Lay It as It Plays
On the Acoustic Documentation and Sampling of Conlon Nancarrow's Player Pianos

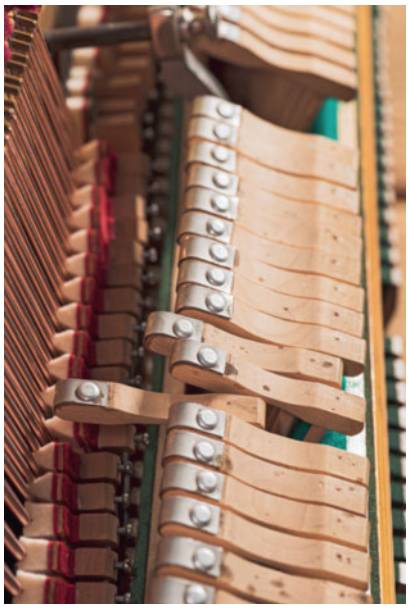
by Helena Bugallo

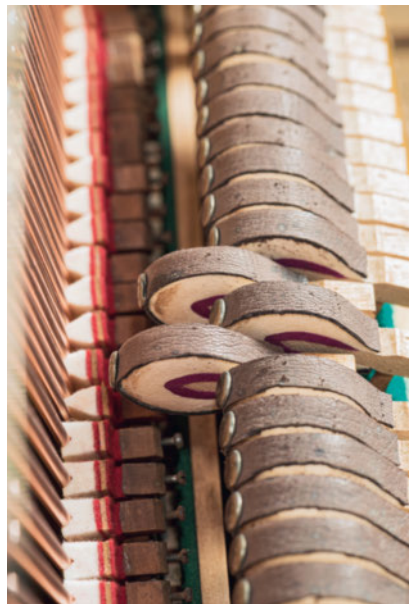
In 1997 the Paul Sacher Foundation added the Conlon Nancarrow Collection to its archives. From the beginning, the holdings included a widely diverse array of items: music manuscripts of different types, original player piano rolls, the composer's correspondence, his punching machine and other working tools and furniture, and two custom-modified player pianos. Further enhancements consisted of the musical portion of Nancarrow's personal library and the acquisition of materials previously in the possession of Jürgen Hocker. An invaluable resource for the researcher, this comprehensive collection allows not only the in-depth study of Nancarrow's legacy from historical and analytical perspectives, but also the reconstruction of key components of the environment in which his creative output was materialized, leading to musicological insights as unique as the oeuvre itself.

An integrative approach to the sources in the Collection shaped a research project funded by the Swiss National Science Foundation and housed at the Paul Sacher Foundation between August 2016 and January 2021. The main goal of this project was to produce the first critical edition of selected *Studies for Player Piano* by Nancarrow, while laying the technical and methodological bases for a future multimedia edition of his complete works. One of the project's stages focused on the acoustic documentation of the player pianos. This investigation also branched into a useful research tool: a digital sampler – here referred to as the Nancarrow Sampler – built with the sounds and operation noises of one of the instruments.[1]

I am deeply thankful to my late husband, Erik Oña, who many years ago envisioned this documentation and contributed his ideas and encouragement at every step of the way.

1 *Conlon Nancarrow's Studies for Player Piano: Towards a Critical Edition.* Project description under p3.snf.ch/Project-166478 (accessed 22 March 2021). Detailed information about all phases of the project under www.paul-sacher-stiftung.ch/en/research-publications/research.html.





1a *1b*

Plate 1: Modified hammers in Nancarrow's player pianos (photos PSS).

