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Biomimetic Design Innovation from Red Sea Seashells: Leveraging Artificial Intelligence to Derive Functional and Aesthetic Product Formulas

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Abstract

This study focused on analysing the seashells and their elements in Saudi Arabia to understand their artistic and aesthetic characteristics. The objective was to use this knowledge as a basis for designing functional and utilitarian products and creating innovative local designs inspired by marine elements. Artificial intelligence programs were utilised to demonstrate various techniques and methods employed in designing functional products. The study aimed to emphasise the importance of extracting design formulas from seashells and enrich the theoretical understanding of the connection between nature, seashells, and design inspiration.

The seashells in Saudi Arabia have not received sufficient attention in both theoretical and applied research. There is an untapped potential of these elements as a valuable source of inspiration for product design, enriching designers' ideas, and enhancing the aesthetic and functional aspects of designs. The utilisation of artificial intelligence programs can play a crucial role in harnessing this potential.

In this study, ideas generated from a pilot experiment were used to create artistically designed utilitarian shoes for men, women and children, catering to various uses. Experts responded favourably to these products. Based on the findings, some recommendations have been made.

1 Introduction

Art is a continuous flow and creative activity that involves mimicking nature or utilising its materials. Artists diagnose and shape the elements of nature, drawing inspiration through visual expressions. They employ specific compositions, arrangements, and laws of growth to capture the aesthetic essence of nature. Through their artwork, they present their interpretation of nature to the public, encouraging interaction and enhancing our perception and reception of nature's messages.

Design, on the other hand, forms a structural system for organising and establishing relationships between elements and forms in its design framework. It results from technical

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and formal shaping processes such as repetition, overlap, intersection, adjacency, connection, and penetration. Design is a human endeavour and a stylistic approach within contemporary life, encompassing fields such as architecture, foundation, fabric, fashion design, and product design. Its ultimate goal is to achieve artistic values that manifest in a holistic outcome embodying aesthetic principles. (Bozar & Habiba, 2021).

The pursuit of visual pleasure and the stimulation of intellectual and experimental engagement are realised through design formulations grounded in proportional structural principles. These formulations employ techniques that resonate with design structures inspired by nature, reflecting its intrinsic eloquence and geometric harmony. The linear shaping of forms and the strategic application of colour play a pivotal role in constructing design elements, fostering a cohesive relationship between these elements and the foundational principles of natural design. This synergy extends to product design, where such integration enhances both the functional and aesthetic dimensions of the products, elevating their effectiveness and appropriateness for their intended use

Art and design have a longstanding association with nature, reflecting the emotional connection that artists and designers have with its diverse elements. Nature serves as a profound source of inspiration for artists and designers, who have excelled throughout history in crafting and shaping their visions by drawing upon the elements of nature. They skilfully derive from nature's formations and structural systems, which encompass the artist, and find in it a wellspring of inspiration, artistic stimulation, modernity, and a driving force for achievement. Nature fuels the soul with positive and motivational energy through its vibrant structural entities and rich architectural systems. Within nature's realm, designers find abundant space to unleash their creative imagination.

Throughout the history of art, ancient civilisations drew deeply from their direct engagement with nature and its abundant elements to inform their creative practices. Nature’s diverse rhythms—manifested in both form and content—served as a profound source of inspiration for expressive visions and design formulations that continue to resonate in modern contexts. The intricate patterns and organic structures found in natural compositions shaped the aesthetic and conceptual foundations of ancient artistic expression. From the contours of flora and fauna to the textures of landscapes and the chromatic richness of the environment, these natural features played a pivotal role in shaping visual languages and symbolic meanings. This enduring interplay between art and nature not only enriched the creative output of ancient cultures but also reflected their deep reverence for the complexity and beauty of the natural world

The inspiration drawn from nature plays a vital and dynamic role in elevating the quality of product design. It underscores the importance of enhancing the active and influential role of nature and delving into the analytical study of its elements, growth patterns, and reproductive

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methods. This exploration aims to shape components and structural systems that abound in natural elements, with the objective of formulating innovative designs derived from the natural environment in the Kingdom of Saudi Arabia. These designs are harmonised with the latest advancements in product design techniques, establishing a cohesive relationship between the elements of nature, their inspiration, and the design of products that align with modern technologies.

To achieve inspired and creative outcomes, it is essential to have a comprehensive understanding of the aesthetic concept related to the chosen theme. This understanding should be accompanied by a series of intellectual or mental processes, leading to a positive outcome based on cultural awareness and perception. The realm of imagination acts as a blueprint, providing an initial spark of emotional charge for the designer to begin their work uninterrupted (Frazer, John, 2016). As a result, an image is created that transcends the realm of emotions and becomes a tangible beauty that can be perceived by the recipient.

Innovative process represents a radical human activity, encompassing both aesthetic and functional dimensions that are inherently linked to human needs. It arises from humankind's endeavours to comprehend the nature of their innovative thinking. What sets the innovation process apart is its reliance on drawing inspiration from and assimilating elements derived from nature. Nature, with its abundant and stimulating constituents, serves as a wellspring of inspiration, propelling the enrichment of visual design processes and product design endeavours

The sea and coastal formations along the Red Sea in the Kingdom of Saudi Arabia have been a significant source of inspiration for artists and designers throughout history. These formations, including seaweed, marine grasses, coral reefs, rocks, sands, marine creature remains, shells, crabs, pearls, jellyfish, sea urchins, corals, fish, starfish, marine organisms, sea turtles, anemones, sea cucumbers, molluscs, squids, and sponges, possess unique characteristics, diverse structures, and a wealth of colour values and dimensions. They have stimulated artistic imagination across different artistic schools and movements, such as surrealism, impressionism, cubism, abstraction, and others. Artists and designers have meticulously studied these elements and integrated marine organisms into their creative designs, yielding visionary concepts characterised by artistic, aesthetic, and functional values.

The Kingdom of Saudi Arabia stands at the forefront of countries blessed with a vital geographical location, encompassing numerous bodies of water. Situated in the far southwest of Asia, within a vast area of the Arabian Peninsula, it is bordered by the Red Sea to the west and the Arabian Gulf to the east. This diversity of aquatic landscapes and their abundance bestow upon the kingdom a distinct and unique marine nature. It serves as a source, treasure, and visual bank for designers and artists, inspiring them to derive lines, details, and design structures from these seashells (Lidia & Anna, 2018).

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The Saudi Arabian seashells, with their elements and vocabulary within the Red Sea, stimulate design thinking and creative imagination. It encourages the presentation of contemporary and innovative design concepts. This has prompted researchers to conduct in-depth analytical studies in the region, aiming to create practical designs that draw inspiration from marine elements. These designs are employed in the creation of products that possess functional and aesthetic aspects inspired by the seashells of the Kingdom of Saudi Arabia

2 The Problem Statement

The design of products has become increasingly important and necessary in the modern age due to the advancement and growing demands of users. The expanding realm of communication, in terms of density, diversity, and classification, has necessitated the need for design innovation and creative imagination in drawing inspiration from new elements in product design. Nature, as a whole, has been one of the most significant sources and inspirations that stimulate the designer's imagination in shaping their ideas into targeted design formats. Specifically, seashells serve as a source for enriching and inspiring the entities and organisms found in nature and the environment, adapting them in line with modern product design concepts (Bruce Brooks Pfeiffer, 1999). Design considerations take into account the specific audience targeted, catering to their preferences, concepts, and cognitive abilities. They are characterised by aesthetic and functional aspects that fulfil the needs of the user.

The researcher aimed to explore and derive design formulas from seashell elements to discover new structural patterns and design compositions that exhibit a diverse and rich visual and structural quality, encompassing aesthetic and expressive values. These endeavours can be utilised in creating three-dimensional designs that possess both aesthetic and utilitarian functions.

Numerous studies have pointed out that seashells and other marine organisms represent a rich source of design inspiration. Designers resort to and draw inspiration from their surrounding natural environment, characterised by varied textures, colour richness, and diverse forms and architectural systems.

