THE CODE – THE KEY THAT UNLOCKS ALL MYSTERIES

In the article Patternology, we made reference to 'The Code' and its relevance to patterns. In this document we will give a more comprehensive understanding of this fascinating subject and focus on the aspects that have been unveiled through a variety of disciplines and research, helping in the process to create a template, which explains many of the phenomena in the universe. This includes how nature performs her magic and how we as human beings have come to be as we are.

Uncovering The Code has helped us to see that the principles of mathematics are at the heart of literally every action, reaction and transaction. As we discovered in Patternology, patterns are behind everything - from the invisible subatomic world to far beyond the visual field, to the movement of the planets and the stars - there really is no such thing as chance or randomness. Chance and randomness are only the labels we have come to use when we attempt to explain something that stands outside of our understanding.

The deciphering of The Code has begun to lift the veil on many of life's so-called mysteries, offering us an insight not only into the marvels of the universe but also how we can change and move beyond our personal limitations - becoming who we most desire to be.

We hope you will enjoy this unusual and amazing voyage…

Prime numbers – the key players

Prime numbers are the most fundamental characters in the world of mathematics and can be found in every equation that explains the phenomena of the natural world. We will explore a variety of these as the journey unfolds.

A prime number can only be divided by one and itself – they are the indivisible numbers that make up The Code. A unique characteristic of prime numbers is that they can't be made by multiplying other numbers together and so if any prime numbers were to be missing, some other numbers just could not exist.

Non-prime numbers (composite numbers) can be created by multiplying prime numbers together - this is why prime numbers could be considered to be the 'genes' within The Code.

Music and ratios

Another arena in which we can see numbers at work is music. Music offers us a wonderful illustration of the rules of mathematics. Music also clearly demonstrates our intimate relationship to sound. It's interesting to note that when the mathematical rules of music are broken, we intuitively know it. An oscilloscope produces a picture of a sound (note). This instrument has helped us to understand the role of ratios in music. Every combination of notes can be defined by simple ratios - when we are listening to something that sounds beautiful to us, and moves us, the oscilloscope actually translates those sounds into wonderful curves, with gentle peaks and troughs, which we can readily observe.

The oscilloscope has allowed us to 'see' these ratios and their patterns and what we

have learnt from this is that the more complex we make ratios the harsher the sound becomes - and the visual patterns that we observe, via the oscilloscope, match the sound. In other words, the wave formation has sharp, jagged edges and lacks the elegance and the sweeping curves of a beautiful melody. If it sounds ugly the wave formation and patterns will look ugly too.

Professor Judy Edworthy (Plymouth University) has spent many years investigating the psychological effects of sound. Her work clearly illustrates the relationship between sound and mathematics. She has shown that certain sounds can elevate or disturb us, as our brains decipher their patterns and are thus called into action in a particular way. These actions may be to dance to a song or to respond to a siren or to remove ourselves from a screeching sound, which is literally getting on our nerves. In each case what we hear and are responding to are those ratios – in other words, the numbers that produce the mathematical formulae, which synchronise with our brains and in turn with our hearts.

Pi

One of the key players in The Code is Pi. It is such a powerful number and provides conclusive evidence of how circles play a fundamental role in the engine room of the universe. The 'discovery' of Pi has been attributed to many different sources including: the Egyptians, Babylonians, Greeks, the ancient Chinese and ancient Indians. What is sure is that each of these cultures and civilisations added something to the refinement of this arguably most fascinating of theories.

India is the mother of mathematics because it is there that the number zero originated. Without the number zero, the world would be a very different place. In fact, none of the scientific wonders we now take for granted would exist. The decimal system on which the modern world also depends was conceived in India along with algebra, calculus and trigonometry. This is no way negates what the ancient Greeks brought to mathematics, but for the sake of accuracy and balance, the Indian contribution should be equally acknowledged. Much has been written about the contributions of Archimedes, Aryabhata and Budhayana. All were brilliant mathematicians and astronomers who, given the roles they played in the journey of Pi, helped lay down the foundation for the world we now inhabit.

The relationship between the circumference and the diameter of a circle always equals the number beginning 3.14 (Pi). Wherever you look in nature, whether that be human biology or the cosmos, this principle is true and constant. So, divide the circumference by the diameter and you will always get a number that begins 3.14 (Pi).

