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Citation: Einbond, A. (2013). Subtractive Synthesis: noise and digital (un)creativity. In: Cassidy, A. & Einbond, A. (Eds.), Noise in and as music. (pp. 57-75). Huddersfield, UK: University of Huddersfield Press. ISBN 9781862181182

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NOISE
IN AND AS
MUSIC

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Published by University of Huddersfield Press

University of Huddersfield Press
The University of Huddersfield
Queensgate
Huddersfield HD1 3DH
Email enquiries university.press@hud.ac.uk

First published 2013
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A CIP catalogue record for this book is available from the British Library.
ISBN 978-1-86218-118-2

Designed and printed by
Jeremy Mills Publishing Limited
113 Lidget Street
Lindley
Huddersfield HD3 3JR
www.jeremymillspublishing.co.uk

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Subtractive Synthesis: noise and digital (un)creativity

Aaron Einbond

Invention, it must be humbly admitted, does not consist in creating out of void, but out of chaos.

—Mary Shelley¹

Source/Filter

Subtractive synthesis is a technique of analog and digital electronic sound production that “consists of submitting a spectrally rich wave to a specific type of filtering, thus arriving at the desired tone by eliminating unwanted elements rather than by assembling wanted ones.”² One common source wave is electronically generated white or pink noise. Early uses included Karlheinz Stockhausen’s *Gesang der Jünglinge*, Joji Yuasa’s *Projection Esemplastic for White Noise*, and the commercial synthesis of drum sounds.³ These uses may not normally be termed “noise music,” but this noise lies beneath the surface of the history of electroacoustic musics.

This source/filter model is not unique to electronics: it is also a model for acoustic sound production, including the human vocal tract and source/filter coupling in wind instruments.⁴ In the example of vocal vowels, the source

1 Mary Shelley, introduction to *Frankenstein*, quoted in Jonathan Lethem, “The Ecstasy of Influence: A Plagiarism,” in *The Ecstasy of Influence: Nonfictions, Etc.* (New York: Vintage Books, 2011), 98.

2 Jean-Claude Risset and David L. Wessel, “Exploration of Timbre by Analysis and Synthesis,” in *The Psychology of Music Second Edition*, ed. Diana Deutsch (San Diego and London: Academic Press, 1999), 128.

3 Jason Anderson, “Slaves to the rhythm: Kanye West is the latest to pay tribute to a classic drum machine,” *CBC News*, November 28, 2008, accessed May 6, 2013, <http://www.cbc.ca/news/arts/music/story/2008/11/27/f-history-of-the-808.html>.

4 Wayne Slawson, *Sound Color* (Berkeley: University of California Press, 1985), 22–28.

is a pitch produced by the vocal chords and filtered by the cavity formed by the throat and mouth, or the noise arising from turbulence to produce a consonant and filtered by the vocal cavity or nasal passage.⁵

I describe a source/filter model as a metaphor for musical creativity where, analogous to white noise, the source is an acoustic totality. Touching upon the history of 20th-century recorded media and digital information, as well as 21st-century music information retrieval, I hope to trace a narrative of subtractive synthesis as artistic process, complemented by musical examples pointing in possible future directions.

Remix

Since subtractive synthesis emerged in the last century, electronic culture has given increasing emphasis to subtraction as a creative act. Some of the most over-used terms in recent media vocabulary suggest this shift, such as “curator,” “DJ,” “remix,” and “mash-up.” Consumption replaces creation among a recent generation of “prosumers.”⁶ Beyond curated clothing or bookstores, the artistic curator has also grown increasingly visible,⁷ as in Carolyn Christov-Barkargiev’s curator-driven dOCUMENTA(13).⁸ The term “disc jockey,” from its first printed appearance in 1941,⁹ moved from radio announcers, through hip-hop, then rave, to a broad designation of large numbers of current electronic musicians. Each change has increased the term’s creative cachet.

5 Slawson, *Sound Color*, 26. See also Aaron Cassidy’s chapter “Noise and the Voice” in this volume.

6 Dayna Tortorici, “You Know it When You See It,” in *What Was the Hipster?*, ed. Mark Greif, Kathleen Ross, and Dayna Tortorici (New York: n+1 Foundation, 2010), 123.