Therefore, the seashells of the Red Sea in the Kingdom of Saudi Arabia are sources of inspiration for designers and artists, which have not been adequately addressed in theoretical and applied research. It serves as a source and inspiration for product design, enriching designers' ideas and updating the aesthetic and functional aspects of the design. This could be accomplished through the "Discord" platform on the "Midjourney Bot" server as one of the applications of artificial intelligence programs.

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The problem of the study can be defined by the following questions

- What is the potential for utilising the characteristics of seashells and their elements to innovate and shape functional and utilitarian products?
- What are the possibilities and applicability of deriving design formulas from seashell elements to shape functional and utilitarian products?
- What is the relationship between deriving design formulas from seashell elements in the Red Sea in the Kingdom of Saudi Arabia and shaping functional products?
- What is the potential for designers to use and employ computer-aided design programs and artificial intelligence in highlighting the various techniques and methods used in innovative designs inspired by marine elements?

These questions help to provide a framework for investigating the potential benefits and challenges of incorporating marine elements into functional product design. They also address the relationship between marine inspiration and functional product creation, as well as the role of computer-aided design programs and artificial intelligence in enhancing the design process.

3 The assumptions of the study are as follows

- There is a potential benefit in utilising seashells and components in highlighting design elements and creating diverse designs that cater to different societal segments.
- The designer's ability to use and employ computer-aided design programs and artificial intelligence helps in showcasing innovative designs inspired by seashells, while ensuring their consistency with the nature of various user segments.

These assumptions form the basis for the study and provide a framework for investigating the potential advantages and challenges of incorporating seashells into design processes. They also acknowledge the importance of considering different societal segments and the role of technology in creating designs that align with their needs and preferences.

4 The objectives of the study are as follows

- To conduct an analytical study of seashells and their elements, components, and characteristics, with a focus on their artistic and aesthetic properties. This will serve as a basis for designing and shaping functional and utilitarian products.
- To innovate local designs inspired by seashells in the Red Sea in the Kingdom of Saudi Arabia and utilise artificial intelligence programs to highlight the various techniques and methods used in the design of functional and utilitarian products.
- To explore the possibilities and applicability of deriving design formulas from seashell elements to shape functional and utilitarian products.

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- To establish a connection between deriving design formulas from seashell elements and the creation of functional products.
- To investigate the impact of deriving design formulas from seashell elements on the visual thinking of products.

These objectives aim to enhance the understanding of seashells and their potential for inspiring functional product design. The study seeks to bridge the gap between nature and design, utilising the rich resources of the seashells in creating aesthetically pleasing and functional products.

5 The Importance of the Study

Theoretical Significance

- The current research contributes to establishing a contemporary approach to linking the derivation of design formulas from seashell elements with product design, enriching the creation of functional and utilitarian products.
- It highlights the role of deriving design formulas from seashell elements in the Red Sea in the Kingdom of Saudi Arabia and utilises them in the design and shaping of functional and utilitarian products.
- It enriches the theoretical aspect of the connection between deriving inspiration from nature and product design, leading to new insights in the field of arts and design.
- It emphasises the importance of cognitive integration between inspiration and the design of functional products, shaping contemporary artistic trends.
- It provides examples of functional and utilitarian designs inspired by the derivation of design formulas from seashell elements.

The Practical Significance

- The study introduces new research approaches by utilising materials and technological methods associated with the use of modern technologies and tools, particularly in the field of designing functional and utilitarian products.
- It harnesses the inspiration derived from natural elements to design and shape functional and utilitarian products.
- It introduces a new form of inspiration, especially from seashells found in the Red Sea in the Kingdom of Saudi Arabia, as a source for designing functional products and enriching visual thinking.
- It involves the implementation and production of functional and utilitarian product designs using artificial intelligence programs.
- It enhances the field of product design, particularly in terms of functional and utilitarian aspects.

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6 Study Limitations

Objective Limitations

The study focuses on designing functional and utilitarian products through the derivation of design formulas from seashell elements.

Temporal Limitations

The study is limited to the analysis and description of design formulas derived from seashell elements within the time frame of 2024.

Spatial Limitations

The study specifically examines the design formulas derived from the elements of the seashells in the Red Sea, Kingdom of Saudi Arabia. It used the "Discord" platform on the "Midjourney Bot" server, an artificial intelligence (AI) program, assisting in translating data and images into binary and artistic formations that celebrate diverse materials, colours, and textures

7 Study Terminology

Inspiration

It refers to the processes of deduction, analysis, and utilisation of forms and structures that provide their apparent configurations directly or indirectly (realistically or through summarising reduction). It is a process that aims to derive design solutions, processes, and propositions inspired by nature, its elements, and its structural laws. This inspiration draws from the abundance of nature as a source of inspiration to extract functional, aesthetic, and expressive designs and means that achieve goals. This includes the elements of the seashells as one aspect of nature, considering their internal construction and external aesthetic appearance, as well as their artistic, aesthetic, expressive, tactile, and colour values, and their design relationships. This enriches the presentation of innovative visual processes characterised by modernity (Dalal Yousrallah, 2014).

Marine Nature

In the Arabic language, "al-ṭabīʻah" refers to nature and everything related to it. In Arab thought, concepts of nature emerge within diverse schools of thought and inferential methods. The abstract term "al-ṭabīʻah" is the eloquent Arabic lexeme corresponding to the Latin term "nature." It is derived from the root "ṭabaʻa" and the noun form "ṭabīʻah." The previous usage of the term was not general but rather encountered in forms such as the verb "ṭabaʻa" and the noun "ṭabī".ʻ

Nature encompasses numerous rich components of the Creator's creative making, such as forests, deserts, mountains, and various environmental elements, including diverse elements

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like trees, animals, birds, and marine organisms. It includes elements such as grass, marine vegetation, coral reefs, rocks, sand, marine creature remains, shells, jellyfish, seahorses, corals, fish, starfish, marine organisms, sea turtles, jellyfish, anemones, sea cucumbers, sea urchins, molluscs, squids, sponges, and more (Lauer, David & Pentak, 2012).

8 Theoretical Framework of the Study

First Axis: The Designer, Nature, and Issues of Inspiration and Derivation

According to the indications of Henri Matisse, there is an inherent necessity for artists to possess nature, to immerse themselves in its rhythm, and to express themselves in their own language. Thus, nature represents a source of inspiration for creators and designers throughout various periods in the history of art, dating back to the earliest humans, who shaped human, plant, and animal forms for planning.

Nature serves as the inspiring and motivating force for artists and designers to create and shape unique and distinctive designs with aesthetic and expressive value in temporal and spatial dimensions. In prehistoric times, subjects and elements were derived from the surrounding nature, including plants, birds, and wild animals (large predatory animals), as well as the depiction of abstract geometric patterns.

It is the designer's primary teacher and the main source of ideas for shaping designs, as it encompasses various elements such as lines, spaces, shapes, textures, colours, and more. Creativity goes hand in hand with good inspiration, which begins with the designer observing, analysing, and interpreting the surrounding nature. By closely examining nature, the designer's ability to extract ideas is enhanced.

The purpose of those drawings and designs was not aesthetic or decorative; rather, they aimed to seek closeness to the hidden higher powers that govern nature. These designs and drawings were a reaction to the mystery surrounding natural phenomena and served to protect individuals from the dangers and harms posed by natural phenomena and predatory animals.

Design across historical periods has consistently drawn inspiration from nature, evolving in form and philosophy according to cultural and intellectual contexts.

In ancient Egypt, design was marked by graphic distinctiveness and individualistic expression, deeply rooted in the surrounding natural environment. Decorative motifs frequently incorporated elements from Nile flora—most notably the lotus flower and papyrus stems—as well as symbolic forms such as sun discs, scarabs, the Ankh (symbolising life), and the Eye of Horus. These visual elements reflected both aesthetic sensibilities and metaphysical beliefs.

