an all-encompassing, realistic experience. A major step on this road toward virtual on-screen reality was the success of the long-awaited union of the descendants of Edison's inventions, recorded sound and motion pictures, in the first synchronized sound films.

From the beginning, artists and inventors worked to unite the visual arts and music, as well as to stretch the boundaries of both through creative techniques. Early nineteenth-century motion pictures were accompanied by music, a combination that came about inevitably

through centuries-old traditions of music accompanying staged performances. Though there is no record of exactly what music was played alongside the first screened motion pictures and whether the music directly accompanied or merely filled the spaces in between reel changes, there are definite records of musicians performing.[3] It is interesting to note that the occurrence was so appropriate as not to earn any special mention in the effusive newspaper descriptions of the first motion pictures.[4] Despite having some musical accompaniment, these films lacked any sound, whether speech or music, that was *synchronized* with the visuals in their recorded state.

Even though the technology existed to record audio tracks, whether speech or music, and to play them back courtesy of Edison's phonograph, and the motion picture camera could record actions/events in real time, it would be decades before those two audio and video innovations could be successfully united. Towards the end of the nineteenth century, Edison saw the potential in the two technologies, and he, alongside his colleague William K. L. Dickson, directed a project to experiment with his "Kinetophone," a multi-part recording system. Around 1895, the staff of the Edison laboratory in New Jersey attempted to create the first sound film using Edison's machines—a phonograph

---

[3] James Eugene Wierzbicki, *Film Music: A History* (New York: Routledge, 2009): 18

[4] Wierzbicki, *Film Music,* 20-21.

with a large funnel (horn) to collect the sound and a hand-cranked motion picture camera.[5]

The moving images of a violinist and dancing men were recorded on a filmstrip, and the sound of the voices and the violin were recorded on a wax cylinder.[6] Nevertheless, as far as historical records can reveal, these two components were never successfully presented together in any way. The wax cylinder was broken in half at some point, and the film migrated to an archive far from its matching cylinder. The final result of the experiment had to wait for more than a century, until 1998, when the archived film and wax cylinder were restored, synchronized, and released to the public.[7] Though Edison and Dickson's experiment may have encountered logistic obstacles, inventors and filmmakers simply would not give up on the idea.

At the Paris Exposition in 1900, short films (with recorded music and sound effects) of various works of opera, theater, and ballet were presented to the public in the first exhibition of sound film, courtesy of Clément-Maurice Gratioulet and Henri Lioret's Phono-Cinéma-Théâtre. Theirs was by no means the only cylinder-based systems presented at the Exhibition. Phonographs and motion picture projectors proved difficult to operate synchronously, however. Thus, in 1902, Léon Gaumont introduced the Chronophone, a sound-on-disc system (i.e. a

---

[5] Patrick Loughney, "Domitor Witnesses the First Complete Public Presentation of the *Dickson Experimental Sound Film* in the Twentieth Century," in *The Sounds of Early Cinema*, ed. Richard Abel and Rick Altman (Bloomington, IN: Indiana University Press, 2001), 218-219.
[6] Gordon Hendricks, *Origins of the American Film* (New York: Arno Press, 1972): 21.
[7] Loughney, "Domitor Witnesses," 215-217.

motion picture projector synced to a gramophone record player). Despite

addressing the synchronization problem, Gaumont's system, as well as

those of his competitors, did not prove commercially successful, and the

demand for sound films subsided for a few years.[8]

Nonetheless, inventors and film technicians still did not give up on

the idea. A technician who had worked in Edison's motion-picture

laboratory, Eugene Lauste, received a patent in 1907 for the first sound-

on-film system. (See Table 1 for system terminology.) Lauste's system

used two separate reels of celluloid film, one for the moving image and

one for the recorded sound.

> [… T]he sound was captured by a microphone and translated
> into light waves via a light valve, a thin ribbon of sensitive
> metal over a tiny slit. The sound reaching this ribbon would
> be converted into light by the shivering of the diaphragm,
> focusing the resulting light waves through the slit, where it
> would be photographed on the side of the film, on a strip
> about a tenth of an inch wide.[9]

In 1919, Lee De Forest was granted patents for a "married" sound-

on-film system. De Forest's machine recorded the soundtrack on a small

strip of film to the side of the image. Thus, problems with consistently

synchronizing the playback were completely prevented, as long as the

sound and visuals were synced correctly in recording. (See Figure 1.) At

last, a system was in production that made sound films commercially

---

[8] Martin Barnier, *En route vers le parlant: histoire d'une evolution technologique, économique et esthétique du cinema (1926-1934)* (Liège: Editions du Céfal, 2002), 25-29.
[9] Scott Eyman, *The Speed of Sound: Hollywood and the Talkie Revolution (1926-1930)* (New York: Simon & Schuster, 1997), 30-31.

viable.[10] Further tests and exhibitions took place throughout the 1920s, of both sound-on-disc (phonograph) and sound-on-film (optical recording) productions. Until 1926, these exhibitions were limited to short films, created as novelty entertainment, rather than feature-length films for mass marketing. The large Hollywood production studios had to be convinced of the profitability of synchronized sound before investing in the technology.[11]

Figure 1. Diagram of DeForest's Single-reel Optical Recording System (Sound-on-film).[12]
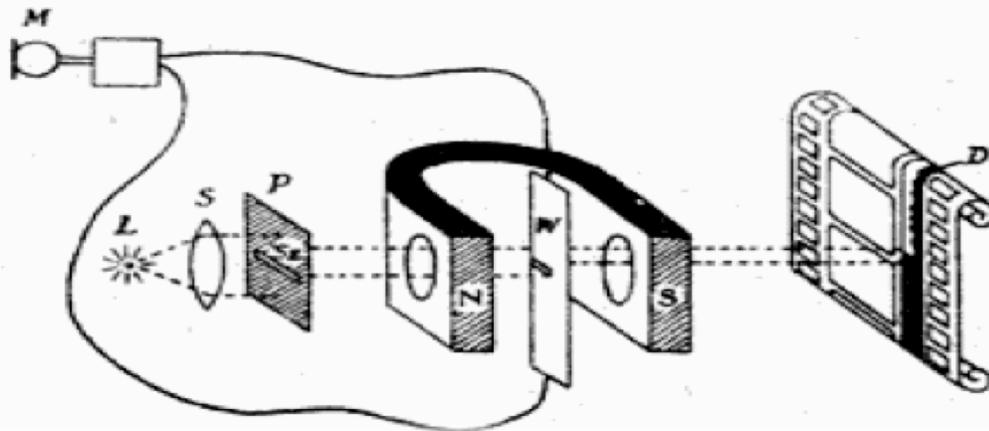
M	Microphone receiving sound	Converts pressure waves to electric current
L	Light source	Used to create pattern on film
S	Lens	Controls light beam focus
P	Diaphragm controlling light ray	Determines width of light pattern
W	Thin ribbon of metal receiving sound vibrations	Moves in and out of magnetic field in order to control wave amplitude
D	Unilateral Variable Soundtrack	Area of the film media to be imprinted with the light pattern

[10] E. I. Sponable, "Historical Development of Sound Films," *Journal of the Society of Motion Picture Engineers* 48/4–5 (April/May 1947), 275.

[11] Douglas Gomery, "The Coming of Sound: Technological Change in the American Film Industry," in *Technology and Culture—The Film Reader*, ed. Andrew Utterson, (Oxford and New York: Routledge/Taylor & Francis, 2005), 54–56.

[12] Derek Holzer, "A Brief History of Optical Synthesis," *Tonewheels: Audio Visual Performance* (Berlin: Tesla Media Arts Laboratory, 2007) http://www.umatic.nl/tonewheels_historical.html.

Table 1. Glossary of Early Sound Film Systems

System (Audio + Video)	Film + Film	Sound-on-film
		Optical recording
	Disc + Film	Sound-on-disc
		Phonographic recording

DeForest's system, based on Laust's experiments, was patented as "DeForest Phonofilm," and in 1922 it would become the principal product of his company, DeForest Phonofilm Corporation. DeForest made many efforts to market his product to major film studios, all of them without success. Nonetheless, his company remained the primary manufacturer of sound-on-film productions, until DeForest declared bankruptcy in 1926.

The rise and fall of Phonofilm mirrored almost exactly that of its European counterpart, Tri-Ergon. Tri-Ergon was a sound-on-film system very similar to DeForest's that was also patented in 1919 in Germany by Josef Engl, Hans Vogt, and Joseph Massolle. The rights to the system were purchased by Fox Film Corporation in 1926, and subsequently used by Fox in court to stop the production of other sound-on-film systems in the United States and Europe.[13]

---

[13] Sponable, "Historical Development," 275.

At first, though, the synchronization of the sound and film production and presentation process was clumsy and time-consuming. The visuals were shot using a celluloid reel-to-reel camera, and the accompanying sound was recorded at the same time as the visuals. A detailed account of the DeForest "married" optical recording and playback process was given in the 1943 informational film, *Sound Recording and Reproduction (Sound on Film),* distributed by Encyclopaedia Britannica/ERPI Classroom Films. The documentary explains each stage of the technological setup, as well as each of the various types of optical recording system.

As a beginning premise, the film's narrator noted that "the sound must be recorded for production when the picture is shown," or in other words, that it must be synchronized. The best way to accomplish this end is, according to the narrator, "photographic film"—otherwise known as an optical recording system. Two filmstrips were recorded as a visual negative and sound negative, respectively, and combined to create the single positive filmstrip that would be used to project both picture and sound in the theater. The photographic film is able to serve as a vessel for the sound record, because the sound waves are converted into light through the optical recording system and thus can be photographed onto the film. The sound waves produced by the human voice, musical instrument, or sound effects device are converted by the microphone into fluctuations in an electric current. The electric current then produces precise changes in the amplitude or width of the light beam through the

DeForest mechanism, which caused a thin ribbon of metal to oscillate in a magnetic field.

The beam of light projected onto the soundtrack may be positioned such that the beam only projects across a portion of the soundtrack area and produces a continuous line, one end of which moves back and forth. This type of soundtrack is called a Unilateral Variable Area soundtrack. If the two ends of the line move simultaneously, creating two rippling areas of black on either side of the soundtrack, it is called a Bilateral Variable Area soundtrack. Finally, the line may stretch completely across the soundtrack area. In this case, the sound waves cause variations in the thickness of the line. This is called a Variable Density soundtrack. If any of these soundtracks are projected into a light meter, the amount of light will be found to be the same, because the variations in the light corresponds directly to the variations in the pressure created by the original sound waves.[14] The Unilateral and Bilateral Variable Area soundtracks could also be printed as single or dual soundtracks. In fact, the Bilateral Variable Area waves could be recorded with many more than two soundtrack lines. These were known as Multiple Variable Area soundtracks, and the technology was preferred by German filmmakers,

---

[14] *Sound Recording and Reproduction (Sound on Film),* Encyclopaedia Britannica Films (Chicago: ERPI Classroom Films, 1943). 16mm Film. Digital copy courtesy of the Prelinger Archives.

especially the Tobias-Klang Company, because it was thought to produce a clearer sound.[15]

In playback, the process of recording is reversed. A light is projected through the soundtrack area onto a photoelectric cell in the projection mechanism. This cell then converts the fluctuating light into electric current. The electrical current is carried to a speaker, where it is converted back into sound waves for synchronized playback along with the motion picture. As long as the soundtrack is accurately synchronized with the film frames in recording, it is guaranteed to be synchronized in playback. This advantage was primarily what made optical recording systems the first choice of filmmakers from 1930 to 1950, after its successful introduction and until the commercial development of magnetic tape for sound recording.

---

[15] Howard M. Tremaine, *Audio Cyclopedia* (Indianapolis: Howard M. Sams, 1969): 915. It should be noted that these multiple tracks were originally identical, unlike the "stereo" (multi-track/channel) recordings popular today.

Figure 2. Types of Optical Soundtracks[16]

Variable Density Soundtrack
Unilateral Variable Area Soundtrack
Dual Unilateral Variable Area Soundtrack
Single Bilateral Variable Area Soundtrack
Dual Bilateral Variable Area Soundtrack
Multiple (Bilateral) Variable Area Soundtrack
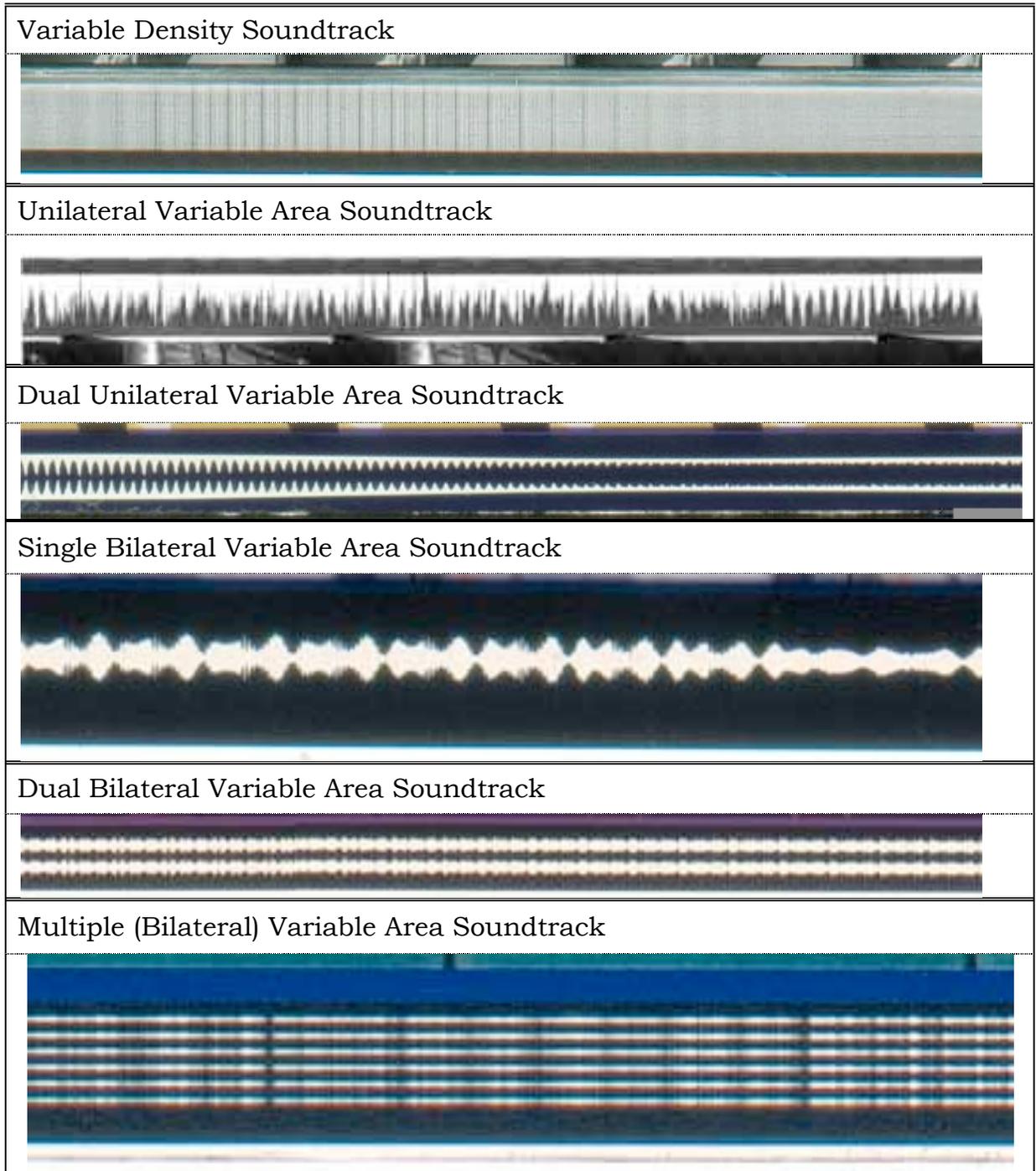
These optical recording mechanisms had an additional advantage.

