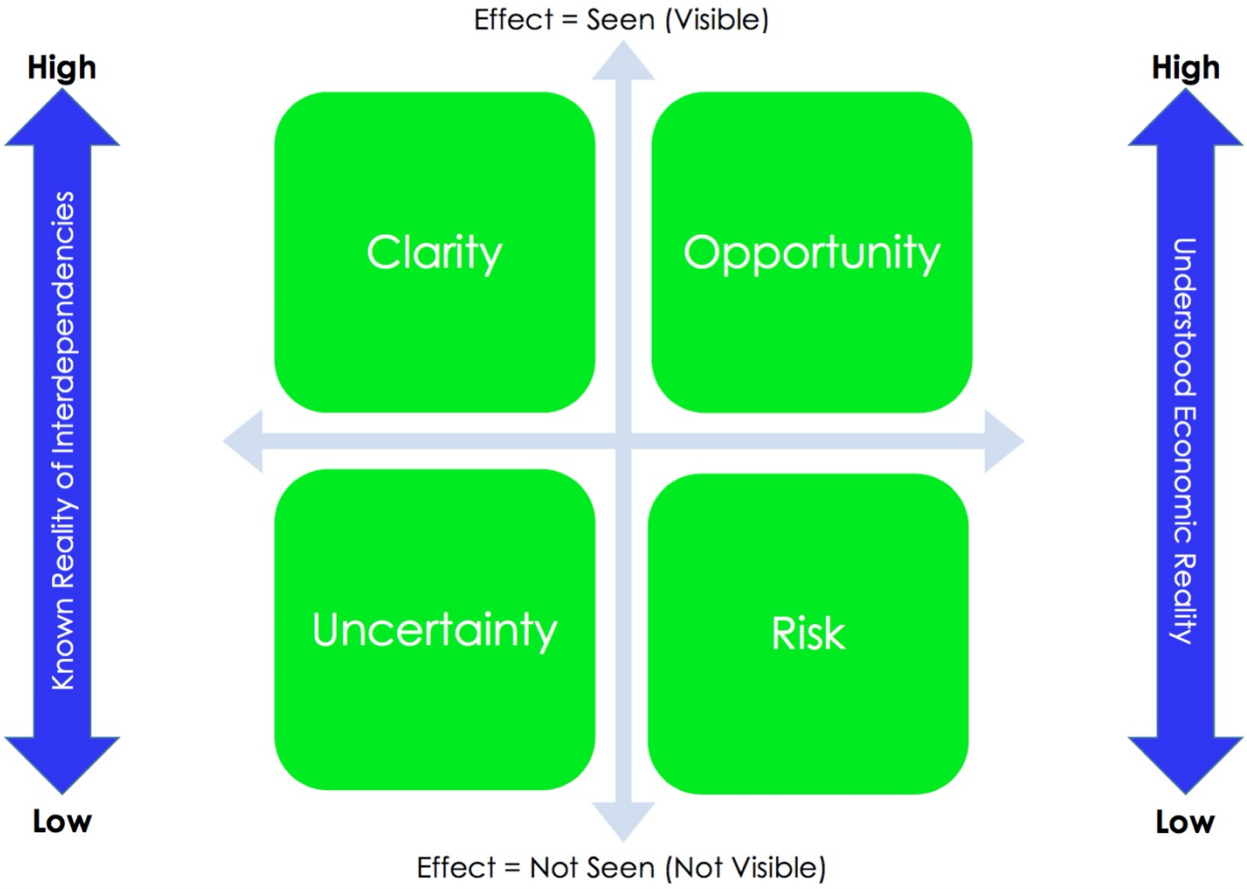
Some Weird Science

Behind

Sustainable Viability



Uncertainty and Entropy

Christopher Gleadle

Introduction

Sustainable Viability is a proven method to lower impact and raise value in organisations. It has been delivered and developed over thirty years practical experience and deep research (see The Five Essential Steps to Sustainable Viability). Never has it failed. Here I give some insight of Sustainable Viability from its scientific roots; and is intended less as a technical document and more of a short and readable overview. More a road sign than a road map since, like The Five Essential Steps to Sustainable Viability, it is to ignite curiosity and question the very slow nature of the current sustainability culture, than deliver all the answers.

Like many experiences in life, on the surface, the idea was simple, but realisation more complex. The desired outcome to assign quantifiable metrics that internalise what is traditionally seen as externalities.

And, since mathematics is a precise language that is the fundamental tool for describing, and therefore measuring, just about everything in our physical world, it was to build a system that bridges the fragmented specialisms that make up the contrasting sustainability nomenclature that tends to be fluffy - despite the large number of proclaimed experts!

The measurement problem

In order to measure anything, surely the first task is to define what it is that is to be measured. Not as easy as one may think, since, even to measure the length of some physical object may not be as simple as the utility of a measuring tool. For example; it is relatively straightforward to find the length of a piece of wood. There may be a need for defining an acceptable accuracy, since a specific tolerance might be needed if the wood is to fit within a particular space. But the length of wood can easily be measured with some level of confidence. The height of a mountain is less obvious. As for measuring the length of a coastline, then the real trouble begins, which results in special branches of mathematics being developed; such as fractal mathematics.

How long is the coastline of the United Kingdom? One estimate is that it's about 2,400 km long. However, the CIA world fact-book puts the figure at more than five time this, at 12,429 km. Your estimate of how long the coastline is depends on the length of your measuring stick - the shorter the measuring sticks the more detail you can capture and therefore the longer the coastline will be.

