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Joseph Schillinger (1895–1943): Music Science Promethean

Joseph Schillinger is a cult figure among music theorists. While he composed over thirty pieces between 1917 and 1941, including the first known work for an electronic instrument and orchestra in 1929, he is best known as the teacher of George Gershwin, Benny Goodman, Glenn Miller, Tommy Dorsey, Vernon Duke, Oscar Levant, Charles Previn, and Carmine Coppola.[1] However, more than anything else Schillinger was a music scientist receptive to new technologies and experimentation related to the arts. He helped solve the problem of artistically coordinating soundtrack with film track, patented inventions that foreshadowed the rhythm box and color organ, and codeveloped with Leon Theremin the first electronic synthesizer (manufactured by RCA in the early 1930s). It is claimed that his treatise describing the mathematical basis of art was heralded by Albert Einstein and Bertrand Russell.[2]

Schillinger systematically applied his theories to music (composition and orchestration), art (painting and model-making), design (architecture, graphics, textiles, and fashion), dance (movement and choreography), photography, and cinematography; he projected to consolidate these independent disciplines in one all-encompassing "Institute of the United Arts."[3] The majority of his system was eventually published posthumously in four volumes consisting of over 3,000 pages of text.[4] Schillinger's personal notebooks and manuscripts

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depicting early versions of his written works and lecture notes were methodologically arranged and preserved in their original form by his wife, Frances. Together these provide important evidence about the developing world of music science and resonate with anecdotes, references, and queries on topics including "Music and Evolution," "The Varieties of Musical Experience," "The Effects of Music," "The Nature of Musical Talent and Genius," "The Popularization of Electronic Instruments," "Sociological Implications of the Burgeoning Broadcasting Industry," and "The Prophecy of an Interdisciplinary Focus on Science and Music."

Aspects of the Schillinger System have been so pervasive that they constitute a hidden, yet largely unacknowledged, undercurrent in American popular music from the 1930s. Even the celebrated and distinguished school of jazz, the Berklee College of Music, was first established as the Schillinger House of Music by its founder, Lawrence Berk, himself a keen student-disciple of Schillinger.[5] Berk's own notebooks provide some interesting insights into the evolution of the Berklee curriculum and point to parallels between Berk and Schillinger.[6] Accordingly, while Schillinger took an unorthodox mathematical approach to the organization of musical elements, Berk internalized these and took an unorthodox approach to music education by systematically organizing the rudiments of jazz and other forms of modern music. Clearly then, Schillinger's influence on Berk may represent an important contribution to American contemporary music. Unfortunately, Schillinger's music and theories suffered a bizarre and almost total eclipse after his death and remain today an insignificant footnote in American music history.

It should be noted that most of what is known about Schillinger surfaces from vignettes or anecdotes, and these should be treated somewhat as hearsay and folk-legend. For example, reports that Gershwin studied with Schillinger on a regular basis for four-and-a-half solid years cannot be verified; perhaps these studies were more irregular than previously accounted for by Schillinger and his disciples. In addition, Einstein's endorsement of the mathematical conceptions employed by Schillinger in his comprehensive system may simply have been a creative legend that could be characterized in Hollywood language as a "buildup."[7] While many magazine articles and news columns account for some biographical background and conceptual underpinnings of the system, there is little documented journal literature of a serious nature, and only a few musicologists have undertaken investigative theses or dissertations.[8] One must, then, question the validity of this collective material especially as the motive of many writers was either to promote or debunk Schillinger and his theories. In doing so, it seems that some authors may have slightly molded the

story. Not the least, much of the existing material that has served as "authentic" background information was prepared by Schillinger's loving wife-promoter. On a regular basis Frances drafted "press releases" of Schillinger's publications and professional activities, as well as "excerpts" of magazine articles highlighting Schillinger. These folders include paste-ups of selected text sections with photos (not necessarily from the same sources), with inserted handwritten publication dates (but rarely a literary citation or original author's name). Nonetheless, by cross referencing many of these resources with additional published materials—such as retail brochures and PR materials, the four-volume book set, biographies and book reviews, memoirs, and museum exhibit notes—the following chronicle can be teased out.[9]

Biographical Sketch

Joseph Moiseyevich Schillinger was born on September 1, 1895, in Kharkoff, Russia, the only child to Anna (*née* Gielgur) and Moses Schillinger. His parents were upper-middle-class Jewish businesspeople, themselves children of immigrants to Russia from Holland. Already in his childhood, at age five, Schillinger showed particular interests in design, dramatics, and verse. By age ten he had experimented with playwriting and composing music; he taught himself to play the piano, and practiced Yoga. By age fifteen he graduated from the Gymnasium.[10]

Schillinger's young adulthood was intense. In 1914, at age nineteen, he completed his formal education at Classical College along with studies at St. Petersburg Imperial Conservatory of Music. For the next four years Schillinger majored in composition under Kalafati, Chernoff, Cherepnin, and Wihtol, and then concentrated on conducting under Cherepnin. At the age of twenty-three he became senior instructor of composition at the Kharkoff Conservatory, and for the next four years he served as the "Head of Music Department" for the Board of Education (Ukraine), as well as consultant to the State Opera. By his mid-twenties Schillinger was already fluent in six foreign languages (Hebrew, Latin, German, French, English, and Italian). He had been exposed to classical and oriental philosophy and religious systems, had taken courses in mathematics with Koltovski and Anton Przieborgski, explored versifiction with Nicholai Schebouver, read Slavonic mythology and history of Russian literature (at the State University of Petrograd), and studied a host of subjects including physics, acoustics, electrical engineering, design, music, drama, art, and dance history.[11] In 1920 Schillinger received a professorship and was appointed dean of the faculty of composition at the State Academy of Music (Kharkoff Conservatory) in Ukraine; he retained this position for a

term of two years. While at the academy Schillinger served as conductor of the United Students' Symphonic Orchestra and Ukraine Symphony. In addition he consulted for the USSR Board of Education and lectured in music composition at the State Institute of Musical Education.

Between 1922 and 1926 Schillinger was a consultant to the Leningrad Board of Education. Then, in 1925 he became a professor at the State Institute of the History (Science) of the Arts at St. Petersburg (later renamed the Institute of Musical Science in Moscow); this was his last major academic position in Russia until 1928 when he left for America. Also roughly about this time, Schillinger married Olga, an extremely beautiful and intelligent actress, but this marriage was not a happy one and ended two years later. In 1926 he lectured at the State Central Musical Technium, and for the next two years he served as vice-president of the Leningrad branch of the International Society for Contemporary Music (later renamed the Leningrad Association for Modern Music). One of his major (albeit not greatly acknowledged) contributions to the world of music was his ethnomusicological field research.[12] In 1927 the State Institute of the History of Arts commissioned Schillinger to document via phonographic reproduction the folk music of four Georgian tribes (Khevsouri, Mokhevi, Mtiouleti, and Ajara) in the Caucasus. These tribes were previously unknown to musicologists, and Schillinger was the first to "capture" their musical culture; this music represented European polyphonic music forms of the tenth to eighteenth centuries.

Public recognition finally occurred in 1927 when Schillinger's *Symphonic Rhapsody* (also called *October*) was chosen by the Soviet State Committee on Symphonic and Chamber Music as the best work composed during the first ten years of Soviet Russia. This composition was a competitive win over *Red Poppy* by Glière and Symphony No. 1 by Shostakovich. At this time Schillinger's piano music was regularly performed alongside works by Stravinsky, Prokofiev, and Hindemith. His compositional style drew inspiration from Scriabin, as well as incorporating music characteristics of the most ancient cultures of the Caucasus (which he himself had documented previously). Finally, a supreme honor was bestowed upon Schillinger when the official program commemorating the Tenth Anniversary of the Soviet Union exclusively featured the music of Schillinger and Beethoven. This event roused his friend and colleague Dimitri Shostakovich to indulge in a prank by creating a photo composite of the two composers sitting together in the forest with Ludwig clearly offering a friendly supportive hug to Joseph.[13]

For two years, 1927 and 1928, Schillinger organized, lectured, and directed (with Leopold Teplitsky) the First Concert Jazz Band.[14] This

activity was viewed by the GPU (a pre-KGB) security organization as potentially dangerous to the state because popular jazz music was perceived as decadent, and those promoting such music were viewed as defending American culture. Subsequently, Schillinger was harshly interrogated on several occasions. Nonetheless, in 1928 Schillinger was appointed Officer of the Committee for Contemporary Music at the State Institute of the History of Arts, and in this capacity was considered to be the authorized representative of the Leningrad Association of Modern Music to Western Europe and America.[15] As a result, in 1928 he was invited to lecture in America on contemporary music. This visit was cosponsored by philosopher-educator John Dewey and the American Society for Cultural Relations with Russia, whose music committee members included Joseph Achron, Kurt Schindler, Leopold Stokowski, Sergei Radamsky, and Edgard Varèse.

Once in America, Schillinger collaborated with his friend and fellow Russian, the inventor Lev Termen (later Leon Theremin) in New York. Between 1928 and 1931 Theremin and Schillinger studied musico-scientific problems and constructed several musical instruments, including some of the first electronic musical instruments (such as the Theremin, the Rhythmicon, and a music synthesizer). Schillinger also focused attention on the problem of artistic synchronization of soundtrack in early movies; these investigations eventually developed into a more systematic method of musical scoring for film sequences. In 1929 Schillinger joined Henry Cowell, Joseph Yasser, Otto Kinkeldey, and Charles Seeger in founding the New York Musicological Society (later the American Musicological Society and the American Society for Comparative Musicology).

