Article

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Empirical Approaches to the Performance Analysis of New Music

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ABSTRACT: New Music inherently challenges norms of performance practice, expression, interpretation, perception, and audience reception. Given the centrality of these themes to musical performance studies and the significant recording and performance traditions of many works of New Music, it is surprising that so little attention has thus far been dedicated to this repertoire. In response to this lacuna and Clarke and Doffman's (2014) prospective paradigm for a performance studies of New Music, this article offers a close reading of the relatively limited empirical performance literature, highlighting the novel and varied epistemological affordances of the works in question, with consideration for repertoire chosen; selection of recordings; methodological approaches; themes addressed; the relevance of score analysis; the role of the performer; and the import of the research for audiences. I then contribute my own practice-based research on Stockhausen's Klavierstück X (1961), illustrating the creative potential of self-reflexive performance analysis for performers of complex music. I thus offer a state of play for empirical research, while showcasing further aims and objectives, allied to the peculiar exigencies, performance ecologies, and aesthetic qualities of New Music.

KEYWORDS: New Music; Performance Studies; Empirical Musicology; Practice Research; Stockhausen

INTRODUCTION

As one of the early outputs from the influential AHRC Research Centre for the History and Analysis of Recorded Music (CHARM) project, Eric Clarke and Nicholas Cook (2005), two of the leading scholars in musical performance analysis, published an article on Bryn Harrison's *être-temps* (2002). It was unusual in applying empirical methods to a work of New Music, whose nested-tuplet rhythms and complex textures marked a departure from the traditional repertoires analysed thus far.[1] Written in collaboration with the composer and a pianist, Philip Thomas, whose preparation methods and recorded performances formed the principal objects of study, it raised novel questions about the nature of interpretation and expression in complex music, leading Clarke to call for a 'broader paradigm than has been normal in either musicological or psychological studies of performance' (p. 64).

Clarke and Mark Doffman (2014) would subsequently hypothesise this paradigm in terms of its continuation, extension, and deviation from traditional paradigms of expression and the relationship of these phenomena to twentieth- and twenty-first-century developments in notation, composer-performer relationships, and questions of instrumentality and embodiment.[2] Recognising a lack of empirical endeavour in the field of New Music, the authors cite five areas for future research: (1) the relationship between notation and expression; (2) interrogation of traditional categories of expression; (3) historical investigation of the development and stabilisation of performance practices; (4) the persistence of historical performance tropes; and (5) the relationship between performers and machines.

Since this time, a small but significant body of empirical research into post-1945 contemporary music has emerged (Krytska, 2015; Sethares & Touissant, 2015; Utz, 2017; Duinker, 2021; Jones, 2022) in addition to the pioneering work of Clarke et al. (2005), and others (Moelants, 2000; Nedelman, 2005), hitherto omitted from surveys of performance research (see for example Gabrielsson, 2003; Cook, 2013; Lerch et al., 2020).[3] This article

[1] The term New Music, elsewhere described as 'contemporary concert music' (Clarke and Doffman 2014), refers here to the commonly periodised (though not concretely determined) repertoires of post-1945 Western art music.

[2] The 'within-category' irregularity paradigm (Leech-Wilkinson 2009a), whereby expression is measured according to its deviation from categorical norms such as rhythm, chromatic pitch, and meter, is the chief measure against which these judgments are made.

[3] These developments are indicative of growing musicological interest in the performance of New Music. This discourse is broad, encompassing, to cite but a few examples, technical and critical writing on performance practice (Schick 1994; Cox 2008; Pace 2009; Kanach 2010), historical investigation (Pritchett, 2004; Iddon, 2011; Karantonis et al., 2020), ethnography (Born, 1995; Payne, 2018), and questions of materiality (Wilson, 2021; McLaughlin, 2022). A spate of recent performance-oriented monographs has expanded this field, exploring themes such as the relationship of theory, analysis, and performance (Leong, 2019); the phenomenology of musical time (Kozak, 2020); and identity and diversity (Nonken, 2020) in New Music. A thorough survey of this literature would be of benefit for future research. Jones (2023), which features empirical performance analysis of Stockhausen's Klavierstück X, and the German-language monograph Unerhörte Klänge by Christian Utz (2023), which brings a wide range of methods and critical perspectives to post-tonal music of the twentieth and twenty-first centuries, were released following initial submission of this article and are therefore not included in my close readings.

offers a close reading of these studies, considering, among other things, repertoire chosen, selection of recordings, methodological approaches, themes addressed, the relevance of score analysis, the role of the performer, and the import of the research for audience perception and reception.[4] I then contribute my own practice-based research on the performance analysis and performance of Karlheinz Stockhausen's Klavierstück X (1961), illustrating the creative potential of critical and self-reflexive performance analysis for performers of complex music, while raising practical and ethical questions about its reproduction. As well as offering a state of play for empirical research on New Music (which, given the mainstream presence of these recent sources, seems set to witness significant expansion), my survey and personal contribution allow for reflection on the progress of Clarke and Doffman's proposed areas of research, while showcasing further aims and objectives, allied to the peculiar exigencies, performance ecologies, and aesthetic qualities of New Music.

EMPIRICAL APPROACHES TO THE PERFORMANCE ANALYSIS OF NEW MUSIC

The first published performance analysis of a work of New Music was by Belgian music psychologist Dirk Moelants (2000) on the second movement of Karel Goeyvaerts's Sonata for Two Pianos Op. 1 (1951).[5] Moelants uses statistical methods to engage with and compare the quantifiable features of the score and the acoustic evidence of live recordings by Goeyvaerts and Stockhausen, Alfons and Aloys Kontarsky, and Jan Latham-Koenig and Geoffrey D. Madge. In doing so, he aims to investigate the nature and location of 'expressive strategies' (p. 55) and to distinguish these from performative 'errors' (p. 49), typically involving the misalignment of attacks between the performers. The data-collection and mathematical procedures used to assess these distinctions are typical of psychological studies of performance and will exceed the skillset and understanding of many performance studies musicologists, including myself, highlighting a problematic impasse between disciplines that share many of the same epistemological aims. His findings are nonetheless thought-provoking, if not musically enlightening.

Moelants proceeds from the assumption that 'the aesthetics underlying serial composition require musical precision' (p. 58) and a view of the music as 'essentially static, non-dramatic, and without (emotional) "expression"' (p. 39). Implicitly 'non-emotional' expression is then identified in traits such as the diminution of inter-onset-intervals (IOI) for longer durations and notes with greater metric strength. In terms of pairings, no clear expressive strategies are observed in the performance of Latham-Koenig and Madge, whereas Goeyvaerts and Stockhausen exhibit different strategies with respect to IOI lengthening. Aloys Kontarsky, meanwhile, exhibits clear expressive strategies in contrast to the minimal expressive consistency of his brother. These conflicts are cited as complementary explanations for the prevailing lack of co-ordination between the pianists, otherwise

[4] These considerations are equally applicable to qualitative discussion of recordings of New Music (see for example Leech-Wilkinson, 2009b; Thomas, 2013; Iddon, Payne, & Thomas, 2019); my empirical focus, however, excludes such studies.

[5] While not as avant-garde in its treatment of temporality as other works of New Music surveyed here, Goeyvaerts's Sonata is justified for inclusion on the grounds of its serialisation of multiple musical parameters and the consequent challenges invoked for performance practice, not least with respect to the co-ordination of two pianos.

attributed to the practical challenges of tempo consistency and metric cueing. The author thus concludes that ‘performers do not use a uniform set of rules to realize an expressive performance of punctual serial music’ (p. 56).

Moelants’s computational methods offer insights into the expressive approach of individual performers in a complicated collaborative context that, crucially, could not be determined by the ear alone. Punctual serial music is particularly suited to such procedures, he argues, since ‘a number of variables […] fully describe the score and can serve as the basis of an objective musicological analysis' (p. 38). This rationalism, however, allied closely and somewhat uncritically to the ideology of the young Goeyvaerts, ignores certain musically intuitive and technical features of the piece that may affect the ‘expressive strategies’ of the performers, such as the idiomatic arrangement of dynamics, the broadly melodic contours of many of the musical ideas, and the necessary management of fingers, hands, and pedals. While identifying ‘hidden’ features of the score through statistical analysis, such as a gradual reduction in ambitus across the course of the movement (p. 43), Moelants does not connect his expressive insights to these findings and is therefore unable to inform the listening experience or shed further light on the aesthetic value of the piece. Nevertheless, his study is important in being the first to address challenges in distinguishing undesirable errors from conscious or unconscious expressive tendencies in performances of complex music.

