By the end of the 1920s, two waves of technological activity had swept across the musical culture of the Weimar Republic. First, automatic instruments such as the Welte-Mignon mechanical piano offered composers a means of transmitting their work directly to a machine, bypassing the variability and physiological limitations of human performers. Second, electrophonic instruments such as Jörg Mager’s Spherophone expanded the possibilities of musical expression through new, ultrasensitive playing interfaces and sound circuitry that enabled the discovery of hitherto unknown sonic phenomena. For the champions of the quest for new instruments, it was a small and self-evident step to seek the unification of these two ideals—an instrument that combined the unbounded potential of electric tone generation with the absolute authorial control of mechanical inscription. The technological basis for this “universal instrument” was to be found in an unexpected place: the sound recording media that had become all but ubiquitous in the first quarter of the twentieth century.

In the fall of 1926, a special issue of the modernist music journal *Musikblätter des Anbruch* appeared, bearing the title “Musik und Maschine.” Alongside reports of the festival in Donaueschingen that featured original compositions for the Welte-Mignon mechanical piano, Hindemith and Schlemmer’s *Triadic Ballet*, and Jörg Mager’s demonstra-

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“Sonic Handwriting”

Media Instruments and Musical Inscription

Every sounding object employed by the composer is a musical instrument.¹

—Hector Berlioz
tion of his Spherophone, there was a short article, “The Talking Film,” under the byline of Dr. Guido Bagier, artistic director of the sound-film department of UFA, the premier film studio in Weimar Republic Germany. Bagier’s text introduced composers to the new technology of optical sound film, which allowed acoustic phenomena to be recorded on a tiny strip of film running parallel to the cinematic frames. Although the title of Bagier’s article signalled that the primary appeal of sound film lay in the synchronization of sound and image in motion pictures, he touched on other possibilities that would endear the technology to modernist composers in search of new instruments. “In a word, we will have to abandon the concept of music based in reality and its imitation through the machine,” Bagier wrote. “Rather, the machine will produce its own acoustic content in accordance with its nature.” Recording devices, Bagier realized, do not capture sounds themselves but only their traces, the grooves or patterns inscribed in the material medium. If these traces could be freely manipulated or even made by hand, a powerful new form of notation (and thus composing) could be born.

Inspired by this vision, a motley assortment of composers, musicians, artists, and intellectuals sought to refunction recording media as instruments for creative experimentation. Challenging the conventional relationship between musical production (composing) and reproduction (recording), they treated media not as a means of capturing performances but rather as a novel instrument capable of uniquely technogenic effects. The exploration of these “media instruments” underwent two technological iterations: at first, these efforts were focused on the gramophone record, and then from the late 1920s onward, composers turned to the new technology of optical sound film. The instrumentalization of recording media further encompassed two distinct compositional techniques—two ways of using the graphical representation of sound as musical material. In the first approach, recordings of natural and human noises, speech, and musical tones were manipulated and rearranged in a manner inspired by contemporary cinematic technique. In the second approach, the conventional recording function was bypassed altogether in favor of direct inscription onto the medium, creating entirely new sonic phenomena. In both cases, the purpose was not to capture a realistic approximation of an actual performance event but rather to construct a deliberately artificial work conceived on the basis of the technological medium and its formative potential.
Like automatic instruments such as the player piano, media instruments provided the composer with a means of notating music in a graphical form that could be realized precisely and repeatedly without human intervention. Writing in 1932, the critic Gerhard Lindner dubbed the new phenomenon “graphomusic” and compared composition for sound film to earlier experimental efforts with the player piano, arguing that sound film was “in principle nothing new, since it stands firmly in the intellectual lineage of the attempts of Hindemith and Toch to compose directly on the paper rolls of mechanical instruments.” The aesthetic debates about mechanical music were, according to Lindner, in no need of revisiting:

It is immediately clear that in the graphical production of tones there is no compulsion to imitate the traditional instruments. Further, one is not dependent on the potential of instruments (which are generally limited with regard to range), nor—most importantly—on the physiological capabilities of the instrumentalist. Perhaps this can be fully appreciated only by the composer, who need no longer be impaired by any attachment to old instruments or any consideration of physiological hindrances. It thus appears in all likelihood that sound film will someday become the most perfect musical instrument.4

At the same time, champions of these new instruments also echoed the rhetoric of electric music. In the same essay, Lindner noted that graphomusic offers not only unsurpassed precision but also the prospect of “new kinds of timbre” and “absolute mobility in tonal space.” Like Mager’s instruments, media instruments promised to transcend the pitch and timbre limitations of the nineteenth-century instrumentarium and furnish an expanded sonic palette that encompassed not only all manner of tones but also unheard synthetic timbres and noises previously considered unmusical. Media instruments seemed to offer the best of both worlds: the organic and the mechanical, fantasy and exactitude.5 More than previous examples, however, the devices considered in this chapter resisted assimilation into familiar concepts of what an instrument is. Whatever their mysterious inner workings, both the player piano and electrophones at least bore outward resemblances to familiar instruments; recording media, however, had no such foothold in conventional models of instrumentality. Though based on the same underlying principles of musical inscription and electric tone generation, these devices lacked the visual and tangible characteristics of traditional musical tools. But the instrumental paradigm they represented—the encoding and manipulation of musical information in a symbolic language that could be “read” and reproduced only by machines—was as promising
for some as it was disturbing for others. Indeed, if media instruments were among the most speculative and experimental manifestations of Weimar Republic sound technology, they were also arguably the most prescient of future developments.

**PAINTING SOUND**

To a greater degree than the devices surveyed in the preceding chapters, media instruments were products of the heady cross-pollination between the arts in 1920s Europe. Tracing their origins requires a historical excursus to the beginning of the decade. In June of 1921, the Italian futurist musician Luigi Russolo gave a series of performances in the Théâtre des Champs-Élysées in Paris. Amid attempts at disruption by Dada artists, Russolo presented a number of works composed for his specially built intonarumori, or noise instruments, with which he had been touring Europe since the publication of his manifesto *The Art of Noises* in 1913.6 In the audience at one Russolo’s Paris concerts was Piet Mondrian, a Dutch painter who had settled in the French capital in 1919. For several years, Mondrian had been developing the theory and practice of what he called “neoplasticism” (*Nieuwe Beelding*), a rigorously geometrical approach to painting that was conceived as a means of achieving an extraindividual, universal kind of artistic expression. Mondrian pursued this ideal through a reduction of visual material to right angle lines and solid fields of color: in his mature style, his paintings consisted simply of black lines dividing the canvas into rectangles of various sizes, which were filled in with one of the three primary colors (red, yellow, and blue) or one of the three “noncolors” (white, black, and gray).

