

# CHAPTER 1

## INTRODUCTION

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### 1.1. Background

Nature is by far the most complex system known to humans. Its scale and diversity are beyond human measure at both micro and macro levels. A paradox of Nature is that in its complexity lies an innate simplicity. The natural world is flexible and diverse. It is dynamic and self-regulating. It adheres to a set of natural laws that govern the existence and behavior of everything in it.

Though Nature is vast and intricate, yet it is not superfluous. There is intent in every design of Nature. *Everything has a purpose and is uniquely designed to fulfill that purpose.* Bersan [41] describes how simplicity is the guiding principle of designs of Nature. According to him Nature “achieves simplicity in a demanding way by always acknowledging the complexity of the purpose at hand, whether in one single organism or in the interplay between a multitude of living species in a habitat.” All areas of science are focused on studying the intricacies of the natural world, and harnessing it wherever possible. People have been turning to Nature for inspiration to help them solve problems for millions of years.

Many great designers derive their inspiration from Nature, and we can find lots of examples showcasing this type of inspiration. From buildings and bridges to materials and medicine – examining the design of Nature has aided in the development of almost every aspect of our lives, and most of us – often without realizing – benefit from these inspired revelations several times a day. For example, the tread on the bottom of our shoes is based on the design of dog’s paw [83]. Also some types of car tyres are based on the feet of tree frogs, which are able to grip slippery surface without falling [42]. Even the computers are inspired from Natures’ creation. The technology which stores programming information in the hard drive is based on the structure of DNA that carries the coding for every feature of plants, animals and humans [83]. However, looking at the world we live in and finding a way to incorporate it into a design requires seeking Nature from a new and very different perspective. *This concept is most commonly known as bio-mimicry, and is an incredible testament of Nature’s superior creation. Bio-mimicry is a way of designing*

that asks 'How Nature does it?'[37]. Creatures on earth have spent millions of years perfecting their craft in ways that are inherently sustainable. The ones that go wrong are extinct. Designers, scientists, and engineers continue to study the complex structures found in Nature to create greener and more efficient products and process for our homes and lives. So Far, the Bio-mimicry has mainly been applied in the field of Engineering and Technology such as product design, manufacturing, green chemistry, structural planning and architecture.

A lot of research has been recorded in universities and corporate laboratories mainly in the field of robotics and material science [142]. However, Nature's wisdom is not limited to these fields. *A business organization operating in a dynamic environment can also emulate Nature's principles. They can also learn and derive solutions to most of their routine conflicts and dilemmas and untraditional problems, from the principles and systems observed in Nature.* Nature's perfection can inspire and inform organizational transformation. This gives us an opportunity to analyze and understand the perfections in Nature's design and operation that could serve as the base for providing solutions to management problems.

## **1.2. Preliminary View of the Problem**

A business organization is a man-made system which has a dynamic interaction with its environment—customers, competitors, labor organizations, suppliers, government, and many other agencies. Besides, the business organization is composed of interrelated sub-systems working in a coordinated manner to accomplish a number of goals of both; organization and its constituent parts. This description parallels that of open systems in general which despite of dynamic exchange of matter and energy reaches a state of dynamic equilibrium within it. Moreover, the systems within which businesses are operating are necessarily complex. They face complex, new and interrelated challenges irrespective of the kind and size of organizations. These challenges include globalization, financial crisis, shifting workforce demographics, strategies to adapt change, organizational redesign, workforce productivity, new management paradigms, effective project and operations management and being able to manage oneself. Such challenges are forcing managers to become proactive as the policies, procedures and intellectual approaches of the past may no longer be viable. All together, these global, industry and organizational forces

impel people to explore radically new approaches. They create an opening for new thinking. It reflects an 'end of the rope' perspective and the invitation to truly reinvent business and our world in a very broad based, holistic way.

