

Video Production of *Magic Music from the Telharmonium*

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Abstract

Magic Music from the Telharmonium is a 29-minute all-digital video program that recounts the history of the first comprehensive music synthesizer. This article briefly outlines pre-production procedures, including research methods and sources. It then describes in detail the image and sound production techniques of the work, and how these carried out the design choices that were made. Features and limitations of hardware and software are also reported.

Introduction

A brief synopsis of *Magic Music from the Telharmonium*:

It was 1906. "Get Music on Tap Like Gas or Water" promised the headlines, and soon the public was enchanted with inventor Thaddeus Cahill's (1867-1934) electrical music by wire. The Telharmonium was a 200-ton behemoth that created numerous musical timbres and could flood multiple rooms with sound. Beginning with the first instrument, constructed in the 1890's, and continuing with the installation of the second instrument at Telharmonic Hall in New York, the rise and fall of commercial service, the attempted comeback of the third Telharmonium, and ending with efforts to find a home for the only surviving instrument in 1951, this documentary provides a definitive account of the first comprehensive music synthesizer.

I produced this all-digital animated documentary on Macintosh computers and completed it in 1998. It is an outgrowth of the book of the same name. The running time is 28:51. It has been released on VHS and BetaSP videocassette in both NTSC and PAL systems, and on 3/4-inch NTSC videocassette.

I completed a first cut of this work on March 2, 1997, at Windsor Digital, New York. After a presentation on April 4, 1997, at the National Conference of the Society for Electro-Acoustic Music in the United States, University of Missouri, Kansas City, I revised about 7 minutes of the footage. I completed the final version on April 6, 1998, at Unitel Post 38, New York. The première was presented on April 15, 1998, at the National Conference of the Society of Composers, Inc., Indiana University, Bloomington.

In 1998 the program was selected for *Synthèse 98: 28e Festival International des Musiques et Créations Électroniques*, Bourges, France, and the 9th Annual Festival *Téléscience*, Montréal, Canada. It was also selected for The Sync Online Film Festival, Laurel, Maryland, and placed on its web site. As of this writing it may be viewed in its entirety at <http://www.thesync.com>. In 1999 it received the Crystal Award of Excellence, History Category, The Communicator

Awards, Arlington, Texas, and was the Viewers' Choice Winner for January 1999, Documentary Category, The Sync Online Film Festival (<http://www.thesync.com/festival/winners.html>).

Pre-Production

When I began to investigate the Telharmonium as a possible research topic in 1981, I was delighted to discover that it was a grand story waiting to be told. Modern accounts were tantalizingly sketchy and confusing, and gave contradictory dates of its use and demise. Even with this limited data, its significance in the history of electronic music was by then well established and accepted. And so I pursued the evidence and told the story in book form.

The world of the Telharmonium was ultimately conveyed to me by over 900 primary sources: letters, patents, court documents, corporate documents, pamphlets, brochures, broadsides, and newspaper and magazine articles. The latter provided words and, of course, pictures. As the pictorial collection increased, I comprehended a visual world that would be too large to include in the book, but that could stand on its own as a way of conveying the history of the instrument.

This realization occurred about a year or two into the book project, at which point my gathering of available pictures had been incomplete and not at the highest resolution available. I re-photographed pictures I had taken earlier, using fine-grain film and a macro lens, and proceeded to acquire copies of any and all new pictures that had any connection to the Telharmonium. I also looked for supplementary images that could be used as foreground and background material. This would enable me to cover the people connected with the Telharmonium (Lee de Forest, Mark Twain, Lord Kelvin, George Westinghouse, Johanna Gadski, Victor Herbert, Walter Damosch), and to recreate the world of New York hotels, restaurants, theaters, and other pertinent scenes and locations (the Maryland Club in Baltimore, buildings on Broadway, various street scenes in New York and Holyoke), and to illustrate developments in invention and technology (acoustics, electrical sound, the telephone, the audion, the radio signal path).

