Nancarrow's "Temporal Dissonance": Issues of Tempo Proportions, Metric Synchrony, and Rhythmic Strategies

Margaret Thomas

When Conlon Nancarrow (1912-1997) claimed that "time is the last frontier of music"[1] he was referring, of course, to the fact that developments in twentieth-century music were centered to a large degree in the pitch realm. Nancarrow's stated focus in his music was rhythm and time, which positions him as a pioneer of this "last frontier." Along with a handful of other contemporary composers, including Charles Ives, Henry Cowell, Elliott Carter, and György Ligeti, Nancarrow created richly expansive, stratified temporal structures, and Nancarrow's works represent something of a pinnacle among this body of music: by writing primarily for the player piano, Nancarrow was freed from concerns of performability, and his textures were thus often more intricate than those of composers writing for live performers. His innovative Studies for Player Piano, composed primarily from the 1950s through 80s, are works of incredible rhythmic complexity whose hallmark is the temporal conflict among simultaneous layers of music. "Temporal dissonance" is Nancarrow's term for this conflict, and it is perhaps the fundamental distinguishing feature of his musical style. It is clearly the quality to which he ascribed the most importance in his music: "I feel that clashes of tempo carry my music, not the fact of canon, not pitch imitation";[2] "One reason [for the use of canon] was my interest in temporally dissonant relationships."[3] Throughout the studies, Nancarrow created an impressively diverse set of structures we can understand intuitively as "dissonant," yet he never defined temporal dissonance in any real detail. Nancarrow's comments on temporal dissonance

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[1] Nancarrow, quoted in Peter Garland, "Conlon Nancarrow: Chronicle of a Friendship," in *Americas: Essays on American Music and Culture, 1973-80* (Santa Fe: Soundings Press, 1982): 185.

[2] Nancarrow, quoted in Roger Reynolds, "Conlon Nancarrow: Interviews in Mexico City and San Francisco," *American Music* 2/2 (Summer 1984): 6.

[3] *Ibid.*: 5.

in interviews are brief,[4] but the term arises frequently enough to suggest its singular significance in Nancarrow's aesthetic. This paper develops the highly suggestive concept of temporal dissonance, considers its relationship to the idea of metric dissonance, as discussed by Maury Yeston, Harald Krebs, and Richard Cohn, and examines its varied manifestation in five of the Studies: Nos. 2, 14, 7, 21, and 27.

Nancarrow discussed temporal dissonance with regard to the proportions formed by simultaneous, different tempos that are so common in his works. As he stated, "Temporal dissonance is as hard to define as tonal dissonance. I certainly would not define a temporal relation of 1 to 2 as dissonant, but I would call a 2 to 3 relation mildly dissonant, and more and more so up to the extreme of the irrational ones."[5] Nancarrow incorporated tempo proportions in many of his works; often supplied in the subtitle to a study, the proportions range from fairly simple, such as 3:4 (No. 15) or 12:15:20 (No. 17), to increasingly complex proportions, like 60:61 (No. 48), $\sqrt{2}$:2 (No. 33), or e:π (No. 40). Nancarrow's statement above implies that we might be able to impose a hierarchy on these tempo ratios, ranging from consonant (1:1 or 1:2) to extremely dissonant (those involving irrational numbers). But such a hierarchy would constitute an over-simplification of the idea of temporal dissonance, which has the potential to encompass a great deal more than tempo proportions. We can hear even the studies that do not contain proportionally-related tempos as rhythmically dissonant in some way, if we acknowledge a broader meaning for "temporal dissonance" beyond a dissonance of tempos, to include a more general conflict or lack of agreement in the time parameter. Certainly, the relative dissonance or consonance of a given passage might be ambiguous, reliant as it is on perception and other rhythmic/musical factors in addition to tempo proportions. But the concept of temporal dissonance can be

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[4] For Nancarrow's discussions of temporal dissonance, see especially Charles Amirkhanian, "Interview with Composer Conlon Nancarrow," in Peter Garland (ed.), *Conlon Nancarrow: Selected "Studies for Player Piano"*: 13, and Reynolds, "Interviews": 3-9.

[5] Reynolds, "Interviews": 5.

developed with considerable specificity. The first step in this development is a discussion of some basic rhythmic issues.

Let us consider possible relationships between two voices with dissimilar rhythmic organization, relationships typically categorized as polyrhythm, polymeter, and polytempo. Example 1 contains a sampling of abstract, rhythmically repetitive two-voice models. Example 1a presents one of the simplest possibilities for two voices having something other than identical rhythms. In this case, their quarter and eighth notes create a 1:2 ratio of articulation. The two voices are undeniably related, however, on the basis of their shared quarter-note overriding pulse and metrical organization. This is true also for Examples 1b and 1c, although the ratios formed by their divisions of the shared pulse are less simple, at 2:3 and 4:5, respectively. These examples exemplify the technique known as polyrhythm: the rhythms of the two voices differ, but they can be reconciled to the same underlying meter and tempo. Example 1d presents a very different sort of scenario, in which the two voices actually share the same eighth-note rhythm, but there is some musical feature such as dynamic accentuation or pitch imitation indicating that the two voices are not in the same "place" at the same time, and thus are not synchronized relative to a common pulse. Their implied meters do not align. This is not a particularly new technique (it might be found in a canon or the *stretto* portion of a fugue, for instance), but it makes perceptual demands far beyond those of the more conventional rhythms of Examples 1a, 1b, and 1c. Careful listeners must expand and fragment their attention in order to track both voices separately, since they are at seemingly different melodic or metric positions. In Example 1e the voices avoid simultaneous articulations by their staggered quarter-note pulses, which produces a similarly asynchronous effect.

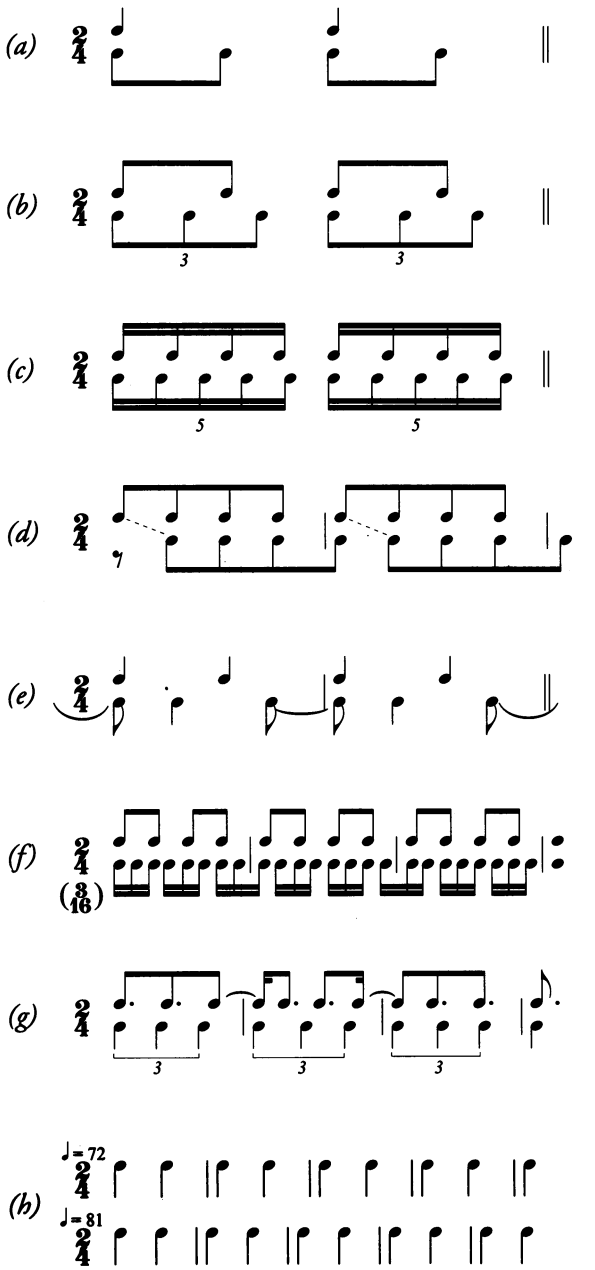
Examples 1d and 1e suggest one form of polymeter: the voices both articulate a 2/4 meter, but their measures seem not to be aligned. Another type of polymeter is given in Example 1f. While the ratio of the articulation rate of the voices is a simple 1:2 (eighth notes to sixteenth notes), the accentuation, articulation, or pitch construction of the lower voice is such that groupings are created that express a meter of 3/16 (or 6/16, 9/16, 12/16, etc.), in contrast to the 2/4 of the upper voice. The lower voice, of course, could actually be notated in 3/16 or some multiple of it. As a

consequence of the suggestion of different meters, the two voices in Example 1f could well sound less closely related than those of Example 1b or 1c, despite the simple 1:2 ratio of their articulations.

Clearly, divisions between the categories of polymeter and polytempo can blur. The polymeter of Example 1f, whether notational or implicit, results in polytempo: although the voices share an eighth-note speed, the metrical pulses (♩ vs. ♪.) proceed at different tempos. Example 1g illustrates polytempo again: here the voices seem to articulate different speeds through their respective pulsations of a dotted eighth note and quarter-note triplet. They have a simultaneous articulation only once every six quarter notes, and their speeds are in the proportion 8:9. These two voices could be notated explicitly in tempos related at 8:9, of course, as in 1h, but the aural effect would be much the same. This is particularly true of Nancarrow's player piano works, in which he did not incorporate the interpretive metrical accentuation found in live performance. Each note at a given dynamic marking is produced at an identical loudness. Certainly, most of his works are notated in a meter, and the effect of metrical organization can be created by means other than dynamic accentuation, but in many cases patterns such as those in 1g and h are interchangeable. This raises an important point concerning the terms polyrhythm, polymeter, and polytempo. Despite their estimable intuitive implications, the terms lack the degree of precision necessary to address the issue of temporal difference in Nancarrow's music adequately. The present work, therefore, will specify in more detail features built into the concepts of polyrhythm, polymeter, and polytempo: shared vs. different pulses and subpulses (in either durational notation or speed); shared vs. different meter; pulse alignment or misalignment; metric alignment or misalignment; and notational vs. perceptual organization of pulse and meter. Considering these features with regard to Example 1f, for instance, leads to the following revised assessment: the two voices share a sixteenth-note subpulse but have a different pulse (by virtue of grouping) and hence a different meter, pulse rate, and tempo (which is defined by pulse rate).

The connection between temporal difference and temporal dissonance is not mutually dependent: the latter is not necessarily a result of the former, although the former is a prerequisite of the latter. Yet Examples 1f, 1g, and 1h illustrate situations in which it

Example 1. Rhythmic relationships in two-voice models.



becomes increasingly difficult to listen to the two voices compositely, that is, to relate them to a single temporal process; rather, we begin to hear the voices in conflict. Such convincing differentiation between voices seems to be the most basic prerequisite for temporal dissonance. But what degree of rhythmic discord is necessary between two voices in order to provoke the perception of them as genuinely separate, each proceeding at its own pace?