They were more independent and portable than the earlier phonographic

---

[16] Photographs courtesy of Paul Ivester, 2009.

systems. The phonographic systems were vulnerable to what sound technicians called "noise"—scratches introduced to the disk by vibrations from machinery and other surrounding sources. Thus, they had to be housed in permanent, vibration-damping structures attached to film studios. The new optical recording system was not affected by those 'noises'. It could be moved in and out of the studio, although it was still extremely large in comparison to modern recording systems. In 1930, the Fox optical recorder weighed around 500 pounds, had to be transported on a Ford truck, and was operated by two technicians.[17] This was a marked improvement over the permanence of wax recording systems and the weight of the earliest optical systems. Because the sound-on-film (optical) recording systems would be adapted for filming everything from commercial blockbusters to wartime newsreels, the smaller size and even portability were highly desirable.

Thus, due to these mechanical advantages and despite numerous commercial difficulties, the persistent experimentation with sound-on-film and sound-on-disc systems gave birth in 1926 to the Warner Brothers's *Don Juan*, the first feature-length film with synchronized sound.[18] *Don Juan* used sound-on-disc technology to play back its musical score and sound effects, although the systems were in their final decline, and would soon be superseded by the sound-on-film systems.

---

[17] John Belton, "Awkward Transitions: Hitchcock's *Blackmail* and the Dynamics of Early Film Sound," *The Musical Quarterly* 83/2 (Summer 1999): 228.
[18] Douglas Gomery, *The Coming of Sound: A History* (London and New York: Routledge, 2005), 38-40.

Then, finally, the "talkie," or motion picture with a recorded, synchronized musical score, sound effects, *and speech* appeared in 1927 with *The Jazz Singer*, starring Al Jolson.[19]

The film was a smash box office hit, and these profitable results convinced movie production studios of the worth of investing in sound film, and more specifically, optical recording technology (sound-on-film).[20] *The Jazz Singer* inaugurated a new era of scripts and screenplays, movie musicals and motion picture epics. As John Belton notes: "The expectations of audiences—and what they perceived as 'realistic'—were changing year by year during this period."[21] Once synchronized sound became reliable and available, audiences began to accept the novelty of hearing film and, eventually, they demanded it.[22]

Music and speech provided continuity that the separate, flickering frames of film lacked. The advent of sound signaled the fading of silent film montage and unrealistic sequences. Sound set the images even more firmly in an imagined reality and dictated a greater consciousness of the surroundings and signals necessary to create a seemingly real world on the screen. Films produced at the cusp of the development of soundtracks show a distinct mixture of silent-film narrative gestures with the new voices of recorded sound. "No matter how hard these films try to conceal the technology that produces them, that technology

---

[19] Wierzbicki, *Film Music*, 92-94.
[20] Ibid.
[21] Belton, "Awkward Transitions," 234.
[22] Gomery, *The Coming of Sound*, 1-6.

nevertheless leaves its indelible traces."[23] These early works paved the way for an entire global industry of sound films with their own idioms and standards.

The earliest film sound and music technicians used a great variety of methods of production, practice, and style, since the new field was undeveloped and open to experimentation. No large companies or production studios had yet become monopolistic arbiters between artists, workers and audiences. No set of standards for "best practice" in sound film had yet been developed, and the standards that had existed for silent film could not be applied in the same ways as they had been prior to the advent of sound film technology. Thus the methods, idioms, and technologies of the industry were not formulated during the first few decades after the initial rise of the motion picture. There existed "a bricolage of narrative, technical, economic, presentational, and audience practices taken from here, there, and everywhere."[24]

---

[23] Belton, "Awkward Transitions," 244.
[24] Richard Crangle, quoted in Wierzbicki, *Film Music*, 14.

Chapter 2: An Introduction to Animated Sound

One of these many varied methods of early film production was the manipulation of the optical recording system to produce completely synthetic sound. It was a clever system with great potential for stretching the boundaries of sonic expression, but it was also exceptionally labor-intensive, required great technical skill, and had severe limitations in areas including variety of sound quality and practicality of equipment. Various techniques for creating animated sound were developed by scientists and artists in several laboratories, with little contact between them. These men all devised their methods from a scientific interest in discovering the vocabulary of sound, an artistic curiosity for the possibilities for sound writing, a desire to stretch the frontiers of electronic music composition, and a need to create a low-cost soundtrack that would permit technological creativity.

A decade before the optical recording system was produced, theories for producing 'graphic sound' were set forth by László Moholy-Nagy, a prominent member of the Bauhaus. In 1922, Moholy-Nagy wrote an article for the art journal *De Stijl*, entitled "Production-Reproduction," which argued that the gramophone could become an instrument capable of creating idiosyncratic sounds—sounds both readily identifiable, suitable for analysis, and able to be arranged into musical works. He also maintained that one could study magnified gramophone records, unlock the logic between a sound and a gramophone groove, and then

purposefully write one's own records in "acoustic writing." He explored

the potential of this imagined "acoustic writing" in a subsequent article.[25]

Moholy-Nagy was especially captivated by the idea that this process

could create brand-new tones and eliminate interpretive performance.[26]

These theories of gramophonic experimentation were never realized, due

to the scattering of its proponents across Europe and the technical

difficulties inherent in analyzing tiny gramophone grooves.

The gramophone may not have been the right instrument for the

type of manual experimentation Moholy-Nagy envisioned, but the optical

recording system was much more suited to fulfill his dream of "sound

writing." After the optical recording system and sound projector were

created in 1930-33, Moholy-Nagy called for "a true opto-acoustic

synthesis in the sound film" to arise out of optical soundtrack study.[27]

Moholy-Nagy took great pride in the optical sound experiments in

Germany in the early 1930s, and held lectures promoting the technology

as an important acoustic recording innovation, worthy of consideration

separately from that of visual film. He even attempted to create some

animated soundtracks of his own, but was much more successful as a

lecturer and advocate for animated sound production. In the Weimar

Bauhaus, he lectured to young artists, challenging them to support the

---

[25] László Moholy-Nagy, "Neue Gestaltung in der Musik. Möglichkeiten des Gramophons" *Der Sturm*, 7 (1923), n.p. Translated and reprinted as "New Form in Music: Potentialities of the Phonograph," in *Moholy-Nagy*, ed. Krisztina Passuth (London: Thames and Hudson, 1985), 289-292.

[26] Thomas Y. Levin, "'Tones from out of Nowhere': Rudolf Pfenninger and the Archaeology of Synthetic Sound," *The Grey Room* 12 (Summer 2003): 44-45.
[27] Ibid., 48.

focused study of synthetic sound production using optical recording technology.

> It will not be possible to develop the creative possibilities of the talking film to the full until the acoustic alphabet of sound writing will have been mastered. Or, in other words, until we can write acoustic sequences on the sound track without having to record any real sound. Once this is achieved, the sound-film composer will be able to create music... merely by means of opto-acoustic notation.[28]

Moholy-Nagy saw the fulfillment of these hopes for "creative possibilities" in animated sound, especially in Rudolf Pfenninger's work drafting waves for individual phonemes and tones. Moholy-Nagy firmly believed that, since the discovery of animated (synthetic) sound production had validated his theories of "acoustic writing," future developments in synthetic sound would continue to expand the "acoustic phenomena that conjure up, out of nothing, audible music."[29] Similar ideas were subsequently put forth by other artists who were even more directly enmeshed in the production of animated sound than Moholy-Nagy.[30] The story of handwritten sound quickly became infused with themes of enthusiastic discovery, high expectations, varied innovation, and technological ephemerality.

It appears as though the techniques and underlying principles behind the creation of handmade optical soundtracks were relatively intuitive, for synthetic, "animated," "ornamental," or "graphical" sound,

---

[28] László Moholy-Nagy, *Vision in Motion* (Chicago: P. Theobald, 1947), 277.
[29] László Moholy-Nagy, "New Film Experiments (1933)," in *Laszlo Moholy-Nagy*, ed. Kristina Passuth (London: Arts Council of Great Britain, 1980), 322.
[30] Levin, "Tones," 46.

as it later came to be known, was developed within the span of a few years by several independent artists in widely separated geographic regions—Germany, Russia, and England. Those working in Germany included Rudolf Pfenninger in Munich and Oskar Fischinger in Berlin. Moholy-Nagy featured Pfenninger and Fischinger's two experimental films, *Tönende Handschrift* and *Tönende Ornamente* respectively, in his previously mentioned 1932 lecture to the *Bund "Das neue Frankfurt."*[31]

There, Moholy-Nagy argued that Pfenninger was the first technician to develop animated sound techniques. He was attempting to change the common opinion that Fischinger was the first. The publicity surrounding Fischinger's experiments influenced public perception considerably in this regard.[32] To this day, it remains sufficient, and more productive, not to quibble over who might have been the first to develop an animated sound technique, but instead to realize that a few artists were working on similar projects during the first few years of the 1930s.

Separately and simultaneously to the developments in Germany, members of the Scientific Experimental Film Institute in Leningrad made short films that experimented with "ornamental animation in sound." During the early 1930s in the Soviet Union, there were no fewer than three separate laboratories in Leningrad and Moscow with research staff working on hand-drawn sound. These research groups were made up of

---

[31] [N.A.], "Film-Experimente: Zu einer Matinée im Frankfurter Gloria-Palast," *Rhein-Mainische Volkszeitung* (Dec. 5, 1932). Reprint in *Neues Bauen/Neues Gestalten: Das neue Frankfurt/die neue Stadt.* (Dresden: Verlag der Kunst, 1984).
[32] Levin, "Tones," 49.

prominent artists and technicians, such as music theorist Arseny

Avraamov, animator Nikolai Zhilinski, illustrator Mikhail Tsekhanovsky,

engineer Evgeny Sholpo, animator Nikolai Voinov, and the inventor Boris

Yankovsky. Their work resulted in at least one film with an animated

musical soundtrack, the cartoon *Wor* (*The Thief*, 1934), which used

synthetic tones drawn by Voinov. [33]

It should be emphasized that there is no evidence indicating that

any of the Soviet artists had any contact with artists in Germany prior to

any discovery of animated sound techniques by any particular group of

either nationality. The influence of the artists in Munich and Berlin can

be traced in the work of animated sound creators in the United Kingdom

and Canada, however. This was largely due to the efforts of Moholy-Nagy,

Fischinger, and the Bauhaus promoting animated sound films in

screenings and lectures, which were well-attended by interested film and

fine art students from institutions across Continental Europe and the

UK.[34]

Each animated music laboratory developed one or more discrete

techniques. Most of the men involved in animated sound production also

formulated their own terms for the technique. These tended to emphasize

the handmade and synthetic quality of animated sound. (See Table 2.)

Commonalities in procedure existed across geographical and

philosophical divisions, whether or not the laboratory had contact with

---

[33] Levin, "Tones," 50.
[34] Ibid., 49.

any other laboratory also producing synthetic sound. Thus, all of these techniques can be broken down into three general categories, according to the method of inscribing the sound symbols on the film soundtrack.[35]

Table 2. Summary of Terms for Sound Synthesized Using Optical Recording Systems

Term	Artist
Animated sound	*Norman McLaren*
Synthetic sound	
Ornament sound	*Oskar Fischinger*
Hand-drawn sound	
Graphic(al) sound	*Fischinger & Russian scientists*
Drawn sound	*Rudolf Pfenninger*
Sound handwriting	

The most popular category (or method) was that of photography. The artist would create designs on or out of a long strip of paper, which would then be photographed onto the soundtrack area of the film. Almost every person who experimented with animated sound used this technique at some point, and several of the most prominent worked with it exclusively. For example, Oskar Fischinger produced all of his experiments in "ornamental sound" by drawing sawtooth waves or designing die-cut patterns and photographing them. According to some research, he was aware of simultaneous developments in drawing

---

[35] I recognized these categories early in my research and later found that they had been previously identified in the documentary film, *The Animator As Musician* (Montreal: National Film Board of Canada, 2006).

sawtooth animated sound waves in Russia by Arseny Avraamov and other members of a group of Soviet artists. Consequently, Fischinger was only photographed for press releases holding fake rolls of paper and film. On the other side, Soviet artists encrypted their instructions and records to prevent imitation. [36]

Rudolf Pfenninger also used this drafting technique exclusively, though his waves were meant to imitate actual pre-existing sound waves rather than ornamental patterns like Fischinger's were. Alternatively, artists such as Evgeny Sholpo created patterns of light and dark shapes by shining a light through a spinning paper wheel cut with ornamental shapes. The flickering light was then photographed onto the soundtrack. Other artists such as Boris Yankovsky and Norman McLaren used the drafting and photography technique in a few of their works, but subsequently found other methods of production that they preferred.

The second method of creating animated sound was that of drawing directly on the soundtrack area of a strip of clear film with an ordinary pen and India ink. This method was developed and favored by Norman McLaren, a Scottish filmmaker who emigrated to Canada to work with the National Film Board of Canada (hereafter the NFB). It paired well with his unusual technique of visual animation—drawing or painting directly on the film frames.

---

[36] Andrey Smirnov, *Sound Out of Paper* (Moscow: Theremin Center, 2006). http://asmir.theremin.ru/gsound1.htm.

The final method involved scratching designs on the soundtrack area of a strip of black film. This technique, in some ways, is the opposite of the pen-and-ink technique, and it is no surprise that it was also practiced almost exclusively by McLaren. In the same manner as the pairing of pen-and-ink sound with animation, the etched sound was paired with etched visual animations.

Robert Russett summarized the curious technology of animated sound thus: "the sound originates from a visual source (a graphic pattern) rather than an audible source. This unique type of sound production is a totally synthetic process."[37] The artistic method was considered widely feasible for only a few years, during the height of the optical recording system's popularity. When new magnetic recording systems replaced the visual recording of sound-on-film, the practice of hand-making synthetic sounds on film largely died away, due to its dependence on that specific technology, except for use by a few artists who valued its freedom, peculiarity, and intricacy. These artists included people like McLaren, who specialized in crafting short films and creating children's animated features for Canadian public television in the 1950s-70s. His work will be examined at greater length later in this study.

Shortly after the development of synthetic sound in the early 1930s, artists and filmmakers across Europe and the United States used the technique to create both musical patterns and other types of sound.

---

[37] Robert Russett, "Animated Sound and Beyond," *American Music* 22/1 (Spring 2004): 111.

