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Article

The Mechanics and Thermodynamics of Mass Societies

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Note

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Abstract

A treatise on sociology using physics and chemistry arguments in which a tentative version of social thermodynamics is developed on the basis of an estimated social Avogadro number of 60.

Introduction

There are only a few economists and sociologists who express real demand for the exact handling of the empirical social science data; a process that has begun in the fields of physics and chemistry with their own data centuries ago. Sociology is still using mathematics in the process of knowledge construction only for the preparations or for the production of the half-finished idea at best: the role of mathematics in sociology is still not the creation of models, as opposed to physics, where this started the scientific break-through in the work of Galileo.

We draw herein on the results of chemistry, geometry, mechanics, and thermodynamics applied to sociology. There are three axioms justifying this method. First, there are certain laws penetrating the whole of nature and society. If these laws did not exist, the interface between nature and society would be heavy with a pressure that would destroy society; moreover, it would have prevented even the evolvement of society. In order to point out that it is so, it is enough to remember that the biological hardware of humanity carries the software generating society: language, communication, and thinking. The hardware and software would not be able to operate, if they were constructed based on contradictory principles. And then, we have not mentioned the demands that originate from the biological needs of human beings, which reach deeply into the volume of society: food production, physical security, conditions of reproduction, education, etc.

Second, if it is recognized that there are social laws, it needs to be acknowledged that humans have no freedom of decision as such: neither consciously nor unconsciously can they disregard the law. Namely, if it were possible to violate the law, then de facto the law would not exist. If, however, people follow the law because they cannot act against it, it is only a philosophical joke that there is such a thing as free will. Every form of normal and deviant behavior and all of their culture-specific variations are law-governed. These two presuppositions are the bases of scholarship: without them social science is either art or journalism. Yet is not enough to accept these theses only on the philosophical level: to show devotion at church and sin at home. The conclusion must be drawn: if there are laws, then people are objects, and their acts are behavior of objects. If it is so, there must be laws that are common laws for every object; otherwise, they could not be put into the same category.

Third, if there are common laws for nature and society, it also means that there are not only formal analogies between certain phenomena of nature and society but essential ones as well. This is what Poincaré refers to, in *Science and Method*, when he says 'mathematics is the art of naming different things in the same way. If we choose the adequate expressions, we will be astonished to see that every demonstration referring to a given object can be instantly applied for many other objects; nothing, not even the words have to be changed, as the denominations become identical'. Mathematical discussion thus creates an abstract level, where the common laws of nature and society can be expressed. The following study, in this theme, targets to model some of the basic phenomena of sociology and history, utilizing the terms, methods, and mathematics of the most developed empirical sciences, particularly thermodynamics.

Constructions of scientific analogy

The most difficult question of using natural scientific analogies does not really lie in quantification, rather in the concepts, which seem to be absolutely foreign to sociological experience. Such as mass, gravitational acceleration, volume, etc. The problem is not only the constructive quantitative management of the models, but also the adoption of the content of the quantities. This can be accomplished only if the contents in question are generalized and extended to social phenomena as well. Actually, this problem is inversely like translating the experience of physical objects into the rather abstract mathematical relationships and into unverifiable axioms. In this case the tangibility and descriptiveness of the experience vanishes, and some kind of elusive abstraction replaces it. In the case of society the structure of cognition is constructed exactly the opposite way. The misty, ductile, and seemingly rather unverifiable social occurrences are assigned to very definitive terms, and they are attributed properties which they do not have 'according to our instinct.'

The question is whether the world of objects does have that basic attribution that 'every object remains at rest or in motion with a constant velocity unless a force is applied on it.' One must realize that this Newtonian axiom is a rather complex and unverifiable statement, regarding the motion of every imaginable object, let it be a star or a dog at any point in time and any position in space. The first axiom of Newton, by extending its validity to infinity, adds something unverifiable and complex to the limited experience, which it wishes to interpret: the mystical concept of force. The force is never experienced, only its effect. The basis of this assignation is anthropomorphism and the naive experience: when one lifts a heavy sack, he believes to experience the force. Actually, what he feels is just pain and tension, which could be the result of an amputated leg as well. To conclude from this that for example the clouds and the hills are as well formed by forces is a rather bold assumption to be smiled at. And still: it works. It works, because the meaning of the force does not depend on words, but on the mathematical assignations and operations, which have been carried but behind the expression:

$$F = ma$$

These assignations and operations, however, remain purely human inventions, that is, they are not directly part of the examined phenomenon: when nature lifts the mist from the ground, she does not calculate velocity, does not calculate the second derivative, nor does she measure the mass, etc.; she simply brings about the process. If the Newtonian method is still adequate to what is actually happening, it can be attributed to that what man adds to the lifting of a cloud is of similar structure although of different matter, that to what he adds it.