After what appears to have been a rather itinerant existence during his first few years in the United States, the early 1930s offered Schillinger a number of employment opportunities. Initially he taught at the David Berend School of Music and lectured at Leon Theremin's studio.[16] In 1932 Schillinger opened his own private music studio, and within six years his clientele had grown to 112 lessons per week at $10.00 per half-hour lesson (a formidable income at the height of the Depression).[17] Schillinger continued to teach from time to time at various centers for adult education and institutions of academic higher learning, and while these brought prestige they offered little money. For example, he lectured at the music school of the Young Men's Hebrew Association (1931), the New School for Social Research at Rockefeller Center (1932), the Musical Cultural League of New York (1933), the Florence Cane School of Art, the American Institute for the Study of Advanced Education, and the American Institute of New York City (1934).[18] These lectures and workshops eventually developed into a more substantial academic curriculum for on-going

coursework offered between 1934 and 1936 at the Teacher's College of Columbia University, in the departments of Music, Fine Arts, and Mathematics, and then at New York University in 1936.[19] Among the subjects Schillinger taught were "The Variety of Musical Experience," "Physical and Psycho-Physiological Nature of Sound," "Natural and Tempered Systems of Tuning," "Tone Space and Musical Matter," "Statics and Kinematics of Musical Matter," "Theory of Musical Perception," "Processes of Musical Structure," "Rhythmic Design," and "Speculative Theories of Art and New Artforms." The last two courses were based on Schillinger's own explorations with visual and plastic arts, which he termed "Geometric and Rhythmic Designs." In 1934 several of his paintings, photographs, and three-dimensional models (constructed of wooden blocks and mirrors) were exhibited at the Mathematics Museum of New York, an achievement of which he was especially proud as he considered these to reflect a new art form.

In July 1936 Schillinger became a citizen of the United States. By that time his reputation had become so widespread that he could afford to give up college teaching and public lecturing in order to devote all his time to his private students. During his fifteen-year private-teaching career, Schillinger is reported to have taught over 500 students (of whom four were female).[20] Accordingly, his most famous student, George Gershwin, scheduled three lessons a week during a four-and-a-half year period.

After an intense six-week romance in 1938 Schillinger married Frances Rosenfeld Singer, a former cover-girl, artists' model, Ziegfeld girl, nude-model to photographer Edward Steichen, secretary to both Dale Carnegie and Rockwell Kent, and a national worker of the Boy Scouts of America. Six years later, at the age of forty-seven, Schillinger died of cancer at his home in New York City.[21] While at the time of his death there were only seven authorized teachers of the Schillinger System, as a result of the GI Bill a phenomenal interest in the system by returning servicemen prompted the establishment of accredited Schillinger courses. Several authorized teachers were besieged by students in the late 1940s, and by 1947 more than forty newly certified Schillinger teachers were teaching the Schillinger System to over 600 students enrolled in courses in New York City, Boston, Chicago, San Jose and Hollywood, Calif., Philadelphia, Hartford, Conn., and Spartanburg, S.C.[22] Especially well-known teachers of the system were Rudolph Schramm at New York University, Ted Royal at Juilliard, Asher Zlotnick at Peabody, and Franklin Marks in Hollywood.

Schillinger's widow, Frances, spent the rest of her life preserving and promoting Joseph's works and system. In 1951 she married American musicologist Arnold Shaw, a nationally acclaimed and academically acknowledged expert of the Schillinger System.[23] Shaw was the direc-

tor of the Schillinger Society from 1946 and became the vindicator and heir to the Schillinger System. Along with Lyle Dowling, Shaw coedited and promoted the posthumous publication of Schillinger's manuscripts in the late 1940s. Frances and Arnold Shaw separated in 1957.

Derision

Schillinger's biography is undoubtedly impressive, and clearly he demonstrated higher ability in several fields.[24] Yet he was unacknowledged and eventually unwelcomed by the mainstream classical-music establishment. This is rather baffling especially as his musical achievements in Russia were convincing. He had been heralded by Dimitri Shostakovich and Vladimir Horowitz as a master composer equal to Beethoven. Prior to his arrival in America, and during the early days of his visit, Schillinger's compositions were performed by the best orchestras in Europe and the United States, and by a host of prestigious conductors and soloists including the Cleveland Orchestra, Leopold Stokowski, Nikolai Sokoloff, Benjamin Zemach, Nathan Milstein, and Vladimir Horowitz.[25] So, what happened in America that caused Schillinger to become *persona non grata*? Ultimately, his failure to succeed in academic circles can be traced to his unconventional terminology and methods, his ridicule of the academic establishment, and his attachment to the commercial side of music through his ties to Tin Pan Alley and Hollywood.

Foremost, Schillinger and his "brotherhood" used an unconventional terminology to depict musical concepts. In addition, he replaced standard musical notation with graph notation whereby the horizontal line, or the abscissa, indicated relative duration and the vertical line, or the ordinate, showed the number of semitones. While he may have thought that these were signs of higher scientific intellectualism, they did in fact cause many great misconceptions. For example, his short-hand term $\Sigma = S_3p\ (E_1)$ was used to indicate a given harmonic aggregate (the Greek letter sigma Σ) constructed of a structure (S) in three parts (p) in the first expansion (E), or what is more commonly known as a major triad. Perhaps as a result, Schillinger's system was seen as one that replaced intuition and inspiration with formulae and intellectual processes. His obsessive focus on the mathematical nature of the system contributed, and even perpetuated, the widespread belief that anything artistic that has contact with mathematics would become mechanical and contrived.[26]

Moreover, Schillinger's flamboyant tactics to prove the value of his system seemed to have backfired and in retrospect could be considered characteristically self-defeating behavior.[27] A particular example was his frequent public ridicule of the academic establishment: at his

lectures in learned musicological societies he declared several well-known composers including Wagner and Beethoven as unmusical (mostly because they composed through trial and error as evidenced by their many sketches).[28] He criticized Rimsky-Korsakov for his helpless attempts at modulations in modes (with the exception of the Dorian and Mixolydian), and guffawed at Chopin and Schumann, who had chaotic styles of piano writing (demonstrating that their compositions basically emerged from piano improvisations). Schillinger even found Bach deficient in utilizing his resources, whereby he never really reached his potential (demonstrating Bach's poor usage of inversions resulting in dogmatic and intuitive compositions rather than becoming true music based on mathematical theories of geometry).[29] In addition, Schillinger repeatedly reported in the press that even his most coveted students—George Gershwin and Glenn Miller—came to him "out of desperation," and composed their best pieces (*Porgy and Bess* and "Moonlight Serenade") as homework exercises.[30] Finally, Schillinger made fatal statements about several great concert soloists who were popular in the late 1920s and early 1930s, highlighting the fact that while society might glorify them as heroes, a natural-sciences viewpoint would rather classify them as parasites.[31]

Schillinger voiced a low and abusive opinion of conventional symphony orchestra instruments and was repeatedly quoted on the subject in many newspaper and magazine articles. He perceived and depicted symphonic instruments as sound-producing tools (made from wooden boxes and bars, wooden pipes, dried sheep's gut, horse hairs, and the like), which are in fact inadequate music devices, having evolved on unscientific trial-and-error methods throughout the years.[32] He underlined the necessity of developing new instruments and proposed that the future of music was to be found with electronic instruments; these would most certainly replace the antiquated orchestra in the near future. To this end, he outlined the history (evolution) of musical instruments.[33] He demonstrated futuristic instruments such as the Hammond Organ (of which he was one of the original owners) to a wide audience of composers and arrangers. The electric organ was seen as an example of an instrument that could produce the sonorities of all other instruments of the orchestra "at the touch of a button." In a cooperative effort, Theremin and Schillinger developed for Henry Cowell the Rhythmicon, the first ever rhythm-box drum-machine, which was reported to produce rhythmic figures and compound meters unimaginable to even the most highly trained ear. The demonstrations of electricity's contribution to the future of music,[34] which often involved early phonographic recording techniques, perpetuated the mysterious and magical atmosphere associated with Theremin and Schillinger. Schillinger's thirteen-room lab-

oratory/workshop/studio was equipped for the investigation of sound and music, to ascertain facts about music, and to test musical procedures.[35] It was fitted with a battery of equipment including the usual musical instruments, as well as a Hammond electric organ, a sound recording system by MP Concert Installations, a Rhythmicon, an oscillograph, and other acoustical and optical equipment.

Schillinger publicly discredited absolute pitch as a "gift" and further declared that practice regimens do not lead to enhancement of musicality.[36] He denounced the music education of his day as employing unscientific methodologies and called on pedagogues to purify music education from all its "casual parasitical forms," such as the use of musical vocabulary, which contributed to its isolation from other fields of study.[37] Schillinger chastised young prodigious talents by referring to such individuals as "musical corpses."[38] He felt that when music educators would teach *facts* instead of *myths*, society would turn its admiration for the gift of musicianship toward an entirely different course. For example, while it was commonly viewed that a great composer requires 60 percent talent, 30 percent feeling/inspiration, and 10 percent knowledge, in reality they only employ 20 percent talent and 10 percent feeling/inspiration, but 70 percent knowledge. Nonetheless, Schillinger's guidelines to create composers were a bit different; his training was to equip them with 100 percent knowledge and intelligence.[39] To exemplify this concept, Schillinger conducted a campaign conveying the message that any individual acquiring the knowledge of music, even someone lacking the ability to play an instrument, could become a capable composer—all that was needed was a high-school-level education, reasonable intelligence, high motivation, and three-and-a-half years tuition to master the *system*.[40] This conception and public campaign did much to alienate Schillinger from academic circles that advocated an approach to compositional training based more on music ability and skills.

