

## BOOK REVIEWS

### Understanding global civility: an analysis of ‘Constructal Law’ in Michael Takac’s Vision

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‘Constructal Law’ (CL), is a principle that attempts to explain how patterns and designs arise to improve the efficiency of energy, matter, or information movement. The principle is applicable to a wide range of systems, including those that are natural, biological, and humans-made. The constructal law is the statement proclaiming the existence and the time direction of the evolution of configuration. It is far more general than ‘maximum entropy production’. It is not a statement of optimality (min, max), end design or destiny. No flow system is destined to end up in a certain configuration at long times (Bejan & Lorente, 2004). From river networks and animal mobility to technological and cultural systems, these designs cover a wide range of topics. The Constructal Law, proposed by Adrian Bejan in 1996, asserts that the configuration of natural systems can be explained by the flow of materials, energy, and information shaping their evolution. [optimization is not guaranteed] It is mostly utilized in thermodynamics and physics, illustrating how design arises in natural systems in the evolution of configuration. Its significance encompasses human affairs, governance, and conflicts, providing a framework for analysing systemic behaviours in social and political spheres.

In the social sciences, enough literature exists that use optima to infer social, demographic, and economic dynamic. The book *Global Civility: Physical Constructal Law* (2024) presents an innovative and interdisciplinary approach to enhancing human civility by applying the physical constructal law. The author Michael T. Takac examines the interrelation of natural systems and how this concept could be used to enhance ethical conduct and harmony among human groups. The book is inspired by the CL theory forwarded by Adrian Bejan, a professor at Duke University.

## **The core concepts of CL**

Flow Systems, Design Evolution and Universality are the three key concepts associated with CL theory. 'Flow Systems' are the systems where material, energy, or information moves through defined pathways (e.g., rivers, blood vessels, tree system, transportation networks, power dynamics such as centralisation and decentralisation through different governance models). Design Evolution signifies the adaptation and emergence of configurations that reduce resistance and enhance flow efficiency over time. Universality means the law applies across scales, from microscopic systems (e.g., capillaries) to macroscopic phenomena (e.g., economies).

## **The evolution of CL**

It is possible to trace the beginnings and development of CL through the emergence of its interdisciplinary approach. The constructal law originated from the field of thermodynamics, specifically the second law, which has the authority to regulate entropy. As part of his efforts to reconcile entropy with order, Bejan attempted to provide an explanation not only for the dissipation of energy but also for the creation of structured patterns in nature (Bejan, 1996). The initial applications concentrated on physical systems, such as river basins and atmospheric currents, and attempted to explain how these systems spontaneously change their topologies in order to improve flow. For instance, river networks develop throughout time in order to reduce the amount of barrier to water flow while simultaneously increasing the amount of access to sources of precipitation (Bejan & Lorente, 2010). Bejan demonstrated how biological structures, such as lungs and circulatory systems, adhere to the same criteria in order to improve flow (Bejan, 2000). This allowed him to extend the domain of the law to include living organisms. In accordance with the constructal principle, the circulatory and respiratory systems of the body have developed designs that improve the movement of oxygen and nutrients.

At the beginning of the twenty-first century, the application of CL to human-made systems was already underway. Bejan provided an illustration of how urban designs, transportation networks, and communication systems evolve in a manner that is comparable to that of natural systems. According to Bejan and Zane (2012), these applications connected the field of CL to the fields of engineering, economics, and even governance. More recently, CL has been positioned as a unifying principle, connecting the physical sciences to social and behavioural sciences. This has resulted in a broadening of its philosophical and interdisciplinary scope. It seems to imply that the search for more efficient flows is also a driving force behind human evolution, cultural growth, and societal shifts.

