

Chronobiology and the ‘time machines’ in art

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Abstract

The present work approaches different definitions of time, going through the objects of time described by Kevin Birth (2012) and artistic works that directly discuss the theme of 'time machines' (JP Accacio, 2017; Andrei Thomaz, 2014; Daniel Buzzo, 2017). The need to look at biological time stands out. For this purpose, we resorted to chronobiology, an area of biology that investigates the temporal dimension in the relationships of organisms and the environmental roles of temporal adaptation. This article also starts with Luiz Menna-Barreto's Internal and External Temporal Organizations (2005). Regarding the different temporalities observed in the arts, we dedicate special attention to the synchronization modes.

Keywords

Chronobiology, Time machines, Artistic installations.

Introduction

This article proposes convergent approaches between art, technology, and biology. The dialogue with chronobiology was born with the desire to understand human perception within the temporal dimension and its relationships with artistic works. Human sensitivity is directly interconnected with time or contrasting times and temporalities in countless forms and models. Therefore, the objective here is to propose an initial approach between art and chronobiology, bringing other parameters to look at artistic proposals that seek the relationship of “time machines,” which are structured based on concepts and analogies that support new perspectives.

1. Objects of time

Objects, devices, scales, and artifacts are created by humans based on ideas and concepts to establish a time-counting system. Kevin Birth refers to these as "objects of time" (BIRTH, 2012). The mechanisms used to create these objects can be mechanical, hydraulic, electronic, or even based on the use of spreadsheets, illustrations, and graphics. While these objects are related to the natural world, such as the Earth's rotations around the Sun, Birth notes that they are primarily associated with the cultural and behavioral environment of the individuals who make up a society. In contrast to other animals' feedback relationships with their habitats, such as tidal cycles, light/dark differentiation,

and temperature changes, human behavioral environments are distinct. Birth emphasizes in Hallowell's speech that the human relationship to behavior is unique. It is exemplified by the fact that the alarm clock is now more critical than the sunrise in activating people's temporal perception, marking the start of a new day in homes, factories, and cities.

The human mind, mediated by the objects of time, is shaped by the passage of time, and influenced by cultural institutions such as schools, universities, religious temples, markets, and other social structures. According to Birth's speech, these legacies have led to a perception of time as a learning process, focused on the methodologies and didactics of educational institutions rather than on the most straightforward and most immediate everyday life, such as waking up and going to sleep or the interaction between different generations. In Brazil, there is a popular expression that says, "I'm going to sleep until I wake up," which implies that sleep is a luxury rather than a necessity when it should be a natural and fundamental part of our biological needs, but our social environment is governing it.

The objects of culture constitute the ways of learning to feel temporality in everyday life through science-generated abstractions. These objects reinforce scientific speech, according to Birth. To this extent, experience is left aside as a genuine “sense of feeling time,” as a perception of the passage of things and experiences, i.e., something qualitative is quantified. Of the different objects of time, clocks are the striking symbols of the cultivation of cognitive dependence on devices associated with tools and machines. Within the logic put forward by Birth, these symbols distance humans from natural phenomena, as their constitution is based on concepts and abstractions assumed by institutions.

Throughout history, many proposals have treated clocks as universal controllers of a single time. However, in fiction, the idea of a machine that can travel through time and visit the past or future is a recurring theme. It appears in literature, such as the famous novel "The Time Machine" by H.G. Wells, first published in 1895. It also appears in cinema, such as the "Back to the Future" franchise directed by Robert Zemeckis in 1985, and in TV series like "Doctor Who", which has been on the air since 1963 and continues to produce new seasons until today. Although there are many proposals for time machines, they often come up against compelling narratives in entertainment. The ambition for control is extremely present in a society that

stipulates time as something accelerated¹ and loaded with concrete values, with the relationship of work and the wear and tear of memories.

We propose looking at machines that aim to control time, in a biological aspect, to launch new perspectives based on art.

2. Biological time and chronobiology

Biological time serves as the temporal dimension in the biological relationships between organisms and their environment. As such, this time is inherently complex, as it is influenced by numerous factors, including the unique characteristics of each species, the elements of the ecosystem, the interactions with other organisms, and chemical, physical, and geographical agents.