Maury Yeston, Harald Krebs, and Richard Cohn have addressed this problem, with the particular aim of distinguishing metric consonance and dissonance.[6] Although the authors address primarily pre-20th-century music—which frequently presents analytical challenges different from those of the present study—there are certain aspects of their work that can contribute to the development of the concept of temporal dissonance as it relates to Nancarrow's music. Krebs takes Yeston's view of meter as a point of departure: meter results from the interaction of two levels of motion, and those levels are consonant when the rates of motion are in an integer multiple relationship, dissonant when not. Krebs extends Yeston's theory by asserting that metrical dissonance requires at least three levels of motion, a pulse level and levels that group pulses differently. The conflicting groupings may involve groups that are different sizes, or groups of the same size that are not aligned. Cohn further defines metric consonance and dissonance as they relate to the partitioning of a given time span. In his construction, consonance results when all of the partitionings ("pulse-levels") participate in integer-multiple relationships with one another, as in a measure of 6/8 that is partitioned into six eighth notes and two dotted quarter notes (6÷2 = 3). Dissonance results from partitionings that exhibit non-integer ratios, such as in a measure of 6/8 that is partitioned not only into six eighth notes

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[6] See Maury Yeston, *The Stratification of Musical Rhythm* (New Haven and London: Yale University Press, 1976), especially chapter 4, "Structures That Arise from the Interaction of Strata": 77-118; Harald Manfred Krebs, "Rhythmische Konsonanz und Dissonanz," *Musiktheorie* 9/1 (1994): 27-37, and *idem*, "Some Extensions of the Concept of Metrical Consonance and Dissonance," *Journal of Music Theory* 31/1 (Spring 1987): 99-120; and Richard Cohn, "Metric and Hypermetric Dissonance in the *Menuetto* of Mozart's Symphony in G Minor, K. 550," *Intégral* 6 (1992): 1-33.

and two dotted quarter notes, but also three quarter notes (6÷2 = 3, and 6÷3 = 2, but 3÷2 = 1.5). The degree of dissonance reflects the number of non-integer ratios created by a set of partitionings. Yeston, Krebs, and Cohn make certain assumptions that are appropriate for the repertoire they address, but that do not apply consistently to Nancarrow's music: the assumption of some degree of metric regularity, in the form of a time span shared by different levels or partitionings, and the assumption of a common tempo. But the essential idea of comparing implicit groupings and levels of motion is a useful one for the refinement of Nancarrow's concept of temporal dissonance.

As I have said, each of the techniques illustrated in Example 1 represents (in simplified form) aspects of Nancarrow's rhythmic practice. While Examples 1b through 1g would be characterized as metrically dissonant following Yeston, Krebs, and Cohn, only the voices of Examples 1f, 1g, and 1h contain rhythmic relationships that fit Nancarrow's model of temporal dissonance. The distinction is based on the presence or absence of a shared underlying pulse. Nancarrow emphasized that true temporal dissonance must be more than what might traditionally be considered a simple polyrhythmic or polymetric relationship:

> I don't think, say, the polyrhythm of 4 against 5 [is dissonant], where after every 4 and every 5 it comes together on the block, but I do think that a *tempo* of 4 [against] a tempo of 5 is dissonant because you have a line going against another line. The former situation is coinciding on, let's say, the measure, and the latter isn't. That's what I call temporal dissonance.[7]

> In spite of the fact that it's [Study No. 15] very simple, 3 against 4—I guess one pianist could play it, almost—the fact is that the "three voice," for example, is not just going in groups of threes. The phrasing and everything is completely independent of the basic three measurement. Similarly in the "four voice." It is a *tempo* relationship, not a metrical one.[8]

Nancarrow's principal criterion for temporal dissonance is thus an infrequency of metrically significant simultaneous attacks between layers, that is, simultaneous attacks that coincide with mutual

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[7] Reynolds, "Interviews": 23.

[8] *Ibid.*: 10-11.

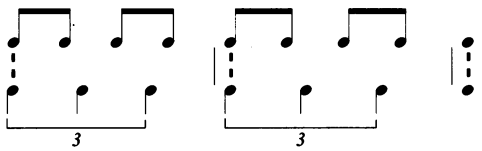
downbeats. Example 2 illustrates the impact of metrical significance: it contains two 2-voice models with an articulation rate of 3:4, presented in Example 2a as a polyrhythm with different subdivisions of a shared measure length and meter, and in Example 2b as a polytempo, with a shared meter but different measure length. Thick dashed lines point to metrically significant simultaneities, and thin lines to metrically insignificant simultaneities, assuming that the notated meters are projected musically. The effect of polytempo in this setting is to reduce the number of aligned barlines between the voices, and thus to reduce the coincidence of downbeats.

Nancarrow rarely used the isochronous pulses of these models, of course. The opening of Study No. 15 (Example 2c), referred to by Nancarrow above as presenting a 3:4 relationship, demonstrates the ways in which varied durations and changing meters can reduce potential simultaneities, and enhance temporal dissonance in turn. In these two systems there could have been sixteen simultaneous articulations between the two canonic voices, had every eighth note (the smallest unit of motion in this piece) been articulated. Frequent rests in the canonic line, however, reduce the simultaneities to eight (marked by dashed lines). Because of meter changes, only the first simultaneity coincides with mutual downbeats.

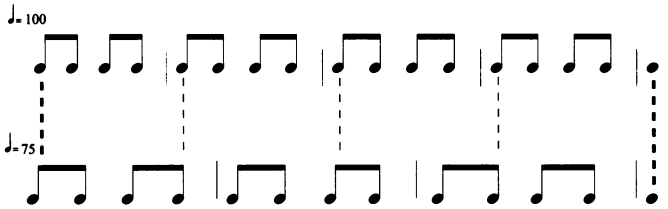
Given the caveat above about the absence of dynamic downbeat accentuation in Nancarrow's studies, a word about metrical organization is in order. The notated changing meters in Study No. 15 (Example 2c) very much reflect the way the piece is heard: the slurs across the barlines (an articulation type the player piano is capable of producing) set up a recurring upbeat-downbeat gesture that emphasizes the meter changes, and thus the metrical significance of downbeat attacks. The notated meter is not always a reliable indication of the metrical significance of articulations, however. Perceptually implied meters and tempos gain considerable importance in some studies. Layers that are notated in the same tempo can be heard as dissonant if their meters and/or rhythmical groupings suggest different, and conflicting, overriding pulse-streams, such as we saw in Examples 1f and g. A somewhat different challenge is presented by the fact that Nancarrow occasionally employs gradually changing speeds in a layer. That

Example 2. (a) Polyrhythm of 3:4; (b) Polytempo of 3:4; (c) Opening of Nancarrow, Study No. 15, annotated to show the impact of diverse durations and changing meters.

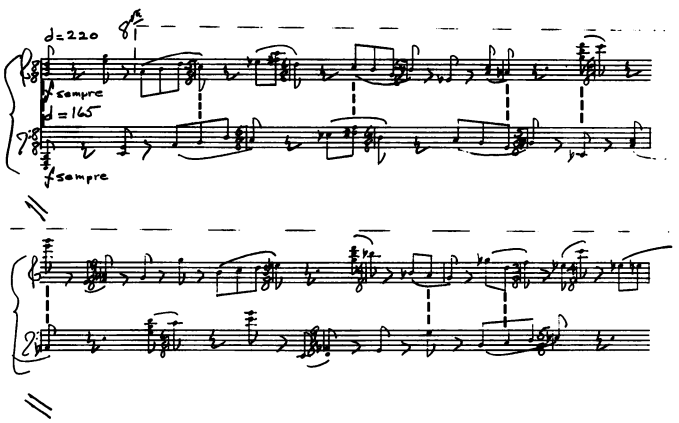
(a)



(b)



(c)



layer thus does not adhere to the notion of tempo at all, yet it can still sound dissonant relative to the concurrent layers, which may feature steady tempos or differently changing speeds. Rather than from a conflict of tempos, then, temporal dissonance can result from a more general conflict of temporal strategies.

Models of pitch dissonance and consonance can inform our further development of the concept of temporal dissonance. Conventional models suggest a mutual relativity: dissonance is defined by its drive toward resolution into some form of consonance. Pitch dissonance can only truly be understood in terms of its counterpart, consonance, and vice-versa. By analogy, temporal dissonance must have a counterpart in temporal consonance. As Roger Reynolds says,

> I think of dissonance [in Nancarrow's music], metaphorically, as the condition of tension that arises from the experience of (usually two) sensory items that conflict with some model of adjacent repose. Items that are to be somehow in tension with each other require, I think, some basic level of agreement (of significant synchrony in the case of tempi) in order that one perceive their deviance.[9]

In Nancarrow's music temporal consonance can be likened to more conventional structures whose layers are relatively coordinated rhythmically, metrically, and in tempo, containing significant simultaneous articulations. Temporal consonance does occur in the studies, if briefly. It typically serves a formal function, frequently in the guise of a simultaneous attack that concludes a section or a piece, or a referential function against which surrounding material can be understood as dissonant. Of course, as in the pitch domain, consonance and dissonance are not absolutes. Rather, they form a continuum representing lesser and greater degrees of conflict. Not every moment of Nancarrow's works is equally temporally dissonant—his rhythmic and textural visions are richer than that—but the expression of some degree, or changing degrees, of dissonance seems to drive virtually all of his music.

A final important consideration regarding the issue of temporal dissonance in Nancarrow's music is the impact of Henry Cowell's

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[9] Roger Reynolds, "'Inexorable Continuities...': A Commentary on the Music of Conlon Nancarrow," in Garland (ed.), *Conlon Nancarrow: Selected "Studies for Player Piano"*: 33.

imaginative treatise, *New Musical Resources*, which Nancarrow read in 1939-1940.[10] First published in 1930, *New Musical Resources* contains provocative ideas for new ways to organize pitch and rhythm. There are striking similarities between the rhythmic systems Cowell proposes and the complex rhythmic structures of Nancarrow's music. Nancarrow spoke of the importance of *New Musical Resources* to his compositional development. As late as 1989 he described it as having "probably the most influence of anything I've ever read in music. In fact, I just reread it again. I hadn't read it in many years, I thought maybe now I wouldn't think so, but I still think it's a very good book."[11] The most important of Cowell's theoretical ideas to Nancarrow was his bold assertion of the desirability of complex polyrhythms, polymeters, and polytempos that are related to pitch proportions. The parallel to Nancarrow's asynchronous layers is unmistakable, particularly in his use of proportionally-related tempos. There is a fundamental difference in the intended effect of those proportions, however: whereas Nancarrow strove for temporal *dissonance*, Cowell advocated "rhythmic *harmony*."[12]

The correspondence of rhythm to pitch is crucial to Cowell's theory. For Cowell, harmony and counterpoint represented naturally well-ordered systems, related as they are to the physical laws of sound production, that is, to the overtone series. By applying ratios from the overtone series to durations, meters, and tempos, a composer could develop rhythmic structures that emulate sonorities common to the tonal system, such as triads and seventh chords. The resulting rhythms would be more complex than those used prior to the twentieth century, but that complexity would be based on natural ratios rather than haphazard disorder. Cowell's aim was to raise rhythmic practices to the standards of other musical parameters. Some of the proportions in Nancarrow's early studies resemble harmonic ratios, such as the 2/3/4/5/6/8 complex of Study No. 9, which replicates the ratios of a major triad voiced

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[10] Henry Cowell, *New Musical Resources* (New York and London: Alfred A. Knopf, 1930). See especially "Part II: Rhythm": 49-108.