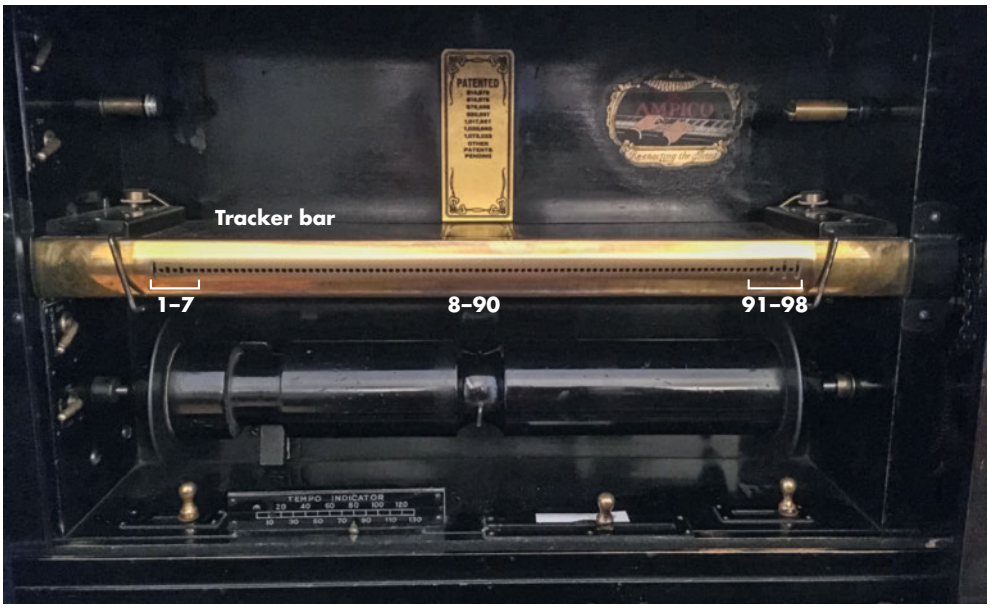
The Instruments

Nancarrow composed and recorded his *Studies for Player Piano* (ca. 1948–92) on two Marshall & Wendell upright pianos equipped with Ampico (American Piano Company) reproducing mechanisms model A (1920). These automatic instruments are driven by an electric motor – as opposed to the foot pedals in a pianola – and their operation relies on a vacuum pump that activates a pneumatic player mechanism according to specific commands encoded in a perforated paper roll. The composer modified both instruments by adding an extra set of dampers in the high register and drastically altering their hammers. One piano has bare hardwood hammers with steel straps fixed over them (*Plate 1a)*, the other possesses hardened felt hammers covered with leather and topped with small metallic pieces (*Plate 1b*).[2]

"I like the harpsichord sound and the clarity of the lines that come out," stated Nancarrow, "[i]t was just a thought that I would like that harpsichord sound with my pianos."[3] These unique instruments are

2 Nancarrow's own description of the modifications is to be found in Charles Amirkhanian, "Interview with Composer Conlon Nancarrow," in Conlon Nancarrow, *Selected Studies for Player Piano*, ed. Peter Garland (Berkeley: Soundings Press, 1977), pp. 6–24, esp. p. 11.

3 William Duckworth, "Conlon Nancarrow," in *Talking Music: Conversations with John Cage, Philip Glass, Laurie Anderson, and Five Generations of American Experimental Composers* (New York: Schirmer Books, 1995), pp. 29–51, esp. p. 45.



1	Slow bass crescendo (11 sec.)	91	Roll rewind
2	**Bass intensity 2**	92	**Treble intensity 0**
3	Sustain pedal	93	**Treble intensity 6**
4	**Bass intensity 4**	94	Fast treble crescendo (2 sec.)
5	Fast bass crescendo (2 sec.)	95	**Treble intensity 4**
6	**Bass intensity 6**	96	Hammer rail up (una corda)
7	**Bass intensity 0**	97	**Treble intensity 2**
8–90	83 playing notes, from B0 to A7	98	Slow treble crescendo (11 sec.)

Plate 2: Tracker-bar functions, Ampico model A (photo PSS).

characterized by a brilliant, percussive attack followed by a relatively soft resonance with a rapid decay. As intended, they display remarkable clarity in terms of polyphony and in the delivery of fast passages. The composer described the metal player piano as more "aggressive" than the other; nonetheless he used them interchangeably to record his pieces.

First introduced by the Welte company in 1901, reproducing pianos were primarily designed to render as closely as possible the interpretations of human pianists and are therefore especially flexible in regards to dynamics.[4] In addition to triggering notes and rhythms, the perforations in the rolls serve to control dynamic levels independently for bass and treble. The Ampico system also features commands for slow or fast crescendo in each

4 For a comprehensive history of the player piano see Arthur W. J. G. Ord-Hume, *Player Piano: The History of the Mechanical Piano and How to Repair It* (London: Allen and Unwin, 1970), and Jürgen Hocker, *Faszination Player Piano: Das selbstspielende Klavier von den Anfängen bis zur Gegenwart* (Bergkirchen: Edition Bochinsky, 2009).

register (and decrescendo when released) and for general pedal actions. The perforations for dynamics and pedals are situated at both edges of the paper roll and correspond to the outer holes of the instrument's tracker bar. The Ampico model A contains ninety-eight tracks in its bar, and the bass and treble registers are split between the central E and F (*Plate 2*).[5]

The intensity commands 0, 2, 4, and 6 can be used individually or in combination, yielding seven discrete dynamic levels that range from the softest (0) to the loudest (6-4-2):[6]

0	*pp*	4-2 or 6	*mf*
2	*p*	6-2	*f*
4	*mp*	6-4	*ff*
		6-4-2	*fff*

Nancarrow often assigned different dynamics to bass and treble, but he avoided the crescendo functions.[7] He instead favored discrete dynamic steps, often coinciding with sectional changes. He claimed to belong to J. S. Bach's "terraced dynamics school,"[8] though he justified this affiliation purely on the basis of personal preference: "The pianos have two different kinds of crescendos. I just don't use them […]. [W]hen I want a crescendo, I do it by steps."[9] Although not specified in the scores, the rolls reveal that the composer deliberately combined most dynamic levels with the *una corda* pedal, enriching in this way his available sound palette in terms of volume and timbre.

