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## OVERT AND HIDDEN PROCESSES IN 20TH CENTURY MUSIC

**ABSTRACT.** For the purpose of contributing to a clarification of the term “process”, different kinds of musical processes are investigated: A rule-determined phase shifting process in Steve Reich’s *Piano Phase* (1966), a model for an indeterminate composition process in John Cage’s *Variations II* (1961), a number of evolution processes in György Ligeti’s *In zart fließender Bewegung* (1976), and a generative process of fractal nature in Per Nørgård’s *Second Symphony* (1970). In conclusion I propose that six process categories should be included in a typology of processes: Rule-determined, goal-directed and indeterminate transformation processes, and rule-determined, goal-directed and indeterminate generative processes.

The term ‘process’ is fairly indeterminate in its meaning. The purpose of the present paper is to draw attention on different kinds of musical processes which may serve as examples of distinct process categories, thus contributing to a clarification of the term.

Musical processes are experimental devices for composers. For the purpose of investigating unknown or relatively unknown musical and perceptual possibilities, a composer may invent the conditions for the realization of a certain process, consisting of a basic material and a number of rules or goals. The unfolding of the intended process will then provide the composer with a musical result which he may find satisfying or uninteresting, predictable or surprising, dull or promising. Subsequently, the composer has a new chance to adjust or refine the process in order to pursue the desired result.

I will focus on four works by composers who have in very different fashions applied the investigation of musical processes in the evolution of their creative work, the American composers Steve Reich and John Cage, and the Europeans György Ligeti and Per Nørgård.



STEVE REICH: *PIANO PHASE* (1966)

For a period of five years, 1965–1970, Steve Reich concentrated his work on the invention of musical processes, and presented his viewpoints in the manifesto-like essay ‘Music as a Gradual Process’ (1968, printed 1974)

I am interested in perceptible processes. I want to be able to hear the process happening throughout the sounding music.

To facilitate closely detailed listening, the musical process should happen extremely gradually.

Performing and listening to a gradual musical process resembles: pulling back a swing, releasing it, and observing it gradually come to rest; turning over an hour glass and watching the sand slowly run through to the bottom; placing your feet in the sand by the ocean’s edge and watching, feeling, and listening to the waves gradually bury them.

Though I may have the pleasure of discovering musical processes and composing the musical material to run through them, once the process is set up and loaded, it runs by itself (Reich 1974, p. 9)

The distinctive thing about musical processes is that they determine all the note-to-note details and the overall form simultaneously. One can’t improvise in a musical process – the concepts are mutually exclusive. (1974, p. 11)

Steve Reich’s first process compositions were based on tape loops. After having assembled some tape collages of recorded sounds, he got the idea of experimenting with tape loops from his fellow composer Terry Riley. Reich experienced that when he played identical tape loops on two tape recorders, repeating the same sounds over and over again, the machines would gradually come out of synchronization with each other, producing unforeseen rhythmic patterns. He then gained control of this sounding phenomenon by starting two tape loops in unison and letting them slowly slip out of phase, and produced two tape compositions based on the phase-shifting repetitions of a few words of recorded speech, *It’s gonna Rain* (1965) and *Come Out* (1966). Reich was struck by the resulting rich variety of rhythms and sound transformations, and described his experience:

As I listened to this gradual phase shifting process, I began to realize that it was an extraordinary form of musical structure. This process struck me as a way of going through a number of relationships between two identities without ever having any transitions. It was a seamless, continuous, uninterrupted musical process. (Reich 1974, p. 50)

Steve Reich’s next step was to transfer the phase shifting process to live instrumental performance. He staged the process by recording a tape loop of a short repeated melodic pattern played on the piano, and subsequently trying to play the same pattern live against the tape loop, changing his

tempo gradually. This experiment turned out to be successful and satisfying, and formed the basis of Reich's composition for two live keyboards, *Piano Phase* (1966).

The process of *Piano Phase* is defined by a basic material and a few rules. The material consists of a mere five different pitches, e b d and f# c#, distributed in a twelve-note pattern (Figure 1, bar 1).

**piano phase**

for two pianos  
or two marimbas\*

**steve reich**

♩ = ca. 72  
Repeat each bar approximately number of times written. / Jeder Takt soll approximativ wiederholt werden entsprechend der angegebenen Anzahl. / Répétez chaque mesure à peu près le nombre de fois indiqué.

Figure 1. Steve Reich: piano phase, bars 1-6.

The rules are:

- (1) Both performers play the pattern over and over again. One performer starts, the other fades in in unison (bars 1–2).
- (2) The first performer keeps a constant tempo. The other performer gradually increases his tempo, until he is one note ahead of the first performer (bar 3)
- (3) After playing in synchronization for a while, the second performer again begins increasing his tempo, and the phase shifting process starts again (bars 3–4)

In the first part of *Piano Phase*, this procedure is repeated twelve times.

*CD reference 1: Reich*

Reich was fascinated by the surprising effects:

The use of hidden structural devices in music never appealed to me. Even when all the cards are on the table and everyone hears what is gradually happening in a musical process, there are still enough mysteries to satisfy all. These mysteries are the impersonal, unintended, psycho-acoustic by-products of the intended process. These might include sub-melodies heard within repeated melodic patterns, stereophonic effects due to listener location, slight irregularities in performance, harmonics, difference tones, etc. (Reich 1974, p.10)

The auditory effects of the phase-shifting process in 'Piano Phase' have been described in an article by Paul Epstein:

Where, then, are the mysteries ? They are in fact numerous and stem in part from the fact that while the process is continuous, our perception of it is not. The listener is presented with a rich array of possibilities out of which he/she may construct an experience of the piece. (...)