7 Tom Morton, “A brief history of the word ‘curator,’” *Phaidon*, September 9, 2011, <http://de.phaidon.com/agenda/art/articles/2011/september/09/a-brief-history-of-the-word-curator/>.

8 dOCUMENTA(13) exhibition website, accessed May 6, 2013, <http://d13.documenta.de/>.

9 Marc Fisher, *Something in the Air: Radio, Rock, and the Revolution that Shaped a Generation* (New York: Random House, 2007), 13.

A predecessor to the DJ was the record collector who, as Jacques Attali demonstrates, can stockpile sound beyond any proportion to listening “use-time.”¹⁰ The computer and internet have transformed the DJ and collector further, as software and hardware from iTunes to iPod to Spotify have increased their reach by many orders of magnitude. Yet when creator becomes consumer, so too can listener become “composer,” as Attali predicts we will “create our own relation with the world.”¹¹ This is Jacques Rancière’s emancipated spectator:

being at once a performer deploying her skills and a spectator observing what these skills might produce in a new context among other spectators. ... It requires spectators who play the role of active interpreters, who develop their own translation in order to appropriate the ‘story’ and make it their own story.¹²

Saturation

While the term remix originated from popular music, the visual arts and writing have also embraced it. Christian Marclay draws on 100 years of cinema history in his 24-hour-long *The Clock*.¹³ Ai Weiwei combines 1-minute videos taken from 88 highway bridges in *Beijing: The Second Ring & The Third Ring*.¹⁴ Kenneth Goldsmith draws moving portraits entirely from

10 Jacques Attali, *Noise: The Political Economy of Music*, trans. Brian Massumi (Minneapolis: University of Minnesota Press, 1985), 101.

11 Attali, *Noise*, 134.

12 Jacques Rancière, *The Emancipated Spectator*, trans. Gregory Elliott (London: Verso, 2009), 22.

13 Christian Marclay, White Cube Gallery website, accessed May 14, 2013, http://whitecube.com/artists/christian_marclay/.

14 Adrian Blackwell, “Ai Weiwei: Fragments, Voids, Sections, Rings,” *Architect*, December 5, 2006, accessed July 30, 2013, <http://architect.com/features/article/47035/ai-weiwei-fragments-voids-sections-and-rings>.

transcribed radio archives in *Seven American Deaths and Disasters*.¹⁵ Jonathan Lethem casts a “copy-left” argument almost entirely using quotations from other writers in “The Ecstasy of Influence: A Plagiarism.”¹⁶ Or Ai Weiwei inverts industrial re-production by commissioning 100 million hand-made porcelain copies of sunflower seeds.