The key to understand fractals is to detect the fundamental properties that do not change from one object under study to another. Even more, by studying the fractal structure of chaotic systems, it may be possible to determine the critical points where predictability in a system breaks down. Accordingly, "fractal geometry is about spotting repeating patterns, analyse them, quantify them and manipulate them, it is a tool of both analysis and synthesis" (Mandlebrot).

It follows, the purpose of fractal geometry is not to obscure the role of science; but instead, give a more creative approach to scientific method. While classical physics used the top down Euclidean method, the fractal approach grows from the bottom up, more specifically from observation (see annexes). Greater, it is a parsimonious method as from simple rules complex phenomena can be explained. According to Mandelbrot (2004), "[The aim of science is] to provide a compromise between two very different goals: satisfactory statistical fit to observations and the highest achievable parsimony". Given these special features, fractal geometry has extended to areas such as hydrology, meteorology and geology, and even to economics (see Annex 1).

What is Sustainability?

The word is derived from the Latin: to maintain, support or endure.

On March 20, 1987, the Brundtland Commission of the United Nations defined Sustainability as it relates to human life on our planet: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

Wikipedia charts the several variations and revisions of this definition.

Elsewhere we find:

- Sustainability is an attempt to merge ecology and economy into one system.

- Sustainability means living a life of dignity in harmony with nature.

- Sustainability means renewing resources at a rate equal to or greater than the rate at which they are consumed.

- Sustainability means living within the resources of the planet without damaging the environment now or in the future.

- Sustainability means creating an economic system that provides for quality of life while renewing the environment and its resources.

- A sustainable community is one that resembles a living system where all of the resources (human, natural and economic) are renewed and in balance for perpetuity.

- Sustainability is creating a world where everyone can have fulfilling lives and enjoy a rich level of well-being within the limits of what nature can provide.

- Sustainability means taking the long-term view of how our actions effect future generations and making sure we don't deplete resources or cause pollution at rates faster than the earth is able to renew them.

- Some of the many uses of the word sustainable include: Sustainable Business / Sustainable Development / Sustainable Agriculture / Sustainable Living / Sustainable Community.

- Sustainability. In essence: to sustain, to continue our capacity to live life on this planet - to endure.

- Sustainability is improving the quality of human life while living within the carrying capacity of the Earth's supporting eco-systems.

- Sustainability is about stabilising the currently disruptive relationship between earth's two most complex systems—human culture and the living world.

- Sustainability is what sustains us as diverse people and communities—from clean air and water to healthcare, education and art—and making decisions in our individual and collective lives with this big picture in mind.

- Sustainability is both local and global. It requires of us that we consider both the past and the future in terms of current and best practices.

And so on, and on and on…Creating confusion, misconception, miscommunication, fragmentation, disassociation and sub-optimal behaviour - much that is conducted in the name of sustainability causes compromised performance and waste.

An attempt to mathematically define Sustainability

We can draw some conclusions from the array of sustainability definitions:

Common amongst these, and from a mathematical standpoint, we can state that Sustainability has a functional relationship with 'time', 'planetary resources' and human decision making or 'intent'; where planetary resources include: animals, vegetables and minerals as well as the natural systems upon which they need to survive: the interdependent systems variously known as 'Nature', 'ecosystems', etc.

So; let us apply a possible formula:

$$S = f_1(t)\ f_2(R)\ f_3(I)$$

We will use equals for simplicity:

where S = quantifiable measure of Sustainability

t = time

R = Planetary resources

I = Intent

f = some functional relationship

Any form of acceptable result for S implies:

f_1 defines a relationship to time. An example of this relationship could be the time it takes for a finite resource to be consumed. Generally, we are sustainable over short periods of time, as we anticipate tomorrow will not be too dissimilar to today. What is more challenging is when time is extended over decades.

f_2 requires understanding (implies mathematically acceptable model) of R. Planetary resources are incredibly complex. While mineral reserves, and their distribution, may be relatively easy to estimate, the effect of human activity on the environment, which in turn is vital to provide other resources (food, water, air quality, etc.), is exceedingly complex.

f_3 requires understanding of I. The complexity of modelling planetary resources pales into insignificance compared to how little we know about human intention. Yet, it is our individual and group intentions that have created the complex world of today (Economy, society etc).

Take a breath…

Let us accept that science is an attempt to understand the physical reality of things, which includes the nature and functioning of what has been defined (in this document) as Planetary Resources. Also, let us accept that science has found the need to create multiple specialist disciplines in its attempt to understand R; and that science has yet to develop a model that can be relied upon to explain the entire system of R, and, given both the fragmentation of

specialisms and the scant attention to I, it is safe to conclude that Sustainability has a long-journey yet to create the outcomes it needs.

Begin again…

To build upon the last loop of thinking, and paying special attention to the unknowns, it can be seen that a desirable result for S would require:

- non inverse relationship with t (i.e. sustainability improves over time)
- non inverse relationship with R (i.e. abundance rather than depletion)

As a result, it is desirable for S to remain constant or improve over time, while improving S is not at the expense of R. (Note: while we can generate a scale of S, such as 0 - 100, the scale represents degrees of un-sustainability - a measure of how bad we are doing. By definition, something is either sustainably viable or not.)

This means, we need only to know something about the nature of f_1 and f_2 as it's not necessary to know R.