However, the most notorious of Schillinger's antics was when he purposefully duped music academics into identifying pieces of music as if belonging to the well-known music repertoire, whereby he would then unveil himself as the composer, having written the music only an hour or so ago (using guidelines found in his systematic approach to composition, employing sources such as the morning's stock market, or the graphic representations of the New York City skyline).[41] While Schillinger looked upon these sensational stunts as harmless parlor games, which clearly delighted some participants in the audience,[42] they also distracted considerably from the more serious aspects of his work and system. Further, these mischievous tricks caused anguish and embarrassment among the professorial ranks who were suckered and victimized in front of their own peers and students.[43]

As a result, many different (and indifferent) individuals contemplated the music of Schillinger and his newly found flock. Schillinger was often criticized because he did not choose to disseminate his system through the academic channels and lifestyle (of which he was very much a part of in Russia), but rather through the more lucrative outlet of Tin Pan Alley and Hollywood.[44] Certainly, the majority of his student-customers were craftsmen, tunesmiths, and arrangers mainly interested in acquiring techniques to facilitate grinding out the commercial clichés in which they specialized. These affiliations, with their associated mercantile motivations for seeking instruction with Schillinger, boomeranged by further blackening the names of both Schillinger and his more serious disciples. That is, while most of the renowned arrangers and composers of Hollywood and American radio broadcasting (in the 1930s) were distinguished students and proponents of Schillinger, their testimonials did not advance the acceptance of the Schillinger System among academic music theorists. Nor was it beneficial to Schillinger when his protegés confessed to having written their most famous pieces with melodies taken from incidental sources such as plotted graph paper, lists of telephone numbers, financial charts, vital statistics, or "compose-a-tune" games.[45]

By 1940 Schillinger was perceived as a dilettante for his nonstandard notation and pseudoscientific approach, as well as an iconoclast who spent his time desecrating the sacred traditions of music, musicians, and musical practice.[46] In part, the establishment retaliated by pointing to the fact that during his own lifetime none of his compositions had ever been published. By the time they ultimately appeared in print, the value and importance of his works were largely dismissed altogether, except by a few important friends such as Henry Cowell, Charles Seeger and Nicolas Slonimsky.

Convergence

While not a prophet in the biblical sense of the word, Schillinger clearly engaged a prophetic-like vision regarding the coming of new media and the engagement of higher technologies by art. Schillinger's visions and scientific achievements are well beyond the scope of any one article. Therefore, a wide picture has been painted to illustrate the extensive scope of his energies.

Schillinger was the first (and perhaps the only) scientist to delineate the art forms according to human sensory abilities. Through an unusual combination of the five senses, he proposed and outlined futuristic cross-modality and multisensory configurations of art. This permutational approach to the arts (forty years before the computer era) defined eighteen different art forms involving sound, mass, odor,

flavor, light, pigment, and surface in relation to general components of time and space.[47] He spoke of synthetic and multisensory associations, as well as about the fusion of sensations, which he referred to as "colored hearing," "sound seeing," and "kinesthetic temperature/texture reactions" of tone quality. Schillinger also raised the question of transformation and coexistence of optical forms based on musical patterns. Further, he envisioned and patented several instruments (devices we would today call synthesizers) referred to as "Musmatons." He outlined two major types: "Graphomatons," or instruments for producing linear designs; and "Luminatons," or instruments for producing designs by projected light. In addition, Schillinger patented an instrument called the "Solidrama"—a device that allowed artists to represent motion and transformation of solids by using magnetic drives and screens.[48] With this apparatus, movement could be synchronized with light and sound. Finally, Schillinger envisioned and wrote a much detailed description of a new type of kinetic art that would appeal to all of the five human senses at one time. In this "Scientific Vaudeville" there would be several types of human actors, including those engaging in pantomime, drama, dance, acrobatics, song, and declamation.[49] He described the actual performances as involving stage settings of different types, including static, kinetic, shadow-play, and cinematic settings. Accordingly, different kinds of lighting, and optical variations of appearances of scenery and the actors, would result in increased attention of the audience because of the excitement of two or more senses with the constant predominance of one. The continual modification of one material into another, appealing to several senses simultaneously, would heighten the psychological reaction of the audience.

The problem of artistically coordinating soundtrack with the film track was solved by Schillinger's concept of background music to fit the time, mood, and excitement of motion pictures. Further, he devised a catalogue that systematically approached the musical elements and their combinations in order to prime and facilitate the viewer's perceived feelings of motion while seated in a movie theater.[50] Moreover, he developed a practical device for correlating music with emotion, which he referred to as the "Psychological Dial."[51] The dial was used as a didactic aid in his private teaching studio to present to his students a set of general laws governing the relationship of sound and emotional reactions in an attempt to encompass the entire range of human emotional responses to musical stimuli. Schillinger saw film and music as processes of "form and structural organization." He analyzed the rhythm of events (plot), the rhythm of actions (actors' motions), the spatial and temporal rhythm of forms and dimensions (scenes), the spatial and temporal rhythm of the overall color sequenc-

es, and the rhythm of the overall accompanying musical sequences. He also looked at interactions of these components, that is, the coordination of the plot with the visual forms and color, the coordination of the plot with the auditory forms, and the coordination of the visual and auditory forms.[52]

Schillinger was attentive to issues of music theory, albeit referring to these as "musico-scientific problems." He developed graphic methods of musical notation, and a system of music composition based on rhythm rather than harmony.[53] He was concerned with the problem of interpretation, especially changes in tempi, which in his view should not be left to the discretion of the performing musician. In his own music he wrote out in exact notation the values of the notes of a retard or acceleration which then bore complicated metric signatures. He catalogued the number of chords that could be constructed out of major and minor thirds and found that there were thirty-six combinations as opposed to the popular four that had been traditionally used in music prior to the 1920s.[54] It is claimed that Schillinger revolutionized the art of orchestration by utilizing combinations of scales, chords, harmonies, and instruments in ways that were until then unfamiliar. Finally, Schillinger evolved a compound tuning system that eliminated the controversies of all systems previously offered, referred to as "Double Equal Temperament."[55] This tuning unified all systems of intonation used in the Western world as it consisted of twelve basic intervals, combined with 144 micro-intervals. This combination permitted one to execute with a high degree of precision twelve-unit Equal Temperament, Mean Temperament, Just Intonation, and the string and vocal inflections of special types of intonation (as found in some chamber, jazz, and gypsy music).

Schillinger often quoted ancient philosophers who long ago suspected there were unconscious mathematical procedures behind conscious musical intentions. He contemplated both the philosophical and aesthetic question: *What is music?* He made several entries in his personal notebooks pondering if music is "what the composer imagined," "what the composer wrote," "what the performer played," "what the listener heard," or "what the critics reported." He realized that these may not be equated: the answer may be multileveled, multifaceted, or even codependent on one of several factors.

Leon Theremin, the great Russian inventor and physicist, collaborated with Schillinger in research on musical acoustics and design. In 1932 they constructed working versions of an electronic organ with microtuning, volume control of differential tones, and a specially designed keyboard for the performance of Double Equal Temperament.[56] Further, they built the first electronic synthesizer (manufactured by RCA). Schillinger and Theremin also constructed the Rhythmicon,

which created rhythmic patterns in the acoustical scale of intonation; the device was commissioned by Henry Cowell and paid for by Charles Ives.[57] Accordingly, these patterns were produced by the interference of one to sixteen generators, resulting in approximately 65,535 polyrhythmic possibilities.[58] Schillinger calculated that it would take 10,922.5 hours to play all the combinations of the Rhythmicon if an average ten seconds was required to play each combination. It would thus take 455 days, 2 hours, and 30 minutes to play all the rhythmic patterns that were readily available through this technological breakthrough.

Schillinger had strong beliefs about the future of music composition training. He expected that composers of the future would be confronted with the task of studying sound from a physical angle, without which the study of composition would be impossible. Therefore, the education of composers would not be complete without the study of physics of sound in relation to music composition and electronic musical instruments.[59] Schillinger proposed that a new rational music education would prove more effective than the acquisition of one type of routine (his view of instrumental practice). Consequently, music education should include technical training, a thorough knowledge of sound material, and a complete understanding of general methods involved in musical procedures.[60]

In 1940 Schillinger predicted that those who would be responsible for the music of radio and television would be neither composers nor performers, but a new breed of music engineer operating the machines that compose and perform music. He predicted that television would undoubtedly stimulate further the fusion of existing art forms. He also felt that as electronically produced sound was far superior to that of conventional instruments, someday an all-electric "symphony" orchestra would make present-day orchestras obsolete. He posited that music in the machine age would become a medium of "music for wholesale entertainment in the promotion of sales." He shocked businessmen and laymen alike (as well as musicians themselves) by quoting his own statistical computations attesting to the fact that in 1936 alone 200 NBC advertising firms were already spending approximately $32,000,000 in broadcasting. In 1943 Schillinger began to plan a revolutionary new project involving the electronic reproduction of music without the use of conventional musical instruments or musicians! He felt that music (as known in the 1940s) would surely disintegrate, but prior to that disintegration it would be manufactured and distributed in the ways that other industrial products are manufactured and distributed.[61] Further, that music would eventually influence the allied arts and come into fusion with them.

Schillinger saw the coming age of the cinema. Two of his most cher-

ished hobbies were photography and cinematography. He composed pictures demonstrating color harmonies. He developed his own film in his personal darkroom laboratory (mastering the skills required for exposure timings, lighting sources, chemical mixtures and combinations, paper selection, and reproduction procedures), and dabbled in movie-making (both directing and producing early shorts). He experimented with shadows causing photographic effects (visual optical illusions), as well as investigating the effects of animation and synchronized sound. Schillinger produced geometric moving pictures and experimented with color-animated abstractions, working with Mary Ellen Bute among others. Schillinger referred to these as transformation and coexistence of optical forms based on musical patterns.[62] He was among the first to teach the "correct" set design to enhance the visual perception of a scene, as well as methods for finding the best angle for filming (utilizing a host of geometrical formulae and calculations).