The phasing process begins with a movement away from unison. Although continuous, it is heard in several distinct stages. At first the impression is of increasing resonance, a change in acoustic quality only. At the next stage one begins to hear the voices separate: echo replaces resonance. At a certain point the irrational division of the beat caused by the echo presents a dizzying rhythmic complexity. When the voices are nearly 180 degrees, or one half beat, out of phase, a doubling of the tempo is perceived; one has a momentary sense of stability, of a simplification of the irrational rhythmic relationship heard previously. This stage is very brief and is one of those events that seem to occur suddenly. The out-of phase quality quickly returns and lasts until the new phase locks in. (Epstein 1986, pp. 497–499)

#### *CD reference 2: Reich*

Epstein concludes that the listener's task in experiencing process music is also one of discovery, and that the listener may focus his attention in different ways by adopting different listening strategies.

Reich's phase shifting pieces are examples of determinate processes, unfolding from a clearly defined initial material and a set of transformation rules. By introducing this kind of rigorously structured repetitive music, Reich was revolting against two prevailing trends on the New York music scene in the 1960's, the complexity of serial music and the indeterminate music of John Cage. Reich's alternative can be denoted as 'determinate simplicity'.

#### JOHN CAGE: *VARIATIONS II* (1961)

In 1958, Cage had introduced his ideas of indeterminacy in Darmstadt, Germany, in his lecture entitled 'Composition as Process', printed in *Silence* (1961). This lecture is a manifesto from a radical period in Cage's life, when he had dismissed the ideas and methods underlying earlier

works such as numerical structures, considered improvisation, unambiguous notation and preconceived form. Here, Cage presents his ideas of 'non-intention':

This is a lecture on composition which is indeterminate with respect to its performance. That composition is necessarily experimental. An experimental action is one the outcome of which is not foreseen. (Cage 1961, p. 39)

The early works have beginnings, middles, and endings. The later ones do not. They begin anywhere, last any length of time, and involve more or fewer instruments and players. They are therefore not preconceived objects, and to approach them as objects is to utterly miss occasions for experience... (1961, p. 31)

... constant activity may occur having no dominance of will in it. Neither as syntax nor structure, but analogous to the sum of nature, it will have arisen purposelessly. (1961, p. 53)

Cage aims at music which is unforeseen and purposeless, music which lets the sounds be themselves, free from the intentions and expressions of the composer's mind. Models for the realization of this kind of music are found in Cage's *Variations I* (1958) and *Variations II* (1961). The *Variations* are not scores, but 'compositional tools' which present procedures for creating scores or successions of musical events. Any trace of preconceived composition has disappeared, and the work exists solely as a model for a process (Pritchett 1993, p. 126).

The materials of *Variations II* consist of a set of transparent sheets with dots and lines, to be arranged in any order and interpreted as musical parameters by the performers. This is the beginning of Cage's instructions for *Variations II*:

Six transparent sheets having single straight lines. Five having points. The sheets are to be superimposed partially or wholly separated on a suitable surface. Drop perpendiculars by means of any rule obtaining readings thereby for (1) frequency, (2) amplitude, (3) timbre, (4) duration, (5) point of occurrence in an established period of time, (6) structure of event (number of sounds making up an aggregate or constellation). A single use of all sheets yields thirty determinations.

In order to illuminate the process defined by Cage, I have produced two short and simple versions for piano of *Variations II*. I have added the following rules for the realization: (a) The established period of time is 45 seconds, divided in three parts of 15 seconds. (b) Each composition consists of five musical events. (c) Each event is defined by Cage's parameters 1, 2, 3, 4 and 5. (No. 6 is omitted for the sake of simplicity). (d) Each of the parameters may adopt three different values.

The practical procedure is the following: (1) Five transparent sheets having straight lines and five having dots are superimposed on the glass plate of a copying machine, and a copy is taken. (2) On the copy, the lines

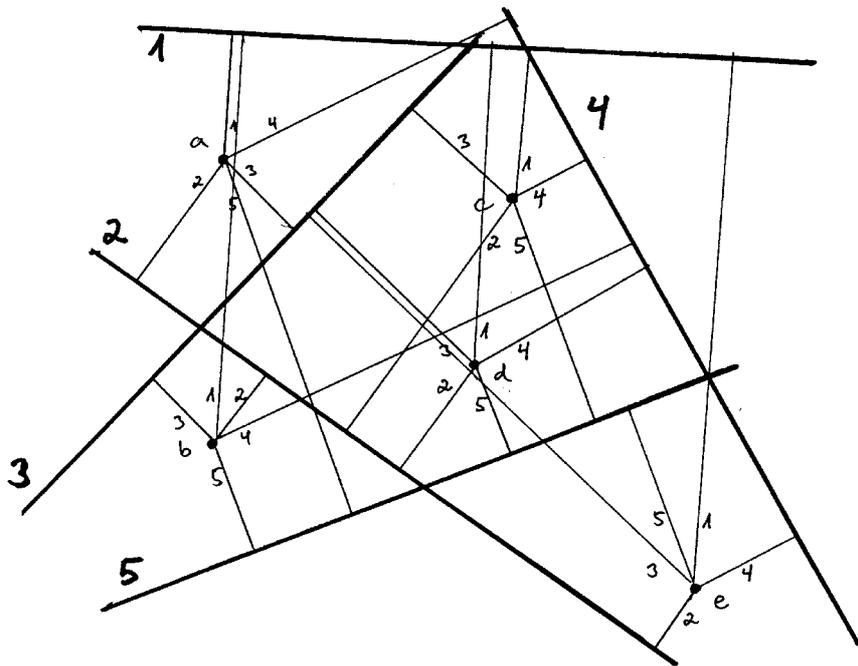


Figure 2a. John Cage: *Variations II*, Version 1.