Three of the eight studies surveyed here address Stockhausen’s early Klavierstücke. This is perhaps unsurprising, given their popularity and focus on aspects of musical temporality, with the application of empirical analysis even prophesied by the composer (Stockhausen 1959, pp. 30–31). Eric Nedleman’s doctoral dissertation (2005), for example, analyses three archive recordings of the miniature Klavierstück III (1952) by David Tudor in comparison with Herbert Henck’s single commercial recording. Like Moelants, whose work is praised, Nedelman aims ‘to provide a quantitative view of the performances rather than a qualitative or aesthetic consideration of correct or better performances’ (p. 145). The analysis itself is contextualised by Tudor’s archival working notes for the early Klavierstücke, as well as extensive documentation of his performance history of the pieces.

Nedelman uses timing and volume data to illustrate a marked consistency in Tudor’s playing across the three versions and a greater overall stability of tempo in Henck’s recording (pp. 144–186). He also describes stylistic traits, such as Tudor’s broad yet nuanced dynamic range, with a remarkable level of granular detail, including consideration of the technical contingency of tempo and the resonance of the instrument. While lacking meaningful connection to the documentary materials presented (no performance notes exist for the brief and relatively simple Klavierstück III and no comparison is made with Tudor’s approach to the Klavierstücke across the decade or so that he worked with the composer), his study thus exemplifies a microscopic approach, with potential for extrapolation to more informative scenarios.

Unlike the relatively obscure case studies of the previous authors, Iryna Krytska (2015) focuses her attention on one of the most notable avant-garde compositions of the 1950s, Stockhausen’s Klavierstück XI (1955). Drawing on the rich historical, theoretical, and critical discourse surrounding the piece, Krytska highlights a problematic lack of engagement with the results of actual performances, which she attributes to the developmental state of

performance analysis in the field of New Music (p. 15).[6] Her use of the term 'interpretation analyses' in the monograph's title is of note in this regard, encompassing not simply the acoustic results of performances, but also the technical and interpretative processes involved in reconciling the open and occasionally contradictory notational affordances of the piece. To achieve this, she argues, requires methods specifically tailored to the work in question (p. 19). This calls for a reconstruction of the formal composition of the nineteen fragments that appear in the score—chosen theoretically at random by the performer, with the performance ending once a fragment is reached for the third time—and analysis of the wholesale changes in tempo, dynamics, and articulation that movement from fragment-to-fragment demands. Krytska illustrates these features via bespoke diagrams that effectively convey both the immanent, polyvalent form of the piece and the expressive and aesthetic qualities of each performance to the listener (see for example pp. 107 and 116), showcasing the value of presentational creativity when working with such data.

Like Moelants and Nedelman, Krytska analyses a small subset of the recording corpus, with interpretations by Tudor, Aloys Kontarsky, and Bernhard Wambach consciously selected for their contrasting approaches (p. 21). Her methods of analysis are otherwise quite different, with timing data used only to compare the stratified tempi of different fragments, highlighting, for example, a higher degree of consistency and balance of tempi in Kontarsky's performances (p. 185) than in the more spontaneous performances of Tudor (p. 166). Her broader observations, meanwhile, are couched in the historical and theoretical context of the piece, and the performance backgrounds and sensibilities of the performers. This musicological approach proffers listener-centric conclusions about the style, aesthetics, and temporal characteristics of the performances. With respect to the latter, Krytska argues that:

> the opposition of both styles (with focus either on the momentary or the processual) is in fact a theoretical abstraction. What can be observed in the versions analysed here is the dominance of one or the other tendency, or more often a mixture of the two. These are tendencies that form the basis of Stockhausen's work: mediation between vectorial time as process and meditative time as moment (p. 284).[7]

As this case study illustrates, New Music frequently invokes a shift away from perception of the work object towards contemplation of the passage of time that the work facilitates, placing a new emphasis on timing data and the contribution of the performer, further theorised in the work of Christian Utz (2017), to be discussed in due course.

My own work (2022) on Stockhausen's Klavierstück I (1952–3) surveys eleven recordings of the piece in detail, allowing for observation of broader trends in performance. My methods and the nature of my findings are also somewhat different to those covered so far, owing partly to the affordances of a larger set of recordings and partly to a more explicit focus on the practicalities and interpretative ambiguities involved in realising the score, including

[6] See Clarke and Doffman's (2014, p. 98) and Ian Pace's (2017, p. 282) similar observations regarding the lack of performance-analytical attention given to New Music.

[7] 'Dabei ist nicht zu übersehen, dass die Gegenüberstellung beider Typen der Zeitgestaltung (mit Fokus entweder auf das Momentane oder auf das Prozessuale) eher eine theoretische Abstraktion ist. So lassen sich in den behandelten Versionen lediglich die Dominanz der einen oder anderen Tendenz und viel öfter ihre Mischformen beobachten, die auch Stockhausens Gesamtwerk zugrunde liegen: die Vermittlung zwischen der vektoriellen Zeit als Prozess und der meditativen Zeit als Moment'.

issues pertaining to pedalling, articulation, dynamics, rhythmic realisation, and choice of tempo. These insights, informed by my own experience of performing the piece, are used to contextualise the expressive contributions of the performers and distinguish them from the technical contingencies involved in interpreting the complex nested-tuplet rhythms and disparate pointillist textures of the piece. I thus bring a practical perspective to aims shared with Moelants in the performance analysis of early serial music

In my article, timing data is used to illustrate a wide range of responses to Stockhausen's 'as fast as possible' tempo direction in relation to both global tempo and local tempo variation (p. 135). The latter is found to be highest in challenging passages that are evenly distributed throughout the piece (pp. 136–8), invoking a statistical performance practice of sorts, whereby precision is conditioned by the serialised distribution and density of materials. Countering unevidenced accusations of sterility in the performance of early serial music (see for example Mathew, 2010; London, 2009), my findings highlight the impact of style, sensibility, interpretation, and technical contingency on the quality of the serial aesthetic, characterised here by the various gradations of parametric equilibrium that emerge in performance (pp. 153–4). These styles of performance, I argue, as well as the hermeneutic contexts that surround and inform them, necessitate different types of aural engagement—including live performance attendance, comparative listening, and repeated close listening—whose significance, while intuitive, remains tacit in much performance analytical discourse.

Unlike speculation into the methods and expressive strategies of performers in the work of myself and others, Thomas's involvement in the *être-temps* study (2005) allows for explicit confirmation that he was not concerned with determining 'how sections are related to each other in time', but rather with attention to 'each moment in time — the weight of a chord, the transparency of a single line, the degree of attack' (p. 39). Indeed, this is the only example surveyed here, my own work on Klavierstück X notwithstanding, that is practice-based rather than phonomusicological, exemplifying a collaborative approach that merits further pursuit.[8] Detailed description of Thomas's methods of rhythmic realisation and documentation of his preparation process confirm a degree of literalism in his attempts to realise the complex nested-tuplet rhythms of the piece, against which Cook's and Clarke's analytical observations are measured. Thomas's involvement also allows for the generation of MIDI performance data via a Disklavier, enabling fine-grained analysis of his realisation of nested-tuplet rhythms in polyphonic combinations.[9] While limited as a data set, such detailed and multi-faceted knowledge of an individual performer's contribution informs conclusions that speak less to the piece itself, and more to the nature of expression *tout court* in complex music. As Clarke remarks:

> "Expression" (if that word is to be used at all here) is located in rather different and much more momentary attributes of the performance, and a concern with rubato and continuous dynamic shaping, both of which have been the central preoccupation in performance

[8] The useful term 'phonomusicology', coined by Stephen Cottrell (2010), refers to the musicological study of recordings: a significant sub-discipline in the broader field of musicological performance studies.

[9] Both Clarke and I use graphical representations of tempo substitutions to convey tempo consistency in performances of nested-tuplets. These methods are, however, tailored to the exigencies of the pieces, with Clarke measuring proportions in seconds in relation to a prescribed base tempo, while I present tempo data in relation to the self-determined 'as fast as possible' tempo of each performer in Klavierstück I.

> research, simply doesn't apply here — both because the musical material resists being treated and understood in that way, and because Philip's primary interest is focused on rather different aspects of interpretation and execution (p. 61).

Together with the approach to preparing the piece that Thomas documents, these are findings that, for Clarke, 'distinguish [the study] from other empirical performance projects' (p. 60). This feeling in relation to complex music is shared by Cook, who calls for a change from traditional understandings of the musical work as 'something comprehensively conceived and intended by the composer, embodied in the score, and reproduced by the performer', to something more open and contingent on the interpreter of notation, whose visual impression of how the music sounds 'is liable to be a misleading one' (p. 44). The depth of knowledge and experience that each contributor brings to the fundamental disciplinary themes of expression, preparation, ecology, and ontology make this a touchstone article for the development of empirical approaches to New Music performance.