It is worthy of note that Schillinger's interest in the synchronization between aural temporal stimuli and visual motion extended to the world of dance: he wrote a monograph in 1932 depicting a dance notation, though this was believed lost during World War II.[63] However, the monograph miraculously survived and resurfaced in the 1980s in the hands of Walter Toscanini; it was subsequently published in 1985. In this graphic notation of human movement, Schillinger used the metaphor of an orchestra to depict the movement of the human body rather than that of a single instrument.[64] He analyzed each movement according to its geometrical shape, plotting it onto a graph, then coordinating the movement in two dimensions (i.e., trajectory and time).

Among other achievements credited to Schillinger is a new system of projective geometry, making all curves expressible in circular areas.[65] As he was interested in fashion, he turned these geometric projections into layouts and designs resembling figures obtained with the 1960s Spirograph game. Referring to these as "Rhythmic Designs" Schillinger used the patterns for a host of products including wallpaper, letter stationery, book covers, textiles, fabrics, linoleum, rugs and carpets, lamps, assorted household items, and furniture.[66] He collaborated on compositions in pure and industrial design with Winogradow and Pregram at the Architecture League of New York, and even had his personal grand piano (manufactured by Steinway) built on his own design as a geometric oblong figure.

Schillinger jotted down a multitude of subjects in his notebooks. These pages are written in a hypothetico-deductive approach whereby first an argument with minimal citations is presented, and then typically summarized into one all-encompassing statement. Such synopses could easily be quoted in an upcoming lecture, or presented to

students learning from a distance via written correspondence. In addition, such quotations were also readily available for press interviews. For example,

> An esthetic reality may be either a natural product, a product of human creative intuition, or a product of scientific synthesis, realized through computation by mathematical logic. In actuality, all three aspects coexist in perceptual interaction.

Among the subjects found in the notebooks were "The Physical Basis of Beauty," "Neurological Correlates of Sensation," "Geometrical Projections of Psychological Categories," and "Notation of Temporal Stimuli."

Schillinger suggested that phasic differences, causing instability in wave motion, are the actual factors controlling esthetic varieties.[67] That is, the sensation and perception of stimuli (visual and auditory) lead to unstable, synchronized, or overactive biological rhythms and can be represented as either subbiological, biological, or suprabiological processes. Hence, the phasic qualities are understimulation, normal stimulation, and overstimulation; the psychological entities are either subnormal, normal, and supernormal. As the sense organs react to frequencies and intensities, esthetic objects are capable of directly stimulating the senses by the number of frequencies and proportions present in the artistic media (and are not just associative psychological forms and images, which was the belief of music estheticians in Schillinger's day). Therefore, esthetic pleasure correlates directly to frequencies of stimuli (albeit visual and auditory modes differ in their casual affects). Conditioned reflexes associated with pleasure and delight grow through repeated experiences. Beauty in a composition, then, would result from the harmonic relations of harmonically developed components (spatial and temporal components). For example, the low frequency of "reds" affects people as understimulation; the middle frequency of "yellows," "greens," and "blues" cause normal stimulation; and the "violets" result in overstimulation. Schillinger observed these phenomenon in the reactions of the emulsion in color films of photographic settings of a sunset (overabundance of reds), a midday (balanced spectrum), and a forenoon (ultraviolet predominance). As far as Schillinger was concerned, these photochemical reactions provided hard evidence of this theory.

Turning to auditory stimuli, Schillinger pointed out that the reaction to sound has much to do with its quality, and that largely depends upon form and frequency.[68] For example, when the frequency is too low (below five cycles per second) the impression is of insufficiency and retarded life speed; when the pulse is normal (five to six cycles per second) the impression is of healthy existence and well-

being; and when the pulse is above the normal (above six cycles per second) the impression is of accelerated, precipitated, and tense existence. Low pitches (or low frequencies) produce quiescent, nocturnal, subbiological understimulating effects. The middle range, particularly that corresponding to the human voice (approximately 64–1200 hz), embraces the psychological range of normal stimulation. The high frequencies produce overstimulation, particularly when abundant with beats. Subsequently, Schillinger envisioned an overall organizing *power* of music. That is, a sound could either signal and induce reactions of fear and evil or attract the favorable and good. Schillinger foresaw in this possibility a medicinal application of music as a healing device in that individuals might someday be treated by soundwaves (believing there to be a quantitative difference between low- and high-frequency soundwaves).[69] Moreover, he felt that the *meaning of music* is related to psychophysiological correspondences.[70] Regularity means stability, simplicity means relaxation, and thus the simple organism at rest is comparable to simple harmonic motion. The loss of stability is caused by powerful excitors affecting the very existence of the organism. The awareness of instability comes through variation in blood circulation, sensed through heartbeat and in blood pressure, resulting in respiratory movements. The whole organism is a variation of stability, fluctuating between certain extremes of restfulness and restlessness. Schillinger claimed that the constitution of music is equivalent to that of an organism. That is, it is a variation of the stability in frequency and intensity. He was convinced that the controversies ascribing to semantic connotation (descriptive or symbolic) would vanish once the real meaning of music has been unveiled. Accordingly, the meaning of music evolves in terms of physico-physiological correspondences, which are quantitative, and the quantities seem to express form. Formation of patterns is due to configuration and periodicity. Configuration may be simple or complicated (in a mathematical sense), and the periodicity defines the recurrence, which may also be of different degrees of complexity. It is interesting to see how Schillinger connected these theories depicting the process of human emotions to certain psychophysiological tensions that are produced by musical dissonance.[71] In addition, Schillinger came to the precept of *training effects* that occur as a result of repeated exposure among students from music departments, who would exhibit characteristically different reactions to music compared to students from nonmusic departments.

Schillinger was a proponent of key concepts regarding the interchange between art and cortical activity. He declared there to be a relationship between the perception and creation of new esthetic patterns with biochemical configurations in brain functioning. Accordingly, our

biogenerator asserts certain tendencies, which in turn produce certain configurations and certain colors or sounds. Schillinger predicted that in the near future we would learn that creative experiences are merely geometrical projections of the electrochemical patterns of thought on various materials having sensory effects on us. He felt that while learning to play an instrument an individual acquires ability and coordination of his muscles and respiratory techniques; and by writing and analyzing music, or by studying music theory, an individual acquires similar agility and coordination of the mind.[72]

Two subjects that Schillinger was adamant about were "perfect pitch" and music notation. Concerning the first, he tackled the concept and stated that such perceptive qualities have nothing to do with musicality. He often wrote and stated that *absolute* pitch has no chance whatsoever to withstand comparison to other absolutes such as absolute zero temperature or the absolute melting/boiling point of certain substances and materials. Accordingly, to Schillinger absolute *A* = 440 is nothing more than a standard set by various national and international conferences. In his opinion, the fact that a certain wave frequency is called *A* is not therefore a natural phenomenon, but simply a mutual agreement by a group of experts valid in certain localities and in certain periods of time.

Regarding the second issue, Schillinger perceived there to be serious shortcomings in standard music notation. He observed that notated music does not portray the temporal mode of music. Owing to its nature, the notational record is not a musical work in itself but is merely a static schematic or "snapshot" thereof, and hence it cannot transmit the most essential property of music, which is motion. Schillinger believed that when making use of note writing, a composer cannot project precisely the process that goes on in his consciousness. While still in Russia, he conceded principal preference to paper rolls, especially if they were prepared by the composer himself.[73] In contradiction to the notational system, rolls give expression to a process that is geometrically precise and adequate to temporal relations. When set in motion the rolls represented exactly (as far as the mechanisms of the instrument permits) the musical work, transferring it by means of a moving special projection, from the category of consciousness into the category of being. Even after his arrival in America, Schillinger still viewed standard music notation as inadequate and inept. In his opinion, music notated on staves simply could not convey aurally conceived impressions, and thus he turned to other graphic representations throughout his lifetime.

As far as Schillinger was concerned, there were still many "unanswered questions" to be investigated (which he unfortunately never accomplished because of his premature death). His listing of such

items in his notebooks was perhaps his way of organizing *what is known* about music and music behavior. For example, among the questions he posed were "Are there unconscious mathematical procedures behind conscious musical intentions?" "What facilities constitute musicianship?" "Since there are visual geometric shapes in nature, does sound in nature also cause geometrical and mathematical organization?" and "Are there different types of temperaments and personality styles among listeners which bring about different reactions to music, and if so can the same be said about music critics?"[74]

In 1940 Schillinger saw an opportunity for immediate market application of his theories. Had he been successful in promoting his system, and had it been put into practice, he would surely have made an impact on a global level in his lifetime. Walt Disney released the film *Fantasia* in 1940. From a conceptual point of view, *Fantasia* contained no dialogue. It matched a pantomime of animated beasts and fantastic creatures to passages of classical music, creating what some critics celebrated as a partnership between fine music and animated film. For example, in one sequence the film featured alluring, barechested, purple and beige female centaurs cavorting to Beethoven's "Pastoral" Symphony as they tried to attract the affections of their mates-to-be. In another segment ostriches were seen pirouetting to Ponchielli's *Dance of the Hours*. There were also segments that involved interesting displays of color as an animation of audible sound effects using musical instruments as figures and characters. Among other compositions appearing in the soundtrack were pieces by Bach, Dukas, Schubert, Tchaikovsky, and Stravinsky. For the production of *Fantasia* Disney recruited Leopold Stokowski and the Philadelphia Orchestra in an effort to put their high-art credentials to the soundtrack.[75] Further, Deems Taylor (who had a popular radio following) was contracted to introduce each segment. Nevertheless, *Fantasia* was a much-praised commercial disaster after it opened at the Broadway Theater in New York City. Perhaps the 1940s audiences were preoccupied by war or put off by the film's highbrow image.