Event	1. Pitch	2. Volume	3. Timbre	4. Duration	5. Occurrence
a	middle	middle	keyboard	long	last part
b	high	low	strings	long	middle
c	middle	high	strings	short	middle
d	high	high	strings	short	middle
e	high	low	knocking	short	middle

Figure 2b. John Cage: *Variations II*, Version 1: Properties of five musical events resulting from the application of Cage's instructions and a number of additional rules.

are numbered 1 2 3 4 5, each representing a musical parameter, and the dots are marked a b c d e, each representing a musical event. (3) From each dot, perpendiculars are drawn to each line, and marked 1 2 3 4 5 (Figure 2a).

(4) The length of each perpendicular is estimated as 'short', 'middle' or 'long', and these three categories are interpreted as parameter values for: (1) Frequency (pitch): low/middle/high. (2) Amplitude (volume): low/middle/high. (3) Timbre: keyboard/strings/knocking. (4) Duration: short/middle/long. (5) Point of occurrence within the period of time: first part/middle/last part. This reading of the perpendicular lines results in the definition of five musical events shown in Figure 2b.

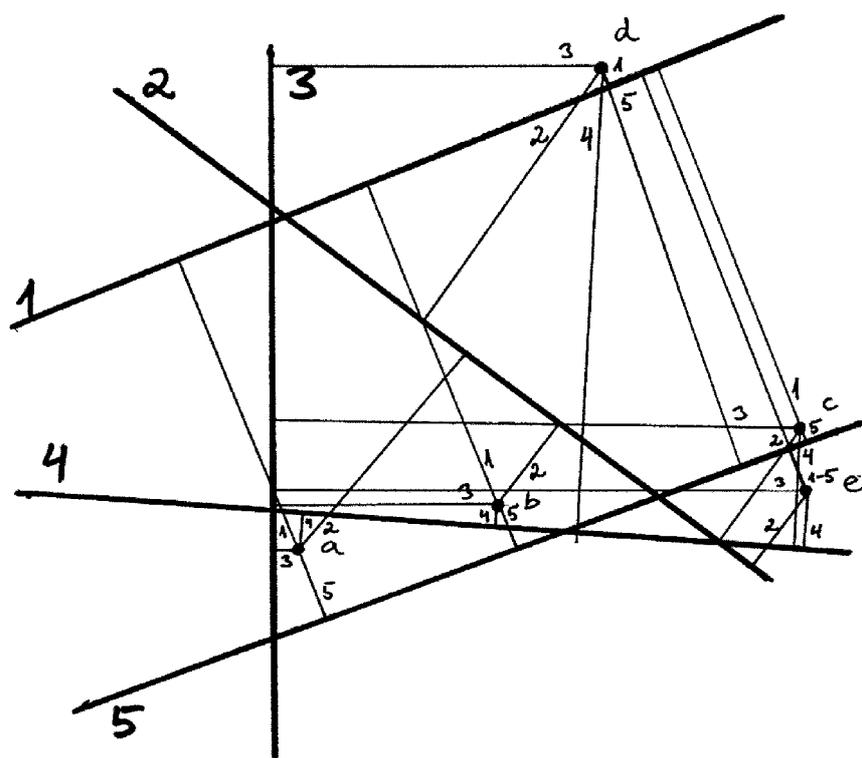


Figure 3a. John Cage: *Variations II*, Version 2.

	1. Pitch	2. Volume	3. Timbre	4. Duration	5. Occurrence
Event					
a	high	middle	keyboard	short	first part
b	high	low	strings	short	first part
c	high	middle	knocking	short	first part
d	low	middle	strings	long	last part
e	low	low	knocking	short	last part

Figure 3b. John Cage: *Variations II*, Version 2: Properties of five musical events.

The performer enjoys considerable liberty in the realization of the events. In this version, no events occur in the first part (15 seconds of silence). In the middle part, the strings are struck, plucked, or scraped 3 times in high, middle, and high pitch range, and the wood of the piano is knocked once. In the final part, a long sound (tone or cluster) is played at the middle of the keyboard. For the realization of a performance, the events may be notated in a performance score, applying appropriate symbols.

Figures 3a and 3b display another version of *Variations II* and the properties of the resulting musical events.

In this version, three different events occur in the first part: keyboard, knocking and strings in the high register. The middle part is silent, and the piece ends with a short knock and a long string sound.

These are two examples out of an infinite multiplicity of musical events and structures which may result from the superposition of transparent sheets having lines and dots. Cage's *Variations II* is a model for indeterminate processes, designed to produce unforeseen results from random inputs.