Man, for instance, is a complex physiological entity, and the cloud and air are physical ones. The mystery of force and the geniality of man lie in that he recognizes and separates the two structures from their carriers, and equals them to each other regardless of their basic qualitative differences. When properties holding a certain basic content are attributed to the social experience, this attribution will be even more explicit than in physics. Actually, what we talk about here is a new perspective, the attribution of a new approach to experience. In such cases, everything stands or falls on whether this attribution is the continuation of the conclusions originating in the structure of reality and leading to beyond experience, or it is ungrounded fiction. When mass is attributed to the subjects of motion, for example, whatever they may be, this mass is not experienced as, let us say, the reacting of the pram against strolling.

But is not there a reacting force within society against changes? Is not the opposition of reaction and progress a well-known phenomenon? Have not we experienced that social ideas, habits, together with the groups representing them, endure for as long as hundreds, thousands of years? The phallus and the vagina, power symbols of the ancient Egypt, for example, still exist as living symbols of power in Ethiopia. Is it not experienced day-by-day that every reform and new measure takes effect only with some delay, if it takes effect at all? What is it, if not the manifestation of social inertia, that is, of mass? In this vein, we will attempt to adopt six of the nine standard quantities of physics into sociology.

Time: out of the standard quantities of physics, time can be easily adopted to sociology, because the present everyday social practice is organized based on the time used by physics and astronomy as well. In sociological practice it is usually not the second which is used as the basic unit, but rather the year or its parts. Of course, however, there is nothing to prevent us from reducing the data into seconds with the help of the established methods, so making it easier to utilize physical relationships.

Distance: any points of a system constituted by coordinates, the distance can be calculated by the following expression:

$$d = \sqrt{\left(x_i - x_j\right)^2 + \left(y_i - y_j\right)^2 - \left(z_i - z_j\right)^2}$$

Furthermore, every social difference, to which a distance can be assigned mutually uniquely, will be called distance. That is, we will not require the shift of prices at the exchange market to have coordinates. It will be sufficient if the prices are measured on a proportion measuring scale, so that two prices can be compared as two segments.

Angle: measured in radians; adopted without change.

Amount of substance: in units of moles, *n*. It is generally accepted in sociology that the particles of a social system are the individuals. At this level of the explication it is actually the same if we regard actions of individuals, individuals, or groups of individuals to be elementary. It boils down to that we have to introduce the concept of the number of particles, which we are able to measure. The number of individuals is adequate for this purpose. It is denoted by N.

Furthermore, the sociological amount corresponding to Avogadro's number is also necessary. In the present study this number has no other substance than to serve as a measurement unit. Its role is merely to simplify the application of thermodynamic formulas. In order to demonstrate that the introduction of Avogadro's number is not entirely arbitrary, in the calculations to follow we shall make a detour without the claim to completeness. As it is well known, Avogadro's number, N_A, is a natural constant of great significance used in chemistry and physics. Technically, Avogadro's number expresses the number of atoms in a twelve gram sample of Carbon-12, which is found to be 6.022×10^{23} atoms. This is the number of particles in a mole of something, such as a mole of gas.

The magnitude of the number suggests that its sociological counterpart has to be searched among the largest social phenomena. Such are the number of people in a society. If a version of Avogadro's number is to be employed in social thermodynamics calculations, then we shall begin at an attempt of an estimate using the logic that the average of the actual number of people is the product of 6.022 and some integer exponent power of 10:

$$A = 6.022 \times 10^{n}$$

On this basis, using an intuitive reduction factor, we will let n = 1 and arrive at the result that the social Avogadro's number referring to society is:[1]

$$A = 60 \text{ individuals}$$

With this value, the concept of the social mole number *n* can be introduced for the amount of substance constituting the social system:

$$n = \frac{N}{A}$$

Beyond this, in calculations where the society is to be modeled using ideal gas based equations, the concept of a 'social Boltzmann constant', as the ratio of the ideal gas constant to the social Avogadro number, needs to be determined in some way.

<u>Mass</u>: this will be determined in several steps, using gravitational acceleration and the concept of status work or potential energy.

<u>Temperature</u>: the thermodynamic temperature can be determined with the help of status work, at the same time conceiving of a 'social temperature'.

Sociological groundwork

The concept of status assumes that to each of the individuals living in a society an amount measured on a proportion measuring scale can be assigned, which is manageable, and which signifies the placement of the individual in society. Status is the ever-changing property of individuals. In the course of their lives at first they have no status whatsoever, they then share the status of their parents for a while, during the school years they obtain the possibility of fulfilling a certain status in the future, and in the later years their status will change with the changes in their income, knowledge, or influence, etc. In other words, the alteration of status in time is rather similar to the concept of distance well known from mechanics. There it means the displacement of a point-like object along a segment, along a plane or in space, etc. In our understanding status means a distance which takes into account the extent to which the individual had risen above the zero level of social status up to a certain point in time. That is, it means the achieved status, and it is not concerned with the actual route the individual covered between the statuses. This is in accordance with the thermodynamic standpoint of Caratheodory, which states that the energy level of a system is independent of what kind of states it had gone through. But it also resembles to that the energy conceived as potential depends only on the differences between the levels, as the displacement on the same energy level does not bring about a potential difference.