A few months after hearing Russolo’s intonarumori, Mondrian turned his thoughts to music in an essay published in the Dutch art journal *De Stijl*.7 Here Mondrian extended his neoplastic aesthetic on the basis of a sound-color correspondence, conceiving of music as an essentially *plastic* art: “Tone like color is free of volume,” he wrote. “Thus music can immediately follow the lead of painting.”8 According to Mondrian, the fundamental duality of neoplastic music is the opposition of “tones” and “nontones” (or “determinate noises”), corresponding to the use of color and noncolor in painting.9 Mondrian proposed dividing tones and nontones into three types, corresponding to the three primary colors and the three “noncolors.” These tones and nontones are not timbres in the conventional sense but rather fully determinate sonic events, invariably fixed in duration, volume, and presumably, pitch.
The influence of Russolo’s intonarumori on Mondrian’s musical imaginings lay not in the instruments’ noisy, abrasive timbres but in a more general idea of the technological control of sound. “If we are to abstract sound,” he mused, “the instruments must first produce sounds as constant as possible in wavelength and number of vibrations. Then they must be so constructed that all vibration will stop when the sound is suddenly broken off.” Mondrian rejected the aesthetics of subjective emotion and sought instead to express depersonalized, “universal” artistic values. Accordingly, pauses or rests have no place in neoplastic music, for silence constitutes “a void that is immediately filled by the individuality of the listener.” Likewise, he opposed the “rounded” timbres of traditional instruments to the “determinate, planar, and pure tones” of neoplastic music. For Mondrian, the organic, natural, and “morphoplastic” voice was the expression of the “individual” as opposed to the universal. Conventional instruments, insofar as they were modeled on the voice, belonged to the same domain. Organic sounds appeal to people as individuals, while rhythmic, material-mechanical sounds address them on the level of pure form. Mondrian foresaw a time when “man will no longer make use of the formal means of the past nor the human voice organ”:

Tones and noises that come from inanimate material will then be called for. The noise of a machine (as a timbre) will be more appealing to him than the songs of birds or men. This song will always touch him only as an individual, more or less according to the manner of its performance, while machine-generated, purely material rhythm exerts less of an effect on the individual. The sound of a pile driver (as a timbre) will be more familiar to him than the singing of psalms. Thus will the new man, through the force of things, arrive at the invention of truly “new” instruments. And this is absolutely necessary, because only new instruments will meet the demands of pure art.

For Mondrian, only mechanical sound production could free music from the individualistic, “organic” mode of expression and allow it to attain universality. “Mechanical intervention will prove necessary,” he declared, “for the human touch always involves the individual to some degree and prevents the perfect determination of sound.” Years before H.H. Stuckenschmidt’s first polemics on behalf of mechanical music, Mondrian had envisioned a radical new instrumental modality based on the automatic production of sound, which seemed to him the only means of achieving the sufficient degree of control for his rigidly geometrical conception of music. But Mondrian went no further in specifying the actual instruments that might make neoplastic music a reality.
He dismissed the futurists’ intonarumori as too imitative and imprecise, without proposing an alternative of his own. “I am not able to work out my neoplastic music in full, as the instruments are not yet available,” Mondrian wrote, striking a prophetic tone, “but I will set out the course it will take.”

However, Mondrian’s imagined music prove influential. In July 1923, an article entitled “Neoplasticism in Music: Possibilities of the Gramophone” appeared in the German art journal Der Sturm. The author was László Moholy-Nagy, a Hungarian artist who had immigrated to Berlin in 1920. A pioneer in experimental approaches to art informed by science and engineering, he had first written about technological extensions of music in an essay entitled “Production-Reproduction” published in De Stijl in July of 1922. In this article he proposed using recording technologies in unconventional ways to bypass their merely “reproductive” function and turn them into experimental instruments. Instead of simply capturing reality, photographic film and gramophone records could be inscribed upon directly, thus creating new perceptual phenomena unique to the medium. Accordingly, Moholy-Nagy drew a distinction between “productive” and “reproductive” uses of technology: the latter simply duplicates what already exists, while the former creates aesthetic configurations without analogues in nature.

Like Mondrian and many other artists of the time, Moholy-Nagy sought new forms of production that bypassed the artist’s personality in order to attain a more “objective” conceptual purity. In 1922, for example, he ordered five paintings in porcelain enamel on steel from a sign factory in Berlin. With a sheet of graph paper and the factory’s color chart in front of him, Moholy-Nagy dictated the design of each painting to a worker over the telephone, thus demonstrating that the objective formal conception of the work, which could be conveyed at a distance, was more important than the “individual touch” of the artist’s hand. In these “telephone pictures,” Moholy-Nagy severed the conception of the work from its execution, subordinating the artist’s personality as expressed in his brushstrokes to the universal and anonymous formal dimensions of the work.

His article on neoplasticism in music was an elaboration of the ideas presented in Mondrian’s essays, which had been published earlier that year in a German translation. Taking a typically interartistic perspective, Moholy-Nagy focused on three different recording media: the gramophone, the photograph, and cinematic film. In each case, he
distinguished between conventional applications of the technology to record and reproduce, and unorthodox uses that allow for the creation of new artistic forms. He invoked the abstract visual projections of artists such as Walter Ruttmann, Thomas Wilfred, Viking Eggeling, and Hans Richter as models for nonmimetic approaches to the art of moving images. Likewise, Moholy-Nagy suggested, photographic film could be used in a “productive” way, “to receive and record various light phenomena which we ourselves will have formed by means of mirror or lens devices.”

Such techniques had recently been employed by the American Man Ray, the German Christian Schad, and by Moholy-Nagy himself.

Moholy-Nagy’s proposal for the productive use of the gramophone was a logical extension of these ideas to music. Instead of recording sound with microphones, he suggested, artists could make inscriptions directly onto the wax disc by hand. In this manner, they could “produce sound effects which would signify—without new instruments and without an orchestra—a fundamental innovation in sound production (of new, hitherto unknown sounds and tonal relations) both in composition and in musical performance.” Going further, Moholy-Nagy called for a methodical study of the correlations between inscriptions and their sonic effects in order to establish a “scratch-writing alphabet” encompassing all possible phenomena of sound, and so to create the “universal instrument” that would render all previous instruments superfluous. He thus refined Mondrian’s intimation of a fully automated form of musical production into the notion of direct inscription via media instruments. Over the course of the next decade, artists would pursue this technological gambit in two media: first, as already suggested by Moholy-Nagy, via the gramophone record, which in the early 1920s was the most advanced and widespread medium for sound recording; and at the end of the decade, in the new format of optical sound film, which offered a more transparent and malleable means of capturing, editing, and manipulating recorded sound.

**GRAMOPHONE MUSIC**

Moholy-Nagy’s idea of using the gramophone as an experimental instrument was one of the formative influences on H. H. Stuckenschmidt’s vision of “mechanical music,” explored in chapter 2. In fact, Stuckenschmidt’s eventual turn to the player piano represented something of an aesthetic compromise: compared with the relatively narrow sonic spectrum of the piano, the gramophone provided the composer with
a virtually infinite tonal range and much finer pitch differentiation. In 1925, Stuckenschmidt made this assessment:

The authentic gramophone has the great advantage over the mechanical piano, that it brings together all imaginable tone colors in an utterly small and simple apparatus. It will possess simply incalculable stimulations for the composer of the future. The number of tone colors is infinite. Every instrumental tone can be given whatever range. The differentiation of pitch is infinite. Quarter and eighth tones can be played with mathematical purity. The variety of sounds will leave the old orchestra in the dust.

However, Stuckenschmidt acknowledged the technical challenges associated with such an approach. Above all, inscrutability of the gramophone grooves constituted a “seemingly insurmountable obstacle.” In this respect, the notation of the piano roll was clearly superior, as it offered a transparent relationship between notation and acoustic result. The fate of media instruments would hinge in large part on this question of what could be called notational transparency—the ability to establish an absolute and unambiguous relationship between the composer’s “score” (reinterpreted as the recording medium) and the capabilities of the “performer” (reinterpreted as the reproducing apparatus). The unclear relationship between composers’ inscriptions and the sounds they call forth would haunt all efforts to refunctio recording devices as “universal instruments.”