They developed their ideas separately, and their specific methods varied widely. For example, artists such as Rudolf Pfenninger and Oskar Fischinger created long strips of die-cut designs and photographed them onto the soundtrack. McLaren painted directly on the filmstrip, in both the video and audio areas of the film. Some artists (e.g. Fischinger and McLaren) were primarily concerned with the novelty of the production and the visual aesthetic of the animated sounds. Others who approached the technique from the scientific point of view were concerned with manufacturing synthetic imitations of actual sound waves through careful analysis and drafting (e.g. Avraamov and Scholpo).

Chapter 3: A Short Study of Graphic Notations

At this point in the discussion of animated sound, it is useful to step back and examine the relationships between graphic sign and musical sound. The history of musical notation has been marked by efforts to prescribe and describe musical events in abstract graphic forms. From Byzantine neumes to FluxBox event scores, notational practices have been rushing to create new marks in order to more accurately or effectively represent the works and sound on the frontiers of musical creation.

Of particular interest, given the basic aesthetic of animated sound, is the tradition of graphic notation that developed in the twentieth century. Graphic notation has been defined as any system "by which visual shapes or patterns are used instead of, or together with, conventional musical notation."[38] A few basic categories of graphic scores can be outlined. The first category includes scores that have been created in order to prescribe the composer's intentions in the most particular way possible. This form is often seen in methods of notation intended for mechanical reproduction, performance by amateur musicians (i.e. those not trained in staff notation or classical performance techniques), or realization of specific performance instructions in a certain number of

---

[38] Anthony Pryer, "Graphic Notation," *The Oxford Companion to Music* (New York: Oxford University Press, 2002), 537. See also: John Evarts, "The New Musical Notation: A Graphic Art?," in *Leonardo* 1/4 (1968), 405-412; Gardner Read, *Pictographic Score Notation: A Compendium* (Westport, CT: Greenwood Press, 1998); Theresa Sauer, *Notations 21* (New York: Mark Batty Publisher, 2009).

variations. An example would be the way in which Karlheinz

Stockhausen notated his "process composition," *Prozession* (1967).[39]

The second category of graphic notation includes scores created

with two possible parameters (or purposes) in mind; both do not have to

exist simultaneously, although this is often the case. Firstly, the

composer notates the score in a manner such that its visual appearance

fits with a certain aesthetic or explores a relationship between the visual

and the auditory. Much animated music was created in this way. For

example, McLaren, a brilliant visual animator, drew his pen-and-ink

animated sound with the expressive imagery and motion of the

soundtrack in mind, rather than the quality of the sound itself.[40]

Also, animated music sometimes was created to conform with a

certain design aesthetic or for the sake of creating a visually pleasing

pattern itself. For example, Fischinger focused on creating *ornamental*

sound—in other words, a graphic sound notation/animation that was

also decorative. His animated music was organized in patterns that

looked much like edging lace or carved railings. It served not only an

auditory but also a visual aesthetic purpose. Animated music was used

to experiment with the contemporary speculations about underlying

relationships between images and sounds. Fischinger, in particular, was

---

[39] Karlheinz Stockhausen, *Prozession* (Varèse International Records VC 81008, 1967), LP.

[40] For a brilliant illustration of the close relationship between movement and sound in McLaren's compositional process, see the musical direction (planning) sheets for his unfinished film *1, 2, 3* in Appendix A.

concerned with potential connections between the two realms.[41]

Secondly, graphic notation may simply suggest general musical contours or actions to be taken to produce some results. The performer is given artistic freedom to interpret the artfully arranged score. A common term for this practice is "indeterminate music."[42] Artists such as Fischinger and Moholy-Nagy considered animated music valuable precisely because of its lack of "indeterminacy." The mechanics of animated sound production completely eliminate the possibility of any interpretations, realizations, or sonic outcomes other than those specifically prescribed by the film technician/artist/composer. In a way, then, it is a perfect fulfillment of the purpose of the first type of graphic notation.

Animated sound notation functions according to the simplest principles of wave physics and drafting. McLaren created a few diagrams to exemplify the basic principles. (See Figure 3.) If the wavelength is short, the pitch will be high; if long, the pitch will be low. The height (amplitude) of the waves on the soundtrack determines the volume; the shorter the amplitude, the quieter the sound, and vice versa.

---

[41] Richard S. James, "Avant-Garde Sound-on-Film Techniques and Their Relationship to Electro-Acoustic Music," *The Musical Quarterly* 72/1 (1986): 83.
[42] Pryer, "Graphic Notation," 537.

Figure 3. Pitch and Volume on Variable Area and Variable Density Soundtracks[43]
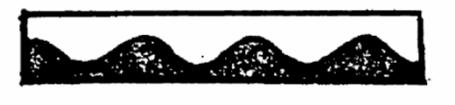
Variable Area Soundtrack	Low pitch (long wavelength)
	High pitch (short wavelength)
Variable Density Soundtrack	Low pitch
	High pitch
	Volume (amplitude shown horizontally in this figure)
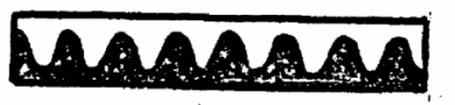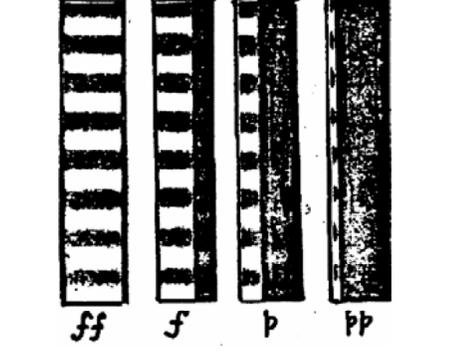
Using these principles, a composer of animated music could write a wide

variety of tones. The slightest variation in drafting would produce a

variation in pitch, volume, or timbre. All those who used the drafting and

[43] Diagrams taken from Norman McLaren, "Technical Notes on the Card Method of Optical Animated Sound," *Technical Notes by Norman McLaren (1933-1984)* (Montreal: NFB, 1952, revised 1985), 62-63.

photography method started by drawing simple sine waves. They then created more complex waveforms to adjust the sound quality.

The result of this determinate musical performance was also achieved by artists using other forms of machine-read music. For example, the mechanism of player piano rolls from the late nineteenth and early twentieth century produced a consistent reading of each piece recorded in perforations on the rolls. It is interesting to note that, like the dots and lines of animated sound, the perforations in the paper rolls could be recognized by a trained or accustomed human eye, even though they were meant for the tines of the player piano mechanism. As long as the rolls remained undamaged, the piece would be "played" in exactly the same way every time the performance was initiated.

The player piano roll system of notation later became the basis for notation used by MIDI computer sequencers.[44] (See Figure 4.) By the 1960s, MIDI technology had replaced piano rolls as the best method for both recording and directly reproducing a musical performance in a single mechanism.[45]

---

[44] Today piano rolls are often directly converted into MIDI files.
[45] For a more detailed description and history of player pianos and MIDI technology, see Peter Manning, "Section VI: MIDI," in *Electronic and Computer Music* (New York: Oxford University Press, 2004), 263-346; Jürgen Hocker, "My Soul is in the Machine – Conlon Nancarrow – Composer for Player Piano – Precursor of Computer Music," in *Music and Technology in the Twentieth Century*, ed. Hans-Joachim Braun, International Committee for the History of Technology (Baltimore: Johns Hopkins University, 2002), 84-96.

Figure 4. Excerpt from J. S. Bach, "Gott sei uns gnädig" (BWV 323), Arranged for Piano.[46]
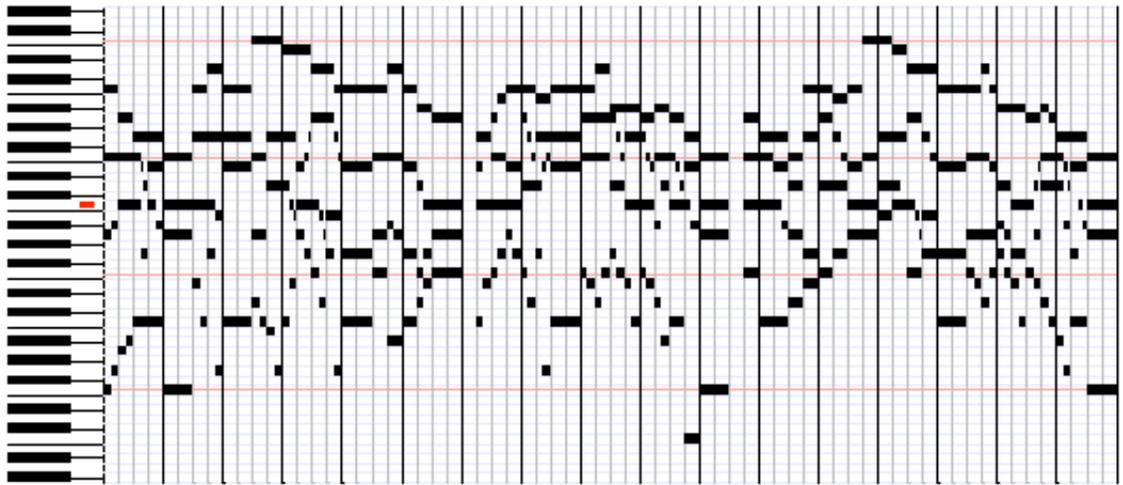
When this form of graphic notation is fed into the machine, whether player piano or MIDI sequencer, a strict playback "performance" will sound forth. In similar fashion, as long as the film remains undamaged, projecting a reel of film with animated sound drawn on the soundtrack will result in the identical musical performance as the original prescribed by the composer.

The various forms of graphic notation may be combined, adapted, or arranged in many ways. That is part of their attraction for composers. In one example, McLaren and the Canadian composer, Maurice Blackburn, combined determinate animated music and indeterminate performance of a graphic notation in the score to the 1955 film, *Blinkity Blank*. The graphic notational quality of animated sound did not escape its contemporary scholars. In fact, one of the primary future functions of

---

[46] Phillip Fraundorf, "Harmonic Analysis of Music, Talk, and Crystals," Lecture for the University of Missouri—Saint Louis (2006). www.umsl.edu. Track recorded on piano roll and converted into MIDI.

28

animated sound predicted by writers of the time was the replacement of traditional notational systems with sound wave handwriting.[47] Animated sound did not revolutionize common notational practice or replace any form of traditional notation, and neither has any other form of twentieth-century avant-garde graphic notation. Nonetheless, animated sound techniques were perfectly fitted to create and record a type of musical art, and thus were successful in part as a graphic notation.

---

[47] For excerpts from some of these articles, see the Foreword and Chapter 8: "Reception and Use."

Chapter 4: Oskar Fischinger

Foremost among those who recognized the compositional potential within animated music was Oskar Fischinger. Fischinger was born in Germany in 1900 and died in Los Angeles, California, in 1967, after a long career as an abstract film artist, technician, and painter in both Germany and the United States.[48] His most famous work was his film *Motion Painting No. 1* (1947), in which he recorded the painting of an abstract work, brushstroke by brushstroke, on individual frames and set the filmed painting to J. S. Bach's *Brandenburg Concerto, No. 3* (BWV 1048). In addition to abstract musical animations, he also experimented with filming wax model cross-sections, the Lumigraph (a color organ), and oil painting. For his work setting abstract animations to popular records, he is generally known as the Father of the Music Video.[49]

His work with synthetic sound systems is almost forgotten today. Fischinger was very important in the early development and practice of animated sound and music, however. As can be seen from contemporary articles, news of his work in this area (and others) reached across Europe and America.[50]

---

[48] Fischinger was trained as an organ-maker, oil painter, draughtsman, and engineer during his childhood and early career in Germany. For a full biography and discussions of his work outside of animated sound, see also: William Moritz, "The Films of Oskar Fischinger," *Film Culture* 58-60 (1974): 37-188; Oskar Fischinger, "My Statements Are in My Work," *Art in Cinema*, ed. Frank Stauffacher (San Francisco Museum of Art: 1947); William Moritz, *The Life and Work of Oskar Fischinger* (Bloomington: University of Indiana Press: 2004).

[49] [N.A.], "The Importance of Being Fischinger," *Ottawa International Animated Film Festival*, Festival Program (Ottawa: NFB,1976).

[50] [N.A.], "Odd Designs on Film Turn to Music," *Popular Science* (March 1933): 36.

In 1932, Fischinger designed a series of experiments using a combination of graphic design and manipulation of the optical sound track. He called these the "Ornament Sound Experiments" and produced a film of the same title later in the year. He created clean-cut graphic designs, such as arches, dots, and fans. Fischinger then cut out templates for each design and photographed each of them one frame at a time. These created long strips of film with repeating arrangements of shapes, similar to a pattern on cloth. (See Figure 5a.) When played back through the sound film projector at twenty-four frames per second, these images create a wide variety of pulsing beats or tones. These "sounding ornaments" were screened by the London Film Society in London in 1933, along with a second set of experimental animated music by Fischinger, entitled "Experiments in Hand-Drawn Sound." Some filmstrips from *Ornament Sound Experiments* have survived, but the "hand-drawn sound" has been lost.[51]

Fischinger approached the creation of animated sound with the visual aesthetics of music and the interrelationships of fine arts and symbolic communication in mind. He was "basically interested in exploring the relationship between given graphic forms and their acoustic correlates, and how that isomorphism might allow one to make… comparisons."[52] For example, one of the geometric patterns he photographed to create ornamented sound was the ancient Egyptian

---

[51] Council of the London Film Society, *The Film Society Programmes, 1925-1939* (New York: Arno Press, 1972), 277-279.
[52] Levin, "Tones," 54.

symbol for the snake. Fischinger was enthralled when he found that the symbol produced a hissing tone that very closely mimicked the sound of a snake.[53] He firmly believed that the ideal music would be visually as well as aurally significant. This and other ideas about the importance of animated music were outlined in his 1932 article, "Sounding Ornaments." (See Appendix B.) This article was to become a sort of manifesto for animated sound artists.

Figure 5a. Detail of a Spliced Filmstrip from *Ornament Sound Experiments*.[54]
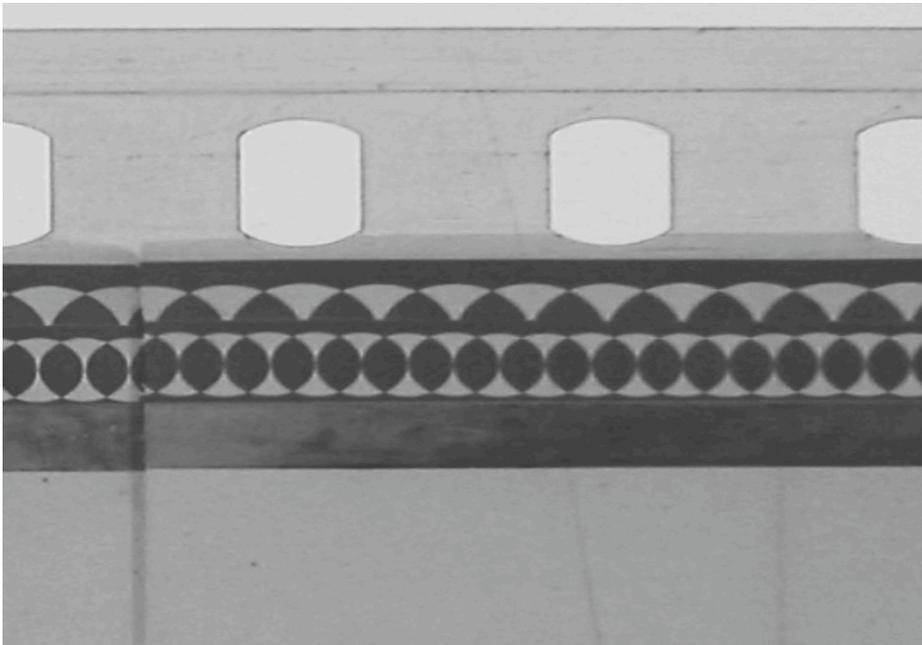
[53] Georges Hacquard, *La Musique et le cinéma* (Paris: Presses universitaires de France, 1959), 34.
[54] Oskar Fischinger, "Sounding Ornaments," *Deutsche Allgemeine Zeitung* (July 8, 1932). Photograph courtesy of the Fischinger Archive and Elfride Fischinger Trust, Copyright 1931-2005.