Chronobiology is a recent area of biology and studies the temporal dimension in the biological relationships of organisms and the environmental roles of temporal adaptation, such extent being understood as biological time. Furthermore, it focuses on the modulations of rhythm frequencies of organisms. Therefore, the temporal dimension studied in this area reverberates in human social and cultural structures (DE LUCCA, 2019). Chronobiology is a multidisciplinary scientific field (ARAUJO; MARQUES, 2002). Chronobiology is a multidisciplinary scientific field that combines concepts and elements from other areas of knowledge.

Chronobiology was officially recognized at the Cold Spring Harbor Symposium on Quantitative Biology in 1960. The symposium focused on "biological clocks" (MENA-BARRETO, 2005). However, the observation of rhythms in nature dates back much further and has been present since ancient times. For example, diverse cultures and contexts observed environmental changes and the metabolisms of plants and animals, influencing agricultural practices' evolution. From the study of nature, knowledge was developed that influenced the maintenance and improvement of cultivation, creation of food, and soil control, among other everyday life characteristics. However, the founding of chronobiology can be traced back to the study of the French astronomer Jean-Jacques d'Ortous de Mairan (1678 – 1771), who observed rhythmic oscillations in the opening and closing of the leaves of a "sleeping" plant (*Mimosa pudica*) in 1729, which provided the first documented experimental evidence for chronobiology.

In his research, Mairan found that the movements of plants remained constant even with changes in lighting. This

finding led to the hypothesis that plants' internal mechanisms regulated their movements. To test this theory, the plant was deprived of light for a few days, and it was observed that its movements remained the same as if it had been exposed to the regular day and night cycle. This experiment was crucial in providing a fresh perspective on how rhythms function within organisms. Before this finding, external factors were believed to be dominant in regulating the rhythms of plants and animals. Understanding the internal characteristics of an organism's temporal organization is essential in assessing how time functions and how different organisms regulate it. This experiment significantly impacted subsequent studies and discussions, leading to the 1960 event.

Mairin conducted an experiment on a plant in a free-running period (FRP), where it was not subject to any external interference. This experimental condition is commonly used in scientific laboratories to study the internal organization of organisms, such as circadian rhythms. Free-running period is created by controlling external factors, such as environmental characteristics. This control allows researchers to observe different biological rhythms that express themselves over days, months, or years, depending on the studied organism, animal, or plant species. For illustrative purposes, the environment can be kept entirely devoid of light or fully illuminated for a specified period.

The idea of free-running period leads us to consider different approaches to multimedia works, installations, and immersive environments. These often take the participant out of his comfort zone and into new situations, where he may lose his sense of control and stability. As a result, when a participant is placed into a poetic system, he becomes influenced by the conditions created by the artists. These conditions can lead to a state of suspension, followed by resynchronization, as he adapts to the new factors introduced by the artwork² between the Internal and external.

This work adopts the approach to chronobiology introduced by Luiz Menna-Barreto³ a prominent chronobiologist who has shared his views on the subject in articles, interviews⁴ and his book *Chronobiology: Principles and Applications*, which is widely considered a reference on the topic. In its 2005 edition, the book includes contributions from various experts in the field and provides updated revisions from its previous editions. This discussion focuses on two critical concepts in chronobiology: Internal Temporal Organization (ITO), which is related to endogenous factors, and External Temporal Organization (ETO), which is associated with

¹ We increasingly see the philosophical analysis of time as in the work of the South Korean philosopher Byung-Chul Han, with a striking Heideggerian basis on society and accelerated time.

² The concepts of chronobiology of Entrainment, Zeitgebers (time donors), and Masking are agents of synchronization of rhythms (MARQUES, GOLOMBEK, and MORENO, 2003). They are highlighted as concepts for readings in the artistic field and which demand, on the other hand, additional deepening. The author has integrated these concepts in his doctoral research.

³ Professor responsible for the discipline *ESC 5738 - Social Times and Biological Times*, in 2020, offered by the Postgraduate Program in Cultural Studies at the School of Arts, Sciences and Humanities of the University of São Paulo (EACH-USP).

⁴ SONO MAGAZINE, Interview with Menna Barreto - 2nd Edition. Youtube, Jun 17, 2015. Available at: <https://www.youtube.com/watch?v=QAM5Hh5JT6g&ab_chann_el=Associa%C3%A7%C3%A3oBrasileiradoSono> Accessed on: November 1, 2023.

exogenous factors. These concepts are essential for exploring time relationships in art.

