



Manan Sharma

M. Des. Student, IDC School of Design, Indian Institute of Technology Bombay

LAWS OF SCIENCE AS A DESIGN DRIVER

Manan Sharma¹, Sugandh Malhotra², Lalit Kumar Das³

¹M. Des. Student, IDC School of Design, Indian Institute of Technology Bombay

²Associate Professor, IDC School of Design, Indian Institute of Technology Bombay

³Ex-Head, IDDC, Indian Institute of Technology Delhi

Abstract

This research paper delves into the concept of "laws of science as design drivers" and explores its significance in both the man-made and natural world. By examining the fundamental principles that govern the universe, we can uncover how these laws have shaped and influenced the design of objects, structures, and systems in human civilization. Moreover, we investigate the manifestation of these laws in the natural world, where they have led to the development of complex ecosystems, geological formations, and celestial phenomena.

Furthermore, this paper analyzes the impact of laws of science in extended time and space. By examining the evolution of the universe, geological processes, and the long-term behavior of ecological systems, we gain insights into how these laws have shaped the world over vast temporal and spatial scales. The findings highlight the inherent relationship between scientific principles and design, shedding light on the interconnectedness between scientific understanding, natural phenomena, and human creativity.

Key Words: *Science Law, Design driver, Nature, Human Creativity, Future.*

Introduction

In 1665, a young Isaac Newton observed an apple fall from a tree. That made him question why the apple fell straight down, instead of sideways or upwards. He observed the moon as a point of reference, and how the moon doesn't fall similarly to the apple. These observations, along with a point of reference, the moon, helped him deduce the theory of gravitational force. After deducing the theory, it was subjected to experimentation. The results convincingly proved his explanation and assumptions, and thus, it became a law, and gravity was discovered.

Hence, the law is a summary of theory after experimentation. The laws of science are what define the basic principle, manufacturing and functioning of every single product or daily object that we interact with. If these laws aren't considered, several products designed to make our everyday life easier will fail to work. Laws of science govern the creation, sustenance and destruction of all matter in the known universe. Many laws that we use today have existed in nature for the past millions of years. The evolution and adaptation of each and every organism on this planet are based around the laws of science.

Meaning of the design driver

'Scientific laws or laws of science are statements, based on repeated experiments or observations that describe or predict a range of natural phenomena.'

Laws of science embody themselves in the simplest of products or activities that we perform in our day-to-day lives. Even a simple paper plane, a simple construct past time in our childhood, works

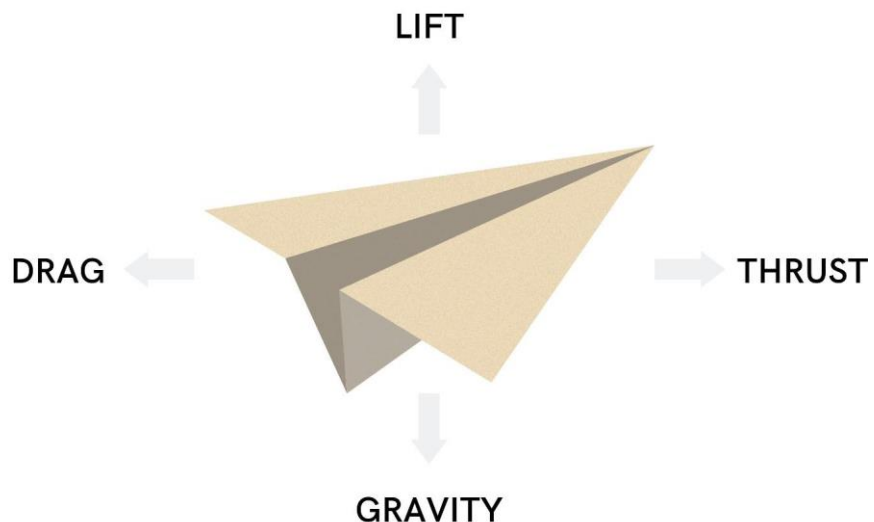
on complex scientific laws of gravity and aerodynamics to function as intended. Even with our layman's knowledge and understanding of scientific laws, we, as children, attempted to create farther-flying and faster iterations of paper planes. As our understanding of these scientific laws gains more depth, we apply these to create better and better products and break further thresholds. Along with their manifestation in the man-made world, these scientific laws have manifested themselves in the natural world ever since its creation. These laws have dictated the transformation and evolution of all matter and species as we know it. We shall discuss this manifestation through four different forces and scientific laws acting on a paper plane, namely - Gravity, lift, thrust and drag.