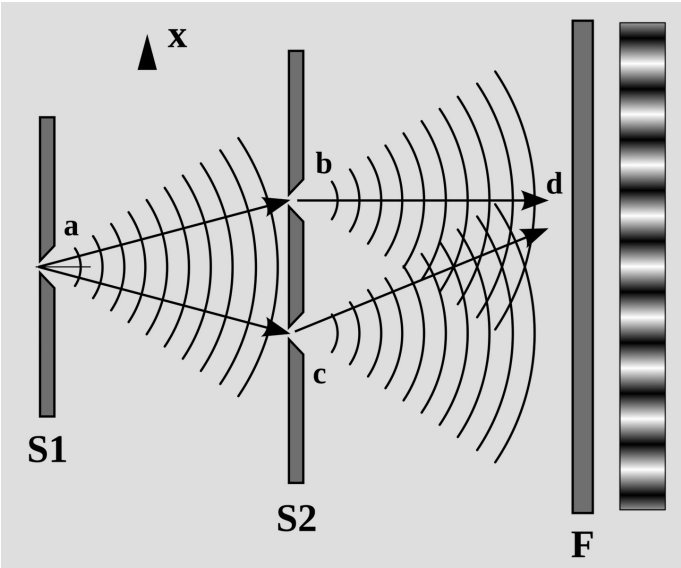
"Many times, there are lots of things we think of as things when actually they are a relationship between things."

It turns out that I or Intent is really interesting!

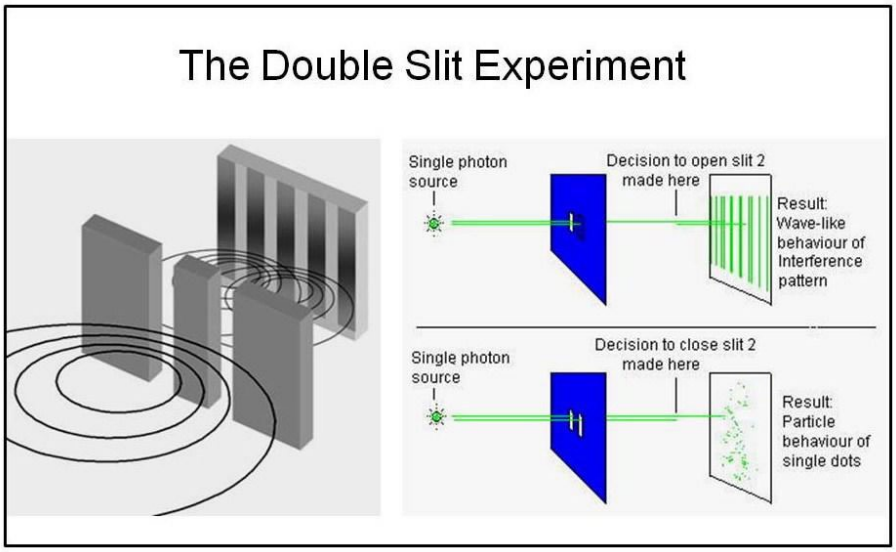
The nature of Intent

In 1801, Thomas Young (1773 - 1829), conducted an experiment in an attempt to resolve the debate as to the nature of light. The discussion at the time was whether light was a wave of energy or a stream of particles. His experiment, the double slit experiment, is today the most repeated experiment ever undertaken. Its repeated with ever increasing refinement and complexity simply because the result belies belief. Our rational minds struggle to accept the evidence. It is important for this discourse to understand that when Young undertook the double slit

experiment, his conclusion was quite clear: light is an energy. Light has wave properties. Light was not a stream of particles.



However, in the early 1920's, Albert Einstein (1879 - 1955), also experimented with light - its speed being the fundamental maximum limit of velocity, and so key to his theories of relativity. His experiments concluded that

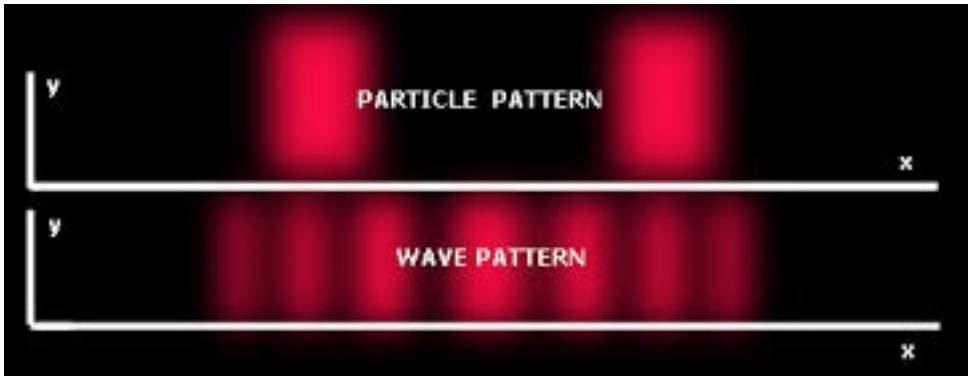


without any doubt light was a stream of particles; and not as Young had concluded.

Consequently, in 1928, in Stuttgart, Germany, there was a meeting of the world's most prominent scientists and greatest thinkers, which resulted in what became called the Stuttgart Statement. Today, the Stuttgart Statement is known as the Stuttgart Interpretation (quite different, because the meeting was simply to record the facts, the results, of their respective works as pertaining to the nature of light, hence a Statement, not an interpretation).

