

Musical Teleology between Newton, Prigogine and Deleuze (with Spinoza Becoming Musical)

Abstract. The concept of *τέλος* (end, purpose) is deeply rooted in European thought, with rich and diverse applicability (ethical, metaphysics, religious). In music, given its temporal and processual nature, teleological issues enjoy a privileged position. Whenever we experience or think about music as a process, we can inquire about the goals of that process, and the paths leading toward these goals. In my previous work on musical teleology, I discussed the types of events that serve as goals, the activity of musical parameters that project goals and steer music toward these goals, and the conditions under which music can be deemed teleological. In the present article, I try to examine teleology in light of ideas that have largely shaped European thought over the past several centuries, particularly ideas that come from “natural philosophy” and the philosophy of science. I will examine, first, the implications of Newton’s (and Spinoza’s) non-teleological, mechanistic determinism; I will proceed with the arrow of time postulated by the highly teleological second law of thermodynamics, as well as the self-organizing, far-from-equilibrium dynamic systems studied by Ilya Prigogine; and finally, the probabilistic aspect introduced by quantum mechanics. My music examples will be from the compositions by Penderecki, Ligeti, and Varèse. While recognizing the autonomy of the respective scientific, philosophical, and artistic fields, we cannot fail to notice that certain ideas at a certain period seem to proliferate and circulate between different fields and that works of art have a way of expressing the same relationships as do phenomena in the both inanimate and animate world, including moving toward a goal/end. This brings us to the idea of univocity as championed by thinkers such as Spinoza and Gilles Deleuze.

Keywords: Newton, Spinoza, Leibniz, Deleuze, Ligeti, Penderecki, Varèse, musical teleology.

1. Prologue

When Krzysztof Penderecki ended his *Polymorphia* for strings with a C major chord, he created a double paradox. What could be a more natural ending in Western European music than a C major, and what could be *less* natural than a C major in this piece? The second and more important paradox is: when you think it over, what could be a more effective ending? At every point in this composition, you could think of a plausible continuation. The C major, unexpected, incongruent as it is, could not have been more definitive. There is simply nothing you can add afterward.

Our next example will be György Ligeti’s *Lux aeterna* for sixteen a cappella voices. Table 1 presents the synopsis of form, indicating pitch collections occurring at structural boundaries.

| Section | I | | | | II | | | | III | | | |
|-------------|----------------|-------|----------------|-------|-----------------|---------|-----------------|-------------|------------------|-------|------------------|-----------|
| Subsection | I ₁ | | I ₂ | | II ₁ | | II ₂ | | III ₁ | | III ₂ | |
| (begin/end) | 0 | 24 | 24 | 37 | 37 | 61 | 61 | 90 | 90 | (101) | (101) | 119/127 |
| Pitch/pc | F→013 | (025) | (A) | 013→A | 025 | 025 | 025 | 025 | 037 | 025 | 025 | 0257 →F+G |
| Texture | canonic | | | | non-canonic | canonic | | non-canonic | canonic | | non-canonic | |

Table 1. György Ligeti, *Lux aeterna*, synopsis of form

There is no a priori reason why should the first section end with the trichord F_♯-A-B,¹ belonging to the set class 025.² Yet, when this pitch collection reappears, we not only recognize its concluding function—confirmed in subsequent sections and subsection as the table shows—but we also feel that it somehow issues naturally from the preceding music flow. Whether or not the previous events point precisely to that event is open to debate. I believe they do, up to a point, and in my previous article (Zatkalik 2013), I demonstrated something I called the rise to power of the 025-pitch collection. What I mean by that expression is how this set gradually becomes increasingly prominent until it assumes a pivotal structural role. It remains questionable, though, to what extent this process is accessible to listeners.

¹ See Example 3a below. For technical reasons I do not provide other examples of this piece. The reader is strongly advised to have the score at hand.

² It would be meaningless to conduct a set-theoretical analysis of this composition, but the Forte labels are the most convenient way of highlighting the common traits of boundary-marking pitch collections.

The end of the entire piece, with its fading out, its total exhaustion of energy feels appropriate, its finality undisputable. The music naturally leads toward such an ending—naturally, but not inevitably. It does not feel like the necessary outcome of the process, the way the perfect authentic cadence does in tonal music. Consider the cadence of virtually any musical sentence in the late eighteenth and roughly the first half of the nineteenth centuries: a sonata theme, the first section of a ternary form and the like. An utterly different ending is conceivable in Ligeti, but not there.

In these examples and music generally, some goals are expected and given a priori, some are created contextually. We, furthermore, ought to distinguish between goals themselves and paths leading toward them. The two aspects can work in tandem, but they can also diverge, be completely divorced from one another, or one of them can be absent. In *Polymorphia*, we can tentatively speak of a goal, but not even tentatively about paths toward that goal. We also need to be aware of the possible discrepancy between the compositional procedures and listeners' experience. Analysis can sometimes disclose procedures that remain hidden from the listener: "polyphony is written, harmony is heard", as Ligeti famously said.