Pi seems to be written into almost all the structures and processes of the planet - and like prime numbers, it can be found literally everywhere. Using The Code, you can calculate all manner of patterns and behaviour i.e. the weather, the tides and even human behaviour can be predicted based on The Code - Pi has proven to be a crucial piece of the jigsaw. This is why it is an integral part of thermodynamics, cosmology, fractals, statistics and electromagnetism.

The normal distribution equation is one of the most important principles within mathematics. Normal distribution is an important component in statistics and is often used in the natural world and social sciences (those disciplines concerned with the study of human behaviour). It has helped us better understand the variations in the natural world - Pi is an integral part of that formula, which further indicates that the geometry of circles can be found within all living organisms and systems.

Pi is known as an irrational number, which extends into infinity without ever repeating and it is postulated that every number you could ever imagine could be found within the Pi sequence. However, only the first thirty-nine numbers in that sequence are needed to calculate the circumference of a circle the size of the known universe!

Imaginary numbers

There is a group of numbers known as 'i' which stands for imaginary and these numbers, first introduced by the Greeks, break some of the fundamental rules of mathematics. For example, when multiplying two negative numbers you always get a positive and yet imaginary numbers actually break that rule.

Imaginary numbers, also known as complex numbers, have taken a long journey before being accepted as valuable contributors to the world of mathematics. The term imaginary number was first used in the 17th century, and it was René Descartes, often described as the father of modern philosophy, who wrote about them in what was initially a derogatory way. It wasn't until the 18th and 19th centuries that they gained respectability, and since then they have found their way into all aspects of modern life.

A good example of the practical application of imaginary numbers can be found in the use of radar - where sound waves are mirrored back from a stationery or moving object. Complex mathematics distinguishes between static and moving objects - for example, without the use of imaginary numbers, air traffic control would be useless. These 'esoteric' numbers like Pi, can be found everywhere.

The role of gravity

Gravity began to be more accurately understood when Galileo, in the late 16th century, undertook his famous experiment of dropping balls from the leaning Tower of Pisa. Galileo was arguably the first to show that all objects 'fall' at the same rate, regardless of their mass - which brought about a paradigm shift from the Aristotelian idea that the mass of the object altered its speed. However, it should be said that Robert Boyle, considered to be one of the founders of modern chemistry and more widely recognised for Boyle's Law (1662), in his research underlined the principle that the mass of an object did not determine the speed with which it fell to the ground. In his experiment, he placed a feather and a coin into a glass tube and removed all the air to create a vacuum. He then inverted the glass tube and was able to demonstrate that both objects fell at the same rate. Therefore, it is only the resistance caused by air that creates the illusion that two objects fall at differing rates.

So, anything under the influence of gravity is moving at the same speed throughout its motion/journey, regardless of its mass - 9.81m per second squared (9.81 m/s^2). Galileo's work set the stage for Sir Isaac Newton who is the scientist most synonymous with the laws of gravity. The number 9.81m/s^2 is the foundation of Newton's Law of universal gravitation - and it's by understanding this mathematical theory that we have been able to put satellites in space and understand and predict the movement of stars and planets.

Since the time of Newton, much more has been discovered about gravity and its role within the universe. In the early 20th century, Einstein further developed the laws and insights

around gravity with his general theory of relativity (1915). Since then, as a result of quantum theory, we've come to understand that gravity is the weakest of the four forces/interactions that underpin our world – the other three being: strong nuclear force, weak nuclear force and electromagnetism.

So, although gravity is a key player in the visible world, in the invisible world, at the sub-atomic level, its role is negligible.

Conservation and efficiency

In nature we see further evidence of The Code, particularly in shapes and forms. What has become clear is that nature is always looking for the most efficient way to produce something or perform a task. This has been described by some scientists as 'nature being lazy'. We think this is a misunderstanding of the wisdom of nature, which is always seeking a balance between creativity and conservation. Why use more energy than needed to fulfil a task when the energy that can be conserved offers the opportunity for further productivity? Is this not wisdom?

The hexagonal shape has proven to be a wonderful example of this efficiency - it underpins many structures in nature, honeycombs being arguably the best-known example of that, a structure that is so strong, uniform and practical that mathematics has helped us deduce that no other structure could ever be more efficient for the bees' honeycomb. Circles, spirals and spheres are other examples, like the hexagon, of nature's efficiency. This is why these shapes can be found everywhere. From plankton to the planet, from cells to countless microorganisms - all provide examples of circles, spirals and spheres being the most efficient way nature has discovered for fulfilling an objective.