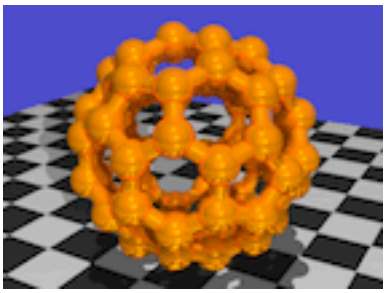
The reason for this change is that it became apparent that human consciousness affects the outcome of the experiment. What happens in the physical reality is determined by the interaction of our consciousness - the observer of the experiment determines the outcome. **Have a look at this!**

"Observations not only disturb what has to be measured, they produce it…We compel [the electron] to assume a definite position…We ourselves produce the results of the measurements." Pascual Jordan (1902 - 1980) Theoretical and Mathematical Physicist



who made significant contributions to Quantum Mechanics and Quantum Field Theory.

When data about the passage of light in the double slit experiment was collected stored and reviewed, the outcome showed that light was a wave. Yet, when data about the passage of light in the double slit experiment was collected, stored and then destroyed after the experiment was long concluded, the outcome showed that light was made up of particles!



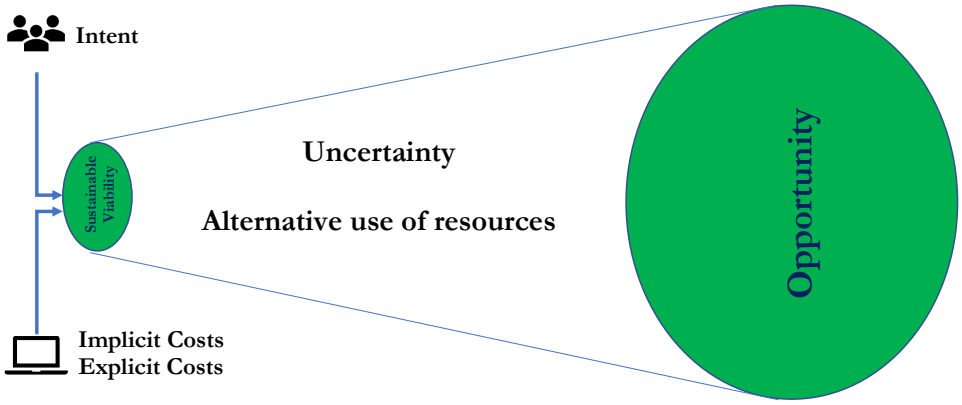
Many variations of this experiment have been devised, and the more complex and innovative the set-up, the more impossible it is to accept the results.

Interestingly the same experiment has been conducted with atoms, molecules and even carbon buckyballs (a molecule of carbon where the carbon atoms are connected in the same pattern of hexagons and pentagons you find on a football - hence the name). So even with relatively large objects, there is the same outcome: albeit more difficult because the degree of conscious influence is directly related to the level of uncertainty in the experiment. Uncertainty is our friend!

Our entire world is made up of atoms whose behaviour (and existence) is determined by consciousness. As a result, consciousness directly interacts with what we call our physical reality.

What this means in practical terms is that when there is uncertainty, there is opportunity to change physical reality.

Uncertainty Fuels Opportunity



It's Impossible

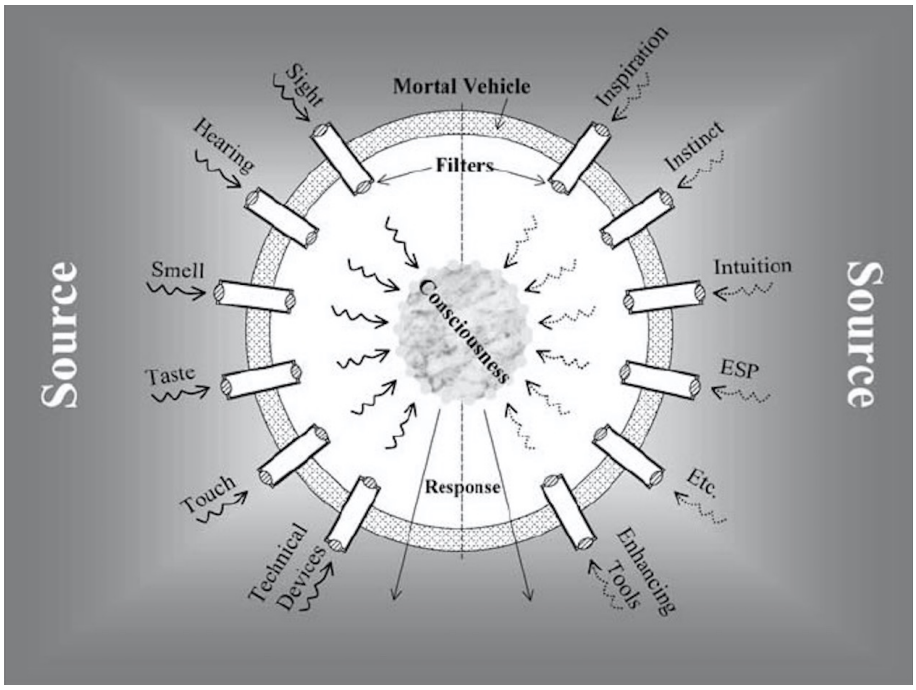
In the 19th Century, the talk of 'impossible', to see electrons carrying insignificantly small amounts of charge may have been interesting. And far removed from the everyday world. Likewise, Maxwell (James Clerk Maxwell FRS FRSE (1831 – 1879), Scottish scientist in the field of mathematical physics) developed a series of complex equations relating electricity and magnetism, which may too have seemed almost beyond even the undergraduate maths student, and again, far removed from the reality of the time. But our world today could not exist without these discoveries. The breakthroughs were made. The evidence was uncovered. And knowledge formed. It took some years before the changes in everyday life were felt. The Stuttgart statement was made nearly 100 years ago: the time is right for Sustainable Viability.