2. Preliminary considerations

The concept of *τέλος* (end, purpose) is deeply rooted in European thought, with rich and diverse applicability (ethical, metaphysical, religious). Every investigation of motion may legitimately pose the question of where the motion is headed. The well-known cognitive schema source–path–goal, very influential in music, is teleology in a nutshell. A narrative structure is teleological. When we talk about tension and release, we are talking about something we can call prototeleology: namely, a process heading toward a goal can be described as moving from a less stable, hence more tense state toward a state of stability, with the concomitant discharge of tension. If this is true, then Freud's structural model of the mind reflects various aspects of teleology. The goal of the unconscious Id is the immediate discharge of tension; I will call this microteleology, moment-to-moment connections. Ego introduces delay: the goal (discharge of tension) is deferred, taking into account reality (one's limitations, for instance), or—with Superego—taking into account norms, conventions, or prohibitions imposed by society.

In music, given its temporal and processual nature, teleological issues enjoy a privileged position. Virtually every aspect of music can have its teleological dimension, and so can virtually every approach to music. Whenever we experience or think about music as a process, a flow, we can inquire about where this process leads to and by which routes. This can ramify into myriads of more specific questions, such as the forces that propel the flow of music towards goals (Larson 2012); various temporalities in music (Kramer 1988); the activities of individual parameters (harmony, counterpoint, form) in projecting and attaining goals; expectations and their fulfillment (Huron 2006), and more. In my previous work on musical teleology (Zatkalik 2013), I discussed the types of events that serve as goals, the activity of musical parameters that project goals, and steer music toward these goals and conditions under which music can be deemed teleological. I also insisted, first, that teleology is not the question of binary choice but of degree: processes can be more or less goal-oriented. Second, a composition is not, or not only teleological in itself; teleology is or is also a way of listening. Teleology is in the ear of the listener.

The "technical" perspective of my previous work will now be broadened and deepened as I try to examine teleology in light of ideas that have largely shaped European thought over the past several centuries. I particularly want to explore relations between musical teleology and how science made sense of the world, first as natural philosophy, later as a philosophy of science. I will examine the implications of Newtonian mechanics, which is deterministic and reversible; of quantum physics, which basically follows the same postulates but adds the aspect of probability. As opposed to that, classical thermodynamics is teleological and irreversible, postulating a unidirectional arrow of time. Possibly the most relevant model for post-tonal music are self-organizing, far-from-equilibrium dynamic systems, studied by the Nobel-prize-winning Russian-Belgian chemist Ilya Prigogine (Prigogine & Stengers 1984). From that vantage, the goals of musical motion act in a way similar to attractors in dynamic systems, as we will explain in due time.

I certainly do not propose a one-to-one mapping between philosophy, science and arts. I am not advocating some mystical *Zeitgeist* that permeates all intellectual, artistic and spiritual products at a given historical time. Still, certain ideas at a certain period seem to proliferate and circulate between different fields. One finds parallels or isomorphism between different areas. These relationships can be regarded in various ways. Thus,

a philosophical system or a scientific theory can trigger something in an artistic field, both directly and indirectly. What exactly the reaction will be, what kind of artistic product this would yield, cannot be specified: the autonomy of artistic creation is responsible for that. This is something like “structural coupling”: the idea originating with Chilean biologists Humberto Maturana and Francisco Varela (1980), meant for biology but used in social sciences, notably by Niklas Luhmann. We can also think with Mikhail Bakhtin about mutual answerability of art and life. Or in the direction of Whitehead’s speculative philosophy as “the endeavor to frame a coherent, logical, necessary system of general ideas in terms of which *every element of our experience* [emphasis mine] can be interpreted” (Whitehead 1978/1929: 3). Or with Deleuze discover the same abstract machine operating in different domains, enabling us to experience the creative power that produces a composition consubstantial with physical forces.

My previous work (Zatkalik 2013; 2015; 2017) discussed musical teleology chiefly in terms of activities of musical parameters. A great deal has been written on teleology in general, the ontology and metaphysics of goal-oriented processes. We need to make a distinction between two fundamental approaches to the concept of goal, going back to Plato and Aristotle. Very briefly, it is the transcendent versus the immanent. The Platonic view sets the goals outside, “beyond the existing material substrate”. Aristotle, however, invested nature itself with goals. Entities are so constructed that they tend to realize this goal; “final causes are metaphysically immanent in nature ... intrinsically directed toward their appropriate ends” (McDonough 2009: 520).

How does this distinction apply to music? We can think on two levels. On a more superficial one, it partly matches the already indicated distinction between goals established by referring to an a priori referential system—chiefly functional tonality—and goals created contextually, emerging from the intrinsic logic of the piece. I would, however, rather think of this issue on a more fundamental level, as a kind of metaphysical underpinning related to the phenomenon of music as such, and how it is constituted as teleological: on what conditions it can be deemed teleological, what kinds of goals it strives to achieve, are the goals inherent in music and so on. It then serves as a basis or a framework for the inquiry into the nature of specific paths and goals in a composition. On the one level, the distinction concerns the activities of musical parameters; on the other, the way we think about music.

A more complex analysis of phenomena commonly discussed under the rubric of teleology delimits several types of processes. It is open to debate, however, whether some of them can be properly considered teleological. Thus, Ernst Mayr (1992) proposes a taxonomy according to which some types of processes can only loosely be identified with teleology.