This problem had been highlighted during the mechanical music kerfuffle of the mid-1920s, when one of Stuckenschmidt’s most vociferous critics, Heinz Pringsheim, questioned whether composers could attain any degree of artistic control over the gramophone disc. A gramophone recording, after all, contains the sum of all simultaneously sounding musical phenomena: the individual voices of the orchestra or ensemble are amalgamated into a single groove on the record. How could the composer begin to map the system of correspondences between these inscriptions and the sounds that they index? Pringsheim juxtaposed conventional notation, in which the clarity of the polyphonic structure is ensured by the “analytical” representation of the score, with the jumbled gramophonic “wave-script,” where the entire sonic phenomenon is captured in a single, undifferentiated groove pattern. Conventional notation is far superior to the mechanical inscription of the gramophone record, Pringsheim argued, because it presents the instrumental lines in their independence. The score is not merely a practical necessity for the performance of a work; it is the logical representation of the musical processes that go into the act of composition. The gramophone groove,
by contrast, represents complex, agglomerated systems of sound instead of interwoven lines of individual notes. Because the medium cannot isolate individual notes and motives, it forces the composer to think in terms of unwieldy sonic masses and timbral progressions [Klangkomplexe-Fortschreitungen]. By this reasoning, the very nature of gramophone inscription ruled out the discovery of a “sound alphabet” of audiovisual correspondences.55

In light of such critiques, early gramophone experimentalists adjusted their tactics. Rather than seeking a tabula rasa on which to construct a new musical language, they began by modifying existing recordings on a hands-on, empirical basis. Moholy-Nagy had made arrangements to begin working in record company laboratories in Berlin in early 1923. Stuckenschmidt and the American composer George Antheil lined up as collaborators, but before work got under way, Antheil left for Paris and Moholy-Nagy was summoned to teach at the Bauhaus in Weimar.26 It was there, in the summer of 1923, that the first known efforts in modernist gramophone manipulation took place. Stuckenschmidt, who joined Moholy-Nagy in Weimar, later recounted: “We experimented together, playing records backward, which created surprising effects, especially with piano recordings. We drilled into the records in strange ways, so that they didn’t play regularly, but wobbled and produced grotesque glissando tones. We even scratched into the grooves with tiny needles and so created rhythmic figures and noises that radically altered the sense of the music.”27 But from these rudimentary investigations, the two men quickly moved on to other projects. Stuckenschmidt turned his attention to the player piano, while Moholy-Nagy dismissed both player piano and gramophone as merely provisional stages in the inexorable technological evolution toward a truly universal instrument, “an apparatus that can be operated directly and produce all manner of tones in any number and quality, without an intervening medium.”28 For his part, Antheil would pursue his fascination with mechanical music in his infamous Ballet mécanique, originally intended to include sixteen player pianos.

The idea of using gramophone records as scores for machine-readable music would reemerge some years later. The only known performance of “gramophone music” took place at the New Music Berlin festival in 1930 and featured a set of short pieces by Paul Hindemith and Ernst Toch.29 This event stood firmly in the lineage of the mechanical music phenomena of a few years earlier: both Hindemith and Toch had written pieces for the Welte-Mignon player piano in 1926 and 1927, and
the Berlin concert was in fact part of the same festival (now relocated) that had hosted the earlier concerts in Donaueschingen and Baden-Baden. Hindemith’s involvement was somewhat surprising, since he had rather firmly dismissed the possibility of “authentic composition” for the gramophone in an essay published in 1927.30 His argument was similar to that made by Pringsheim: the sheer indecipherability of the tiny record grooves meant that even the simplest musical relationships would be virtually impossible to establish. But he and Toch found a way of working in the medium that sidestepped the problem of legibility. Their “original works for gramophone record” were made not by etching discs by hand but rather by using the gramophone to alter instrumental sounds. By adjusting the playback speed of recordings, they changed the pitch and tone quality of the originals; this modified output was in turn recorded on a separate gramophone machine.

Although the details of the 1930 Grammophonmusik performance remain fuzzy, the two surviving recordings (both by Hindemith) provide a glimpse into the composers’ approach. A disc labeled “Song over Three Octaves” features a brief vocal melody, likely sung by Hindemith himself, which is heard in juxtaposition with two phonographically altered versions, one played at double the original speed (thus one octave higher), and another played at half the original speed (one octave lower). At the end of the one-minute piece all three voices sound together, creating a three-voice closing chord. The other recording, marked simply “Xylophone,” is a roughly two-minute composition consisting of a two-voice xylophone part and two pizzicato string parts, likely Hindemith’s viola played back at higher and lower speeds to sound like a violin and cello, respectively. Though fascinating in their own right, these recordings were apparently conceived as “sound material” for use in conjunction with live performance.31 A witness to the concert describes how this took place: “The original music for gramophone record was produced through the cross fading of various recordings and live music, through the use of speed, pitch, and timbre that are impossible for live playing to attain. Thus emerged an original music that can only be rendered by the gramophone apparatus.”32 (The odd phenomenon of a performance of recorded music required the use of the phrase “actually played music” [real gespielte Musik] to distinguish what was performed “live” from what was merely played back.)

For Toch’s three-movement work, entitled Gesprochene Musik (Spoken music), he recorded a chorus pronouncing precisely notated text
passages and then modified the speed of playback on the gramophone record, changing the tempo and thus also the timbre, to create “a kind of instrumental music” in which the origins of the sounds were almost entirely obscured.\textsuperscript{33} Toch described his intentions in terms that echo Moholy-Nagy’s production-reproduction dichotomy: “The concept arose from the attempt to extend the function of the machine—which up to now has been intended for the most faithful possible reproduction of live music—by exploiting the peculiarities of its function and by analyzing its formerly unrealized possibilities (which are worthless for the machine’s real purpose), thereby changing the machine’s function and creating a characteristic music of its own.”\textsuperscript{34}

The works performed by Hindemith and Toch diverged significantly from the original conceptions of gramophone music. While Moholy-Nagy and Stuckenschmidt dreamed of coaxing from the disc sounds that had no acoustic correlate in the natural world, Hindemith and Toch exploited the playback mechanism of the gramophone to alter the sound of recordings made in the conventional way. But even if the 1930 concert of \textit{Grammophonmusik} contained no purely synthetic sounds, the music was nonetheless estranged from the familiar world of acoustic phenomena. Georg Schünemann, head of the Radio Research Section in Berlin, where the pieces were produced, wrote of the “astounding effect” of Toch’s pieces: “There was scarcely a musician there who could say where these unfamiliar sounds came from; no one knew whether musical instruments, voices, or even noises were being combined.”\textsuperscript{35} While composers and theorists made much of the distinction between synthetic sound and modified recordings, for listeners both forms could have a similarly otherworldly aesthetic effect.

\textbf{SOUND FROM LIGHT: THE PHOTOELECTRIC CELL}

The public debut of \textit{Grammophonmusik} in 1930 turned out to be its swan song. But as it happened, the genre’s demise coincided quite precisely with the appearance of its technological successor. Toward the end of the 1920s, a new recording medium emerged that promised once again to deliver the long-desired “universal instrument”: optical sound film. Surprisingly, however, neither Hindemith, nor Toch, nor Stuckenschmidt would pursue the ideal of mechanical music into the new medium. Of the original cadre of gramophone experimentalists, Moholy-Nagy alone would champion sound film in the waning years of the Weimar Republic.\textsuperscript{36}
The working of optical sound film is most readily understood in analogy to the more familiar technique of phonographic recording. In the latter process, acoustic vibrations cause a stylus to cut into a spinning cylinder or disc, thus encoding the sounds as a pattern of pits and grooves. Upon playback, another stylus “reads” the inscriptions in the record, thereby activating a diaphragm that produces acoustic vibrations that can be heard as a reproduction of the original sound. With optical sound film, by contrast, sounds are encoded as a two-dimensional graphical pattern on a spinning band of film. In the recording process, acoustic vibrations are picked up by a microphone diaphragm, as in phonographic recording or telephonic transmission. The vibrations are then converted to an electrical current, which in turn governs the intensity of a beam of light emitted by an electric lamp. The fluctuating rays of light are projected on the sound track of the moving band of film, where they are captured as a fixed graphical pattern. In playback, a beam of light is trained on a photoelectric cell. As the film is unspooled, it passes between the beam of light and the cell. The light falling upon the cell is thus modulated by the patterns inscribed in the film, and the sounds emitted by the cell in response to the light correspond to those captured on the film in the recording process.