*CD reference 3: Cage*

GYÖRGY LIGETI: *IN ZART FLIESSENDER BEWEGUNG* (1976)

In his indeterminate works, John Cage has arranged his composing means so that he has no knowledge of what may happen. The composer György Ligeti works in the opposite manner. He relates that his music takes shape in his imagination as a sonorous form, and that he is able to listen to the piece from beginning to end in his mind (Ligeti 1971). His next step, then, is to invent constructions which can transform his inner vision into a web of musical relations and connections. These constructions will often be conceived in the form of carefully designed musical processes. One striking example is Ligeti's piece for two pianos, entitled *In zart fließender Bewegung* (In a Gently Flowing Movement), which is the last of the three pieces for two pianos *Monument, Selbstporträt, Bewegung* (1976). This piece is a meticulously woven web of arpeggiated piano tones, often moving in canons or mirror canons, an incessant flow of rise and fall, fluctuation and acceleration, expansion and contraction. The beginning of the score is shown in Figure 4.

In order to render the ongoing processes in this piece intelligible, I have visualized the musical flow in the first 53 bars of Ligeti's piece in a graph (Figure 5). In the graph, the vertical axis represents pitch, the divisions in equal steps corresponding to the chromatic scale. The horizontal axis represents time, each unit corresponding to one quarter note in the score. Four quarter notes make up one bar of music. The bars are numbered in accordance with the score.

Each vertical column in the graph shows all tones (between 6 and 12) played by both pianists within the quarter-note time unit. Each short tone of the piano arpeggios is plotted in the graph as a black dot. A tone which occurs twice within the time unit is marked as a white dot, and a tone which occurs three times is marked as a white dot with a point. Accented short notes are marked as small triangles, strong accents (*sforzando*) as large

3. In zart fließender Bewegung

NB! # bzw. b sind - falls möglich - kurzzeitig aufgehoben - jeweils für den gesamten Takt gültig, doch nur im selben System.  
NB 2. Stab mit Pedal (noch oft wechselnd)

Figure 4. György Ligeti: In zart fließender Bewegung, bars 1–8.

triangles. Longer notes are drawn as squares or lines. The graph displays the temporal and spatial evolution of the music.

#### CD reference 4: Ligeti

A detailed analytical description of this music has been provided by Herman Sabbe (1987, pp. 37–48). With reference to Sabbe's analysis, the following musical processes can be pointed out:

1. *Expansion and contraction of the pitch space*: Expansion in bars 1–14, contraction in bars 15–22. Renewed expansion from bar 25, reaching the upper and lower limits of audible pitch in bars 51–53.
2. *Increase and decrease of interval size*: The musical intervals are enlarged and diminished in accordance with the overall expansion and contraction throughout bars 1–36. Then follows a gradual diminishing of intervals, as the music moves towards the extremes in bars 51–53. These processes are heard as changes and fluctuations of harmonic color.
3. *A hollowing out of the total soundspace* begins in bar 39, to be followed by a filling of the void by a succession of slow chords in bars 49–63. (The chords are not shown in the graph)
4. *Increase and decrease of tempo*: From the beginning until bar 48, a stepwise increase of the number of tones per time unit takes place, perceived as increasing tempo. This is reinforced by a gradual accel-

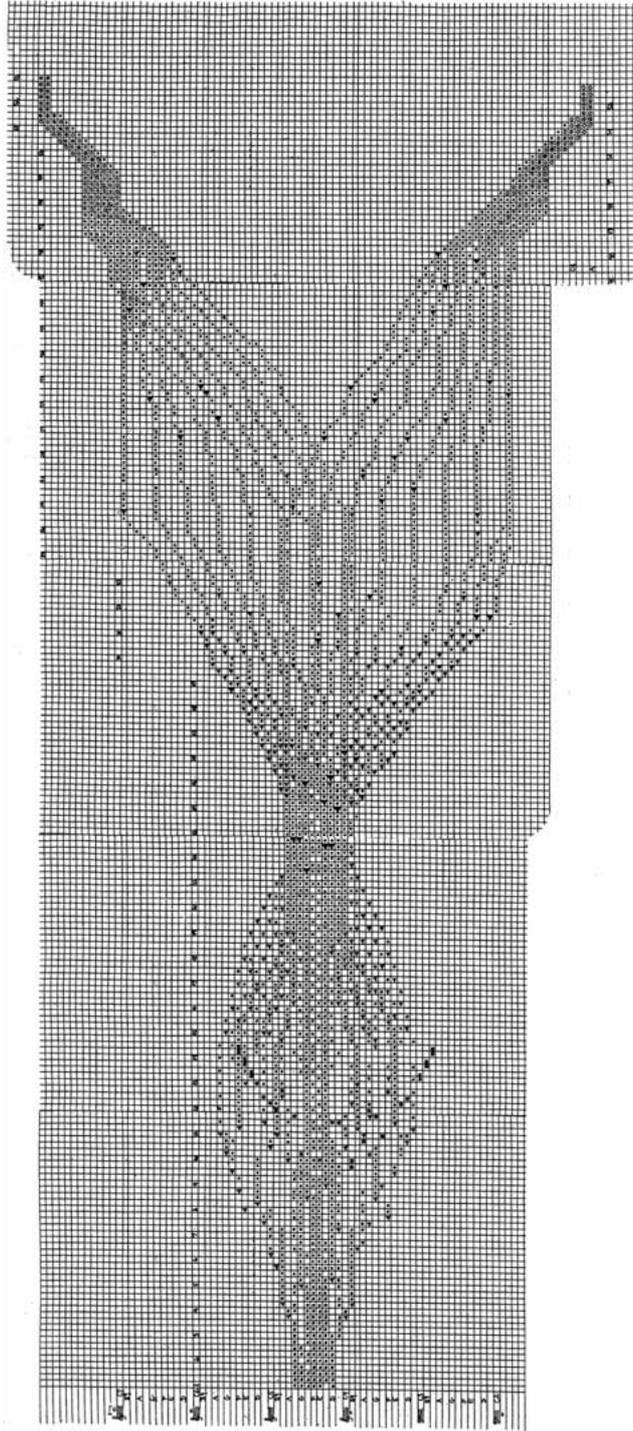


Figure 5. Graph of the temporal and spatial evolution in Ligeti's *In zart fließender Bewegung*.

erando in both instruments in bars 31–48, leading to a culmination in the trill in bar 52, whereupon a sudden shift to slow tempo takes place.