- *Telematic*, when the end is automatically achieved, as in the law of gravity, the second law of thermodynamics and other processes in the inanimate world. Such processes come to an end when their potential is used up, or when stopped by an external impediment (e.g. a falling object hits the ground).
- *Teleonomic*, when there is coded and prearranged information that governs a certain process/behavior toward a specific outcome: birds are genetically programmed to migrate; a computer is programmed to perform a certain task.
- *Adaptation* by natural selection.³

Natural processes tending toward a final state could be called end-oriented rather than goal-oriented—finious as Charles Sanders Peirce says. It follows that teleology proper must include intentionality, intentionality being taken both in the technical sense of “aboutness”, that is, the property of the mind of being about something or directed toward something and in the everyday sense of having an intention or a purpose. Authors like Mayr and Nagel talk about phenomena rather different from music. But in music, what do we mean—in light of the above—when we talk about goals and their achievement, or the endpoints and paths leading toward them? Are these processes like a stone that falls, or is it more like biological evolution? Or a computer program that is being executed? Apparently, musical teleology eludes such classifications, which, however, does not invalidate them completely. Works of art have a way of expressing the same relationships as do phenomena in both inanimate and animate worlds, including moving toward a goal/end. The latter aspect is especially relevant for music, the art of change in time. We can, therefore, be justified in the attempt to establish correspondences between music and such taxonomies of teleological or pseudoteleological phenomena, both in the sense of specific compositional procedures and the ways in which we think about

³ He first proposed these terms in an earlier publication, and was critiqued by Ernest Nagel (1977), who offered useful suggestions on the criteria for teleology, albeit never mentioning an artistic creation.

music. To anticipate the ensuing discussions, when Jean Philippe Rameau treats musical events as masses in motion, as colliding bodies; when he talks about tonal attraction, he connects with the Newtonian vision of the universe, which matches the description of telematic processes. Furthermore, organicistic views of music also used to be highly influential; in Schenker's version, motives even have the urge to procreate. We can then update Schenker's views and claim that a composition is genetically programmed to follow a specific course of events. This is clearly a teleonomic view. And once we are in the realm of biology, then evolution cannot be far, and indeed, a composition may follow an *evolutionary* course, it *evolves* toward certain outcomes, regardless of whether or not evolution is considered to be teleological or not.⁴

To conclude this preliminary discussion: we may or may not sort out what is goal-oriented and what is merely end-oriented, but when discussing musical teleology, we must pay attention to both. Furthermore, it may be true that goals pertain to the creator of music. In the music itself, there may not be an actual purpose, but formal relations—purposiveness—is there. That's what we learn from Immanuel Kant.

3. The Newtonian Universe

Having previously mentioned natural philosophy, I could have started with pre-Socratic philosophers as they arguably provided a framework for both scientific and philosophical thought with their interest in the nature of physical reality and the nature of temporal change. I could have started from many other points, but as this paper has no pretensions to exhaustiveness and choices had to be made, my choice of the starting point is the scientific revolution of the 17th century. Indeed, around the year 1600 major scientific and philosophical advances were accomplished—Galileo, Kepler, Francis Bacon—continuing with Descartes, Pascal, and many more, and culminating later in the century with such gigantic figures as Spinoza, Leibniz and Newton.

Newtonian mechanics is deterministic. Everything is explained in terms of forces and masses in motion and everything is determined by initial states and laws of motion. Newtonian Universe is reversible, a body moves from point A to point B, reverse the direction and it will retrace all its previous states; the pendulum swings back and forth; planets revolve around the Sun and there is no privileged point on their trajectories, nor would their motion be different if they revolved in the opposite direction. All states are equivalent: “each of them allows all the others to be calculated, along with the trajectory which connects them, be they in the past or the future” (Prigogine & Stengers 1984: 60–61). A trajectory is not (or not necessarily) a path toward a goal. The circle of fifths is a trajectory, and to jump two centuries ahead, this connects to transformational and neo-Riemannian theories. Maximally smooth cycles are trajectories, and reversible.

The ultimate conditions of Newton's system are absolute time and space. Time for Newton is not much an arrow, it is rather like a container to be filled.⁵

Newton expresses the laws of nature in exact formulas, but he also considered himself a philosopher of nature. His mechanistic, clockwork model of the universe was shared by the major philosophers of his age. Thus, Spinoza's stark determinism expresses similar ideas: Newton's gravity is Spinoza's God, *Deus sive natura*. For Spinoza, there is no free will, only the necessary cause (Spinoza: I, 32⁶), and there is no room even for divine intervention. Both Newton and Spinoza are anti-teleological. Spinoza clearly states this when he says that Nature has no fixed goal and that all final causes are figments of human imagination. If God acts with an end in view, he must necessarily be seeking something that he lacks, which would clearly contradict his perfection (Spinoza: I, appendix).

This has an ambiguous relationship with musical teleology. Generally, science deals with causes and effects. Spinoza himself argues that nothing exists from whose nature an effect does not follow (Spinoza: I, 36). We need to be reminded that the teleological status of causality is dubious, as the Mayr taxonomy suggests. It does have some pre-teleological qualities, though: a teleological equivalent in the inanimate world. If a cause yields an effect, the effect may, at least in principle, be conceived of as the goal. We can presume certain logic in the succession of states: the present state of the system constrains the next state. These point-to-point

⁴ It used to be considered as such, complete with the idea of the Great Chain of Beings and the like. Nowadays, the prevailing view is that adaptedness is “an a posteriori result rather than an a priori goal-seeking” (Mayr 1992: 131). Gary Tomlinson talks about “emergent, bottom-up complexity” (Tomlinson 2015: 16); De Landa (2000) insists on feedback loops and so on.