Although sound film is usually thought of as part of the technological development of motion pictures, the underlying principle of “sound photography” has a much deeper history. As Thomas Levin has shown, optical sound film was a relatively late manifestation of the long-standing effort to establish nonarbitrary, scientifically grounded correlations between acoustic and visual phenomena. Until the late nineteenth century, these efforts resulted only in mute graphical traces: sound could be rendered as a visible pattern, but it could not be reproduced. With Edison’s invention of the phonograph in 1877, however, this “sound-writing” became a form of recording in the sense in which we understand the term today, capable of capturing sound as an inscription and later reconstructing the acoustic phenomena by reversing the process by which it was encoded.37

The use of light in the process of sound recording had a lengthy history before the 1920s as well. Scientists had long realized that the quick, subtle vibrations of a beam of light were better suited to capturing the rapid oscillations of acoustic waves than the cumbrous mechanical apparatus of needles and wax cylinders.38 The phonographic potential of light became apparent through the remarkable properties of the element selenium, which was discovered by the Swedish chemist Jakob Berzelius
in 1817. Over the course of the nineteenth century, scientists found that the electrical resistance of certain allotropes of selenium varied in proportion to the element’s exposure to light. Thus, a selenium cell could be used in electrical circuits to govern the flow of electricity. When it was dark, the cell’s resistance was high enough that the circuit was effectively closed. When exposed to a fluctuating light source, however, the cell’s resistance lowered, allowing electrical current to flow through the circuit.

The first practical attempt to connect sound and light using the photoelectric cell was the Photophone, invented in 1880 by Alexander Graham Bell and Charles Tainter. Essentially, this device replaced the electrical wire of the telephone with a beam of light. A thin, mirrored diaphragm functions as a “light microphone,” vibrating in response to acoustic waves and modulating the light focused on it from an external source. The light beam, whose patterns of fluctuation correspond to the acoustic energy of the transmitted sound, travels some distance until it reaches the selenium cell, where it elicits analogous variations in electrical current. These, finally, are converted via a speaker diaphragm into acoustic vibrations that produce an approximation of the original sound. At the root of this device is the phenomenon of transduction, through which different forms of energy can be transformed into each other and thereby encoded and transmitted. Similar to the functioning of the telephone, the underlying equivalence between the mechanical energy of sound waves and the electrical energy of the flowing current enables the transmission of sound over great distances.

Not long after the invention of the Photophone, the German inventor Maximilian Plessner sketched a prescient, if highly speculative, application of the photoelectric cell. He imagined a way to use light not to transmit sound but rather to encode it on a recording medium in a manner analogous to Edison’s phonograph. This device, which Plessner envisioned but apparently did not construct, was dubbed the “optograph” to distinguish it from Edison’s device. The idea of using light to record rather than transmit sound was developed further in the Photographophone invented by the German Ernst Ruhmer around 1900. In Ruhmer’s contraption, the flame of an arc light (a gas lamp that could be made to flicker in response to acoustic vibrations) is focused on a lens positioned in front of a reel of photographic film. The fluctuations of light caused by the acoustic vibrations are thus captured on the film as fields of varying shades. After being developed, the film is played back at the same speed at which it was recorded, while a constant source
of light is directed upon it. On the other side of the film from the light source is a selenium cell, which is connected to a battery and a telephone receiver, as in Bell’s apparatus.\textsuperscript{42} The patterns encoded on the film are thus transmuted into electrical fluctuations and again back into acoustic vibrations, re-creating the original sound. Ruhmer’s Photographophone possessed the essential elements of later optical sound film recording systems, but its widespread adoption was hindered by the difficulty of recording and amplifying playback with the technology of the time. The sound film techniques of the 1920s picked up where he left off, making use of improved vacuum tube and loudspeaker technology.\textsuperscript{43}

**THE EMERGENCE OF SOUND FILM**

The development of sound film in the 1920s was spurred above all by the burgeoning motion picture industry. The ability to synchronize
the moving images of the film with a recorded sound track was widely hailed as a kind of cinematic holy grail, a breakthrough that would relieve motion pictures of their much-lamented muteness and create a new Gesamtkunstwerk for the twentieth century. But ironically, the advent of optical sound film toward the end of the decade provoked a decidedly negative reaction among some of the foremost directors in Europe. The French filmmaker René Clair, fearing that the synchronization of sound and image would lead to the dominance of spoken dialogue over visual interest, declared the new technology a “terrible monster, a creation against nature, courtesy of which the screen will become an impoverished theater.”

Sergei Eisenstein and other Russian directors issued a statement declaring that sound film threatened “not only [to] hinder the development and perfection of the cinema as an art but also threaten to destroy all its present formal achievements.”

But while many directors resented the aesthetic compromises augured by the arrival of sound film, some musicians welcomed the new technology as an instrument without precedent. Just as cinematic film had liberated the image from the shackles of sequential time and conventional narrative structure, sound film promised to free sound from the limitations imposed by notation and instrumental tone production. The techniques of the artistically advanced cinema—close-ups, slow motion, double exposure, and montage—could now be applied to the composition of music.
László Moholy-Nagy, champion of media instruments since the early 1920s, became the leading exponent of sound film as a vehicle for modernist experimentation. Echoing Ferruccio Busoni, who had called for a “protracted education of the ear” to orient musicians amid the musical possibilities of the twentieth century, Moholy-Nagy argued that the inherent “laziness of the ear” prevented composers from realizing the full potential of such new technologies as the gramophone, radio, and “ether instruments” (meaning the Theremin and other electrophones). In order to contribute to the progress of art, sound film “must go beyond the documentary function of recording and enrich our ears with previously unknown sonic properties.” Here Moholy-Nagy restated the basic argument of his earlier essays, in which he envisioned a creative, or “productive,” role for technologies that had hitherto served merely naturalistic, or “reproductive,” functions. The development of sound film as a vehicle for modernist art, according to Moholy-Nagy, hinged on the ability of musicians to conceive of the recording medium in a creative and nonnaturalistic way, just as avant-garde filmmakers had done in the visual domain.

Like the Russian authors of the “Statement on the Sound Film,” Moholy-Nagy rejected the conventional uses of the new medium, such as reproducing dialogue and creating realistic sound effects to strengthen cinema’s dramatic illusion. The proper function of sound film was instead analogous to the use of montage in silent film. Indeed, Moholy-Nagy essentially paraphrased the Russians’ arguments about the need for an independent, “contrapuntal” relationship between sound and image in the modern film. But before the goal of “opto-acoustic synthesis” could be attained, the musical potential of sound film must be dealt with on its own terms: “Sound film should thus pass through a provisional period of purely musical experiments,” he wrote. “In other words, sound should at first be treated in isolation from the visual. In practical terms, this means separating the soundtrack of the film and experimentally combining individual compositions.” Moholy-Nagy believed that sound-film composition must go through a period of development equivalent to cinema’s silent phase, an exploration of the inherent dynamics of the medium that was strictly limited to the acoustic dimension.

Drawing out a distinction implicit in his earlier theorization of “gramophone music,” Moholy-Nagy differentiated between two basic methods of working with sound film. First, the composer could manipulate “real acoustic phenomena, as they present themselves in natural
sounds, in the human voice, or in musical instruments.” The possible techniques for such acoustic transmutation of recorded sound were drawn directly from contemporary cinematic methods:

Just as the optical film possesses the possibility of capturing an object from different perspectives—from above and below, from the side and from the front, foreshortened—something similar must happen with sound. There must be different “angles of hearing” to correspond to the various “angles of view.” To this can be added acoustic close-ups, slow motion, time lapse, distortion, washes—in short, all the means of a “tone montage.”