Recording Sessions

Following extensive planning and two test phases, the acoustic documentation of Nancarrow's player pianos took place in the early months of 2018. The purpose of the sessions was twofold:

---

5 For a full description of the Ampico system see Arthur A. Reblitz, *Player Piano: Servicing and Rebuilding* (Vestal, NY: Vestal Press, 1985), pp. 157–67; see also the comprehensive video "A Demonstration of How the Ampico A and Ampico B Expression Systems Work" (Historic Pianos, 2016; www.youtube.com/watch?v=elGdG95vwb0, accessed 22 March 2021).

6 The correspondence with musical dynamics suggested on the right-hand column is not absolute and varies depending on register and context.

7 An exceptional case is *Study #6*, where he makes use of the slow crescendo function.

8 Charles Amirkhanian, "Interview" (see note 2), p. 10.

9 Roger Reynolds, "'Inexorable Continuities …': A Commentary on the Music of Conlon Nancarrow," in Conlon Nancarrow, *Selected Studies* (see note 2), pp. 26–40, esp. p. 27. The fixed durations automatically assigned to the slow and fast crescendo functions (eleven and two seconds respectively) probably influenced the composer's avoidance of these features as too limiting in the context of his music.

3a *3b* *3c*

Plate 3: Recording setting (photos PSS).

1) to create a digital audio database containing all the notes of each instrument, triggered by a player-piano roll, in all dynamic levels with and without the *una corda* pedal, and
2) to sample the instruments to pursue the construction of a virtual player piano, to be utilized as a research tool and in the context of the Critical Edition.

After the player pianos were regulated and tuned, the room was outfitted with acoustic panels for the recording (*Plate 3a*). Cedric Spindler conducted a multichannel recording, using four pairs of microphones with different qualities.[10]

The recorded material consisted of chromatic scales in all dynamic levels, performed with rolls especially manufactured for this project. While the audio database captures the conventional reproduction of these rolls, the recordings for the sampler required a different approach. In order to avoid an undesired multiplication of background noises (i.e. vacuum pump, roll transport mechanism, paper noises of the roll), it became indispensable to separate these noises as much as possible from the actual piano sounds. The following recording protocol was developed based on this necessity:[11]

10 Hans Schmitz and Markus Mahlstein were in charge of the maintenance service of both instruments. The microphones utilized by Cedric Spindler were pairs of DPA 4006 (AB, total perspective undistorted, in front of the instrument), AKG C414 (string resonances, below the keyboard), Sennheiser MKH 80 (hammer action and string resonance, vertical above the instrument), and Schoeps MK4 / CMC6 (resonance of the soundboard, behind the instrument).

11 I am indebted to Robert J. Berkman, Hans Schmitz, and Cedric Spindler for their helpful input in the development of this protocol.

1) record background noises only by playing a blank roll,
2) partially remove the vacuum pump and place it in an adjacent room,[12]
3) connect the removed pump and the instrument with a long hose,
4) test the reproduction fidelity of the piano with the removed pump by making recordings and comparing them with the analogous documents in the audio database,
5) disconnect the roll-transport mechanism to diminish noises near the microphones,
6) with the remote pump turned on, advance the roll manually and record individual notes, by opening and blocking with one finger the pitch perforation aligned with the tracker bar. Record three variants of each note (short, medium, and long), including key noises,
7) repeat recordings at different dynamic levels, with and without the *una corda* pedal,
8) capture the resonance produced by the sustain pedal through impulse response and digital sound processing technology (*Plates 3b–c*).[13]

Results and Impact

The outcome of the recordings and the related metadata are archived at the Paul Sacher Foundation. This material makes possible the digital acoustic mapping of the player pianos – as they were in 2018 – and the scientific evaluation and comparison of their qualities. In addition, recordings of a few of Nancarrow's works were made during the sessions, to capture not only the instruments at work but also to document the given external conditions (room and microphones). These recordings are also archived, both in eight individual channels as well as in a stereo mix. The sampler construction was done afterwards. For the metal player piano, the noises produced by the portion of the vacuum pump kept inside the piano proved to be too loud. The recordings of the leather player piano, on the other hand, met the needed requirements. After extensive sound cutting and programming, the Nancarrow Sampler based on the leather piano was successfully finalized in April 2019 by Cedric Spindler.[14]

The software sampler instrument can be utilized to play Nancarrow's music as a result of a parallel component of the research project. There are 293 original rolls in the Conlon Nancarrow Collection, including definitive and earlier versions of complete pieces, fragments, and sketches. As part of

12 In order to realize this step, it was necessary to manufacture precise duplicates of two wooden pieces of the pump.

13 A sine sweep is played into the resonance board of the piano and the resulting recording is processed into an impulse response.