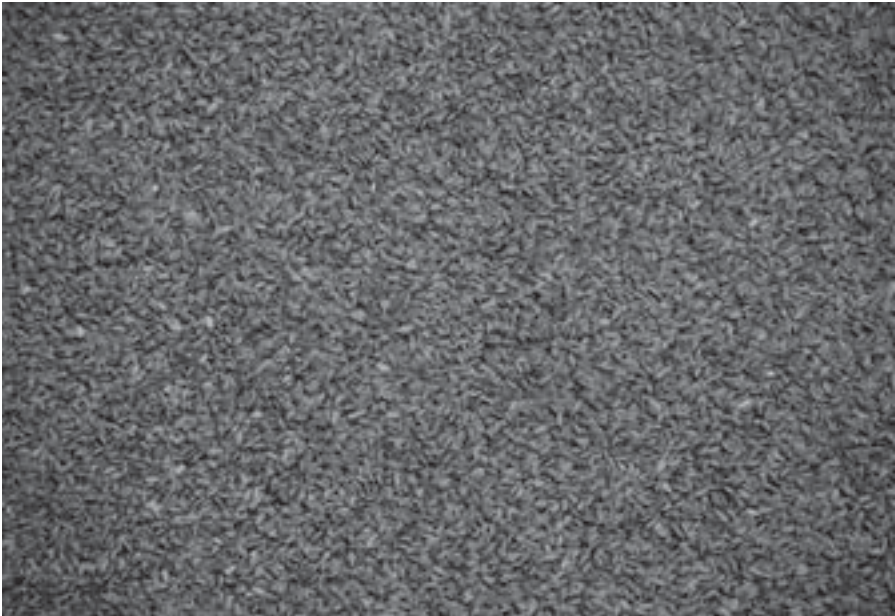


Figure 1: Ai WeiWei, *Sunflower Seeds*, Tate Modern, 2010 (photo by Mike Peel)¹⁷

These works have in common not only their borrowings but also their presentation of an archive-like totality, inviting the audience to make their

15 Kenneth Goldsmith, *Seven American Deaths and Disasters* (Brooklyn: powerHouse Books, 2013).

16 Lethem, “The Ecstasy of Influence,” 93–120.

17 “Ai Weiwei’s Sunflower Seeds, Tate Modern” Wikimedia Commons, accessed May 8, 2013, http://commons.wikimedia.org/wiki/File:Ai_Weiwei%27s_Sunflower_Seeds,_Tate_Modern_1.jpg.

own selections. Attali writes in *Noise*, “the absence of meaning ... is nonsense; but it is also the possibility of any and all meanings,”¹⁸ reminiscent of the random writing machines Jonathan Swift depicts in *Gulliver’s Travels*, or Jorge Luis Borges’s “The Library of Babel.” This idea of noise as total possibility is also cited by recent sonic artists: JLIAT enumerates the total number of possible audio CDs, and Johannes Kreidler says “every piano tone can be understood as a fragment of piano music,” as filtered from the historical record.¹⁹ But the idea also goes far back into pre-digital music.

Cage quotes Debussy, “I take all the tones there are, leave out the ones I don’t want, and use all the others,” and Peter Ablinger relates this to diverse strains of noise in the 20th century.²⁰ When Cage filters with a radio frequency dial in *Imaginary Landscape No. 4*, or a phonograph cartridge in *Cartridge Music*, the source is the media noise radiating around us, and the composer/performer is an early DJ.²¹

Stockhausen’s *Mikrophonie I* is another kind of live subtractive synthesis, with the tam-tam as a noise source filtered, amplified, and focused through attentive listening by composer, performer, and audience. Stockhausen phrases his attitude more generally:

Use all the components of any given number of elements, don’t leave out individual elements, use them all with equal importance and try to find an equidistant scale so that certain steps are no larger than others. It’s a spiritual and democratic attitude toward the world.²²

18 Attali, *Noise*, 122.

19 See James Whitehead’s chapter “Un-sounding Music” in this volume and Johannes Kreidler, “Music with Music,” lecture at the Darmstadter Internationale Ferienkurse, 2010, accessed July 4, 2013, <http://www.youtube.com/watch?v=BsFtHsxvoWs>.

20 See Peter Ablinger’s chapter “Black Square and Bottle Rack” in this volume. Fittingly, Ablinger uses filtered white noise in his own work, for example *Weiss/weißlich 27 “komplementäres Rauschen”* and *IEAOV*.

21 Paul Hegarty, *Noise/Music: A History* (New York: Continuum, 2007), 26.

22 Jonathan Cott, *Stockhausen: Conversations with the Composer* (New York: Simon and Schuster, 1973), 101.

Other serial or algorithmic techniques, like those used by Brian Ferneyhough, generate a saturation of available materials. The composer is engaged constantly as a listener evaluating, discarding, or incorporating the results, like a photographer examining images in a contact sheet to select the final print. Or in the “saturation” music of composers like Franck Bedrossian, the listener is engaged as a creator, making his or her own selection from the tangled surface.



Figure 2: Toni Frissell, contact sheet, “Fashion model posing near Tidal Basin with Washington Monument in background,” 1946²³

Heard in this way, the expansion of Morton Feldman’s late work, or the work of many sound installation artists, asks the listener to trace a path in time and space, filtered through his or her body and attention to shape the

23 Toni Frissell (public domain), image from Wikimedia Commons, accessed May 6, 2013, http://commons.wikimedia.org/wiki/File:Toni_Frissell,_fashion_model_near_tidal_basin,_Washington,_D.C.,_ca._1946.jpg.

experience. Like an abstract-expressionist canvas viewed close-up (Rothko specifies a distance of eighteen inches²⁴), the viewer's field of vision becomes a filter from which the expanse of the canvas is subtracted.