⁵ “All things are *placed in time* as to order of succession” (emphasis mine). His view of time is, of course, rather more complex. He recognizes the difference between absolute and relative time (the later also called duration), and he recognizes the *order of succession*, which may contain a seed of teleology (Newton 1999: 408–410).

⁶ References to Spinoza's *Ethics* are made by the book number, followed by the number of propositions.

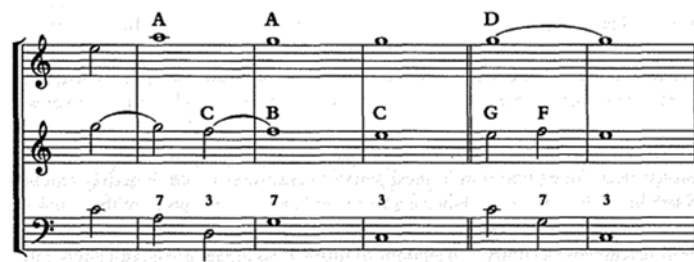
connections may or may not provide sufficient information on the final state, but they in themselves constitute something for which we have already coined the term microteleology.

Another caveat is the problematic status of causality in music. We could hardly say that a dominant chord is the cause of the tonic that follows, that a trio is caused by the preceding minuet and so on. To claim that one musical event causes another is to probably commit the fallacy *post hoc ergo propter hoc*. The reason why I nonetheless toy with the cause-effect pattern is our predilection for inferring causality. We easily read both teleology and causality into everything, artistic works in particular. A nightingale sings at dawn and afterward the sun rises. But we can envision a world in which a nightingale's song *causes* the sun to rise, and in which he sings *in order* for the sun to rise: this is what art is doing all the time.⁷ Since it has been repeatedly argued that music is isomorphous with physical or psychological processes, it is only natural to invest it with both causality and purposiveness.

We need now to return to Spinoza and approach the relevance of his thought for teleology from another angle. It may be somewhat surprising to invoke Spinoza in a discussion on the arts when his meticulously elaborated system leaves little room for such discussion. Yet, it can hardly be conceivable that his profound thoughts could be irrelevant for such a major aspect of human existence. It has been demonstrated (Rice 1996) that his ideas reverberate through aesthetics in important ways. Namely, "the major goal of Spinozistic ethics is the replacement of passive states or affects (wherein one is blindly controlled by the environment) with active affects (wherein one becomes a controlling factor in the environment which is operative upon him or her) ... accomplished through the use of reason, but without abandoning the framework of sensory stimuli which form the core of human experience" (Rice 1996: 482). Referring to "sensory stimuli" is clearly applicable to arts. Moreover, his teaching of affects, drawing on Stoics, may be interpreted as the mastering of tension, that I have already indicated, first as the most fundamental mode of experiencing music, and next, as a kernel of teleology.

If we want to explore in more concrete terms how all this relates to music, a good place to start is Jean Philippe Rameau. As Lawrence Zbikowski puts it, Rameau's conceptual model for musical mechanics maps Newtonian physics onto musical events to explain musical syntax (Zbikowski 2002: 125), even if it considerably trails behind the scientific advancements it draws on.

Nothing moves in the physical Universe without some causation, so must apply to music. Rameau finds such a causative force in dissonance: an agent that propels the motion. Thomas Christensen captures this idea when he says that "In Rameau's mechanistic image, consonance is like equilibrium in mechanics; it constitutes a state of repose and stability. Dissonance is a displacing force, a disruption of this repose. The effect resulting from this so-called collision of sound has much in common with the collision of solids" (Christensen 2004/1993: 107).



Example 1. Rameau, Example II.8 from *Treatise on Harmony*

This is illustrated by Example 1 from Rameau's *Treatise on Harmony*. Here is Rameau's analysis: "dissonance B is at rest when consonance A strikes it. Immediately after the collision, the consonance becomes immobile and obliges the dissonance to pass to C. This is effectively the place to which the consonance itself could have passed but can no longer do so since the dissonance has taken its place. The consonance seems to have given all its motion to the dissonance. Consonance D, however, which seems to be immobile, after having collided with dissonance F obliges it to return to G, from where it started" (Rameau 1971/1722: 234–35).

⁷ Here we may again refer to narrative theory. According to Roland Barthes, "the mainspring of the narrative is precisely the confusion of consecution and consequence, what comes *after* being read in narrative as what is *caused by*" (Barthes 1977: 94).

The dissonance hence seems to be reflected with all its motion, after having struck an immovable consonance. This is actually reminiscent of pre-Newtonian (Cartesian) mechanics in which the causative agent in nature is matter impacting upon matter (Christensen 2004/1993: 103).

The entire Newtonian Universe is held together with gravity. And as Rameau's harmonic theory evolved, he started talking (in his 1737 *Génération harmonique*) less about collisions of entities, and more about non-tonic chords returning to their source, drawn toward the center. What matters now is attraction, gravitational pull, rather than impact, and the tonic as the center that draws everything (Christensen 2004/1993: 189). This facilitates the introduction of functional relationships and inevitably paves the way for longer-ranging processes. Both gravity and tonal attraction are unseen forces capable of operating over long distances. Add to this his other major ideas: falling seventh chords moving towards the tonic, fundamental bass as a directed progression, his recognition of the importance of the *cadence*, and the stage is set for the transition from microteleology to teleology proper.