Second, Moholy-Nagy envisioned the creation of “optically notatable sound shapes, which are independent of actual objects, and which are photographically transferred to the sound track according to a pre-composed plan and thereafter converted into actual tones.” In this way, composers could circumvent the recording process altogether, imprinting patterns directly on the sound track to generate tones without correlates in acoustic nature. Here sound film was treated not as a medium of recording in the strict sense but as a means of composition via the “opto-acoustic alphabet.”

Both techniques had parallels in the cinema of the 1920s. The first tendency could be traced to surrealist-influenced films by filmmakers such as Clair and Germaine Dulac, in which cinematic devices such as montage, double exposure, and slow motion create a dreamlike simultaneity of images and undermine linear narrative flow. The second approach found precedent in the groundbreaking works of experimental animation of the early 1920s, in which various techniques were used to bypass the naturalistic function of the movie camera and construct a world of pure form and motion. (The German word for a cartoon, Trickfilm, highlights the medium’s potential for legerdemain and illusion.) It was no coincidence that the three German pioneers in sound-film composition—Walter Ruttmann, Oskar Fischinger, and Rudolf Pfenninger—were all veterans of avant-garde cinematic production.

Another parallel to the groundbreaking efforts in optical sound film could be found in the experimental approaches to the new genre of the “radio play” (Hörspiel) that had been undertaken soon after the first national German radio broadcast in October 1923. A new breed of radio artists—sound engineers by training—such as Hans Flesch and Friedrich Bischoff created imaginative programs only loosely linked to literary or narrative models, guided instead by the seemingly limitless
evocative potential of sound. (Flesch declared in 1929, “We need to fashion not only a new medium, but a new content as well: Our program cannot be created at a desk.”) The prospect of an “absolute radio art” also enticed classically trained composers such as Kurt Weill, who imagined a new form of music indigenous to radio, whose expanded repertoire of sonic material included “sounds from other spheres, calls of human and animal voices, the whirring of wind, water, and trees and a legion of new, unknown noises, which the microphone can generate artificially, when sound waves are raised or lowered, superimposed or interwoven, blown away and born again.” Weill’s projected radio-art featured two classes of sounds closely resembling Moholy-Nagy’s categories: “nonmusical” noises derived from recognizable physical processes, and “abstract” tones with no purchase in known acoustic reality. Weill’s thoughts on the matter were directly influenced by the experiments in absolute film, which he had experienced through a screening of films by Richter, Eggeling, Ruttmann, and Clair arranged by the November Group in Berlin in 1925. (A good leftist, Weill had joined the organization in 1922.) “Just as film has enriched the visual means of expression,” he wrote, “so shall the acoustic means be multiplied to an unforeseeable degree through radiotelephony.” Like Mondrian, however, Weill belonged to those whose ability to imagine new forms of technological art outstripped their interest in exploring these new possibilities in their own work.

CINEMA FOR THE EAR: SOUND MONTAGE

Although the two techniques outlined by Moholy-Nagy—what might be called the phonographic (recording-based) and the synthetic (inscription-based)—were by no means incompatible, sound-film practitioners tended to focus on one or the other approach. The phonographic technique was the inspiration for Robert Beyer, who put forth an elaborate theory of experimental sound-film composition in a series of articles published between 1928 and 1930. Beyer had an unusual background that combined experience in the film industry and classical musical training: after studying composition, conducting, and musicology at the Cologne Conservatory, he worked from 1928 to 1934 as a Tonmeister (sound engineer) for Tobis-Klangfilm, a company that consolidated the patents for Tri-Ergon and a number of other European sound-film systems. Beyer’s boosterism for sound-film experimentation resembled H.H. Stuckenschmidt’s activism for “mechanical music” a few years
earlier: like Stuckenschmidt, Beyer championed a musical movement in which he himself had no creative part. He envisaged a type of musical production possible only on the technological basis of optical sound film, “a new interpretation of the concept ‘music’ that is suitable to filmic form.” Beyer argued, sound film would usher in a new music whose only link with previous forms was the shared medium of acoustic vibrations.

Beyer’s vision of instrumentalized sound film began with the recording process itself. The first stage in the “composition of the audible” was the use of the microphone as an “acoustic camera.” The microphone gave the composer complete control over the material of sound, freeing him from the inherent ephemerality of sound and opening up an unlimited space of creative possibility. The centerpiece of Beyer’s approach to sound recording was a technique he called Raumton (room tone), through which the recording process deliberately captures the ambient environment along with the intended sounds. When it is reproduced, the recording projects a sense of space separate from that inhabited by the listener. Because the sound is presented together with the spatial imprint of its environment at the time of recording, listeners are forced to confront it as what it in fact is: a technologically transfigured fragment of reality. This shattering of the illusion of immediacy—which calls to mind the famous “alienation effect” first theorized by Bertolt Brecht in 1935—fundamentally alters the listener’s relationship to recorded sound. Rather than bringing the sound into the room, Raumton projects the recording at a distance, so to speak. For Beyer, sound came into its own as an object of aesthetic perception only through this radical intervention of technology. Ironically, he explained the resultant “revolutionization of hearing” by means of visual metaphors: in confronting the “sound image” of the disembodied acoustic phenomenon, we become “auditors, or rather ‘spectators,’ in the truest sense of the word.”

Extending the metaphor, he suggested that recordings are to “live” or “embodied” sound as the cinema is to the theatrical stage: a different medium with different rules.

Next, Beyer suggested that recording media such as optical sound film undermine the hallowed aesthetic distinction between musical and nonmusical sounds. The recording apparatus registers all phenomena indiscriminately; it knows no difference between tones and noises. In contrast to the holes on the piano roll, the blackened blotches on the film sound track relate ambiguously to the
phenomena they encode. These markings, when read by the playback apparatus, may produce notes of definite pitch, but they also may not: the only thing that they must produce is sounds. Thus, Beyer declared, optical sound film makes it clear once and for all that sound and not tone is the irreducible element of music. The new medium ushers in the “wide-open orchestra, which secretly bears the sound of the world”:

One must naturally free oneself from the old notion of music if one wants to perceive the possibilities of sound-image photography. The concept ‘music’ must be more widely drawn so as to encompass the world of noises. [...] The inclusion of the endless multiplicity of the world of noises, which has become necessarily the primary function of music over against the soundless motion of the imagery, means something more than a linear expansion of its means and possibilities.59

Beyer was not alone in drawing a connection between the indiscriminate ear of the microphone and the musical viability of sounds hitherto dismissed as noise. Walter Gronostay, a Schoenberg pupil and a film composer, likewise suggested that sound film augured a new role for noise in music. Just as early silent film sensitized viewers to the visual “language” of reality, he argued, so too sound film must awaken our attention to the previously unheard world of noises. Gronostay proposed a taxonomy of noise as the foundation for the incorporation of these “nonmusical” sounds into contemporary composition. He distinguished between three types of “interesting noise”: noises whose sources can be clearly determined, such as the siren of a fire engine; “unclassifiable” noises, whose sources cannot readily be ascertained; and noises with a salient perceptual contour, which Gronostay called “organized noises.”60 Across the Atlantic, the conductor Leopold Stokowski—at that time the conductor of the Philadelphia Orchestra—echoed this sentiment when he declared that “[sound] film is bringing into consciousness the idea that much in sound has aesthetical value that formerly we wouldn’t call music at all. It evokes emotion, and if it evokes emotion, it is aesthetic, and if it is aesthetic, we must bring it into the field of music and not bar it and say that it is mere noise.”61 By taming and capturing the un pitched, ephemeral, and nameless acoustic phenomena previously dismissed as “nonmusical,” sound film inspired musicians to reconsider the boundaries of their art form—just as, on a larger scale, magnetic tape would do some twenty years later.