Richard Barrett's phrase "radically idiomatic," adapted from Derek Bailey's "non-idiomatic" improvisation,²⁵ could be used to describe many musicians working with noise-rich playing techniques. Like Helmut Lachenmann's *musique concrète instrumentale*, which references Pierre Schaeffer's phenomenological taxonomy, they work with the totality of sound production methods available through the performer's body and instrument, both idiomatic and not. Again composition, performance, and listening are blurred,²⁶ as playing techniques must be "performed"—through self-experimentation or collaboration—before they are "composed." Selection is here an empirical process, like Schaeffer's "new conditions of observation."²⁷

Searchability

This empiricism, however, is experiencing a radical change in the early 21st century as saturation gives way to searchability. In *Uncreative Writing*, Kenneth Goldsmith illustrates how the collage, archive, and cut-up of the 20th century were fundamentally transformed by digital text.²⁸ Copying is native to the computer, where it is a nearly instantaneous activity as

24 Marjorie B. Cohn, *Mark Rothko's Harvard Murals* (Cambridge: Harvard University Art Museums Center for Conservation and Technical Studies, 1988), 15.

25 Richard Barrett interviewed by Daryl Buckley, 2003, accessed May 6, 2013, <http://richardbarrettmusic.com/DARKMATTERinterview.html>.

26 Or described more generally by the term "musicking" in Christopher Small, *Musicking: The Meanings of Performance and Listening* (Middleton: Wesleyan University Press, 1998).

27 Pierre Schaeffer, "Acousmatics" in *Audio Culture*, ed. Christoph Cox and Daniel Warner (New York: Continuum, 2004), 76–81.

28 Kenneth Goldsmith, *Uncreative Writing* (New York: Columbia University Press, 2011).

documents are automatically cached, downloaded, or cc'd.²⁹ Text searching has existed as long as digital text itself, or longer, and is one of the primary modes of digital reading.³⁰

According to Goldsmith, “with the rise of the Web, writing has met its photography.”³¹ Perhaps writing at the turn of the last century even borrowed the metaphor of the copy from sound and image media, which had been transformed by recording and photography, respectively. Industrial technology not only enabled the widespread distribution of audio recording but also electrical amplification and broadcast of sound of unprecedented amplitude and reach, as Luigi Russolo celebrates in *The Art of Noise*, now in its centennial year.

Debussy, who himself acknowledged that “the century of airplanes has a right to its own music,”³² asks Russolo: “can it ever really compete with that wonderful sound of a steel mill in full swing.”³³ Russolo, however, stresses that “*the art of noises must not be limited to a mere imitative reproduction.*”³⁴ Further:

The variety of noises is infinite. We certainly possess nowadays over a thousand different machines, among whose thousand different noises we can distinguish. With the endless multiplication of machinery, *one day*

29 Kenneth Goldsmith, *On Uncreative Writing*, lecture at Transmediale BWPWAP, Berlin, February 2, 2013, <http://www.transmediale.de/content/kenneth-goldsmith>.

30 James Gleick, *The information: a history, a theory, a flood* (New York: Random House, 2011).

31 Goldsmith, *On Uncreative Writing*.

32 Howard Decker McKinney and William Robert Anderson, *Music in History: The Evolution of an Art* (New York: American Book Co., 1957), 640.

33 Claude Debussy, *Writings on Music* (London: Secker & Warburg, 1977), cited in Hegarty, *Noise/Music*, 14.

34 Luigi Russolo, *The Art of Noise (futurist manifesto, 1913)*, trans. Robert Filliou (New York: Something Else Press, 1967), reprinted by ubuclassics, accessed May 4, 2013, <http://www.ubu.com/historical/russolo/index.html>, 9 (original emphasis).