Given the global challenges and the growing realization that 'business as usual' is not a tenable model, management via systems concepts fosters a new way of thinking which not only helps to dissolve some of the complexity but also helps the manager to analyze the complex problems and thereby operate within the perceived environment. Therefore, attention has been focused more and more on over-all systems as frame of reference for analytical work in various areas. For this purpose, existing similarities in the theoretical construction of various disciplines can be pointed out. Models can be developed which have applicability to many fields of study. In this regard, there has been some development of interdisciplinary studies. Areas such as social psychology, biochemistry, astrophysics, social anthropology, economic psychology, and economic sociology have been developed to highlight the interrelationships of previously isolated disciplines. In fact, areas of study and research have been developed wherein numerous subfields were interrelated. For example, cybernetics, the science of communication and control, calls on electrical engineering, neurophysiology, physics, biology, and other fields. Operations research is another discipline which calls on numerous subfields. Organization theory comprises economics, sociology, engineering, psychology, physiology, and anthropology. Problem solving and decision making are the key reasons for organizational study and research, which demands drawing on numerous disciplines for development of an over-all framework as a reference.

Interestingly, an ideal discipline to emulate is around us only i.e. the Nature. Nature has been dealing with dynamic change for more than 3.8 billion years, and more we explore Nature's ways the more we find inspiration for operating in a dynamically changing environment. In this regard, Ludwig von Bertalanffy emphasized that an organism is also an open system which maintains a constant state while matter and energy which enter it keep changing (so-called dynamic equilibrium) [177]. The organism is influenced by, and influences, its environment and reaches a state of dynamic equilibrium in this environment. Such a description of a system adequately fits the typical business organization. *In fact, in this regard human body, the Nature's perfect creation can also be visualized as an organization*

*surviving in complex and dynamically changing condition.* Detailed comparison of human body and business organization from open system perspective are compiled in Table 1.1.

Moreover, a common analogy is the comparison of the organization with the human body, in which the skeletal and muscle systems represent the operating line elements and the circulatory system as a necessary staff function. The nervous system is the communication system. The brain symbolizes top-level management, or the executive committee. Such an analysis hints at the type of framework which would be useful as a systems theory for business—one which is developed as a system of systems and that can focus attention at the proper points in the organization for design of management planning and decision making system, control system, both from the standpoint of the individual and the organization.

Nevertheless, many designs and ideas inspired by Nature have led to dramatic product innovations. But a very limited research has been done where bio-mimicry and Nature's principles have been applied at the business process level, i.e. giving solutions to problems of running business in a meaningful way. Therefore, in this Thesis, endeavor is made to explore the natural processes and managerial principles found in the Nature's best creation, i.e. the human body and to a limited extent from other creations as well. These processes will be used to learn about improvements in the design and functions of a business organization. By mimicking a variety of elements in the Nature's creations, the resulting philosophy may not only respond to various activities within the organization but also to the surrounding environment.

Table 1.1: Similarities between human body and business organization from open systems perspective

<b>Elements for comparison</b>	<b>Human Body</b>	<b>Organization</b>
<b>Open system</b>	Human Body is continuously affected by external environment, e.g. exposure to cold temperature (an external factor) tends to reduce body's internal temperature.	Organizations are always influenced by the external factors like what customers want, what the competitors are doing, how technology is changing which directly influences the competitive position of the organization. [258].
<b>Interacts with external environment</b>	Human Body continuously interacts with external environment by exchanging resources, information etc. such as we require oxygen for sustaining the system and eliminating some undesirable products like carbon-dioxide, into the environment.	As an open system corporate organizations interacts with their environment as: a) the environment provides resources that an organization needs in order to create goods and services, b) the environment is a source of opportunities and threats for an organization.
<b>Composed of sub-systems</b>	Human body system is composed of many sub systems like digestive, circulatory, nervous, muscular system etc. [294]. Although various different human organ systems are often studied as separate entities but in reality they all interact with each other and work together to keep the human body functioning in a normal and healthy fashion.	In an organization system, there are various ways of classifying subsystems. Each unit of the organization, as such, is a subsystem. For example, Seiler has identified four components in an organization system. These are social, human, technical and organizational subsystems [329].