Ben Duinker's performance analysis (2021) of Iannis Xenakis's *Rebonds* (1987–9) also places a strong emphasis on processes of preparation, but in the context of a work for percussion. As with Thomas and myself, his observations are informed by extensive experience of performing the piece, as well as the relatively rich literature on Xenakian performance practice.[10] Like Cook, Duinker questions 'the utility of a score-centred analytical approach' (p. 1), choosing instead—via the influence of Caroline Palmer (1996) and Daphne Leong (2016)—to work 'backwards from performances to recover sources of the expression and manifestation of structure' (pp. 2–3). This is evidenced in his use of timing data to highlight instances of higher density where musicians tend to slow down. Unlike my serial-aesthetic interpretation of this phenomenon in Klavierstück I, Duinker favours broadly traditional narrative interpretations of tempo fluctuations in *Rebonds*, in which constant tempi accentuate climactic passages and drops in tempo signal the 'culmination of multiple simultaneous processes of musical development' (p. 5). His interrogation of the mediating role played by the performer in 'negotiating' certain 'impossibilities' – typically associated with Xenakis, though equally found in other forms of complex music – is, however, less traditional. This renders the connection between score and structural narrative indirect, calling into question the function of traditional score analysis, while placing a stronger emphasis on the cognitive and embodied role of the performer within the analytical paradigm.

A more theoretically ambitious approach to reconciling score and performance analysis is taken by Christian Utz, whose 'morphosyntactic' model, inspired by the temporal theory of the post-war avant-garde, seeks to 'describe different strata of aural experience and relate them to one another, demonstrating possible synergies as well as conflicts between them' (Utz, 2017, p. 217). Utz applies this model to multiple recordings of 'act- and perception-oriented' compositions by Helmut Lachenmann, Xenakis, and Brian Ferneyhough, in order to explore 'how specific models of temporality isolated in [score] analyses are actually rendered in performance' (p. 217). Unlike Krytska, whose identification of contrasting temporal modalities in performances of Klavierstück XI *follows* engagement with recordings (at least in the framing of her text), Utz proceeds by first hypothesizing performance tropes that may

[10] See for example Kanach (2010).

give rise to spatial, processual, or presentist temporal modalities, and then identifying the varied manifestations of these tropes in the recording corpora of the pieces. As in my work, the result is a toolkit for critical and reciprocal engagement with scores and a diverse range of performances, with an explicit focus here on pieces that thematise the passing and shaping of time in various ways.

William A. Sethares and Godfried T. Toussaint's paper (2015) on Steve Reich's *Clapping Music* (1972), the last to be surveyed here, shares a number of similarities with Moelants's earlier study: both use sophisticated quantitative methods of analysis, both address the co-ordination challenges arising from a piece for two musicians, and both focus on the presence and significance of different types of temporal deviation in performance. The general scope of the authors' research, however, is considerably broader, highlighting the empirical affordances of works outside the European serialist and post-serialist canon, which have otherwise dominated the performance analysis of New Music.

Sethares and Toussaint argue that 'minimalist music is worthy of study because the rhythmic and timbral features can be more easily investigated quantitatively when not confounded with other complexities', invoked by 'pitch, melody, and harmony' (p. 11). In this sense, recordings of *Clapping Music* offer a remarkably pure data set, oriented around patterns of the three different events that comprise the piece: double claps in unison, single claps, and silences. Seven performances are chosen, ignoring those that do not 'respect Reich's instructions' (p. 16), thus diverging from musicologically oriented approaches, such as those of myself, Duinker, and Utz, that explicitly embrace the hermeneutic significance of outlying performances. The authors also take a novel and effective approach to graphical presentation, using 'phylogenetic trees' to illustrate the relative similarity or difference of performances via their spacing from one another on the page (see, for example, p. 19).

The data itself shows lower levels of consistency and co-ordination in patterns with more interlocking claps (pp. 21–2), signalling an inverse relationship between complexity and precision that echoes the findings of myself and Duinker in more overtly complex contexts. Sethares and Toussaint's greatest insights, however, come via comparison of these findings with synthetic models, demonstrating the influence of the varied real timbres of the paired performers' claps on the listener's perception of their relative degrees of simultaneity (pp. 18–21). The authors thus use recordings of *Clapping Music* as a lens through which to address fundamental aspects of human perception that would be challenging if not impossible to investigate under artificial circumstances. A welcome musical focus is nonetheless retained via concrete listening strategies, informed by insights from this and prior research into the nature and limits of perception and cognition.

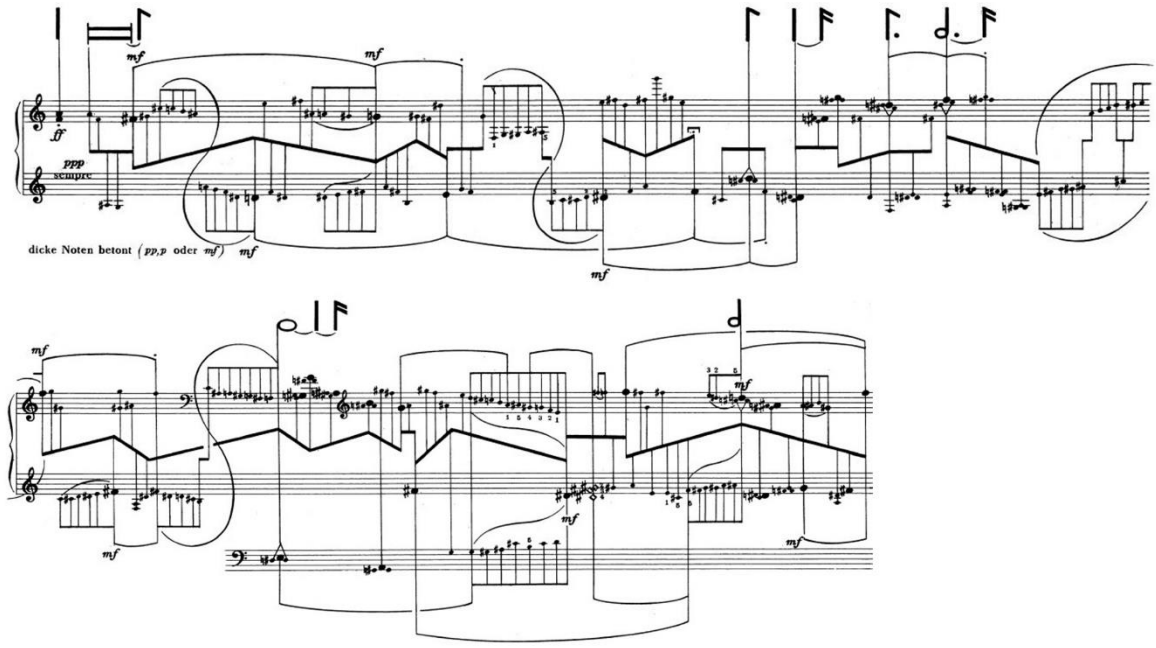
PERFORMANCE ANALYSIS AS A MEANS OF CREATION IN STOCKHAUSEN'S KLAVIERSTÜCK X

Introduction

Klavierstück X begins with an uninterrupted and seemingly chaotic array of clusters, chords, and single-note lines; this is followed by an extended series of fragmentary vignettes, characterised by the predominance of one or other of these features, and separated from one another by various periods of inaction on the part of the performer (see Examples 1–4).[11]

[11] Ian Pace, one of the piece's most celebrated contemporary performers, describes this form as 'a sharply

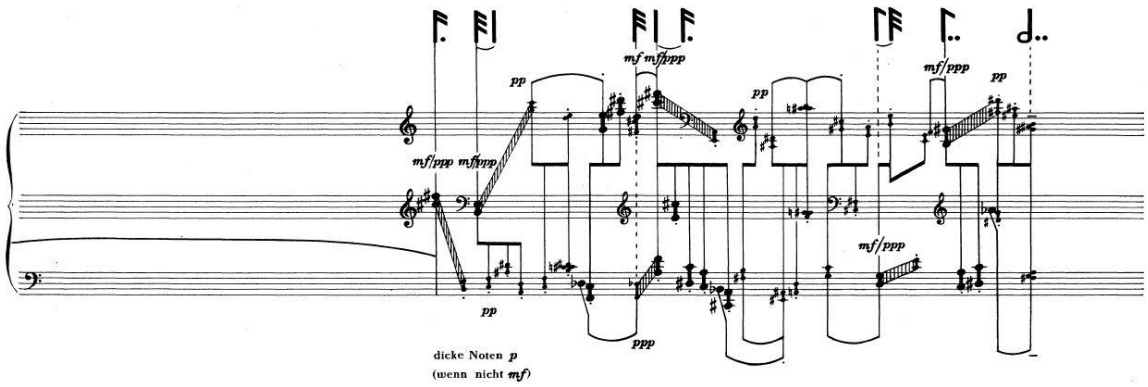
In addition to the opening, the main body of the piece is divided into seven 'phases' of equal length (Henck, 1980, p. 16).[12] The material itself, along with many other aspects of the piece, is divided into seven categories, which Stockhausen terms 'characters' (Henck, 1980, p. 17). Each character has a chord and a cluster form. These range from single-note attacks, corresponding to major-second cluster, to seven-note chords, corresponding to a chromatic cluster with an ambitus of two octaves and a major seventh, to be performed with both forearms. Character materials are allied to individual vignettes across the course of the piece, with an intermixture in the opening phase.