But another possibility (as construed by Schillinger) was that Disney had miscalculated the integration of visual animation with musical components. Even before the public saw Disney's film for the first time, there were contentions about the quality of *Fantasia* as a product related to art and music. The famed German artist and high-art animator Oskar Fischinger, who was hired to work on the segment of Bach's Toccata and Fugue in D Minor, eventually left the studio and abandoned the project. Fischinger publicly disowned his own contributions to *Fantasia*, stating that no work of art could be made with the procedures used in the Disney Studio.[76] Accordingly, he felt that there was no possibility of combining high art with Disney car-

toons. At the center of the debate seems to be the question of "Referentialism." At times the issue took on the debate of "drawing as language" *versus* "music syntax in painting." The dispute seems to look at the music—its purpose and representation. Clearly, Disney was not creating sound to accompany his work but was designing animation to accompany well-known high-art music. As such, many critics questioned the systematic use of Disney's *Fantasia* to expose and teach the general public about music. Among the musically cultured and sensitive, *Fantasia* was perceived as distasteful because Disney forced his unique visual images on defenseless viewers (and listeners) who might have quite different associations with the music. Critics pointed out that historically, where music and the visual arts have been joined, music has been employed merely to enhance the story: not so with Disney, who reversed the process.[77] Accordingly, Disney committed the unthinkable act of stripping away the infinite variety of plastic meanings that can be found in music.

In Schillinger's eyes, Disney's project was an example of poorly coordinated art forms that were void of a scientific method. In a series of letters he offered Disney his system and outlined his ideas.[78] Unfortunately, Disney did not graciously accept these. As a result, Schillinger felt belittled, unappreciated, devalued, and even ridiculed. He went on public record reporting that Disney did not know how music should be projected into form and color, and therefore resorted to the "accessories of music." Schillinger overstated Disney's mistake in seeking a fundamental relationship between forms of musical sound and the physical forms of musical instruments, and conceded that unity was absent from the production in other ways as well. Schillinger claimed that even with the help of Leopold Stokowski and Deems Taylor, *Fantasia* failed to solve the fundamental problem of combining visual images with music. He envisioned that solutions to such problems could be accomplished through the mathematical methods represented in his system. Ironically, subsequent releases of *Fantasia* to movie theaters proved more lucrative than the 1940 premier: with each reissue, *Fantasia* eventually gained popularity, and by its last theatrical release in 1990 it had earned $78,300,000.00. A videotape became available for purchase in 1991, and an all-new, updated version (with different repertoire and voices) was more recently released under the title *Fantasia 2000.*

Resolution

While this is not an attempt to evangelize Schillinger, it is perhaps reasonable to propose the following conclusion and in doing so lay the foundation for a resolution to the questionable impact of Schillinger's

career. As a composer Joseph Schillinger was certainly one of the rising stars in the young Soviet Union. His piano and orchestra works appeared regularly in Soviet concert programs. He was one of the many remarkable Russians who left the Soviet Union when it became apparent that the spirit of free artistic expression of the early 1920s was being replaced by repression, as Stalin's paranoid cultural policies began to take hold.[79] Once in America, Schillinger gained access to New York's academic and musical circles and began a career involving private and public teaching and lecturing. He quickly became a magnet for professional arrangers, composers, and bandleaders—especially those working in jazz orchestras, radio, and motion pictures. Nevertheless, his interest in the speculative side of musical knowledge was far too great, and his energies were directed toward musico-scientific problems, theories, and inventions. These were then rechanneled back into his curriculum and used to broaden the cultural and musical outlook of his students. This is what all the talk was about—so much so that Schillinger became a legend in his own time (at least for some). Especially after several disciples achieved great success, which involved much public fame and fortune, the legendary Schillinger quickly rose to mythical status. Schillinger eventually believed in his "calling" as a music scientist. He is quoted by his wife as having said, "My theories are more important than my music, for no matter how good my music may or may not be, I am one of many composers. But my theories are original and unique."[80] He believed that he made discoveries that humankind had been seeking for hundreds of years. He stated, "My theories, particularly my Theory of Rhythm, have significance for scientists in other fields. When they become familiar with my discoveries, they will find the answers to problems they have been working on for many years."[81] Schillinger seems to have been overrambunctious and even obsessed with his own preoccupations, and this may have led much of the traditional academic music establishment to feel that he overvalued his own theories. As a result they rejected him as a master composer and music theorist.

Yet, while Schillinger was not the best ambassador of his own findings, his perceptions were very advanced and impressively prophetic. The establishment-minded music society may simply not have been ready for him. Perhaps more than any other prominent musical figure between 1930 and 1940, Schillinger was able to cross disciplines and make intellectual connections that had never before been conceptualized. It may have seemed to some people that Schillinger was not developing a music science, but a futuristic musicological science-fiction, and this may have caused some to react with fear and eventual rejection to such new, unfathomable, and mysterious schemes. But Schill-

inger's creative imagination knew no limits and far surpassed what was comprehensible in his day; he pointed to new directions, trends, theories, and discoveries. Joseph Schillinger attempted to create a new world—and to him, his world was the world of tomorrow.

Postscript

Frances Schillinger-Shaw died in 1998. Prior to her death she expended much of her time dispersing her and Joseph's personal effects (including several valuable museum-quality collections of paintings, jewelry, and furniture), as well as Joseph's music (including scores, texts, rare phonograph recordings, and musical instruments). Frances both donated and sold the collections and works to museums and university libraries in the hope that they would perpetuate Schillinger's memory and system.[82]

In 1998 Frederick Siegmund of New York City, the executor of the estate, implemented the instructions outlined in Frances's will to endow a sum of money to an academic institution of higher learning. The endowment came to Ben-Gurion University of the Negev in Israel and was used to fund a two-year postdoctoral fellowship (of which the current author was the recipient). The Schillinger Fellow was mandated to complete three tasks. The first task was to impart information about Joseph Schillinger to academic, professional, and public figures. This was achieved through an international symposium celebrating the life and works of Joseph Schillinger. The second task was to implement an empirical research study on a subject related to Schillinger's legacy—taken from his unpublished notebooks describing his fascinations, imaginations, and prophetic visions—and to report such findings and implications in the professional literature as an acknowledgment of Schillinger's contribution to music science.[83] To achieve both of these goals, several of Schillinger's own collections that are housed in archives and depositories in America were examined. The search for relevant material led to the discovery of Joseph Schillinger's personal notebooks, which had been saved, wrapped, and buried in white tissue paper by his wife Frances. These are found at the Arthur Friedheim Library in the Peabody Institute at the Johns Hopkins University in Baltimore. The third task was to lay the foundation for the further establishment of a music-science laboratory to study the effects of music on general human behavior, and the human development of specific musical skills. This research laboratory, especially devoted to an empirical approach, was part of Schillinger's vision as outlined in his unpublished manuscript titled "The Institute for Musical Science."[84]

Notes

The author would like to thank Mr. Edwin "Ned" Quist of Brown University, former director of Information Services and the Schillinger Archive in the Peabody Institute at the Johns Hopkins University in Baltimore, for his personal assistance, active collaboration, and participation at the Israel symposium celebrating the life and works of Joseph Schillinger, as well as for his comments on earlier versions of this manuscript. In addition, the author would like to thank Professor Eliyahu Schleifer, director of music at Hebrew Union College in Jerusalem, Israel, for his review of the current manuscript. This research was supported by the estate of Joseph Schillinger and Frances Schillinger-Shaw. The author wishes to acknowledge the assistance of the estate's executor, Frederick Siegmund.

1. See Ned Quist, "Toward a Reconstruction of the Legacy of Joseph Schillinger," *MLA Notes* 58 (June 2002): 765–85, and *The Works of Joseph Schillinger* (Baltimore: Author, 2000), the most up-to-date comprehensive listings of Schillinger's works, which were compiled for the April 17, 2000, "International Symposium on Joseph Schillinger: His Life and Works in Performance, Composition, and Music Science," in Beer Sheva, Israel. The catalogues survey Schillinger's published writings, articles and pamphlets, poetry, some unpublished writings, the musical works, recordings, visual works, and other materials, as well as providing a concise bibliography and a list of all published reviews of Schillinger's works. A limited number of *The Works of Joseph Schillinger* are available at Ben-Gurion University. Another list is available on-line at www.peabody.jhu.edu/current/js.

The November 28, 1929, performance of the *First Airphonic Suite for Theremin and Orchestra* by the Cleveland Orchestra conducted by Nicholai Sokoloff, with Leon Theremin as soloist, was surveyed by both the local and national press. See "Radio Brings about New Type of Orchestration That Plays to Wave of Arms, How an Artist Pictures the Symphony Orchestra of Modern Age, Playing Music Specially for Peculiar Instruments, Electrical Music Instruments to Be Heard Here Friday; Ensemble to Play Without Keyboard, Strings, or Mouthpieces," *New York Herald Tribune*, April 20, 1930; Archie Bell, "Notable Soloists with Orchestra to Be Heard: Symphony Concerts This Week to Feature Schillinger's Theremin Number," *Cleveland News*, Nov. 24, 1929; and Bell, "New Musical Instrument Tested Here Gets Applause," *Cleveland News*, Nov. 29, 1929, 22. Further, several commemorative programs often cite this fact, for example, "NY Public Library Cites Thirtieth Anniversary of Joseph Schillinger's Death," news article of unknown source, dated June 1972.