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<b>Elements for comparison</b>	<b>Human Body</b>	<b>Organization</b>
<b>Open System follow the cycle of input-throughput-output,</b>	1. Inhales oxygen out of the environment and exhales carbon dioxide into the environment. 2. Consumes food, breaking it into energy and after absorbing, expels wastes. 3. Senses stimuli within internal and external environment and produces appropriate response.	The business organization takes capital from the external environment, converts it into products and services that are marketed and sold, the revenue from the sales are then used to turn out further products and services and so forth. E.g. a manufacturing system accepts raw material as inputs and produces finished goods as output [236].
<b>System Boundaries</b>	Skin acts a boundary in human body which is selectively permeable and allows interaction with the external environment to maintain equilibrium.  Permeability is essential as human Body needs infusion of energy and other resources to survive like new blood, nutrients, oxygen etc.	Organizations also have boundaries that distinguish it from external environment. It has a permeable boundary that allows information, products, human and other resources to move in and out of the organization.  To survive and grow competitively, organizations need infusion of new ideas, information, skills and resources

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<b>Elements for comparison</b>	<b>Human Body</b>	<b>Organization</b>
<b>Interactive and interrelated subsystems</b>	Complex interactions within the various sub-systems can be seen in human body, for instance, there is a close and important working relationship between the nervous system and the endocrine system; this specialized subsystem is called neuro-endocrine system.	Each sub-system like HR, Marketing, and Finance represents an interactive function that together connects management processes and their communication channels [388]. Some of these may be structural components such as information, authority delegation, and so on. Others may be behavioral or cultural factors such as motivating behavior or building the right values. These systems are interrelated which means that we must design each one recognizing its impact on the other components. E.g. we must consider how information will impact human behavior and vice versa.
<b>Operates in dynamically changing environment</b>	Human body is operating in dynamically changing environment as it has to face changing conditions like temperature, humidity and other conditions.	The organization has to face changing external conditions like government policies, technological up gradation, competitors moves, customer tastes etc.
<b>Hierarchy</b>	Hierarchy exists in our body wherein cells are at the bottom and organ systems are at the top, and comprising tissues, organs, in between.	Hierarchy exists in the form of scalar chain

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<b>Elements for comparison</b>	<b>Human Body</b>	<b>Organization</b>
<b>Dynamic Equilibrium</b>	Human body exists in a dynamic or ever changing external environment. In order to survive it has to maintain stable internal physiological environment. Homeostasis is the process of maintaining a relatively constant internal physiological environment despite changing external conditions. Homeostasis in body regulates blood pressure, sugar level, temperature etc, to maintain balance.	No environment is stable over time as new competitors may enter the market, population, economy may change either positively or negatively. All such conditions distort the external environment from its original state. Therefore, organizations have to keep themselves alert to external impacts and consider them while making response strategies to maintain the balance state.
<b>Network of Flows</b>	Network of blood flow, oxygen flow, protein flow, hormones etc which is regulated by circulatory, respiratory, lymphatic, endocrine system respectively. In fact the flow of stimuli through reflexes is also part of this network.	Organizational network of flows includes information, orders, delegation, materials, money etc.

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<b>Elements for comparison</b>	<b>Human Body</b>	<b>Organization</b>
<b>Communication system</b>	Internal and external communication is taken care by nervous system through network of nerve cells along with endocrine system. Another way to understand it is Autocrine, Paracrine, and Endocrine Signaling	Internal communication within an organization can be upward & downward (Intradepartmental) or lateral (Interdepartmental). Organization also communicates with external bodies like vendors (through purchase department), competitors and customers (through marketing research and sales department).
<b>Synergism</b>	Synergetic effect can be seen in neuro-endocrine system, working of cells and among other sub-systems. They are working for their own individual interest that are general for others and activity of others as a whole.	Organizational sub-units often can be more successful together than working alone, as specialization and experience of others can be used.