[11] Nancarrow, quoted in Kyle Gann, *The Music of Conlon Nancarrow* (Cambridge: Cambridge University Press, 1995): 43.

[12] Cowell, *New Musical Resources*: 53.

with a tripled root. But the pitch material of the study does not assert triadic sonorities; Nancarrow did not intend listeners to intuit a "harmonic" tempo relationship. On the contrary, we are to perceive separate and uncoordinated voices. For Nancarrow, the ratios were simply tools to create conflicting simultaneous tempos. Despite the differences in the aesthetic stances of Cowell and Nancarrow, their common emphasis on the use of proportions in the rhythmic domain is an important indicator of the significant impact *New Musical Resources* had on Nancarrow.[13]

We turn now to an examination of temporal dissonance in Nancarrow's studies. Study No. 2 features a succession of simultaneous tempos based on the ratios 10/12/15/20, which occur over an ostinato that opens the piece and is present throughout.[14] The ostinato (see Example 3) comprises two layers whose tempos themselves are related at 12:20, or 3:5 (♩= 69 in a 3/4 meter against ♪ = 115 in 5/8). The compound nature of this ostinato contributes to the work's temporally dissonant complex. While the ostinato appears to be more polymetrical than polytemporal in the score, in that its two component layers share measure lengths rather than meters, the articulative groupings of both layers suggest a more complicated relationship.

The first five measures of the ostinato are presented both as notated in the score (Example 3a) and with the meters that the two components gesturally imply (Example 3b). The four simultaneous

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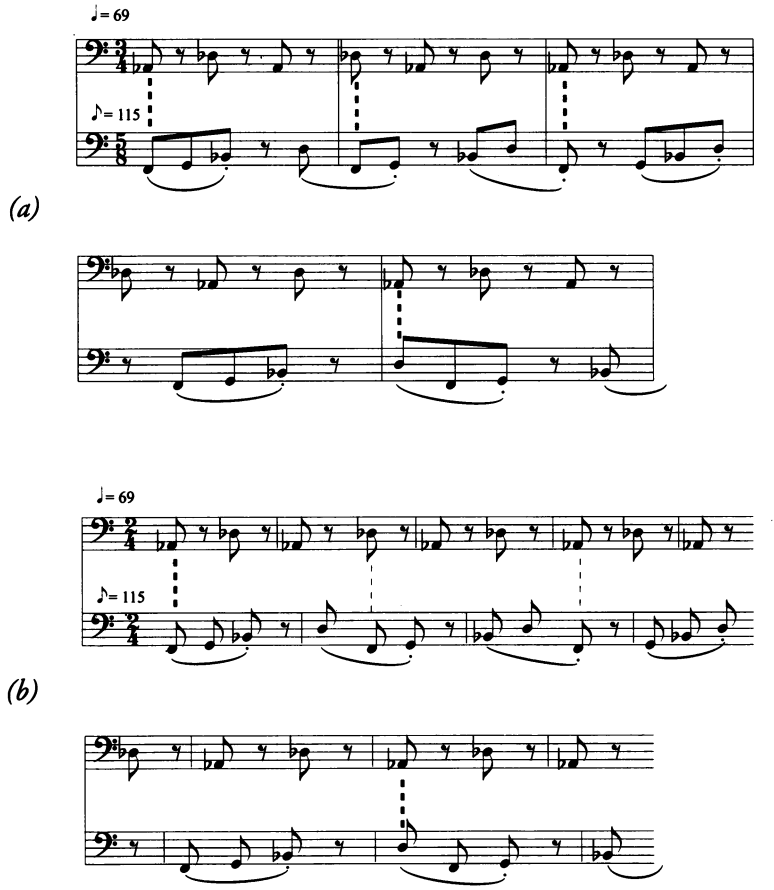
[13] Study No. 37, in fact, contains a series of twelve-voice canons whose tempos are based on the proportions of a justly-tuned chromatic scale outlined by Cowell in *New Musical Resources* (p. 107), though the pitch intervals of the canonic imitation do not correspond to the chromatic scale. Nancarrow's set of tempos, which multiply those in Cowell's chart by 2.5, are: 150 / $160^5/_7$ / $168^3/_4$ / 180 / $187^1/_2$ / 200 / 210 / 225 / 240 / 250 / $262^1/_2$ / $281^1/_4$.

[14] Study No. 2 is recorded as Study No. 2a in Conlon Nancarrow: *Studies for Player Piano*, Vol. III and IV (WER60166/67-50, Wergo, 1990), but the score is published as Study No. 2 in *Conlon Nancarrow: Collected Studies for Player Piano*, Vol. 5 (Santa Fe: Soundings Press, 1984). Study No. 2b in the recording is a different, also early, work that Nancarrow discarded for some time and revived more recently. Its score has not been published.

Example 3. Nancarrow, Study No. 2, mm. 1-5 of ostinato. (a) As notated in the score; (b) Metrical implications of the isorhythmic pitch patterns.



Thick dashed lines show metrically significant simultaneities.

articulations during these measures are indicated by vertical dashed lines in the examples, occurring on the downbeats of four of the five notated measures. The isorhythmic patterns of the layers account for their perceptual deviance from the meters given in the score. The upper layer of the ostinato alternates between two pitches, A♭2 and D♭3, at a regular quarter-note pulsation (expressed as an eighth note followed by an eighth rest), which creates the illusion of a 2/4 meter. The pitch pattern of the lower layer is <F2, G2, B♭2, D3>; this is superimposed upon a rhythmic pattern of three articulated eighth notes (grouped gesturally by a slur) followed by an eighth rest. The result is the continual grouping of three members of the four-note pitch series, and each grouping lasts for four eighth notes. Thus the lower layer also expresses a 2/4 meter, but one whose measure length differs from that of the upper layer, and whose pitch content continuously cycles, as illustrated in Example 3b. As a result, two of the four simultaneous articulations of the excerpt that appear to be metrically significant in Example 3a are perceptually not very significant after all, as represented by the thin vertical lines in Example 3b, since they do not coincide with mutual perceptual downbeats. The ostinato thus has a less coordinated and more dissonant effect than the score suggests.

The layers paired with the ostinato throughout Study No. 2 generally have contrasting but proportionally-related tempos to those of the ostinato, completing the complex of ratios 10/12/15/20, which is illustrated in Example 4a. The added layers (whose speeds are explicit in the score, shown by metronome markings) form a series of two- or three-voice tempo-proportion canons among themselves. Each canon is based on the same material, but features a slightly different combination of speeds. The opening eight measures of three of the canonic layers are given in Example 4b.[15] The basic pulses of the three excerpts are (1) the ♩ = $86^{1}/_{4}$, (2) the ♪. = 115, and (3) five sixteenth notes = 69. The slight rhythmic differences that result from their different notational meters are insignificant to the effect of canon. There are

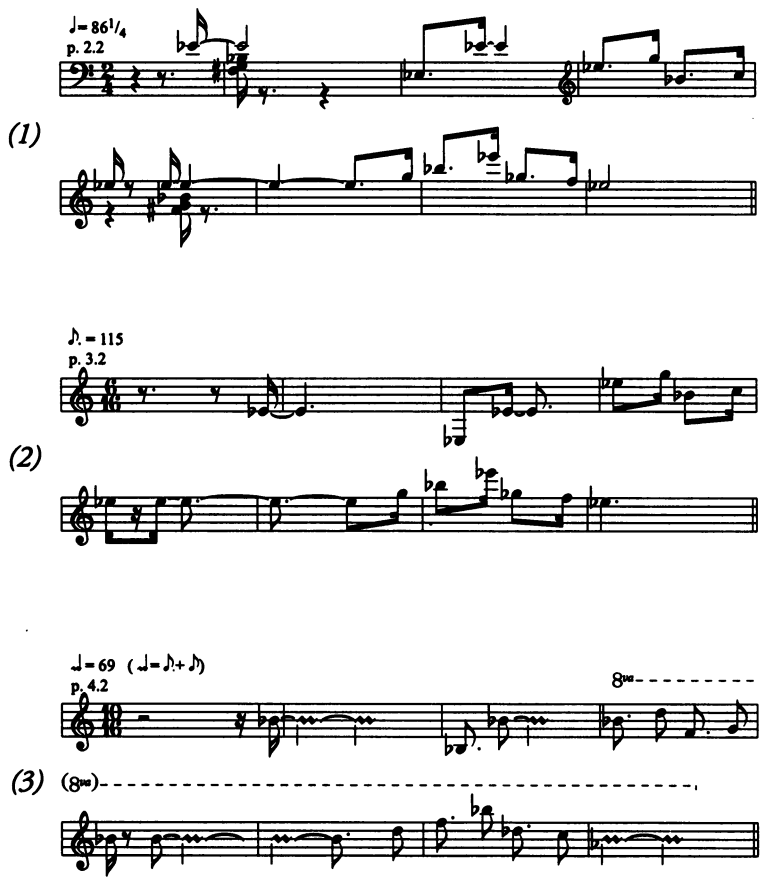
[15] Page reference for the studies is as follows: the integer preceding the decimal refers to the page number hand-written by Nancarrow in the upper right or left corner of the score, and the number following the decimal refers to a system on that page. Page 3.2, therefore, is page 3, system 2.

Example 4. Nancarrow, Study No. 2, canonic layers.
(a) Tempo-proportion complex of the study's four speeds;
(b1-3) opening eight measures of three of the canonic layers.

(a)

Tempo proportions	Pulse speeds	Proportional pairs
10	57 1/2	5 1 2
12	69	3 4 6
15	86 1/4	3 5 3
20	115	5 4 2