Occams Razor

The principle of Occams Razor (attributed to William of Occam (1287 – 1347) is that in explaining a thing, no more assumptions should be made than are necessary.

Moreover, little known is the amount of research being undertaken by different groups around the world based upon the alarming, but most likely conclusion: our physical reality is not what we have always thought it to be: it's not 'objective and causal', its 'subjective and probabilistic'.

What this implies is that our 'outside of ourselves' world is nothing but an illusion. Accordingly, what we sense, feel, see, smell, taste, hear, is no more than a stream of data flowing from our senses to our consciousness.



Ummm…So What is reality?

Possibly, the easiest way to understand reality is to think of our experience - of what we call reality - as a total immersion into a highly sophisticated digital virtual reality. As a result, digital where the 'bits' are quanta of Planks constant resolution. (Max Plank 1858 - 1947 theoretical physicist - his constant being equal to the energy of a

quantum of electromagnetic radiation divided by its frequency; giving rise to the natural (smallest) units of length, time, and energy (Plank units)).

Naturally, there is a tremendous body of authoritative research that has been, and is being, undertaken on the simple assumption that our reality is purely subjective and probabilistic. Hence our apparent objective cause and effect reality is but a subset (see Annex). Nothing has yet been able to disprove this revised view of our world. Accordingly, more and more evidence has accumulated - though some is extremely challenging to accept: not for lack of evidence, but simply because of our life long mental conditioning that has led us to the unshakable assumption that everything we see and touch actually exists as a physical reality separate from ourselves.

Does it make a difference?

For most of us, getting up each day, going to work, spending time with our families, does this new model, this new way of thinking, make any difference? The answer is a resounding yes. The why is beyond the scope of this document, but it becomes clear in The 5 Essential Steps to Sustainable Viability.

Also, for those of us who wish to understand and improve sustainability (whatever definition we prefer) then it is important to understand our interrelation between Nature or Ecosystems, is in reality, the interdependent relationship between our intent and our physical reality. To see all is interdependent and see uncertainty as our friend to make use of this knowledge, then we have an advancement to create better quality lives for all, including future generations.

Consciousness and Intent

We can focus ourselves to varying degrees, just like light through a lens, and it is this focusing that we call intent.

When we focus our consciousness either individually or as a group, it has impact on our reality. Interestingly, this is not a one-way relationship, and the so-called physical reality has a direct impact on our consciousness - bypassing our physical senses and hence the need to process data in our brain and mind.

"Everything we call real is made of things that cannot be regarded as real" – Niels Bohr (1885 - 1962). A Danish physicist who made foundational contributions to understanding atomic structure and quantum theory - Nobel Prize for Physics 1922.

Measuring consciousness

Much work has been undertaken since the mid 1960's that show individual and group consciousness can be easily and accurately and repeatably measured. It obeys a logarithmic scale from 1 to 1000.

Consequently, intent can also be measured - using similar methods.

Introducing Sustainable Viability

If we can measure intent, which we can, then we have progressed enormously in our ability to measure sustainability.

But the journey of exploration to reach this point has opened so many more possibilities that to just measure Sustainability is to take the frame but leave behind the priceless work of art.

Sustainable Viability

Sustainable Viability is an enabling method to measure the effect of sustainability in three dimensions with something as simple as an excel spreadsheet. And:

1. Accepts that 'physical reality' is subjective and probabilistic
2. Posits, that what we call 'physical reality' is the product of consciousness and includes the results of the sum total of human intention, focused or scattered, selfless or selfish.
3. Enables capability to influence physical reality using our natural and innate power of consciousness and intent
4. Understands and accepts the limitations and restrictions that are automatically and irreversibly imposed

Annex 1

No More Normal, A New Normal…What's Normal?

Critical information is often unknown at the time or unknowable, concealed, misrepresented, and/or misunderstood.

"To all the complexity of the physical world of weather, crops, ores, and factories, you add the psychological complexity of men acting on their fleeting expectation of what may or may not happen," **Benoît Mandelbrot.**

Utilising fractal mathematics, Mandelbrot created market simulations that matched the characteristics of the financial markets—from volatility to patterns of advance and decline, cyclical movement, and other mathematical relationships.

Unlike most complex physical systems, the agents of an economy, and perhaps to some extent the economy itself, have an extra ingredient, an extra degree of complexity. This ingredient is (mis)behaviour, which in itself is at the heart of all risk management optimal performance strategies.

Power Law (the functional relationship between two quantities) distribution has a dramatic impact on what may be seen as normal: it renders the term normal, nonsensical. For example, imagine a room full of people. We measure their heights. From their heights we can determine an average. Imagine to this room of people we introduce the world's tallest person. The average height will increase only marginally. Now, imagine to the same room of people we have measured the average income. To this room we introduce the world's wealthiest person. The average will now change by such a vast amount – perhaps billions – it renders the average nonsensical.

As we increase the number of samples the values will not converge to a normal but diverge. This makes asking for an average a bit like asking how long is the average piece of string?

Consequently, what we develop is an exponential relationship between:

1. The size of the event
2. Frequency of it occurring

And, for example, in the natural world, more and more do we witness extreme events. We see this effect in increasing hurricanes, droughts, floods, fires, pandemics etc. Normal is no longer applicable.

Normal distribution is vaguely derived from the fact of taking random samples from components that have no correlation between them. For example, if you were to flip a coin, the coin will follow a pattern of normal distribution of heads and tails. But this does not mean that winning on one table in a Casino you will, as a result, win on another.