14 The sampler is built with actual recordings of dynamic levels 0 *una corda*, 0 ordinario, 4 *una corda*, 4 ord., 6-2 ord., 6-4-2 ord. The remaining dynamic levels are extrapolations from these recordings. Its technical requirements include a personal computer (Windows or Mac) equipped with *Kontakt 6* or *Kontakt 6 Player* (Native Instruments, 2019), a MIDI sequencer application, and a stereo audio interface.

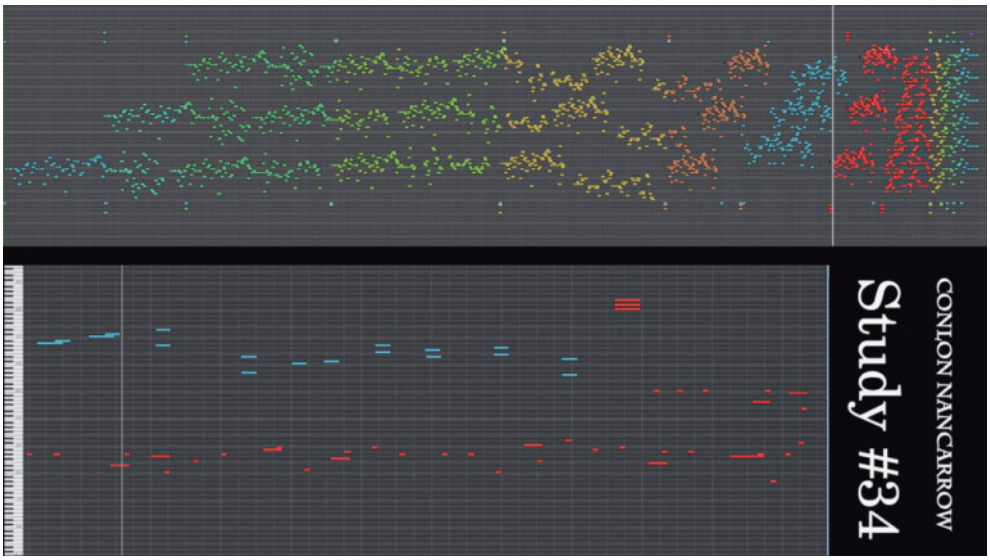


Plate 4: Conlon Nancarrow Critical Edition, Audio Visual Supplement (photo by Helena Bugallo/PSS).

its preservation efforts, the Foundation made optical scans of these fragile documents for the purpose of producing faithful duplicates for the archive. A byproduct of this initiative was a collection of MIDI files that record the exact location of all the perforations in each roll. For the present project, these MIDI files were reorganized and adapted to be played by the Nancarrow Sampler.[15] The adaptations enable a digital representation of the rolls with their dynamic levels and pedal actions colored, as well as a visual emulation of their reproduction with the sounds of the original instrument. Potential usages of this powerful interactive tool include: to modify the tempo, to listen to passages or strata of the music selectively, to compare multiple rolls side by side, to reconstruct pieces from discarded fragments, to study the precise articulations in the rolls, and to identify variants among rolls and written documents.[16] In addition to the many benefits that this tool contributes to an editorial process, videos extracted from its interface constitute the audiovisual component of the Critical Edition. These videos show the rolls from two different perspectives: general and detailed (*Plate 4*).

15 It is important to note that the optical scans and the derived MIDI files capture the perforations in the rolls but not their annotations and corrections (covered perforations). These are to be found in the originals and in the microfilmed images of them. The adaptation of the files is described at www.paul-sacher-stiftung.ch/en/research-publications/research.html.

16 The Nancarrow Sampler and the MIDI files will be made available in-house at the Paul Sacher Foundation for research purposes.

The altered player pianos took part in Nancarrow's compositional process, enabling him to hear his music right away and to realize his most experimental ideas, particularly within the temporal domain. Mensural canons reaching up to twelve voices, extremely close and even irrational tempo proportions, superimposed accelerandos and ritardandos were all delivered by the pianos effortlessly and with utmost precision. Once he chose to work with these instruments, however, he was bound to play by their rules. How they operate, how they sound, and how the composer exactly laid out his pieces within their limited environment, are all crucial factors in understanding Nancarrow's musical legacy.