5. *Increase and decrease of volume*: A gradual crescendo follows the accelerando from bar 31, culminating in bars 47–48, then cut off by a subito pp in bar 49.
6. *Emergence of patterns of accents and sforzato accents*: In the flow of fast tones, certain accented tones stand out like clear points on a blurred background. The moderate accents articulate the overall process by accentuating the emergence of new tones in the flow, as well as the outlines of expansion and contraction. The succession of strong sforzato accents, beginning in bar 21, constitute independent patterns of melody, which display a canonic structure (Febel 1978).

Altogether, the unfolding of the interrelated processes in Ligeti's *In zart fließender Bewegung* represents the audible realization of the composer's vision of a musical form. As a means of attaining a preconceived compositional goal, they can be characterized as goal-directed processes. The rules or principles guiding these processes are not meticulously defined, but clearly observable as predominant tendencies in the evolution of the process.

#### PER NØRGÅRD'S INFINITY SERIES

My final example of musical processes is a generative process of fractal nature which creates multiplicity out of an initial unity. When the Danish composer Per Nørgård was investigating principles of organic growth in the 1960's, he discovered a tone series which possesses unique properties of self-similarities, repetitions and symmetries. Nørgård named it the 'infinity series', and continued to explore its properties for several decades. The infinity series is generated by mirroring an initial interval symmetrically downwards and upwards, thus producing new intervals which, by repetition of the mirroring procedure, form an endless succession of further intervals. The generation of the series is explained in Figure 6.

The unfolding of the first 64 tones of the series, displayed in Figure 7, shows a remarkable emergence of self-similar figures, symmetries and interrelations. The series generates a repeated succession of figures, which can be described as M- and W- shapes separated by rising axes: M/M/W/M. The interval ranges of the M- and W- shapes correspond two by two, and numerous other intervallic relationships between the figures can be observed.

Generation of Nørgård's infinity series

a) Two tones are given, 1 and 2.

Tone 1 is the beginning of a lower voice of odd-numbered tones, drawn in black.  
Tone 2 is the beginning of a higher voice of even-numbered tones, drawn in white.  
New tones are generated by the projection of a previous interval; each interval is projected twice. In the lower voice, the interval is projected in the opposite direction. In the higher voice, the interval is projected in the original direction.

b) Generation of tones 3 and 4

The interval 1-2 is a rising semitone. In the lower voice, it is projected as a falling semitone, producing tone 3. In the higher voice, it is projected as a rising semitone, producing tone 4.

c) Generation of tones 5 and 6

The new interval 2-3 is a falling whole tone. In the lower voice, it is projected as a rising whole tone, producing tone 5. In the higher voice, it is projected as a falling whole tone, producing tone 6.

d) Generation of tones 7 and 8

The new interval 3-4 is a rising minor third. In the lower voice, it is projected as a falling minor third, producing tone 7. In the higher voice, it is projected as a rising minor third, producing tone 8.

e) Generation of tones 9 and 10

The new interval 4-5 is a falling semitone. Projections produce tones 9 and 10.

f) Generation of tones 11 and 12

Produced by projections of the new interval 5-6, a falling semitone.

g) Successive generations

Produced by successive projections of new intervals.

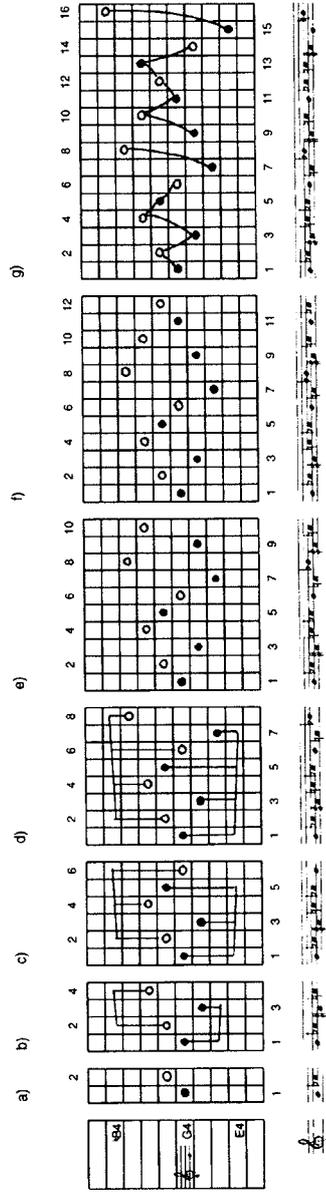


Figure 6. Generation of Nørgård's Infinity Series. Reproduced from Christensen (1996, Vol. II, p. 59).