### **CL and human systems**

The Constructal Law offers insight into the development of governance systems, economic frameworks, and social networks within human communities. Governance and political institutions can be regarded as “flow systems” intended to regulate resources and information. This theory posits that systems adjust to facilitate the effective allocation of power, resources, and decision-making. For instance in the hierarchical and decentralized governance structures mirror flow patterns. Centralized systems prioritize efficiency at scale, while decentralized systems adapt to localized needs, balancing the trade-offs between robustness and flexibility (Bejan & Zane, 2012). Similarly the supply chains, trade networks, and financial systems evolve based on flow principles. The rise of globalization illustrates this, where economies improvement for resource distribution on a global scale (Bejan, 2016). According to Freire and de Andre (2018) CL even applies to institutions, being state of mind entities. The main flows of an organization are credit and information. Of course, organizations engaged in production of goods also need physical assets. But the exchange of any physical material or good involves credit and information. Institutions evolving in the sense of improving those flows make organizations grow powerful. Institutional entrepreneurship in the sense of constraining credit and information flows withers an organization.

In addition, CL also offers insights into the mechanics of conflict through its application. Blockages or inefficiencies in the flow of society resources are frequently the root cause of wars and disputes. Among the examples are, competition over access to resources such as water or energy is akin to natural flow systems that are attempting to overcome obstacles. Territorial conflicts are a manifestation of this competition. The nations that are engaged in geopolitical rivalries are flow systems that are competing for dominance in trade, technology, and influence. The power dynamics of these nations are determined by the efficiency of both their internal and external flows. It is possible to understand social movements as efforts to unclog societal pathways, addressing injustices that restrict the flow of opportunities and resources. Civil unrest is a form of social unrest.

### **Michael T. Takac’s addition to the CL theory**

*Global Civility* by M. Takac is a ground-breaking work that provides a new and innovative interdisciplinary solution to the problem of elevating humanity to new levels of civility through the implementation of the physical constructal law. In this book, the author explores the interconnection of natural systems and how this notion might be extended to increase ethical behaviour and harmony among human communities. The book draws inspiration from the well-known constructal theory that was presented by Adrian Bejan, a professor at Duke University. The volume has nine chapters ranging from CL to morality, economics, social system, and rule of law making their interrelationships to be understood, quite interesting and complex at the same time.

Language is an essential instrument for communication that has undergone continuous evolution. Its evolution and precision in communication may definitely help in applying natural physical laws in social and political domains. According to Takac, ultimately, the physical rules of nature can also be perceived as a distinct language. They provide a framework of principles that regulate the functioning of the cosmos, and through scientific inquiry, we have succeeded in elucidating and modelling these

laws. Utilizing mathematical language and the scientific method, we have explored the universe's mysteries and made remarkable discoveries (p. 9).

“Global Civility” is a novel approach to addressing difficult problems in a world that is currently experiencing a variety of challenges, including cultural conflicts, environmental degradation, and social instability. This approach is based on the application of a scientific notion. This book finds fascinating connections between the development of peaceful human interactions and the evolution of natural flows by exploring a variety of disciplines, historical situations, and philosophical perspectives. In addition, it also includes a discussion on how adopting the ideas of constructal theory might result in economic models that are more sustainable, governance systems that are more efficient, and social frameworks that are more inclusive.

In the introductory chapter Michael Takac exemplifies the image:

Imagine a physical law in nature with the potential to reduce warfare, invasions, and political instability that have plagued humanity throughout the ages. There are patterns within the social domain that mirror the signature of the latest discovered law in thermodynamics. These patterns suggest the existence of fundamental principles governing the behaviour of social systems, similar to how physical laws regulate the universe. This physical law, known as the constructal law, maintains a relatively interesting principle linking social systems to the physical realm, and its utilization has the potential to profoundly transform society. It could offer a shared framework for comprehending social evolution and empower us to develop more effective policies and interventions to tackle societal challenges such as poverty, opportunity, and conflict. Moreover, the simplicity of this law enables readers of this book to test it and enhance their own standard of living (13).

