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Research paper

Thermodynamic transformation determining the essence of time

Mieczysław Dobija [1] *, Jurij Renkas [2]

[1] Cracow University of Economics, Rakowicka St., 27, 31-425, Cracow, Poland ORCID No: 0000 0003 0670 2313
[2] Cracow University of Economics, Rakowicka St., 27, 31-425, Cracow, Poland ORCID No: 0000-0001-7139-5458
**Corresponding author E-mail: dobijam@uek.krakow.pl*

Abstract

The consistent application of thermodynamic knowledge makes it possible to analyze in detail and modify the definition of time formulated by Isaac Newton. It also makes it possible to integrate Immanuel Kant's ideas about the relationship of human sensuality with the modern category of time. As a result of these analyses, there is an updated definition and indication of the constant that determines the rate of passage of time. A distinction between the concepts of time and duration emerged, making it possible to conclude that only processes described by the category of duration can be reversible. Other processes considered in terms of time are irreversible. The main purpose of this article is to precisely define the original thermodynamic transformation, which is the basis for measuring the pace and feeling of the course of time.

Keywords: *Use about five key words or phrases in alphabetical order, Separated by Semicolon*

1. Introduction

The article (Dobija, Renkas, 2021a) presents the current definition of time. The basic rationale for this work was the knowledge of thermodynamics, which belongs to the fundamental principles. The aforementioned article contains a new definition of time, in which a natural constant appears that determines the rate of its passage. It also turned out that this constant had already appeared in economic studies (Dobija, Renkas, 2021b). It is worth noting that since Newton stated that time „flows evenly," the existence of a constant already follows from this opinion. Time does not stop, it is not variable, so there must be some number that determines its constant speed. This constant was discovered in the study of economic processes related to the passage of time, such as interest and periodic profits, and now its important significance for understanding the essence of time has been revealed.

It should be noted, however, that viewing the second principle of thermodynamics mainly through the prism of entropy and increasing disorder is hardly adequate for considering the issue of time. The need to focus attention on thermodynamic transformations. This proved creative in formulating a new definition of time. There was a need to understand the existence of transformation, as a result of which the human ability to do work, i.e. human capital, is created. An approach limited only to considering the growing disorder in the human body would be too narrow. The description of thermodynamic transformation as the basis for defining time and the rate at which it passes is the main motive of this study.

The transformation is written in an encyclopedic term for thermodynamics. The term „Thermodynamics" developed by Gordon W.F. Drake (last updated 25.08.2022) defines the scope of this science as:

Thermodynamics, the science of the relationship between heat, work, temperature, and energy. In broad terms, thermodynamics deals with the transfer of energy from one place to another and from one form to another. The key concept is that heat is a form of energy corresponding to a definite amount of mechanical work.

For the discussion of time, the phrase about the transformation of energy from one form to another is significant. This transformation has been recognized before, ascertaining the transformation of raw energy of life into human capital (Dobija, 2015). However, interest was focused on economic issues, such as the rate of capital multiplication, fair compensation of labor, and the theory of measuring asset depreciation. Thermodynamics in the form of the second principle has been applied to the theory of human capital as the knowledge that a heat engine cannot operate without the loss of energy from the heat source. It is widely known that the human body can reasonably be viewed as a heat engine that spontaneously loses heat (Atkins, 2005, p. 133 - 161), (Greene, 2020, p. 63-65), and others. A constant a = 0.08 [1/year] has appeared in articles presenting models for measuring human capital and fair labor compensation (Dobija, 2015), (Dobija, Renkas, 2021b).

By taking a broader look at the second law of thermodynamics, it turned out that the discovered constant also determines the rate of passage of time. Contributing to this conclusion was the knowledge that the end of human life is 120 years (Vijg & E. Le Bourg, 2017). Thus, time flows evenly and human life has an unambiguous end. Hence the possibility of quantitatively determining the rate of passage of time.