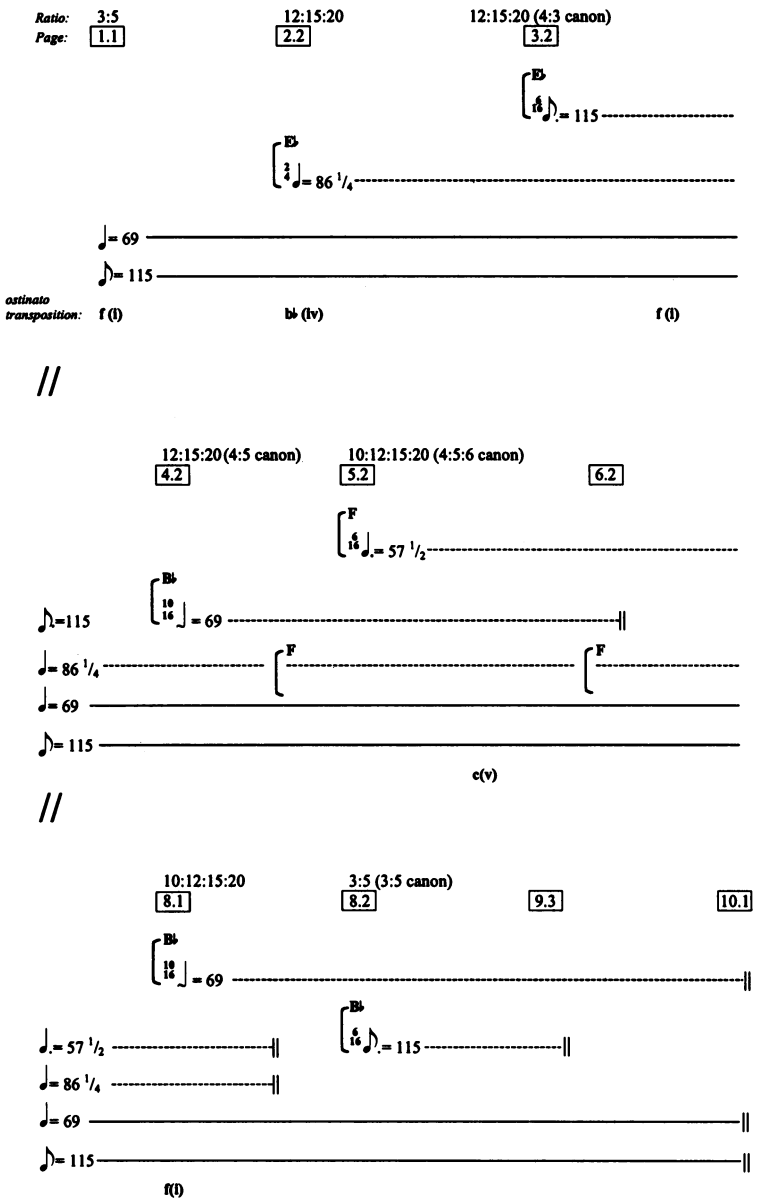
(b)



four distinct tempos in the piece, and the same tempo sometimes occurs simultaneously in a canonic layer and ostinato layer. The metrical implications of those layers, however, along with their contextual functions, differ. There is a clear material and registral division between the ostinato layers and the canonic layers, which function, respectively, as the bass underpinning of the work and the melodic voices. These functional differences enable our aural discrimination of individual layers, including layers that share a tempo. The temporal tension of two such layers is enhanced, in turn, by metrical conflicts between them.

Example 5 contains a summary of the tempos and material of Study No. 2's layers. The solid horizontal lines represent the ever-present ostinato layers, and the dashed horizontal lines represent the canonic layers, which variously enter and depart. The beginning of the canonic material is bracketed at each entrance. Though the study is not strictly tonal, it does have strong tonal implications. The ostinato undergoes a pattern of transposition every sixteen notated measures that suggests a blues harmonic pattern i-iv-i-v-i. The transpositions coincide with the realignment of the ostinato components. The canonic voices emphasize various tonal centers, which are indicated by boldface in Example 5. As is typical of many of Nancarrow's works, particularly the earlier ones, Study No. 2 exhibits a large-scale coordination among the layers, as evidenced by their transpositional patterns, or tonal centers. The tonal center of the canonic line tends to be a perfect fourth above that of the ostinato, following its transpositional pattern. The transpositional coordination contrasts with the work's temporal dissonance, which is exemplified by its explicit polytempo and infrequency of metrically significant simultaneous articulations. An excerpt containing a passage of a 3-voice canon, p. 6.1, illustrates the temporal dissonance of the full texture of the study, where all four notational tempos are present (Example 6). The ostinato appears on the lowest two staves, and the canonic lines on the upper three. There are fourteen simultaneous articulations in just this single system, but only three of them feature coinciding perceptual downbeats, marked by asterisks in the example. In other words, the layers do not "come together on the block," as Nancarrow put it. Even the layers that share a tempo avoid this: the second and fourth layers in Example 6 both have a pulse of 69,

Example 5. Nancarrow, Study No. 2.
Summary of tempos and material.



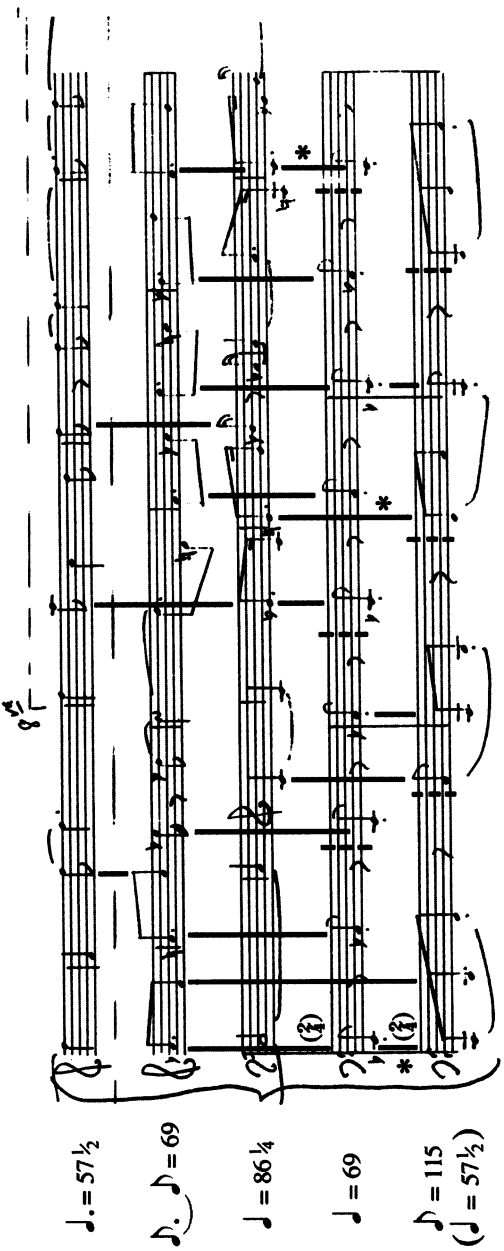
but their perceptual measures are staggered to avoid coordinated downbeats, and the same is true of the first and fifth layers, whose pulse is $57^{1}/_{2}$.

A number of Nancarrow's studies are cast in their entirety as tempo-proportion canons whose voices feature different, but unchanging tempos. Once the canon is underway, the proportions formed by the tempos of the individual voices do not change. This approach to tempo-proportion differs significantly from that of Study No. 2, in which the tempo complex continually changes as a result of the entrances and exits of voices. It is precisely the changing components of the complex that animate that work's temporal dissonance. But in a tempo-proportion canon, the tempo complex remains unchanged once the tempos are established. In such a case there are different factors contributing to the temporal dissonance.

Study No. 14, a short and simple 4:5 tempo-proportion canon, is set as a converging-diverging canon. Its two voices have staggered entrances (the slower voice begins the piece and the faster voice enters later) followed by a convergence, or gradual shortening of their imitative gap, which leads to a moment of synchronization in the canonic material. After this point of synchrony the imitative gap widens again as the voices diverge, resulting in staggered endings. The 4:5 proportion controls the rate of convergence and divergence, and it is responsible, obviously, for the existence of the two different tempos, but it seems to have little to do with the temporal dissonance itself. Instead, the work's temporal dissonance is created primarily by the processes of canonic convergence and divergence, along with the rhythmic and metric variety of the canonic line.

Whether placed at the beginning, middle, or end of a work, the point of synchrony in a tempo-proportion canon acts as a large-scale mutual downbeat, or metrically significant simultaneity. Its structural significance, which is far greater than that of other simultaneous articulations, arises from the coincidence of a simultaneity with the melodic coordination of voices. As such, it represents temporal consonance in an otherwise dissonant or uncoordinated setting. But, as I have already stated, canonic process greatly impacts that dissonance, which seems to undergo changes in intensity as the canon unfolds. The question (assuming

Example 6. Nancarrow, Study No. 2, p. 6.1.



Asterisks identify metrically significant simultaneities, which coincide with mutual perceptual downbeats. Solid vertical lines denote simultaneities, and dashed vertical lines show perceptual barlines.

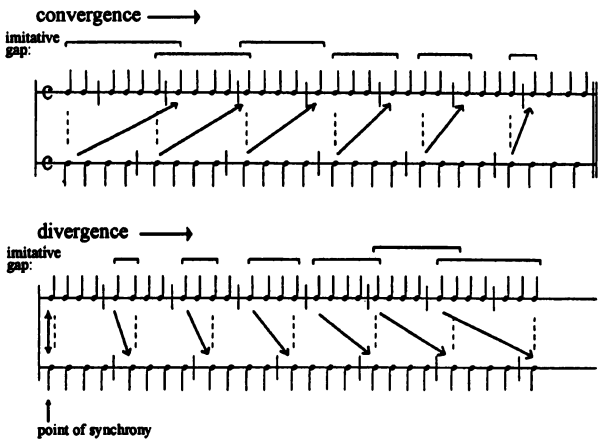
a converging-diverging canon) is whether the point of synchrony acts as a consonant peak to which the convergence builds: do the voices become ever more consonant as they approach the point of synchrony, and do they become ever more dissonant as they depart it? If that is the case, then the canonic process and changing imitative gap between the voices parallel changes in the degree of temporal dissonance. Or, could the reverse be true: as the canonic voices approach the point of synchrony does their temporal conflict intensify, only to have a sudden resolution at the moment of synchrony?

The length of the imitative gap seems to have very much to do with the perception of dissonance. When the voices are widely separated, the retention time necessary for the listener to track the canon from leading to following voice is considerable. As a result, the listener is likely to focus more on the metric and tempo relationships of the voices than their canonic disjunction. The fact of canon is apparent, of course, but the main source of temporal dissonance at this point is the tempo ratio and rhythmic/metric structure, and the resulting presence or absence of metrically significant simultaneities. A shorter imitative gap enables the perception of canonic displacement to become a part of the extended musical "present," a duration of time a listener holds in short-term memory and experiences as a cohesive moment.[16] Thus the imitative gap itself is added to the perceived temporal relationship of the voices, and the melodic misalignment of the voices magnifies the sense of conflict between them. The actual length of the extensible present is surely contextual, dependent on the amount of information being received, and any attempt to quantify it is beyond the scope of this paper. But allowing it as a factor in tempo-proportion canons helps to explain why the intensity of conflict seems the greatest when voices are almost, but not quite, synchronized.

A model of canonic convergence and divergence will illustrate. Example 7 represents the portion of a two-voice, converging-

[16] Jonathan D. Kramer argues persuasively for the importance of such an extended present (which he calls horizon, or specious present) in music perception, and cites relevant cognition research supporting it. See *The Time of Music* (New York and London: Schirmer Books, 1988): 370-374.

Example 7. Model of a convergence to a point of synchrony in a 4:5 tempo-proportion canon, followed by a divergence.