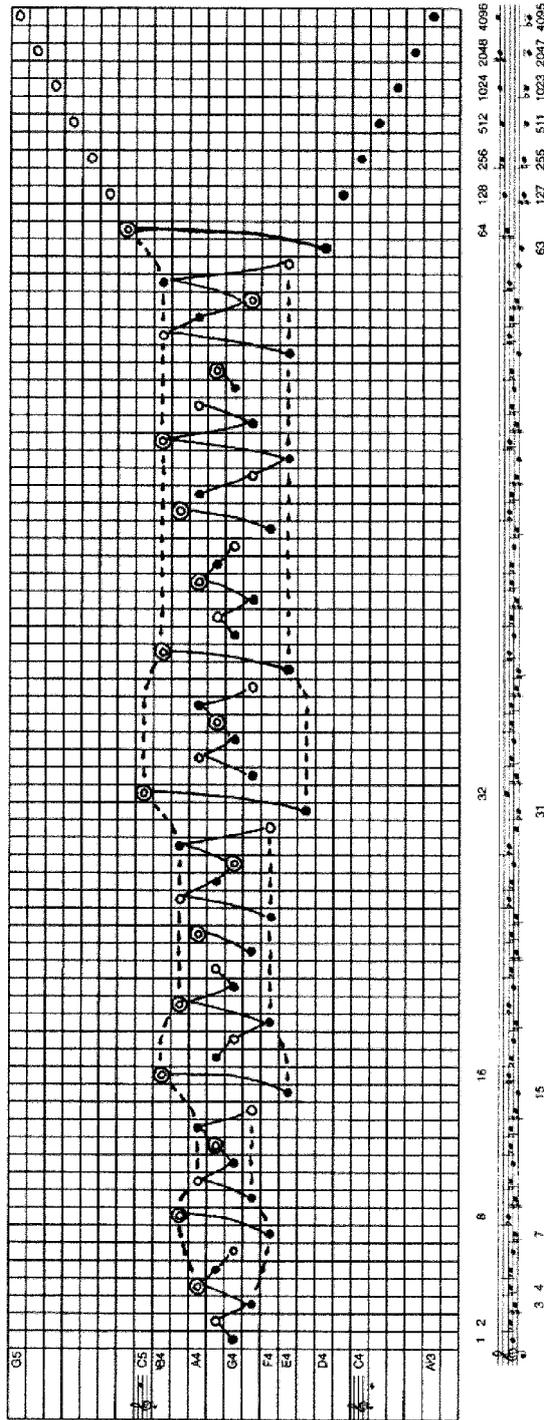


Figure 7. Unfolding and expansion of the *Infinity Series*. Reproduced from Christensen (1996, Vol. II, p. 58).



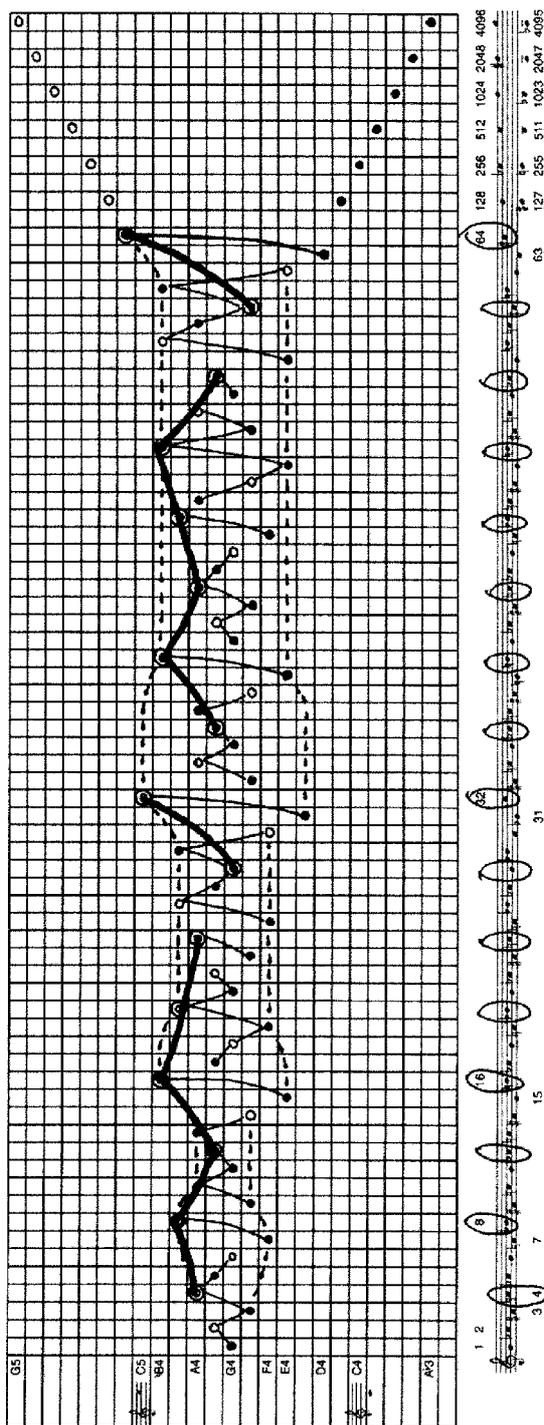


Figure 9. Tones 4, 8, 12, 16, ... constitute a transposition of the series.

