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Extended Abstract

Stonier´s definition for kinetic and structural information revised †

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When viewing differences that make differences from an evolutionary perspective, information is not just communication. When one has won the fight with the many different definitions of entropy and finally understood that what corresponds to information of communication theory is best viewed as a tendency for equilibrium distribution functions in matter, one knows only a half. Knowing that Shannon´s formula relates a distribution function between set elements to the amount of decision-events necessary helps, but questions remain. What influences this amount? If the set evolved, how could decision-events not follow the tendency to equalize obeying the maximization of statistical entropy? How could relations stabilize? The set´s information is a non-equilibrium distribution´s cause. In physics, if some properties which deviate from equilibrium depend on spatial configuration, such properties are said to be in a field; and they represent a potential energy if they provoke forces in interactions. Stonier thought that the cause of non-equilibrium distribution functions in stable configurations and material structures is only one kind of in-forming influence; and that it is inherent in the structure. He called it *structural information* and discerned it from what he called *kinetic information*. This is the other cause of non-equilibrium distributions and it names the externally introduced information which leads to a non-stable situation triggering work to be done. This is what makes Stonier´s definition of information difficult to grasp: Energy which is physically potential energy, as it is stable inside a certain conformation, is stable because of structural information; and it is converted over several steps of non-stable states back into energy which can´t do any work. The state stabilized by structural information became in-stable because kinetic information was added. This sounds unfamiliar.

But one has to consider the context before contradicting. Stonier chose the example of a steam engine for the process described above [1]. In this context, the idea that information is needed to *directedly* destabilize makes more sense: The machine has a characteristic structure which exists due to a stable configuration which can be trailed until one arrives at the atom and molecule relationships inside its crystal lattice micro structure. The structural information of the machine enables it to provoke an instable situation which will produce work; i.e. it enables it to introduce kinetic information into the gas-boiler-piston-part of its structure. Not all of its structural information is needed to introduce the kinetic information needed to provoke the non-equilibrium situation for work production. Some of the structural information serves other functionalities like holding the gas inside the system or other forms of self-maintenance. On the one hand this distinction Stonier made sounds quite plausible. Information changes organization and thermodynamic improbability affords information. Provoking a non-equilibrium situation which leads to the production of work -which is an organized process in Stonier´s terms-, therefore demands for information. What provokes the change to non-equilibrium in the steam engine is externally introduced information which directly

causes the production of work. Is it really plausible? What discerns the inducer of non-equilibrium from the keeper of stability inside the machine´s molecular structure?

The stabilizing non-equilibrium inside the crystal lattice micro structure is kept for a long time and at constant energy by structural information. The work-producing non-equilibrium between itself as a whole and its colder environment is not maintained for a long time; and it will result in a heat flow to the surroundings which involves a change in energy. Nevertheless the structural setup of the machine´s material as well as the setup of all parts of it viewed in relation to its surroundings both have to be interpreted as distribution functions between particles. The fact that the semi stable state of "machine in temperature gradient to external particles" produces work during restructuring does not change the type of information compared to the stable state "the metal atoms inside the micro-structure crystal lattice keep the set of relations which produce the macrostate of the steam machine". Both states are dependent on temporally invariant relations between particles. So what enables the steam machine to produce work? It is its structural information, the structural information which this generates inside a reference frame which includes the machine as well as its surroundings and a trigger to generate the "needed" change to the structural information. The fact that the trigger can change the state of the system and some of its structural information does not turn the trigger itself into information, at least not in the way Stonier claims for this example. The capacity to trigger the production of work does not make the information kinetic. It still is a form of Stonier´s structural information and a change to structural information, what a heating fire causes in the steam machine. The fact that one of the information types – the "keeper" is acting on a long-term scale while the other type "the inducer" is acting comparatively short until the production of work is the only means to return to a stable state. But mathematically different scales for one and the same quantity do not justify a differentiation.

Our approach is a bit different: Structural information needs to define invariance in relations between particulate objects and the invariance is not due to a thermodynamic equilibrium situation. Thereby the duration of the deviation from thermodynamic equilibrium plays no role. Neither does the fact whether work is going to be produced or not. Information is a quality with some kind of store and it influences selective processes respectively processes comprising decision-events leading to relations. Therefore it has to play a major role in all evolutionary processes, not just in biologic evolution. We agree with Stonier that evolutionary systems can only be understood when two classes of stores or sources for in-formation of relations are considered. Where we do not fully agree with Stonier is regarding his definition for kinetic information. It is right that some structures allow the direct production of non-equilibrium states due to characteristic relations between particles carrying characteristic properties, while other structures contribute nothing to slow down the process of establishing thermodynamic equilibrium. But in both cases the information defines spatial relationships and is not directly dependent of time. More than that, inside stable structures time could seem to stand still, since energy as well as observable form is conserved. A second type of information, non-structural information would need to carry a kind of temporal non-equilibrium, a pattern of change in time. Let us once more look at Stonier´s steam engine example: Which selective influence that induces time dependent changes and which defines the serial sequence of events could play a role as an inducer of the process of reorganization? Could this influence be stored in some medium? It might be difficult first, to compel one's mind to think in that way. Humans are used to think focused on material and structural aspects. In the steam machine example (aside from structural information) it is the fire which triggers thermal non-equilibrium with the machine´s surroundings. Could a fire give any information? It could transfer heat. Heat introduced into a stable organized structure disorganizes that structure. But as Lambert showed, organization itself is a subjective term; what matters physically is the distribution between different energy levels. As broader the distribution curve, i.e. the more randomly the energy is distributed between available levels, the larger the entropy. Therefore the fire introduces a change in the distribution function, the distribution function of kinetic energies. But wait. It introduces a change of kinetic energies? Here is a connection with changing time, since kinetic energy implies changing velocities. Fire denotes a set of electromagnetic wave functions with different frequencies and characteristic observable properties

considering e.g. the capacity to trigger chemical reactions etc. Viewed as single temporally stable units, fire´s electromagnetic radiation waves of different frequencies are characterized by distinctive temporal patterns. Let us consider another example, where the influence of temporal patterns causes changes in material structures exactly because of its pattern´s characteristic sequence of events in time: Inside a human ear, there exist structures which – due to their structural information – possess a strong sensitivity for sound waves of a certain spectrum. When gas molecules which carry a distinctive temporal pattern (sequence) of dense and less dense regions arrive inside the human ear, their information can be recognized as a signal, as music, as speech etc. Here intuitively the term information is justified. What is the difference to the fire inside the steam engine? The temporal pattern is organized. But what does this mean? The human ear can also register a beat of random superposed frequencies and distinguish it as noise. Noise is no information? This is common consensus, but is it justified? Isn´t this distinction between the kinetic information which defines an organized music and the randomly combined wave functions which define the noise again a subjective judgment which has no relevance for physical general effectiveness? I will discuss this question in my talk and present an approach to define structural and kinetic information in a way that a framework to study the evolution of information processing systems can be established.

References

1. Stonier, T. *Information und die innere Struktur des Universums*; pp. 68-72. Publisher: Springer Verlag Berlin, Heidelberg, New York (1991). Original title: *Information and the internal structure of the universe*; Publisher: Springer London Limited 1990