One source that proved to be invaluable was picture postcards—skylines, hotels, restaurants, skyscrapers, and people (using the telephone, eating and drinking, “glamour” pictures). Postcards were quite the rage in the early 1900s, when they were produced in greater quantity and variety than ever before or since. The all-time record number of postcards mailed in one day occurred at Coney Island in 1906—over 200,000 of them. The inexpensive color images were a popular attraction in an era when mass-circulation periodicals were printed in black-and-white. I visited many postcard shows, and found that those with the greatest selection of New York City subjects were held in Florida—where expatriates assemble collections with nostalgic devotion.

The gathering process was essentially completed in 1991 and resulted in a collection of 840 images. The video program incorporates 261 of these.

Image Production

All visual sources are historically authentic still images. There are no live-action images, visual recreations, or mock-ups. I photographed the stills on film transparencies and scanned these onto a computer hard drive. Image processing and animation were created with Photoshop 3.0.4 and Director 5.0.1 on a PowerMac 8500/120 (144mb RAM).

When these historically authentic stills first faced me on the computer monitor, any respect for preserving their original appearance faded altogether. The importance of clarity superseded any notion of conveying the actual form in which these venerable gems arrived on my hard drive. As examples, some techniques employed in the image processing and animation may be cited:

Scene 1. Starting with the very first image (ballroom dancers), I “dodged” (lightened) faces to make them clearer and “sponged” areas to increase color saturation. Broadcast television conveys some colors better than others—good blues are everywhere but just try to get a decent orange, let alone a yellow. Photoshop has an NTSC color filter and Director an NTSC color palette. Director’s is about as thin and wan as television

color can possibly become, and inexplicably lacks magenta, so it can't even be used for color bars. I eventually found I could ignore the stock palette and rely on the on-line video editing studio to rein in and "legalize" my colors where necessary.

Scene 9. Here I used a split screen to present a composite of several locations. In fact there is no such thing as a video-type independent split screen in Director (picture within picture). All the images are partially overlaid. I set up borders to place three pictures in the video frame and cover their edges, and each picture was given its own movement (pan, tilt, or diagonal). In the beginning of this scene, the Ritz-Carlton (top) is moving right, the St. Regis (lower right) is moving down (from underneath the Ritz-Carlton), and the "Cozy Nook" (lower left) is moving diagonally left-down (underneath the other two). The edge of a picture moving straight up/down/left/right can form the frame edge of a split screen, which eliminates the opportunity for multiple diagonal movement (a limitation not at all disagreeable).



Ritz-Carlton Roof Garden



Hotel St. Regis Dining Room



"A Cozy Nook"

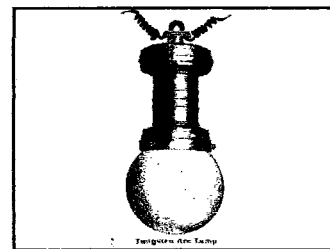
Three Original Images Used for Split-Screen Composite Image

Scene 10. The cartoon of the couple in the roadster presented an interesting opportunity to work with color transitions. Several color transformations were created in Photoshop and the animation dissolved from the original to several radical color renderings, aimed at centering on the couple. This violation of the original directs the viewer's eye and moves to a simplification of the content.

The long fade of the tungsten arc lamp at the end of the scene looks vigorously animated with flashing colors. Would that I could take credit for an arduous week of frame-by-frame creativity, but it is only an 8-bit NTSC-palette color fade. I cannot say whether it was a feature or a bug, but fades using this stock palette consistently refused to hold stable color. Each change in luminance level called up a new set of colors unrelated to those before or after. This turned a fade into a fascinating romp through a range of darkly flickering colors, reminiscent of the northern lights.



"All Roads Lead to Café Martin"



Tungsten Arc Lamp

Scene 11. The two pictures of Mark Twain were typical of many shots photographed directly off screens of microfilm newspaper readers in libraries. There are flare and glare in these displays, and the use of a polarizing filter on my still camera helped to raise the quality from mediocre to indifferent. As any user of these readers knows, the films are often heavily scratched. As long as the words remain barely legible, the quality is more than satisfactory for library patrons. I spent many Zen-like hours patiently retouching the images in Photoshop to remove spurious marks. After that,

Mark in bed underwent the Photoshop filter treatment—I dissolved his original to a version with a halo of yellow-white light, followed by a sepia dust-and-scratches-filter blur. It functions primarily as a long fadeout without lowering the luminance, as the filters degrade and remove information. Perhaps there is also a sense of changing the writing-in-bed scene to a deathbed scene, illuminated dimly at the end by an NTSC-palette fadeout.