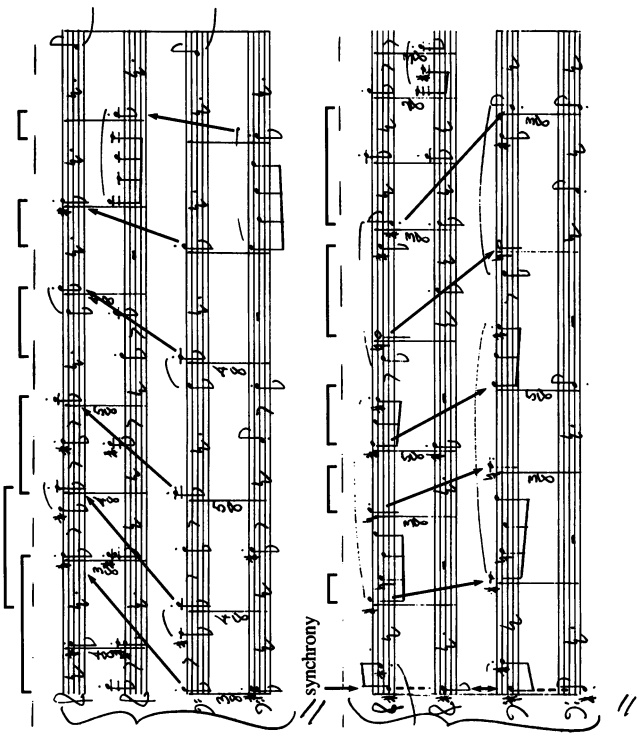


diverging 4:5 proportional canon surrounding its point of synchrony. For clarity's sake, the voices are simplified to repetitive quarter notes in common time, devoid of melody. As the vertical dashed lines in the example show, the frequency of simultaneous articulations (or the potential for them, at least) does not change as the point of synchrony nears; it is set by the 4:5 tempo ratio. What does change is the size of the imitative gap. Isolated, matching downbeat points in the canonic line between the voices are identified by angled arrows in the example, and the length of the corresponding imitative gaps are shown by horizontal brackets above the staves. These brackets provide a clear visual representation of how quickly and dramatically the voices draw near one another in their approach to synchrony, and how quickly they pull apart following the synchrony. Indeed, the changing melodic alignment of the voices is most noticeable in the area immediately preceding and following a point of synchrony. In the downbeat-to-downbeat imitative gaps shown in Example 7, for instance, the difference of one quarter note between the two gaps just before the synchrony, which are one and two quarter notes long, is much more significant perceptually than the difference between the gaps just a few measures earlier, which are five and six

quarter notes in length. Although the increment of change is the same, its percentage of the current gaps differs markedly. When the synchrony is more distant the changing degree of dissonance suggested by the shrinking or growing imitative gap is of minimal significance: there is very little perceptual difference between an imitative gap of twenty quarter notes, for instance, and one of twenty-one quarter notes.

These generalizations regarding changing degrees of temporal dissonance in converging and diverging canons hold true for Study No. 14, where the strongest sense of dissonance occurs in the two systems surrounding the central point of synchrony of the piece. This central passage (pp. 3.1-3.2) is provided in Example 8, annotated to follow the pattern set in Example 7. Once again the lengths of successive imitative gaps undergo progressive and dramatic changes near the synchrony, despite the fact that these downbeat gaps are also affected by metrical changes within the canonic line. The notable and increasingly proportionately significant changes in the gaps, and the attendant modifications in temporal dissonance, are responsible for the intense perceptual focus a point of synchrony achieves in a tempo canon, whether that synchrony occupies the beginning of a diverging canon, the ending of a converging canon, or the middle of a converging-diverging canon. Although it is clear that voices at different tempos gradually and constantly draw nearer to or farther away from one another, their degree of dissonance can seem nearly uniform for a good portion of a canon. Only near the point of synchrony does the rapidly changing alignment of the voices claim perceptual prominence. Temporal dissonance and consonance thus inform and, in fact, amplify the formal shape of Study No. 14, and canons like it, profoundly. In the case of a converging-diverging canon, such as that found in No. 14, the formal shape is symmetrical, with a central focal point.

While the point of synchrony is crucial to the tempo-proportion canon of Study No. 14, the remainder of the study is not insignificant. It is important to consider how temporal dissonance is created, other than by the distance separating a given passage from the point of synchrony. There are two factors to consider. First, the 4:5 tempo ratio sets up the potential for dissonance, though it does not ensure a temporally dissonant fabric.



Example 8. Nancarrow, Study No. 14, pp. 3.1-3.2. Canonic convergence, point of synchrony, and divergence.

Second, Nancarrow realizes this potential and intensifies it by using changing meters in the canonic material, which shifts among 2/8, 3/8, 4/8, 5/8, 6/8, and 7/8 irregularly, rarely maintaining one meter for more than one to two measures. The one notable exception is the set of five consecutive measures of 4/8 that surround the point of synchrony (see Example 8), which provides a metrical and pulse regularity to support the consonance of the synchrony. Elsewhere the changing meters create an irregularity within a voice, an irregularity not only of the downbeat-to-downbeat pulsation but also of the beat pulsation, since the various meters in the study can suggest either quarter- or dotted quarter-note beats. The changing meters also affect the relationship of the two canonic voices: the downbeats are shifted so as to remove metrically significant simultaneities, which, as we have seen, is important in creating temporal dissonance. In Example 8, for instance, there are seven simultaneous articulations, but only one occurs on a mutual downbeat. It coincides, significantly, with the point of synchrony.

The tempo proportion and shifting meters thus create a complexity of detail in Study No. 14 that complements the simplicity of its symmetrical canonic plan. As in Study No. 2, we find a large-scale coordination, now in the guise of shared motion of the voices in convergence toward synchronization, and divergence from it. The moment of canonic alignment is the peak in temporal consonance, yet the approach to it is characterized by a sense of intensifying conflict. Therein lies one of the intriguing paradoxes of Nancarrow's music.

Another interesting feature of temporal dissonance is its relationship to the textural density of a work. We might expect temporal dissonance to increase with the number of voices present, as the fabric becomes more complex. Indeed, sometimes that is the case. But sometimes the degree of temporal dissonance changes inversely to the number of layers in a given texture, according to a principle of "less-is-more." Nancarrow discusses this effect with Roger Reynolds as follows:

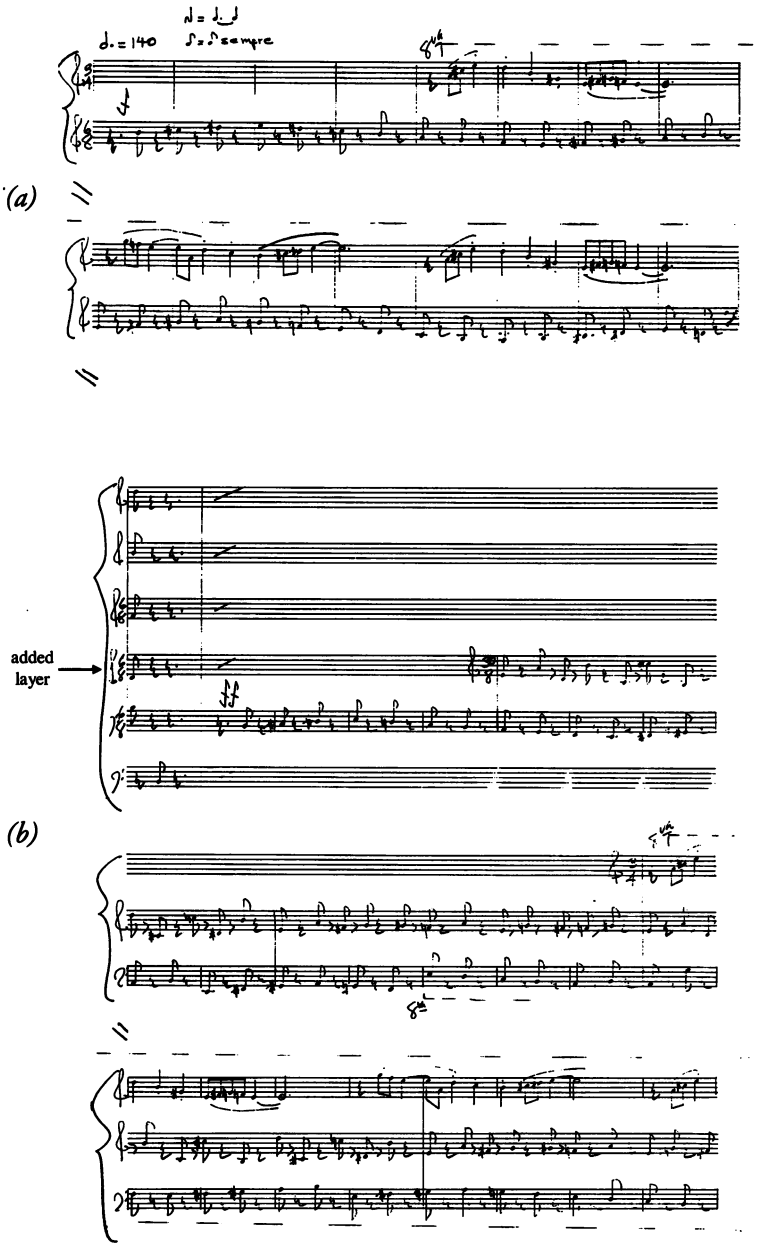
Reynolds: ...do you think there is an optimum number of canonic voices for projecting the most *intense*—if that's an appropriate word—the most intense

temporal dissonance? Is there an optimal number of voices that produces a situation in which you get the most satisfying sense of "temporal dissonance"?
Nancarrow: I've never thought of it that way, but come to think about it, probably the piece with 2:√2 [Study No. 33] with just two voices is probably the most dissonant of all because it's just the two clashing all the time.
Reynolds: As you add voices...
Nancarrow: It tends to smooth out...[17]

A comparison of the short two-voice passage that opens Study No. 7 with its reprise later in the work, to which a voice is added, illustrates the less-is-more principle. The two excerpts are provided as Examples 9a and 9b. The voices share a notated tempo of 𝅗𝅥. = 140. At the beginning the basic relationship of the voices is a simple 2:3 ratio: the lower voice divides their common measure length into two dotted quarter-note halves, as 6/8 (expressing a dotted quarter-note pulse of 280), while the upper voice divides the measure into three quarter notes, for the most part, as 3/4 (expressing a quarter note pulse of 420). With their frequent downbeat simultaneities, in fact, the voices border on being polymetric rather than polytemporal. This apparent simplicity is deceptive, however. The lower voice subtly contradicts the regular phrasing of the upper voice by shifting the contour peaks of its scalar material so that its metric orientation is ambiguous. As illustrated in Example 9c, the contour peak in the first four bars (E5 in m. 3) sounds like—and is notated as—a downbeat. But during the next two four-measure units the low and high peaks occur on notated upbeats, undermining the seeming metric regularity of the layer. When a peak occurs again on a notated downbeat in m. 14 it may well not be *heard* as a downbeat, due to the ambiguity of the peaks that precede it. The lower voice material of the first half of this passage, mm. 1-8, is repeated in mm. 9-16, but transposed down a fifth and metrically shifted one-half measure earlier. The upper voice, meanwhile, begins with four measures of rest, followed by two eight-measure phrases that form something of a period. The metrical shift of the lower voice calls into question the metrical coordination of the two voices and creates a sense of conflict between them they would otherwise lack, given their simple 2:3 rhythmic relationship and frequent

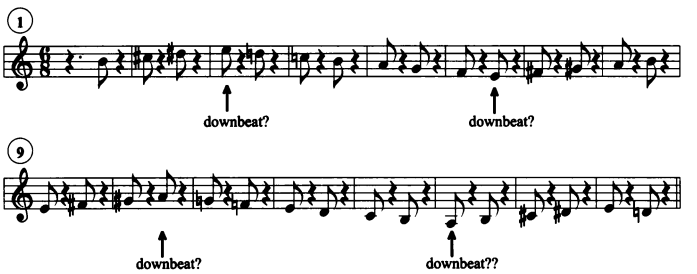
[17] Reynolds, "Interviews": 22.