4. Leibniz, the fugue, and onward to the 18th century

Venturing a tentative generalization of musical teleology in the 17th century, I surmise that the bleakly deterministic and non-teleological thought, as outlined above, was insufficient to sustain an elaborate teleological form such as the fugue. Indeed, in 17th-century music immediate progressions are regulated with considerable precision, events seem to logically proceed one from another, one event leading towards another locally, but the overall form of composition is only weakly teleological.

If we are looking for a truly teleological thinker of that time, it will be Leibniz. The Leibnizian world is composed out of an infinite number of autonomous, self-sustaining elements called monads. Let it be mentioned in passing how admirably his monadology and infinitesimal calculus inform each other. The monadic teleology lies first in the fact that each state of a monad is caused by its preceding state, and more importantly, that a monad strives to actualize its potentials. This is connected with the concept of entelechy, which in the original Aristotelian sense was the realization of the potential, but could also be a realized potential—Leibniz attributes some sort of perfection to it (Favaretti Camposampiero 2018)—as well as the vital force, moving spirit.

Leibniz's God has chosen the best of all possible worlds, and this very fact is teleological. The creation had a goal, and the goal was to create the best of all possible worlds. This lays the foundation for a broad teleology of the arts. The artists must imitate this best possible world; otherwise, they will be correcting God.

As pointed out by a number of scholars, a musical form that would in a way embody Leibniz's philosophy would certainly be the fugue. Fugue is also a form in which teleological potential is already evident. Numerous contemporary authors like Scheibe and Baumgarten, acknowledged the importance of the return to the tonic coinciding with the statement of the subject, which concludes an absolute necessity. Leibniz enters the picture when one views the fugal subject in monadic terms: there is the telos of revealing the innermost essence of the subject, and the best possible realization of the subject (Sheldon 1986: 50–51).

There are many more ways in which we may regard the interplay between philosophy, science and art: the importance of the musical scale for Newton's optics, or the behavior of a ray of light for Leibniz's teleology, and so on. Yet, music is not shaped primarily by scientific modeling, or philosophical systems; it is a most complex *human* activity. Then, we ask with Diderot where do we, organized beings with sensations fit into an inert world subject to dynamics. Science must strive to understand life before it can hope to achieve a coherent vision of nature. This applies to art as well. Then we are bound to take into account the human experience of time. To take into account that the reversible universe is far from our everyday experience: just play a film backward. To take into account that no single idea has been more important than the idea of progress in Western civilization for nearly three thousand years (Prigogine & Stengers 1984: 79). Progress, infinite linear progress, in modern thought replaced Christian salvation, claims Karol Berger (Berger 2007: 162). Ernst Mayr draws attention to "the enthusiasm for progress promoted by the Enlightenment" (Mayr 1992: 117). Becoming increasingly aware of these issues, the 18th century was capable of inaugurating large-scale goal-reaching processes in music, teleology on the global level. This is basically what Berger argues in his *Bach's Cycle, Mozart's Arrow*, within a somewhat different intellectual and spiritual framework. He may have just a little bit downplayed the teleological character of the fugue, but his work is a remarkable accomplishment, too substantial to be discussed now.

5. The Science of Heat

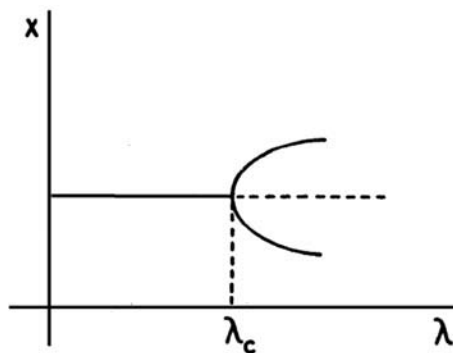
We proceed now to the beginning of the 19th century and the new science of *heat*, thermodynamics. Newtonian gravitation acts upon the inert matter, which submits to it unaffected. *Heat* transforms matter, determines the inner structure, and leads to the modification of intrinsic properties (Prigogine & Stengers 1984: 105). The second law of thermodynamics states that in an isolated system, entropy—the measure of disorder—can only increase. Thus, thermodynamics is an utterly teleological science. The system evolves toward an equilibrium, which is also the most probable state, and this means that all differences are canceled out, the flow of energy ceases, and there is no longer available energy for any work. A comparable example in music could be found in another Penderecki's piece from his "sonoristic" period, *Threnody*. In its quartertone cluster ending, no single voice stands out, no appreciable interaction occurs between the particles. They are evenly distributed, but not because of a set of syntactic rules steering the course of music toward that point. Energy is evenly distributed; the equilibrium is absolute; the music has reached the state of entropy. Such distribution is also the most probable: the *Threnody* cluster is located around the middle register, where the tones are most likely to be. This enables a more general formulation of this law, whereby things evolve from a less to a more probable state. As Thomas Nagel (1986) reminds us, the very fact that of all possible people it is precisely I who was born is extremely improbable. My death is certain. This is a manifestation of the unidirectional arrow of time.