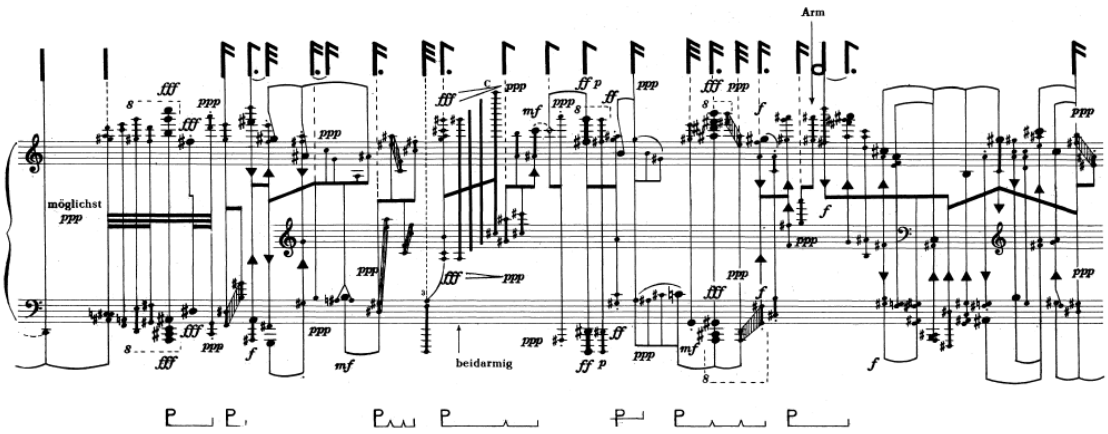
Example 1 Klavierstück X, p. 1

characterised 'cosmic explosion' (itself with a high degree of inner variegation) which recedes a little so as to allow greater apprehension of the various categories of fragments (or atomic dust, if one likes) that emerge out of such an explosion' (2009, p. 182).

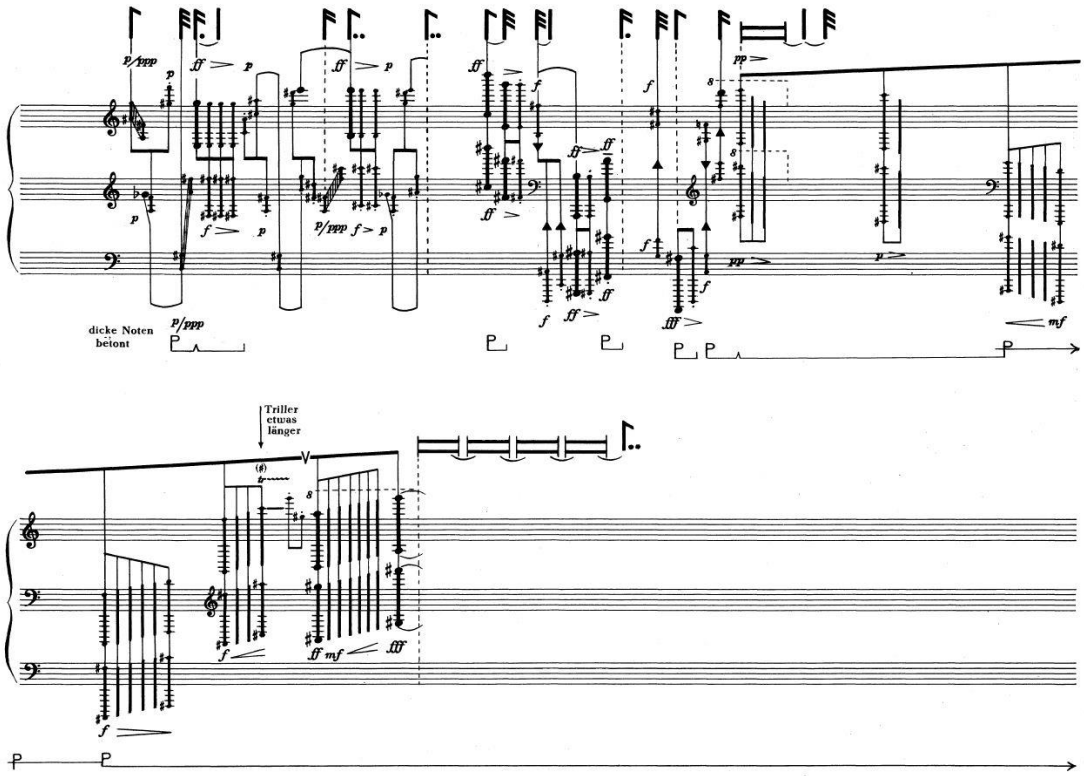
[12] See Henck (1980) for a comprehensive exposition of the piece's formal, material, and serial processes.



Example 2 Klavierstück X, p. 10, second system



Example 3 Klavierstück X, p. 3, second system



Example 4 Klavierstück X, p. 11

Durational values in Klavierstück X appear above the upper stave in multiples of a demi-semiquaver base unit, ranging from a single demisemiquaver to sixty-four crotchets in length (see again Examples 1–4). The character materials themselves appear in groups of small notes, to be performed within the time-space of the superordinate durational values. The beaming of the small notes dictates internal fluctuations of tempo, with rising beams indicating *accelerandi*, descending beams indicating *ritardandi*, and horizontal beams indicating a steady tempo. The shaping of these fluctuations may be freely determined. As with Klavierstücke I–IV, the performer is directed to perform the piece 'as fast as possible'; here, however, they are given leeway by the composer for the tempo to fluctuate in the ratio 2:3 (Stockhausen, 1965, foreword). Together with the typically extreme technical demands of the character materials, the notation thus offers a complex set of affordances to negotiate, granting the performer significant agency in determining the small- and large-scale temporal and aesthetic characteristics of the piece.

In sum, the serially balanced distribution of materials and the large-scale dimensions of Klavierstück X lend themselves to global temporal analysis of the kind undertaken by Utz, with implications for the formal ontology and overarching characteristics of different interpretations. I have explored such performance analysis and its implications for interpretation of Herbert Henck's (1980) seminal score analysis of the piece elsewhere (Jones, 2023). What interests me here, is the finely wrought details of the *rhythmic* scheme and how empirical performance analysis may be used both to interrogate and support their realisation.

Performance analysis and Version A

In preparing my initial version of the piece (henceforth Version A), I took a broadly literalist approach to the rhythmic notation. This involved working out metric realisations of the various *accelerandi* and *ritardandi* within the space of the superordinate values. I then conducted regular practice with a metronome, gradually increasing my tempo to a personalised upper limit of ♪ = 75. Once the piece was memorised, I recorded three unedited takes of Version A in the same recording session to preserve a concert-like impression of its large-scale temporal processes, as well as the technical and mental challenges of its complete performance in real time.[13] Next, I calculated IOI's for all note values using Sonic Visualiser.[14] I then translated this data into a series of 357 tempo values.[15] Finally, I repeated this process for the eight commercially available recordings of the piece (see Table 1).

Performer	Year of recording	Publisher and year of release	Duration
David Tudor	1962	EM Records – EM1104CD, 2012	19'42"
Frederic Rzewski	1964	Wergo – WER 6772 2, 2012	22'03"
Aloys Kontarsky	1965	Sony Classical, S2K 53346, 1993	22'22"
Herbert Henck	1986	Wergo, WER 60135/36-50, 1996	25'25"
Bernhard Wambach	1988	Schwann Musica Mundi, 310 009 H1, 1989	29'15"
Ellen Corver	1997	Stockhausen-Verlag, 56 A-C, 2000	27'34"
Benjamin Kobler	2014	Ensemble Musikfabrik, 2014	27'47"
Sabine Liebner	2016	Wegro, WER 7341/2, 2018	44'46"

Table 1. Current commercially available recording corpus for Klavierstück X

To pinpoint instances where the majority played slower or faster than their respective base tempi, I calculated theoretical tempo limits for each performer (including myself), 1.5 times lower and 1.5 times higher than their base tempo (i.e., in the 2:3 ratio permitted by Stockhausen); a base tempo of ♪ = 75 would thus give a lower limit of ♪ = 50 and an upper limit of ♪ = 112.5. These limits were calculated for each phase, thereby allowing for global tempo fluctuation as an expressive strategy, while maintaining focus on the proportional distortion of note values in localised contexts. I then tabulated the data, highlighting values that fell below each performer's lower limit in yellow and those that rose above their upper limit in red.