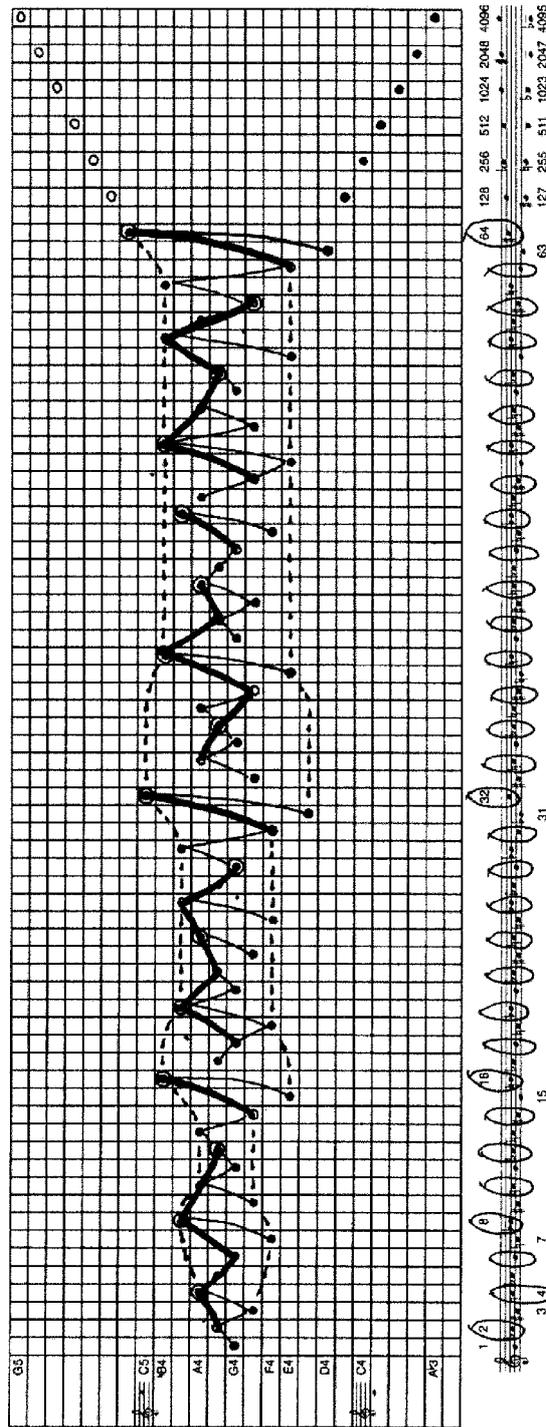


Figure 10. Tones 2, 4, 6, 8, ... constitute another transposition of the series.

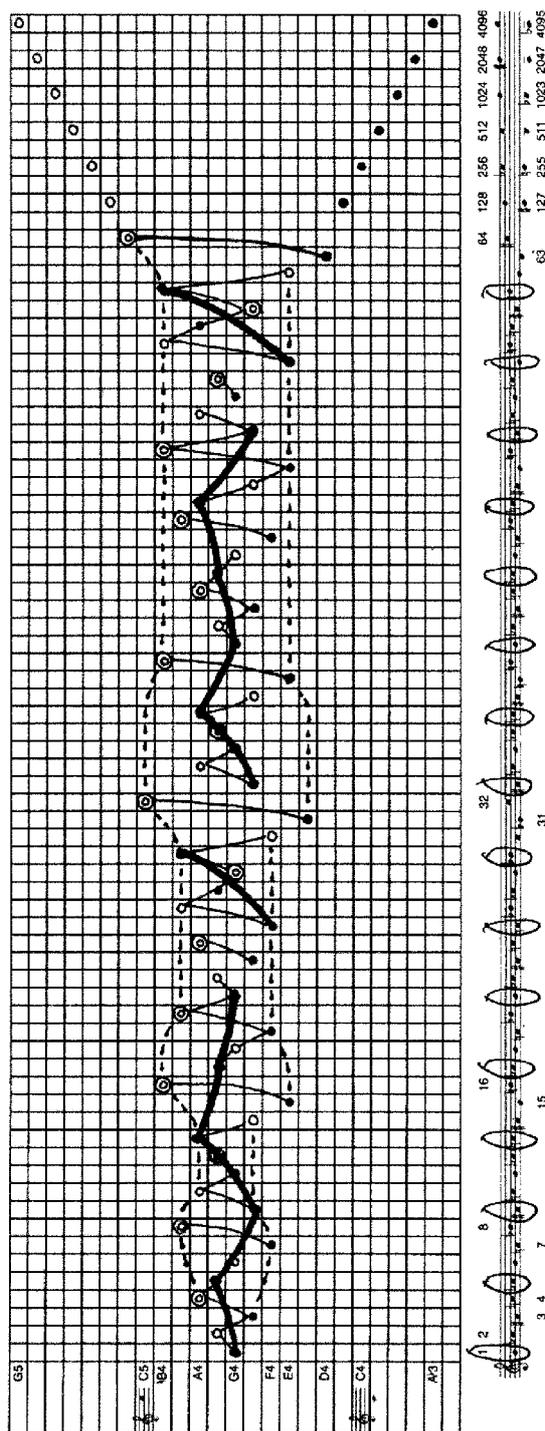
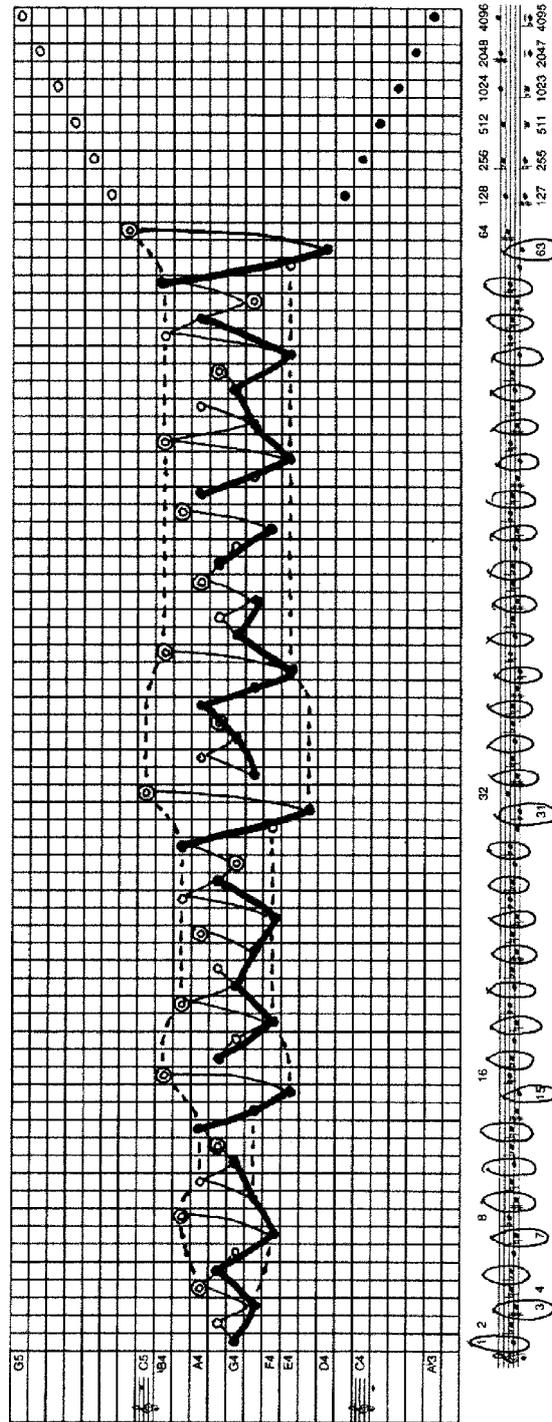