- Scene 12. The color image of the Casino Theatre roof garden came from a printed program found at a used book shop. The cheap paper cover retained intense chroma for over 100 years. Its original image is followed by a transformation with a red color cast, which dissolves to a washed-out lighting filter.

Color here is a way to observe time flow and to emphasize the graphical, black and white content, the only thing that remains consistent. Historical purists who wish to see their original colors unsullied may not take kindly to this admittedly subversive treatment. However, the problems of video color make the medium marginal at best for their kind of faithfulness, and using coloristic devices over time helps to create movement and flow in a video built up entirely of stills.



Mark Twain Writing in Bed



Casino Theatre Program

- Scene 15. Director is an engine that obsessively throws its power into doing a few things remarkably well. (Synchronization to audio is not one of them, which is probably why audio people avoid working with the program.) Re-sizing and re-proportioning animated images is one such forte. Here I was able to combine two images of the audience at Telharmonic Hall—one a photograph, the other a pantographic line drawing of that photo. These images appeared in different publications, and naturally their aspect ratios had shifted slightly. Director handled the re-alignments with ease, so that a slow dissolve between the two was accomplished while they remained perfectly lined up.



Audience at Telharmonic Hall
PHOTO

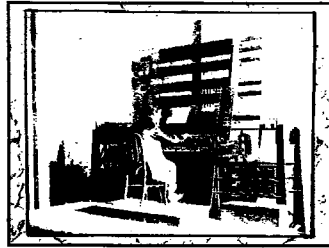


Audience at Telharmonic Hall
DRAWING

The next shot, Elliott Schenck at the keyboard, was a black-and-white picture that was rendered as a duotone. This comes from the pre-press printing side of Photoshop. A color is selected and assigned to a range of gray levels, and then the image is printed both with black ink and the colored ink. It is an inexpensive way of adding color to an image, such as a cover or label, without going to the expense of the full four-color process. The effect is subtle and muted, very pastel-like on video.

The Three Muses picture (Scene 19) is an instance of a quadtone—four colors on overlapping grayscale ranges to replace the black ink of the original.

The Schenck image appears to be a zoom out, but the actual technique is a blend of stills of decreasing size. Director is pathetic in zooming, with blocky artifacts penetratingly evident in the image.



Elliott Schenck at Keyboard



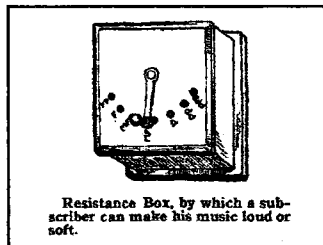
Three Muses with Lute

Scene 16. The headshot of the Rev. Henry Marsh Warren was a newspaper microfilm photo no more than an inch high, and no sharpening filter could restore it. Photoshop filters were used to provide a blurred mosaic image for the “Musical Redeemer/Lord’s Prayer” dialogue.

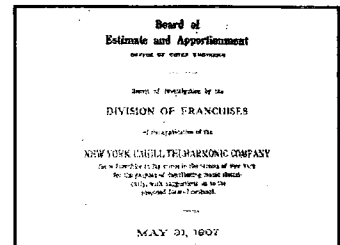
Scene 18. The pictures of the resistance box and the Board of Estimate report cover benefited from the extensive filtering features on the subtle side of Photoshop. High pass and gaussian filters provided more than a simple sharpening, giving a kind of engraved or layered quality to the image, while not obscuring the content.



Rev. Henry Marsh Warren



Resistance Box, by which a subscriber can make his music loud or soft.



Report

Scene 20. The last shot, Broadway and 25th St. at night, is a series of four duotones or tri-tones, each with a different color design, zooming out. Eleven very muted colors over time tend to cancel out and the sense of a black-and-white original is retained.

Scene 22. The 5-part split screen of the Plaza Hotel employs one pan, one tilt, and the rest stills. Proportions were laid out according to the golden rectangle (1.61803:1) to render this melange more harmonious.