2. While these testimonials are often cited, it must be pointed out that there is no documented hardcopy of such, and hence there are some who contest if such support was indeed offered. Reports of testimonials can be found in Alfred Auerbach, "A Method of Evolving Rhythmic Design: Joseph Schillinger Offers a New Approach to the Composition of Linear Patterns," *Retailing, Home Furnishings Edition*, Nov. 19, 1934, 3, 22. Also see "Music Makers to Be 'Engineers': Schillinger Teaches Composition on the Basis of Pure Mathematics," *New York Sun*, May 11, 1940, 26; Horace M. Kallen, "Mathematics and Beauty: Matila Ghyka, Joseph Schillinger, and Bertrand Russell," in *Art and Freedom* (New York: Duell, Sloan and Pearce, 1942), 784–85; "Schillinger, 47, Formula-Music Composer Dies," *Herald Tribune*, March 24, 1943; "Setting a Financial Statement to Music," *Magazine Digest* (1947): 7–12; Alfred Human, "Schillinger Challenges Genius," *Musical Digest* 29 (1947): 12–14, 16.

3. A host of unpublished manuscripts have been archived at the Peabody Institute of Music at the John Hopkins University in Baltimore. Most of these were transcribed, prepared, and placed meticulously in three-ring binders by Frances Schillinger. These have

been identified by the title appearing on the manuscripts, and not as the subsequent chapter designation that were eventually published in the four volumes. See Joseph Schillinger, "A System of Projects for the Development and Advancement of Scientific Functioning of the Arts," unpublished typed manuscript, Peabody Institute of Music.

4. The four volumes of posthumously published books are *The Mathematical Basis of the Arts* (New York: Philosophical Library, 1948; New York: Da Capo Press, 1976); *Schillinger System of Musical Composition*, 2 vols. (New York: Carl Fisher, Inc., 1946; New York: Da Capo Press, 1977); and *Encyclopedia of Rhythms* (New York: Charles, 1966; New York: Da Capo, 1976).

5. "Announcement of Classes and Special Summer Courses in the Schillinger System of Arranging and Composition at the Schillinger House by Lawrence Berk, Director," *Boston Sunday Herald*, June 9, 1946; and "Lawrence Berk Announces New Semester in the Schillinger House," *Downbeat*, Dec. 17, 1947.

6. "The Schillinger/Berklee Connection," *Berklee Today* (Fall 2000); on-line at www.berklee.edu/bt/122/connection.html.

7. Some writers have questioned different aspects of the Schillinger legend. For example, Gershwin's length of study with Schillinger has been raised by Gill Goldstein. See Goldstein, "Joseph Schillinger: A Brief Look at His Life and His Theoretical System," *Contemporary Keyboard* (January 1980): 8. Paul Navert, "Theory and Practice in *Porgy and Bess:* The Gershwin-Schillinger Connection," *Musical Quarterly* 78 (Spring 1994): 9–31. In addition, the stories about the supportive testimonials of Einstein have been queried by Human, "Schillinger Challenges Genius."

8. One researcher who has committed himself to documenting original Schillinger publications, as well as subsequent studies, articles, theses, and dissertations is Louis Pine. See Lou Pine's 1997 listing titled, "Joseph M. Schillinger—A Bibliography," on-line at www.peabody.jhu.edu/current/js/pine.html. Also see Quist's *Works of Joseph Schillinger.*

9. Various assorted advertisements and brochures, all of which include biographical details, can be found in the Schillinger Archives at the Peabody Institute. These were preserved, sorted, and arranged by Frances Schillinger. See "Presenting the Schillinger System of Musical Composition," "The Schillinger System Now in Its Fourth Printing," "The Authoritative Answers to Your Questions about the Schillinger System" (Carl Fischer, Inc., New York). Also see "The Schillinger System" (Carl Fischer, Inc., New York; reprinted by Da Capo Press, New York, 1977). Also "Carl Fischer Releases Schillinger Edition," *The School Musician* 16 (May 1947): 42.

Among the important biographical sketches are "Joseph Schillinger," *Pro Musica Quarterly* (March/June 1929): 44. Also see original public-relations brochure produced by his early artistic manager, the impresario Richard Copley, "Joseph Schillinger—1929 Biography and List of Works" (Richard Copley, New York, 1929). Other materials are listings and entries in biographical encyclopedias, such as "Joseph Schillinger," in *Encyclopedia of American Biography* (American Historical Company, Inc., ca. 1938); and Edwin "Ned" Quist's 1996 biographical details of Schillinger titled, "Joseph Schillinger: Curriculum Vitae," on-line at www.peabody.jhu.edu/current/js/cv.html. Among the important book reviews (which also offer biographical details) is Lyle Dowling, *A Brief Note on the Schillinger System: The Scientific Way to Success in Music* (New York: Allied Music, 1942). Also see Nicolas Slonimsky, "Book Review: The Schillinger System of Musical Composition," *Musical Quarterly* 32 (June 1946): 465–70. The memoir to which I refer is Frances Schillinger, *Joseph Schillinger: A Memoir* (New York: Greenberg, 1949; New York: Da Capo, 1976).

Finally, several exhibits have displayed Schillinger paraphernalia commemorating anniversaries of his birth or death. Most of these offer a biographical synopsis. See Marion L. Simmons, "Exhibit of Schillinger Music Career," New York Public Library,

unpublished press release, March 22, 1967; a press-release pamphlet of an exhibit about Schillinger at the Cooper-Hewitt Museum (The Smithsonian Institution's National Museum of Design in New York), "Cooper-Hewitt Museum Schillinger Exhibit" (Fall 1990); Clive Phillpot, "Joseph Schillinger: Notebooks and Designs," Museum of Modern Art Library, *Library Bulletin* 82 (May–Aug. 1991): 3–5; George Boziwick, "Joseph Schillinger's World of Tomorrow: An Exhibition Celebrating the Centennial of His Birth," New York Public Library, 1995; and Herb Scher and Alex Wing, "Making Music from Math: Joseph Schillinger's Unique System of Musical Composition Explored in Exhibition of the New York Public Library for the Performing Arts," unpublished exhibit program, 1996.

10. There is little evidence of Schillinger's religious orientation or affiliations. Frances's memoirs offer no details, and this perhaps is a sign that he was fully assimilated into an American secular society. Clearly his father's name (Moses) and his middle name (Moiseyvich) would suggest that Schillinger was of a Jewish family background. Yet no pictures from his childhood of Jewish holidays or festivals associated with wearing a Yalmulkah skull-cap are among the collections in the archives. Further, no pictures of typical rites-of-passage such as a Jewish bar-mitzvah at age thirteen exist. However, his biographical sketches clearly delineate Hebrew as one of the six languages he mastered (a language that would not have been studied by a non-Jew in the first decade of twentieth-century Russia). Moreover, Schillinger was listed as one of the rising Russian Jewish composer immigrants to America. See Erminie Kahn, "Aid Sought for Worthy Jewish Composers: Lazare Saminsky Is Forming International Society to Achieve That End," *The American Hebrew*, Feb. 15, 1929, 515, 523. Finally, Schillinger's CV lists that in 1931 he applied his pedagogical skills at New York's Young Men's Hebrew Association (YMHA). Hence, one could conclude from these pieces of information that his parents were Jewish, and that upon his arrival in America he identified himself as a Jew (at least for the purposes of financial support and income). See Schillinger, *Joseph Schillinger: A Memoir;* "Joseph Schillinger" in *Encyclopedia of American Biography.*

11. "Joseph Schillinger" in *Encyclopedia of American Biography;* Robert Bagar, "Schillinger Music System Printed: It's Higher Mathematics for Composers," *New York World-Telegram,* March 23, 1946, 7.

12. Not much has been written about Schillinger's musicological field experience, nor his actual findings. Nevertheless, many biographers highlight this commission as an important undertaking that contributed greatly to his prestige and academic standing. See "Joseph Schillinger" in *Pro Musica Quarterly.* Also see "Joseph Schillinger" in *Encyclopedia of American Biography.*

13. The original paste-up can be found at the Lincoln Center for the Arts in New York.

14. S. Frederick Starr, *Red and Hot: The Fate of Jazz in the Soviet Union, 1917–1980* (New York: Oxford University Press, 1983).

15. "Joseph Schillinger" in *Pro Musica Quarterly.*

16. Several catalogues and leaflets were compiled by Frances Schillinger documenting Joseph Schillinger's early activities. Among these are handbill circulars. See "Opening of the Department of Musical Analysis and Composition, Directed by Joseph Schillinger," Theremin Studio, New York, ca. 1930. Also see "Rudimentary Analysis of Musical Phenomena: A Series of Twelve Lectures by Joseph Schillinger," Theremin Studio, New York, April 17, 1931.

17. "Music by Slide Rule," *Newsweek* 24 (Sept. 25, 1944): 81–82; Tweed Brown, "Music by Mathematics: Thanks to Joseph Schillinger, Busy Composers Can Grind Out Slide-Rule Scores by the Yard," unknown source and date, in Peabody Institute.

18. "New Art Forms: A Speculative Theory of Art—Joseph Schillinger, 12-Session

Lecture Series," *1932–33 Course Catalogue* (New York: The New School for Social Research, 1932); "Announcement of Lecture Series at the Florence Cane School of Art," unpublished press release, Oct. 31, 1931.

19. Joseph Schillinger, "Rhythmic Design: Transcription of 12–Session Course Lecture at Teachers College, Columbia University," unpublished typed manuscript, 1934.