Example 9. Nancarrow, Study No. 7. (a) Opening, p.1., in two voices; (b) Reprise of the opening material with an added layer (middle staff).



Example 9 (continued). Nancarrow, Study No. 7. (c) Metrical implications of contour peaks of the lower layer, mm. 1-16.

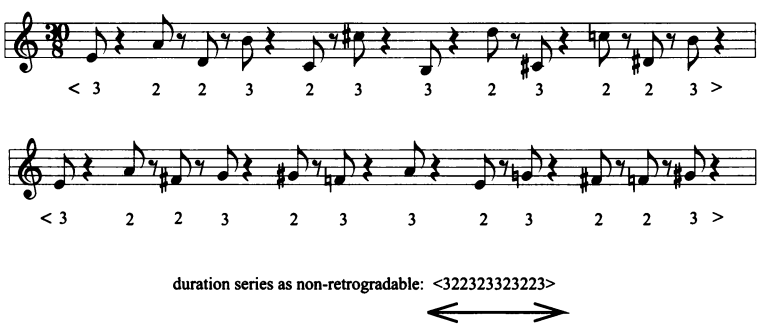
(c)



simultaneous articulations. The overlapping phrase structure of the voices adds to their non-synchronized effect. The result is a temporally dissonant texture of considerable clarity.

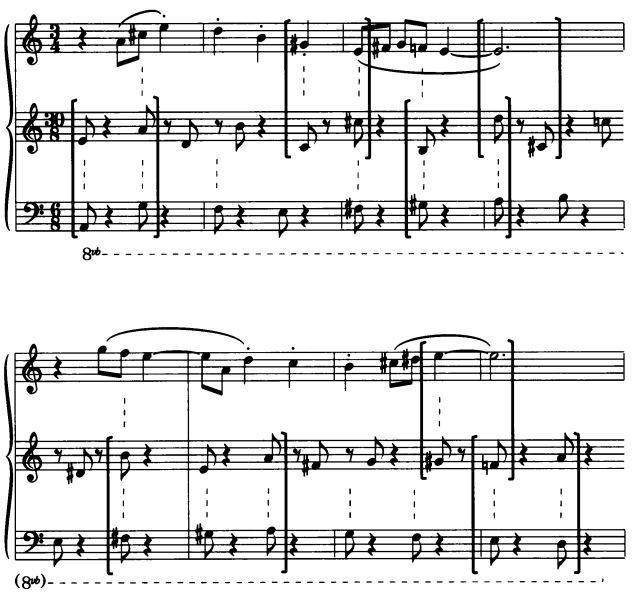
Now let us see what happens when a third voice is added to the return of this material (Example 9b). The voice that is added at p. 16, notated on the middle staff, shares the tempo of ♩. = 140 of the original two voices, but not their measure length nor their relatively regular rhythmic quality. In this, the added layer dramatically increases the complexity of the passage and offsets its prior clarity. A close examination of the layer will demonstrate how it has such a profound effect. As shown in Example 10, it does not have a regular unit of pulsation, but proceeds with motion by *either* the quarter or dotted quarter note. The rhythms cycle through a palindromic duration series that is notated within a single 30/8 measure. In terms of eighth notes the series can be represented as <322323323223>. Not only are the pulses irregular, consisting of an amalgamation of the prevalent beat durations of the other two layers, but the rhythms also contradict both the metric and phrase regularity of the other layers. The length of the duration series, at thirty eighth notes, does not match the original voices' recurring, if staggered, eight-measure units.

Example 10. Nancarrow, Study No. 7. Duration and pitch series of the added layer, p. 16.



Simultaneities abound among the three layers at p. 16 (see Example 11), but they are significantly neutralized by the rhythmic irregularity of the added layer, which sets up a fundamental conflict with the relative regularity of the other two layers. The use in the added layer, alternatively, of the prevalent durations of the other layers further complicates the texture. The added layer seems unpredictably (and briefly) to agree metrically with first one and then another of the other two layers, as illustrated in Example 11. These shifts of allegiance are so temporary that they serve merely to confuse the texture of the passage: is the new layer coordinated with one of the other layers or is it not?

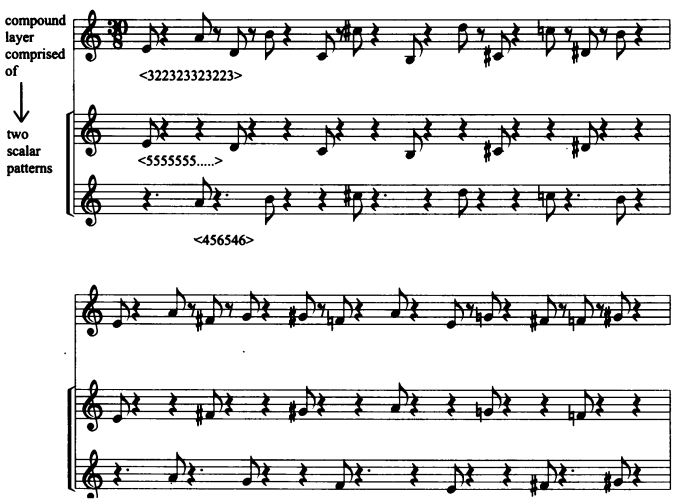
Example 11. Nancarrow, Study No. 7. Simultaneities among the three layers (dashed vertical lines), and shifts of durational allegiance of the added layer (vertical brackets).



The texture is further complicated by the compound nature of the added layer itself (see Example 12). Since it is composed of two separate lines, each of which follows its own recurring rhythmic and melodic pattern, the effect of the added layer on the passage in

question is magnified. The melodic patterns are modeled on the scalar material of the lowest layer (ascending major and descending minor scales). This detracts from any distinct melodic identity the added layer might have. The material of p. 16 is tremendously active, to be sure. But an active texture is not equivalent to a temporally dissonant one. Once all three layers are present the texture becomes obscured, as does, therefore, the relationship of the layers to one another. The contrast between the brief passages under discussion here, and between others like them, accounts in part for the magic of Study No. 7. The fuller passages forego the kind of textural clarity required to articulate definitive temporally dissonant structures, particularly when an added layer has the rhythmic and melodic complexity of the third layer of p. 16. The study's changes in texture and temporal dissonance are largely responsible for articulating its form.

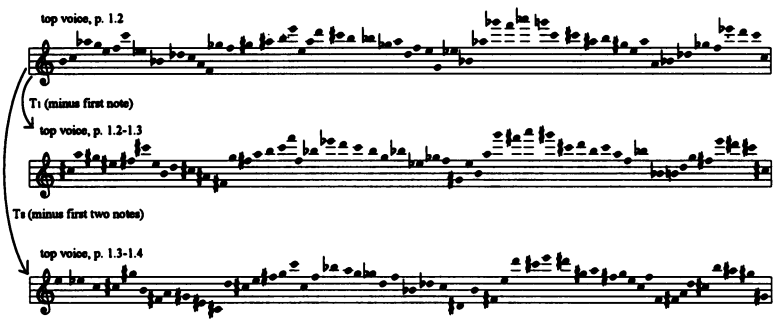
Example 12. Nancarrow, Study No. 7. Compound construction of the added layer.



The works examined so far have utilized metered, primarily non-changing tempos. There are two other important methods of rhythmic organization in the studies. Some works do not follow a steady unit of pulsation. They are written in non-metered, or

proportional, notation rather than with conventional durations. Other works feature gradually changing speeds. These different rhythmic approaches raise new issues with regard to an examination of temporal dissonance: tempo ratios and simultaneous articulations generally no longer serve as markers for dissonance. The dissonance, instead, is created contextually, as is its implied companion, relative consonance. Two different time types may, in fact, coexist within a single study, in which case the main source of the dissonance may well be the conflict of time types itself.

Example 13. Nancarrow, Study, No. 21. 54-note series and its first two permutations.



One of Nancarrow's best-known pieces, Study No. 21 ("Canon–X"), features continuously changing speeds. Both voices in the work are based on the same 54-note pitch series (Example 13). The series undergoes a systematic subtractive process, which omits the first note with each subsequent repetition. The series is also transposed with each repetition (the first two transformations appear in Example 13). Although the transposition levels seem to replicate the opening intervals of the series (T_1 and T_8), that correlation does not continue past the first two transpositions. Once the series is reduced to a single note, the lower voice presents the entire subtractive/transpositional process again while the upper voice states the series just once in its entirety. Antithetical temporal processes in the voices drive this study. The lower voice begins with fairly widely spaced staccato articulations, approximately 3.4 per second, and gradually accelerates to an extraordinary 110

articulations per second by the end of the study.[18] Meanwhile, the upper voice begins quite rapidly, with approximately 36 articulations per second, and gradually slows to 2.3 per second at the close. Hence, by exchanging speeds, or at least their relative speed functions of faster and slower, the voices form the metaphorical "X" of the work's subtitle. Initially, the listener is unlikely to hear the voices as dissonant. One is fast and the other slow, certainly, and they are well-differentiated registrally. But without any sense of pulse—which is certainly undetectable in the fast upper voice at the opening, and which, once the work gets well under way, is heard to be gradually and continually changing in both voices—the fast/slow relationship does not translate directly into temporal dissonance. The voices create an overall effect of difference, but not continuous conflict.

Yet the basic tempo exchange process does produce moments characterized by a greater sense of conflict between the voices, or, at times, near consonance. As the speeds of the voices converge, the articulations of the slower voice sometimes seem to impose a grouping structure on the faster voices. This is especially true when a slower articulation nearly coincides with a faster one, and when the implied grouping of faster articulations is close to a familiar integer-ratio grouping (e.g., 4:1, 3:1, or 2:1); these kinds of ratios are essential to Yeston's, Krebs's, and Cohn's definitions of metrical consonance. Because the speeds of the voices constantly change, these grouping structures are quite brief, and they are never exact. But their near coordination suggests a striving for consonance, and the fact that they almost attain that consonance intensifies the sense of conflict between the voices at that point, much like the approach to canonic synchrony in Study No. 14 was found to intensify temporal dissonance. Eventually the voices approach a 1:1 speed ratio, before they exchange faster and slower roles. Another set of briefly implied groupings follows, as the speeds move back apart. Example 14 contains representative passages of near-consonant grouping: 4:1 (p. 4.1), 2:1 (p. 5.3), and 1:1 (p. 7.1).