Broadway and 25th St. at Night



Plaza Hotel



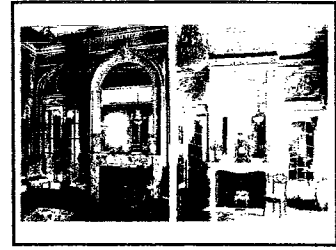
Main Corridor, Palm Room



Drawing Room and Dining Room, State Apartments



Ball and Banqueting Room



Mantels in State Apartments

Most of the footage was generated in segments of 14 seconds or less. This was the upper limit of full-sized uncompressed PICT frames that the computer could fit into RAM and output at 30 frames per second. If a portion of the footage consisted of a still frame, that segment could exceed the 14-second limit.

The advantage of working with such short segments was that custom master 8-bit color palettes were produced for each segment. (Director stops animation when it has to load a new palette, so a continuous animation employs one palette throughout.) If the material was black-and-white, a grayscale palette would render an image in as many as 256 gray levels, giving beautiful monochrome tonal qualities.

Often two or three color images were used in a segment, and each of these was first sampled into one big scrapbook image for production of an indexed master palette to display that segment. An 8-bit palette contains 256 colors, not enough to be photo-realistic for live-action video. In video animation, however, this becomes a major limitation only when one is using a stock palette, such as the NTSC or Apple palette, to display a variety of images. Custom 8-bit palettes provide adequate-to-excellent video reproduction. The payoff is that not having to run a 16-bit palette keeps the animation fast.

For post-production, the segments were transferred from computer to 3/4-inch video, and from that to D2 video for on-line editing and mastering.

Music Research and Production

Nearly all of the 31 music selections in the program are known to have been performed on the instrument. The few exceptions include rags by Scott Joplin (that ragtime was played on the Telharmonium was mentioned in news reports, but no titles were cited) and *Auld Lang Syne*. I composed and included a period-style tune, *Telharmonia*, as my own small homage to the music of the era.

I could locate no recordings of the Telharmonium, so the music was recreated without acoustic models. The only guide was the written descriptions of the sound quality, which were voluminous. Unfortunately, they indicated that a bland organ-like tone color prevailed—except for irritating attack transients. The instrument lacked a wide palette of sounds and the keyboard action was slow. I opted not to impose a half-hour of such music on my audience. The music on this video, unfortunately, must therefore not be considered authentic in sound—except, perhaps, for Handel's "Largo," the second piece on the soundtrack.

I developed sound patches on a Yamaha DX7-II, which permitted the use of just intonation where appropriate. Some simple additive-synthesis sounds and tack-hammer attacks were created, along with basic organ-stop sounds. Keyboardist Barbara Blegen recorded performances on this synthesizer as MIDI files. It later became evident that shorter versions of the selections were needed and other refinements had to be made, particularly in tuning of the patches, too-clicky attacks, and tempi. The files were edited and the music was generated again, this time on a Yamaha TX802 Tone Generator, and transferred to DAT.

Sound Software

The audio processing was accomplished primarily with SoundHack 0.803, 0.861, 0.865, 0.873, and 0.880, and HyperprismPPC 1.1 and 1.2.1. Occasionally Reverb 5.3 was also used. Editing was achieved using Sound Designer 2.8 on a Macintosh IIfx, and Peak 1.02, 1.10, and 1.52 on a PowerMac 8500/120.

Automation sessions in Deck 1.04 and 2.03 were used to mix the piece. Sound Designer was used for some premixes and simple mixes.

Time Bandit 1.00 and 1.5 were used to tune and transpose files. Sometimes Sound Designer or SoundHack was used for this and yielded a sound quality more faithful to the original.

Some compression and level control was accomplished with a plug-in, Chip Burwell's Power Transformer.

Sound Effects Production

Sound effects were taken from commercial libraries; many sounds of antique machinery and automobiles came from the sound collection of Marilyn Reese. The sounds included cork popping, liquid pouring, glasses clinking, old typewriter, thin trumpet, generator static, high-voltage arcing, tone generator sweep, women's conversation ("tea party"), giggling, Times Square ambience, factory roar, rock grinding, transformer hum, push buttons, switches, hum tube, arc welding, blacksmith shop, electric grinding wheel, heavy electric motor, slab grinding machine, antique telephone ringing, hollow electric hum, teenage girl's laughter, man's laughter, crowd noise, tuning old radio, Morse code, steamship horn blast, ship bell, electric static, radio static/whines/crackles, angry crowd, horses and carts, streetcars with bells, Model A/Model T/other autos, antique traffic jam (klaxons, horns, whistles), antique tractor engine, trolley cars, electraloaf, sparks, and hammering. Considerable layering and audio processing were employed to build up the effects tracks.