At this point, it is worth emphasizing the importance of the principles of thermodynamics as fundamental to cognitive processes. They are recognized as principles from which other truths can be derived. In the Internet Encyclopedia of Philosophy, one can find a similar opinion; knowledge of the laws of nature is essential for arriving at the truth about the nature of reality . In considering time, it proved positive to move away from a narrow view of entropy, merely as an accumulation of disorder. This approach was already criticized by F. Lambert (2002), and Chalidze (2000, pp. 41-54) explains that entropy viewed through the prism of disorder can even do without thermodynamics.
Going back to the root of the concept of entropy also underscored the need to identify the relevant process of transformation. Recognizing that human capital is created through transformation required a detailed discernment of what is transformed and at what rate. In the case of humans, the transformation of life energy into human capital is a fundamental issue. On the other hand, the increase in entropy as a buildup of disorder in the human body associated with the aging process also takes place and is significant for identifying the arrow of time, closely related to its qualitative definition.
Defining thermodynamics as the transformation of energy seems to be key. Consider the statement that thermodynamics originated as the science of firepower (Bejan, Tsatsaronis, 2021). It developed in the 19th century, about a century after the first steam propulsion systems were introduced, and is a pillar of physics, chemistry, life sciences and engineering sciences. Let's add that thermodynamics turns out to be the foundation of the correct arrangement of basic concepts in accounting theory and economic theory (Dobija, Kurek, 2013), (Dobija, Renkas, 2020). Let's ask, where does this fire creating driving force come from? It is known, for example, from coal or wood. These raw materials come from trees that once grew on planet Earth. What is a tree? It is a living being that transforms, under the conditions of Earth's material environment, the energy of life (largely derived from the Sun) into capital embodied in biomass, which is convertible into energy and labor.

2. Analysis and update of newton's definition

The definition of time given by Isaac Newton is somewhat complicated, since the author introduces universal time and allows that it is also called duration. On the other hand, he calls the practice of measuring duration using astronomical units relative time, distinguished from ideal abstract and absolute time. In this, inconsistency is manifested, the reason for which is the lack of a thermodynamic basis for understanding the defined phenomenon. The complete definition given by Newton is as follows:
Absolute, true, and mathematical time, in and of itself and of its own nature, without reference to anything external, flows uniformly and by another name is called duration. Relative, apparent, and common time is any sensible and external measure (precise or imprecise) of duration by means of motion; such a measure – for example, an hour, a day, a month, a year – is commonly used instead of true time.
I s a a c N e w t o n, The Principia. Mathematical Principles of Natural Philosophy, The Authoritative Translation by I. Bernard Cohen and Anne Whitman assisted by Julia Budenz, U n i v e r s i t y o f C a l i f o r n i a P r e s s, 1999, p. 54
The passage „Absolute, true, and mathematical time, in and of itself and of its own nature, without reference to anything external, flows uniformly" is unambiguous, so allowing that „duration" is just another name for time creates confusion. The term „mathematical time" implies that time is an abstract category and its description requires the use of mathematical tools. From the statement „flows uniformly," it follows, as already said, that there is a number that determines the constant rate of its passage, i.e. the constant of the passage of time. In contrast, the term „flow" is used colloquially without specific content. What is flow if it is neither energy nor matter? What is missing here is what we commonly feel and perceive as we grow up and age, that is, the thermodynamic transformation of the energy of life into our growing ability to do work – human capital.
In turn, „duration" in terms of the meaning of this noun and the corresponding verb means the persistence of some process. Thus, this process can be described in part using astronomical (calendar) units; hours, days, years or in relation to other cyclical processes. Newton goes on to point out that describing duration using a clock and calendar quantifies relative time instead of this absolute, real time. This arrangement of „absolute time" and „relative time" is a fashionable reference to the Platonic concept of ideas at the time.
Thus, the conclusion is imposed that the difficulty of formulating a good term for time is mainly due to the lack of real content of the word „flow." Pointing to the transformation that is the basis of time completely changes the situation. The essence of things is approximated by the following general statement:
Time in the general sense is the process of transformation in the environment of planet Earth of the primordial energy of life into resources embodying energy, that is, the abstract ability to do work.
Examples of resources are: coal seams, people, animals, trees, plants, etc.
This general definition of time applies to all living beings. But time, like „money" for example, is a human product necessary for the development of civilization. Therefore, the transformation of the energy of life pertaining precisely to humans concretizes the definition of time and determines this most important arrow of time. So the full definition, which we think integrates the beliefs of Newton, Leibniz, Kant and others, is as follows:
Time is the process of transforming the stock of primordial energy of modern man's life into his ability to do work, i.e. human capital. The rate of passage of time is constant and independent of anything. This rate is determined by the constant a = 0.08 [1/year].
As already said, the study of human capital revealed a natural constant a = 0.08 [1/year], which is the key magnitude of the thermodynamic transformation of the energy of life into energy contained in human resources. This constant applies to humans; in the world of plants and animals, the analogous magnitude exceeds the number 0.08. For example, dogs and cats that live to 20 years are subject to a transformation of about 0.20 [1/year]. Similarly, a tree, which is a living being that transforms, under conditions of a material environment, the energy of life (largely derived from the sun) into capital embodied in biomass, which is convertible into energy and labor.
An example of conversion is shown by M. Sporek (2013), who conducted a study of forest biomass formation and its bioenergy potential. The aim of the study was to determine the value of potential energy accumulated in the aboveground part of the biomass of Scots pine (Pinus sylvestris L.). As part of the field research, stands of different number of years were established, model trees were cut down after 5, 8, 12, 15, 17, 19 years. The calculations resulted in a measurement of energy potential in units [MJ]: 15, 19, 69, 96, 94, 146 [MJ].
In doing so, it is worth calculating the average annual growth rate of biomass. For this purpose, three subgroups of years are formed: (5,8), (12,15), (17,19). For the first one, one gets: 19/15 = 1.26666667, which gives an average annual growth of 0.0888888889, or 9%. For the second group: 96/69 = 1.391304348, giving an average annual increase of 0.130434783 (13%). For the third group: 146/94 = 1.553191489, giving an average annual increase of 0.184397163 (18%). These calculations support the opinion (Table 1) that the average growth rate in the plant kingdom exceeds the value of the constant a = 0.08 [1/year].
Table 1 summarizes basic information about the time lapse constant and its other functions.