*we will be able to distinguish among ten, twenty or thirty thousand different noises. We will not have to imitate these noises but rather to combine them according to our artistic fantasy.*³⁵

For Russolo, imitation of noises is only an initial step. What is lacking is the ability to “distinguish” among them: to measure, organize, retrieve. In 1913 the tools for audio searchability were still awaited.

Unlike writing, the transition of sound from analog to digital was not accompanied by a similar revolution in searchability. Archives of digital audio may include many more recordings in much less physical space, but the means of retrieval at first did not fundamentally change. Audio can be searched through textual metadata, an especially powerful tool when it is used in conjunction with the internet. But this is an adaptation from the media of reading and writing, much like the textual copy was imported from the medium of audio recording a century before. Only more recently has technology emerged for searching sound itself, and it could yet transform how we imagine listening and composing.

Concatenation

Since the late 1990s, the growing field of Music Information Retrieval (MIR) has explored the uses of audio feature extraction to summarize information about digital sound.³⁶ An audio feature, or descriptor, is any characteristic attributed to audio, such as pitch, loudness, brilliance, or higher-level metadata. MIR is changing the way music is categorized, marketed, and recommended through companies like Pandora and The Echo Nest. It also has applications for creation.

35 Russolo, *The Art of Noise*, 12 (original emphasis).

36 Michael Fingerhut, “Music Information Retrieval, or how to search for (and maybe find) music and do away with incipits,” *LAML-LASA Congress*, Oslo, 2004, accessed May 6, 2013, <http://articles.ircam.fr/textes/Fingerhut04b/>. See also Nick Collins’s chapter “Noise Music Information Retrieval” in this volume.

Emerging from research in speech synthesis, concatenative synthesis uses audio descriptors to analyze short samples of recorded sound and concatenate them into a synthesized output.³⁷ An increasing number of tools are available for various computer platforms, including CataRT, Soundspotter, MeapSoft, TimbreID, SCMIR, and AudioGuide. CataRT, developed by Diemo Schwarz, implements corpus-based concatenative synthesis (CBCS), where a database containing a large number of samples, the “corpus,” is the source. The novelty of CBCS is that it works through concatenation of audio already recorded in its full detail. Like the subtractive synthesis or granular synthesis of a generation before, a desired result is subtracted or selected from a spectrally rich source. But with searchability now made possible through the comparison of audio descriptors, the selection process itself presents new means of organization. And like subtractive and granular synthesis, CBCS is especially effective at dealing with noisy sources, both of acoustic and electronic origins.

Figure 3 (see Appendix, p.229), a screenshot from CataRT, shows a corpus of vocal samples representing 42 minutes of soprano Amanda DeBoer Bartlett singing through vocal “preparations” including police whistle, kazoo, coffee mug, cardboard tube, and spring drum. The recordings are segmented into short “units” and plotted in two dimensions according to descriptor values averaged over each unit: spectral centroid (the perceptual correlate of which is brightness) along the horizontal axis and spectral flatness (a measure of “tonality,” here understood as the opposite of noisiness) on the vertical axis. Each vocal preparation is indicated by color and label printed at the center of the corresponding group of units. It can easily be seen how the preparations filter the vocal noises in different ways, adding an extra layer to the source/filter model of acoustic voice production. For example, the samples performed through spring drum or teapot are positioned at the upper left,

37 Diemo Schwarz, “Corpus-based concatenative synthesis,” *IEEE Signal Processing Magazine* 24, no.2 (March 2007): 92–104.

indicating a relatively low brightness and high tonality. The police whistle, ceramic whistle, and kazoo fall further toward the lower right, indicating higher brightness and lower tonality (or higher noisiness). The unprepared voice, labeled “amanda,” lies near the center of the distribution.

The model of a space of sounds identified with audio features as a metric preceded the technology of digital descriptors. Pitch and harmonic lattices, or *Tonnetze*, were used as models during the 18th and 19th centuries.³⁸ More recently perceptual models of timbre have been proposed by John Grey³⁹ and David Wessel⁴⁰ based on the listening judgments of experimental subjects. These “timbre spaces” were an inspiration for the development of concatenative synthesis tools and are also a compelling model for their application.