Often it was necessary to tune sound effects together or to the music.

Designing and Processing Dialogue

An interesting aspect of the production was to work with the quality and texture of the dialogue—people's comments about the sound quality of the Telharmonium, as reported verbatim in newspaper and magazine accounts. My goal was to keep their speech understandable, but to create an expressive degradation of these phrases. This would replace representational dialogue with a re-representation, an obvious deception. The sound is thereby given a unique spatial identity, and it rings with a certain sense of decay, of historical context.

The general reader's forbearance is implored, as references to SoundHack functions and settings are given, for the benefit of colleagues who use that software and may wish to try similar production. These citations will leave the uninitiated feeling clueless but may be safely glossed over.

Scene 5. *"All the notes were inaugurated with little explosive puffs."* [Roseanne Limoncelli, Florence Barrau] A spectral mutation of two different female voices. It begins with one voice, crosses to the other, and returns to the first at the end. Like many first attempts at mutation in SoundHack, it sounds more like a crossfade than a morph, with slight glissando artifacts throughout.

Scene 8. *"Like a church organ,..."* [Reynold Weidenaar, Elliott Crown]. A mix of two spectral mutation hacks. The first bore nothing but very nice bouncy sine-like resonances (settings: Linear Contour Modulation, $\Omega=$ /, Absolute Interval, Source Absolute Value = .8, Target Absolute Value = .2, Band Persist = .9). The second bred similar strong, sine-like resonances plus a very clear arrival at a mutant spectrum

(prior settings changed: Linear Contour Modulation/Uniform Unsigned, Source Absolute Value = .1, Target Absolute Value = .4, Band Persist = .6).

"...much softer and sweeter." [Reynold Weidenaar, Elliott Crown] A mutation emphasizing the two voices in turn, to vague effect because the voices are not completely in sync.

- Scene 9. *"Absolutely perfect and beautiful music by the best musicians upon the only perfect musical instrument."* [Dennis Heaphy] A convolution with an impulse soundfile of restaurant ambience. The high, glassy sounds come from the clatter of silverware and dishes.
- Scene 12. *"Sweet and rounded music."* [Dennis Heaphy, Elliott Crown] A mix of four hacks, including a moving convolution that provided elegant resonance but no intelligibility, another convolution that inexplicably ran only the first word—twice, and a spectral mutation from the first to the second.
- Scene 13. *"Clear, sweet, perfect tones."* [Roseanne Limoncelli] A phase vocoder for transposition and a jagged pitch function. It was mixed with the original file and reverb added.
- Scene 15. *"A blend of woodwind and brass, with a peculiar twang of its own."* [Dennis Heaphy] Convolution with a non-moving impulse file of soda bubbles gave an excellent series of multiple echoes. This was mixed with the original soundfile.
- Scene 16. *"When the Musical Redeemer comes, he will be able, by means of the Telharmonic system, to draw unimagined harmonies from the caves of sound."* [Roseanne Limoncelli] I intercut this line with the Lord's Prayer, antiphonal style, to conclude a scene on the Lenten gospel service. A convolution of the soundfile with impulse files of Lord's Prayer segments yielded unintelligible results for the main file; some clarity of impulse file was preserved. A reversal of the files, where the Lord's Prayer was the main file and the Musical Redeemer was the impulse file (moving through the file with a very short window, .02 sec.), yielded attractive results. It had a piously spooky quality with some high-frequency grainy splice-type noise from the short moving window. This was mixed with a 40% proportion of the original soundfile to restore intelligibility.
- "Our Father, Who art in heaven,..."* [The Lord's Prayer] A self-convolution with a 100ms delay yielded a pumpy, peaky version of the soundfile.
- Scene 18. *"As sensitive to moods and emotions as a living thing."* [Elliott Crown] Convolutions with impulse files of a soda pour and a water spring. Keeping to short (.15, .75 sec.) moving windows retained intelligibility and gave comely sound sweeps from the impulse files. The two convolved files were delayed and mixed with the original.
- Scene 19. "Angry Crowd" sound effect. This was self-convolved, which resulted in more interesting dynamic variations than the original while still being recognizable.
- Scene 20. *"Absolute faithfulness."* [Dennis Heaphy] Convolution with an impulse file of a steam blast gave a considerable sense of sweep with a slightly grainy flutter.
- "The notes are/were clear and vibrant."* [Dennis Heaphy, Lisa Brenner] A spectral extraction of stable components from Dennis and a mutation on Lisa; these were mixed with Dennis's original.
- Kiss Me Good-bye and Go, Jack.* [Music] Instead of using heavy echo on the stinger at the end, for exaggerated length and spaciousness, a convolution worked better. The file was self-convolved with a 400ms delay, giving a solid bass and a more ethereal quality.