Figure 5b. Film Strips from Fischinger's *Ornament Sound Experiments*.[55]

---
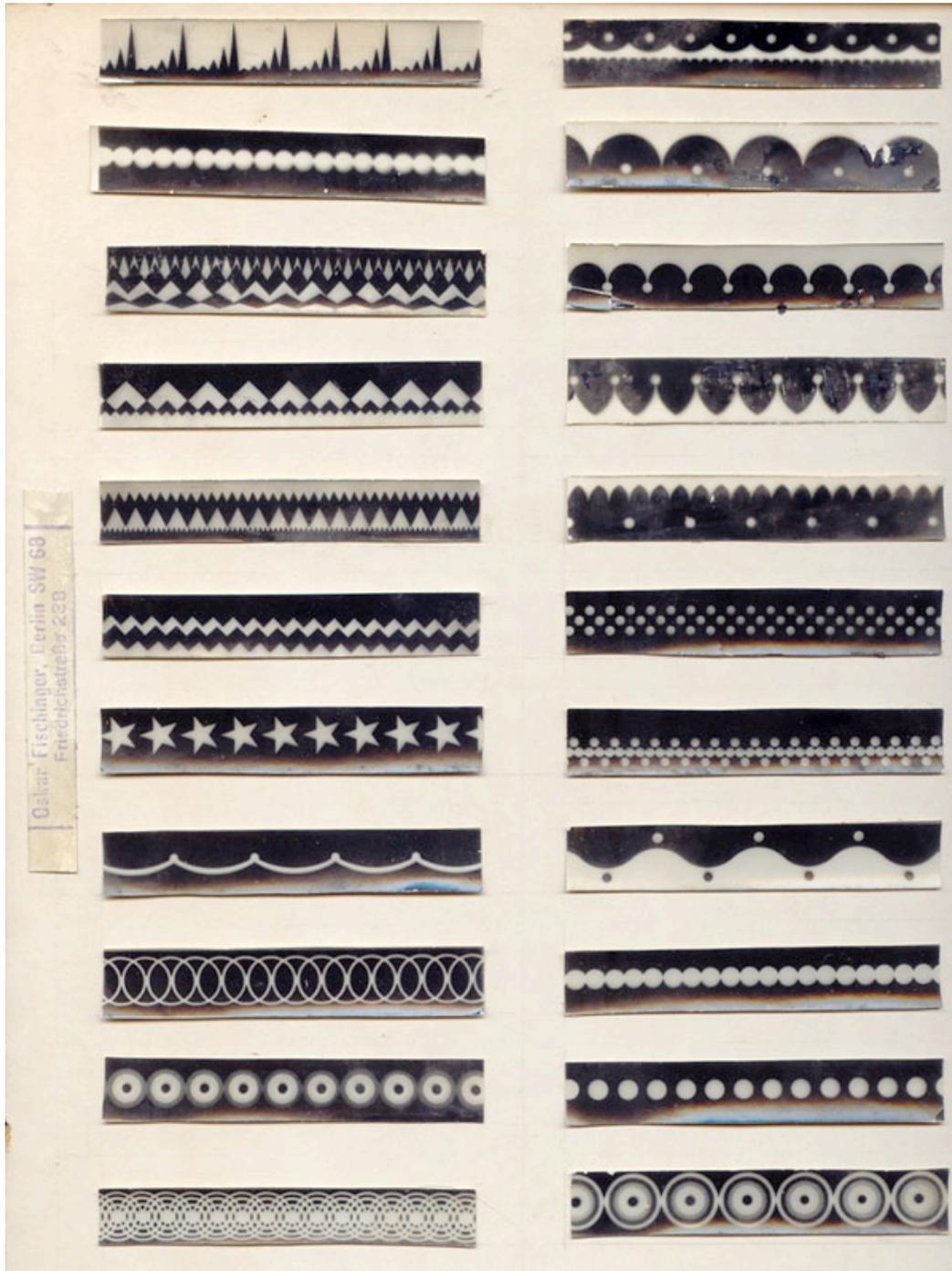
[55] Photograph courtesy of the Fischinger Archive and Elfride Fischinger Trust, Copyright 1931-2005.

In Figures 5 a-b, notice the precise design and graceful arrangement of the die-cut shapes. Fischinger was preoccupied with the possible underlying relationships between image and sound. This fascination stemmed from his underlying attraction to the limitless possibilities present in the study of abstract art techniques. He noticed that every sound was distinctive—not only verbal sounds, but also abstract, non-"organic" sounds.[56] If these sounds were discrete to our ears, Fischinger surmised that their wave shapes must also be distinct to our eyes. He started to categorize individual wave shapes, as they appeared on optically recorded soundtracks, in hopes of identifying a set of core shapes. With this vocabulary, Fischinger intended to create a "visual calligraphy of sound." He also explored the sound qualities of pre-existing forms of writing. These "experiments led him to postulate a connection, largely subconscious, between society's ornamental patterns and the sounds of what they represent."[57]

In the introduction of his "Sounding Ornaments" article, Fischinger laid out his ideas for the potential use and benefits of animated sound. He wished not only to explain his own processes, but also to encourage other artists to perform their own sound experiments. He introduced the art form thus:

> If you look at a strip of film from my experiments with
> synthetic sound, you will see along one edge a thin stripe of

---

[56] By "organic" sound, I refer to sound that is not produced by electrical machines, only by traditional instruments and the voice. See pp. 60-61 below.

[57] James, "Avant-Garde Sound-on-Film Techniques," 83.

jagged ornamental patterns. These ornaments are drawn music—they are sound: when run through a projector, these graphic sounds broadcast tones or a hitherto unheard-of purity, and thus, quite obviously, fantastic possibilities open up for the composition of music in the future.[58]

These "fantastic possibilities" take the form of three general areas of potential. First is the fact that the production and playback of animated music completely eliminates the possibility for any interpretation of the composition, other than the composer's own vision. Fischinger points out that no longer must the careful work of composers across the globe be "abandoned to various capricious reproducers. Now control of every fine gradation and nuance is granted to the music-painting artist, who bases everything exclusively on the primary fundamental of music, namely the wave."[59] This particular idea seems to have been the primary attraction of animated sound, and was echoed many times over in academic and general articles.[60]

The second possibility cited was the potential to create sounds that extended beyond the normal range of any known instruments. Fischinger envisioned an animated music composer drawing an entire orchestra of filmic sounds with brand-new timbres blending in an unlimited spectrum. This particular hope was shared by most animated sound artists. The ability to create "tones out of nowhere" would seem to open up the possibility of creating a limitless spectrum of sounds.

---

[58] Fischinger, "Sound Ornaments."

[59] Ibid.

[60] For example: "Odd Designs on Film Turn to Music," *Popular Science* (March 1933: 36); Leonid Sabaneev and S. W. Pring, "Music and the Sound Film," *Music & Letters* 15/2 (April 1934): 149.

Thirdly, Fischinger saw in the creation of animated sound the foundation of a modern methodology for studying music. He pointed out the readily identifiable differences between the visual profile of various nationalistic styles of singing and surmised that a future animated music scholar might be able to catalogue many musical fingerprints on film.[61]

Interestingly enough, Fischinger did not follow his course of synthetic sound production and innovation for very long. Instead, he chose to focus the rest of his career on the significantly more well-known and marketable techniques of motion painting and setting abstract visuals to pre-recorded music. His ideas would continue to be worked out and amended by animated music artists in the United States and Europe throughout the 1930s, '40s, and 50s.

---

[61] This theory was later realized by other scientists via experimentation with the spectrograph and voice analysis.

Chapter 5: Rudolf Pfenninger

Oskar Fischinger was not the only German artist working with animated sound techniques in the early 1930s. In Munich, many kilometers away from Fischinger's Berlin laboratory, a relatively unknown film technician and animator, Rudolf Pfenninger, worked on experimental techniques he called the *Tönende Handschrift*, or "sounding handwriting."[62] He was a part of the EMELKA studios and had worked as a technician and projectionist for several Munich-area cinemas, with both silent and sound film equipment.

By the time he was offered a position experimenting with new film and audio technology in the EMELKA studio, Pfenninger had already spent many years surrounded by drawing and animation technology. His father, Emil Pfenninger, was an illustrating artist, who encouraged his son to pursue drawing apprenticeships and to work painting sets and animations for silent films. Pfenninger also had experience early in his career with experimental audio equipment. In fact, updating existing systems and developing new audio devices were some of his main tasks as an engineer at EMELKA.[63] This work, of course, gave him an intimate understanding of the internal mechanisms behind sound production and re-production, as well as solidifying his understanding of classical wave

---

[62] It is interesting to note early animated sound artists' consistent choice to use the German gerund as adjective *tönende* to describe the unlimited and continuous "sounding" quality of the symbols inscribed on soundtracks. This term literally means "sounding," even "resounding," but not "many sounding."
[63] Levin, "Tones," 53.

physics and its applications in audio technology. These skills would become the foundation for his work with animated sound.

In terms of underlying philosophy and purpose, Pfenninger stood at the opposite end of the spectrum from artists like Fischinger and McLaren. Their innovations were driven by a curiosity about interrelationships between art forms and a desire to realize artistic philosophies or a hypothesis about the nature of sound visualization. In Pfenninger's work, it is easy to see an emphasis on the technical (physical) aspects of animated sound production, rather than on the artistic or philosophical side effects. This emphasis colors even the contemporary reviews and records of his work, especially those that provide comparison and contrast between the Berlin and Munich laboratories. They characterized Fischinger's work as "dancing lines" and "decorative music." Pfenninger, on the other hand, was "thorough and practical" in his pursuit of "the calculations of sound writings."[64]

According to established legend, Pfenninger's animated sound had a practical beginning, rather than originating from a formal plan for artistic or scientific experimentation. He wanted to have soundtracks for his abstract animated films, but did not have the funds to pay for recordings or studio musicians. Thus, probably sometime in 1929, he instead spent many hours studying waves, found several individual wave

---

[64] Andor Krasna-Krausz, "Beginning of the Year in Germany," *Close-Up* 10 (March 1933): 76. See also Oskar Fischinger, "Early Experiments in Hand-Drawn Sound." *The Film Society Programmes (1925-1939)* [May 21, 1933], ed. Council of the London Film Society (New York: Arno Press, 1972),, 277.

shapes, and copied them onto cardboard strips. These were then arranged in the desired sequence and photographed onto the soundtrack.[65] Using this technique, Pfenninger created animated soundtracks for a few films that were publicly released, including *Serenade, Barcarolle,* and *Pitsch und Patsch,* the aquatic cartoon pictured in a 1933 *Popular Science* article. Though journalists would claim that Pfenninger was working on a "contrivance resembling a typewriter which, instead of letters, will set together sign waves in succession," his active laboratory work ended with the 1932-33 films.[66]

---

[65] Peter Weibel, "Von der visuellen Musik zum Musikvideo," in *Clip, Klapp, Bum: Von der visuellen Musik zum Musikvideo*, ed. Veruschka Body and Peter Weibel (Cologne, Germany: Dumont, 1987), 84.
[66] [N.A.], "Soundless Film Recording," *New York Times* (Jan. 29, 1933), Sect. 9, 6. Digital copy courtesy of the *New York Times* archive: http://timesmachine.nytimes.com.

Chapter 6: The Soviet Laboratories

Another article (by an unnamed author) written for popular consumption, a feature entitled "'Sketches' Sound; Files It For 'Talkies'" in the February 1936 issue of the magazine *Modern Mechanix*, describes the work of the prominent Soviet artists, rather than the more famous Germans. (See Figure 6.) It specifically names N. Voinov and E. Scholpo, describes their work, and also discusses the findings of another unnamed "research worker." The three or four separate labs in the Soviet cities of Moscow and Leningrad had developed some of the most distinctively scientific methods of animated music creation.

One of these devices from Scholpo's laboratory is more closely related to contemporary work on color organs, such as Fischinger's Lumigraph and Thomas Wilfred's Clavilux ("Lumia"), because it uses similar rotating-wheel mechanisms. Instead of projecting light for display in synchronization with music, the die-cut rotating wheels caused light patterns to be developed onto the soundtrack of a strip of optical recording film. In technical terms, Scholpo's instrument, "the Variophone[,] was an optical synthesizer that utilized sound waves cut onto cardboard disks rotating synchronously with a moving 35mm movie film while being photographed onto it to produce a continuous soundtrack."[67] Composer Georgy Rimsky-Korsakov (grandson of famed composer, Nikolai Rimksy-Korsakov, and son of musicologist, Andrey

---

[67] Smirnov, *Sound Out of Paper*.

Rimsky-Korsakov) assisted Scholpo, a scientist, in creating these "tonewheels."[68] The *Modern Mechanix* article pictures several of Sholpo's disks in the upper left corner of the page. (See Figure 6.)

The article also discusses the work of the Russian animator, Nikolai Voinov. Voinov's sound combs were similar in some ways to Fischinger's die-cut ornaments and, of course, McLaren's wave cards. Voinov drafted waves, cut them out on cardboard strips, arranged the strips in sequence, and photographed them onto the soundtrack. His combs were, in many cases, reproductions of the wave outlines of musical tones. The eighty-seven individual combs put in sequence would produce a chromatic scale of about seven octaves.[69] Participants and spectators alike expressed a hope that this particular system would allow for cleaner recordings of simple piano pieces or folk tunes, for example. In this vein, the article's author presents a side-by-side comparison of the soundtrack outline of an arpeggiated tonic chord recording from a piano and one of the same tones created from Voinov's combs. According to the author, the piano's outlines are "ragged" in comparison with the clean "sketched sound."[70]

---

[68] Norman McLaren, "A Brief Summary of the Early History of Animated Sound on Film (From Available Information)," Manuscript for the NFB. (August 16, 1952), 1. Digital scan of MS made available courtesy of the NFB. Many such documents from McLaren's laboratory can be found at the NFB's online archive: http://www3.nfb.ca/animation/objanim/en/filmmakers/Norman-McLaren/archives.php.
[69] According to the Theremin Center archive (consulted on March 29, 2010), Voinov also produced an instrument called the "Nivotone" which could play back musical sequences created by feeding combs into its slots.
[70] [N.A.], "'Sketches' Sound; Files It For 'Talkies'," *Modern Mechanix* (February 1936): 83.

