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## **The Second Law of Energy Degradation** *Including Biological and Intelligent Processes*

The Second Law made its appearance around 1850, and almost a century later, the physicist/philosopher Bridgman (1941) still complained that “*there are almost as many formulations of the Second Law as there have been discussions of it.*” Even today, the Second Law remains so obscure, due to the lack of its comprehension, that it continues to attract new efforts at clarification, including this one. Einstein, whose early writings were related to the Second Law, remained convinced throughout his life that “*thermodynamics is the only universal physical theory that will never be refuted.*” Namely, the phenomenological Laws of Thermodynamics have much wider, including philosophical significance and implication, than their simple expressions based on the experimental observations.

It is only possible to produce work during energy exchange between systems in non-equilibrium, therefore, the work potential is measure of the systems’ non-equilibrium, thus the work potential could be conserved only in processes if the non-equilibrium is preserved (conserved, i.e. rearranged), and such ideal processes could be reversed (reversible processes). Therefore, it is impossible to produce work from a single thermal reservoir in equilibrium, then a non-equilibrium will be spontaneously created.

All natural spontaneous, or over-all processes (proceeding by itself and without interaction with the rest of the surroundings) between systems in non-equilibrium have tendency towards common equilibrium and thus irreversible loss of the original work potential, by converting other energy forms into the thermal energy accompanied with increase of entropy (randomized equi-partition of energy per absolute temperature level).

The Second Law has been challenged by some, since certain technical, physical, chemical, biological, and/or intelligent processes produce local non-equilibrium, like moving fluid or refrigeration-heat to higher elevation/temperature, cyclone or crystal formation, in life-creating processes or cognitive reasoning (by increasing local non-equilibrium, i.e., energy density/potential/organization); however the over-all non-equilibrium, including all interacting boundary systems, i.e. affected environment (very important) only proceed towards over-all (global) equilibrium with over-all entropy increase. In many processes the latter could be confirmed experimentally but some appear to be mysterious and self-organizing; however, the miracles are until they are comprehended and understood.

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