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<b>Elements for comparison</b>	<b>Human Body</b>	<b>Organization</b>
<b>Holistic</b>	<p>Perfection in human body is contributed to its various sub-systems working in harmony with each other. Also, our body as a whole determines how our individual parts would function rather than vice-versa. But functioning of an individual organ affects the overall health. This would mean that to understand the functioning of human body, one need to study and try to understand the body as a whole and not just focus on one single organ, part or a subsystem.</p>	<p>Overall efficiency of an organization depends on quantity and quality of the interaction among the various sub-systems. Holism approaches an organization in totality with its environment including suppliers, customers and competitors. It analyzes the interaction between the whole organization and the external environment.</p>

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<b>Elements for comparison</b>	<b>Human Body</b>	<b>Organization</b>
<b>Feedback</b>	Feedback involves a cycle in which the output of a system 'feedback' to either modify or reinforce the action taken by the system. Positive feedback refers to a process where a reaction contributes to its own propagation e.g. formation of blood clot to inhibit blood flow while in negative feedback the end product of a reaction inhibits the propagation of that reaction e.g. body temperature control. In human body both types of feedback systems i.e. positive and negative exists.	An organization has to sustain (survival) and develop (growth) through constant communication and interaction (feedback). Many companies constantly gather feedback from customers. They analyze this feedback to determine if they are meeting the needs of their customers, and what they can do better. They then combine their findings with data about consumer trends. Based on the results of the feedback and trend analysis, the company may decide to make product improvements. Thus, the company has changed its product (one component of the marketing mix) in reaction to environmental changes.
<b>Multiple goal seeking</b>	Human Body as a system has many subsystems for achieving different goals. Every subsystem of the human system has a role to play in making the whole body work efficiently.	Overall organizational objective is divided into several goals, each performed by separate subsystems. Moreover to achieve organizational success all individual goals have to be achieved.

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<b>Elements for comparison</b>	<b>Human Body</b>	<b>Organization</b>
<b>Equifinality</b>	The concept of equifinality can also be seen in human body wherein there are multiple ways of achieving a goal. For example, when external temperature reduces, various efforts like shivering, contraction of blood vessels for conservation of energy; are put in by the body to achieve the goal of healthy survival.	It recognizes that many different designs for a management control system can lead to the same end result. For example, the productivity of a worker is not only affected by how a task is designed, but it is also affected by the social environment in which he or she works. Therefore, increase in worker productivity can be achieved by redesigning the task or by redesigning the social system within which the worker is operating. [11]

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<b>Elements for comparison</b>	<b>Human Body</b>	<b>Organization</b>
<b>Negative entropy</b>	<p>In human body, disease is an expression of increased entropy; in fact, a new definition of disease is failure to maintain low entropy. Entropy is favorable when chaos within the DNA informational molecule results in mutations (or self-organization, self-repair) that allows life to survive when the environment changes. Entropy is also unfavorable causing disease and individual lives to decay. Life has to combat entropy to maintain health. An unhealthy body can regain health; thus entropy can reduce.</p>	<p>For example, for survival to be ensured, the organization must import more energy from its external environment than it uses. Thus there is extremely important need for any organization to monitor and take energy from its marketplace, whether for profit or not for profit. Thus a disorderly organization can become orderly reduced entropy.</p>

### **1.3. Preliminary definition of the proposed research problem**

The aforementioned discussion leads to the following preliminary definition of the research problem:

*Studying the design and operation of various systems and subsystems of human body and Natures other creations by establishing one to one parallels, to derive managerial insights which may be valuable for the organization in significantly improving their structure and operating procedures in order to enhance the performance of individuals and organization as a whole.*

### **1.4. Research issues**

Apparently, the following issues seem to be relevant:

- a) Explore human body systems and subsystems considering it as a perfect creation of Nature.
- b) Investigate human body as a metaphor of an organization.
- c) Identify parallels between the human body and an organization in terms of planning, organizing, directing and controlling.
- d) Seek specific human body systems and sub-systems that are better managed than an organization.
- e) Explore the processes and causal mechanism because of which the human body is so optimally managed.
- f) Propose a model which can be referred by businesses in management of various issues.
- g) Gain managerial insights from human body organization for better management of a business organization.
- h) Seek reverse learnings from organizational and systems theories towards better management of human body.
- i) Seek managerial learnings from Nature's other biological creations as well

The present research is undertaken to address these issues. Literature relevant to these issues is reported in chapter 2 of this Thesis.