Extreme events are much more likely. We see this effect in increasing hurricanes, droughts, floods, fires, pandemics etc.

In contrast, we do not live in a linear world. It is the misbehaviour of man that has created linear processes and forced them upon a circular, three-dimensional, looped, feedback world. On this basis, the siloed thinking of 'green', 'low-carbon', energy, water etc will at best deliver sub-optimal performance.

Isolated (siloed) processes allow only incremental improvement. Integrated systems allow exponential improvement.

Whereas fractals have symmetry with respect to scale and are both mathematical constants that derive from iterative functions and real-world phenomena. As with non-linear systems, the idea behind fractals is feedback and iteration. Behind Sustainable Viability is feedback and iteration.

The Earth's surface and all living things upon it are incredibly diverse. The Earth presents a vast template of geology, physical oceanography and limnology and a climate that varies on a scale from the largest oceans, continents, lakes and rivers to the tiniest microsites. Billions of individual organisms belonging to millions of species are

distributed over the Earth. These and many more act upon one another interdependently.

As with non-linear systems, the idea behind fractals is feedback and iteration. Behind Sustainable Viability is feedback and iteration.

It follows, natural complex systems offer many orders of magnitude and provide a means for extrapolating between scales: between the large scale of the globe, region, ecosystem or habitat where ecological relationships appear to be complex. The study of scaling is a way of simplifying ecological complexity and of understanding the human, physical and biological principles that regulate biodiversity.

Vivid biological patterns emerge from even subtle interactions. Similar phenomena are seen in the emergence of order in economic, social and political systems.

Dr Jim Haseloff, from the Department of Plant Sciences at the University of Cambridge

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Understanding Economic Risk

Mixed with the complexity of nature's systems, is man's intentional impact upon those systems and the economies [of scale], that along with the resources of the planet, help provide for the well-being and growth of communities intermingled with the creation of self-sustaining systems.

And, using tools of probability, investors can evaluate the odds for or against some outcome. Yet such tools rely upon the normal bell curve and standard deviations. And, while forecasting markets may be perilous, fractal mathematics can estimate the odds of future volatility from a wider, more complex spectrum of systemic risk.

In contrast, one of the simplest models for price and market variation is based on the sum of independent random numbers where the random numbers are considered to conform to normal distribution. For example, a financial

trader needs to obtain information that can provide some confidence in the immediate future of a stock. This is often based upon repeating patterns from the past - patterns based on the interplay between greed and fear. This based on a backdrop of increasing extreme events. It follows, the normal dynamics of market (mis)behaviour will attract extreme events, such as Black Monday, when in October 1987, the markets fell twenty two percent: which under normal distribution has a 10^{50} chance of happening!

The fractal model describes a process that leads to long-tail distributions. Consequently, the markets, portfolios and individual businesses become inclusive and circular in nature as they become self-aware of the greater dynamic systems that will affect value in the future: that value in the future will have little to do with the 'normal' distribution patterns of the past.

Consequently, Sustainable Viability explores outcomes of non-linear feedback loops, verified across the whole. The process of SV is outcome focussed to produce structures that have a scale and variant property to produce de-risked value optimised eco-innovative organisations.

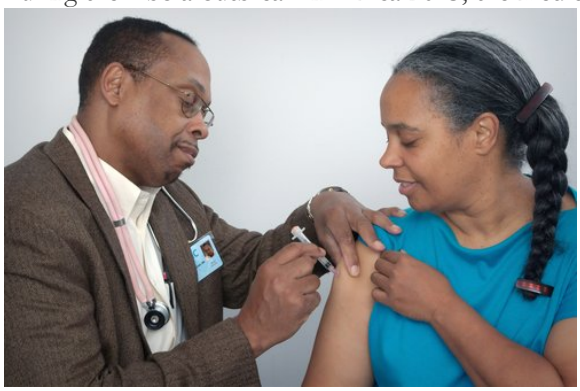
Annex 2

Naïve Modelling and Covid 19

"If you can't imagine it, your model can't capture it, and that means the evidence won't reflect it." CMG

A Cautionary Tale

During the Ebola outbreak in Africa 2013, the medics that attended the stricken countries installed procedures. They



treated patients as best they could and isolated communities to stop infection spreading. But Ebola continued to rise and rise. Initially, despite their best efforts, they were confounded and alarmed by this trend. Then, they got a lucky break. A group of doctors and nurses visiting a village noticed body bags in houses. Upon further investigation they discovered that the bodies of deceased relatives had been dug up (from UN monitored and approved burial sites) and moved to the relative's homes awaiting re burial.

Culture, an aspect not imagined in the models, was the critical factor. The people who had died were originally put into black body bags. Black was seen by the local people as ill-omened, as black stopped the souls of the dead rising to heaven. So, each night, they dug up their relatives' bodies and moved them back to their villages in order to replace the black body bags with white shrouds. This action allowed the infection to continually spread. The answer was to replace the standard black body bags with white ones.

This action combined with doctors and nurses changing to white suits, as well as using clear face shields that increased trust (the typical surgical mask hid their faces increasing fear and distrust) allowed better access to the villages.

Modelling Problems And Problems With Modelling

With Covid 19, the data is showing a skew toward ethnicity. In addition to genetic and physiological elements, could this have trust and cultural components both of BAME communities themselves and of those doing the analysis?

The use of mortality data in modelling Covid 19 is problematic: most notably "using death data is ……good for making decisions approximately four weeks back". However, time may not be the only potential issue. Another significant factor could lay in the mind and intent of the modeller. For example, records are kept for decades of people who have occupied hospital beds. These are people who have been in hospital, been treated and left. So, measurements have been taken. Experiments have taken this historic data and broken up the data into chunks, some put on one side as a control, the other focused on by an experienced practitioner with the intent to give those people represented by those records' better health. As a result, they would appear not to stay in hospital so long.