Although the recording process alters the phenomenological status of sound by projecting it into a “virtual space” and expands the composer’s
material to include all acoustic phenomena that can be encoded on film, Beyer saw these effects as “only the smallest part of the creative process.” The heart of the new compositional technique lay in the process of “sonic chemistry” through which the recorded material is transformed into acoustic figures, forms, and tropes—the syntactic units of the new musical language, comparable in function to the tones and themes of traditional compositional technique. The sound-film composer “atomizes” and “dynamizes” the recorded material, breaking it down to its component parts and reconstructing it into novel perceptual configurations. These new figures are then assembled into larger compositional units via montage technique. Through this process, electric tone generation takes on a productive as opposed to reproductive meaning. Invoking Moholy-Nagy’s distinction between productive and reproductive technologies, Beyer envisioned sound film as a means of not simply capturing and recreating acoustic reality but of transfiguring recorded sound into a musical “second nature”: “With these and other methods it will be possible to atomize sound, to construct from its basic elements new tone colors, to traverse a timbral domain of almost cosmic vastness, which far exceeds the known boundaries.”

All the techniques of experimental sound film are motivated by a common aesthetic objective: to allow the composer to work not with notes or other abstract entities but with the fabric of sound itself. “Ultimately,” Beyer declares, “the desire to emancipate timbre as an independent element is the driving force that has fundamentally guided the musical development of the past decades.” Here the radical nature of Beyer’s vision becomes clear. Arnold Schoenberg famously disliked the term atonal because of its absurd implication of music without tones. But a music without tones—or in which tones and tonal connections are no longer the most important phenomena—is precisely what Beyer had in mind. His idea of Klangfarbenmusik involves not simply the incorporation of timbral logic into the existing compositional process but a complete transcendence of pitch relationships as the guiding structures of musical creation. In this respect, Beyer’s defense of sound-film composition turns on its head earlier critiques of the medium’s supposed intractability. Recall that Heinz Pringsheim had attacked the idea of composing directly onto recording media because the composer would be unable to isolate individual tones and forced instead to work with unwieldy “timbral complexes.” From Beyer’s perspective, this aspect of sound-film composition is precisely what constitutes the medium’s aesthetic potential. Working with recorded sounds compels the
composer to think in terms of “floating” timbral masses instead of the “point-like” tones of conventional music. For Beyer, optical sound film heralded nothing less than an epochal transition from a tonal language of discrete pitches and timbres to a new musical order based upon the limitless nature of sound itself.

In his 1928 essay “The Problem of the ‘Music to Come’”, Beyer presented a poetic, almost incantatory description of what he called the “new tone”:

When we attempt to define more closely the materiality of the “new tone,” which makes it possible for timbres to manifest in innumerable gliding transitions, we learn that we can produce only vague conceptions: we assign to it such predicates as floating, unbounded and open in its dying away, abruptly broken off; pendulous sound; uncertain in its origin, as if it came out of thin air; filling up space, resting and oscillating around a nucleus; it is the tone of the turning filmstrip and its potential, no longer to be grasped on the keyboard, nor devised by the measure of the human and its bodily dimensions, but a step beyond it, a new possibility in the empire of sound. One can approximate the impression of this “new tone” by striking a number of keys at random on the piano with the pedal raised and awaiting the sounds’ decay, and then you will, as it were, begin to hear for the first time, when the tones flow into each other, and there emerges the shapeless buzzing of the sound mass. Similar sound images are produced by the whirring harmonies of jazz, the loudspeaker, the buzzing noise of machines, the metropolis, and the newest music. The “new tone” does not move according to the rules of vocal parts; it is beyond all attempts to give it form.

The “new tone,” then, is not a tone at all, in the traditional sense of a discrete acoustic phenomenon with determinate pitch, duration, and timbre. It is sound emancipated from the structures imposed upon it by conventional instruments and systems of notation—abstracted, objectified, and made malleable by the technology of sound film.

For Beyer, media instruments suggested nothing less than a new relationship between technology and the artistic imagination. Since Busoni’s Sketch of a New Aesthetic of Music, advocates of new instruments had clung to the notion that technology had to be brought up to date with the needs of the contemporary composer. But by the early 1930s, this relationship appeared to be turned on its head. Now, it was the composer who must adapt himself to the exigencies of the new technology. Inverting Busoni’s famous lament that “the progress of music is impeded by our instruments,” Beyer asserted that the creative mind lagged behind the capabilities of its time. “The instrumental technology of sound film, and of music as such, surpasses our imagination,” he declared.
Without the proper creative energies to direct them, new technological forces are doomed to remain mere “dynamics, expansion in empty space.” The apparatus awaits the animating spirit of artistic intelligence, Beyer argued, which alone can unleash from the machine the otherwise unfathomable lineaments of the “music to come.” His remarks on sound film could be extrapolated to encompass the new and ever-expanding instrumentarium of the twentieth century:

It can hardly be questioned that the progress of music—indeed, of art—goes through the machine. The problem is to switch art from manual to technological methods of production. [. . .] Today sound film is still in the periphery of music. Tomorrow the two will be organically united. Today sound film exists alongside music as an artistic genre with its own set of problems. Tomorrow these problems will no longer be its own but rather those of music as a whole.\textsuperscript{69}

Not surprisingly, given the uncompromising nature of his vision, Beyer was dismissive of the contemporary technological experiments of which he was aware. Electric instruments, he claimed, in spite of their inventors’ fantasies of unheard tone colors, were doomed by design to reproduce the circumscribed musical gestures of their performers. He singled out Paul Hindemith’s compositions for the Trautonium, premiered at the Neue Musik Berlin festival in 1930, as evidence of the unwelcome persistence of contrapuntal, note-centered thinking. In these works, according to Beyer, the use of tone color is comparable to that of traditional orchestration technique; “the problem of transitions between timbres is not even glimpsed.”\textsuperscript{70} (The Trautonium will be discussed at length in chapter 5.) Theremin’s “ether wave” instrument was likewise too closely tied to traditional models: in a strikingly contrarian argument, Beyer claimed that with the Theremin, “music returns to the primitive conditions that it had happily left behind it.” The instrument is diametrically opposed to the spirit of the new music, “which strives precisely to overcome the ‘handicraft’ of tone generation and to eliminate the visual exhibition of the acoustic.”\textsuperscript{71} Though Beyer never mentioned Jörg Mager or his instruments, his critique of the Theremin would likely apply to other electrophones as well. In his view, all such devices hewed too closely to conventional models of instrumentality to do justice to the elusive and disembodied nature of “the new tone.”

Beyer also dismissed contemporary efforts at “noise montage,” such as the compositions of gramophone music by Hindemith and Toch and the sound track to Walter Ruttmann’s film \textit{Melodie der Welt}.\textsuperscript{72} However, Beyer’s writings on sound film predate the only surviving work of
purely acoustic sound-film montage from the Weimar Republic: Ruttmann’s eleven-minute composition entitled *Weekend*, which was first broadcast in June 1930. Based entirely on sounds recorded both in the studio and on the streets of Berlin, *Weekend* assembled this material into a “symphony of noises” comprising six programmatic movements: “The Jazz of Work,” “Closing Time,” “Journey into the Open,” “Pastoral,” and “Return to Work” (movements 5 and 6).  