Greek artists and designers, guided by Platonic ideals, sought to emulate nature through archaic stylistic conventions. Their pursuit of a mythical, idealised world positioned nature as

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both a model and a philosophical reference point, enriching the cultural and artistic legacy of classical Greece.

During the Italian Renaissance, visual discourse underwent a profound transformation, shaped by intellectual and humanistic revival. Artists re-engaged with classical Greek aesthetics, producing highly detailed and realistic portrayals of natural subjects. Innovations such as linear perspective and dramatic use of light enabled deeper interaction with form and space, while nature remained a central source of inspiration—informing both idealised and lifelike representations.

In Islamic art, nature was expressed through symbolic and stylised depictions, including palm trees and other vegetal motifs. These elements formed a rich visual vocabulary characterised by diversity in form, scale, and pattern. Through intricate interweaving, they achieved a harmonious unity emblematic of Islamic artistic philosophy.

Modern designers have reinterpreted these natural motifs through the lens of abstraction and reduction, seeking to distil their essence. Influenced by movements such as realism, impressionism, and abstraction, artists captured dynamic phenomena—weather patterns, wave motion, and maritime landscapes—using varied stylistic approaches. These compositions often featured elemental triads of water, sky, and land, occasionally incorporating human figures to enhance narrative depth (Salah al-Din, Muhammad & Ayatollah, 2012).

In contemporary practice, scientific and technological advancements have enabled designers to explore nature at microscopic levels. Tools for observing cellular structures, tissues, and biological layers have facilitated a deeper understanding of living systems. This knowledge has been integrated into artistic design, allowing for nuanced representations that reflect the complexity and intricacy of natural forms.

Experimental thinking and stylistic skills of the designer

Victor Papanek stated that design is the culmination of deliberate and conscious efforts that align with aesthetic, expressive, functional, and meaningful objectives—each precisely defined by the designer and the institutional context. It embodies a harmonious integration of beauty and utility, serving both human sensibilities and practical needs.

At its core, design synthesises aesthetic and utilitarian dimensions, fulfilling dual purposes of visual appeal and functional efficacy. The elements of design—often referred to as the vocabulary of form—are strategically employed within the design space to articulate conceptual intent. These elements are mobilised through diverse methodologies that reinforce the foundational principles of design.

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Design is fundamentally a series of creative decisions, manifested through the orchestration of shapes, colours, lines, and spatial relationships. It facilitates the free expression of ideas, enabling intellectual agility, flexibility, and innovation. This creative latitude empowers designers to experiment with formal elements and structural foundations, exploring methodologies and approaches that enhance expressive communication.

Moreover, design is inherently future-oriented, driven by the pursuit of novelty and relevance. It seeks to produce creative outputs that are both profound in meaning and accessible in form—bridging conceptual richness with user engagement. Through this dynamic process, design evolves as a communicative medium that reflects cultural shifts, technological advancements, and the evolving needs of society.

The artistic style encompasses every methodology used by professionals and artistic designers in a unique manner characterised by singularity, modernity, agility, and individuality. It aims to nourish and enrich the entrances of contemporary design through interaction with a range of factors within the designer's nurturing environment, whether they are natural, social, or cultural. The style does not limit itself to the observable form and the perceived meaning of designs but extends to the media, methods, and tools employed in the creation and design of artistic works, which themselves are based on their own styles and inputs. Modern artistic styles refer to the approaches and directions utilised by designers, artists, and professionals in a specific artistic field to express their own perspectives, opinions, and ideas.

Experimentation is a defining characteristic of artistic practice, functioning as a psychological analogue to the dynamic processes by which living systems organise perceptual stimuli. It serves as a contemporary strategy for formal articulation in art, encompassing both structural form and expressive content. This duality—between the internal spatial logic of form and its vital expressive locus—is conceptually framed by Lauer and Pentak (2012).

As a technique of artistic performance and creative inquiry, experimentalism engages with novel dimensions of aesthetic exploration. It involves presenting diverse aesthetic visions, cultivating perceptual and cognitive readiness for artistic engagement, and pursuing alternative solutions. In the modern context, experimentation has evolved into a dynamic and indispensable value, fostering innovation and expanding the boundaries of artistic meaning. It activates creative thought, enhances visual relationships, and informs the development of formal and structural systems that integrate content meaningfully.

Experimentation can be broadly categorised into two modes: the renewal of traditional paradigms through modern reinterpretations and radical innovation. The first mode reimagines established artistic formulations by introducing new materials, colour schemes, compositional strategies, and integration techniques—often resulting in heightened dramatic

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effect. The second mode departs from convention entirely, privileging spontaneity and direct self-expression through diverse stylistic approaches (Agkathidis, 2014).

Types of experimentation can be defined based on intellectual, methodological, and technological aspects. Intellectual experimentation involves arranging and formulating elements to achieve modern design objectives. Methodological experimentation focuses on the artist's performance style, distinguishing and characterising their approach. Technological experimentation combines contemporary trends and technology, blending multiple techniques in a single work for experimentation.

Figure 1: Experimentalism in Thought - Arrangement and formulation of elements in the work, inspired by free vocabulary and components

The Mechanism of Inspiration, Influence, and Design Thinking

The process of inspiration entails a dynamic interplay of intuition, imagination, instinct, and systematic thought, enabling the exploration of diverse possibilities and solutions that enhance value for the end-user. Perceptions of natural elements—and how artists engage with them—are shaped by temporal, environmental, and personal factors. The act of interpreting and shaping nature follows a methodical approach, infused with the artist’s emotional and affective responses.

English poet John Dryden emphasised that the genesis of creative imagination lies in innovation and the emergence of novel ideas. Inspiration, in this sense, is not merely spontaneous but is coupled with deliberate reflection on origins and their reinterpretation. Through this contemplative process, imagination materialises in literary and artistic forms that amplify the distinctiveness of the work. Artistic inspiration thus generates aesthetic imagery that accumulates across life stages—manifesting in behaviours, visual motifs,

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language, and events—through the interaction of emotion and intention, and through the internalisation of affective experience.

Inspiration is a generative force—a radical human activity that integrates aesthetic and functional dimensions in response to evolving human needs and interpretive frameworks. Innovation, as an extension of inspiration, draws upon and assimilates elements from nature, which serves as a rich reservoir of stimuli. These natural elements invigorate visual and product design processes, offering both conceptual depth and sensory enrichment.

Creative design thinking comes as a set of processes and strategies to solve problems in a creative way, to attract attention and interest from customers and users, and to influence their decision-making. It revolves around a human-centred, deep understanding of the target audience, their challenges, needs, culture, and lifestyle. It aims to solve a problem by studying all its aspects.

Design thinking is a strategic framework that guides the definition of design goals and fosters creative problem-solving. It cultivates a deep understanding of its principles, methodologies, and tools, enabling the generation of innovative ideas and the development of actionable strategies. This process is supported by diverse information-gathering techniques, including surveys, user feedback, customer narratives, and interviews.

At its core, design thinking is rooted in a nuanced understanding of users—their backgrounds, behaviours, cognitive patterns, and needs. It transcends the conventional view of users as passive recipients of services, instead positioning them as active contributors to product development and problem resolution. As such, design thinking integrates a comprehensive set of techniques, tools, and methods that empower organisations to refine their business models and achieve strategic objectives.

Characterised by its human-centred orientation, design thinking offers a creative and adaptive approach to problem-solving. It leverages contemporary and innovative practices to align design processes with the evolving demands of management and organisational development, ensuring that solutions are both aesthetically compelling and functionally effective

Contemporary creative narration has excelled in the process of drawing inspiration from heritage as a source of knowledge and human achievement. In doing so, the contemporary designer extracts the influence of heritage into the self, allowing the creative self to explore and comprehend heritage within the layers of tradition. Returning to heritage does not entail rigid adherence to it but rather the assimilation of the past to shape the present and envision the future.