The arrow of time specifies a direction, and in thermodynamics, it also specifies the final state. The cosmological arrow postulates a final state of the universe when it is maximally expanded, but it is not clear whether we have any reliable description of that final state. There is also the psychological arrow, the way in which human beings generally experience time.

While random, chaotic behavior is characteristic of near-equilibrium, Ilya Prigogine brought to light some extraordinary principles governing systems that are far from equilibrium. These systems can be self-organizing. Correlations and coherence will arise spontaneously, as evidenced by many examples of chemical reactions he adduces. Nonequilibrium brings order out of chaos.

The relatively stable states to which such a system tends to evolve are called attractors, and they determine the evolution and guide processes toward definite, yet not always predictable outcomes. To recall the Ligeti example from the beginning of the paper, the interval signals that provide points of stability in *Lux aeterna* fit this description.

Another concept related to the non-linear behavior of these systems is bifurcation (Example 2), "the crossing of nonlinear critical thresholds" (De Landa 2000: 14) when any determinism breaks down and minor fluctuations can produce enormous changes. In *Lux aeterna*, canonic voices pile up and at certain points, the process has a choice: to end on a cluster, or to rarefy the texture and let some clearer sonorities emerge. Vastly different outcomes are equally consistent with the evolution of the system.



Example 2. Bifurcation

To continue with Ligeti. If we compare Ligeti's *Lux* and *Lontano* or *Atmosphères*—their micropolyphonic texture makes them suitable for comparison—we could say that in *Lux*, lower amounts of motion, therefore lower kinetic energy of sound particles, allows for greater *potential* energy owing to the relative positions of these particles, which enables states in which these particles occasionally behave as if imprisoned by their interactions with their neighbors. These states are, of course, boundary-forming interval signals. In *Atmosphères*,

the entire system behaves as if it has nearly reached entropy. *Atmosphères* exists in a kind of thermodynamic equilibrium in which structures are a result of statistical compensation for the activity of microscopic elements. They are inert at the global level (Prigogine & Stengers 1984: 127). The densely packed intertwining lines, no matter how intricately woven, and how hectic their activity, stifle each other, and all this microscopic commotion amounts to an overall sense of stasis.

a) *Lux aeterna*

b) *Atmosphères*

Example 3. György Ligeti

Edgard Varèse's *Ameriques* furnishes an instructive example of how the world construed by the science of heat is recreated in music. This composition is certainly not teleological in any usual sense. It starts from a state one could conceivably imagine as near equilibrium (Example 4). When the horns explode the flute motives, the violence, the unexpectedness of this destructive event feels like an influx of external force, wrenching the system out of equilibrium, introducing a certain level of entropy, of chaos. There is neither an external formal model that the composition follows, nor a syntax regulating succession of events, nor yet rules of voice-leading. The composition, however, does not fall apart; we do not see a consistent increase of entropy as in classical thermodynamics. The system seems to be self-organizing, as provided by Prigogine's theory. The interactions between constituents are amplified by positive feedback loops creating attractors resulting in new patterns emerging; it is an autocatalytic process. The interactions or collisions of motives or cells seem to generate new motives or motives transmuted to unrecognizability; the products, then, of these interactions further intensify these same interactions to yield more material, whether new or transmuted, which intensifies the process even more, as in an autocatalytic chemical reaction in which the product of the reaction catalyzes and speeds up the process of creating this same product. This is longer-ranging than microteleology, but does not reach goal-directedness on the global level. The process is clearly directed, but it can become unpredictable when a point of bifurcation is reached and then an almost negligible change produces enormous effects. There are two such effects. One is the theme-like entity, the only event in the composition that approaches the idea of the theme. We encounter it first at rehearsal 13 (Colfranc Edition) in a very rudimentary form, and later at 33, where it indeed sounds like a full-fledged theme. The other is the Grandioso coda. It sounds like an appropriate ending, in its synthesizing function, and its character in general, but still, nothing in the preceding music pointed toward it.

a)

Alto flute
Harp 1
Harp 2

Example 4. Edgard Varèse, *Ameriques*: a) beginning, b) rehearsal 1

b)

I Animato molto subito (♩.112)

Picc.
Fls.
C A. Fl.
Obs.
CLARINETS
E♭
B♭
Ben.
F Hrns.
C Tpts.
Trbs.

6. Quantum mechanics

The first three decades of the twentieth century saw the publication of Einstein's theories of relativity and the inauguration of quantum mechanics. Space, time, matter, energy: our view of the most fundamental properties of the Universe underwent a change so radical, possibly comparable only to the seventeenth-century scientific revolution.

But here we enter a truly conflicting world. Einstein stipulates that theory determines what is possible to observe, but his universe is again timeless and deterministic—he read Spinoza, after all. In his relativistic universe, everything is still determined in terms of initial states and the laws of motion. Irreversibility is an illusion. “For us, convinced physicists,” says he, “the distinction between past, present and future is an illusion” (qtd. in Prigogine & Stengers 1984: 294). Quantum physicists, for their part, could plausibly subscribe to that, but their universe is probabilistic. For Einstein, God doesn't play with dice. For the followers of Heisenberg with his uncertainty principle, God not only plays with dice but is also left-handed.