Accordingly, repeated experimentation shows that the intention behind modelling correspond to various realities. In other words, model outcome could be due to the conscious reality of the interpreter of the data. Experience, bias or simply the desire to predict an outcome (and by that prediction enforce a context) can create the desired outcome (See: The 5 Essential Steps to Sustainable Viability; 62/63). In other words, how patient files are viewed in relation to one another and the relationships drawn between them can align to create a new or different reality. Patient history has not, in itself, been changed, but how that history has been interpreted. That new reality can tell a new story.

Benjamin Libet found that unconscious brain electrical activity occurred up to ten seconds before there was any conscious sense of decision-making by a subject. This and other experiments prove the brain makes its own decisions on a subconscious level, and people only later feel "they" have performed a conscious decision. Consequently, we go

through life thinking that, unlike the autonomous operations of the heart, we are in charge of the brain's workings. As a result, control, is largely an illusion:

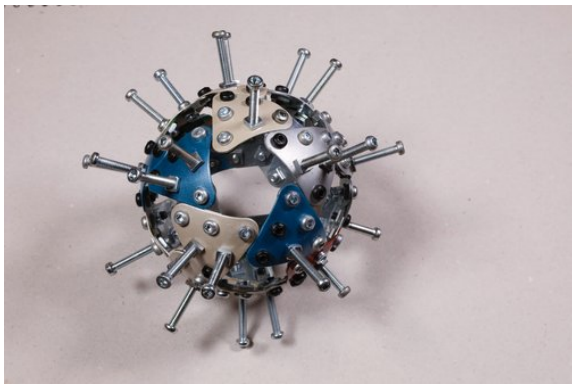
"We can will ourselves to act, but we cannot will ourselves to will." Einstein.

Consequently, in terms of subjective probabilistic reality, it is the reality perceived by the conscious mind that exists, and not necessarily in any physical sense. Hence, intention is likely to be the result of a subconscious action and reaction in the brain. The moving of a finger, the action to push a button could be deemed to be a conscious intent applied to an unconscious initiator. Could therefore free-will be under threat? Probably. Since, the action of an intent is probably the result of the subconscious one. (See New Social Media and Impact of Fake News on Society).

Data Vs Information – Knowledge Vs Wisdom

Intention is about understanding the difference between data and information. The data for each patient exists on file, but it is the information that resulting from collecting the data into random groups and dividing into chunks. Thus, the information has uncertainty, and if it has uncertainty, then it can be influenced by intention. Focusing intent on the results of a random mix of the data could influence the outcome.

Accordingly, there is a need to break away from the assumption that the reality illustrated in models is causal, even though it may seem logical to assume that what happened in the past caused what is happening now: concluding it is a causal world since cause and effect are part of the collapsed wave function[1].



However, what happened in those hospitals is a matter of historic fact. What happened when the data was collected, mixed up, devised into chunks and analysed is entirely different. It is not an effect of what happened in the past, it is separate, and breaks the link between the idea of cause and effect, which is deeply ingrained in our assumption system.

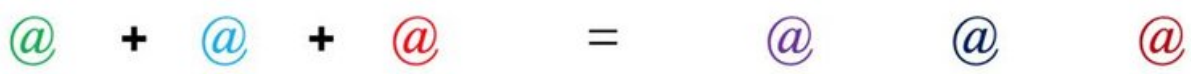
[1]In quantum mechanics, wave function collapse occurs when a wave function—initially in a superposition of several eigenstates—reduces to a single eigenstate due to interaction with the external world. This interaction is called an 'observation'.

For example, when we make assumptions of equality, we are implying that two objects are exactly the same. Equality is a strict relationship- either two things are equal, or they are not.

Equivalence, however, considers the many ways that two objects stand in relation to each other.

A very simple example.

1 + 1 + 1 = 3



Set theory recognises that two sets with three objects each pair exactly. But it doesn't perceive the different ways we can do the pairing. (I have used colours so that you may see the variables.)

As a result, whilst there are lots of things we think of as 'things', in reality they are not things but in fact a relationship between things.

To reimagine decisions, forces the expansion of the decision space – to be three dimensional as well as multidisciplinary.

"*To all the complexity of the physical world of weather, crops, ores, and factories, you add the psychological complexity of men acting on their fleeting expectation of what may or may not happen.*" Benoît Mandelbrot.

Hence, Sustainable Viability shows how waste and emissions relates as much to fiscal measurement and productivity to realise true value as why understanding what the laws of thermodynamics can tell us about how to improve organisational interactions between hard and soft systems. As a result, how to apply imagination to modelling to reflect the evidence.

Consequently, for all of us, to understand the true nature of information that is being presented it is important to understand the interdependent relationship between the intent and the physical reality. As a result, this will free us to see all is interdependent and see uncertainty as our friend to make use of the knowledge we gain and deliver the wisdom to create better quality lives for all, including future generations.

Annex 3

Evidence to Proof

The Importance of Expanding the Decision Space

Definitions:

Evidence: the available body of facts or information *indicating* whether a belief or proposition is true or valid.

Proof: argument *establishing* a fact or the truth of a statement.

Introduction

There is a near universal agreement that Net-Zero Carbon by 2050 is a desirable target for meeting the challenges of the Climate Emergency. This is too slow. And, to meet a Net-Zero target within an earlier time horizon will require a shift in approach to climate mitigation actions since until now an incremental sub-optimal path has been chosen. As a result, progress has been very slow.

