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In Celebration

Celebration of Professor Adrian Bejan on his 70th birthday

1. In honor of Professor Adrian Bejan on his 70th anniversary

We celebrate the extraordinarily creative career of Professor Adrian Bejan in the thermal sciences. His life and scientific record were reviewed in detail ten years ago, on the occasion of his 60th anniversary [1]. His work across decades is consistently scholarly. One wonders if the primary reason for this is his conscious avoidance of administrative positions, be it in academia or in the research enterprise.

Today, we marvel at what he has accomplished since 2008, and how revolutionary and long-lasting his career contributions continue to be. There is so much to choose from in what he has accomplished during the past ten years that here we present only three of the highlights:

Professor Bejan took his science and made it accessible to the general public. He published two highly successful books for general audiences, Design in Nature [2] and The Physics of Life [3]. These books start from thermodynamics and convection, and build the physics foundation for everything around and inside us: flow, power, life, death, technology, wealth, social organization and evolution. They have been translated in Japanese, Chinese, Korean, Russian and Romanian. Professor Bejan is a public figure, an advocate for the pivotal role of engineering science in the advanced civilized world. Adrian Bejan speaks loudly through his remarkably creative deeds. He first built a magnificent record of scientific contributions, and now, on that record, his physics arguments and predictions rest firmly.

Adrian Bejan's impact on the thermal sciences is made permanent by his original methods of theory, modeling, analysis and design, which today are associated with his name: entropy generation minimization, constructal law, evolutionary design, life and evolution as physics, scale analysis, intersection of asymptotes, heatlines and masslines, the temperature–heat diagram (the T–Q diagram), and many more. He teaches the history of science, graphics, the oneness of science and art, and defends the integrity of science [4,5]. He sounds the alarm against publishing practices that give the impression of false science, citations cartels, nationalism, groupthink, unoriginal work, and lack of credit given to the original sources.

Professor Bejan continues to be widely acclaimed for his legendary position in science. A fitting summary was just published on the occasion of his Benjamin Franklin Medal [6], from which we reproduce these passages:

<<**Citation:** For his pioneering interdisciplinary contributions in thermodynamics and convection heat transfer that have improved the performance of engineering systems, and for constructal theory, which predicts natural design and its evolution in engineering, scientific, and social systems.

It is rather unusual for a mechanical engineer to be credited with conceiving a new theory in physics. Engineers, after all, generally specialize in coming up with new applications of physical laws, leaving the fundamental principles to the physicists. But Adrian Bejan is more than a typical engineer. He became a full professor at Duke University in 1984, already making major contributions to the field of thermal sciences.

He published several books, which have become seminal works in thermodynamics. In 1982, his very first book introduced the concept of entropy generation minimization, which combines heat transfer, fluid mechanics, and thermodynamics principles into simple models to facilitate engineering design. His colleagues even coined the "Bejan number" (*Be*) after him, a mathematical term

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for a certain ratio used in thermodynamics in combination with fluid mechanics.

It was in 1996, however, that he published what became his most notable and daringly original work to date. At a conference a year earlier in France, he heard Nobel Laureate Ilya Prigogine discuss branching patterns found in nature, such as in trees or in the vascular systems of animals. He found himself disagreeing with Prigogine's assertion that such phenomena were merely coincidental. Bejan was certain that there had to be an underlying principle at work that governed it all. He found that principle in what he termed "constructal theory."

Constructal theory states that a finite system can persist only if it evolves in accordance with the currents that flow through it. As he explains, "The designs we see in nature are not the result of chance. They arise naturally, spontaneously because they enhance access to flow in time." A river delta, for example, begins with a single stream, then develops tributaries and branches, increasing in complexity as water continues to flow and seek easier paths. Constructal theory is grounded in the laws of thermodynamics, but has shown applicability far beyond, through a wide, and often surprising, range of fields. Bejan has used constructal theory to show how patterns of social interaction and economics evolve in an analogous fashion, holding implications for the social sciences and demonstrating the fundamental physics underlying even these disciplines.

It sounds simple, but in that simplicity is its power, as has been demonstrated in the work of Bejan and others. Emphasizing the ongoing evolution of design in nature over both short and long time scales, constructal theory points the way to engineering approaches consistent with those observed in the natural world and allows for more efficient and sustainable approaches to the design of electronics, heating systems, vehicles, traffic management, and urban infrastructure, among many other areas.

Adrian Bejan's career serves as a unique example of how an engineer can make lasting and seminal contributions that transcend the conventional barriers that separate disparate fields and instead unify them in ways that benefit and complement them all.>>

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