Although the sphere is the most efficient form for many tasks within nature, it's interesting to note (as revealed through the science of soap bubbles) that when spheres come together the geometry around what is most efficient changes so spheres can form pentagons, tetrahedrons, dodecahedrons, all in the name of saving energy and improving output. This discipline offers a wonderful illustration of the rules of geometry, space and energy conservation - see the work of Paola Rebusco at MIT.

The story of light provides another wonderful example of this pattern of energy conservation and efficiency. Plants and natural vegetation imbibe photons (the sun's energy). We then consume the food, imbibing those photons, which provide us with energy. The foodstuffs that are good for us slowly release the energy, the photons, into our bodies, promoting health and wellbeing. Those foods we put into our bodies that are not good for us are like little infernos that release their photons quickly, disturbing the delicate balance of creativity and conservation. As a result, we have energy flooding the system too quickly, providing us with a surge of power, quickly followed by a 'crash', which in turn affects our perception, personality, and performance.

So, we can see in this example, that our bodies also seek the most efficient way to best meet our needs - but where we don't cooperate it struggles to find health and wellbeing.

Geometry and nature

As we've discovered, the nature of The Code is to conserve energy. This is elegantly demonstrated by the hexagon, the circle, and spirals. This same wisdom can also be found in the best of both ancient and modern architecture.

Frei Otto, German architect and structural engineer, famous for the 1972 Munich Olympic Stadium, began a revolution in modern architecture by observing the natural phenomena within nature and using that as a template to build wonderful, stable structures.

The Munich stadium is a great advert for energy efficiency, illustrating the principle that by copying nature we can achieve the best outcomes. However, it would be a mistake to believe that Frei Otto 'discovered' The Code. It would be more accurate to say that he tapped back into that wisdom, because in fact evidence of this understanding around structure and form goes back thousands of years and can be found in the ancient Chinese and Indian cultures.

The Egyptians were also clearly working with the principles of The Code using mathematics to build the pyramids – wonderful monuments to shape, symmetry and order.

The ancient Greeks are the ones who first coined the term 'geometry'; they believed that this was a potential key to understanding the world we inhabit. They discovered, through this discipline, five basic shapes called platonic solids, named after the Greek philosopher Plato. These were believed to be the primary building blocks of nature. They are the tetrahedron with four faces, the cube with six faces, the octahedron with eight faces, the dodecahedron with twelve faces and most complex of all, the icosahedron, with twenty faces (these are the only perfectly symmetrical solids). The Greeks believed that these five shapes were the building blocks for the natural world.

What is fascinating about this premise is that these geometric laws have only become clear in the 20th century! So, their calculation that these five shapes were solely responsible for all forms in nature, was in fact a phenomenal discovery, clearly built on part science and part intuition.

It's only with the discovery of x-rays (Wilhelm Conrad Roentgen - 1895) that we have come to understand even further the geometry and the symmetry of shape and form that underpins not only the world we inhabit, but also our bodies. As a result of x-rays there has been a paradigm shift in our understanding of biology and all living organisms.

With the ability to see inside our own bodies came further evidence of The Code but it was probably only when we began to x-ray crystals that we were able to appreciate the beauty and the efficiency of the atomic structures underpinning all things.

So, the five main shapes that the Greeks first identified are also found encoded within our bodies. Circles, hexagons and spirals again make an appearance. It's the neat, symmetrical patterns known as diffraction patterns, which have revealed how individual atoms have been put together, providing us with a better understanding of atomic structures and giving us an insight into the geometrical principles governing all life.

Professor Stephen Matthews (Imperial College, London) is amongst those who have helped us further understand that the structures and geometric laws discovered within crystals can also be found in the biological structure of humans - his work looks at how atoms are constructed to make living organisms. His research has highlighted how 'bits' of protein come together creating

wonderful structures and symmetry, underlining the fact that within the evolution of our bodies very efficient structures are always used to perform biological tasks. The study of pathogens and viruses has also illustrated that everything from the cellular level up to what we know of the cosmos honours the laws of geometry and symmetry.

Physicist Professor Kenneth Libbrecht (California Institute of Technology) through his fascinating work with snowflakes (the physics of crystal growth and ice formation) has enabled us to see that even the 'apparently' random phenomena in nature, like snowfall, are not random at all. By producing endless permutations of snowflakes in laboratory conditions he's been able to see that no two snowflakes are alike - and yet they are nonetheless bound together by the laws of geometry and symmetry.

What's important to point out is that when a snowflake is first formed it could be described as geometrically perfect - certainly at the atomic level. However, on its long journey from the cloud to the ground, the many climatic changes it is subject to cause it to lose the perfect geometry and symmetry it originally had. And so, the complexity of the natural world requires more examination of patterns if we are to understand the part chaos also plays in nature.