Table 1: Natural Constant „A" and Random Variable „S" Shaping the Economic Environment

The natural constant „a"	Random variable „s"
The rate of the passage of time and the metabolism of modern man	HC dissipation rate according to the second law of thermodynamics
Size needed to calculate the value of human capital (HC)	The rate (percentage of HC value) that determines the fair value of salaries.
Positive factor affecting capital growth in management	Destructive factor affecting capital growth in the economy
Bottom line of growth rates in the plant kingdom	The magnitude underlying the „uncertainty" category
Constant quantifying the impact of natural forces on economic development and growth.	The basis of the „risk premium" in finance and economics

Research indicates that the average value of the random variable is slightly less than the constant:

$$E(s) \leq a = 0.08 \text{ [1/year]} \quad (1)$$

It means that the average magnitude of destruction E(s) is minimally smaller than the constant of potential capital growth in economic activities, which guarantees the possibility of generating profits.

3. Formal form of transformation of life energy into resources embodying capital

From the definition of time, it follows that the primary energy of life is transformed into energy of action, i.e. human capital, and the rate of this transformation is 0.08 [1/year]. Thus, time „flows" evenly, equally for every inhabitant of the Earth. The passage of time is also a measure of the decrease in the potential of life energy E and the corresponding increase in human capital C mainly in youth and the years of education preparing for professional work (Figure 1). This is illustrated on the figure 1 where two curves characterize the changes of human energy over the time of its existence: the line of the disappearance of the initial stock of (E), and the line of the increase of human capital (H). The line H is brought to scale by dividing Ht by Hmax. As is clear from the definition, the course of these processes is controlled by a constant whose a priori value is 0.08 [1/year], and whose unit of measurement refers to the astronomical calendar.