Scene 24. *"There are still many improvements to be made in the tone and carrying power of the Telharmonium."* [Dennis Heaphy, Elliott Crown] Dennis was the lead track and Elliott was edited to synchronize at seven word-beginnings. A spectral mutation gave mostly intelligible results, with no low bass and a very strained quality. The file was quite voice-like, with none of the tone-like resonances that occur easily (settings: Linear Contour Modulation/Irregular Unsigned, $\Omega=.5$, Relative Interval, Delta Emphasis = $-.5$, Band Persist = $.7$). The file was mixed with Dennis's original, and this mix was compressed with Power Transformer.

"The absence of brilliancy, mordancy, incisiveness, makes the Telharmonium but a sorry substitute for an orchestra—even a small one." [Elliott Crown] A convolution with an impulse file of a water spring, a short (.05) moving window. A rectangle window emitted clicks, so a Hamming window was employed, at the sacrifice of some impulse sound.

"Rather crude and the operation not as rapid as an organ." [Dennis Heaphy and Roseanne Limoncelli] I edited the two readings to synchronize at six points. A spectral mutation began with Roseanne, moved to Dennis, and back to Roseanne. It did not happen as planned—the two voices are quite equal at the end (settings: Linear Contour Modulation/Irregular Unsigned, $\Omega= \square$, Relative Interval, Delta Emphasis = $-.9$, Band Persist = $.5$):

Scene 25. *"As a matter of fact, only the usual organ tones are perceptible to the musically informed."* [Roseanne Limoncelli]. A spectral dynamics hack, with a vowel used as the threshold to prevent vowel material from being extracted, giving snippy, chirpy consonants. Soft sections were boosted with Power Transformer. An echo sweep was added in Hyperprism. The original file was mixed at low level with the processed files.

Scene 27. *"It was like invisible hands at the close of summer day striking from unseen harp strings unspeakable music, to comfort, to solace, and to cheer."* [Elliott Crown] I applied a varispeed function (+14, -12 semitones), and the resulting file was convolved with a short impulse file of Roseanne's vowel "a". The result was totally unintelligible resonance that made a worthy background sound. There was no sense of Elliott's voice. It was a flow of Roseanne's formants. The varispeed was also not evident. It sounded like several of Roseanne's voices in a fast hocketing texture. I also ran another convolution with an impulse file of an "expectant crowd". This gave a noisy edge to the sound while still preserving some intelligibility. Mixing these with the original yielded the final file.

"Subtle and entrancing beyond any harmony yet heard." [Lisa Brenner, Roseanne Limoncelli] A discreet spectral mutation was performed on the two files, resulting in some slight resonances and rapid volume changes. Another hack was run with the Band Persist reduced to decrease stability, and with a negative Delta Emphasis value replaced by a small positive value to make the mutation less "damped." These new settings yielded a file with agreeable ringy buzzes that did not obscure the words (settings: Linear Contour Modulation/Uniform Unsigned, $\Omega= \square$, Relative Interval, Delta Emphasis = $.02$, Band Persist = $.4$).

"Absolutely perfect music." [Julia Pennington] I ran a gate-duck spectral dynamics hack, with a noise file used as the threshold. This was followed by a spectral extraction of stable components above 3 Hz. The former file was intelligible, and the latter added some piquant harmonics.