Manifestation in the man-made world

Laws of science are visible all around us. Over the past centuries,



Basic forces acting on a paper plane - Thrust, Drag, Gravity and Lift



these laws have influenced the design of objects and products that we see and use in our day-to-day lives. Not only have they helped us invent newer technologies, but it has also helped mankind in developing further and raising the bar to achieve newer possibilities.

Since automobiles were developed, manufacturers have pushed the boundaries of material science and manufacturing capabilities to pack the maximum safety, technologies and performance in the most efficient and lightest chassis/frame possible. From using materials like stainless steel, we have progressed to aluminium, magnesium alloys and carbon fibre. The shape of automobiles has also seen a drastic transition based on weight-distribution, momentum and aerodynamics, all in the chase of performance and efficiency. Similarly, Newton's laws of motion have been instrumental in developing several safety technologies. The seat belt was designed to absorb the momentum of the human body in the event of a crash.

Taking this concept one step further, airbags provide a cushion for a slow deceleration and transfer of momentum to prevent any shocks or injuries to the human body. Combined, these provide a vital safety net. Our greater understanding of the laws of lift and aerodynamics has also helped us manipulate these factors and forces to create greater functionality, as seen in the F-14 Tomcat combat aircraft.



Change in vehicle form to reduce drag



Manipulation of aero and lift

Earlier aeroplanes relied on thrust from rotors and a hefty, bulky build to transport humans from one place to another. When we built

upon the concepts and laws of motion and aerodynamics, planes became more and more streamlined, and efficient, and rotor-propulsion was replaced with a much more powerful and efficient jet propulsion. These concepts have been fine-tuned to reach the pinnacle of air travel in the form of fighter planes and the Blackbird, a jet plane capable of reaching speeds of up to Mach 10. Our understanding of gravitational laws, along with material/weight saving, has helped us develop innovative and efficient housing/roofing methods. The fuller geodesic dome utilizes hexagonal elements to distribute weight evenly among all its members to provide unrivalled material and weight saving as compared to concrete roofing methods.



Development and transition to cleaner, more efficient propulsion methods

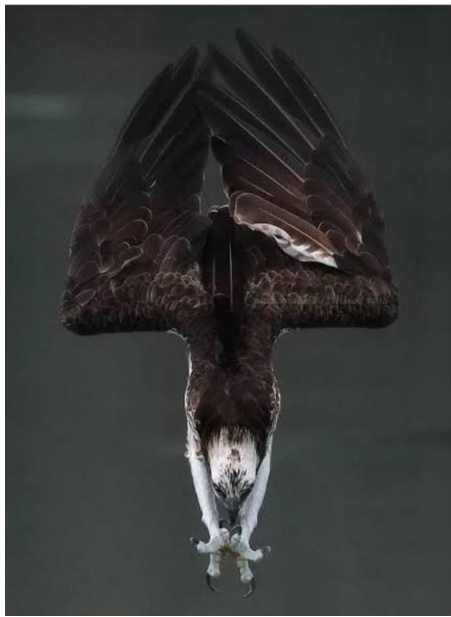


Fuller geodesic dome - A material and weight efficient roofing method

Manifestation in the natural world

In the natural world, laws and concepts of science can be identified in how animals have evolved over millions of years. Several species have developed body features and mannerisms that help them survive or adapt better to their habitat. The concepts of thermodynamics and insulation are seen very frequently in nature, especially in mammals. Several animals make use of several layers of thick fur to trap body heat and prevent themselves from cold surroundings. Birds and other species with the ability to fly are

some of the most complex and scientifically evolved species. Birds use a combination of thrust and Bernoulli's principle through the flapping motion of their wings, which helps them generate flight. In addition to this, their hollow bones allow significant weight saving, and aerodynamics/streamlined shape only enhances their capabilities. Birds like sea hawks can transform into extremely aerodynamic shapes to enhance their hunting abilities.