This probabilistic aspect of science is highly relevant in music, and since the probability is future-oriented, musical teleology. I am not referring only aleatorics, or stochastic procedures as found in Xenakis. Even music that is precisely fixed in the score leaves the impression of being probabilistically organized and impossible to predict; even in the strictest pre-composed serialism, no one can really envisage the exact sound of the composition. The Markov chain—a stochastic process involving a sequence of events in which the probability of each event depends only on the previous one—can be used as a model for the description of specific teleological

properties of certain twentieth-century pieces. I do not mean only algorithmic music created according to the Markov chain principles. We sometimes encounter situations where we perceive goals locally: the immediate goals, the teleology of moment-to-moment connections, or microteleology as I have called it. A currently occurring event determines the next one but does not seem to give rise to any longer-ranging processes.

The behavior of elementary particles studied by quantum mechanics can indeed be baffling. Consider Erwin Schrödinger's wave function.



Example 5. “Double slit experiment”: wave vs. particle

Example 5 represents the famous two-slit experiment. It has been performed in a number of variants, but for the sake of this paper, I will describe it rather like a thought experiment (but with the outcomes that have actually been experimentally confirmed). If we have a plate pierced by two parallel slits, and if we fire a solid body through a slit, it could go through either one or the other. If instead of a solid object, we run liquid, a wave, it will pass through both slits, and beyond the barrier, interference of waves will occur. But if you run an elementary particle, an electron, it will nonetheless display interference, as though a wave passed through both slits. A particle behaves like a wave. If originally—in the early 19th century—the experiment was intended to demonstrate the wave behavior of light, in quantum physics it led to the conclusion about the wave-particle duality. In a more general version, multiple states of elementary particles can be superimposed upon one another, as in Schrödinger’s notorious thought experiment in which a cat is both dead and alive. But once we are reconciled with this situation, totally inexplicable in terms of classical physics (to say nothing of our everyday experience), another surprise is awaiting us. If we observe an individual electron, it will always pass through one slit, as any solid object would. So, the very act of observation collapses the wave function.

Leaving aside the mathematics behind this (Schrödinger’s equation), but following its ontological implications, we could say that the experiment captures in a formula a) inextricability of the observer from the observed (which brings us back to the subjective aspect of teleology); b) the limitations of the observer’s capacities; and, crucially for teleology c) the multiplicity of goals (goals in this case meaning the states to which the particle tends). These generalized implications can hold for music as much as they do for science. So, let us look at a concrete piece to instantiate this.

Example 6. Edgard Varèse, *Offrandes*

At the opening of Varèse’s *Offrandes*, the pitch D in the trumpet is the pivotal intonation, and we are likely to expect it to recur and to conceive of it as a goal of musical motion. There is a psychological mechanism involved, and it was described by David Huron (2006)⁸ At the same time, there is aggregate completion

⁸ Based on robust empirical evidence, Huron makes a claim about “statistical learning”: we predict the most frequently occurring past event (138). At the same time, the event we have predicted accurately is a source of pleasure. Consequently, we are highly gratified by those recurring moments that we can accurately predict (164).

(the F in the French horn marking the end of the first sentence-like structure), a well-known post-tonal teleological resource. The musical matter appears both in a more solid state represented by the intonational fulcrum, and a more dynamic, wave-like one: two quantum states superimposed upon one another. Even as they are goal-oriented, they are also reversible.

Composers like Varèse and especially Webern probed deeply the “subatomic” level of musical substance. And when we observe long-distance connections between their musical particles, we are aware that they do not arise through reference to a center of gravity, but rather resemble quantum entanglement—fundamental identity of particles without any contact. This, however, does not indicate any definite direction in which the sonorous objects move, nor what they are expected to attain. Any teleology sought in such music is very feeble.

7. Conclusions

What is perhaps more important than these particular correspondences are the broader underlying principles: the metaprinciples of science, philosophy and arts, the principles that also underlie the principles of composing music. Newton united the micro and macro worlds with his laws of motion. Twentieth-century science divorces micro from the macrocosm. There is relativity for the cosmic, and quantum for the atomic level. Both seem to be right in their respective domains. We still have no Grand Unified Theory or the Theory of Everything. Our world is extremely teleological and irreversible heading toward entropy; it is also inexorably deterministic, and reversible, hence predictable; but again, it is self-organizing and unpredictable. “Each scientific language can express only part of reality”, says Prigogine (Prigogine & Stengers 1984: 224). There is a place both for reversibility and irreversibility, determinism and stochastic processes; a world of trajectories and of processes; a universe “simultaneously organizing and de-organizing itself” (Prigogine & Stengers 1984: xxvii). Our reality is fragmented. And so is music, and in that context, musical teleology. If functional tonality provided secure teleological underpinnings at all levels, music of the last hundred years or so can devise goal-attaining process locally, but the overall form is rarely and weakly teleological. Micro is divorced from macro.

Within all this multiplicity, the only thing for which there is little room is grand teleological schemes. Here is where I give the floor to the French philosopher Gilles Deleuze, who talks, with Félix Guattari, about the atomization of materials and cosmicization of forces (Deleuze & Guattari 1987: 345–46). And when you are opening toward the cosmos, where might your goals be, facing billions of galaxies each with billions of stars? Proceeding in Deleuzo-Guattarian vein (by proxy, since the following quotation comes from the composer Pascal Dusapin), “to compose is to never begin, to recommence, *or to finish*. To compose is to *continuer*” (qtd. in Campbell 2013: 51). There is neither *telos* nor *eschatos*, only plateaus; no trajectories and no points to reach, just wandering, nomadic lines that do not issue from, nor lead toward any fixed points of striated space; a rhizome, rather than a tree.