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Approaches and Trends of Design Inspiration from Nature and Entities

Nature represents the primary source from which designers draw their design elements and compositions. Nature operates according to well-defined mathematical laws characterised by flexibility. Designers uncover these laws and the organisational systems of nature to shape the essence and principles of their work through conscious and sensory creative thinking. Nature's abundance, including plants, seas, mountains, fish, birds, and more, serves as a foundation for artistic principles. The strong balance in nature supports stability and infinite diversity, as well as the proportional relationships between parts and the whole. The vitality of masses, spaces, and surfaces, viewed as a source and wellspring of inspiration, transforms natural form into a stimulus for design thinking, imagination, and the stimulation of emotions and reactions. This fosters an emotional connection between humans and nature, aiming to achieve an integrated construction that realises the idea by assembling and organising elements in a new structural framework.

According to Aristotle's views, the designer's inspiration from nature does not imply replication. Instead, it originates from the analysis and understanding of nature. The process of inspiration begins with the designer absorbing the components of nature, including colours, and translating and shaping them within the framework of their work. Seashells, in particular, present regular geometric shapes, organic forms, spiral patterns, and radiating structures that directly apply mathematical laws, proportional relationships, and aesthetic connections. Organic forms are **characterised by curves, curved lines, and flowing extensions.**

A study conducted by Habiba and Bouzara (2021) identified two stages of the designer's inspiration from nature and its components:

Internal Stage: This stage involves the designer's cognitive abilities, mental capacities, knowledge, and physiological capabilities. It focuses on the designer's internal qualities and how they perceive and interpret nature.

External Stage: This stage relates to the designer's interaction with nature and their methods of communication with it. It involves observation, monitoring, analysis, and interpretation of natural phenomena using all the designer's senses. The designer utilises their imagination and organisational skills to connect information and shapes from the surroundings, establishing meaningful relationships and cognitive rules.

As the era advances, three-dimensional designs have evolved and become more prominent. Modern technology has introduced new materials and media, making three-dimensional forms an effective means of expression. These forms rely on the integration of design, material, and colour in compositions that resonate with the users. With the development of

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the era, the visual rhythm plays a vital role in expression, characterised by clear content, vibrant colours, and creative design thinking in three-dimensional compositions.

Designers draw artistic and aesthetic values from natural elements to create captivating and visually stunning designs. They aim to have a profound impact on the audience through three-dimensional compositions. Exporting solutions that align with the era, where visual rhythm plays a vital role in expression, is essential.

Several studies, such as AlJarushi, Abdullah and Mawahib (2011), have identified general concepts that define the relationship between nature and design, including:

The constancy of nature's laws and systems, evident in humans, animals, plants, and the sea, allows for the creation of fundamental entities in nature in simple ways. These entities exhibit characteristics of unity and diversity.

Nature operates according to mathematical laws characterised by flexibility and fluidity. It also contains structured systems and constructive elements, allowing designers to explore and create through their creative imagination.

Many artists and designers have drawn inspiration from marine components, such as the spiral shape, shells, and marine creatures like crocodiles, in their three-dimensional artworks. They employ suitable materials that enhance the artistic value, aesthetics, and expressive qualities, resulting in distinct forms and textures. For example, they utilise silver and metal strips, red and yellow copper, natural materials, coloured transparent stones, and ivory in their creations, as shown in Figures 2 and 3.

Figure 2: A collection of three-dimensional designs inspired by marine natural components, as described by (Rihan, Ibrahim, Mustafa & Iman, 2021).

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Figure 3: A set of three-dimensional designs that are founded upon the utilisation and inspiration of marine natural components within artistic works.

The second axis: Seashell elements shaping functional and utilitarian products:

Contemporary Design Trends

In the designer's quest for modernity and keeping up with user needs, the nature of the era, and the desired functionalities, there is a search for sources of inspiration and influence from art, heritage, and nature itself. Nature serves as an active visual source and stimulant to deepen the design message. The designer organises the elements through design relationships such as adjacency, contact, overlap, transparency, scaling, penetration, and repetition, following the laws and patterns of nature's growth and generation. This requires studying and analysing those systems to transform the designer's ideas and visions into a structured design pattern that maximises the power of imagination and interactive response to sensory, emotional, and mental aspects of natural elements. This enables the derivation and inclusion of innovative design solutions characterised by privacy, contemporaneity, and national identity. This is achieved through two design orbits:

First: Visual analysis and exploration of the components and elements of nature. The designer aligns with the natural component and draws inspiration from it to shape artistic propositions, benefiting from its richness, diversity, and the innovative utilisation of natural elements that provide aesthetic pleasure, functionality, and user satisfaction.

Second: Abstract analytical reduction of the natural component. This is accomplished by analysing the components of nature and deeply understanding them, which aids in condensing and abstracting their external entities, moving away from appearance to reach the essence, pure form, and the geometric composition of nature. This involves establishing organised laws and relationships for the designer's ideas to align with functional and utilitarian purposes, contributing to solving user problems and aligning with the ever-growing intellectual, social, and industrial nature of the era.

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The seashells possess a unique, rich, and distinctive character, teeming with living organisms, elements, and components. It represents a natural museum and a treasure.

Regarding the importance of aesthetic and structural values for designers and their vital role in the attractiveness of design, Rudolf Meyer stated that, alongside functional aspects, there are aesthetic aspects that must be achieved in two-dimensional and three-dimensional design models to achieve coherence in the work. Contemporary design trends refer to the visions, proposals, principles, and methodologies followed by designers, upon which they base their two-dimensional and three-dimensional design models. These models are intended to be received and interacted with by users and recipients according to specific desired functions, purposes, and objectives, as well as their intellectual, cultural, and perceptual backgrounds, to ensure the achievement of the intended purpose and interaction with the product (Mentegazzi & Edoardo, 2014).

Several contemporary design trends and schools have emerged, which have motivated the inclination and motivation to draw inspiration from elements of nature as visual stimuli and enriching elements that stimulate the designer's imagination and emotions. Whether these components are mountainous, coastal, marine, or natural, their elements are utilised to aesthetically and functionally enrich the inputs of contemporary design. Examples of these trends include environmental design, organic design, industrial design, product design, interior and architectural design, and media and communication design. Please refer to Figure 3 for an illustration.



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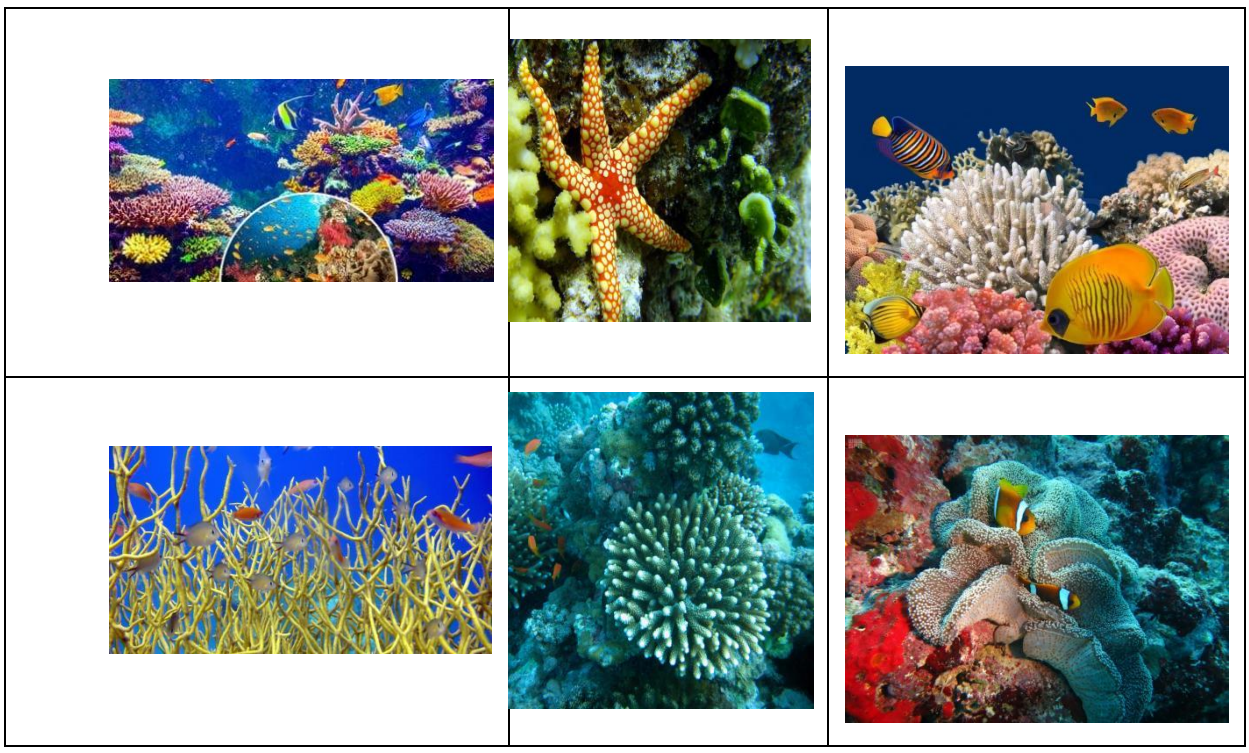
Figure 3: Seashell elements from the Red Sea that can be beneficially utilised in three-dimensional designs and formations.