In the ‘Philosophy’ section of the ‘Introduction’ chapter, Takac considers philosophy as an important course to be introduced in every institution of higher learning. Everyone has their own philosophy, and there is always room for more wisdom. Philosophy encompasses various branches, one of which is the philosophy of language. The “language of calculation” in relation to mathematics is also a branch of philosophy, as it involves axioms and rules. Even a theory that is solely based on mathematical principles can be considered a form of philosophy. Many scientists may not realize the philosophical aspect of their theoretical work prior to scientific verification (p. 14).

To be suppositional, the potential of discovering a connection that integrates the physical and social realms, could be a connection capable of revolutionizing our quality of life. A link exists in the form of the physical CL which establishes a framework for comprehending the flow patterns in natural systems, yielding significant insights into the evolution of life, energy, and matter. The ramifications of CL transcend beyond the physical realm, infiltrating the social fabric of human existence in both revolutionary and transformative manners. The physical rules of the universe constitute a unifying element among diverse human cultures, faiths, and philosophies. Irrespective of belief systems or worldviews, these rules remain immutable and steadfast, forming the fundamental basis of existence. Historically, the ethical implementation of these physical principles has led to progress in various domains, including medicine, technology, and engineering, greatly enhancing the quality of life for numerous individuals globally. Nonetheless, the physical Constructal Law presents an even more significant opportunity: the capacity to reveal the concealed relationships between physical principles and the societal frameworks that regulate human existence.

This book invites readers to embark on a captivating journey through the corridors of knowledge, where a tantalizing mystery awaits discovery. It challenges the curious to delve into the depths of human understanding and explore a pattern that is both ubiquitous and elusive. This common pattern—intuitively

recognized yet seldom articulated—resonates across history and contemporary discourse, manifesting in natural systems, human behaviour, and social constructs. Its full significance, however, remains shrouded, waiting for the brave and inquisitive to unveil its secrets. Also serving as a concept book, it encourages ongoing research into the evolution and applications of CL.

In the chapter “The Natural Law” Takac relies on Thomas Jefferson’s concept of “unalienable Rights” [“Life, Liberty, and the pursuit of Happiness (positive feedback)”] as innate to all forms of life, from single-cell organisms to complex animals and humans. These bio-primitives, or innate rights, are based on the axiomatic logic that life must have freedom within its domain in the pursuit of survival; otherwise, there is no life.... this principle can be applied to human societies and the evolution of ethical and moral systems. In order for society to evolve and progress, there should be some dynamic striving for balance between opposing forces such as individual freedom and social responsibility, innovation and tradition, and tolerance and justice...from a biological perspective, we can see these rights as a reflection of the basic needs of all living things (pp.30-34). In the chapter “Constructal Law,” Takac demonstrates a one-to-one mapping between the Constructal Law and the axiom of innate rights—or life’s bio-primitives—based on the principle of symmetry. (p. 42)

At its core, the book posits that the Constructal Law - a principle governing the flow configurations that evolve to facilitate movement - has profound implications for understanding not only physical systems but also social systems. This perspective offers a radical yet intellectually grounded way to view evolution as a unifying force that transcends traditional boundaries. By examining the interplay between the physical and social domains through the lens of CL, readers are invited to see patterns where they may have previously perceived chaos and to discern order in complexity.

The volume also explores multidimensional nature of CL. The journey begins with the philosophy of natural law and transitions into the physical realm, guided by the fundamentals of CL as it

applies to the natural world: how rivers carve their paths, how trees branch, and how life forms modify their structures to improve energy flow towards its currents. From there, the narrative seamlessly transitions into the social domain, revealing how these same principles manifest in human systems such as governance, education, and economics. The parallels drawn between the physical and social realms are both striking and thought-provoking, challenging readers to rethink long-held assumptions about the nature of evolution and progress. In the realm of social systems, the book offers ground-breaking insights into the dynamics of human behaviour and societal evolution. From the meticulous study of dendritic patterns in nature to the philosophical implications of CL for human values and ethics, the narrative is both intellectually rigorous and deeply engaging. It explores how CL underpins the flow of ideas, the development of cultures, and the progression of governance structures—not globalism, which represents an entirely different concept. For instance, the book examines how information flows within societies, drawing parallels between neural networks in the brain and communication networks in human communities. This analogy highlights the universality of CL as a principle that transcends the boundaries of biology, physics, and sociology, offering a unifying framework for understanding the complexities of life.

