

**Revisiting The Second Law of Energy Degradation and Entropy Generation:  
*From Sadi Carnot's Ingenious Reasoning to Holistic Generalization***

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**Abstract:**

Sadi Carnot's ingenious reasoning of reversible cycles (1824) laid foundations for *The Second Law* before *The First Law* of energy conservation was even known (Joule 1843) and long before Thermodynamic concepts were established in 1850s. A century later, Bridgman (1941) '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.

The *Laws of Thermodynamics* have much wider, including philosophical significance and implication, than their simple expressions based on the experimental observations – they are *The Fundamental Laws of Nature: The Zeroth* (equilibrium existentialism), *The First* (conservationism), *The Second* (directional transformationalism), and *The Third* (unattainability of emptiness). They are defining and unifying our comprehension of all existence and transformations in the *universe*. The *forces*, due to *non-equilibrium* of *mass-energy* in space (non-uniform 'concentrations'), causing the *mass-energy* displacement, thus defining the process direction, are manifested by tendency of *mass-energy* transfer in time towards common equilibrium. It should not be confused with local creation of non-equilibrium and/or 'organized structures' on expense of 'over-all' non-equilibrium, by spontaneous and irreversible conversion (dissipation) of other energy forms into the thermal energy, always and everywhere accompanied with *entropy* generation (randomized *equi-partition* of energy per absolute temperature level).

The fundamental laws of nature are considered to be axiomatic and many believe they could not be explained, proven or questioned. However, everything may and should be questioned, reasoned, explained and possibly proven. The miracles are until they are comprehended and understood.

**Brief Biography of the Speaker:**

*Milivoje M. Kostic*, Ph.D., P.Eng., Professor of Mechanical Engineering at *Northern Illinois University*, is a notable researcher and scholar in energy fundamentals and applications, including nanotechnology, with emphasis on conservation, environment and sustainability. He graduated with the University of Belgrade highest distinction (the highest GPA in ME program history), obtained Ph.D. at University of Illinois at Chicago as a Fulbright scholar, appointed as NASA faculty fellow, and Fermi and Argonne National Laboratories faculty researcher. Professor Kostic also worked in industry and has authored a number of patents and professional publications, including invited articles in prestigious energy encyclopedias. He has a number of professional awards and recognitions, is a frequent plenary speaker at international conferences and at different educational and public institutions, as well as member of several professional societies and scientific advisory boards.

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