Table 2 presents tempo data for the opening eight note values of the piece, governing single-note and major-second-cluster character materials (see Example 1). Video Recording 1 shows my performance of this passage in Take 2 of Version A. As the data show, there is a widespread tendency for performers to rush values four and five, lasting a crotchet and a

13 All recordings were made in the Clothworkers Centenary Music Hall in the University of Leeds, School of Music in November 2021 on a modern Steinway Model D grand piano.

14 Sonic Visualiser is an easy-to-use, open-source application for the analysis of sound recordings. It can be downloaded for free from https://www.sonicvisualiser.org/.

15 A full overview of data for Take 2 of Version A is provided in Appendix 1. Data points that were impossible to perceive due to unclear durational cut-offs or a lack of textural clarity were omitted; these are highlighted in red, with no timing recorded, and the necessary adjustments to phase duration accounted for.

semiquaver, and a dotted quaver respectively (this is particularly pronounced in Herbert Henck's recording). Only Benjamin Kobler performs value four within his upper limit, and only Frederic Rzewski and I (in take 1) perform value five within our upper limits, with variation across my takes betraying an unconscious lack of metric consistency. Sabine Liebner's typically iconoclastic reduction of speed for this value, meanwhile, is an extreme outlier. As can be seen in Example 1, the third value, following a fermata, marks a stylistic shift in character material, with the onset of major second clusters in a series of alternating groups. It seems that performers instinctively mark this transition with an increase in energy, thereby emphasising the latent delineation of the passage.

	Introduction tempo (quaver bpm)			**Page 1 note values**							
Pianist	**Average**	**Min**	**Max**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Tudor	90	60	134	142	143	89	165	172	95	120	110
Rzewski	122	82	184	137	170	131	250	137	118	137	130
Kontarsky	100	66	149	81	124	223	250	169	93	127	110
Henck	92	61	138	120	92	93	246	306	78	154	80
Wambach	73	49	109	102	92	131	173	157	70	91	60
Corver	77	51	116	76	83	114	132	143	70	98	58
Kobler	71	47	107	73	76	114	103	127	78	78	75
Liebner	34	23	52	56	49	23	60	23	40	45	48
Version A Take 1	73	49	110	78	79	83	161	103	63	82	62
Version A Take 2	72	48	109	81	75	88	160	115	59	80	58
Version A Take 3	74	50	111	78	79	88	150	128	63	81	61

Table 2. Klavierstück X, opening note values: tempo comparison

The opposite situation, in which the majority of performers slow down, can be heard in a vignette from the second principal phase of the piece, involving perfect-fourth and major-sixth clusters, and cluster glissandi, to be executed using fingerless gloves (see Example 2). Table 3 presents tempo data for the corresponding note values. Video Recording 2 shows my performance of this passage in Take 2 of Version A. As the data show, I was the only performer to play the third value above my minimum tempo, with my performance in Take 3 the fastest on record by a small margin (♪ = 57 compared with Kontarsky's ♪ = 56). This tendency to slow down for the brief third value coincides with a challenging leap from a perfect-fourth to a major-sixth cluster in the right hand, accompanied by a precise cluster glissando in the left hand; this suggests the presence of a singular crux: an individual gesture that is challenging to perform in the context of the surrounding material and the strictures of the rhythmic scheme.[16]

Still unaware of the general tendency to slow down that would later be revealed by the data, I achieved rhythmic proportioning of the third value via an anticipatory movement of my body from left to right, in order to arrive decisively on the upper cluster. As a corollary, I

[16] See Jones (2022) for further discussion of crux passages and their performance-analytical significance in Klavierstück I.

was relatively slow to set off on the subsequent downwards glissando. In combination with my efforts to accurately reproduce each cluster's full chromatic pitch content using a combination of palms and fingers, and to manage the underlying suspensions using the sostenuto pedal and redistribution of material between the hands, this resulted in a significantly slower execution of the fourth value, in contrast to most other performers. Precise rhythmic proportioning of the third value thus affected the rhythmic proportioning of the fourth. My complicated technical management of the material governed by the fourth value, orchestrated with maximum fidelity to the score in mind, also made it unreliable, resulting ironically, more often than not, in a loss of pitch definition, dynamic control, and textural clarity (this can be witnessed in Video Recording 2). At Rzewski's extreme tempo (♪ = 99), meanwhile, more than double that recorded for the fourth value in my performances, these details become as difficult to perceive as they are to realise, demonstrating a broad spectrum of musical priority within the performance tradition.

	Phase 2 tempo (quaver bpm)			**Page 10 note values**					
Pianist	**Average**	**Min**	**Max**	**1**	**2**	**3**	**4**	**5**	**6**
Tudor	101	68	152	61	73	33	49	147	91
Rzewski	88	59	132	252	80	35	99	125	118
Kontarsky	94	63	141	81	85	56	68	151	112
Henck	80	53	119	54	88	49	54	115	110
Wambach	75	50	112	45	52	29	39	60	112
Corver	79	53	119	105	73	51	61	92	94
Kobler	78	52	116	87	70	46	63	110	58
Liebner	51	34	77	56	32	16	17	57	45
Version A Take 1	74	49	111	56	65	52	40	78	75
Version A Take 2	72	48	108	59	60	52	35	78	71
Version A Take 3	72	48	109	55	63	57	41	83	74

Table 3. Klavierstück X, page 10 vignette: tempo comparison

If the gesture governed by the third value of the preceding case study constitutes a singular crux, then the diverse materials governed by the sequence of values that span the second system of page 3 constitute a 'crux passage' (see Example 3). This is confirmed by the number of times that tempi for constituent values fall below each performer's lower limits in the recording corpus, as well as the high level of tempo fluctuation between values (see Table 4).[17] This suggests that rhythmic execution in this passage is overwhelmingly dictated by the physical distribution of the materials and the unprecedentedly dense interpolation of chords, clusters, and cluster glissandi, rather than the prescribed proportions of the durational values. This holds true for my takes of Version A, which, while more consistent than some of the recordings, exhibit a high level of inconsistency, in spite of many hours of variable speed practice with the metronome (see Video Recording 3 for my performance of this passage in

[17] Onsets for note values 16 and 21 were not determinable and therefore omitted, with the necessary adjustment to IOI's and tempi of adjacent values.

Take 2). The passage thus manifests as a variously nuanced overabundance of musical information, with the embodied role of the performer (or transmitter, to use the language of information theory) taking centre stage over the structured arrangement of materials.[18]

Augmented performance practice: Version B

Having observed these trends in the recording corpus and in my three takes of Version A (Take 2 is presented in Video Recording 4; audio recordings of Takes 1 and 3 are included in Audio Appendices 1 and 2),[19] I became interested in refining the inconsistencies revealed by the data and then assessing their aesthetic and structural impact: a sort of 'augmented performance practice', with parallels to what Cook has called 'augmented-listening' (2017, p. 207), similarly facilitated by empirical data.

I began by exploring ways to bring values falling below the lower limits of each phase tempo up to the requisite speed.[20] To adjust the fourth value in Example 2, for example, I arrived less emphatically on the high cluster attack, allowing for immediate downward movement with both hands. I then sacrificed the precision of the subsequent suspensions, using dabs of damper pedal, rather than *sostenuto* pedal, to create the fleeting illusion of sustained inner voices. I also increased speed and reliability by tactically omitting pitches from some of the perfect-fourth clusters that I had been playing with full fingerings, while bouncing my palm across the keys in an approximation of others. This practice, whose ethical implications I address shortly, finally brought me to within my prescribed tempo limits (see Table 5). While still relatively slow in comparison with the surrounding values, this effected a greater sense of *Gestalt* formation, as well as a more nuanced shift in density between the fourth and fifth values, subtly transforming the delineation of the passage; thanks to my technical simplification, it was now also reliable in performance (see Video Recording 5 for comparison of this passage in Versions A and B).