The implications of these insights are far-reaching, extending to areas as diverse as education, environmental sustainability, and governance. By applying the principles of CL to these domains, the book suggests innovative approaches to addressing some of the most pressing challenges of our time. For example, it explores how fostering greater alignment between natural flow patterns and human-designed systems can lead to more sustainable and equitable solutions. This vision of harmony between the physical and social realms is both aspirational and achievable, providing a roadmap for a future where progress is guided by the pedagogic currents of nature. As readers progress through the book, they are introduced to a series of revelations that challenge conventional thinking and inspire a paradigm shift in understanding. The



exploration of CL as a unifying principle opens new vistas of knowledge, pushing the boundaries of perception and inviting readers to embrace a more holistic view of evolution. This journey of intellectual enlightenment is not merely an academic exercise but a call to action—an invitation to join the ranks of those who dare to challenge the status quo and envision a future where humanity thrives in harmony with the physical laws of the universe.

The volume also succeeds in balancing the scientific rigor with accessibility. While the concepts explored are profound and complex, the author's clear and engaging prose makes them accessible to a wide audience. Whether you are a scientist, a philosopher, or simply someone with a curiosity about the world, this book offers insights that will resonate and inspire. The narrative is enriched with vivid examples and thought-provoking analogies, bringing abstract concepts to life and making the exploration of CL an immersive and rewarding experience. Besides, science, medicine, food, and agriculture which have progressed astonishingly in the last two centuries, technology has profoundly transformed the globe by facilitating the unrestricted interchange of ideas. The emergence of the internet facilitates effortless access to information, the interchange of ideas, and connections with individuals who possess both similar and unique interests. The worldwide internet has transformed social dynamics, enabling unprecedented communication and collaboration. While humanity awaits the ethical maturity of AI in modelling consciousness—or something resembling it—we can begin the journey toward global civility at the individual level. This can be achieved through the ethical application of the physical Constructal Law in our social interactions, both online and offline. By fostering civility within our families, neighbourhoods, classrooms, social groups, and workplaces, we contribute to a collective pursuit of happiness and a more harmonious society.

Beyond its intellectual appeal, the book possesses a deeply humanistic dimension. By emphasizing the ethical implications of CL and its potential to shape human values, it underscores the vital

role of civility and cooperation in the evolution of societies. The narrative challenges readers to reflect on how the principles of CL can be applied to foster greater understanding, empathy, and collaboration across cultural and ideological divides. This vision of global civility, grounded in the universal language of physical laws, is both timely and transformative. It offers a beacon of hope in an increasingly complex and interconnected world, inspiring a profound shift in perspective as readers explore the far-reaching implications of the physical Constructal Law across various domains.

This exploration resonates uniquely with each reader, subtly transforming their worldview. Subconsciously, you’ll begin to see the social domain through the lens of nature’s omnipotent forces. This newfound perspective is poised to positively influence your life, shaping your interactions with others and contributing meaningfully to the broader path toward global civility. Starting from the matrix of the physical laws of nature to Artificial Intelligence, this book is not just a journey of discovery but an invitation to engage with the mysteries of existence in a profound and meaningful way. It offers a fresh perspective on the interconnectedness of the physical and social domains, challenging readers to rethink their assumptions and embrace a more holistic understanding of evolution. With its blend of scientific insight, philosophical depth, and humanistic vision, the book is a must-read for anyone seeking to expand their horizons and explore the limitless possibilities of human knowledge. Whether you are a seasoned scholar or a curious novice, this book will leave you inspired, enlightened, and eager to explore the fascinating world through the lens of the Constructal Law - so powerful and elegant, so ancient and vast, yet so simple and profound -guiding the flow of evolution across all domains and shaping its implications for humanity. By harnessing the power of advanced algorithms and machine learning towards consciousness, we may find new ways to analyse complex data, predict outcomes, and improve systems, in part through the ethical application of the physical constructal law. And on the horizon is a new “language of calculation,” not one