The work being done by Voinov, Scholpo, Avraamov, and others in the Soviet laboratories was most similar in purpose and execution to that being accomplished simultaneously in Germany by Pfenninger. Pfenninger and the Soviet technicians looked to create vocabularies of individual soundwaves, whereas Fischinger and McLaren desired to transform images into sounds. In his short history of animated sound, McLaren pointed out that Avraamov, in particular, was concerned with creating a carefully drafted tone vocabulary.

> Avraamov, who had set as his goal the freeing of his music from the restrictions of the 12-tone tempered scale, and the creation of new tonal systems assimilating many of the scales of the traditional folk music of the Eastern and Southern Republics, achieved very accurate control over pitch and volume... He was using an empirical approach to tone-quality.[71]

Boris Yankovsky developed a system based on the same principles as those of Avraamov and Voinov, but, rather than a set of wave cards, he printed the drafted patterns on continuous rolls by means of a rotating gear system.[72] He was particularly concerned with analyzing, breaking down, and re-assembling sound waves. Thus, he progressed further toward creating a variety of high-quality, stable timbres than his colleagues did. It should be noted that Yankovsky probably was the unnamed "research worker" mentioned in the *Modern Mechanix* article, who made a pattern of his own silhouette profile into a soundtrack.[73]

---

[71] McLaren, "A Brief Summary of the Early History of Animated Sound," 1.
[72] Ibid.
[73] Smirnov, "Sound Out of Paper."

These efforts resulted in the production of a flurry of popular films with animated soundtracks in the Soviet Union. The most prominent among these were *Plan of Great Works* (1931), *The End of a Sensation* (1931), *Symphony of the World* (1933), and *Romance Sentimentale* (1934). They also led Russian critics to be just as effusive as their counterparts in other countries about the potential revolution animated sound could bring in musical composition and performance. For example, Leonid Sabaneev wrote of the advent of animated sound in 1934: "Gone are the limitations of the orchestra… of which we are sick and tired." He surmises that there will no longer be any need for traditional scores or performers and boasts, "music may be said to have acquired the possibility of regaining its supernatural, immaterial quality."[74] Lest any of his readers be unfamiliar with the developments underway in the Moscow and Leningrad laboratories or skeptical of his triumphant language, Sabaneev reassures them—"this is not a dream of the future… I am writing only of that which already exists."[75] In actuality, his techno-musical revolution was still at least thirty years in the future, but during the first years of the 1930s, it seemed that the future of music had already arrived with the full force of synthetic sound.

---

[74] Leonid Sabaneev and S. W. Pring, "Music and the Sound Film," *Music & Letters* 15/2 (April 1934): 149.
[75] Ibid.

Figure 6. *Modern Mechanix* (Feb. 1936): 83.

"Sketches" Sound; Files It For "Talkies"
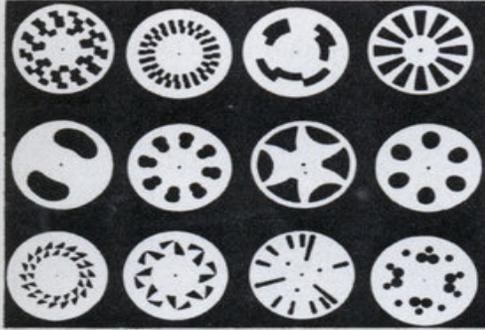
Above are 12 types of "musical disks" designed for one system of synthetic sound. Disks are revolved as film moves through camera, resulting in pattern on sound track to produce music.

SYNTHETIC musical notes that can be filed away in a card index have been developed by a group of Soviet musicians and scientists. The hand-sketched notes, resembling combs, are used to produce musical accompaniment for motion picture films.

N. Voinov of Moscow sketched and cut out cardboard combs of the 80 semi-tones of the piano. By selecting the proper combs and photographing one after another in correct order on the sound track of a movie film, Voinov was able to produce any favorite piano melody.

E. Sholpo of Leningrad developed another method of producing synthetic sound. Instead of sketching individual notes, he prepared disks with cut out openings. The speed at which a disk is revolved when photographed determines the pitch of the sound. Notes of high pitch are produced by revolving the disk rapidly; low speeds produce low notes.

A third research worker has found an interesting experimental line in the same field. He made sound track photographs of ornamental designs to discover the resulting sounds. He found, for instance, that a sound track photograph of his own profile produced sounds similar to those of a violincello. His experiments led to the "retouching" of real sound tracks. His process enabled him to obtain truer notes from actual musical instruments.

Further development in these lines may result in the production of sound movies without the use of any musical instruments.

Magazine, February, 1936
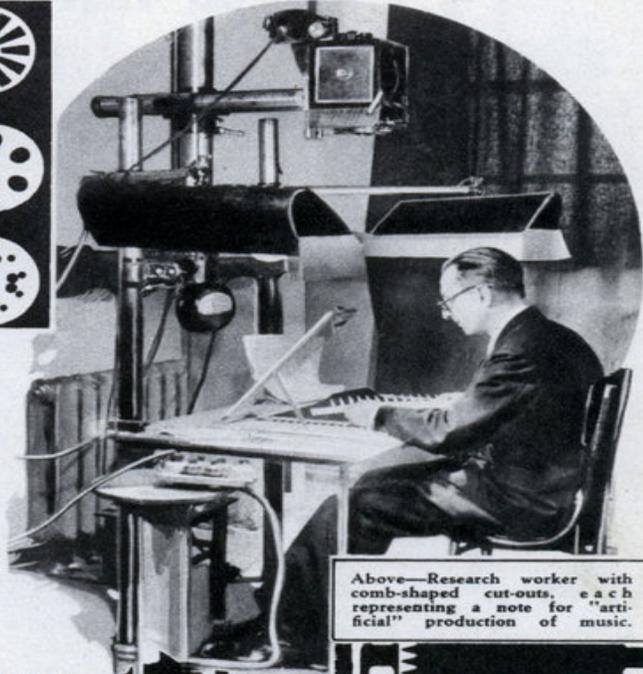
Above—Research worker with comb-shaped cut-outs, each representing a note for "artificial" production of music.
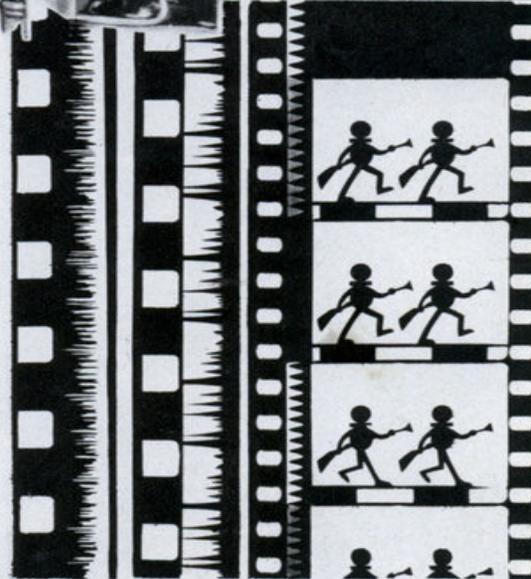
Two large sound tracks at left show comparison of natural and sketched sound. Ragged track at far left is chord do-mi-sol on piano. Next is same chord drawn by hand and photographed. Frames are from animated cartoon with sketched sound which produces the sound of marching feet.

83

Chapter 7: Norman McLaren

A few years after Fischinger's work with ornamented sounds was publicized, Norman McLaren, a young Scottish-Canadian animator then in the dawn of his long and illustrious career, decided to produce his own form of animated sound by drawing loops and dots on the film soundtrack. McLaren was born in 1914 in Sterling, Scotland, and attended art school in Glasgow as a young man. There he became enamored with Marxism, playing the organ, and filmmaking. In order "to make his first animation, he begged the print of a commercial 35mm feature, took it home and soaked it in the bath for a fortnight to strip away the emulsion, then painted over it freehand."[76] This raw beginning was the start of an artistic career defined by direct, organic, hand-made approaches to filmmaking and animation.

McLaren's developments in abstract animation were put on hold, however, while the student filmmaker was sent to cover the Spanish Civil War through newsreels made by Ivor Montagu. McLaren was horrified by the carnage and profiteering he witnessed, and this would spark a lifelong anti-war concern that appeared in his films several times, as well as spurring McLaren to move away from war-torn Europe to a job with the National Film Board of Canada. He was mainly commissioned to write public announcements, such as holiday greetings and war bond

---

[76] Tom Charity, "Music in Motion," *Sight & Sound* 17/1 (January 2007): 92.

advertisements, but the NFB supported and encouraged his experiments as part of their mission "to engage in research in film activity."

Through the NFB's production studios, McLaren gained national popularity and, eventually, a name on the world arts stage. His unique animation style enchanted ordinary viewers and great abstract artists alike with its organic, hand-made aesthetic and lively, colorful movements. For McLaren, composing animated music was a natural extension of his animation techniques. His extended experimentation with animated sound had a pragmatic beginning. Early in his career, McLaren marketed his abstract films to contemporary art museums. He noted in a 1977 CBC interview that, after receiving a commission from the Guggenheim Art Museum, "I rushed home… and bought clear film, but the soundtrack was going to cost 50 or 100 dollars, and I couldn't afford that. So, I thought, well, I'll just have to make my own soundtrack."[77] This cost-effective film-making resulted in some of McLaren's most well-known films, such as *Dots* and *Loops.*

McLaren maintained a visual perspective toward music, always showing an intuition for finding the motion and shape in musical forms, and many of his short films could accurately be called music videos. "In these films, McLaren makes colour and line whirl and dance, not as an illustration of the music, but as an extension of it. …He was painting his

---

[77] Norman McLaren, *Night Cap—The Five Faces of Norman McLaren* (Ottawa: Canadian Broadcasting Company, August 1977). Radio Broadcast. Audio file courtesy of the NFB—also released as a supplement to *Norman McLaren: The Master's Edition* DVD. (Chicago: Home Vision Entertainment, 2006).

own soundtracks, composing his own films. Typically, McLaren's

synthetic music is both methodical and whimsical, the sound of a

dedicated dabbler."[78]

In 1951, McLaren starred in a documentary written by Don Peters,

filmed by Lorne Batchelor, and produced by McLaren, Tom Daly, and the

National Film Board of Canada. Entitled *Pen Point Percussion*, or *À la*

pointe de la plume, it provides an introduction to the hand-painted

animated music that accompanied McLaren's peculiar animated short

films—which McLaren himself called "cartoons."[79] The short

documentary film constitutes an introduction to the variety of visual

representations of sound among various fields and the method of visually

recording sound on a film soundtrack.

The narrator explores the film silhouettes of various recorded

sounds before moving on to explain McLaren's animated sound

technique. McLaren himself demonstrates his method, painting several

sounds on a blank film reel, which the audience is then able to hear. The

documentary also shows McLaren in the process of crafting his 1940

animated short film *Dots*. *Dots* is a quintessential example of both

McLaren's quirky abstract animations and his application of the

---

[78] Charity, "Music in Motion".

[79] Norman McLaren and Tom Daly, *Pen Point Percussion* (Montreal: The National Film Board of Canada, 1951), 16mm film. It is interesting to note the multiple possible meanings of the word "cartoon," with all of which McLaren was probably familiar. According to the *Oxford English Dictionary* (Oxford: Oxford University Press, 2009) a "cartoon" is "a drawing on stout paper, made as a design for a painting of the same size to be executed in fresco or oil, or for a work in tapestry, mosaic, stained glass, or the like; a full-page illustration in a paper or periodical; especially applied to those in the comic papers relating to current events; or an animated film."

animated sound technique to create lively, colorful music videos. Rather than using the technique of die-cut patterns, as in Fischinger's sound ornaments, McLaren chose to create sounds by painting directly on the soundtrack film, in the same way that he painted his visual animations. This technique tends to result in fuzzier tones that vary more widely between repetitions than the drafted wave patterns do.

He also experimented with patterns he etched into the soundtrack area of black film, using a similar technique as drawing dots and lines on clear film. The sound qualities of the animated music produced by these two methods are slightly different. McLaren experimented with the two methods of visual and musical animation, not only for their technical differences, but also for their aesthetic characteristics. McLaren composed the soundtrack for his 1965 short abstract film, *Mosaic,* by etching on special film with a black soundtrack area and clear image area. (See Figure 7.)

Figure 7. McLaren Examining a Strip of the Dual Black/Clear Film Used for *Mosaic* (1965).[80]

---

[80] This image and all other images of Norman McLaren's laboratory courtesy of the National Film Board of Canada.

He used the etching method for both the visuals and the animated sound portions of *Blinkity Blank* (1955), one of his most famous films. It was not only an exercise in hand-etched animation, but also an experiment with a type of optical illusion called "persistence of vision." When the eye sees a bright image flash across a contrasting background, the image persists on the retina even after it has vanished in actuality. This is called an "after-image," and it may remain in the mind's eye (literally) for a moment amidst darkness or until the next image is seen. McLaren etched bright, hand-colored designs into the main area of the film. "By engraving non-representational visuals directly on black, emulsion-coated film in interrupted sequence, he achieves a "'now you see it, now you don't' effect."[81] Some of the images are abstract, and some are representations of objects and animals.

The music of *Blinkity Blank* was the result of McLaren's etched animated sound cleverly combined with composer Maurice Blackburn's score for wind quartet and 'cello. In *Blinkity-Blank*, animated sound provides some of the framework of the film score, as it alternates with the instrumental quintet. As a whole, the score relies heavily on rhythm to provide continuity, rather than on smooth melodic lines connecting the disjunct fragments that jump from one instrument to another. The interplay between sound and silence in the music of *Blinkity Blank*

---

[81] *Film Information Bulletin: Blinkity Blank*, Pamphlet. (Montreal: NFB, 1955). Digital scan can be found at the NFB's online archive: http://www3.nfb.ca/animation/ objanim/en/filmmakers/NormanMcLaren/archives.php.

mirrors that between flickering light and smooth darkness in the frames, emphasizing the impact of the after-images in combination with the resonance of tones.

The composer notated the quintet in an invented graphic notation that was a simple variation on staff notation. In an interview, McLaren described the method thus: "staff with three lines … high, low, and middle. Notes appeared only on these three lines."[82] Spaces between lines were not used. The instrumentalists chose their pitches in relation to these parameters and to the harmony of the quintet as a whole. They were not without other directions:

> The notes, however, indicated the precise time value and rhythmic pattern, time signatures and bars being used in the usual manner. It was therefore possible to conduct the orchestra and give some coherence to the group of instruments. Signs for the control of dynamics and signs for instrumental colour were used in the conventional manner.[83]

The bounded improvisation of the quintet musicians working from these indeterminate scores created a "complete divergence of inspiration" that yet resulted in coordinated heterophony. In the typical vein of his music, McLaren's accompanying animated sound is based on his idea of linked, repeating musical patterns, rather than formal melodies. This musical technique would be more fully developed, as his animated music became clearer and more complex.[84]

---

[82] Norman McLaren, Interview conducted by Peter Raymont for the NFB (Oct. 1983). Audio file courtesy of the NFB.
[83] Maurice Blackburn, "Notes on the Music of *Blinkity Blank* by Maurice Blackburn" (Montreal: NFB, 1955). Digital scan of manuscript courtesy of the NFB.
[84] McLaren, *The Eye Hears*.