Social thermodynamics

This section will consider society as a thermodynamic system. If we examine either stratification or mobility, the present theories are only descriptive. Usually it is not even attempted to say something about the dynamics of social changes; the word dynamics meaning here what it means in mechanics and in physics in general. Dynamics primarily means the causal explanation of changes. Secondarily, different sciences choose the devices used for the causal explanation of changes in different ways. In empirical sociology there are only separated attempts for the causal explanation. It is so, because society is a holistic, communicated, and an extremely complex system.

Our approach will be to look for causal explanation, which are general enough to embrace the whole of a holistic society, and which can be applied to any arbitrary level of abstraction at the same time. Namely, due to the heterogeneity and chaotic movement of society it is not useful to look for the casual explanation on a low level of abstraction, because that would make research very limited, and it would lose the holistic nature. An abstraction level, which is too high, on the other hand, would bring about the danger of being solid but meaningless, even in the form of the most factual statement.

The main question is where to find a model which can handle dynamics. Theoretically, there are two possibilities for this: either it has to be established within sociology, or it has to be adopted from another science. Here we will follow the latter alternative and adopt from the established science of thermodynamics. It is a matter of taste whether the reader will accept the following model of thermodynamics for first reading or not. Theoretically, it is just as bad or good as any other is. It speaks for this model that it is concerned with energy and its transformations, that is, with the most general properties of movements. If we do not regard social movements as virtual, and it is difficult to say, for instance, that the world wars or the oil crisis are virtual, then there must be an energy, which characterizes this field. The goal of this study is to introduce this energy and the utilization of thermodynamics. There have been attempts for the thermodynamic modeling of certain subsystems of society. The motivation behind this is probably that the physicist and the sociologist meet problems of the same nature and complexity. The former faced an unsolvable task in the form of the mechanics of systems having many elementary constituents, for example gases. One mole of gas contains 6×10^{23} chaotically moving molecules. Theoretically, it is an impossibility to describe their behavior with the equations of the Newtonian mechanics. The sociologist is in a little better situation, because he or she should say something about the chaotic behavior of groups of people with maximum 6×10^{9} members; however, no social mechanics exists which could be helpful in this case. In physics, the solution was provided by that the behavior of gases, and later of every other physical system, could be delineated in phenomenological thermodynamics with relationships between at least three global quantities. These quantities are usually the N the number of the particles, E potential energy, and V the volume of the system, respectively.

Also, instead of one of the above quantities, we can use temperature, pressure, or entropy. The main thing is that if we know any three of the above listed quantities the missing properties can be calculated from their relationships. Now, if one would like to explain the behavior of people in a simple, clear-cut way, it is obvious that the methods of phenomenological thermodynamics should be used. It also encourages us to do so that thermodynamics makes universal statements, that is, it does not matter to what kind of physical system it is applied to. Of course, when we change over to sociology, it may be questioned whether the principles of thermodynamics can be extended to society as well. One of the goals of this study is exactly to demonstrate this change-over.

Firstly, we will attempt discussion on social entropy. Out of the triads necessary to describe a thermodynamic system we have three already: the number of elements constituting the system (N), the volume (V), and the total energy (E). A further quantity, however, is missing: entropy.[2]

References

1. Note: the original calculation attempt of a ‘sociological Avogadro’s number’ made by Laszlo is rather incoherent. He seems to attach significance to the number 6.022 as having some sort of important physical meaning, whereas correctly the number is arbitrary. To quickly go through how Laszlo arrives at his A=60 value, for what he calls the ‘sociological Avogadro’s number (A)’, he begins by stating that in 1992, there were 87 countries had a population above 6 million, the average being 6.01E7, and that these 87 countries accounted for 97 percent of the world’s population. He then divides Avogadro’s number (6.022E23) by this average country population (6.01E7) to obtain the number f=10E16 (which he calls a reduction factor). He then divides this number (reduction factor) again into Avogadro’s number to obtain 6.022E7, which is his first estimate of A. Laszlo then says: “in fact, the reduction of f = 10E16 is not enough. Why it is so,

will be answered by subsequent parts of this study. To put it concisely, what I mean is that the thermodynamic model I am going to use for modeling society is originally defined on atoms and molecules. This model can be adopted by sociology only if it is observed that society is made up of much larger constituents, than molecules. For this reason the f = 10E22 reduction factor needs to be introduced here. In this case the Avogadro's number referring to society is: A=60.2257 individuals."

2. (a) Nagy, Karoly. (1991). *Thermodynamics and Statistical Mechanics* (*Thermodinamika es Statisztikus Mechanika*). (pg. 229). Tankonyvkiado, Budapest.

(b) Laszlo concludes the last four pages of his paper by, it seems, cherry picking a handful of equations, from the above statistical mechanics book, in attempts to estimate social entropy, social pressure, social temperature, social mole weight. The entire attempt at derivation, however, is too incoherent to repeat here and the choice of equations seem to be essentially baseless as to why the equations Laszlo chooses should apply to society. To cite one example error, he assumes that potential energy and internal energy are the same thing.