with only mathematical symbols but a calculated language in all its forms: linguistic, art, music, poetry, and so on, guiding humanity while changing the way we understand and interact with the world and humanity. Through generations, this concerted effort will propel us toward the zenith of “Global Civility,” where the essence of deterministic freedom blooms anew, transcending boundaries and guiding humanity to unprecedented heights. Hence, the solution is at hand. Will humanity take the “red pill,” or the “blue pill”? (pp. 217-219).

### **The questions before CL**

However, while the CL focuses on efficiency and access in physical and flow systems, it lacks prescriptive power for resolving normative questions of right and wrong. “When analysing the constructal applications in detail, we have found that there are significant problems, which show clearly that the constructal theory is questionable” (Cheng, 2019). It does not address social issues and subjective dimensions of morality, such as empathy, justice, and ethical reasoning, which cannot be reduced to flow optimization. For instance, every single religion is created by humans. Every one of those ‘truths’ is created by humans. The consequent moral code is therefore entirely dependent on the principles of each religion, separately, not likely to be always compatible... CL does not change this state of affairs. Whatever ‘flow’ you think should happen; it may very well not happen as you expect. Conflicts, driven by power dynamics, cultural differences, or ideological clashes, cannot be solely explained or resolved by flow optimization patterns... About ethical codes what it claims is naturally and universally moral, part of our universal ‘unalienable rights’, in contrast the claim of others is sinful and depraved (Manfredi, 2024). The law also fails to address the subjective dimension of human values, such as freedom, equity, or dignity, which are tied to human ideals and philosophical traditions. “A value could be objective, and thus beyond mere human opinion, yet not universal. It may be that moral values have evolved for their survival value, being instilled by evolution, and are thus objective, not being derived from human opinion or

knowledge” (Thakur, 2024). Analogical overreach risks overgeneralization, as it may oversimplify human agency and ethical considerations. Although, the Constructal Law offers profound insights into the evolution of physical and social systems but is inherently limited in its ability to grapple with normative questions of morality, human conflict, and values. Reason being, the moral code will redirect that ‘flow’. It is difficult to find uniform patterns universally in human nature, behaviours and cultures. While universal morality may smoothen the conflicting zones of thought it doesn’t provide solid solutions like constructal laws do in physics (Thakur, 2024).

## Conclusions

There is a risk of oversimplification when applying a physical principle to complicated human systems, which is known as reductionism. It is improbable to model human affairs using a mechanistic approach since they involve cultural, ethical, and psychological components. The constructivist legal theory does not inherently provide normative solutions, despite the fact that it describes systemic behaviours. The Constructal Law does not prescribe an ‘ideal governance structure’, rather it evaluates existing structures as a function of civility. When it comes to matters of ethics, the justification of governance or policy decisions solely based on flow efficiency has the potential to marginalize equality and justice issues, particularly in societies that are diverse. For the purpose of comprehending the development and dynamics of human systems, CL provides a convincing framework. Providing a scientific foundation for the analysis of systemic behaviours, it places an emphasis on the significance of flow efficiency in governance, economics, and conflicts. However, in order to avoid deterministic traps, its use needs to take into account the ethical and complicated aspects of human affairs. As a conceptual instrument, it contributes to the enrichment of multidisciplinary conversation; yet, in order to address issues that are relevant to the real world, its practical efficacy requires careful calibration. Therefore, philosophy feels indebted to A. Bejan, and other CL theorists especially Michael T. Takac for approaching the

human questions so rationally, scientifically and more importantly so sensibly.

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