McLaren would later experiment with clear-cut drafted waves very similar to those produced by Fischinger and Pfenninger's experiments— "frame by frame photographing of striped cards on the soundtrack area of the film".[85] He was exposed to the German technicians' methods of animated sound production when he saw, among a series of experimental films presented in Glasgow, the 1932 film by Pfenninger entitled *Die tönende Handschrift*.[86]

When using this technique, McLaren worked from musical tone to visual animation, rather than beginning with the visual animation idea and drawing dots, lines, and loops that seemed to best express the motion of the work, not knowing exactly how they would sound. He described the process in an interview for a BBC/NFB production, entitled "The Eye Hears, The Ear Sees":

> This time I'm starting out with the music, by working it out on the piano. I fiddle away, picking out the patterns. They're not tunes; they're formal patterns. And I notate them, and then I photograph them. Evelyn Lambert and I used Pfenninger's method of making music…We have here a collection of seventy-two cards covering a six-octave chromatic range.[87]

McLaren organized the cards in boxes, with tabs identifying their pitch in both letter and staff notation, for easy matching to his handwritten score guides. (See Figures 8a-b.) He arranged these bar waveform cards in sequence and photographed them one-by-one,

---

[85] Norman McLaren and William Jordan, "Notes on Animated Sound," *The Quarterly of Film Radio and Television* 7/3 (Spring 1953): 225-227; Norman McLaren, "McLaren on McLaren," Interview by Grant Munro (Montreal: NFB, 1983). Audio file courtesy of the NFB.

[86] Maynard Collins, *Norman McLaren* (Ottawa: Canadian Film Institute, 1976), 73.

[87] McLaren, *The Eye Hears*.

controlling the height of the waves (the volume) with the shutter of the

soundtrack card mounting mechanism, which can be seen on the left-

hand side of Figure 8b. Also included in Figure 8b is McLaren's box of

cards with a piano key graph and one of his soundtrack scores with

several repetitions of a short musical pattern.

Figure 8a. McLaren's Wave Card Filing System.
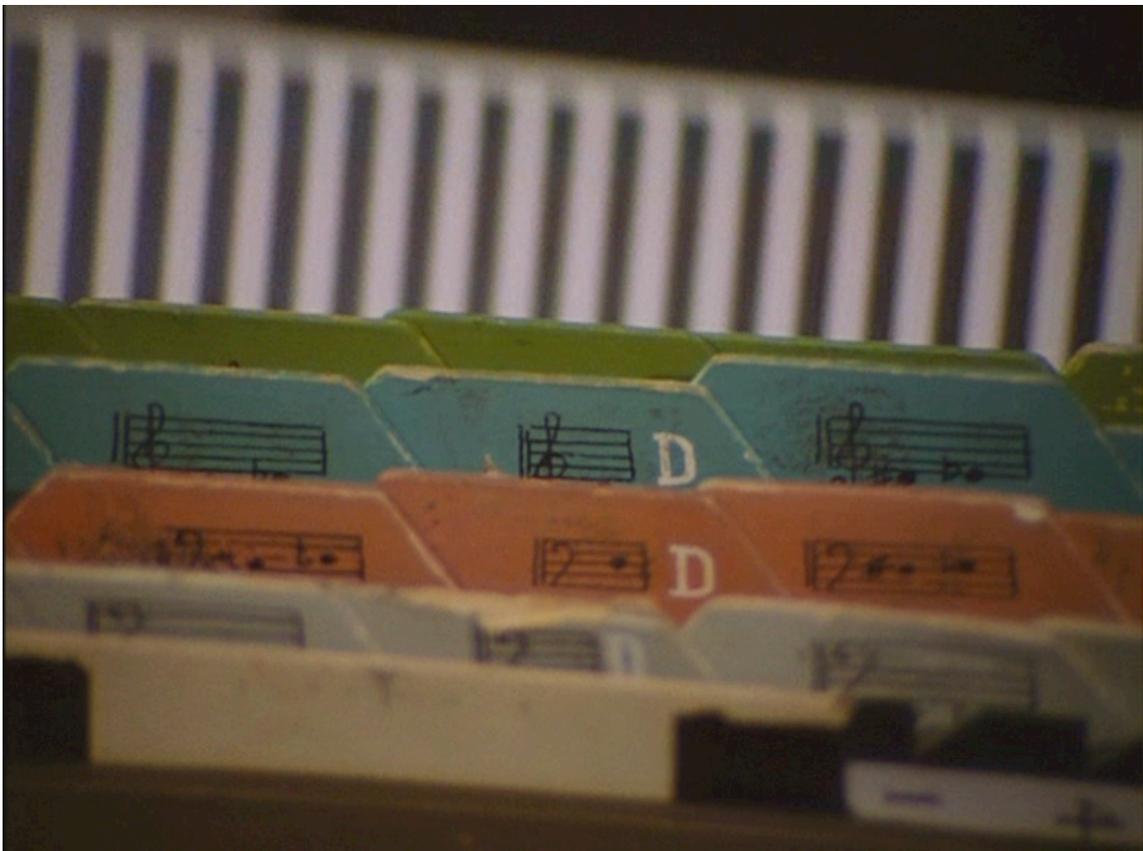
Figure 8b. McLaren's Wave Card Composition System: Cards in Filing Box, Photographing Mount with Shutter, and Manuscript Score.
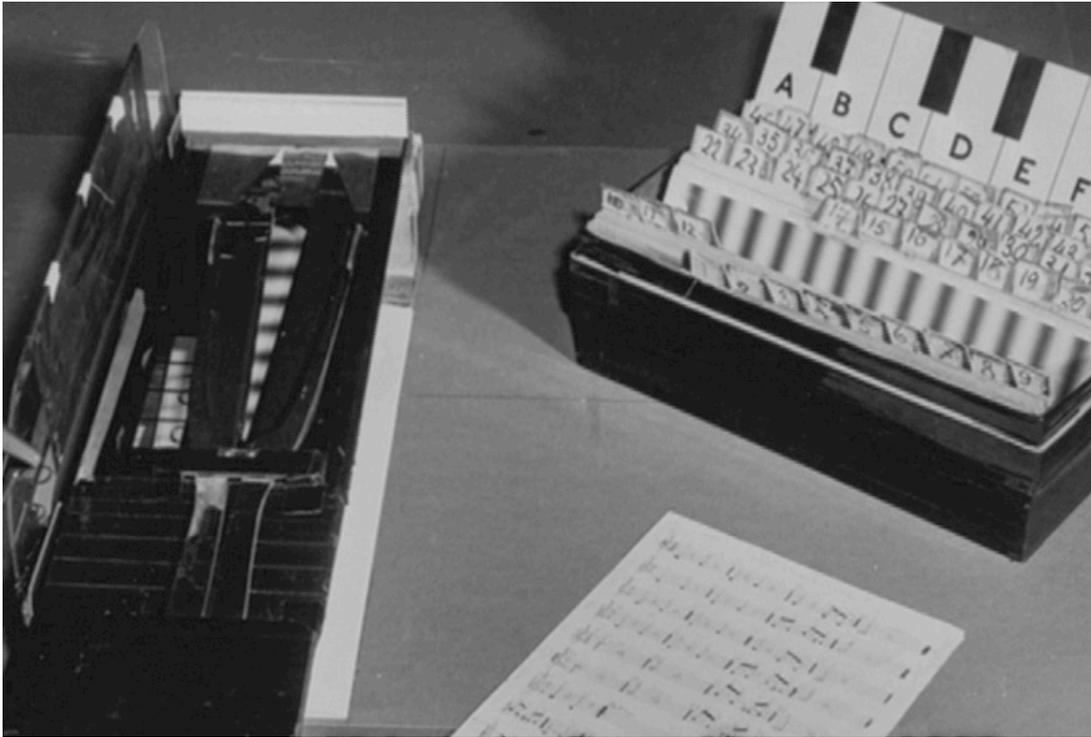
The music McLaren created with these patterns of bar wave cards sounds like the 8-bit sound produced by digital devices of the late twentieth century. His films *Neighbours* (1952), *Canon* (1964), and *Synchromy* (1971) use this animated music technique.[88] *Neighbours* won both a Canadian Film Award (1952) and an Academy Award (1953), the latter at the 25th Awards in Hollywood, where it was nominated for the Short Subject and Best Documentary Academy Award categories and won Best Documentary. This highly allegorical and political film clearly

---

[88] *Neighbours: An Academy Award Film (1955*) (Montreal: NFB, 1952) Information Booklet; Norman McLaren, "Technical Notes on *Synchromy* (1971)," *Technical Notes by Norman McLaren (1933-1984),* (Montreal: NFB, 2006), 57.

did not belong in the Documentary category, and that error was later

recognized by the Academy of Motion Picture Arts and Sciences in a

press release. The soundtrack for *Neighbours* was created using

McLaren's first set of wave cards, which had sine waves rather than the

more popular sawtooth or square waves.

While *Neighbours* was created purely as an artistic work, both

Canon and *Synchromy* were created not only as artistic expressions, but

also as teaching aids. McLaren was fascinated by the relationships

between visual and audio film, as well as by the importance of

movement. *Canon* explores the idea of layered stop-motion animation

and intricate animated music. In *Synchromy*, McLaren's "object was to

try to make the spectator understand, in a very rigorous and methodical

fashion, how the correspondences between sound and image are set up."

Thus the visuals for *Synchromy* are photographs of the square wave

cards used to create the synchronized music. The card images are

arranged into various colored columns, so that the viewer can see the

interplay of the musical layers. Even the colors of the columns

themselves help to illustrate the musical structure:

> In general the colouring was changed at the beginning and
> end of musical sentences or phrases for variety's sake;
> although no "colour-sound-theory" was relied upon,
> pianissimo passages were usually in muted hues, and
> fortissimo passages in highly saturated contrasting hues.[89]

Synchromy would later be considered the masterpiece of

---

[89] Norman McLaren, "Technical Notes on *Synchromy* (1971)," *Technical Notes by Norman McLaren (1933-1984)*, (Montreal: NFB, 2006), 58.

animated sound.[90] It won at least eight international awards and has remained a "classic" animated music film.[91] It has been described as "a fascinating exercise in the 'perception' of sound."[92] It would be the last major film using animated sound that McLaren would complete. In 1974, he would publish a statement on his work that would outline his move away from camera-less animation and composition techniques toward a focus on live-action techniques.[93]

[90] Levin, "Tones," 65.

[91] [N.A.], *Synchromy/Synchromie*, Archive Description (Montreal: NFB, 2010).

[92] David Wilson, "Synchromy," *Monthly Film Bulletin* 39/466 (Nov. 1972): 241.

[93] Norman McLaren, "Statement on My Own Work," Letter to St. James Press for an unpublished film book series (Montreal: NFB, 1974): n.p. Digital scan can be found at the NFB's online archive: http://www3.nfb.ca/animation/objanim/en/filmmakers/ NormanMcLaren/archives.php.

Chapter 8: Reception and Use

Most of these efforts to develop animated sound techniques were limited to short abstract art films, because they were produced as private experiments, and the techniques never gained lasting popularity among the major commercial film companies or studios creating feature films. That trend would remain largely true of all animated sound production throughout the rest of the twentieth century, with the exception of a few synthetic soundtracks for commercial films in Russia and England, as well as Norman McLaren's popular works created for the national Film Board of Canada. During its heyday, animated sound production was practiced by ten to twenty film artists in about five locations across the Northern Hemisphere.[94] It was a prominent topic in the general and artistic press, but people were more captivated by the science and art behind the music than by the actual sounds themselves.

The history of the use and reception of animated sound is, in some ways, curiously similar to that of another early twentieth-century electronic musical instrument also developed in Russia—the theremin. The inventors and promoters of the theremin wanted it to be an instrument for the concert hall. Some exhibited it in combination with other traditional instruments, such as the piano, as well as with new instruments, including Lev Theremin's Illumovox.[95] The theremin was

---

[94] Levin, "Tones," 50.
[95] Albert Glinsky, *Theremin: Ether Music and Espionage* (Urbana: University of Illinois Press, 2000), 45.

very popular among twentieth-century avant-garde artistic ventures for a short time, but, in the end, it stuck in the minds of general audiences as the sound of the ethereal, eerie, and otherworldly. It has been used in several film soundtracks. In fact, the Russian composer, Dmitri Shostakovich, was one of the first to include parts for the theremin in orchestral pieces, including his score for the 1931 film, *Odna* (*Alone*).

The theremin would continue, to the disgust of its earliest masters, to be a featured instrument in the soundtrack for films about the supernatural and spine-chilling, such as *Spellbound*, *The Red House*, and *The Lost Weekend* by Miklós Rózsa, as well as *The Spiral Staircase*, *The Day the Earth Stood Still*, *The Thing (From Another World)*, and C. B. DeMille's *The Ten Commandments*. Audiences could not become accustomed to the sliding electronic tones of the theremin next to the warm, organic pitches emanating from a traditional orchestra.[96]

Animated music was received in a similar manner to the theremin, because the theremin was born of technological invention, intended for sophisticated performance, and ended up as the sound of aliens in films, as did animated sound. When animated sound was premiered, it was an artistic and scientific phenomenon. The composition mechanism and playback system behind animated sound fascinated audiences, especially in the early years of the twentieth century, when scientific innovations and processes were held in almost religiously high esteem. The creativity and scientific knowledge behind handmade optical sound creation is still

[96] Glinsky, *Theremin,* 252-255.

captivating today—how much more so when it was premiered in auditoriums across Europe! The actual sounds were not quite the miraculous spectrum of tones that people expected, however.

In early 1931, news of the development of animated sound in England, Munich, and Berlin was released to the press and public in various media, including articles, special demonstrations, and gala screenings. Enthusiastic journalists were able to compare in print the innovations of artists who had been working in isolation, and all of Europe marveled at the similarity and ingenuity of this "sound handwriting." Yet, as Levin wryly notes: "Although generally fascinated by the technical achievement and its promise, most critics were perplexed and even annoyed by the new sounds."[97]

A contemporary critic in Munich, R. Prévot, asked shrewdly, "Our technological sense was fascinated, our imagination of the future provoked! At the same time, I must admit that our music-loving ear did go on strike, and our lively artistic consciousness was troubled. Was this still music?"[98] He later describes the sound as "steam whistle" and "xyolophone-like… all crafted together with great precision… the effect like that of a dance of the dead." Another critic, A. Huth, described animated sound as "an impression of the mechanical, soulless" and having "a snoring sound and (because the sounds belong mainly to the

---

[97] Levin, "Tones," 54.
[98] R. Prévot, "Musik aus dem Nichts: Rudolf Pfenninger's 'Tönende Handschrift'," *Münchener Neueste Nachrichten* (Oct. 20, 1932). Reprinted in Sophie Duplaix and Marcella Lista, eds., *Sons et lumières: une histoire du son dans l'art du XXe siècle* (Paris: Éditions du Centre Pompidou, 2004), 34. Exhibition catalogue.

areas of the flutes and plucked instruments) also had something of a monotone sound."[99] The actual sounds produced by the drafted waves and photographed patterns were not quite the wondrous sonic horizon that the visionaries of the Bauhaus and their inquisitive audiences expected.