20. While it has not been possible to certify this number with hardcopy evidence (such as records of payment or appointment schedules), the following ninety-nine names appear in Schillinger's own notebooks, monographs, and posthumous publications, as well as among listings found in commercial PR brochures, advertisements, and magazines about Schillinger or describing his methods and students achievements. Among those who studied with Schillinger were Jeff Alexander, Meyer Alexander, Fabian Andre, Edwin Bave, Victor Bay, Richard Benda, Lawrence Berk, Eubie Blake, William H. Borden, Lawrence H. Bracken, Will Bradely, Nat Brandwynne, Irving Brodsky, Earle Brown, John Cage, Margaret Carlisle, William Challis, Nathan L. van Cleave, Norman Cloutier, John Coltrane, Carmine Coppola, Clarence Cox, Jesse Crawford, Edward Lodge Curran, Robert Emmett Dolan, Tommy Dorsey, Vladamir Dukelsky (Vernon Duke), Alfred Evans, Belle Fenstock, Harry Gellert, Russel Genner, Edwin Gerschefski, George Gershwin, Felix Giardina, Marjorie Goetschius, Benny Goodman, Ralph Gordon (Gus Levine), Ross Gorman, Jerome Jerry Gross, Michel Gusikoff, Ralph Hallenbeck, Lennie Hayton, Charles Hayway, Alexander Hellman, David Holywin, Hal Kemp, Stan Kenton, Nina Koshetz, Paul Laval (Joe Usifer), Leo Lefleur, George B. Leeman, Oscar Levant, Gus Levene (Ralph Gordon), Joseph Lilley, Franklyn Marks, Rosolino de Mario, Bernard Mayers, John McGee, James J. McInerney, Albert Meiff, Glenn Miller, Jack Miller, Toots Mondello, Lee Montgomery, Harold Mooney, Lyn Murray, Red Norvo, Val Olman, Charles Paul, Mel Powell, Edward Powel, Charles Previn, Samuel Raitz, Alvino Ray, Sonny Rollins, Harold Rome, Ted Royal, Myron Schaeffer, Rudolf Schramm, Vladamir Selinsky, Winston Sharples, Milton Shaw, Harry Simeone, Frank Skinner, Herbert Spencer, Paul Sterrett, Leith Stevens, Morris Stoloff, Freddie Stulce, Dave Trbett, Gerald F. Warbury, Mark Warnow, Lazar Weiner, Milton Weinstein, William Welch, Paul Whiteman, Ralph Wingert, John Winters, and Samuel Zimbalist.

21. Edwin "Ned" Quist, "Joseph Schillinger: A Man of Music by the Numbers," *Peabody News* (Sept./Oct. 1996): 42–44.

22. Arnold Shaw, "Schillinger: The New Science in Music," *Accordion Times and Musical Express* (Nov. 14, 1947).

23. Human, "Schillinger Challenges Genius," 12–14, 16. Also see Schillinger, *Joseph Schillinger: A Memoir;* Harry Lyden, "Schillinger and Shaw (1)," *News Letter of the Arnold Shaw Research Center for Popular Music* 3 (April 1994), and "Schillinger and Shaw (2)," *News Letter of the Arnold Shaw Research Center for Popular Music* 3 (May 1994).

24. Frances Schillinger described her husband's activities and works in layman's terms. From these it is clear that Joseph Schillinger had a mature disposition for both visual and auditory sciences and arts. See Frances Schillinger, "Excerpt from a Theory of Synchronization by Joseph Schillinger," edited version from *Experimental Cinema* 5 (1934), unpublished typed manuscript, May 13, 1940.

25. Human, "Schillinger Challenges Genius"; Nicolas Slonimsky, "Schillinger of Russia and of the World," *Music News* 39 (March 1947): 3–4; Harry Lyden, "Joseph Schillinger (1895–1943): A Biography," *News Letter of the Arnold Shaw Research Center for Popular Music* (April 1990), also on-line at www.geodyne.com/schillinger/bio.htm; Henry Cowell, "Joseph Schillinger as Composer," *Music News* 39 (March 1947): 5–6.

26. Joseph Schillinger, "Variations of Music by Means of Geometrical Projections," *Musicology* 1 (1946): 197–214; Brown, "Music by Mathematics"; Goldstein, "Joseph Schillinger," 8; Schillinger's *Mathematical Basis of the Arts, Schillinger System of Musical Composition*, vols. 1–2, and *Encyclopedia of Rhythms;* Kent Holliday, "Long's Peak Profile

(Schillinger Notation)," in *Contempo 2: An Introduction to Twentieth-Century Idioms for the Pianist*, selected and edited by Mary Elizabeth Clark (Boulder, Colo.: Myklas Press, 1974): 16–23; Slonimsky, "Book Review: The Schillinger System of Musical Composition"; Henry Cowell, "The Case for the System: Proponent of Debated Schillinger Methods States It in Introduction," *New York Times*, March 26, 1946.

27. Seymour Solomon, "Schillinger and Twentieth-Century Rationalist Trends in Music," *Music Forum and Digest* (January 1950): 4–5.

28. Joseph Schillinger, "Plain Talk on Musical Genius," *Tomorrow* 1 (March 1942): 33–36; "Music by Slide Rule," 81–82; Human, "Schillinger Challenges Genius," 12–14, 16.

29. "Music by Slide Rule." See also Slonimsky, "Book Review: The Schillinger System of Musical Composition"; and Schillinger, "Variations of Music by Means of Geometrical Projections," 197–214.

30. This is a direct citation from Schillinger himself. While to him this story may have been complimentary, it no doubt offended his prized students. See Joseph Schillinger, *Kaleidophone; New Resources of Melody and Harmony. Pitch Scales In Relation to Chord Structures; An Aid to Composers, Performers, Arrangers, Teachers, Song-Writers, Conductors, Critics, and All Who Work with Music* (New York: Witmark, 1940; New York: Charles Colin, 1967), preface and 1–23, and on-line at www.geodyne.com/schillinger. Also see "Finding Cube Root of Inspiration," *Philadelphia Inquirer*, March 23, ca. 1941; "Music by Slide Rule"; Hugh Scott, "Getting the Upper Hand by Mathematics," *Philadelphia Inquirer*, April 14, 1946, 19; Brown, "Music by Mathematics"; Paul Lavalle, "Schillinger System Still Sells," *Music Journal* (Feb. 1974): 30–31.

31. See Human, "Schillinger Challenges Genius."

32. Schillinger, *Schillinger System of Musical Composition*, vols. 1–2. Also see Slonimsky, "Book Review: The Schillinger System of Musical Composition."

33. Joseph Schillinger, "Electricity, a Musical Liberator," *Modern Music* 8 (March–April 1931): 26–31; Schillinger, "The Electrification of Music," unpublished typed manuscript, Peabody; Vernon Duke, "Gershwin, Schillinger, and Dukelsky: Some Reminiscences," *Musical Quarterly* 33 (January 1947): 102–15; Joseph Schillinger, "Text Book I: Chapter 1. History of Music: 1. Evolution of Instruments; 2. Growth of Audiences; 3. Evolution of Recording; 4. Art Judgments; 5. Music of Nature," unpublished typed manuscript, ca. 1936, Peabody.

34. "Finding Cube Root of Inspiration." Also, one enchanting description of Schillinger's studio, and the marvels that occurred there, is offered through the eyes of Jessica Dragonette (a well-known acquaintance and confidante of Schillinger from before his marriage to Frances). While Jessica was certainly not an outsider, she was not partner to his teaching or scientific prowess. Hence, her vantage and subsequent narration is not only extraordinary, but often amusing! See Jessica Dragonette, *Faith Is a Song: The Odyssey of an American Artist* (New York: David Mckay, 1951)

35. Dowling, *A Brief Note on the Schillinger System*.

36. Schillinger, "Plain Talk on Musical Genius." Also see "'Plain Talk on Musical Genius': A Concise Summary of Article Which Appeared in *Tomorrow* Vol. 1, Pages 33–36, March 1942," *Education Digest* 7 (March 1942): 30–32; and Human, "Schillinger Challenges Genius," 12–14, 16.

37. The following unpublished manuscripts, all by Schillinger: "The Varieties of Musical Experience: Lecture Notes of New York Musicological Society" (handwritten, 1932); "The Varieties of Musical Experience: Transcription Notes of 6–Session Course in Private Studio" (typed, 1939); "'Defrosting Music': An Introduction to the 'Varieties of Musical Experience'" (typed, n.d.); and "Varieties of Musical Experience: Transcript of a 1939 Lecture Series," foreword by Arnold Shaw (typed, 1939).

38. Schillinger, "Plain Talk on Musical Genius." Also see "'Plain Talk on Musical Genius': A Concise Summary of Article," 30–32.

39. Joseph Schillinger, "Text Book II. Chapter 1: Mathematical Basis of Music; 1. Introduction: The Varieties of Musical Experience; 2. Rhythm Applied to Arts; 3. Unexplored Realms of Music; 4. How to Make Music; 5. The Schillinger System Vs Standard System; 6. Liberation Through Scientific Creation; 7. The Truth about Music [Book Outline]," unpublished typed manuscript.

40. Human, "Schillinger Challenges Genius"; Dragonette, *Faith Is a Song;* and Joseph Schillinger, "How to Make Music: The Making of Music," unpublished typed manuscript.

41. While this story has been cited by many authors, and leaves the impression that such behavior by Schillinger was repeated continuously, the truth is that it is rather difficult to ascertain if in fact the reported circumstances were a one-time event that was simply built-up and overstated (partially by Schillinger himself). See "Setting a Financial Statement to Music," 7–12. Also see Slonimsky, "Schillinger of Russia and of the World," 3–4; Brown, "Music by Mathematics"; Lavalle, "Schillinger System Still Sells," 30–31.

42. This description was offered by Jessica Dragonette who witnessed various auditory spoofs and acts of aural deception by Schillinger on his house guests and visitors to his studio. See Dragonette, *Faith Is a Song.*

43. Solomon, "Schillinger and Twentieth-Century Rationalist Trends in Music."

44. Ibid.

45. "Be a Composer—For $3," *Time* (Aug. 23, 1944): 46; and Solomon, "Schillinger and Twentieth-Century Rationalist Trends in Music," 4–5.