Subtractive Composition

I used the corpus of samples shown in Figure 3 (see Appendix, p.229) to compose both the vocal and electronic parts of *Without Words* for soprano, eleven instruments, and live electronics.⁴¹ The vocal part was transcribed from the electroacoustic samples, producing notated material to be re-interpreted by the performer.⁴² Taking the empirical approach to an extreme, all of the sounds that were used in the score are already represented in the corpus, and composition is a process of subtraction from this totality. However, unlike

38 Fred Lerdahl, *Tonal Pitch Space* (Oxford: Oxford University Press, 2001), 42.

39 John M. Grey, “Multidimensional perceptual scaling of musical timbres,” *Journal of the Acoustical Society of America* 61 (1977): 1270–77.

40 David Wessel, “Timbre space as a musical control structure,” *Computer Music Journal* 3, no.2 (1979): 45–52.

41 Written for Ensemble Dal Niente and DeBoer Bartlett in 2012.

42 Aaron Einbond, Diemo Schwarz, and Jean Bresson, “Corpus-based transcription as an approach to the compositional control of timbre,” *Proceedings of the International Computer Music Conference*, Montréal (2009): 223–26.

some historical sources used by artists discussed above, here the corpus is also a product of the composer and performer that is subject to their preferences, biases, and abilities. Building the corpus, and then subtracting from it, are both layers of the creative process that contribute to the result.

This is not only “radically idiomatic,” but also radically personalized, as with composers like Barrett who work with single performers over long periods of collaboration. The samples record DeBoer Bartlett at a specific time and place, and future re-interpretations recall this setting as the live, amplified soprano blends with electronic re-syntheses of her samples. If the work is performed by a different soprano, it becomes a “cover,” a change in timbral profile much like the change in sonic identity implied by a pop music cover. This personalization also provides an advantage for performance practice: having recorded all the samples herself, it is easier for the performer to recall how to produce them again. For guidance, in addition to the performance notes in the score, the performer is provided with recorded examples of her own samples as a mnemonic for re-interpretation.

In *Without Words*, subtraction is applied not only to instrumental and vocal sound but also to a database of textual fragments from other collage-inspired writers including Marianne Moore, Douglas Huebler, Walter Benjamin, Ai Weiwei, and Kenneth Goldsmith. DeBoer Bartlett took the texts as a resource for speaking, whispering, singing, and improvising, both unimpeded and through the vocal preparations listed above. When taken as a corpus for concatenative synthesis, the resulting micro-montage bears an unpredictable relationship to the original texts.

While the origins of most of the phonemes are at first unrecognizable, further repetitions and developments open windows on specific syllables, words, and eventually full lines. For example, in Figure 4, “more in” turns out to be taken from Douglas Huebler’s conceptual art mantra: “the world is full of objects more or less interesting: I do not wish to add any more.”⁴³

43 Douglas Huebler, “Untitled Statements (September and December 1968),” in Germano Celant, *Arte Povera* (New York: Praeger, 1969), 43.



Figure 4: excerpt from *Without Words*, soprano part, mm. 65–69

The other intelligible words, “okay yeah,” were ad-libbed by DeBoer Bartlett during the recording session—a trace of the process of collaboration between composer and performer. This “noise” of the sampling procedure, usually edited out, is instead combined in the database on an equal footing with the more literary texts, calling to mind the information theory concept of noise as unwanted signal.

Another source is encoded in the excerpt beyond the texts and vocal samples themselves: the vocal line is an audio mosaic of a field recording. Another metaphor of subtraction—echoing Cage, Ablinger, or R. Murray Schafer and other artists associated with the acoustic ecology movement—the field recording captures noises filtered by the ears and microphones and framed by the start and stop of the recorder. In one of the emerging applications of MIR, an audio mosaic takes a target recording and matches it with a montage of shorter segments from a different audio source. In this case, the spectral descriptors of the vocal samples were matched to the same descriptors of the field recording to assemble a mosaic with the maximum timbral fusion of the two sources. This allows the amplified soprano to fade in seamlessly over the field recording as the work opens. As with the photographer’s contact sheet, the choice of recording, corpus, and the specific descriptor weights for the mapping all become compositional decisions.