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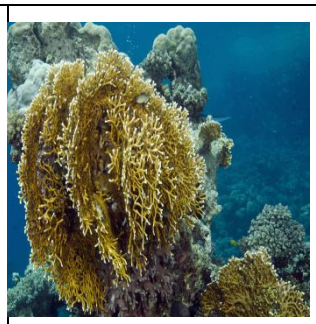









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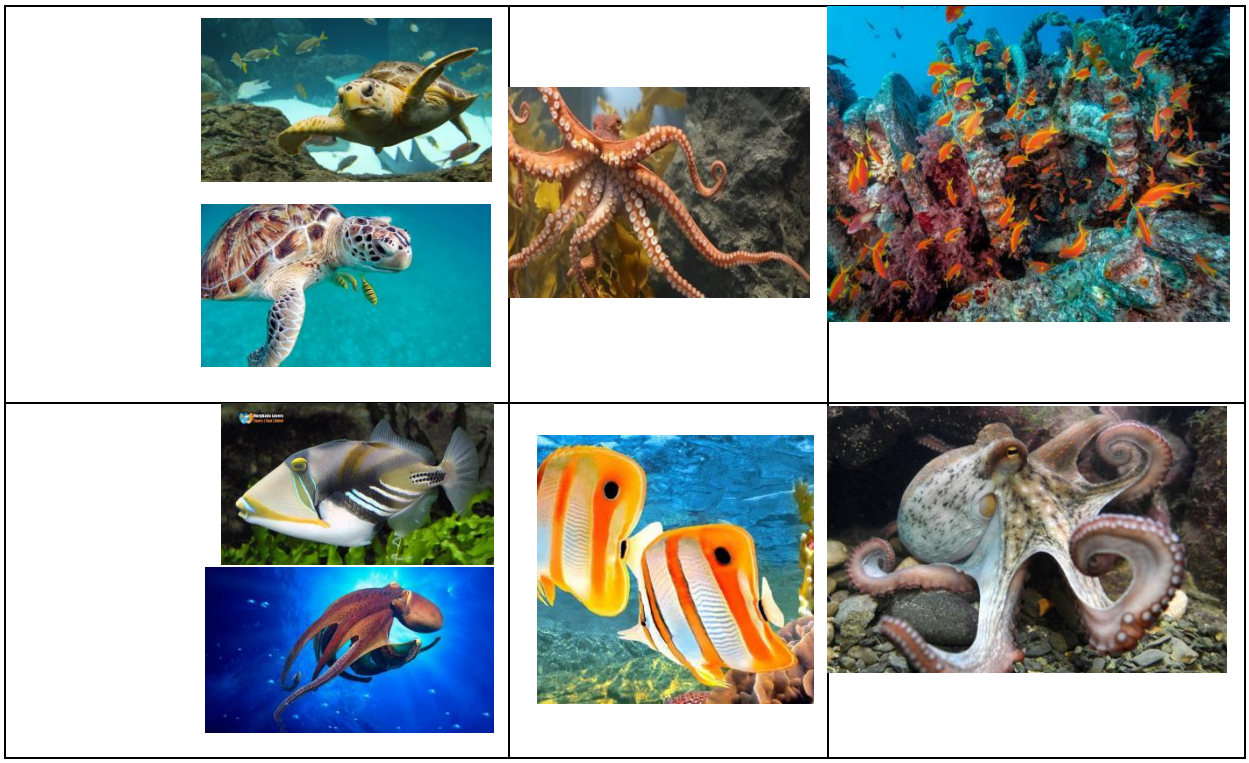

Figure 4: Seashell elements from the Red Sea, distinguished by their aesthetic and expressive values, as well as their diverse layered structural and colour compositions, linear and textural rhythms.

Design thinking influenced by nature:

Design thinking represents a scientific and practical methodology for creatively solving problems in a non-traditional way. It is a comprehensive creative approach used in product and service design, focusing on analysing human needs, a deep understanding of user experiences, identifying and studying their needs and the problems they face. The effort is concentrated on identifying the functional and aesthetic desires of the user, satisfying them, and delivering the desired benefit to ensure success and increased demand for the designed product, exporting integrated innovative solutions.

Thus, design thinking becomes a bridge to reach modern solutions and succeed in facing various challenges by placing the users at the centre of attention and providing services that meet their expectations and suit their lifestyle. This improves processes and organisations in more efficient and effective ways, enhancing social interaction through individuals' participation in the solution development process and better responding to user needs.

Adaptability refers to the ability to deal with changes and challenges that arise during the design process flexibly and effectively. This capability is one of the fundamental elements in design thinking, as it helps achieve success in various fields. Improving the user experience

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aims to make it more satisfying and comfortable, contributing to building stronger relationships with users.

Regarding the concept of system in nature and its relation to the field, opinions have varied. Some have linked the system to repetition, while others associate it with growth and argue that the system is the external equality resulting from the continuous repetition of a specific element. They believe that the basis of beauty is founded on the system and its achievement of symmetry, unity, and balance. The system represents the interconnected relationships in which any organic entity, whether human, animal, or plant, is interconnected. All natural elements are shaped according to simple mathematical laws, and they all reveal the presence of meticulous organisation within nature, both in its hidden and visible aspects. The beauty of nature lies in the ways its components are organised.

Organic Designs and the Art Nouveau Movement

Artworks and designs are classified into two directions based on their forms and technical styles: the first is the "organic direction," which is associated with natural models, and the second is the "geometric direction," which is associated with geometric shapes, patterns, and elements.

The Art Nouveau movement is characterised by avoiding straight angular lines and embracing organic forms and natural ornamentation. It emphasises the dominance of smooth and interweaving curved lines, along with the widespread use of arches and asymmetrical shapes. Construction materials such as wood, metal, and glass are prominently utilised. The new style is characterised by undulating shapes, flowing ornamentation, and innovative designs featuring curved lines, floral forms, and plant-inspired motifs. Additionally, a geometric aspect emerged in this new art, manifested through the use of geometric shapes and patterns in the form of perpendicular or right angles, dynamics, undulating shapes, flowing lines, various arches, and lines with varying rhythms. These elements constituted the essence of this movement.

The organic nature of this direction is characterised by dynamism, undulating shapes, flowing lines, various arches, and lines with varying rhythms, which formed the personality of Art Nouveau. Furthermore, the excessive and equivalent cuts were employed to give traditional moulds a sense of life and growth inspired by botanical forms.