For most commercial producers, there seemed to be no intuitive use for these strange tones, except perhaps to signify the eerie, but the technique was briefly so popular among audiences that it could confidently be used in a few commercial films. The 1931 film adaptation of *Dr. Jekyll and Mr. Hyde*, directed by Rouben Mamoulian, used animated music composed by staff members Rudolph G. Kopp, John Leipold, and Ralph Rainger. The music was created with the drafting and photography method and combined with other electronic music components, such as manipulated recordings of bells and gongs to signal the transformation of Dr. Jekyll into Mr. Hyde and back again.[100]

Nonetheless, neither the critics nor the general public gave up on the potential development of animated sound into a significant, widespread musical technique. As Prévot notes in the conclusion of his review of Pfenninger and Fischinger's premiere in Munich.

---

[99] A. Huth, "Die tönende Handschrift: Eine sensationelle Erfindung," *Nordhäuser Zeitung u. Generalanzeiger* (n.d.). Reprinted in Levin, "Tones," 55; and *Zwischen Rauschen und Offenbarung: Zur Kultur- und Mediengeschichte der Stimme*, ed. Friedrich Kittler and Thomas Macho (Berlin: Akademie Verlag, 2008): 340.

[100] Arthur Knight, *The Liveliest Art* (New York: Macmillan, 1957): 158. The music for this scene is closer to *musique concrete* than any other example of animated music I have encountered. In general, it would seem that animated sound composers did not go so far as to loop, splice, or otherwise manipulate the playback of their hand-drawn waves; only in a few cases did they slow playback to better analyze the sound components.

Film has finally succeeded in creating a new "technological art" which has its own essence distinct from that of live theater. Perhaps the Pfenninger method will also succeed in finding tones and tonal complexes which are new and cannot be produced by natural means—i.e. a music which does not yet exist, a real music of the future? Let us hope that it turns out to be beautiful![101]

It is interesting to note that these critics and writers overwhelmingly emphasized the difference between animated sound production and "natural" sound production with traditional instruments. The electronic musical instruments that were developed during this time—such as the theremin, animated music, and, later, Moog synthesizers—were all subject to this type of pro-organic reasoning. Each new foray into the possible combinations of art and technology caused critics and artists alike to re-consider what they thought to be the proper relationship between invention and nature. The blending of technological invention with manual creative techniques was described as eerie or uncanny (*unheimlich*). All instrumental music is, of course, to some degree "in-organic" and mechanical. Nevertheless, to those most unnerved by the advent of electronic music, "the degree to which technology unceasingly renders superfluous in all domains both organic creation and the natural labors of man" perfectly reflects the psychoanalytical definition of *unheimlich*—something both familiar and foreign at the same time.[102]

In perhaps the most curious example of animated sound creation merging with an organic sound process, a studio in England used optical

---

[101] Prévot, "Musik aus dem Nichts."
[102] W. P., "Der gezeichnete Tonfilm," *Die Frankfurter Zeitung* (Nov. 2, 1932). Microfilm.

recording technology to create a synthetic voice. The technician, E. A. Humphries, had some years of previous experience with sound-on-film recording systems, but the process of creating a voice that had never existed was a new breakthrough. "In order to create a synthetic voice," so Humphries explains, "I had to analyze the sounds I was required to reproduce one by one from the sound tracks of real voices. Well I chose the words I wanted the robot to speak and dissected them into their various sounds—the 'fff' of 'of' for instance, or the 'trrr' of 'tremble'."[103]

After Humphries identified each individual wave pattern with its matching sound—the "graphic sound signatures of all the required phonetic components"—he was able to reassemble them in new patterns. Specifically, he put several wave patterns together in sequence to create the sound of an English woman's voice speaking the corrected line. The organized waves were copied onto paper rolls after assembly and then photographed onto a segment of film soundtrack, which was then spliced into the pre-existing film. When played back on a projector for sound film, according to eyewitnesses, "slowly and distinctly, with an impeccable English accent, it spoke: 'All-of-a-tremble,' it said. That was all."[104]

This development created waves and ripples in the media across Europe, and artist-technicians in other laboratories found their work compared to that of Humphries and his "impeccable" voice. A

---

[103] [N.A.], "Synthetic Speech Demonstrated in London; Engineer Creates Voice Which Never Existed," Special Cable to *The New York Times* (Feb. 16, 1931).
[104] Levin, "Tones," 34.

consideration of the amount of labor, technical knowledge, and audio-

visual technological capability that had to exist in order for this

remarkable event to take place, a mere matter of decades after the

invention of the motion picture camera and phonograph, can give

observers in the twenty-first century some small idea of the levels of

ongoing innovation and experimentation at this time. The ideas—

sometimes only faraway dreams and myths—of previous centuries were

coming to fulfillment in the new scientific world of the twentieth century.

As Levin writes, Humphries' creation of the synthetic voice made "a

technical reality" of the "elusive theoretical fantasy" of previous

centuries. Scientists working as far back as the eighteenth century

thought and wrote about the possibility of creating a synthetic sound,

voice, or music.[105] Joseph Fourier's wave analysis conducted during the

first decades of the nineteenth century unlocked a field of sound wave

analysis that continues to be explored today. It also opened up the

possibility for the study of graphic representations of sound waves. If

sound could be seen as a wave, then could it not also be written as a

wave?[106]

Understanding the scientific processes behind the creation of

synthetic/animated sound quickly fascinated the minds of both film

industry technicians and the movie-going public, more so than the

slightly underwhelming "eerie tones" themselves. It fueled the inventive

---

[105] Levin, "Tones," 34.
[106] Holzer, "Optical Synthesis."

imagination of the early twentieth century, which would give birth to the technological revolutions of the late twentieth century. The artistic technique of animated sound, specific examples of works, and even the underlying technology itself are now (in the twenty-first century) almost completely unfamiliar to scholars, much less to general society. On the other hand, the technique was somewhat well-known, even among the general public during its heyday.

For example, an article by an unnamed author from the periodical *Popular Science* in March, 1933, detailed how "odd designs" were miraculously transformed into familiar music through film.[107] (See Figure 9.) Included is a photograph of Oskar Fischinger at work in his laboratory in Berlin, along with some pictures of examples of his die-cut graphic ornamental sound. Oddly enough, despite there being no mention in the article of Rudolf Pfenninger or his Munich laboratory, the "animated cartoon bearing hand-made music" figure is a frame from Pfenninger's 1930 animated film about marine life, "Pitsch und Patsch."

The anonymous *Popular Science* writer eagerly notes the possibility that animated sound could eliminate a musical "middleman"—the performer. In this process, the composer is prescriber, notator, and executioner of his musical idea, with only the exactitude of the reading technology to bring the ideas into living sound. This possibility would be widely discussed and applauded by participants in synthetic sound creation throughout the decade. Also, the public, artists, and critics alike

---

[107] [N.A.], "Odd Designs on Film Turn to Music," *Popular Science* (March 1933): 36.

were interested in the nearly unlimited potential for creating a spectrum of tones they supposed must lie in the technique. If animated sound could reproduce pre-existing tones and create tones of a previously unheard-of quality, then why not tones that have simply never been heard before? As the unnamed author writes, "Fascinating possibilities await perfection of the method, which American experts compare at present to the "first crude stages of television."[108]

As can be seen from the articles presented here, as well as the NFB's popular short films and the success of commercial films with animated sound, such as *Dr. Jekyll and Mr. Hyde* (1931) and *Romance Sentimentale* (1934), the technique had a particularly warm reception in North America and Russia. It faded from the laboratories in Germany when the Nazi Party seized power. The most active and long-lived laboratory in North America was McLaren's NFB workshop; his short films remained a well-loved feature on television for many years. Overall, however, the global public was completely distracted by new technology within twenty years of the first discovery of animated sound.

---

[108] Ibid.

Figure 9. *Popular Science* (March 1933): 36.

Chapter 9: The Fade-Out

From its conception in 1930, the capabilities of sound-on-film technology served to animate and inspire private artists, large corporations, the general public, and even governmental institutions. Developed as a solution to the problem of synchronizing audio and video, and explored as a possible method of musical composition and cryptographic communication, it brought with it the excitement of a theoretically unlimited number of new applications. Yet the technology, though not the excitement, disappeared quickly from the minds of all but a few of its most active users. By the end of the 1950s and early 1960s, newer, more efficient and cost-effective technology had risen to the top of the market. Both commercial film studios and private artistic ventures shelved their optical recording systems in favor of magnetic tape and other systems. In addition to the mechanisms of production, the personnel who produced animated sound faded away also. None of the animated sound laboratories had been successful in fostering a new generation of artists devoted to discovering the vocabulary of sound handwriting, and most of the original artists moved into other fields. The technique was several decades ahead of its time. In addition, it was considered a technology rather than a musical instrument, which meant that it was irrelevant to non-filmmaking musicians, and easily forgotten even among composers for film once new systems were developed.

When, within a few decades of the discovery of animated music magnetic tape and digital recording emerged with their own seemingly infinite possibilities, the field of electronic music expanded far beyond the capabilities of the sound-on-film systems. Animated music was an art form entirely dependent upon playback technology, and, as such, it was doomed to fade as soon as the technology was superseded by more innovative equipment. Such ephemerality is a recurring theme across the history of humanity's use of technology. The constant flux of time appears nowhere else in such an extreme form as it does in the history of technological innovation. For technology, truly "the altar cloth of one aeon is the doormat of the next."[109]

The composers of electronic music, David Behrman and Ron Kuivila, summed up this everlasting predicament of electronic composition in a conversation in 1998:

> Behrman: "Those of us working with technology are often fascinated by devices or techniques that are (a) new and (b) inexpensive, and a result of this is that works tend to be very involved with things that may appear in the marketplace one decade and be gone the next."
> Kuivila: "The ephemerality of technology is two-fold— technology can become unavailable or just horribly banal. It seems to me that there are three ways people avoid this: by getting "under" technology, by working directly with physical principles; by staying "over" technology, by working with abstract principles; or by diving "into" obsolete or banal technologies."[110]

---

[109] Mark Twain, *Notebook* (New York: Harper,1935), 346.
[110] Ron Kuivila and David Behrman, "Composing with Shifting Sand: A Conversation between Ron Kuivila and David Behrman on Electronic Music and the Ephemerality of Technology," *Leonardo Music Journal* 8 (1998): 13.

Though animated sound may have fallen victim to this "ephemerality," thanks to the preservation of original equipment and the adaptability of digital technologies, it can still be appreciated decades after the last optical recording system was tossed out of the studio. As a young man, American avant-garde composer John Cage met Oskar Fischinger and subsequently wrote an article praising the work of composers who could "make music directly…[for whom] a portrait of Beethoven repeated fifty times per second on a sound track" was as much music as the tones of a violin were.[111] Musicians today who create their own animated music are following the same physical and abstract principles that guided innovators such as Oskar Fischinger and Norman McLaren in their creation of 'tones from nowhere'. For example, Derek Holzer, an American electronic music composer, has been fascinated by the capabilities of analog electronic sound production, especially animated sound produced using Scholpo's tonewheel system. He currently tours the world giving concerts and lectures on synthesized sound, analog sound technology, and digital audiovisual programs. Animated sound has also been the focus of other public concerts and lectures, such as the iotaCenter's *Kinetica-2* festival in 2000, which celebrated the work of Oskar Fischinger, including his *Sounding Ornaments*. Norman McLaren's work, both with animated sound and live-action animation, has also been the center of some recent performances

---

[111] John Cage, "The Future of Music: Credo," in *Silence* (Middletown, CT: Wesleyan University Press, 1961), 4.

in Scotland.[112] Animated music techniques could be revived more fully if they gain musical consideration—outside of the historical interest of film scholars. This study has presented, with a musicological focus and technological emphasis, a synthesis of the available information on animated sound in order to provide a new history and perspective on the technique. Further research could examine animated sound within the histories of notation, music technology, philosophy, art history, and electronic composition.

If nothing else, the brief, bright history of animated sound gives us insights into the relationships between drafted sound wave and artistic image, organic performance and synthesized sound, man and machines. In the early twentieth century, artists and scientists held out great hope and faith in technological innovation. Many constantly customized their methods to the latest systems, despite some deeply held misgivings regarding the meaning of synthesized material. These continuous changes had both positive and negative results. New discoveries happened frequently, but technology-specific methods were doomed to become obsolete.

Studying animated sound allows present-day musicologists to understand how musicians in the past thought about technology, and how scientists thought about musical sound. It also provides perspectives on the consequences of working with constantly changing

---

[112] Tim Cornwell, "Beyond the Norm," *The Scotsman* (April 17, 2008): 48.

technological systems, which pervade life in the twenty-first century. Dr. H. W. Strauss summarizes the ephemerality of technology thus: "It is rare that a new technology offers substantial improvements… More often, what is found is an improved understanding about the status of the system."[113] Animated sound did not fulfill the expectations or predictions of its contemporary proponents, who hailed it as an immeasurable improvement in musical technology. Nonetheless, its study can bring a better understanding of its time and surrounding philosophies, as well as provide historical precedence for discussions of current technological developments and their impact on art, science, and the historical record. Perhaps, most importantly, examining the short story of animated sound can inspire current artists to re-examine the possibilities for manual adaptation of mechanized systems, however inorganic or clumsy they may seem.

---

[113] H. William Strauss, "Ode to Ephemerality," *Journal of Nuclear Medicine* 31/1 (1990): 3A.