By the time he created *Weekend*, Ruttmann had already established himself as one of the premier experimental filmmakers in Germany. His pioneering abstract films of the early 1920s (*Opus I–IV, 1921–1925*) employed a variety of advanced techniques, including photographing hand-shaped plasticine formations and painting directly onto the filmstrip. In the latter part of the decade, Ruttmann turned his attention to experimental documentary films, such as *Berlin: Die Sinfonie der Großstadt* (*Berlin: Symphony of a Metropolis*), a cinematic ode to modern life without plot or characters, held together entirely by the up-tempo juxtaposition of shots.  

Ruttmann envisioned *Weekend* as a musical analogue to the cinema, both in technique and in effect: he called it a “study in tone montage” and a “blind film.”  

The purpose of the film was “to discover overarching rules governing the connection of sound elements and their combination into an aesthetic unity, as we have previously seen done with visual elements in silent film.” Like *Berlin*, to which it is closely related in terms of form, *Weekend* is a tour-de-force of montage technique and film editing. Ruttmann whittled 2,000 meters of film down to a mere 250 to create a composition consisting of 240 discrete “cuts.” In Moholy-Nagy’s terms, *Weekend* trafficked in the “real acoustic phenomena” of natural, human, and instrumental sounds. The focus is not on the development of sound-image correspondences or the discovery of new synthetic timbres but rather on the compositional organization of various recorded sounds, mostly of recognizable origin. These sounds, for the most part quotidian and referential, are rendered strange and artistically compelling through the rapid-fire contrasts and repetitions of montage technique.  

*Weekend* was hailed as a groundbreaking success by many of Ruttmann’s peers in the artistic vanguard. Hans Richter, like Ruttmann a pioneer of experimental film, wrote that “by not treating sound naturalistically as had become common in sound film—that means, when the mouth opens and moves, then words must come out—but instead treating sound creatively and musically, Ruttmann had in fact established
the artistic domain for sound film. From isolated sonic impressions, he created new unities.” According to Richter, Vsevolod Podovkin, one of the signatories of the “Statement on the Sound Film,” likewise hailed Weekend as proof that sound could be handled in a dynamic and non-naturalistic way, rather than used to undermine the visual aspect of cinema, as many directors had feared.76

Given these plaudits, it is remarkable that Weekend was an artistic singleton, a work without parallel until the first experiments of musique concrète in the late 1940s. (Perhaps the closest counterpart was the groundbreaking 1931 documentary film Enthusiasm: Symphony of the Donbass, by the Russian filmmaker Dziga Vertov, who devised a plan for the sound track independently of the visual component of the work.)77 One reason was the composer’s own discontent with his work: Ruttmann judged the piece to be “difficult and incoherent,” stating in an interview that the listener “gets lost in a sea of tones,” grasping at associative threads while much goes by unnoticed.78 Another factor may have been the “laziness of the ear” lamented by Moholy-Nagy: perhaps most listeners were simply not ready for a compositional genre based on the formal possibilities of sound film. Like so many other products of the Weimar period, Ruttmann’s Weekend was of its time in being ahead of its time.

EXPERIMENTS IN SYNTHETIC SOUND

However visionary the notion of “sound montage” theorized by Beyer and put into practice by Ruttmann, there was another and arguably more radical way of subverting the intended use of optical sound film and turning it into a modernist instrument: synthetic sound. The fundamental realization behind this approach was that the same graphical patterns created by the recording process could also be made, so to speak, from scratch. In a sound-film recording of a speaking voice or a musical performance, acoustic phenomena are represented by inscriptions on the filmstrip. But if sounds could be captured and re-created in this manner, they could also be summoned up from nothing. In the words of media historian Dieter Daniels, “anything that was technologically reproducible could in principle be technically produced.”79 Rather than capturing sounds for later reproduction, the medium becomes the point of origin for the phenomenon it produces. Thus, in theory, all known sounds could be synthetically re-created by the careful etchings of the sound-film composer. Not only could any preexisting sound be reverse-engineered by
hand-drawing its acoustic profile, but the technique of direct inscription could also create acoustic manifestations sui generis, phenomena with no correlate in natural or instrumental sound. Any imaginable combination of pitch, timbre, duration, and envelope had its corresponding graphical representation that could be codified and inscribed according to the composer’s designs. Sound film could furnish the “universal instrument,” allowing the composer complete control over the entirety of possible sound phenomena. Moholy-Nagy again led the charge:

Sound film will have reached a genuine plateau of creative exploitation only once we have mastered the acoustic alphabet in the form of photographic projections. This means that—without actual acoustic events in the external world—we deliberately inscribe acoustic phenomena on the film strip, and, where necessary, synchronize them with the optical part. The sound-film composer can create a thought-out, but never before heard, indeed nonexistent play of sounds using only the opto-phonetic alphabet.\(^{80}\)

As noted earlier, it was the painters Mondrian and Moholy-Nagy who first hatched the idea of media instruments, and the concept’s later incubation was continually nourished by the interdisciplinary connections between music and the visual arts.\(^{81}\) Eager to play up the parallels between the two, sound-film enthusiasts often described composition in the new medium as a kind of “painting with sound.” But this metaphor obscured the fundamental opacity governing the relationship between input and output. To be sure, sound film was considered an advance on the gramophone record precisely on account of its greater legibility: composers could now actually see the visual designs that they made. But the next stage—the relationship between those markings and the sounds they produced upon playback—was trickier. Sound film was a different beast from the piano roll, the earlier pinned cylinder and, indeed, conventional musical notation, all of which function on the basis of clear relationships between inscriptions and the phenomena they represent. These earlier forms of notation transparently encode a virtual alphabet of compositional possibilities. With optical sound film, however, the relationship between the image on the filmstrip and the resulting sound turned out to be less straightforward than composers had hoped. Because the photoelectric cell reacts only to variations in light but not to particular patterns, different graphical traces could produce the same acoustic output.\(^{82}\) These “homographs” gravely complicated the effort to establish a universal “sound alphabet”: like verbal communication, this new musical language was beset by redundancies and breaks in the logic of the system.
In spite of these difficulties, by the early 1930s Europe was percolating with experiments in synthetic sound via optical film. The leading exponents in Germany were Oskar Fischinger and Rudolf Pfenninger. Fischinger (1900–1967) was a visual artist whose ventures into experimental filmmaking were inspired by viewings of Ruttman’s abstract films in 1921. His most famous films were the series of Studies, in which he photographed thousands of hand-drawn shapes in charcoal on paper to create elegant sequences of abstract moving figures that “danced” to synchronized musical accompaniments. His first experiments with optical sound film likely took place around 1930. For Fischinger, sound film promised nothing less than the attainment of complete artistic self-sufficiency: “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 vibrations or oscillation in and of itself.” In an essay entitled “Absolute Sound Film,” published in January 1933, Fischinger argued that the value of sound film lay in its ability to free the composer from the onerous collective work processes that have traditionally diluted the creative energy of the individual artist: “Hand-made film makes possible pure artistic creation.” The product of this “authentic composition” is marked by the concentrated personality of the artist—the “writerly [handschriftliche], irrational, and personal.” In stark contrast to figures such as Stuckenschmidt and Moholy-Nagy, who sought instruments that would purge these subjective qualities, Fischinger saw sound film as the consummation of the romantic aesthetic ideal of expressive immediacy.

Fischinger’s compositional process involved drafting sequences of graphical patterns, transferring them to the sound track, and playing them back to determine correlations between image and sound. His work involved both reproductions of familiar timbres and “new musical sounds, pure tones with a precision of definition in their musical vibrations that could not be obtained formerly from the manipulation of traditional instruments.” He envisioned composers working with several film sound tracks in tandem in order to create polyphonic textures and orchestral layerings: “Each track would produce a different, well-defined sound, and planning them together, the composer could design and organize overlapping and intersecting wave patterns on the minutest level.” Contemporary accounts and photographs of Fischinger’s work
show a variety of graphical forms, including among others “diamonds, zig-zags, stair-step shapes, circles, stars, fish forms, sinuous lines, waves, curves, angles, saw-shaped edges.” Fischinger called these shapes “ornament tone” or “sounding ornaments” (*Ornament Ton, klingende Ornamente*).