Designers of this movement drew inspiration from nature and its organic and geometric forms. They produced designs that unified natural shapes in one place or distributed them within the artistic space. These designs were utilised in exterior architecture, employing asymmetrical and undulating lines that imitate nature, taking the form of buds, flower markets, and insect wings. The movement also embraced an exaggerated use of decorative forms in exterior ornamentation and the shaping of interior voids. Additionally, the

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comprehensive principle of sculpting masses was adopted, with attention given to designing long, flowing hair with intertwined braids at the ends, as well as intricate embroidery and detailed embellishments. These elements deeply interacted with interwoven and intertwining vegetal patterns (Mohamed & Osama Youssef, 2019).

The organic system and the design of products inspired by seashell components

The organic system represents the coordination of nature in its forms, achieved through various factors such as biological growth and the vital functions of living organisms, as well as environmental factors like weathering. Organicity originates from the state of curvatures and organic connections, where all its parts are closely interconnected through consistent components. The fundamentals of organic design include innovation based on inspiration, the connection of design with the environment in which it is created, the use of materials and media in their natural state, and the incorporation of movement, growth, flexibility, cohesion, coherence, and abstraction. Please refer to Figure 4 for the visual representation of these principles.

Figure 4: Organic design, innovation based on inspiration, and the connection of design with seashell components.

The elements of engineering and structural components derived from marine nature

Nature exhibits a deep preference for certain proportions in shaping its forms. These are the geometric relationships that inspired the emergence of sacred geometry, with the history of engineering usage dating back to ancient civilisations that enhanced traditional Pythagorean, Egyptian, Babylonian sciences, and Persian mathematics. It is based on the rationality of Pythagoras, which relies on a sacred concept of numbers, symbols, and regular geometric shapes. These shapes adhere to a constructive law based on precisely calculated geometry that can be measured (Yen, Lishan Xue, & Ching Chiuan, 2007). They manifest in forms with specific measurements, dimensions, and angles between their lines, such as equilateral triangles, squares, circles, rectangles, ellipses, and parallelograms.

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Engineering represents a practical application of shapes through measurement and relationships. As Plato indicated, this geometry consists of original models or pure nuclei, with no reflection of the visible world. Sacred geometry stems from the underlying unity behind all geometric forms, emphasising the inseparable relationship between the part and the whole. It constantly reminds us of the unity and sacred origin in creating all things.

Fractal Geometry Formulas and Marine Component Structures

Nature serves as the primary teacher for designers, encompassing systems and relationships characterised by repetitive patterns. Various forms of fractal systems are abundant in nature and can be observed in the growth stages of organisms, dictated by the underlying systems governing their nature. We find repetitive manifestations in the plant kingdom, where growth patterns differ in appearance from the repetition observed in humans, animals, and birds. Additionally, repetitive systems manifest in the structure of natural elements, not limited to their growth stages, but also in their relationship with the surrounding environment.

Fractal formulas represent mathematical patterns and precise geometric systems responsible for the complex structures of natural and physical phenomena. Fractals serve as a form of artificial intelligence art, fractional particles, and yield computed results in static images, animations, and multimedia (Lauer & David, 2012). Fractal art has evolved since the mid-1980s and continues to progress. It is a genre of digital art that forms part of modern media. It combines to produce a type of abstract art and finds applications in the fields of arts and design. Fractal art has provided artists and designers with an understanding of geometric systems known as "fractal geometry" or "fractals" to describe mathematically advanced phenomena and interpret the theory of holism. The evolution of fractal art is facilitated through computer advancements and intensive computational processes. Fractions are generated by applying iterative functions to solve nonlinear equations or boundary equations.

Fractals have been extensively utilised in various forms within digital art and animation. They have enabled the creation of high-resolution graphical representations and have found application in diverse artistic endeavours, such as fabric generation, plant growth simulation, landscape creation, and the design of marine-inspired products. Fractals are integrated with evolutionary algorithms, either by selecting well-formed samples from a set of linked random variations in fractal artwork or by patterns emerging from the balance between system equilibrium and chaos theory. Similar approaches have been described in Chinese painting, bonsai trees, and rock formations (Figure 5).

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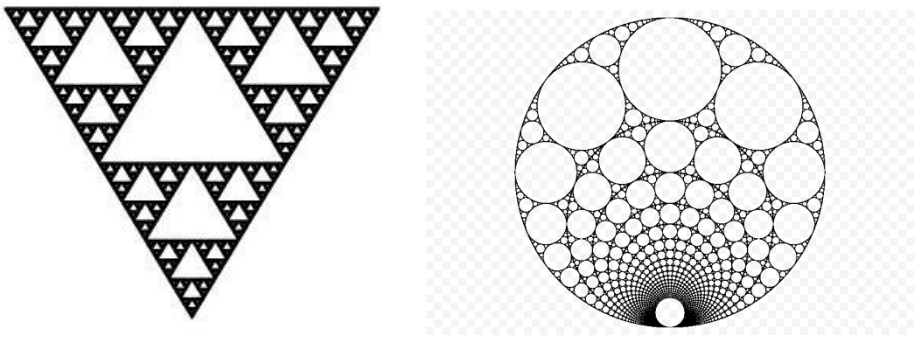

Figure 5: The recursive geometric formulas of fractal structures.

Fractals, as mathematical recursive systems, embody various artistic values. Consequently, artists can draw inspiration from these systems to captivate their senses. To fully grasp the aesthetic beauty of rich seashells, particularly their intricate repetitive patterns, artists and designers must study the natural manifestations that reveal the artistic role of fractals.

The recursive nature of fractal systems becomes evident in numerous marine formations. Some structures are built upon repetition, while others exhibit it as a technique in surface treatment. Fractal imagery can be classified into different aspects within natural elements, such as fractal patterns in the construction and surface treatment of these elements, the presence of groups of natural elements in natural phenomena, and their significance in organ functions and microorganisms (Almerbati, Headley, Ford, & Taki, 2016).

Fractals can be classified into several categories, including:

1. Self-similarity fractals: This category refers to the resemblance of any part of the fractal shape to the whole. Self-similarity can be further divided into two types:
    - Exact self-similarity: Fractals that appear the same at any level of magnification. They rely on the use of iterated function systems and exhibit exact self-similarity.
    - Apparent self-similarity: Fractals that display similarities and contain miniature replicas of the entire original fractal. They also rely on recursive relationships.
2. Statistical self-similarity: In this type, fractals exhibit consistent numerical or statistical measurements regardless of the scale of magnification.
3. Regular fractals: These fractals possess the previously discussed characteristic of self-similarity, where a part of the fractal resembles the entire shape. Regular fractals are the most prevalent in nature, especially in seashells.

Regular fractals consist of small and large structures of varying sizes that exhibit identical patterns regardless of the scaling factor.

4. Irregular fractals: These fractals represent parts in which the shape itself is replicated.

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Figure 6 illustrates an example of an irregular fractal.

Figure 6: Fractal Geometry embodies the geometric formulas of fractals as a mathematical recursive system that achieves various artistic values.

The logarithmic spiral

The logarithmic spiral represents a unique form in nature, characterised by its diverse manifestations. It can be observed in seashells, plants and their leaves, seed arrangements, and certain flowers. The spiral is one of the significant patterns and structures belonging to geometric shapes with mathematical characteristics and precise numerical sequences. The spiral pattern is found in nature, both in external entities and internal details, particularly in seashells, plants, ocean waves, and celestial galaxies (AlKholy, Hafez & Muhammad, 2011; Matar & Hoda, 2011). The spiral is formed by a curve that wraps around a fixed point without crossing itself. Each circle represents a complete rotation around the axis, either in a flat surface or in an ascending or conical shape, resembling the structure depicted in Figure 7.