Mairin's experiment with plants revealed that they maintained their movements even without external stimuli, suggesting that these plants had an endogenous character. It means they had a specific mechanism within their organism that recorded their movements, implying that they possessed a biological clock that kept a rhythm like that seen outside the experiment. The biological clock acted like a metronome in music, promoting regular periodic changes that were not dependent on the environment - "A mechanism that promotes regular (periodic) changes and that does not depend (or depends very little) on the environment can be compared to a clock" (MENNA-BARRETO, 2005). In other words, a mechanism that could maintain periodic changes without depending on the environment was like a clock. This conclusion was drawn from the study conducted by Menna-Barreto in 2005.

Understanding temporal organizations through the biological clock metaphor is crucial. In 1960, biological clocks were discussed in a meeting in the USA, and this analogy is widely used in chronobiology and common sense. This metaphor has even been adopted in genetics, where clock genes have been identified. It highlights the differences between individuals and assumes endogenous variations in the perception of time and frequency of rhythms, making it essential to promote studies on chronobiology and Internal Temporal Organizations (ITO). These systems are responsible for timing and synchronization and are closely related to External Temporal Organizations (ETO). According to Menna-Barreto (2005), the concept of biological clocks can lead to confusion. When we assume that organisms and clocks are closely related, we ignore the complexity of variations and imperfections in bodies and the environment. It creates an illusion that the body is a perfect apparatus with invariable frequencies and can be formed of interchangeable parts or controlled by a single core that regulates all variations. Menna-Barreto suggests replacing the term "biological clocks" with "timing systems," which can be categorized into different performance systems to avoid this confusion.

3. "Time Machines"

As we explore the field of chronobiology, we also examine artworks that specifically address the concept of "time machines" and are titled as such. These pieces offer unique perspectives on time, capturing the movements and effects of time through various devices. They present a fusion of art and technology that explores the quantification of moments and their displacement.

The first Time Machine⁵ we present is that of the artist Andrei Thomaz, created in 2014 at the Blau Projects gallery, curated by Douglas Negrisolli [Figure 1]. The set of works exhibited by the artist was generated by the software Ampulheta, developed by the author. This software extracts

the pixels from the frames of the images captured by a camera. During a 12-hour recording, all video frames are compiled into one image, resulting in overlapping points, lighting changes, and landscape element displacements. As described by the artist in the documentation: "the images condense a time interval, consisting of pixels recorded at different times" (THOMAZ, s/d).



Figure 1. Detail from the exhibition Time Machine, by Andrei Thomaz, 2014. Available at: <<https://www.andreithomaz.com/portfolio-item/maquina-do-tempo/>> Accessed on: Nov.1, 2023.

The capture software influences the time at which an image is recorded, resulting in both individual and shared times in the gallery environment and other spaces. The works in the gallery display the results of the captured images, such as landscapes displayed through projections and the system created by the artist. This system encompasses the objects captured, the video capture process, the computer processing, and the resultant images. Andrei conducted a scientific experiment to display the growth relationship of plants in an exhibition environment. The final images generated by the software were displayed on a monitor installed in the gallery in short intervals. Andrei's work aims to demonstrate that the experience of the passage of time is more complex than what is presented in other objects, as inaccuracies, intervals, and 'mishaps' accumulate and show themselves. It flattens the past, present, and future, thereby revealing the complexity of the experience of time.

The Time Machine⁶, is an audiovisual installation created by artist JP Accacio in 2017 [Figure 2]. It consists of a dot matrix printer placed on top of a stack of concrete bricks. The printer continuously prints the current time, minute by minute, and receives commands based on programming on a Raspberry Pi microcomputer. The paper on which the time is printed builds up continuously, creating a physical record of all the previously recorded moments. The dot matrix printer works by using needles to transfer ink from a ribbon to the paper. The accuracy of the numbers that come out of the machine is often compromised due to the vibrations of the machine mechanics and in the exhibition room. The sound that the machine produces is distinct and reflects its bureaucratic function. Additionally, the artist's model uses printed carbon paper sheets, which produce duplicates that

⁵ Available at: <<https://www.andreithomaz.com/portfolio-item/maquina-do-tempo/>>, accessed on Nov.1, 2023.

⁶ Available at: <<https://www.jpaccacio.com/maquinadotempo/>>, Accessed on: Nov.1, 2023.

gather at the back of the printer, creating negative versions of each recorded hour. The artist explains on his website that unlike time machines in books and movies, which have a fantasy character and a certain degree of freedom, this Time Machine works to demonstrate the 'exact opposite.' (ACCACCIO, n/d). It is essential to understand that devices like clocks do not show the time that has passed but use the movement of their hands to represent time. This work records time and prints as data considering the computational markings. It is like Thomaz's concept of time recovery but with a different approach. The art in these Foucauldian Counter Spaces brings together contrasting times, meanings, and multiplicities that, although incompatible, connect with each other. (FOUCAULT, 2013).



