

Human society evolution: a physicist's view

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The concept of phase transition was built for defining temperature. The dilatation of solids and liquids was known to occur with an increase of temperature but the definition of a temperature scale requires reference to two invariants, i.e. fixed points. In 1724 Fahrenheit chose for invariants the melting point of a brine made from equal parts of water and salt as 0°F and the average temperature of a horse as 100°F. Later in 1742, Celsius chose for invariants, the boiling point of water under normal pressure and the freezing point of water. More recently, new precise marks were chosen with reference to more precise invariants, issued from phase transitions of pure elements, such as triple point of water and lowest temperature. So, the notion of phase transition involved practical homeostasis, a biological concept of living systems as well as physics transitions. So, physical problems and more complex ones such as those of biology were mixed together from empirical evidence. In physics, the difference between equilibrium systems and out-of-equilibrium systems appeared early and the notion of phase transition for pure systems evolved with the observation of an objective mark of the evolution of this transition, the order parameter, as proposed by Landau.¹

Nowadays quite numerous phase transitions and order parameters are known. For instance, water, a rather simple molecule with a rather complex ground state, shows a very large number of phases and of phase transitions of different natures. Thus, even if the analogy between physics and other observations on a large number of objects suggests the occurrence of transient configurations, in this whole forest of phases and transitions, just a few main ones must be selected as the main steps of evolution of human society.

In physics, two simple examples of relevant order parameter are the averaged occupied atomic volume, i.e. the whole phase volume divided by the number of éléments, and the averaged mobility of an element, i.e. the averaged atomic or molecular displacement during a time large in front of individual collisions. The averaged atomic volume distinguishes a gas from a dense phase and the averaged atomic mobility distinguishes a solid phase from a liquid one. So, the very basic physical transitions, gas-liquid and liquid-solid are deduced. With such strong order parameters, the evidence for traffic jam as a phase

transition sounds obvious. So even if in social phenomena, there is no equilibrium, and even if the number of individuals is not as large as in atomic problems, rather persistent states of social life are observed from simple order parameters.

The basic order parameter of human society is life necessity. The simplest way for human survival consists in taking advantage of nature by gathering. Probably, hunting, which is common for animals, appeared nearly at the same time as gathering among human communities. Ibn Khaldun² early studied this way of life and social transitions. He noted that these ways of life required a lot of consequent social conditions. For instance, a corollary of hunting and gathering is displacement, since local resources soon disappear. So nomadic life is necessary. A further practical condition of nomadic life restricts the number of individuals to a small consistent group, a tribe. And tribal life requires a natural regular production of resources. It defines a few convenient equatorial regions. In such optimal conditions this way of life is relatively comfortable as recently observed in such surviving tribes.³ Taking ad-

vantage of their free time, tribes early developed their own specific cultures as observed by numerous anthropologists.⁴ On the other hand, these tribes developed their own social life with a repartition of duties and responsibilities such as the choice for a chief.

The transition towards a settled life needed favorable natural conditions and a deeper knowledge of the way of producing food. For instance, the seasonal flooding of the Nile created the fertile land that allowed agriculture. Other large valleys such as Mesopotamia, Indus valley and Yellow river valley knew parallel developments. The transition from nomadic life to settled life favored agriculture and livestock. This rather high technical level led people to develop technics, science and education. The specialization of these activities led to simultaneously develop exchange and trade between specialized producers. Thus, a basic urban life was developed in these settled regions with a more complex social organization than residual nomadic life which was restricted to long ranged exchange between different settled communities. Physical strength has a strong weight in agriculture and livestock. This leads to a strong difference between male and female basic activities, even if education and trade were rather equally open to women and men. The stability of this settlement led to develop permanent buildings. Agriculture and livestock required built parts as well as convenient tools and so handcraft was simultaneously developed. These activities led to very complex social and urban organizations⁵ with numerous variants.

The complex geographical pattern of Greece led to develop independent cities. Oppositely, the easy communication within the Nile valley led to a full large nation. Moreover, the use of slavery resulting from numerous wars and battles allowed Athenians to reach a "golden age" where citizens were free from basic duties and just had to deal with ideas. The complexity of large nations avoided such a democratic arrangement. Roman Empire was largely extended and lasted during a very long time because of both its material efficient organization and its flexibility about local rules. During these

eras, the main changes were due to new Christian and Islamic religions which tried to refresh the social order. However, these changes of religious practices did not perturb too much these principles. The main social changes occurred because of technics and science.