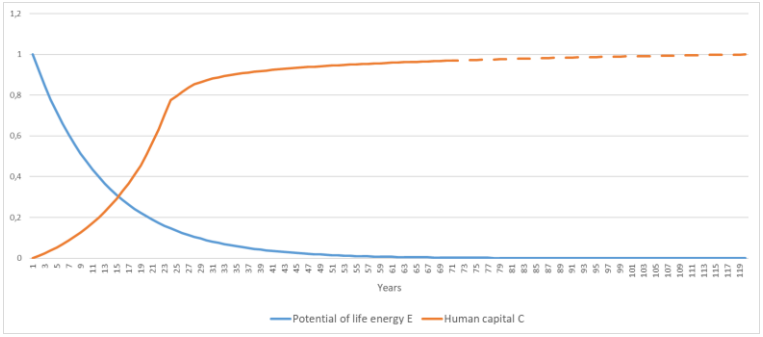

Fig. 1: Transformation of Life Energy E Into the Human Capital C That Determines the Course of Time.

The formalized description of the transformation (T) that determines the course of time is as follows:

$$T: E_0 \times e^{-at} \text{ transforms into } C_0 \times L \times F(e^{+at}) \quad (2)$$

Where: constant a = 0.08 [1/year], t - number of years of the process, L - energy-material inputs.
Taking the maximum $E_0 = 1.0000$, we get that after one year $E_1 = 0.9231$, after the second year $E_2 = 0.8521$, after the third year $E_3 = 0.7866$, ..., while $E_{65} = 0.0055$, and so on. This transformation makes the infant after one year look like a grown-up one-year-old child, and the following years also show the rapid growth of a person's capital C, however slowing down. At the retirement age of 65, E is already very small, which is associated with certain effects in the physical body, as medic Ki Bo informed the Yellow Emperor (Maoshing, 2012, pp. 22-23). However, with this residual energy E, some people even reach an age close to 120 years, when $E_{120} = 0.000068$. This is because humanity still has at least two available sources of life energy: air and food. Thus, the indicated value of E with four zeros after the decimal point represents the biological end of life, so this is the biological zero for the function $E(t) = e^{-0,08t}$ at, t = 120 years.
The transformation shown characterizes time and indicates the rate at which time runs. Time flows evenly at a rate determined by a constant, and at the same time it is a non-linear process for the growth of the human body and capital. We can see what a great change takes place from an infant to a one-year-old child and how the process of change slows down in the following years. The presented definition of time agrees with the experience of people living on planet Earth; it is fully in line with the statements of I. Kant on the subject of time and its inalienable role in human life.
To illustrate the $C_0 \times L \times F(e^{at})$ function, we will present the transformation in terms of an American teenager taking his first gainful employment at age 17. So t = 17 years old, C_0 = 1,0000, L = $585/mc, $F(e^{at}) = \frac{\exp(0.08t)-1}{0,08}$.

Calculated capital $C(17) = (12 \times 585)\frac{\exp(0.08\times17)-1}{0,08} = 254{,}141$ USD.

Having the value of a person's capital, a fair wage is calculated. It should not be less than the loss of energy in the work of the heat engine (s), which represents the body teenager. The relation $s \approx a$ is assumed and wages are calculated.

Annual salary W = s × C = 0.08 × 254,141 USD = 20,331 USD

Hourly wage = 20,331 USD: 12 mc : 176 hour = $9.63/hour

Adjusting the hourly wage for the Social Security (6.2%) and Medicare (1.45%) contribution paid by the employer, one gets a theoretical value of an hourly wage of $8.95/hour. This value is in line with the federal government's prevailing rate set at $9.00/hour. This is a positive factor in the US economy.

4. The new concept of time in the context of J. Barbour's theory

Nowadays, in the discussion of time, one cannot ignore the considerations presented in his works by J. Barbour (2018, 2021). This author conducts a consideration of the existence of time very generally, not only as a phenomenon concerning civilizations on planet Earth, but in the aspect of the origin, existence and development of the Universe. The author clearly abandons the adherence to the paradigm of the original order and the subsequent progressive accumulation of entropy. On the contrary, he recognizes that the beginning of the Universe is homogeneous Chaos, followed by an increase in complexity, so the history of the Universe is not a description of increasing disorder, but rather the development of structure (Barbour, 2021, p 31-32). One can agree that these ideas about the Universe are very natural and open up new avenues of knowledge.