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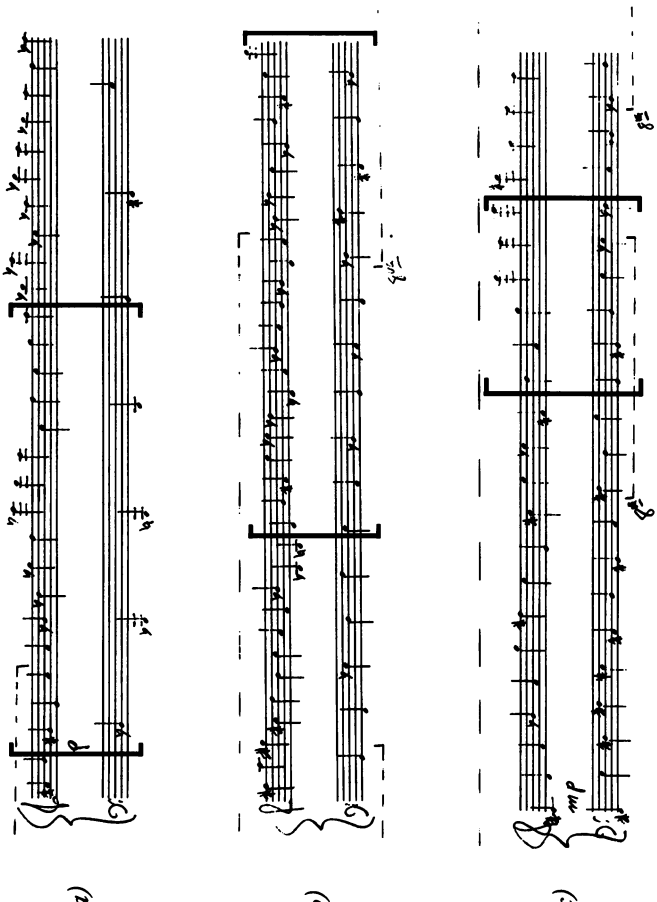
[18] The study is written in proportional notation, in which the durations of notes are represented by the space separating them on the page. Speeds are calculated by measuring the distance between adjacent notes in the score, and it is in this way that they are approximations.

Example 14. Nancarrow, Study No. 21. Implied groupings: (a) 4:1 (p. 4.1); (b) 2:1 (p. 5.3); (c) 1:1 (p. 7.1).



Brackets identify moments of near coordination.

These moments of near-coordination (and thus intensified dissonance) are situated roughly in the center of the study, where the speeds do not differ as extremely as in the outer passages of the study, and where the speeds therefore are more easily compared. At the beginning of the study there are approximately 11 notes in the upper voice to each note in the lower voice, and by the end of the study the lower voice has approximately 48 notes for each note in the upper voice. A textural process that occurs in the second half of the study is also important in setting it apart from the central section. Beginning at p. 10.1, the upper (and now slower) voice is reinforced by octave doublings, and it becomes progressively more strongly reinforced until the end of the work: at p. 10.5 its line is presented in three octaves, at p. 12.1 in four octaves, and at p. 14.1 (to the end) in five octaves. These changes are illustrated in Example 15a.[19] The lower voice, meanwhile, shifts to a higher range at p. 14.1 than it had previously occupied (see Example 15b). It now spans the middle register of the expanded upper voice. As a result, the voices lose their previously distinct registral identities. The lower voice also loses its identity as a melodic line, through its incredibly fast pace. By the end of the study it sounds more like a near static flurry of indiscernible notes than a succession of pitches, and, because of this, as well as because of the registral mingling that occurs, the voices tend to merge and become indistinguishable. The lower voice overwhelms the upper voice and absorbs it perceptually, despite the ultimate five-octave doubling of the upper voice. Any sense of independence between the voices is essentially dissolved; the dissolution is punctuated by the singular simultaneous (consonant) articulation on octave C's that concludes the piece. The shape of the piece effectively results from the superimposition of two opposing tendencies: the simple tempo process, whereby the voices are very different, become almost the same, and then become very different again, and the concentration of temporally dissonant near-integer groupings in the center of the study, where the speeds are closest.

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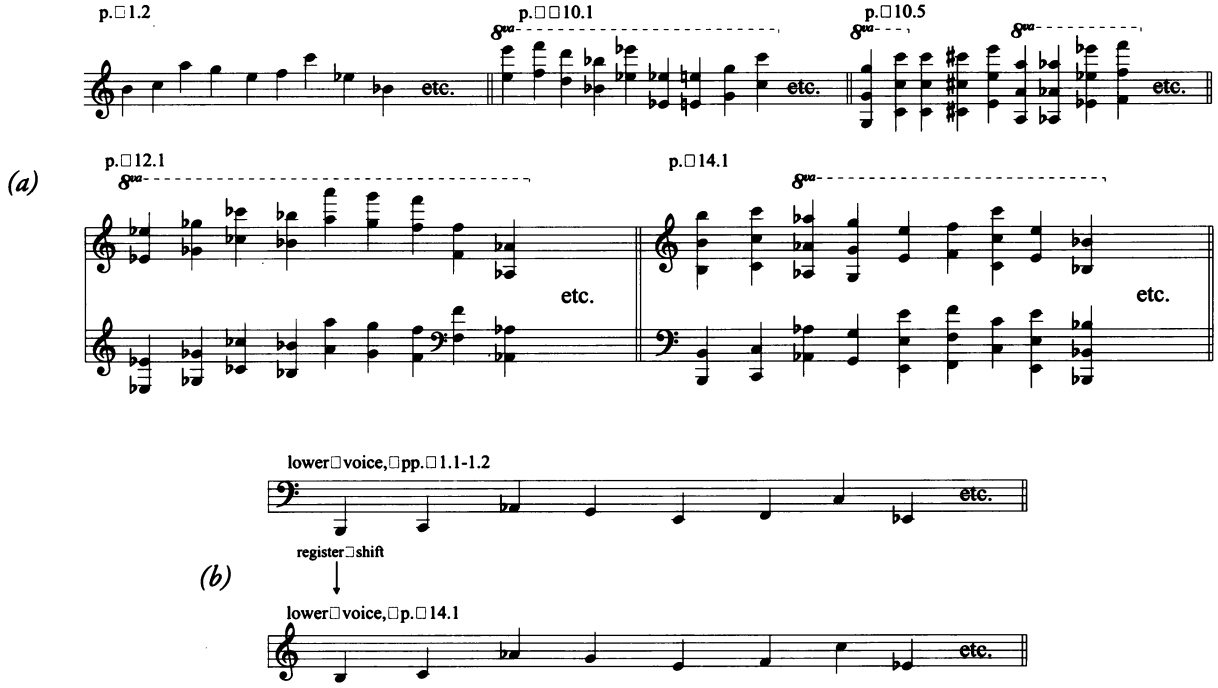
[19] In *The Music of Conlon Nancarrow*, Gann notes (p. 153) that Nancarrow added the octave reinforcements to the upper voice of Study No. 21 after the original composition of the study, in order to make the upper voice more audible against the increasing flurry of the lower voice.

Example 15. Nancarrow, Study No. 21. (a) Progressive doublings of upper voice in second half of study; (b) Upward register shift of lower voice at p. 14.1.



Unlike Study No. 21, Study No. 27 (subtitled "Canon–5%/6%/8%/11%") features the contrast of steady with changing tempos, and its texture is further complicated by the fact that it is constructed of more than two layers. In fact, the texture resembles that of Study No. 2: a single-layer ostinato with a steady tempo appears throughout the movement against a series of canons in two to four voices, whose tempos continually change. Because of these additional layers there is the possibility not only of a fundamental dissonance between the steady ostinato and the layers with changing speeds, but also of dissonance among the layers with changing speeds themselves.

Nancarrow likens the ostinato to "the ticking of an ontological clock."[20] Page 1 of the score is provided as Example 16.[21] It consists of staccato articulations based exclusively on a chromatic pitch cluster, D♯4-E4-F4-G♭4.[22] The pitches of the cluster appear in perpetual, random reorderings throughout the Study, in two staccato durations, a "short" and a "long." A short equals half the duration of a long, measured as $6^1/_2$ and 13 millimeters in the score, respectively, where 13 millimeters represents MM = 220.[23] There are no specific, recurring pitch or rhythmic patterns within the layer, but it achieves its ostinato nature through its limited content, its constant presence, and its steady character relative to the surrounding layers, whose tempos continually and gradually change. Even when the pitch material of the ostinato is modified, through appended octaves (p. 18.3), thirds (p. 29.2), triads (p. 42), seventh chords (p. 47), and multiple octaves (p. 53), its contextual function as an ostinato remains unchanged.

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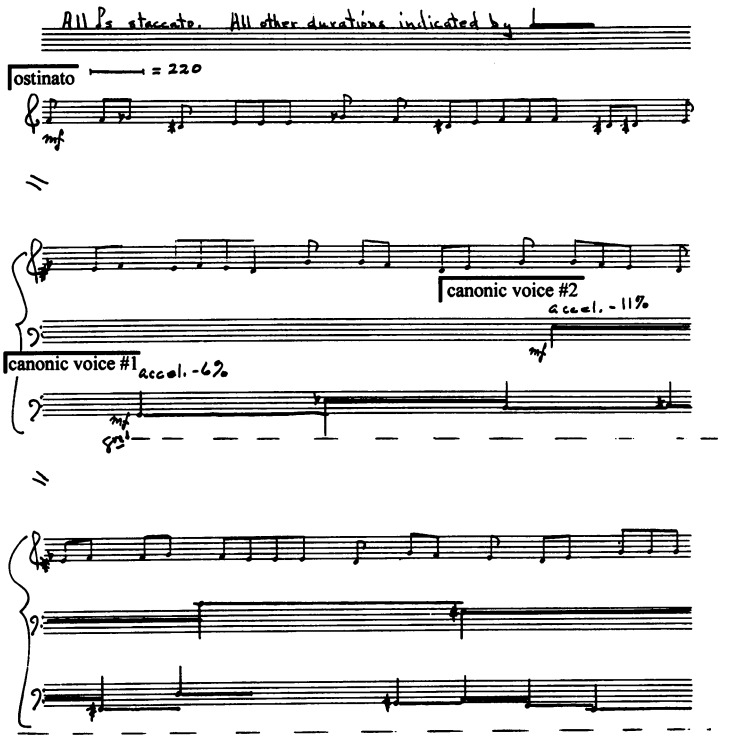
[20] Reynolds, "Interviews": 9.

[21] In the proportional notation of Study No. 27 traditional durations have meanings unrelated to their conventional rhythmic implications: eighth notes represent staccato articulations, and quarter notes are sustained notes whose durations are shown by horizontal lines following their noteheads.

[22] The two pitches of the ostinato that end the piece, A♭-G, are the only ones that deviate from the cluster. They create a concluding/cadential gesture on G, which is also the final note of the surrounding layers.

[23] These measurements correspond to the printed score of Study No. 27, not the reproduction of p. 1 of it given in Example 16, which has been reduced in size.

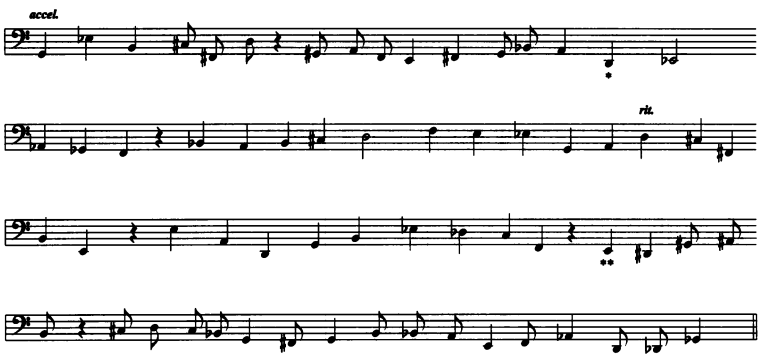
Example 16. Nancarrow, Study No. 27, p. 1.