46. Dragonette, *Faith Is a Song.*

47. Schillinger, *Mathematical Basis of the Arts;* and Arnold Shaw, "A Pioneer Still Leads the Way: Joseph Schillinger? The Father of Electronic Music, That's Who," *Los Angeles Times,* June 11, 1972, 58, 60.

48. Schillinger, *Mathematical Basis of the Arts;* U.S. Patent, "Animated Display Apparatus," by Joseph Schillinger but filed posthumously by Frances Schillinger on Sept. 4, 1945, U.S. Patent Office #2,492,241, Dec. 27, 1949.

49. Joseph Schillinger, "Definition and Classification of Visual and Oral Arts," unpublished typed manuscript; Schillinger, *The Mathematical Basis of the Arts;* Shaw, "A Pioneer Still Leads the Way"; and Schillinger, "System of Projects for the Development and Advancement of Scientific Functioning of the Arts."

50. Charles Previn, "Schillinger's Influence on Film Music," *Music News* 39 (March 1947): 39–40; Shaw, "A Pioneer Still Leads the Way"; Lyden, "Joseph Schillinger (1895–1943)"; and Schillinger, *Mathematical Basis of the Arts.*

51. This very interesting concept has been the root of much debate and subsequent research by various music psychologists as well as applied clinically by music therapists. For a description of Schillinger's Dial, see Shaw, "A Pioneer Still Leads the Way." Also see Bruno Degazio's 1999 article, "Nikola Telsa and Joseph Schillinger the Music of NT: The Man Who Invented the Twentieth Century," found on-line at www-ks.rus.uni-stuttgart.de/people/schulz/fmusic/telsa.html; and Jeremy Arden, "Focusing the Musical Imagination: Exploring in Composition the Ideas and Techniques of Joseph Schillinger," unpublished Ph.D. dissertation, Department of Music, City University, London, 1996, on-line at www.mrac.demon.co.uk/schillinger.pdf

52. Joseph Schillinger, "Project for Walt Disney: Three Versions," unpublished typed manuscripts, April 17, 1940; Frances Schillinger, "Excerpt from a Theory of Synchronization by Joseph Schillinger"; and Schillinger, *Joseph Schillinger: A Memoir.*

53. Joseph Schillinger, *Schillinger System of Musical Composition,* vols. 1–2. Also see Slonimsky, "Book Review: The Schillinger System of Musical Composition"; Richard Benda, "Schillinger System Arranging, Lessons 1–5," *International Musician* 55 (1956); 55 and 56 (1957); 56 and 57 (1958).

54. Schillinger, *Joseph Schillinger: A Memoir;* Schillinger, *Kaleidophone,* preface and 1–23; Solomon, "Schillinger and Twentieth-Century Rationalist Trends in Music," 4–5.

55. Schillinger, "Variations of Musical by Means of Geometrical Projections," 197–214; Brown, "Music by Mathematics"; "Joseph Schillinger" in *Encyclopedia of American Biography;* Schillinger, *Mathematical Basis of the Arts.*

56. "Joseph Schillinger" in *Encyclopedia of American Biography.*

57. William Grimes, "Obituary: Leon Theremin, Musical Inventor, Is Dead at 87." *New York Times,* Nov. 9, 1993.

58. "Robot Composer of Music Knows 65,000 New Tunes," *Popular Science* (August 1940); Schillinger, *Mathematical Basis of the Arts.*

59. Joseph Schillinger, "The Hammond Organ: Transcript of Lecture at the League of Composers," unpublished typed manuscript, May 1939. Also see Schillinger, "Plain Talk on Musical Genius."

60. Most certainly if such a curriculum were to be translated into the language of the current century then it would read: Music Technology and Computer Music, Acoustics and Music Perception, and Music Theory and Composition.

61. Joseph Schillinger, "The Destiny of Tonal Art," *Sixty-first Proceedings of the Music Teachers National Association, December 21–31, 1937* (Oberlin, Ohio: MTNA, 1938), 31–40. Also see "Music Makers to Be 'Engineers,'" 26; and "Setting a Financial Statement to Music," 7–12.

62. Joseph Schillinger, "Excerpts from a Theory of Synchronization," *Experimental Cinema* 5 (1934): 28–31; William Moritz, "Mary Ellen Bute: Seeing Sound," *Animation World* 1, no. 2 (May 1996), on-line at www.awn.com/mag/issue1.2/articles1.2/moritz1.2.html; Schillinger, "The Varieties of Musical Experience: Lecture Notes of New York Musicological Society," and "The Varieties of Musical Experience: Transcription Notes of 6–Session Course in Private Studio."

63. Joseph Schillinger, "Graph Method of Dance Notation," unpublished manuscript, 1934; published in 1985 by Cervera Press Publications, London. Also see Janet Moekle, "Schillinger's Notation," *Dance Chronicle* 9 (1986): 403–4.

64. Schillinger's dance notation is unique. It is not at all like either the Noh Eshkol Movement Notation, or Laban Dance Notation, both of which are taught in dance academies, and used by choreographers.

65. Schillinger, *Mathematical Basis of the Arts.* Also see "Joseph Schillinger" in *Encyclopedia of American Biography.*

66. "Announcement of Lecture Series at the Florence Cane School of Art," unpublished press release, Oct. 31, 1931; "A Review of the Field of Art Education: Relativity and Art," *Art Digest* (Nov. 15, 1934): 24; Auerbach, "A Method of Evolving Rhythmic Design," 3, 22; Schillinger, *Joseph Schillinger: A Memoir.*

67. Schillinger, *Mathematical Basis of the Arts.*

68. Ibid.

69. The clinical application of vibrotactile intervention has been investigated by many music therapists and psychologists. See Clifford K. Madsen, Jayne M. Standley, and Dianne Gregory, "The Effect of a Vibrotactile Device, Somotron, on Physical and Psychological Responses: Musicians Versus Non-Musicians," *Journal of Music Therapy* 28 (1991): 14–22. Also see Jayne M. Standley, "The Effects of Vibrotactile and Auditory Stimuli on Perception of Comfort, Heart Rate, and Peripheral Finger Temperature," *Journal of Music Therapy* 28 (1991): 120–34; Tony Wigram and Cheryl Dilelo, eds., *Music Vibration* (Cherry Hill, N.J.: Jeffrey Books, 1997); Warren Brodsky, "Post-Exposure Effects of Music-Generated Vibrotactile and Whole-Body Acoustic Stimulation Among Symphony Orchestra Players," *Psychology of Music* 28 (2000): 98–115.

70. Schillinger, "Destiny of Tonal Art."

71. Schillinger, *The Mathematical Basis of the Arts;* Slonimsky, "Book Review: The Schillinger System of Musical Composition."

72. Schillinger, "Destiny of Tonal Art," 31–40; Schillinger, "The Hammond Organ." This concept (albeit based on controversial and suspect research data) has become known during the last decade as the "Mozart Effect." In general, such findings highlight both the short-term effects of music, as well as long-term music learning, on brain (cortical) plasticity.

73. Joseph Schillinger, "The Problem of Musical Education," State Institute of the History of the Arts, Leningrad, Russia, 1925. This article was translated into English by an unknown translator; it could have been completed in Russia before Schillinger left in 1928, in Germany before he entered America, or once in America prior to meeting Frances. At any rate, two versions exist at the Peabody Archives—an earlier typed version, and one typed out by Frances after 1938.

74. "Schillinger's Influence on Radio," *Music News* (May 1950). Also see Degazio, "Nikola Telsa and Joseph Schillinger the Music of NT."

75. Harry M. Benshoff, "Heigh-Ho, Heigh-Ho, Is Disney High or Low? From Silly Cartoons to Post Modern Politics," *Animation Journal* (Fall 1992): 62–85. Also on-line at www.tasc.ac.uk/dept/media/staff/ls/Modules/MED2210/Disney/Benshof.html.

76. Ibid.

77. H. B. English, "'Fantasia' and the Psychology of Music," *Journal of Aesthetics and Arts Criticism* 2 (July 1943): 27–31.

78. Joseph Schillinger, "The Disney Case: Project for Walt Disney," three unpublished handwritten manuscripts, April 17, 1940; "Finding Cube Root of Inspiration."

79. Quist, "Joseph Schillinger: A Man of Music by the Numbers."

80. Schillinger, *Joseph Schillinger: A Memoir,* 130.

81. Ibid., 56.

82. The musical manuscripts can be found at the New York Public Library for the Performing Arts at Lincoln Center, the Edwin A. Fleischer Collection at the Free Library in Philadelphia, and the British Museum. The visual art works (including paintings, drawings, and films) can be found at the Museum of Modern Arts, the Smithsonian Archives of American Art, Metropolitan Museum of Art, Cooper-Hewitt Museum, the Brooklyn Museum, Finch College Museum, Solomon R. Guggenheim Museum, Whitney Museum of American Art, Newark Museum, Albert-Knox Art Gallery, and the Art Gallery of Ontario. Schillinger's papers and theory notebooks can be found at the New York Public Library for the Performing Arts at Lincoln Center, the Smithsonian Institute, Columbia University Libraries, University of Wyoming Library, and the Arthur Friedheim Library at the Peabody Institute of the John Hopkins University. Finally, the Rhythmicon can be found at the Smithsonian Institution in Washington, D.C. For more details, see Quist, "Toward a Reconstruction of the Legacy of Joseph Schillinger."

83. Warren Brodsky, "The Effect of Music Tempo on Simulated Driving Performance and Vehicular Control," *Transportation Research, Part F: Psychology and Behavior* 4 (2002): 219–41.

84. Joseph Schillinger, "The Institute of Musical Science," unpublished handwritten manuscript.