In some instances, individual gestures could be sped up through practice or alterations to my technical approach with no compromise in pitch content. For example, the final value of page 3 (see Example 3)—falling below every performer's lower limit save Kontarsky and Henck (see Table 4)—could be sped up quite easily via lighter execution of the cluster glissando and preparatory movement of the body to the right, allowing for timely execution of the subsequent double-forearm cluster in the highest register of the piano (see Video Recording 6 for comparison of this gesture in Versions A and B). These data, and the ease with which this value could be adjusted, highlight an expressive tendency in the performance tradition (unconscious on my part) to prolong this gesture, signalling the end of both the crux passage as a whole and the local tempo arch of its concluding clusters. In fact, precise realisation of the note value proportions, drawn to my attention by the data, reveals a *defamiliarising* tendency in the rhythmic notation, effecting a continued transformation—as

[18] See Grant (2005) for more on the influence of information theory on Stockhausen's compositional practice and musical thinking in the 1950s.

[19] Takes 1 and 3 both included small memory slips, which were factored into my data analysis.

[20] Another option would have been to reduce the overall speed. This would make for a valuable sister study, investigating the affordances of a slower tempo in a more consistent and thorough manner than Liebner in her existing 45-minute version. For the purposes of the current investigation, however, I was interested in the effect of 'top-down' rhythmic refinements on the complexion of a performance at an orthodox tempo.

opposed to a dissipation—of energy across latent borders at a significant cadential juncture in the middle of the phase.

	Phase 0 tempo			Page 3, second system, note values																						
Pianist	**Average**	**Min**	**Max**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Tudor	90	60	134	258	129	118	109	78	-	-	41	60	56	50	53	96	81	-	48	92	63	66	-	47	160	72	67
Rzewski	122	82	184	133	133	157	73	58	51	66	97	115	210	60	78	70	143	-	86	85	69	104	-	63	70	84	47
Kontarsky	100	66	149	148	118	141	40	91	36	64	71	95	164	52	39	67	112	-	73	82	47	65	-	55	84	96	72
Henck	92	61	138	80	143	115	37	53	41	54	67	103	76	39	43	59	115	-	67	64	34	73	-	57	70	84	56
Wambach	73	49	109	68	108	144	25	34	55	78	82	99	46	26	17	48	99	-	51	76	35	43	-	61	66	68	25
Corver	77	51	116	70	48	105	39	76	53	46	74	79	76	47	39	62	91	-	60	84	48	69	-	44	109	69	45
Kobler	71	47	107	88	77	102	85	78	79	64	94	72	85	66	35	63	92	-	76	83	61	70	-	62	77	74	40
Liebner	34	23	52	49	30	35	-	16	19	42	15	26	35	15	21	27	36	-	33	31	19	23	-	16	53	34	20
Version A Take 1	73	49	110	70	64	80	60	68	47	49	63	85	72	50	38	54	85	-	63	54	40	70	-	45	92	61	24
Version A Take 2	72	48	109	78	59	110	65	69	40	39	60	81	69	51	46	52	89	-	74	58	39	71	-	46	78	56	25
Version A Take 3	74	50	111	64	70	88	78	62	40	52	57	79	68	47	54	51	90	-	73	57	41	80	-	42	83	63	32

Table 4. Klavierstück X, 3, second system (the crux passage): tempo comparison

Table 5 Klavierstück X, page 10 vignette: tempo comparison between Versions A and B

	Phase 2 tempo (quaver bpm)			Page 10 note values					
Pianist	**Average**	**Min**	**Max**	**1**	**2**	**3**	**4**	**5**	**6**
Version A Take 1	74	49	111	56	65	52	40	78	75
Version A Take 2	72	48	108	59	60	52	35	78	71
Version A Take 3	72	48	109	55	63	57	41	83	74
Version B	78	52	117	67	65	69	56	88	80

Table 6 Klavierstück X, forearm cluster vignette: Versions A and B tempo comparison

	Phase 2 tempo (quaver bpm)			Page 11 note values						
Pianist	**Average**	**Min**	**Max**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Tudor	101	68	152	80	109	-	49	59	61	101
Rzewski	88	59	132	108	125	-	41	77	55	80
Kontarsky	94	63	141	82	94	-	43	51	24	82
Henck	80	53	119	57	84	-	24	43	34	72
Wambach	75	50	112	56	71	-	30	57	40	53
Corver	79	53	119	90	101	-	26	60	48	80
Kobler	78	52	116	79	82	-	36	50	64	72
Liebner	51	34	77	35	47	-	35	24	30	53
Version A Take 1	74	49	111	76	68	-	36	60	32	71
Version A Take 2	72	48	108	79	64	-	32	55	28	67
Version A Take 3	72	48	109	94	60	-	38	62	37	71
Version B	78	52	117	96	62	-	82	65	53	82

Other gestures demand significant technical compromise to be played at speed, as exemplified by the leap from a low, spread octave-and-major-sixth cluster to a pair of low double-forearm clusters in one of the more virtuosic vignettes of the second phase (see note values ten to eleven in Example 4). As Table 6 shows, this was a crux gesture for the majority of pianists.[21] To bring it into proportion in Version B, I simply omitted the lower half of the first cluster, playing from E to D# with the outstretched right hand, and then playing the larger clusters with a single outstretched left forearm, thereby projecting the notated iamb without reducing my global tempo (see Video Recording 7 for comparison of this passage in Versions A and B).

This practice and others involving the tactical omission of pitches is potentially controversial, challenging the distinction between what pianist Philip Fowke has called 'justifiable enablement' and 'inappropriate facilitation' (2021, p. 95). Drawing on his own extensive experience of traditional concert repertoire, Fowke stresses the importance of

[21] The third value of this case study was factored out of analysis due to unclear perception of the brief rest duration onset in the majority of recordings.

Table 7 Page 3, second system: Versions A and B tempo comparison

	Phase 0 tempo			Page 3, second system, note value																						
Pianist	**Average**	**Min**	**Max**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Version A Take 1	73	49	110	70	64	80	60	68	47	49	63	85	72	50	38	54	85	-	63	54	40	70	-	45	92	61	24
Version A Take 2	72	48	109	78	59	110	65	69	40	39	60	81	69	51	46	52	89	-	74	58	39	71	-	46	78	56	25
Version A Take 3	74	50	111	64	70	88	78	62	40	52	57	79	68	47	54	51	90	-	73	57	41	80	-	42	83	63	32
Version B	76	51	114	74	78	72	69	87	89	75	66	83	87	53	82	60	76	-	95	91	52	82	-	69	65	58	77

exploring 'a wide range of physical choices' when negotiating these limits, arguing that 'to play with ease, comfort, and security requires a mind open to many possibilities, the sound and musical context always being the priority' (p. 95). Such negotiations, recalling those involved in realising certain 'impossible' technical demands in *Rebonds* (Duinker, 2021, pp. 10–13), take on a different dimension when applied to a work such as Klavierstück X. As a recent empirical study by Arvid Ong (2019) has shown, the brain's auditory perception of clusters is relative, meaning that certain degrees of omission are unlikely or impossible to be perceived. This is particularly true in the case described here, where brief durations, use of damper pedal, and the low register of the clusters, all mitigate perception of the omission of pitches, thus justifying this practice in terms of pitch content versus comfort, reliability, and rhythmic proportioning at speed. The effect itself is subtle yet distinct, enhancing the *élan* of the movements while maximising contrast with the subsequent *pianissimo* double-forearm clusters, as illustrated in Video Recording 7.

Similar strategies of pitch approximation and tactical omission allowed for execution of all note values in the crux passage of page 3 within my tempo limits, as illustrated in Table 7. The result is aesthetically similar to the original, though with a notably different rhythmic profile, dictated by a subtle sequence of agogic delays, more closely allied to the rhythmic scheme than to the physical exigencies of preparing and executing the constituent gestures. Omitting and adjusting pitches from the contrary motion series of demisemiquaver note value clusters (governed by a superordinate crotchet value) that open the passage, meanwhile, allowed for more even and reliable execution of the gesture—one of the most difficult of the entire piece to perform accurately—introducing the aperiodic groove of the passage with a periodic flourish (see Video Recording 8 for comparison of this passage in Versions A and B).

Finally, I addressed values that strayed above my upper tempo limit, beginning with adjustments to the fourth and fifth note values of the opening page (see Example 1 and Table 8). When played in proportion, this sequence takes on a pensive character—enhanced by more gradual and perceptible articulation of the notated tempo fluctuations—marking a striking contrast with the general mood of the recorded tradition (see Video Recording 9 for comparison of this passage in Versions A and B). Furthermore, while attention is still drawn to the change from individual tones to major second clusters and the subsequent integration of these two forms, my literalist reinterpretation places greater emphasis on the diversity of the character material itself, as opposed to its modulation through shifts in tempo.