Fractals – nature's fingerprint

Jackson Pollock - abstract expressionist artist - was declared artist of the 20th century, although he split the opinion of the artistic world, with some calling him a drunken lunatic, whilst others considered him a genius. Professor Richard Taylor of the University of Oregon - artist and physicist - was the first person to demonstrate that the chaotic, random images for which Pollock was famous, actually told a story that literally mimicked the patterns that we can find in nature.

These patterns found in the 'chaos' of Pollok's work are known as fractals. Fractals are how nature builds the world – using detailed, never-ending patterns that repeat themselves across different scales identically. These never-ending, repeating patterns can be found in rocks, mountains, clouds, coastlines and trees.

Pollok's work was examined by Professor Taylor, and what he uncovered was a mathematical rhythm and symmetry that could be found everywhere in the world around us, suggesting that when something appears random or chaotic, there is in fact an underlying symmetry and pattern even when it appears not to be obeying any laws. Pollok's artwork was and still is considered unique and Professor Taylor believes, evidenced through his research, that Pollok's contribution was more than paint on canvas. It gave us an insight into the true workings of nature and the principles that underpin chaos.

The fractal system is governed by one rule that can be found running through nature - 'grow and divide'. Everything in nature is striving for the optimal growing conditions, whether that be a seed, a leaf on a tree, a human cell, a pathogen, the brain - everything honours this one law in its attempt to survive and thrive.

The idea that fractals are inherent in every facet of nature, was first pioneered in the 1970s by French mathematician, Benoît Mandelbrot (see his most famous creation the Mandelbrot Set). The 'grow and divide' principle explains the fascinating complexity of the world around us, a complexity largely governed by this rule - a rule that further illustrates that nature, in fact all energy, is always looking for the most efficient way of doing things.

Fractals give us an understanding of the mathematical rules that influence the visible and the invisible.

Where does chaos fit into The Code?

Chaos has been defined as 'The behaviour of a system which is governed by cause and effect but is so unpredictable as to appear random.'

As we can see from this definition of 'chaos', the idea that things and events 'appear' random does at first seem to be accurate. However, the more you examine chaos the more you find that the randomness of things does indeed have a strange order and beauty of its own - as revealed by fractals.

Chaos is a central part of The Code and applies to the entire universe, including humankind. The difficulty with chaos is that prediction is much more challenging because tiny variables, under the influence of the cause-and-effect principle (which underpins all life's dynamics) can be magnified into huge events; our weather being one of the best examples.

This is why weather predictions beyond five days become more challenging and speculative as weather is dependent on so many variables. Therefore, to factor them all into an equation of prediction is almost impossible. How can we know, precisely, the pressures of all the different weather systems anywhere in the world and how they might interact with one another? How can we be exactly sure of what the wind will be doing in a week's time? How can our calculations about temperature be absolute at any given point? The answer is we can't 'tie down' those factors precisely, especially the further we attempt to project these predictions into the future. Scientific data demonstrates that weather predictions under three days have a high level of accuracy, but that our mathematical formulae and calculations break down when we start trying to calculate the weather beyond a week.

So, we can see, chaos is an illusion only supported by our ignorance about The Code.
When we see variations in the symmetrical order of the known universe, what we are in fact seeing is variables impacting on that neat sequential equation that can be best observed at the atomic and subatomic levels. As discussed earlier, these variables largely generated by natural phenomena, create a disruption of The Code, therefore distorting the outcomes. But despite these onslaughts The Code remains intact, making it possible for us to predict so much about human behaviour and the natural world.

Human behaviour – the patterns of predictability

We are slowly beginning to see that The Code is in fact a simple set of rules, managing great complexity. Each rule managing one bit of the web of life and yet each overlapping and cooperating in such a way that throughout the universe there is seamless unison.

There does appear to be one law under which all the others operate and that is the law of cause and effect. In other words, nothing ever happens without reason. We may not always be able to see it, understand it and therefore explain it but the world around us and the world inside us always respond to this overarching principle.

Professor Iain Couzin of Princeton University has studied the movement of living things from

microorganisms to human beings. What his study has shown is that with all these organisms, be they ants, fish, or humans the rules are essentially the same - each striving for order and efficiency.