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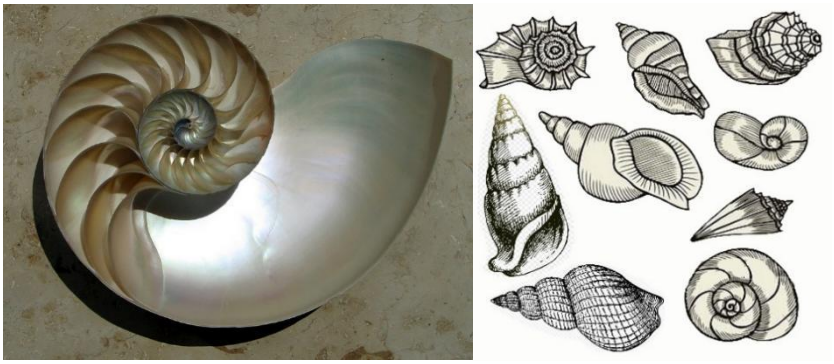

Figure 7: Marine seashells that are structured based on the logarithmic spiral system

The spiral is a curve traced by a point that starts from the centre and moves around it while simultaneously moving away from it. These two properties, the movement around the centre and the outward expansion, are what distinguish the spiral. The spiral shape encompasses aesthetic proportions that adhere to principles of harmony and balance, reflecting the variations found in the language of visual art, including lines, spaces, colours, textures, blocks, rhythms, and symmetries, in accordance with the numerical ratios present in the Fibonacci sequence and the golden ratio.

Despite the external variations in the appearance of spirals, there is unity and similarity in their underlying structural system. This system is characterised by the presence of a central point from which semi-diameters emerge, ultimately forming a series of repeated elements that extend from the inside to the outside or vice versa, representing the mathematical nature of the spiral system. There are various types of spirals, including the Archimedean spiral, which was studied around 225 BCE by Archimedes, the Fermat spiral, and the logarithmic spiral, also known as the equiangular spiral or the symbolic spiral. The logarithmic spiral was discovered by the French mathematician René Descartes in 1638.

The Fibonacci spiral, or the golden spiral

The Fibonacci spiral, or the golden spiral, is formed by the Fibonacci sequence and resembles a seashell. It is commonly referred to as the "logarithmic spiral" and is characterised by the golden ratio, which represents a proportion of beauty discovered by humans in all things. For artists, it serves as a standard of beauty, as it achieves a visually pleasing distribution of elements within artistic works through mathematical calculations, resulting in aesthetically pleasing forms. The golden ratio is known as a mathematical sequence in the structural composition of elements, using mathematical operations to obtain a systematic pattern. An example is the "golden triangle," which is derived through radical mathematical calculations, and the "golden rectangle," which is divided into thirds to create a square and rectangle. Figure 8 represents an illustration of this concept.

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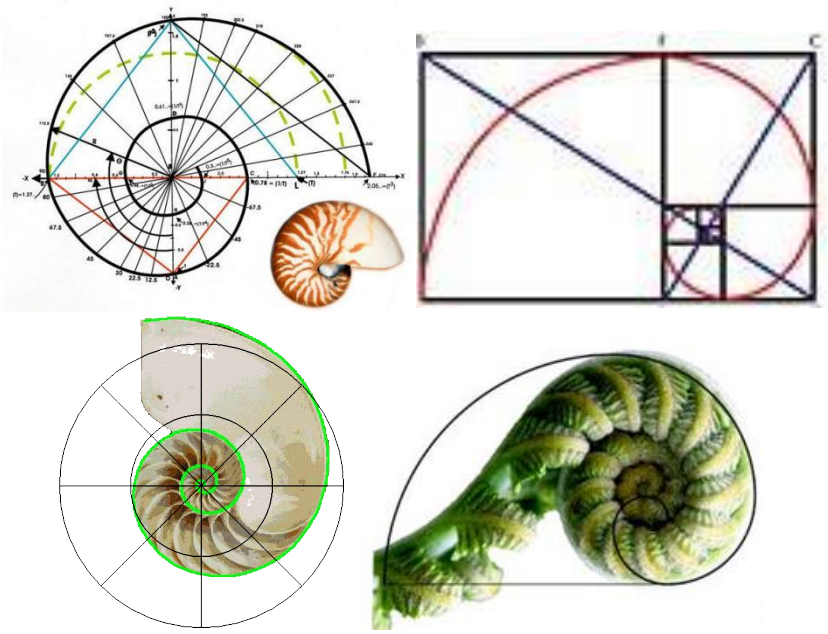

Figure 8: The logarithmic spiral, which is one of the significant systems and patterns belonging to geometric shapes and numerical sequences. It is a fundamental concept in mathematical geometry and number theory.

9 Experimental sample and three-dimensional applications

Practical proposals

In this section, a collection of models and proposals that have been designed as real three-dimensional sensors is presented. This was achieved through studying and analysing the design formulas of seashells elements in the Red Sea in the Kingdom of Saudi Arabia, and seaweed, marine grass, coral reefs, rocks and sand, as well as the remains of marine creatures, shells, seashells, pearls, jellyfish, sea urchins, corals, fish, starfish, marine organisms, sea turtles, jellyfish, anemones, sea cucumbers, sea urchins, sea cucumbers, molluscs, squids, sponges, and others. These designs aim to create functional and practical products as a result of the experiment. The experiment was carried out using the "Discord" program on the "Midjourney Bot" server, which serves as one of the applications of artificial intelligence programs. It serves as a creative visualisation for designing three-dimensional products using diverse materials, colours, and techniques. These designs aim to illustrate the research idea and its objectives and can be used by individuals of all genders in society.

- As footwear for various age stages and genders (children, women, men), these shoes possess artistic, aesthetic, and functional values. They are suitable for both indoor and outdoor use, with materials and colour shades that complement their form, function, and environment. These three-dimensional applications combine authenticity and

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modernity, distinguishing themselves in their relationship with the surroundings. Therefore, these designs need to be works of art in themselves, moving away from tradition and stereotypes, while embracing the new technological language of the era and providing enjoyment for the users.

- Additionally, designing a range of accessories to accompany these shoes, such as bags, that aesthetically align with the products and their materials.

Several proposals are presented for these three-dimensional real sensors as a result of studying and analysing the design formulas of seashell elements in the Red Sea in the Kingdom of Saudi Arabia to create functional and utilitarian products. These proposals aim to illustrate the research concept and objectives.

Below are some visualisations of real three-dimensional designs with diverse materials and colours:

1. Children's Shoes: Vibrant and playful designs incorporating bright colours, cartoon characters, and interactive elements to appeal to young children. The materials used would be lightweight, flexible, and durable to ensure comfort and safety.
2. Women's Shoes: Elegant and stylish designs featuring a combination of bold and subtle colours, intricate patterns, and embellishments. High-quality materials like leather, suede, and satin would be used to create a luxurious and fashionable look.
3. Men's Shoes: Sophisticated and versatile designs combining classic and contemporary elements. Neutral colours like black, brown, and navy would be prominent, with subtle textures and details adding visual interest. Durable materials such as genuine leather and suede would be utilised for longevity and comfort.
4. Outdoor Adventure Shoes: Robust and functional designs suitable for outdoor activities. These shoes would feature rugged materials like waterproof fabrics, reinforced soles, and adjustable straps for stability and protection in various terrains.
5. Beach Sandals: Lightweight and breathable designs perfect for beachgoers. These sandals would incorporate bright colours, tropical patterns, and quick-drying materials like rubber or neoprene for comfort and convenience.
6. Formal Evening Shoes: Glamorous and eye-catching designs for special occasions. These shoes would showcase metallic finishes, sequins, and delicate embellishments, paired with rich colours like gold, silver, and deep jewel tones.
7. Sports Performance Shoes: Dynamic and high-performance designs engineered for specific sports activities. These shoes would feature breathable mesh, supportive structures, and specialised cushioning systems tailored to enhance performance and reduce the risk of injuries.

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These three-dimensional designs aim to provide functional, aesthetic, and diverse options for individuals of different age groups and genders, catering to their specific needs and preferences.