Table 8 Klavierstück X, opening note values: Versions A and B tempo comparison

	Phase 0 tempo			**Page 1 note values**							
Pianist	**Average**	**Min**	**Max**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Version A Take 1	73	49	110	78	79	83	161	103	63	82	62
Version A Take 2	72	48	109	81	75	88	160	115	59	80	58
Version A Take 3	74	50	111	78	79	88	150	128	63	81	61
Version B	76	51	114	84	80	64	71	68	65	81	66

It is worth noting that most upper limit tempo transgressions in the data relate to single-line character materials, likely owing to the fact that they are the simplest to perform. This is particularly true for later phases, where note values increasingly govern individual attacks and gestures. Adjustments in such instances therefore called for tighter metric feeling, as dictated by the underlying demisemiquaver pulse. As a consequence, the strict and relatively simple rhythmic proportions of these passages become foci for listening, in maximum contrast to the physically mediated temporality of passages in which longer note values govern multiple groups of virtuosic materials. Together, the distribution of these statistical extremes outlines a teleological progression, discussed at length in Henck's analysis (1980), dictating a large-scale process of formal closure. As my empirical performance analysis and Version B's refined spectrum of rhythmic relationships illustrate (see Video Recording 10 for the complete performance), the salience of these teleological processes, as well as the individual complexion of Klavierstück X's many vignettes, remains highly contingent on performance practice.

CONCLUSIONS

As the sources surveyed and case study presented here illustrate, New Music inherently challenges and thematises norms of performance practice, interpretation, expression, agency, form, and perception, to the extent that they may become different in kind to those on which traditional forms of empirical performance research are based. This calls for a new paradigm, drawing upon and expanding that proffered by Clarke and Doffman, which recognises the centrality of the technical, interpretative, and creative contribution of the performer; takes into account the diverse and rapidly changing hermeneutic contexts that surround the repertoire; makes use of the rich documentary evidence of the performance traditions involved; and embraces the creative and revelatory use of data and technology.

In the 1950s, performers such as Tudor and the soprano Cathy Berberian became increasingly central to the development of experimental scores, whose practicalities, interpretive demands, and expressive qualities may have been imagined by the composer, but only truly emerged during the initial acts of preparation and performance. Analyses of performances resulting from such collaborations thus call for a reappraisal of the relationship between the composer and performer, as exemplified by Clarke et al. (2005). Certain authors (see, for example, Iddon, 2013; and Karantonis et al., 2014) *have* explored these processes and relationships via documentary research, though without reference to the artefactual evidence of recordings. Within the performance-analytical literature, the tantalising archival work of Nedelman hints at the epistemological possibilities afforded by cross-examination of performer testimony, working notes, sketch materials, and recordings of New Music.

As illustrated by engagement with recording corpora of works of New Music, certain practical, interpretive, and expressive potentialities may be initiated via these performer-composer interactions yet continue to evolve and stabilise as new practices and techniques are assimilated, accruing new meanings as they progress through different stages of historical reception. While not fundamentally different following their genesis to traditional developments in performance practice, the hothousing of New Music traditions, facilitated by composers, such as Stockhausen, playing a strong hand in their development over many years; the influence of expert-led courses in performance, such as those provided by the

Darmstadt International Summer School for New Music; and the continuing mass-market expansion and proliferation of recordings, offer unique opportunities for contemplation. In such cases, the development and stabilisation of a tradition may be documented from the outset via recordings, composer theory, performer testimony, and other archival materials. Combined with other forms of historical and ethnographic research, such cases may therefore offer holistic insight into how canons of practice are formed, with implications for understanding in other fields of music.[22] While Krytska, myself, and others offer a starting point in this regard, the field of historically informed New Music performance analysis remains in its infancy, with large swathes of territory yet to explore.

Within this milieu, an array of different themes and theoretical frameworks have emerged, offering a range of perspectives from which to approach performances of New Music. As the case studies surveyed here demonstrate, engagement with the thematic content of New Music via recordings can provide a direct route to exploration of certain aesthetic, perceptual, and philosophical principles, such as the abstract balance of musical elements, the nature of temporality, or the essence of musical expression. For now, these themes remain relatively limited in scope, as the field awaits expansion and application to a far wider range of repertoire, considering, for example, the material significance of instrumental timbre, loci of meaning in spectrally oriented musics, and the theatrical dimensions of Cagean and post-Cagean experimental traditions; such research would also call, perforce, for a welcome methodological extension to the current prevalence of timing-based studies on New Music performance.[23]

Empirical data, and timing data in particular, take on new epistemological significance in relation to New Music. As Clarke and Doffman note, 'the ubiquity and wide dissemination of the standard repertoire and its performance conventions mean that listeners and performers feel a degree of confidence in making evaluative judgements of expressive performance' (2014, p. 107). As a result, graphical representations of empirical data have traditionally been used to illustrate deviations from normative models that most readers will be able to infer from the simple temporal relationships of predominantly binary or tertiary metric divisions and interpret through a shared knowledge of certain stylistic norms. In the case of works such as *être-temps*, Klavierstuck XI, or Lachenmann's *Pression* (1969–70), as studied by Utz, the relationship between the score and the sounding result may be unclear or ambiguous, owing to rhythmic or textural complexity, formal indeterminacy, or the prevalence of non-traditional instrumental techniques. In such cases, performance data becomes a more fundamental source of revelation, supporting informed understandings of complex or unusual interpretative processes, while guiding the listener away from normative modes of listening. As evidenced in several of the papers surveyed here, to use such data successfully often requires a detailed appreciation of the preparatory processes that condition the manifestation of certain quantifiable musical features, as well as a degree of visual imagination with regards to presentation. Whether this proves a hurdle for non-specialist

[22] As Clarke and Doffman remark, performance histories of New Music help demonstrate how 'expression is […] a much more social and collaborative practice than much of the expression literature seems to suggest' (2014, p. 104).

[23] For example, practice-based research into different combinations of recording and performance techniques for spectral or materially oriented musics using timbral analysis.

authors wishing to conduct similarly in-depth analysis of a wider range of repertoire remains to be seen, though the work of Clarke et al. (2005) and the collaborative projects of Daphne Leong, such as her joint analysis of Milton Babbit's *Lonely Flute* (1991) with flautist Elizabeth McNutt (Leong, 2019, pp. 263–86), offer hope in this direction.

As my case study on Klavierstück X illustrates, timing data may also have practical uses in the performance of New Music.[24] While it could be argued that using such data to refine practice in this way risks an over-rationalisation at odds with the spirit of the works in question, invoking ethical questions about the performance practice of temporally oriented musics,[25] I prefer to view performance-analytical tools such as Sonic Visualiser as analogous to the metronome in preparation of traditional repertoire, whose rigidity may be of limited use in certain complex interpretative scenarios. As my practice demonstrates, such methods can be extremely useful in uncovering and (should one wish) combatting unconscious expressive biases. From my own experience, returning to the piece several months after the production of Version B, I was not inclined to produce further data analyses, in spite of the relative simplicity of the procedure. Instead, I was satisfied with the refinements and insights provided by the data, and content to let the piece breath and develop without further empirical assistance, just as metronome practice will often be discontinued or adopted periodically by musicians at certain stages of preparation of traditional repertoire.

From a creative standpoint, Version B of Klavierstück X and the generation of other experimental performances of works of New Music via analogous or yet unexplored means may be seen as both artistic statements in the mould of iconoclastic recordings of traditional repertoire by performers such as Glen Gould, as well as models against which other performances may be measured, compared, and understood.[26] In this instance, my challenge to tradition involved pursuing a certain type of temporal literalism, which in turn shed unexpected light on the contingency of other musical parameters. Yet one might equally move in the opposite direction, testing the limits of transgressive practice for repertoire whose threshold complexity, allowing for consistently high levels of precision by performing specialists, has perhaps led to a state of interpretative ossification, or whose affordances have not been fully considered or explored, much in the way advocated by Daniel Leech-Wilkinson and others (2020) in the context of traditional repertoire. The insights to be gained from experiments and creative 'transgressions' such as these highlight the importance of contributions from performers and performing scholars in the emerging field of New Music performance studies and the lessons to be learned and applied from such repertoire in the broader field of musicological practice research.

[24] Franklin Cox (2008) cites the use of computer technology to produce models against which performances of complex music may be honed. My auto-analytical methods, however, remain untried in professional circles to the best of my knowledge.

[25] For comparison, see discussion of 'unethical' realisations of experimental music in Clarke and Doffman (2014) and Panzner (2015).