Figure 11. Tones 1, 5, 9, 13, ... constitute a replica of the series.



1 (-2) 3 (-1) (-1) (-2) 5 (-4) 3 (-2) 1 1 (-3) (-2) 7  
 3 (-1) (-2) 5 (-3) 1 (-2) 3 (-4) 5 (-2) (-1) 3 (-5) (-2) 9 .... etc.

Figure 13. The beginning of the infinity series represented by numbers .

transformation process	rule-determined goal-directed indeterminate
generative process	rule-determined goal-directed indeterminate

Figure 14. Six process categories.

13, ... constituting a four times slower replica of the basic series (Figure 11). In these first measures and throughout the work, the infinity series is omnipresent in different self-similar transpositions and different tempo layers. By the mere presence of the series, time is stretched, compressed and stratified. For example, tones 16, 32, 48, 64, 80, 96, ... will form a new, slower transposition. A further characteristic property of the series is its self-mirroring, as seen in the shapes constituted by tones 1, 3, 5, 7, 9, ... (Figure 12) or tones 1, 9, 17, 25, 33, ...

The infinity series, discovered in the 1960's, is an early example of a generative fractal process, a process which reproduces and mirrors its own shapes and structures infinitely in different orders of magnitude. From the emerging shapes of this series, it is possible to extract innumerable melodies and melodic fragments. Per Nørgård has included selected features of the series in a large number of his compositions, and he has extended the principles of the series to the generation of rhythms and rhythm patterns (Beyer 1996)

In the above examples, the unfolding of the series has been demonstrated within the frame of an equidistant scale. The succession of intervals, as seen in Figure 7, can be read as a number series which displays characteristic recurrences (Figure 13).

Read as a succession of scale steps upwards and downwards, this number series can be applied to any kind of scale, equidistant or non-equidistant, such as diatonic or pentatonic scales, quarter-tone scales, the overtone series etc., producing different musical shapes of the infinity series. A discussion of the mathematical properties of the series is provided by Thor A. Bak (2002).

In conclusion, let me suggest a modest contribution to the typology of processes. With reference to the process examples discussed above, six possible categories of processes can be proposed, shown in Figure 14.

The four musical examples represent four of these six categories. Steve Reich's *Piano Phase* represents a rule-determined transformation process, and György Ligeti's *In zart fliessender Bewegung* can be described as a goal-directed transformation process. Per Nørgård's Infinity series is a model for a rule-determined generative process, and John Cage's *Variations II* is a model for an indeterminate generative process.

#### ACKNOWLEDGEMENTS

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## CD REFERENCES – RECOMMENDED LISTENING

- Steve Reich: *Piano Phase*. Wergo – WER6630-2, Track 3: 0'00–2'15.
- Steve Reich: *Piano Phase*. Track 3: 2'00–3'20.
- György Ligeti: *In zart fließender Bewegung*. SONY – SK 62397, Track 15.
- John Cage: *Variations II*. The described versions are not recorded. Other versions of *Variations II* are available on Etcetera – KTC 2016 and Hat Hut – HATARTCD 6146.
- Per Nørgård: *Second Symphony*. Point – PCD 5070, Track 1: 0'56–2'06.
- Per Nørgård: *Voyage into the Golden Screen*. Dacapo – DCCD 9001-B, Track 12: 0'58–1'44.