Appendices

Appendix A:

Music Direction Sheet for *1, 2, 3* by Norman McLaren (1954). First Page Only. Copyright NFB of Canada, 1954.
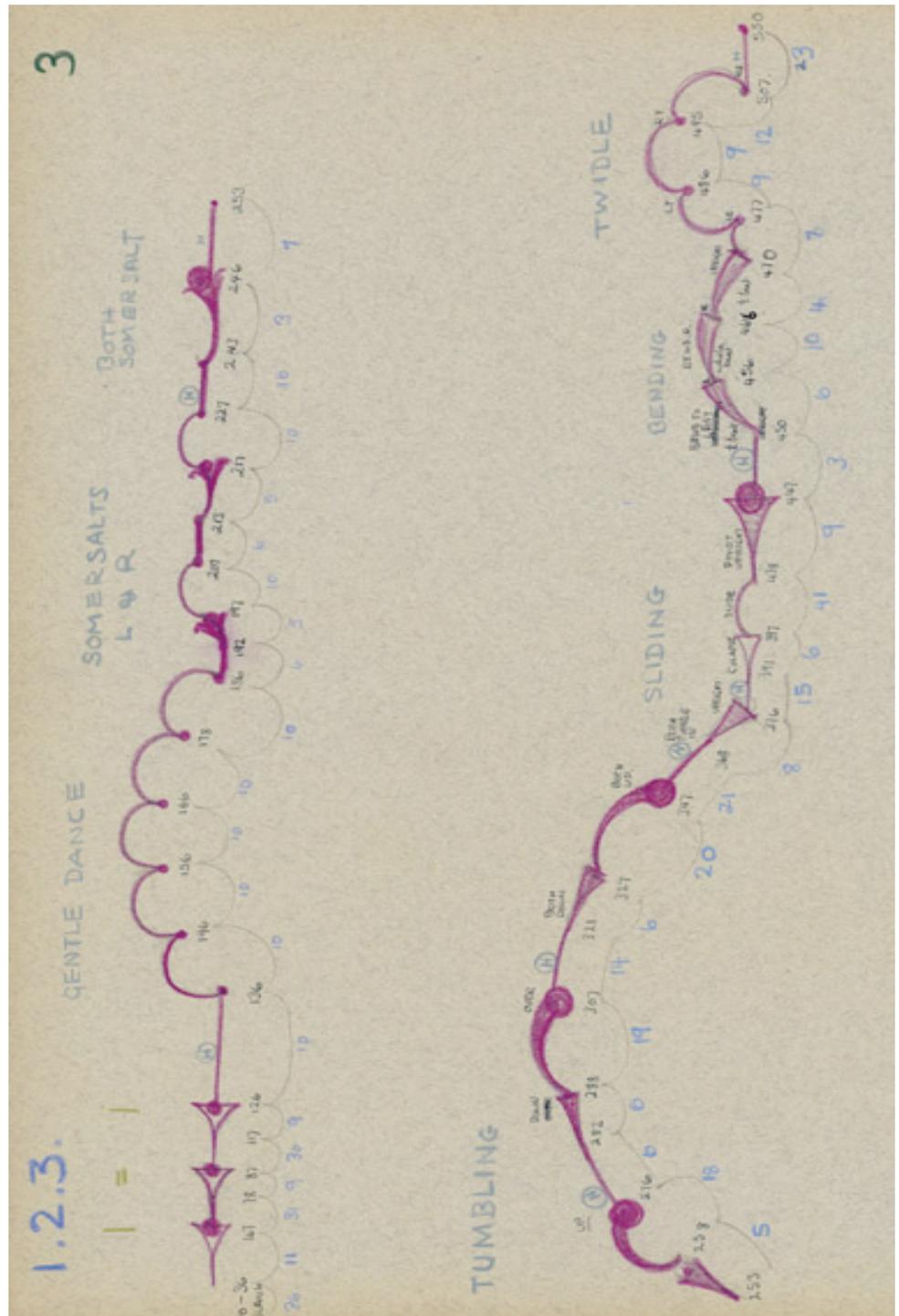
Appendix B: Selections from Oskar Fischinger's *Sounding Ornaments* (1932)

(First published in the *Deutsche Allgemeine Zeitung*, July 8, 1932, then widely syndicated in other newspapers.)

"Between ornament and music persist direct connections, which means that Ornaments are Music. If you look at a strip of film from my experiments with synthetic sound, you will see along one edge a thin stripe of jagged ornamental patterns. These ornaments are drawn music—they are sound: when run through a projector, these graphic sounds broadcast tones or a hitherto unheard of purity, and thus, quite obviously, fantastic possibilities open up for the composition of music in the future. Undoubtedly, the composer of tomorrow will no longer write mere notes, which the composer himself can never realize definitively, but which rather must languish, abandoned to various capricious reproducers. Now control of every fine gradation and nuance is granted to the music-painting artist, who bases everything exclusively on the primary fundamental of music, namely the wave—vibration or oscillation in and of itself. In the process, surface new perceptions that until now were overlooked and remain neglected. Possibilities that are definitely significant for a scrupulous and profound creator of music, for example, precise overtones or timbres characteristic of a certain voice or instrument can be reproduced with accurate fidelity through these drawn patterns. Or, when desirable, the profile of sound waves could be synchronized exactly, wave-trough with wave-trough, so that their dead-centers would coincide, sounding in perfect accord. Or, furthermore, new musical sounds are now possible, pure tones with a precision of definition in their musical vibrations that could not be obtained formerly from the manipulation of traditional instruments [...]

Study of sample soundtracks containing these complex tonal patterns reveals that not only do the layered ornaments produce refined, intricate musical sounds but also they appear unexpectedly as attractive abstract visual images [...]

The basis of designing a graphic art that can be actuated by a beam of brightest light will be the definitive, direct building blocks of music [...]

These music artists must also be concerned with combining their musical compositions created in this new manner together with appropriate optical imagery. This should result in the potential for combination of sounding ornaments with visible filmic, spatial forms and movements. With that union, the unity of all the arts is definitively, finally achieved, and has become unquestionable fact."

Bibliography

Primary Sources

Films and Sound Recordings:

Sound Recording and Reproduction (Sound on Film). 16mm film. Encyclopaedia Britannica Films, Courtesy of the Prelinger Archives. Original by ERPI Classroom Films, 1943.

McLaren, Norman. Interview conducted by Peter Raymont for the NFB (Oct. 1983). Audio file courtesy of the NFB.

McLaren, Norman. *Dots.* 16mm Film. Montreal: NFB, 1940.

McLaren, Norman. *The Eye Hears, The Ear Sees.* Documentary feature. Interview by Gavin Millar. Montreal: BBC/NFB, 1970.

McLaren, Norman. *Night-Cap—The Five Faces of Norman McLaren.* Radio Broadcast. Ottawa: Canadian Broadcasting Company, August 1977.

McLaren, Norman and Tom Daly. 16mm Film. *Pen Point Percussion.* Montreal: NFB, 1951.

Stockhausen, Karlheinz. *Prozession.* LP. Varèse International Records VC 81008, 1967.

Magazines and Newspapers:

N.A. "Film-Experimente: Zu einer Matinée im Frankfurter Gloria-Palast." *Rhein-Mainische Volkszeitung*, Dec. 5, 1932. Reprint in *Neues Bauen/Neues Gestalten: Das neue Frankfurt/die neue Stadt. Eine Zeitschrift zwischen 1926 und 1933.* Dresden: Verlag der Kunst, 1984.

N. A. "Odd Designs on Film Turn to Music." *Popular Science* (March 1933): 36.

N. A. "'Sketches' Sound; Files It for 'Talkies'." *Modern Mechanix* (February 1936): 83.

N. A. "Soundless Film Recording." *The New York Times*, Jan. 29, 1933, Section 9, p. 6.

N. A. "Synthetic Speech Demonstrated in London; Engineer Creates Voice Which Never Existed." Special Cable to *The New York Times*, Feb. 16, 1931.

Fischinger, Oskar. "Sounding Ornaments." *Deutsche Allgemeine Zeitung*, July 8, 1932, n.p.

Huth, A. "Die tönende Handschrift: Eine sensationelle Erfindung." Review. *Nordhäuser Zeitung u. Generalanzeiger*, n.d., n.p. Reprinted in Levin, "Tones," 55; and *Zwischen Rauschen und Offenbarung: Zur Kultur- und Mediengeschichte der Stimme*, ed. Friedrich Kittler and Thomas Macho (Berlin: Akademie Verlag, 2008): 340.

Krasna-Krausz, Andor. "Beginning of the Year in Germany." *Close-Up* 10 (March 1933): 76.

W. P. "Der gezeichnete Tonfilm." Microfilm. *Der Frankfurter Zeitung,* Nov. 2, 1932.

Prévot, R. "Musik aus dem Nichts: Rudolf Pfenninger's 'Tönende Handschrift'." Review. *Münchener Neueste Nachrichten*, Oct. 20, 1932. Reprinted in Sophie Duplaix and Marcella Lista, eds., *Sons et lumières: une histoire du son dans l'art du XXe siècle*. Paris: Éditions du Centre Pompidou, 2004. Exhibition catalogue.

Other Primary Sources:

Film Informational Bulletin: Blinkity Blank. Pamphlet. Montreal: NFB, 1955.

Council of the London Film Society. *The Film Society Programmes 1925-1939.* New York: Arno Press, 1972.

N. A. "The Importance of Being Fischinger." Festival program. *Ottawa International Animated Film Festival*, 1976.

Neighbors: An Academy Award Film (1955). Information booklet. Montreal: NFB, 1952.

N.A. *Synchromy/Synchromie.* Archive Description. Montreal: NFB, 2010.

Maurice Blackburn, "Notes on the Music of *Blinkity Blank* by Maurice Blackburn" (Montreal: NFB, 1955). Digital scan of manuscript courtesy of the NFB.

McLaren, Norman. "Statement on My Own Work." Letter to St. James Press for a film book series (unpublished). Montreal: NFB,1974.

Moholy-Nagy, László. "New Film Experiments (1933)." In *Laszlo Moholy-Nagy.* Ed. Passuth, Krisztina. London: Arts Council of Great Britain, 1980. Originally published as Moholy-Nagy, László. "Új film-kísérletek." *Korunk* 8/3 (1933): 231-237.

László Moholy-Nagy, "Neue Gestaltung in der Musik. Möglichkeiten des Gramophons" *Der Sturm*, 7 (1923), n.p. Translated and reprinted as "New Form in Music: Potentialities of the Phonograph" in *Moholy-Nagy.* 2nd Ed. Passuth, Krisztina London: Thames and Hudson, 1985.

Moholy-Nagy, László. *Vision in Motion.* Chicago: P. Theobald, 1947.

Secondary Sources Consulted

The Animator As Musician. DVD. Montreal: NFB, 2006.

N. A. "Animated Music, 1-5." *Proceedings of the 8th International Festival of Animated Film in Stuttgart.* http://www.awn.com/stuttgart_ anifest/music.html. Stuttgart: Animation World Network, 1996.

Barnier, Martin. *En route vers le parlant: histoire d'une evolution technologique, économique et esthétique du cinema (1926-1934).* Liége: Editions du Céfal, 2002.

Belton, John. "Awkward Transitions: Hitchcock's *Blackmail* and the Dynamics of Early Film Sound." *The Musical Quarterly* 83/2 (Summer 1999): 227-246.

Cage, John. "The Future of Music: Credo" and "Forerunners of Modern Music." In *Silence.* Middletown, CT: Wesleyan University Press, 1961, 3-65.

Charity, Tom. "Music in Motion." *Sight & Sound* 17/1 (Jan. 2007): 92.

Chun, Wendy, Hui Kyong and Thomas Keenan, eds. *New Media, Old Media: A History and Theory Reader.* New York: Routledge, 2006.

Maynard Collins, *Norman McLaren* (Ottawa: Canadian Film Institute, 1976).

Cornwell, Tim. "Beyond the Norm." *The Scotsman*, April 17, 2008, 48.

Duplaix, Sophie, and Marcella Lista, eds. *Sons et lumières: une histoire du son dans l'art du XXe siècle*. Exhibition catalogue. Paris: Éditions du Centre Pompidou, 2004.

Eyman, Scott. *The Speed of Sound: Hollywood and the Talkie Revolution (1926-1930)*. New York: Simon & Schuster, 1997.

Fraundorf, Phillip. "Harmonic Analysis of Music, Talk, and Crystals." Lecture at the University of Missouri—Saint Louis, 2006. www.umsl.edu.

Glinsky, Albert. *Theremin: Ether Music and Espionage*. Chicago, IL: University of Illinois, 2000.

Gomery, Douglas. *The Coming of Sound: A History*. New York: Routledge, 2005.

Gomery, Douglas. "The Coming of Sound: Technological Change in the American Film Industry." In *Technology and Culture—The Film Reader*, ed. Andrew Utterson. Oxford and New York: Routledge/Taylor & Francis, 2005.

Gorbman, Claudia. "Bibliography on Sound in Film." *Yale French Studies* 60 (1980): 269-286.

Hacquard, Georges. *La Musique et le cinéma*. Paris: Presses universitaires de France, 1959.

Hendricks, Gordon. *Origins of the American Film*. New York: Arno Press, 1972.

Holzer, Derek. "A Brief History of Optical Synthesis." *Tonewheels: Audio Visual Performance*. Berlin: Tesla Media Arts Laboratory, 2007. http://www.umatic.nl/tonewheels _historical.html.

James, Richard S. "Avant-Garde Sound-on-Film Techniques and Their Relationship to Electro-Acoustic Music." *The Musical Quarterly* 72/1 (1986): 74-89.

Karlstrom, Paul J., ed. "Visual Music and Film-As-An-Art before 1950." In *On the Edge of America: California Modernist Art, 1900-1950*. Berkeley, CA: University of California Press, 1996.

Knight, Arthur. *The Liveliest Art*. New York: Macmillan, 1957.

Kuivila, Ron and David Behrman. "Composing with Shifting Sand: A Conversation between Ron Kuivila and David Behrman on Electronic Music and the Ephemerality of Technology." *Leonardo Music Journal* 8 (1998): 13-16.

Levin, Thomas Y. "'Tones from out of Nowhere': Rudolf Pfenninger and the Archaeology of Synthetic Sound." *Grey Room* 12 (Summer 2003): 32-79.

Loughney, Patrick. "Domitor Witnesses the First Complete Public Presentation of the *Dickson Experimental Sound Film* in the Twentieth Century." In *The Sounds of Early Cinema*, ed. Richard Abel and Rick Altman. Bloomington: Indiana University Press, 2001, 215-219.

McLaren, Norman. "A Brief Summary of the Early History of Animated Sound on Film (From Available Information)." Manuscript for the NFB. Aug. 16, 1952.

McLaren, Norman; Donald McWilliams; Marc Bertrand; Marcel Jean; National Film Board of Canada.; Home Vision Entertainment; Image Entertainment; et al. *Norman McLaren, the Master's Edition.* DVD. Chicago, Ill.: Home Vision Entertainment, 2006.

McLaren, Norman and William Jordan. "Notes on Animated Sound." *The Quarterly of Film Radio and Television* 7/3 (Spring 1953): 223-229.

McLaren, Norman. *Technical Notes by Norman McLaren (1933-1984).* Montreal: NFB, 1952, rev. 1985.

McWilliams, Donald. "Norman McLaren: Hands-on Animation." Montreal: NFB, 2009. http://www.nfb.ca/playlists/donald_mcwilliams/ mclaren/.

Prendegast, Roy M. *Film Music: A Neglected Art*, 2nd ed. New York: W. W. Norton, 1992.

Pryer, Anthony. "Graphic Notation." *The Oxford Companion to Music.* New York: Oxford University Press, 2002.

Russett, Robert. "Animated Sound and Beyond." *American Music* 22/1 (Spring 2004): 110-121.

Sabaneev, Leonid and S. W. Pring. "Music and the Sound Film." *Music & Letters* 15/2 (April 1934): 147-152.

Smirnov, Andrey. *Sound Out of Paper.* http://asmir.theremin.ru/ gsound1.htm. Moscow: Theremin Center, 2006.

Sponable, Earl I. "Historical Development of Sound Films." *Journal of the Society of Motion Picture Engineers* 48/4–5 (April/May 1947): 275-303.

Strauss, H. William. "Ode to Ephemerality." *Journal of Nuclear Medicine* 31/1 (1990): 3A.

Tremaine, Howard M. *Audio Cyclopedia* (Indianapolis, IN: Howard M. Sams, 1969).

Twain, Mark. *Notebook* (New York: Harper,1935).

Weibel, Peter. "Von der visuellen Musik zum Musikvideo." *Clip, Klapp, Bum: Von der visuellen Musik zum Musikvideo.* Ed. Veruschka Body and Peter Weibel (Cologne, Germany: Dumont, 1987): 84.

Wierzbicki, James E. *Film Music: A History* (New York: Routledge, 2009).

Wilson, David. "Synchromy," *Monthly Film Bulletin* 39/466 (Nov. 1972): 241.
`