A field recording of frogs was chosen here, referencing one of the texts in the soprano’s database by Marianne Moore: “imaginary gardens with real

toads in them.”⁴⁴ The mapping explains the high brightness values called for in the soprano’s whispered speech (indicated by rectangular noteheads), the preparation with police whistle (indicated on the upper staff), and the breathy high Ds (indicated by diamond noteheads), which are a prominent frequency of the frogs’ song. The audio mosaicking process is reenacted in performance, as the amplified soprano is accompanied again by her own samples matched according to spectral descriptors in real-time.⁴⁵

Each of the sources activates a different time and place in the work’s genesis: the lines written and revised by Moore and Huebler, the “performance” of the frogs captured by the field recording, the soprano’s improvised performance during the sampling session, and the live performance in which the soprano reinterprets the transcribed score. Like the memory-infused landscapes in W.G. Sebald’s *Die Ringe des Saturn*, multiple temporalities are collapsed as these layers are simultaneously transmitted to the listener.

Arcade/Archive

While historical resonances have long been sourced for creative filtration, whether explicitly musical or not, they also present new possibilities for concatenative synthesis. In *Passagework* for two pianists, two percussionists, and live electronics, written for Yarn/Wire in 2009, the noise of decay is foregrounded with the covered arcades of Paris as a source. Following Walter Benjamin’s *Das Passagen-Werk*, field recordings of five arcades in contrasting locations respond to the architecture, time of day, and changing cast of fellow

44 Marianne Moore, “Poetry,” *Complete Poems* (New York: Penguin Books, 1981), 267. In another layer of transcription, Moore removed this line from the 1924 version in her 1967 *Complete Poems*, in which she notes “omissions are not accidents.” See Robert Pinsky, “Marianne Moore’s ‘Poetry,’” *Slate*, June 30, 2009, accessed May 16, 2013, http://www.slate.com/articles/arts/poem/2009/06/marianne_moores_poetry.html.

45 Aaron Einbond, Christopher Trapani, and Diemo Schwarz, “Precise Pitch Control in Real-Time Corpus-Based Concatenative Synthesis,” *Proceedings of the International Computer Music Conference*, Ljubljana (2012): 584–88.

“improvisers” as well as over a century of time that has left some arcades filled with fashionable shops while others are repurposed or nearly abandoned. Benjamin’s *Arcades Project* remains unfinished, as if the strain of pre-digital recopying and rearranging was too much to handle in a work that can be read as a prototype of the hyperlink.



Figure 5: Galerie Vivienne, photographed in 1905 (public domain)

Transcriptions for Yarn/Wire, composed through a process of sampling and mosaicking similar to *Without Words*, reveal these changing urban environments as the musicians' own samples define the spaces inside two pianos. The percussionists, using only mallets and small instruments placed inside the pianos, activate these spaces while the field recordings are played through speakers positioned under the soundboards. For example, in Figure 6, one percussionist uses a bird call to mimic distant birds in a neighboring park, while the other uses homemade foam mallets and fingertips to excite resonances corresponding to an automobile engine outside the arcade's exit.

The analogy between the architectural space of the arcades and the acoustic space of the instruments suggests the work as a performed installation, a sonic sculpture that draws the listener into the delicate soundscape. He or she may strain to identify the sources of the performers' nearly invisible, amplified gestures, as well as the field recordings filtered acoustically by the resonance of the pianos above the hidden loudspeakers, another version of live subtractive synthesis. This threshold between Schaefferian "reduced listening" and causality reveals the antecedents of the work in Parisian *musique concrète* and Berliner *Hörspiel*. Or alternatively the pianos are an archive out of which these historical references, along with the storied instrumental sounds, are drawn by the performers, like the antique wooden card catalogue in Janet Cardiff's and George Bures Miller's *Cabinet of Curiousness*.⁴⁶

Noise Movement

The internet offers a yet noisier source of information for purposive filtration. In *Resistance* for prepared bass clarinet and live electronics, written for Heather Roche, recordings are taken from YouTube of the "Occupy Wall Street" and "Arab Spring" protests of 2011. While referencing possible political meanings

46 Janet Cardiff and George Bures Miller, *Cabinet of Curiousness*, 2010, artists' website accessed May 14, 2013, http://www.cardiffmiller.com/artworks/inst/cabinet_of_curiousness.html.