The decisive change in human society came from the study of navigation by Prince Henry the Navigator (1394-1460), with the dream of an overseas leadership. A stable boat, the "caravel" was derived and soon travelled through the whole world. Portugal and Spain emerged among over European nations because of the fantastic amount of wealth resulting from the resources of these newly colonized countries. So, encouraged research in technics and sciences led to the Age of Enlightenment with the definition of temperature and phase transitions, as well as a complete renewal of antique sciences by Galileo, Newton, Euler, Descartes, Volta. Thermodynamics initiated the creation of engines with the hope of a new era free from energy, while the mastering of chemistry enabled to use new materials. The common result of this active research was the industrial revolution with the search for natural products by means of mining as well as the creation of motorized displacements. This is the second main transition for human society: necessity means mining and industrial use of resources.

The new industrial organization involved a lot of human energy for mining, creating factories and working in these new factories with large numbers of workers at the very same place and large urban areas: the Ruhr valley, the Newcastle area, the Pittsburgh coal seam. Other urban centers for producing textile, metals at a huge scale, close to consumers, appeared everywhere from the middle of the nineteenth century. Between these cities connections by means of railways, ships, roads and later flights were developed. Such a process evolved in all countries with some lags according to local histories. A fast organization was achieved with general bad conditions for workers. Industrial workers came from agriculture and livestock world and were suddenly gathered together in an explosive way with an actual critical mass. This new collective situation

led to create unions, strikes, and so, new political forces. Just a few people were required for highly mechanized agriculture and countryside was deserted. Physical strength was a main factor. It led to strong differences between male and female jobs. In these industrial jobs, the level of knowledge was also a discriminating factor. So, a completely new social organization appeared as reported in the nineteenth century literature by Stendhal, Balzac, Zola and Tolstoï.

Nowadays the increasing level of robotization and delocalization of the industrial production makes marginal the need for energy, mining and industry. This is the transition towards a pure conception era. Assuming that robotization and delocalization will soon enable people to perform everything, the only remaining need is will, desire. But desire is infinite as philosophes said. So, the new society is widely open, without any imperative goal. So, advertisement has an essential part in restricting this open field to more simple goals. The French sociologist Pierre Bourdieu (1930-2002) early noticed this deep social change when writing *Distinction: a social critique of the judgement of taste*⁶, the fruit of a collective social analysis where the new society is analyzed by means of a new criterion, a new order parameter, the taste and its numerous variants.

The new coming society starts with a general deconstruction⁷ of the previous one, the industrial society. Such a research of attractive newness requires small teams of high level searchers and their surrounding people with strong connections with similar teams. This generalized "Silicon Valley" process occurs. A hint on this new society is the emergence of luxury industry as a leading activity. Individualism appears strongly as well as the power of unions and correlated parties becomes lower and lower. There is no need for physical strength. So, men and women are perfectly equal about work. And family life is changing. In this new "Athenian" golden age city, leisure, as the engine of will and desire is becoming more and more important. A three-dimensional fractal city⁸ with an optimal connectivity and freedom for the future sounds plausible.

Finally there are obviously strong differences between matter and human individuals. For instance, the emergence of violence in revolution, in terrorism is a typical fact of human society. Numerous cases of violence such as wars, terrorism, or revolutions appeared and were linked with the emergence of new kinds of social life. The nineteenth century local revolutions were connected with the general industrial revolution. Quite similarly present terrorism is linked with the emergence of the new society.

¹ Lev Landau (1908-1968) was a physicist with a broad spectrum and influence who introduced an order parameter for the helium transitions.

² Ibn Khaldun (1332-1406), a philosopher and historian, wrote the *Muqaddimah*, an introduction to history, which is translated in many languages.

³ Pierre Clastres (1924-1977), an ethnologist and anthropologist, noted that three hours a day were enough ensuring survival in an active Guyaki tribe, leaving time for art and leisure. See P. CLASTRES, *Chronicle of the Guyaki Indians*, Cambridge, MIT Press, 1998.

⁴ For instance, Claude Levi-Strauss (1908-2009), a philosopher and ethnologist, published an extensive review. See C. LEVI-STRAUSS, *Myth and meaning*, London, Routledge & Kegan Paul, 1978.

⁵ See Ibn Khaldun.

⁶ P. BOURDIEU, *Distinction: a social critique of the judgement of taste*, Cambridge, Harvard University Press, 1987.

⁷ The term deconstruction was introduced by Jacques Derrida. J. DERRIDA, *Positions*, Chicago, Chicago University Press, 1981.

⁸ J.-C. S. Levy, "New evolutive 3D urban architecture: a physicist' view", *LINKs* 1.