A sea hawk hunting for prey



Manipulation of aero and lift

Efficient methods of propulsion can be seen in various forms of aquatic life. Propeller-like motion is observed in fishes, the only difference being that the flexibility and curvature of their fins provide much more efficient propulsion than achieved by mankind. Examples of jet propulsion are seen in some squids, which use a jet of water to propel themselves forward.

Examples of material saving and efficient construction are seen in the case of honeycombs. These examples indicate that a significant part of our understanding and discovery of scientific laws comes from the observation of their application in nature.



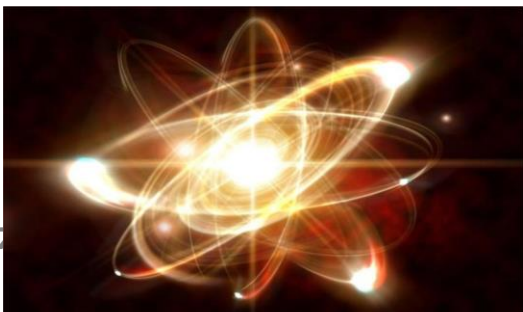
Propulsion in aquatic life



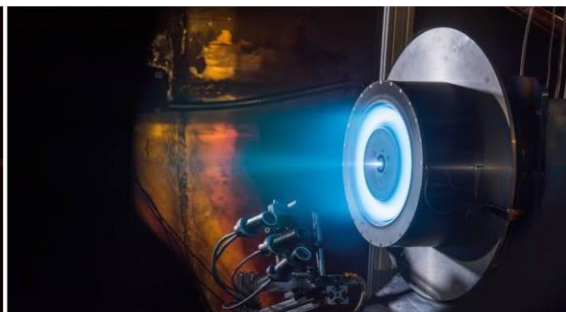
Weight distribution and material saving in nature

Impact in extended space and time - Future scenarios and conclusion

While the advancements made by scientists and mankind in the field of science are noteworthy and have changed the course of human history, there are still a lot of unknowns out there. For years scientists and astronomers have been trying to figure out what lies beyond the event horizon, the existence of life beyond Earth, the very creation of our universe as we know it, and even the theory of multiverses. As science moves forward and we discover and unearth more and more laws and secrets of our universe, we might use energy and our resources in a much more efficient manner. The constant work being done on achieving nuclear fusion and NASA's SEP can provide us with means of ultra-efficient, unlimited sources of energy.