The image shows a musical score for four systems of staves. The first system includes a rehearsal mark 'I' and a text box: 'Blockoff: Use sounds following the indicated notes. Lighter parts represent following indicated notes.' The score features various musical notations including notes, rests, and dynamic markings such as 'ppp' and 'pp'. Performance instructions like 'overblowing' and 'screaming' are indicated by encircled noteheads and diagonal lines. The score is written in a complex, multi-measure format with frequent rests and dynamic shifts.

Figure 6: excerpt from *Passagework*, mm. 199–207, corresponding to field recording of Galerie Vivienne

of noise, as developed by Attali and others, these samples also present unique sonic qualities. The low-fi, compressed, and over-saturated samples become advantageous materials for transcription and cross-synthesis with amplified bass clarinet. The bass clarinetist's sound is also modulated with overblowing and screaming (indicated by encircled noteheads and diagonal lines in the example in Figure 7), distorting it into a noise-rich source. This is combined with protest samples played from a low-quality miniature loudspeaker placed in the bell of the instrument, another literal application of source/filter subtraction through the colored speaker response and instrumental cavity. Preparations with paper, plastic, and aluminum foil over speaker and bell produce an additional layer of filtration and distortion before being further amplified (indicated by cross-hatched horizontal lines in Figure 7). A signal "path" is traced from the performances of the original protesters, through

recording and post-processing, through the audio ripped from YouTube, through the miniature loudspeaker in the bass clarinet, blended with the live sound of the instrumentalist and her voice, through a layer of foil, through an additional microphone for amplification, and diffused out of full-range speakers to the listener.



Figure 7: excerpt from *Resistance*, mm. 174–76

Similar to *Without Words*, the excerpt shown in Figure 7 is a transcription of audio from a YouTube video of Tahrir Square, Cairo.⁴⁷ This source has been mapped to an audio mosaic of samples of Roche improvising on prepared bass clarinet, then transcribed into notation. The re-interpreted result is cross-synthesized through spectral convolution with the original sample, causing amplification of the spectrum where the two signals overlap, and a filtration where they do not. This produces a controlled feedback loop between the microphone used for processing and the miniature speaker. In this way the residue of imperfections in the transcription process becomes a feature of the saturated texture, forcing another layer of subtraction where the two do not coincide.

These examples suggest just a few possible directions the audio database (personal archive) and internet (collective archive) can take as sources of compositional synthesis. Others are being explored by a young generation

47 Al Jazeera English, “Scenes from Tahrir Square: Mubarak’s Non-Resignation,” accessed May 9, 2013, <https://www.youtube.com/watch?v=nRBGPZkTam0>.

of composers and improvisers including Johannes Kreidler, Maximilian Marcoll, Matthew Shlomowitz, Alec Hall, Bryan Jacobs, William Brent, Ben Hackbarth, and Diemo Schwarz. Many of these artists program their own computer tools: software development becomes an extension of the compositional process for gathering and filtering material. Kreidler, discussing his work *product placements*, in which 70,200 sources are sampled in a 33-second electroacoustic piece, summarizes: “the work is a network.”⁴⁸ But even with music bathed in samples, databases, references, and borrowings, the contrasting musical results these artists derive attest to the individuality of their approaches.

Less is more: the future promises to be subtractive.

48 In German: “Das Werk ist ein Netzwerk.” Thomas Groetz, “Kunst muss verdächtig sein: Der Komponist und Aktionskünstler Johannes Kreidler,” *MusikTexte* 123 (2009): 5–10.

Appendix: Color Images

Chapter 4. Subtractive Synthesis: noise and digital (un)creativity



Figure 3: Screenshot from CataRT showing vocal samples plotted by spectral centroid (horizontal axis) and spectral flatness (vertical axis). Colors and labels correspond to vocal preparation materials