[26] Parallels may be drawn here to the use of computer modelling in music-psychological research into expression, as surveyed by Clarke (2004) and discussed by Friberg and Bisesi (2014).

APPENDICES

Audio Appendix 1: Stockhausen Klavierstück X Version A Take 1 (Gabriel Jones, piano)

Audio Appendix 2: Stockhausen Klavierstück X Version A Take 3 (Gabriel Jones, piano)

Appendix: Stockhausen Klavierstück X Version A Take 2 Timing Data and Problem Data Points

REFERENCES

Born, G. (1995). *Rationalizing culture: IRCAM, Boulez, and the institutionalization of the musical avant-garde*. Berkeley: University of California Press.

Clarke, E. (2004). Empirical Methods in the Study of Performance. In E. Clarke & N. Cook (Eds.), *Empirical musicology: Aims, methods, prospects* (pp. 77–102). Oxford: Oxford University Press.

Clarke, E., Cook, N., Harrison, B., & Thomas, P. (2005). Interpretation and performance in Bryn Harrison's *être-temps*. *Musicae Scientiae*, *19*(1), 31–74.

Clarke, E., & Doffman, M. (2014). Expressive Performance in Contemporary Concert Music. In D. Fabian, R. Timmers, & E. Schubert (Eds.), *Expressiveness in music performance: Empirical approaches across styles and cultures* (pp. 98–114). Oxford: Oxford University Press.

Cook, N. (2013). *Beyond the Score*. New York: Oxford University Press.

Cook, N. (2017). Inventing Tradition: Webern's Piano Variations in Early Recordings. *Music Analysis*, *36*(2), 163–215.

Cottrell, S. (2009). The Rise and Rise of Phonomusicology. In A. Bayley (Ed.), *Recorded music: Performance, culture and technology*. Cambridge: Cambridge University Press.

Cox, F. (2008). Notes Toward a Performance Practice for Complex Music. In C.-S. Mahnkopf, F. Cox, & W. Schurig (Eds.), *Polyphony and complexity, New music and aesthetics in the 21st century* (vol. 1, pp. 70–133). Hofheim: Wolke.

Duinker, B. (2021). *Rebonds*: Structural affordances, negotiation, and creation. *Music Theory Online*, *27*(4).

Fowke, P. 2021. Part I appendix: The fingering of Benno Moiseiwitsch in manuscript illustrations. In J. Banowetz (Ed.), *The performing pianist's guide to fingering* (pp. 95–108). Bloomington: Indiana University Press.

Friberg, A & Bisesi, E. (2014). Using Computational Models of Performance to Model Stylistic Variations. In D. Fabian, R. Timmers, & E. Schubert (Eds.), *Expressiveness in music performance: Empirical approaches across styles and cultures (*pp. 240–59). Oxford: Oxford University Press.

Gabrielsson, A. (1999). The performance of music. In D. Deutsch (Ed.), *The Psychology of Music*, *2nd ed.* (pp. 501–602). San Diego: Academic Press.

Gabrielsson, A. (2003). Music performance research at the millennium. *Psychology of Music*, *31*(3), 221–272.

Grant, M. J. (2005). *Serial Music, Serial Aesthetics: Compositional Theory in Post-War Europe*. Cambridge: Cambridge University Press.

Henck, H. (1980). *Karlheinz Stockhausen's Klavierstück X: A contribution toward*

understanding serial technique: history, theory, analysis, practice, documentation. Cologne: Neuland.

Iddon, M. (2013). *John Cage and David Tudor: Correspondence on interpretation and performance*. Cambridge: Cambridge University Press.

Iddon, M., Payne, E., & Thomas, P. (2019). Disruption and discipline: Approaches to performing John Cage's Concert for Piano and Orchestra. *Music & Practice*, *5*.

Jones, G. (2022). 'Irrational Nuances': Interpreting Stockhausen's Klavierstück I. *Twentieth-Century Music 19*(1), 117–58.

Jones, G. (2023). Analysis and Performance of Stockhausen's Klavierstück X**.** *Music Analysis*, *42*(3), 331–362.

Kanach, S. (Ed.) (2010). *Performing Xenakis*. Hillsdale: Pendragon Press.

Karantonis, P. (Ed.) (2014). *Cathy Berberian: Pioneer of contemporary vocality*. London: Routledge.

Kozak, M. (2020). *Enacting musical time: The bodily experience of new music*. New York: Oxford University Press.

Krytska, I. (2015). *Karlheinz Stockhausens Klavierstücke XI: Interpretationsanalysen*. Kassel: Gustav Bosse.

Leech-Wilkinson, D. (2009a). The changing sound of music: Approaches to studying recorded musical performances. London: CHARM. http://www.charm.kcl.ac.uk/studies/chapters/chap1/html.

Leech-Wilkinson, D. (2009b). Musicology and Performance. In Z. Blažeković (Ed.), *Music's intellectual history*. New York: RILM.

Leech-Wilkinson, D. (2020). Challenging performance: Classical music performance norms and how to escape them. Version 2.14 (03.03.23). https://challengingperformance.com/the-book/.

Leong, D. (2016). Analysis and performance: Or *wissen, können, kennen*. *Music Theory Online 22*.

Leong, D. (2019). *Performing Knowledge: Twentieth-century music in analysis and performance*. New York: Oxford University Press.

Lerch, A., Arthur, C., Pati, A., & Gururani, S. (2020). An interdisciplinary review of music performance analysis, *Transactions of the International Society for Music Information Retrieval*, *3*, 221–45.

London, J. (2009). Temporal complexity in modern and post-modern music: A critique from cognitive aesthetics. In D. Crispin (Ed.), *Unfolding Time* (pp. 45–68). Leuven: Leuven University Press.

Mathew, N. (2010). Darmstadt pianism, "historically informed" Webern, and modernism's vanishing Performer. *Keyboard Perspectives*, *3*, 49–73.

McLaughlin, S. (2022). On Material Indeterminacy. *Contemporary Music Review*, *41*(2–3), 216–233.

Moelants, D. (2000). Statistical analysis of written and performed music. A study of compositional principles and problems of coordination and expression in "punctual" Serial Music. *Journal of New Music Research*, *29*, 37–60.

Nedelman, E. M. (2005). Performance analysis of David Tudor's interpretations of Karlheinz Stockhausen's Klavierstücke. Unpublished doctoral dissertation, University of California, Santa Barbara.

Nonken, M. (2020). *Identity and Diversity in New Music: The New Complexities*. New York: Routledge.

Ong, A. (2019). *Die Ähnlichkeit von Tonclustern*. Berlin: Wissenschaftlicher Verlag Berlin.

Pace, I. (2009). Notation, time and the performer's relationship to the score in contemporary music. In D. Crispin (Ed.), *Unfolding Time* (pp. 151–92). Leuven: Leuven University Press.

Pace, I. (2017). The new state of play in performance studies. *Music and Letters*, *98*(2), 281–292.

Palmer, C. (1996). Anatomy of a performance: Sources of musical expression. *Music Perception*, *13*(3), 433–53.

Panzner, J. (2020). *The process that is the world: Cage/Deleuze/Events/Performances*. London: Bloomsbury Academic.

Payne, E. (2018). The craft of musical performance: Skilled practice in collaboration. *Cultural Geographies, 25*(1), 107-122.

Pritchett, J. (2004). David Tudor as composer/performer in Cage's "Variations II". *Leonardo Music Journal*, *14*, 11–16.

Schick, S. (1994). Developing an interpretive context: Learning Brian Ferneyhough's *Bone Alphabet*. *Perspectives of New Music*, *32*, 132–53.

Sethares, W. A. & G. T. Toussaint. (2015). Expressive timbre and timing in rhythmic performance: Analysis of Steve Reich's *Clapping Music*. *Journal of New Music Research*, *44*(1), 11–24.

Stockhausen, K. (1959). ...how time passes....(C. Cardew, Trans.). In H. Eimert & K. Stockhausen (Eds.), *Die Reihe 3: Musical Craftsmanship* (pp. 10–40). Bryn Mawr: Theodor Presser (Original work published 1957).

Stockhausen, K. (1965). *Klavierstücke V–X*. London: Universal Edition.

Thomas, P. (2013). Understanding indeterminate music through performance: Cage's Solo for Piano. *Twentieth-Century Music*, *10*(1), 91–113.

Utz, C. (2017). Time-space experience in works for solo cello by Lachenmann, Xenakis and Ferneyhough: A performance-sensitive approach to morphosyntactic musical analysis. *Music Analysis*, *36*(2), 216–256.

Wilson, S. (2021). *New music and the crises of materiality: Sounding bodies and objects in late modernity*. Abingdon: Routledge.

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