According to his biographer William Moritz, Fischinger was struck by the ability of sounds to signal the objects from which they issued—a realization he had upon hearing a key hit the floor and recognizing the object instantaneously by its sound alone. But it wasn’t just that things could sound like what they were. Fischinger surmised yet deeper bonds linking the visual and the acoustic. He found for example, that the ancient Egyptian symbol for a snake, when copied to the sound track, produced a distinct hissing sound. Such hidden correspondences between different sensory codes resonated with the quest for a primal language connecting the outwardly unrelated phenomena of nature. In fact, this aspect of Fischinger’s work suggests a techno-aesthetic attitude quite at odds with his own avowals of absolute creative autonomy, according to which the instrument is treated as a subordinate means of realization for preformed artistic ideas. Arguably, his pursuit of sound correspondences signals his openness to the generative function of technological mediation and points to a new and overtly experimental conception of instrumentality.

In spite of his predilection for suggestive audiovisual symbolism, Fischinger’s goal in his *Ornament Ton* works was to establish systematic correspondences between sound and image: as one contemporary journalistic account stated, “he seeks above all the elements of a sound image, as it were the characters from which the sound writing is composed. Once these characters—which Fischinger sees as precise, ornamental figures—are found, he believes that the entire acoustic domain and the quality of any given sound can be captured in writing.” Fischinger made significant progress in wresting musical tones from their unruly medium: though he was apparently disturbed by the weird sounds created by the first test reels, a later account of a public demonstration emphasized that the films produced no “wild cacophony” but rather “tones, at times precisely defined, at times similar to this or that instrument.” In 1933, Fischinger’s films were screened at the London Film Society and by Moholy-Nagy at the Bauhaus in Berlin, but soon thereafter he abandoned work in the medium of synthetic sound film.

The work of Rudolf Pfenninger (1899–1976) presents both a parallel and a contrast to Fischinger’s sound-film experiments. Pfenninger,
who was trained as an animator and radio engineer, was driven to synthetic sound by economic necessity: unable to afford musicians or recording fees to produce musical accompaniment for his short animated films, in the late 1920s he began investigating the possibility of creating his own entirely artificial music. After drawing various patterns on paper and then photographically transferring them onto the sound track, Pfenninger was able to empirically determine how the different graphical patterns were interpreted as sound by the photoelectric cell. In this manner he could painstakingly create synthetic scores by arranging on the filmstrip the wave forms and timings corresponding to the tones and rhythmic values of a given composition. Invoking a metaphor of script, in contrast to Fischinger’s ornament, Pfenninger called his approach to optical sound film *tönende Handschrift* (sonic handwriting). Whereas Fischinger took ornamental visual forms as the starting point and asked how they sounded when “read” by the photoelectric cell, Pfenninger began with the repertoire of existing timbres and scales and systematically devised the graphical patterns required to summon them on command. He was unconcerned with formal analogies between sound and image, taking for granted an arbitrary
relationship between the two, similar to that between words and their meanings in human language.

Pfenninger’s surviving films highlight a striking discrepancy between the modernist tenor of sound-film theory and the decidedly childlike quality of the music. Pitsch und Patsch (1932), for example, is an underwater fantasy that follows two fish as they encounter and evade a series of would-be predators. The seven-minute film calls to mind contemporaneous zoological animation such as Disney’s famous Silly Symphonies. Pfenninger’s music is simple and diatonic in terms of compositional structure, which is hardly surprising given the context. The timbre—bright, clipped, and unabashedly artificial—is largely consistent throughout, with a few minor variations for contrast and white noise bursts as an illustrative sound effect. Pfenninger was clearly uninterested in the exploration of tone color that entranced other sound-film enthusiasts such as Beyer and Fischinger – Klangfarbenmusik this is not! But in spite of the uniform timbre and the conventional, quality of the music, Pfenninger’s sound track does occasionally astonish.

**FIGURE 17.** Rudolf Pfenninger at work on his “sonic handwriting.” These hand-painted patterns would later be photographed and reproduced on the filmstrip on a much smaller scale. Source: Animierte Avantgarde: Der künstlerische Animationsfilm der 20er und 30er Jahre, curated by Ulrich Wegenast (Berlin: Absolut Medien, 2010), DVD.
flurries of notes create tonal blurs and dizzying auditory illusions. Indeed, these techniques recall similar effects in the compositions for the Welte-Mignon player piano discussed in chapter 2. In both cases, the monotony of unchanging tone color and metronomic pulse is enlivened by spasmodic bursts of activity, scalar runs of extrahuman speed, and tonal gestures that defy all sense of instrumental propriety.

Pfenninger’s mastery of the medium thus came at the cost of extreme simplification. In order to crack the code of sound film, he had to reduce the bandwidth of compositional information to a monophonic minimum: only one note at a time. His sound-film music thus exemplifies what philosopher Don Ihde has called the “amplification-reduction” effect of technology: the way that instruments narrow some aspects of work even as they open up new zones of freedom. However, the simplifications arising as by-products of technological progress can themselves elicit new forms of inventiveness through the very constraints they impose. Forced to think monophonically, Pfenninger discovered a means of creating pseudopolyphonic textures with a single voice, and so arrived at a radically technogenic form of expression.

Reviews of Pfenninger’s music called attention to the “mechanical” (or even “soulless”) quality of the tones. Critics lamented the lack of subtle pitch variation (vibrato), unnaturally sharp attacks, and the bright, nasal timbre. One reviewer happily conceded the inventiveness of Pfenninger’s technique but recoiled from the “abstract, skeletal music” it produced: “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? [. . .] Rarely have we felt so clearly the inner difference between live art and technological construct.”

Many critics harped on a similar discrepancy between the technological allure of the new instruments and the meager aesthetic quality of the works in which they were employed. In Pfenninger’s case, however, this reaction was especially acute: technically the most accomplished exponent of synthetic sound film in Germany, he was at the same time aesthetically the most conservative.

At a presentation of experimental sound-film compositions in Frankfurt in late 1932, Moholy-Nagy hailed Pfenninger’s work as the vindication of his own decade-long quest for synthetic sound: “Today, thanks to the excellent work of Rudolf Pfenninger, [these ideas] have been successfully applied to the medium of sound film. In Pfenninger’s sound script, the theoretical prerequisites and the practical processes have
achieved perfection.”

Moholy-Nagy’s acclaim is somewhat vexing in light of the conventional character of Pfenninger’s music. In hailing Pfenninger’s work, however, Moholy-Nagy was presumably addressing not the music itself but the means by which it was created and the further possibilities that it signalled. The work as an object of aesthetic contemplation was secondary to the demonstration of optical sound film as a viable medium for future artistic development.

In the same year, Moholy-Nagy offered his own contribution to the genre of synthetic sound film with a work entitled Tönendes ABC (Sound ABC). The film “used all types of signs, symbols, even the letters of the alphabet, and [his] own fingerprints. Each visual pattern on the sound track produced a sound which had the character of whistling and other noises.”

The optical track and the sound track of Moholy-Nagy’s film were identical, allowing viewers to witness the graphical correlate of the sounds as they heard them. Sound ABC can thus be seen as the long-awaited fulfillment of modernist artists’ synesthetic aspirations, bridging sound and image through the universal artistic medium of the electric current. This film, like so many of the period’s most fascinating products, is considered lost.