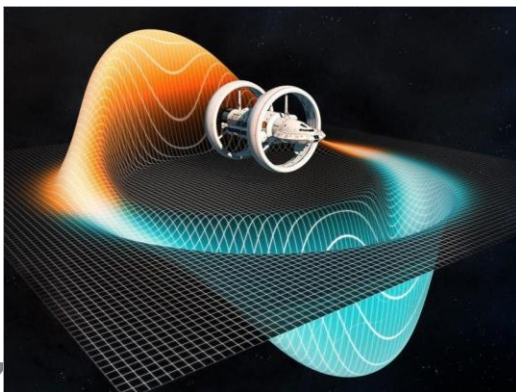
Nuclear Fusion



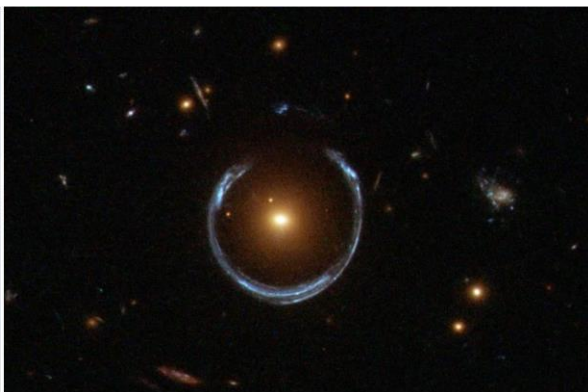
NASA's SEP - Solar electric propulsion

Advancements in the artificial creation of nuclear fusion will solve the world's energy crisis. Newton's laws of motion state that every action has an equal and opposite reaction. We might develop a new, more efficient way of burning fuel that creates greater amounts of thrust, hence propelling us to supersonic or even light speed. As we develop science in higher dimensions, we might be able to harness time and gravity and utilize them to create wormholes for intergalactic and interstellar travel. Matter and our reality as we know it makes up only 5% of our universe. 'Dark energy' and 'Dark matter' make up about 68.3% and 26% of our universe, respectively, and are conceptualized as the 5th fundamental force. Dark energy and dark matter have the strength to drive the universe apart and bring it closer and, if harnessed, can help us achieve intergalactic travel with ease. As dark matter interacts with gravity to cause various phenomena

like gravitational lensing, harnessing dark matter will lead to the harnessing of gravity itself. This might help us develop anti-gravity, which can be another propulsion for future human races. Anti-gravity can help us develop moveable settlements and inter-galactic modes of travel like warp drive, which can help mankind to live in favourable conditions all year round, instead of staying stationary in one region and experiencing the entire seasonal cycle.



Warp Drive



Dark Matter - Gravitational Lensing

A significant amount of our understanding of the future and expectations of scientific advancements comes from science fiction. Visionaries such as the creators of sci-fi genres like Total Recall (1990), Star Trek (1966), and Star Wars (!977) have given us several ideas like the first flip phone, AI/self-driven vehicles, Holographic technologies etc. Similarly, science fiction and conspiracy theories of today, like UFOs, warp drive, and extraterrestrial settlements, give us an idea and a sense of direction where scientific laws and design can lead us to.

References

- **Livescience, "What is a law in science?"**,
<https://www.livescience.com/21457-what-is-a-law-in-science-definition-of-scientific-law.html>
- **National Geographic, "Isaac Newton: Who he was, why apples are falling"**,
<https://education.nationalgeographic.org/resource/isaac-newton-who-he-was-why-apples-are-falling>
- **Wikipedia, "Grumman F-14 Tomcat"**,
https://en.wikipedia.org/wiki/Grumman_F-14_Tomcat
- **Youtube, "WIRED - Aerodynamics explained by a world record paper airplane designer"**,
https://www.youtube.com/watch?v=3KqjRPV9_PY&t=13s
- **2-10, "The Pros and Cons of Geodesic dome homes"**,
<https://www.2-10.com/blog/the-pros-and-cons-of-geodesic-home-homes/>
- **Wikipedia, "Geodesic Dome"**,
https://en.wikipedia.org/wiki/Geodesic_dome
- **Wikipedia' "Aquatic Locomotion"**,
https://en.wikipedia.org/wiki/Aquatic_locomotion#:~:text=Aquatic%20locomotion%20or%20swimming%20is,reptiles%2C%20birds%2C%20and%20mammals.
- **BirdNote, "What is a sea hawk"**,
<https://www.birdnote.org/explore/field->

[notes/2014/01/what-seahawk](#)

- **National Geographic, "Many scientists see fusion as the future of energy", <https://www.nationalgeographic.co.uk/science-and-technology/2022/10/many-scientists-see-fusion-as-the-future-of-energy-and-theyre-betting-big#:~:text=In%20October%202021%2C%20the%20Department,of%20current%20nuclear%20power%20stations.>**

- **Nasa, "Solar Electric Propulsion (SEP)", https://www.nasa.gov/mission_pages/tdm/sep/index.html**

- **Wikipedia, "Warp Drive", https://en.wikipedia.org/wiki/Warp_drive**

- **ESA/Hubble, "Gravitational Lensing", <https://esahubble.org/wordbank/gravitational-lensing/#:~:text=Gravitational%20lensing%20occurs%20when%20a,accordingly%20called%20a%20gravitational%20lens.>**

- **MICRON, "Future Shock: 11 Real-Life Technologies That Science Fiction Predicted", <https://in.micron.com/insight/future-shock-11-real-life-technologies-that-science-fiction-predicted>**