The remaining layers of the study are canonic. Like the ostinato, the canonic line is based on limited durations, often using a single repeated duration, or two durations, a short and long, with a short again being half the duration of a long. The canonic layers feature percentage tempo changes of 5%, 6%, 8%, and 11%, either by *accelerando* or *ritardando*, as specified in the score. In an "*accelerando*-5%," for example, each successive duration, assuming they are functionally equivalent as "short" or "long" durations, would be 5% shorter than the previous duration. In the opening sections of the study, upon which we will focus, the material of the canonic layers consists of sustained single pitches. The pitch imitation among the canonic layers, which number from two to four, occurs at various intervals. Long and short durations are also imitated, although loosely: the voices proceed at their own rates of *accelerando* and *ritardando*, and they frequently start at slightly different speeds.

Because two or more of these changing layers always appear concurrently with the very different and ever-present ostinato layer, there is an extreme sense of disparity throughout Study No. 27 between the two types of material. This disparity is so great, in fact, that the canonic and ostinato layers seem completely unrelated and unrelatable: the relationships that achieve perceptual prominence in the work are instead those involving like material, that is, the relationships among the canonic layers. The contrast of the steady and changing tempos does not seem to create temporal dissonance, because their representative layers are too dissimilar. The ostinato and canonic layers occupy distinctly independent time worlds: because of this extreme temporal division there is no implication that the tempos of the changing layers might approach the tempo of the ostinato (creating a kind of consonance), nor does that approach ever occur. The ostinato truly plays the role of a separate and immutable underpinning, which Nancarrow sets up for its referential, clock-like constancy. The detached nature of the ostinato is confirmed by the close relationship among the other two or more contemporaneous canonic layers, a relationship from which the ostinato is excluded. It is to the canonic layers that our attention is drawn, therefore, and primarily among them that temporal dissonance is created.

Example 17. Nancarrow, Study No. 27, pp. 1.2-4.2. Lower canonic voice, with suggested long and short rhythms represented in conventional durations.



*The previous "long" is reinterpreted as a "short," to prolong the *accelerando*.

**The "short" of the middle passage is once again reinterpreted as a "long" for the remaining *ritardando*.

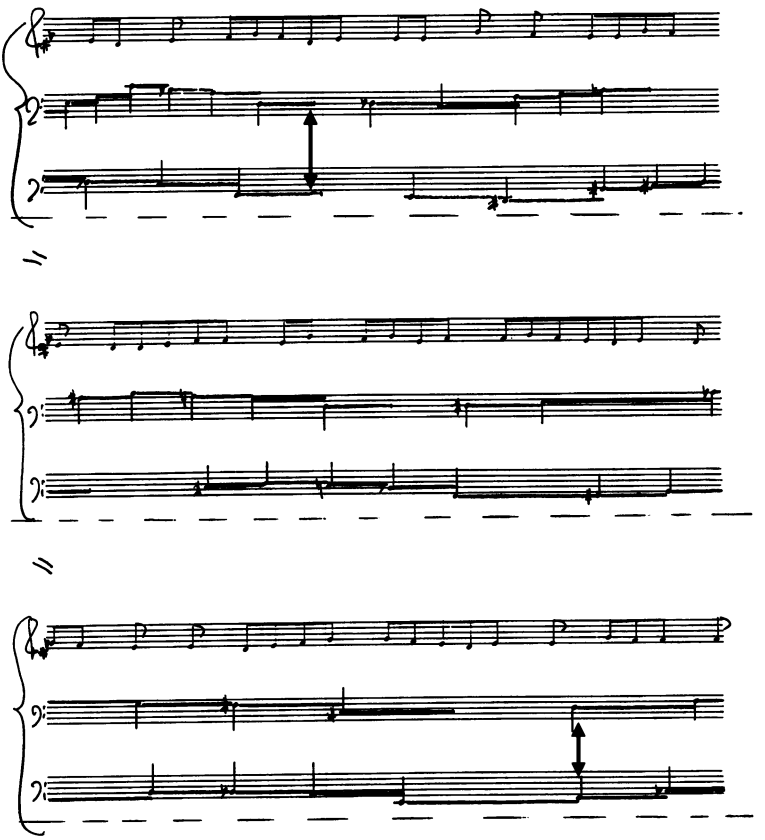
There are two canonic voices in the opening section of the Study, pp. 1.1-4.2, with pitch imitation at the major sixth plus an octave (see Example 16). Both voices perform an *accelerando* followed by a *ritardando*; the first and lowest voice proceeds by 6% and the second voice by 11%. Their durations suggest a pattern of short and long rhythms that remains clear despite their continual modifications. The canonic line, re-notated in representative conventional durations in order to illustrate its rhythmic pattern, is provided in Example 17. Given their staggered entrances and their different rates of change the voices could well have converged quite rapidly upon a simultaneity, but Nancarrow guards against this by assigning the voices different starting speeds. The later but more rapidly accelerating voice starts with much longer durations, so that it cannot catch up with the first voice as quickly as it might have. The voices maintain their relative leading and following positions until after they begin their *ritardandi* at p. 2.3. At p. 3.1 they finally converge upon the same place in the canonic line, although the convergence actually occurs during the sustained portion of

articulations (D3 in the higher voice and F1 in the lower voice) rather than at attack points, so perceptually it is fairly ambiguous. The higher voice then briefly assumes the lead in the canon, and it is moving faster, but because it is slowing down at a greater rate (11%) than the lower voice another point of convergence follows, at p. 3.3. Page 3 of the score is provided in Example 18, where double-headed arrows indicate these two points of synchrony. This second convergence again coincides with the pitches D3 and F1, but it is now marked by simultaneous attacks between the layers.[24] As a result it has a stronger effect than the previous convergence. Together the canonic convergences provide brief moments of coordination in the passage, coordination that represents consonance with respect to the layers' otherwise staggered positions in the canonic line, their different speeds, and their different rates of change.

In the short passage of pp. 7.3-10.1 a new four-voice canon accompanies the ostinato, and its convergence is much more conspicuous than those in pp. 1.1-4.2. In fact, the process of convergence is very plainly the point of this particular canon, which culminates with a simultaneous articulation by the four voices upon the final note of the canonic line at p. 9.2. The four-voice texture and canonic process of this section are exceptionally clear. The simplicity of the canonic line and the sharp registral contrasts of the voices are responsible for this. The canonic line features constant reorderings of a four-note chromatic cluster, akin to that of the ostinato, presented in equivalent durations (i.e., all "shorts") that are subjected to *ritardando* only. The entrances of the voices are staggered and distinct. The order of entrances can be described registrally as tenor-bass-soprano-alto, and the rate of *ritardando* increases with the successive entrances, each of which also begins faster than the one before. See Example 19, where the discrete registral space of each layer's cluster in the passage is illustrated, including that of the ostinato. What is so remarkable about this canon is its single-minded pursuit of convergence, and its rapid

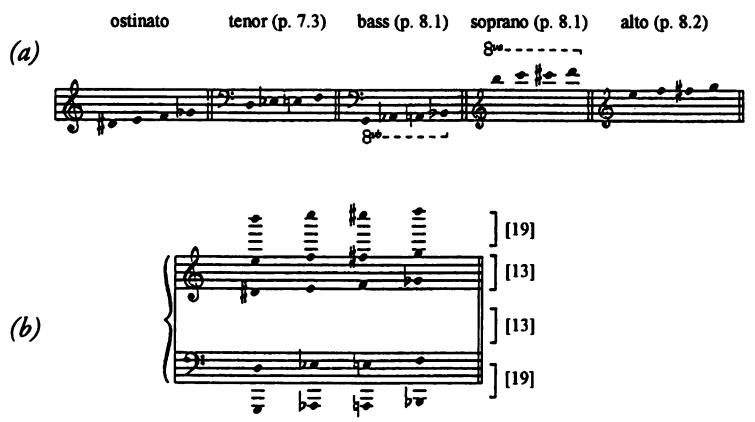
[24] There are two slight misprints in the score on p. 3 that can confuse our visual tracking of the layers' canonic positions: at p. 3.2 the lowest voice should have a period of rest occupying the second half of its notated F1, and at p. 3.3 it should also have a period of rest occupying the second half of its E1.

Example 18. Nancarrow, Study No. 27, p. 3. Arrows identify points of synchrony.



attainment of it. Within the span of approximately eighteen seconds, the four related but temporally clashing canonic voices resolve their dissonance through their convergence upon a simultaneity, which represents consonance. Because the voices not only start at different speeds but also proceed at different rates of change, the convergence is dramatically faster than in a strict tempo-proportion canon: the pace of the process itself is magnified through the use of gradually changing speeds.

Example 19. Nancarrow, Study No. 27. (a) Unordered chromatic clusters of the ostinato and canonic layers, pp. 7.3-10.1; (b) Resulting symmetric pitch complex.



The question remains how the use of percentage changes in the canonic voices of Study No. 27 relates to temporal dissonance. Difference, after all, is not the same as dissonance. Difference does occupy a prominent position in Nancarrow's style: differences of register, tempo, rhythmic organization, and melodic material can define the individual layers in his stratified textures. But dissonance goes beyond difference to incorporate the element of conflict relative to consonance. As we have seen in No. 27, the process of convergence can serve the same function in a canon with changing speeds as in a tempo-proportion canon, that of driving

toward a coordinated consonance against which proximate material may be perceived as dissonant. How does the effect of changing tempos relate to that of steady, proportionally-related tempos, however? One significant difference is the lack of a steady pulse, so that, in essence, there is no tempo at all. Layers with percentage changes bypass the notion of tempo, and usually meter, as well. As a result, the possibility of metrically significant simultaneities disappears. In fact, in this kind of work Nancarrow usually avoids all simultaneities except those at convergence points. This raises another important issue relating to changing speeds, the issue of control. With steady, proportional tempos there is an element of inevitability: once the different tempos are introduced, and the process (i.e., canon) established, it can be very clear where a piece is headed. With changing speeds, on the other hand, there may be no such predictability. In No. 27, for instance, one cannot know when a voice will switch from *accelerando* to *ritardando*, what percentage rate of change it will follow, at what speed the voices of a phrase will start and end, and thus where, if any, a convergence might be placed.

This quality of unpredictability seems to be one of the most important elements in the formation of temporal dissonance in a study with changing speeds. The tension required for dissonance is situated in the continuously changing relationship of the voices. As with all of Nancarrow's temporally dissonant structures, the perceptual integrity of layers is crucial, as is the presence of some element of temporal consonance. In most of his works, that consonance (usually represented by simultaneities) serves a broad formal function, which is often accompanied by harmonic and/or processive coordination. The interaction between large-scale coordination and temporal dissonance, or between conventionality and innovation, distinguishes Nancarrow's music. It is remarkable that the studies are so varied, grounded as they are in this specific interaction, and limited as they are in instrumentation. Narrowing his compositional focus primarily to exploring temporal dissonance in a player piano setting seems to have vitalized Nancarrow's creative energies: "Probably *because* of the piano's limitations, I had many more possibilities, since I wasn't spread out all over the place,

I could concentrate on this little thing [temporal dissonance]."[25] Whether temporal dissonance is a "little thing" is debatable, but Nancarrow certainly did explore the potential of temporal dissonance, with wondrous results.

[25] Reynolds, "Interviews": 21.