Figure 2. View of the work mounted in the exhibition space. 'The Time Machine' by artist JP Accacio in 2017. Available at: < <https://www.jpaccacio.com/maquinadotempo>>, Accessed on: Nov.1, 2023.

Finally, we bring the work Time Machine⁷, 2017, by artist Daniel Buzzo. This Time Machine is a multi-screen art installation with generative videos. It is based on multiple low-cost computer platforms, using the algorithmic selection of palindromic loops from time-lapse videos. Each video is based on different captures taken worldwide, and the system creates a tic-tac function. This operation develops backward and forward movement of the images, creating a distinct piece of time across the twelve screens. The images move back and forth on each installation screen. The proposal creates a polyrhythmic clock. Each video structures a frozen passage of time (past/present/future) in a rhythmic contrast back and forth. The generative algorithm selects from a bank of over a thousand separate pieces to create each time-lapse, with each change occurring slowly. The artist proposes the creation of a time machine that reflects the world, with a myriad of sub-cadences that "sway

⁷ Our translation. Original version: *Gently rocking back and forth with a myriad of sub cadences, confronting the viewer with the unanswerable challenge of comprehending time.* Available at < <https://buzzo.com/making-a-time-machine/>> Accessed on: Sep. 10, 2022.

gently back and forth. This presents an unbeatable challenge to viewers trying to understand the concept of time" (BUZZO, n/a). Unlike the two previous machines, the generative process in this machine causes randomness between the past, present, and future, which is documented. In addition to the accumulation of simultaneous times, moving images are also rescued, creating new present moments loaded with potential from the past and future.



Figure 3. 'The Time Machine', Daniel Buzzo at VolksHotel, Amsterdam, July 2018. Available at: < <https://buzzo.com/making-a-time-machine/>>, Accessed on: Nov.1, 2023.

The artworks in this context depict machines that can control and travel through time. These machines are based on memories that allow access to distinct aspects of time (past, present, and future) at a single moment. These aspects can be seen in various forms, such as Andrei's images, Daniel's videos on different screens, or even Accacio's accumulation of paper. Each work has a distinct poetic system controlled by a machine that documents and presents data about chronological time⁸ that is converted into imagistic memories. These memories bring the future and the past as the crystallization of each temporal point, a flattening. The challenge is to understand how these artistic proposals synchronize with the structure brought by chronobiology. As previously described, the internal temporal organization (ITO) and external temporal organization (ETO) are apparent in living beings. However, these concepts have not always been well-defined in science and are still being studied. The system of each machine can be interpreted as its individual time or ITO. The actions performed by the device within exhibition spaces, such as the images on the screen, the choices made by the generative process in the database, or the printing of sheets of paper, are all ways in which it synchronizes with the external organization or the shared time of the environment in which the work is

⁸ To learn more about the definition of chronological time, we recommend the article *Temporalidades da arte interativa*, by Cleomar Rocha, of 2017.

inserted. This synchronization makes the device open to transformation.

4. Conclusions:

Upon first observation of these systems, one might conclude that the time machines being discussed here serve to document the passage of time. However, upon closer inspection, we realize that these systems encourage a dialogue between each system's individual times and the gallery's shared times. This dialogue is made possible by using specific codes and hardware that create a metalanguage of temporal documentation, where the counting of time is intertwined. This metalanguage employs analogies between objects and concepts of time, which can often become blurred, giving rise to different interpretations of the proposed systems.

The synchronization of all these Time Machines is accomplished through computational technological mechanisms that are organized in a way different from the organisms studied by chronobiology since they possess machine characteristics. However, when we observe the synchronization relationship between ITO and ETO from the biology perspective, we can see some poetic questions that transcend the control and documentation of time, influencing the temporal flattenings. The artists' selection of elements brings a temporal decomposition to the existing temporalities, creating analogies that allow people to feel time in new and unique ways. These synchronizations are not commonly seen, but they encourage the public to perceive the created systems. By incorporating biological time, art can be used to explore innovative approaches and dialogues with chronobiology. It expands the study of chronobiology and offers a unique artistic repertoire that can provide different readings and perceptions for humans.

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