Professor Couzin, by establishing the patterns of human beings within crowds and then using that data, has been able to predict all manner of things about human behaviour - like how people behave in shopping malls, supermarkets and railway stations, through to what is likely to happen during the evacuation of a building. The study of people in crowds shows that although things may appear chaotic, we are unconsciously following the innate rules of efficiency, always trying to improve and maximise output.

When we look more closely at an individual there is greater complexity and yet the patterns of predictability are still apparent, which is why subjects like sociology and psychology have been very helpful and for the most part have proved successful in understanding human behaviour and in predicting how to get the best outcomes through a variety of therapeutic programmes.

Criminologists have drilled down into human behaviour to such a degree that they have come to understand humans are addicted to patterns. This has helped in de-coding and predicting the behaviour of criminals. One very clear pattern is that by understanding past behaviour, future behaviour can be predicted in quite precise ways, not just for an individual criminal but for all criminal behaviour - and so the 'drivers', which influence their decisions and choices can be used to anticipate what a criminal might do next. By working out these patterns it is also possible to retrace the steps of criminals and calculate what else they might have done.

To further understand how criminologists are using the knowledge of patterns, see the work of Dr Rossmo of Texas State University, who specialises in analysing the behaviour of serial killers. Through his research, Dr. Rossmo has distilled the patterns of criminals down to a primary equation, which has been used to great effect in police work all over the world. This formula and the techniques and strategies that have emerged from it have come to be known as 'geographic profiling'.

The wisdom of the crowd

The 'wisdom of the crowd' is a term that statisticians use for asserting that the 'mind of the group' is greater than the individual. This conclusion has been drawn by repeatedly observing what happens when you apply the mathematical formula for calculating averages. If you get a large enough group to guess something they achieve a startling level of accuracy. A typical experiment that demonstrates this phenomenon is placing a number of jellybeans into a glass jar and asking each member of that group to guess how many jellybeans are in the jar. What you will find is there'll be some who are extremely high in their estimates and others who are very low. Almost no one will get the number correct, although some might be close. However, if you add up all those guesses and divide them by the number of individuals in the group, some interesting patterns emerge. Generally, that average will be very close indeed to the actual figure - within the 1% range and in many cases as low as 0.1%.

This is again further evidence of the underlying principle of the seemingly chaotic being more ordered and calculated than we might think. Interestingly, this is why organisations like the NHS, Apple, Google, and other institutions interested in social patterns and behaviour have begun to use the wisdom of the crowd principle to predict all manner of things pertaining to human

behaviour. Based on the data accrued, they make predictions around disease and health, buying patterns, where we are likely to go on holiday, how we might vote, the cars we might buy and other social trends.

Physicist, Professor Geoffrey West of the Santa Fe Institute, who has spent his professional life trying to figure out different patterns in the universe, most recently has turned his attention to human life within cities. Through his research studying the evolution of cities, he has come up with an interesting observation, which presents us
with another piece of The Code.

His claim is that there is a magic number, which is 1.15 and that this number is arguably the most important number driving human behaviour. Looking at the historical evidence and the evolution of cities as they exist today, this number continues to turn up and he believes it can accurately predict what we will do for as long as civilisation continues.

His definition is "1.15 is the amount by which social and economic activity rises per capita when the population of a city doubles. In other words, there follows an increase of 15% in every social and economic area of life". This calculation has continually stood up to mathematical scrutiny wherever he has focused his attention in the world.

Here we see again that we are not living in a world of chance. Patterns are driving all events. We can either work with them fulfilling our potential in the process... or we unknowingly succumb to their unwavering force.

We hope this synopsis of The Code has lifted the 'veil of mystery' in such a way that the wisdom and hidden workings of life have been further illuminated. By looking behind this veil we have discovered life's systems and events are governed by clear, precise and efficient rules – always striving for the greater good.

We hope you will use these insights to strive for a better balance between creativity and conservation in your own life – fulfilling your potential in the process.

"When everything is stripped away you find mathematics at the heart... and all we're left with is The Code"

Professor Marcus du Sautoy (2011)

Please Note:

The research references in this paper have been drawn primarily from two sources:

1. Many of the modern references have been drawn from Professor Marcus du Sautoy's excellent work on The Code.

2. Many of the references from ancient civilisations/cultures are the by-product of the research undertaken by Reach over the last 25 years, which have led to two books.
The first is entitled Science the New God? which addresses science's rise to supremacy, arguably at the cost of our values and beliefs. The second book, Antiquity Comes Full Circle, addresses the ancients' contribution to the modern world.

Also see:

Patternology

The Journey of Becoming

The Story of Light

Metaphysics