10 Research Methodology

The research employs both the descriptive and experimental approaches

Research Population: This study encompasses the elements of the seashells in the Red Sea in the Kingdom of Saudi Arabia, which serve as a source of inspiration for the designer in designing products, that have not been sufficiently explored in theoretical and applied research as a source and inspiration for product design, enriching the designer's ideas and enhancing the aesthetic and functional aspects of the design product. The research utilises the "Discord in Server" program, specifically the "Midjourney Bot," as one of the applications of artificial intelligence.

Creating a questionnaire form to measure, evaluate, and judge the proposed design solutions as remedies for the research problem. The questionnaire was presented to a number of experts in the field to gather their opinions and guidance. **The questionnaire** included the following axes:

- What is the potential for utilising the characteristics of the seashells and their elements to innovate and shape functional and utilitarian products?
- What are the possibilities for applying the design formulas of seashell elements to shape functional and utilitarian products?
- What is the relationship between applying the design formulas of seashell elements in the Red Sea in the Kingdom of Saudi Arabia and shaping functional products?
- How feasible is it for designers to utilise computer-aided design programs and artificial intelligence to highlight the various techniques and methods used in innovative and nature-inspired design?

Each axis comprises a set of statements for a comprehensive description and evaluation of that axis.

Questionnaire Form			**The Axis**
			The First Axis
Quality Factor	The Percentage	The Number	
	What are the possibilities of utilising the features of marine nature and its elements to create and shape functional and utilitarian products?		

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	Disagree	Neutral	Agree	Disagree	Neutral	Agree	
%100	0	0	%100	0	0	10	
%95	What are the possibilities and feasibility of applying design inspirations from seashell elements to shape functional and utilitarian products?						**The Second Axis**
	0	%10	%90	0	1	9	
%95	What is the relationship between drawing design inspirations from seashell elements in the Red Sea in Saudi Arabia and shaping functional products?						**The Third Axis**
	0	%10	%90	0	1	9	
%100	What are the possibilities of using and employing computer-aided design software and artificial intelligence by designers to highlight the various technologies and methods used in innovative designs inspired by marine natural elements?						**The Fourth Axis**
	0	0	%100	0	0	10	

Sample of Questionnaire Results and Expert Opinions in the Axes

11 Set of Designed 3D Models and Proposed Concepts

Personal Experience

These 3D models represent elements of the seashells in the Red Sea in the Kingdom of Saudi Arabia. These elements serve as the main sources of inspiration for artists and designers due to their uniqueness, diversity, and distinctive forms, as well as their rich tactile values, varied structures, and the richness of colour dimensions they possess.

The designed 3D models aim to capture the essence and beauty of these marine elements, allowing individuals to have a personal experience and connection with the seashells. By exploring these models, one can appreciate the intricate details, textures, and colours found in the marine ecosystem.

Whereas the seashells in the Red Sea in the Kingdom of Saudi Arabia stimulate design thinking and creative imagination, the researcher has been driven to conduct in-depth analytical studies in that region. The goal is to create practical designs that draw inspiration

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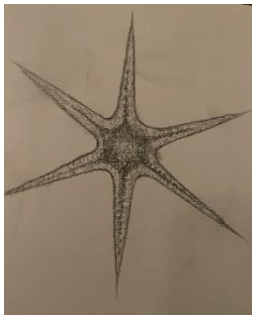
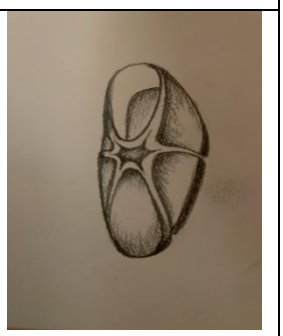
from the marine elements and employ them in the design of functional and aesthetically pleasing products inspired by the marine nature in Saudi Arabia. This process involves updating the design of products both aesthetically and functionally.

To facilitate this endeavour, the researcher has utilised the "Discord" application on the server named "Midjourney Bot." This server serves as one of the applications of artificial intelligence programs. Through this platform, the researcher aims to collaborate, share ideas, and engage in discussions with other individuals interested in design and artificial intelligence, fostering a dynamic and contemporary design approach.

The following section encompasses the aforementioned experience and practical proposals:

Proposed 3D application		The Artistic And Aesthetic Values of Three-Dimensional Formulas	The Design Formula for Three-Dimensional Sculptures
		Examples of experimental elements, components, and sketches from the researcher's settings, which he drew inspiration from a .pilot experiment	**My Sketch**
			

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   	A collection of women's sneakers inspired by elements of the Saudi seashells, designed with a modern frame, using the Mid journey Bot Discord server, an artificial intelligence application called Mid journey Bot. The design uses colourful, age-appropriate plastic.	**New women's sports shoes**
   	A design for a collection of women's evening shoes inspired by marine elements, within a contemporary framework, and employing leather with diverse colour and texture values that suit the age group of this segment.	**Women's evening shoes**

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 	 	A design for a collection of innovative children's shoes, crafted in a new and diverse artistic and aesthetic way, inspired by elements of the seashells to form functional and utilitarian products, within a contemporary framework.	**New children's shoes**
 	 	Designing a collection of men's shoes with innovative designs, inspired by a specific source, consistent with the age group, gender, and functional and utilitarian aspects, using colored plastic materials that suit the various men's age groups.	**New men's shoes**

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	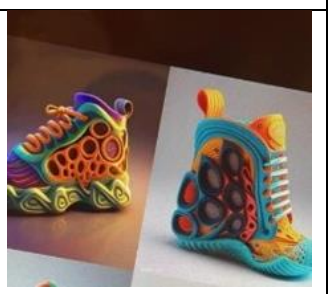		
		Designing a collection of women's bags with modern formulations, inspired by marine elements and creatures, consistent with the nature of the species, age group, and functional and utilitarian aspects, through colored leather materials with diverse tactile and colour values.	**Accompanying accessories such as women's handbags**
			
			

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12 Results and Recommendations

First: Study Results

1. Using seashells: The study emphasises the potential to incorporate seashells from the Red Sea in Saudi Arabia into innovative and functional product design. Designers can draw inspiration from these elements to create practical and visually appealing products.
2. Computer-Aided Design and Artificial Intelligence: The research indicates the use of computer-aided design programs and artificial intelligence in showcasing innovative designs inspired by marine elements. Designers can leverage these technologies to explore various techniques and methods.
3. Cognitive Integration and Contemporary Trends: The study emphasises the importance of integrating inspiration from natural elements into the design of functional products. This integration can contribute to contemporary artistic trends and offer new perspectives in arts and design.
4. Sustainability and Awareness: The research suggests promoting sustainable design practices by using eco-friendly materials and minimising environmental impact. Additionally, raising awareness about the significance of the seashells and their preservation is essential.
5. Collaboration and Education: Encouraging collaboration between designers, researchers, and marine experts can facilitate knowledge sharing and a deeper understanding of the marine ecosystem. Educational initiatives can also play a vital role in fostering responsible design solutions.
6. Design for Local Context: Considering the cultural and social context of Saudi Arabia, designers should incorporate traditional motifs and design elements to create products that reflect local identity and cultural relevance.
7. Correlation exists between design inspiration from seashell elements and shaping functional products.
8. The potential and applicability of design inspiration from seashell elements in shaping functional and utilitarian products can be identified.
9. There is a direct link between design inspiration from seashell elements and the creation of functional products.
10. Models of functional and utilitarian designs inspired by seashell elements can be presented.

Second: Study Recommendations:

1. Intensify the study of the analytical and design aspects of marine vocabulary, elements, and components, and utilise them in creating designs for products

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characterised by artistic, aesthetic, and functional values that cater to diverse segments.

2. Expand the scope of studies and research to employ marine vocabulary, elements, and components in creating designs for products tailored to specific age groups, such as children in particular.
3. Make use of marine elements and materials to create complementary decorative items.

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