Naturally, we are not obliged to subscribe to such a radical statement. We are perfectly entitled to believe in music as a paramount *human* activity, expressing our strivings, desires and hopes; in Ernst Bloch’s *noch nicht*, not yet: music as a truly utopian art. But there is an ultimate teleology even in Deleuze, too: the creation of the new, the only teleology he recognizes (Deleuze 1993: 151). Not a bad prospect for artists.

One final thought. The extramusical principles that I apparently impose upon music are not mere metaphors, analogies or models to imitate. Relying on the line of thinking running from Duns Scotus, to Spinoza and Leibniz, to Gilles Deleuze, we would rather think in terms of univocity as Scotus and Spinoza do; of the Deleuzian plane of immanence where “Being expresses in a single sense all that differs”. Every monad, musical or otherwise, may be self-contained, autonomous, with its unique zone of clarity, yet—as Deleuze reads it—it is folding, unfolding, refolding its potentials, which is the entire Universe.

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Muzikos teleologija tarp Newtono, Prigogine'o ir Deleuze'o: Spinozos tapsmas muzikaliu

Santrauka

Telos konceptas (gr. *télos* – tikslas, pabaiga) yra giliai įsišaknijęs europietišrame mąstyme ir labai plačiai pritaikomas (etikos, religijos, metafizikos srityse). Teleologiniai klausimai muzikoje, turint omeny jos laikinę ir procesinę prigimtį, yra labai svarbūs. Beveik kiekvienas muzikos aspektas gali turėti savyje užkoduotą teleologinę dimensiją, kaip ir kiekvienas požiūris į muziką. Kaskart patiriant ar mąstant apie muziką kaip procesą, tėkmę, gali kilti klausimų apie to proceso tikslus ir būdus jiems pasiekti. Šie klausimai išsišakoja į begalę kur kas specifškesnių temų, pvz.: muzikinio proceso tikslų ir teleologijos sąlygų tipologija (Zatkalik 2013); įvairių parametų (harmonijos, kontrapunkto, formos) procesai, padedantys nustatyti ir pasiekti tikslus; muzikos tėkmę link tikslų nulėmiančios jėgos (Larson 2012); lūkesčiai ir jų patenkinimas (Huron 2006), įtampa ir jos sprendimas bei daugelis kitų.

Savo ankstesniuose darbuose aptariau įvykių, atliekančių tikslo funkciją, tipus, įvairių parametų procesus, kreipiančius muziką link šių tikslų, sąlygas, kai muziką galima įvardyti kaip teleologiską. Šiame straipsnyje gilinama ši „techninė“ perspektyva tyrinėjant teleologiją idėjų, per keletą pastarųjų šimtmečių suformavusių europietišką mąstymo būdą, kontekste.

Itin imponuoja santykiai tarp muzikos teleologijos ir būdų, kuriais remdamasis mokslas istoriškai suvokė pasaulį – iš pradžių per gamtos, o vėliau per mokslo filosofiją. Čia nagrinėjama Newtono mechanikos dėsnio įtaka: determinizmas (visos pirminės būsenos ir judėjimo dėsniai yra nustatyti) ir grįžtamumas (gamta turi vienodą polinkį tiek į pradinę, tiek į galutinę būsenas), taip pat analogijos iš kvantinės fizikos, kurios vadovaujasi tais pačiais postulatais, bet inkorporuoja tikimybės aspektą. Visa tai yra priešpriešinama klasikinei termodinamikai, kuri yra itin teleologiška (izoliacijoje pusiausvyra nepasižyminties sistemos patiria tam tikrus evoliucinius procesus tam, kad pasiektų tarpusavio pusiausvyrą) ir negrįžtama (entropija gali tik didėti). Ko gero, posttonaliai muzikai aktualiausia yra toli nuo pusiausvyros esančių sistemų, kurios gali pačios save organizuoti, koncepcija (Prigogine & Stengers 1984). Žvelgiant iš šio taško, muzikinis vyksmas panašus į atraktoriaus termodinaminėje sistemoje: santykinai stabilios būsenos, link kurių evoliucionuoja sistemos, apibrėžiančios kismą ir vedančios procesus link konkrečių, bet ne visada tiksliai nuspėjamų rezultatų. Šie principai yra iliustruojami Ligeti, Pendereckio ir Varèse'o kūriniių pavyzdžiais.

Galiausiai, viršmuzikiniai principai, kuriuos autorius išvėlgią muzikoje, nėra vien metaforos, analogijos ar imituojami modeliai. Remdamiesi nuo Jono Dunso Škoto iki Spinozos, Leibnizo ir Deleuze'o besitęsiančia mąstymo linija mes galime mąstyti Škoto ir Spinozos vienareikšmiškumo arba Deleuze'iško imanentiškumo kontekstuose, kur „būtis tuo pačiu būdu išreiškia viską, kas kinta“. Mes galime traktuoti muzikinę kompoziciją kaip Leibnizo monadą: uždara, autonomingą, su savo unikalia aiškumo zona, tačiau, pasak Deleuze'o, atsiskleidžiančią, perverčiančią / naujai atveriančią savo plačius kaip Visata potencialus.