## **1.5. Organization of the report**

The Thesis comprises of eleven chapters which are briefly described as below:

### **Chapter 1: Introduction**

This chapter presents basic background and a preliminary view of the research, key research issues, broad concepts and definitions.

### **Chapter 2: Literature review**

A review of literature is presented in this chapter under three separate sections covering a) evolution of the concept, b) biologically inspired technology and mechanisms and c) few studies carried out on application of bio-mimicry in business management. The research gaps in the existing literature are also identified primarily in the domain of management of organizations using bio-inspired models.

### **Chapter 3: Research design**

In this chapter research problem is defined based on gaps in the literature. Specific research objectives are also stated along with the overview of the general methodological approach, tools and techniques proposed to be followed.

### **Chapter 4: Modeling human body organization using analogy approach, SAP-LAP analysis, ISM and AHP**

This chapter partially contributes towards achievement of first three objectives of research study. This chapter begins with developing analogies between human body and corporate organization. Thereafter there is a section describing modeling process using SAP-LAP Analysis, ISM and AHP is there. Key managerial insights based on the model are also suggested.

### **Chapter 5: Developing a bio-inspired model of organizational excellence using analogy approach and Total Interpretive Structural Modeling (TISM)**

Key attributes of human body organization are identified in the beginning of this chapter. Subsequent sections describe modeling of these attributes using TISM.

### **Chapter 6: Validation of bio-inspired model of excellence using Structural Equation Modeling (SEM) and Analytic Hierarchic Process (AHP)**

In this chapter, validation of model is done using SEM and AHP. Application of the model in calculating organizational excellence score is given in the last section of the chapter. This chapter has a major contribution towards achievement of first three objectives of the research study undertaken.

### **Chapter 7: Bio-inspired model for understanding conflict in line and staff functions in organizations**

Literature pertaining to line and staff function is reviewed in beginning of the chapter. The enablers identified from the review are modeled using ISM in the subsequent section of the chapter. Specific observations based on the model are also highlighted in the later parts of this chapter. This chapter contributes towards second and third objectives.

### **Chapter 8: Bio-inspired performance management system**

This chapter contributes towards second and third objective of this research. The chapter begins with visualizing the human cell analogous to an employee in an organization. Next section of this chapter describes the cell suicide mechanism in the human body performance management system. Thereafter based on cell suicide mechanism a Performance Management Action Grid is proposed in next section, which can be insightful in evolving performance management system in organizations.

### **Chapter 9: Insights for inculcating optimal degree of flexibility inspired by human body**

The first section of this chapter will involve flexibility analysis of human body. In the subsequent sections a human body inspired 'flexibility valuation grid' is proposed to suggest optimal degree of flexibility in various parts of an organization.

## **Chapter 10: Muskmelon and orange organization: learning from nature on team work**

Similarities between high performance and pseudo team with muskmelon and orange fruit respectively are made in first section of this chapter. Subsequent sections are dedicated to explain the difference in the team spirit primarily on the structure of these two fruit. Analogy is further expanded in comparing the attributed of team work. Insights on the ways of encouraging team work based on the two fruits are also suggested in this chapter.

## **Chapter 11: Insights for better management of human body from management science principles: reverse learning**

This chapter is divided into two parts. The first part deals with deriving insights from Denison model of organization culture for improvising value system of an individual. The second part reports certain postulates after validation of Vrat's conjectures for managing human body food supply chain learning from the basic principles of supply chain management in organizations.

## **Chapter 12: Major Findings and Conclusions**

This chapter presents summary of major research findings and significant research contributions made. It also outlines the limitations of the study and possible extensions of the research with suggestions for future research efforts.

### **1.6. Concluding remarks**

This chapter was intended to present background of the research. The subsequent chapters will show a detailed account of key research done.