In this state of affairs, the evolution of the Universe can be largely viewed along the lines of the rebirth of the Solar System after a Supernova explosion. With this approach, the new theory of time can be presented as the logical result of developmental processes, starting with the formation of planets due to the forces of gravity and the principle of conservation of angular momentum. The developmental processes lead to the formation of conglomerates on niche planets that have the characteristics of autonomous systems striving to sustain duration. We leave aside the question of the causes and drivers of these processes. These are contentious issues between orthodox materialism and representatives of the existence of a universal life factor.

As a result of further increases in complexity, more and more complex biological structures appear, and processes are stimulated by the engine of change, the second law of thermodynamics. Rational beings emerge, for whom interaction is a condition of survival. Communities are formed, with measures and measurements of work duration and calendars necessary for the organization of social life. These intellectual creations result from the recognition and observation of the cyclic movements of the planet and other objects of the solar system. The development of cognition leads to various concepts, such as: various time capsules and arrows.

The process of transforming the original energy of life into human capital determines the original arrow of time associated with human life and duration, so in conjunction with the calendar are the basis for determining the essence of time. Empirical studies indicate that the time lapse constant a = 0.08 [1/year]. This constant appears in considerations and studies of economic processes of capital growth, especially: interest and discount rates, as well as the theory of fair payment of labor (Dobija, Renkas, 2020, 2022). Thus, the basis of time is the transformation of the energy of life, the arrow of time is clearly defined, and the rate of this transformation in a person is the rate of passage of time.

So is time real or does it not exist? For the human population existing on planet Earth, time is real and inalienable. When conscious humanity becomes extinct, time will cease to exist, but changes driven by the second law of thermodynamics will continue generating more time capsules. In contrast, it is difficult to share J. Barbour's (2018, pp. 84 - 90) view of the non-existence of motion. The ancients' thoughts on the subject (Achiles and the Tortoise and others) lacked mathematical knowledge about the finite size of the sum of infinite series. J. Barbour's current highly intellectual explanations of the non-existence of motion (the example with the jumping cat and earlier ones), are not convincing. The cat jump could be an example of the irreversibility of a thermodynamic process.

In the physical sciences, there may be difficulties in interpreting time due to the fact that a well-known formula like Shift = v × t does not have a fully expressed category of time (such as the capitalization and summation factor considered earlier in economics), but only the number of periods of motion. If someone drove a car for 2 hours at a speed of 70 km/hr to a designated destination, he physically covered a distance of 140 km. And this is a measure of duration. In terms of the given definition of time, it would still be necessary to take into account the change defined by the constant „a" in the driver's body, as well as in the car itself, that is, realities not related only to the number t. The essence of time is not limited to the number of periods. Processes that take into account time are irreversible.

Duration can be considered an element of the concept of time. Three characteristic quantities appear in the current definition: the transformation and its rate, i.e. the passage of time a = 0.08 [1/year], and the duration determined by the number of calendar periods (unlike Newton's). The third quantity is a random variable that determines the spontaneous dissipation of man's capital, which arises from the transformation of the original energy of life. These quantities need to be taken into account in applications of the new term time. Time, like most scientific categories: energy, capital, labor, is an abstract category. For its theoretical grasp, mathematical tools are needed to describe abstract quantities. More is needed; since Newton recognized that time flows uniformly, there must be some natural constant that determines this course of time. Although he was the discoverer of the first constant, he did not have this awareness and knowledge of natural constants as J.D. Barrow (2003) describes them in his work.

Learning about the essence and nature of time is of great importance. For example, the truth about the passage of time can contribute significantly to the significant extension of productive, healthy life, which would provide socio-economic benefits. Looking at Figure 1 and understanding the rate of transformation of the primordial energy of life into the ability to work and act will make reasonable people aware of the need to act to prolong these processes. One can already benefit from the ancient knowledge of Eastern sages. But a significant good effect will only come from the widespread teaching of the essence of time and the preservation of the life forces until the end at 120 years of age.

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