Consequently, to attain Net-Zero will need both a strict measurement methodology to remove ambiguity of emission and waste claims as well as a multidisciplinary, three-dimensional, systemic approach to create exponential change and zero-waste systems. Accordingly, Sustainably Viable behaviour is essential if all countries are to act in harmony and are to tackle meaningfully such complex real-world challenges as climate change mitigation and net zero carbon emissions in an inclusive balanced manner that delivers climate justice and meets the Sustainable Development Goals.

As a result, to raise the bar to sustainably viable behaviour will require systems of proof. This does not deny evidence is important too, but as we have witnessed, evidence can be subject to, for example, spin, manipulation, bias, or even Base Rate Neglect*. Thus, 'green', 'carbon-neutral', 'carbon-free' claims are unreliable since they lack the rigour of quantitative information and fail to effectively internalise 'externalities'. Inevitably climate change has morphed to a climate emergency. This means that modelling projects, businesses or Government is a variable and dangerous game suggesting evidence is not enough. To attain Net-Zero institutions need to become acquainted with providing proof and shifting to sustainably viable behaviour.

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* when the mind is in the receipt of both general information and specific information, it tends to ignore the former and focus on the latter. Judgement Under Uncertainty, Amos Tversky and Daniel Kahneman, 1974. See The 5 Essential Steps to Sustainable Viability

Understand modelling and what story is being told

To keep it simple, let us take an easy to follow sequence. And see if we can predict the future of that sequence:

1, 2, 4, 8

Not difficult to predict the future of such a sequence. But to allay any nagging doubt, let us add another number:

1, 2, 4, 8, 16

We should all feel comfortable with this sequence. The next number will be 32 since the pattern is very clear. To find the next number all one has to do is double the current number. The evidence to this assertion is (for simplicity we shall use an equal's sign):

1 x 2 = 2

2 x 2 = 4

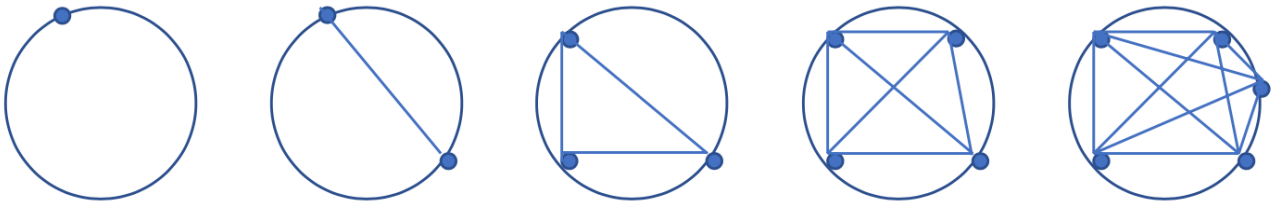
4 x 2 = 8

8 x 2 = 16

Consequently, the next number should be 32:

16 x 2 = 32

Let us consider the following sequence:



1 Point = 1 Region 2 Points = 2 Regions 3 Points = 4 Regions 4 Points = 8 Regions 5 Points = 16 Regions

Here, what we count are the regions formed within a circle by connecting the points on a circle. As a result of this action, one point on the circle leaves one region within the circle. It follows, two points connected create two regions; three points create four regions and so on to five points giving us sixteen regions.

Likewise, with the first example, we have the sequence: 1, 2, 4, 8, 16

A model now created will show the evidence that six points on a circle will give us thirty-two regions within that circle when all six points are connected.

However, to assume the answer is thirty-two is wrong!

It is actually thirty-one.

6 Points = 31 Regions

It is important not to ignore the fact that there are patterns that go 1, 2, 4, 8, 16, 32, 64 and so on. Doubling each time. However, there are also other patterns, as exampled above, that show the maximum number of regions that are formed from connecting points on a circle. As illustrated this sequence goes 1, 2, 4, 8, 16, 31, 57, 99, and so on.

The point of this example is that individuals or groups of individuals make assumptions based on their experience and bias.** This misbehaviour limits their decision space. As a result, decisions get made in silos that have sub optimal outcomes at the very best. People make assumptions and think that all the evidence has been provided. That the sequence 1, 2, 4, 8, 16 points to thirty-two being the next number. But it could be something else.

** The 5 Essential Steps to Sustainable Viability

Therefore, for people to expand their decision space also requires individuals to expand their imaginations – something little used in decision making. Hence, what we are establishing here is that it is proof that establishes the truth of things. As seen here all available evidence might point to 32 as the next number in our sequence, but without a proof, we can't be certain.

I do not deny that evidence is important. Often, before proving something we explore various examples and collect data. But it is how we then manipulate that data, based on bias, and intent, to construct information that, for example, advisors supply as evidence to policymakers based on what they have decided comes next. These results shape everyone's futures.

Decision Space is Three Dimensional

We can never be certain that our model behaves enough like the thing we are actually trying to understand to draw conclusions about it. Nor can we be sure that our model is similar enough in the ways that really matter since there are lots of things we think of as 'things', whereas, in reality, they are not things, but in fact a relationship between things. So, it can be hard to know that the evidence we collect from the model is truly evidence about the thing we want to know about.

Accordingly, to think on this requires an imagination to also think in three dimensions. For example, imagine we want to investigate the claim: Any two lines either intersect or are parallel. For simplicity, by "intersect" we mean the lines share a point in common, and by "parallel" we mean they go off in the same direction but do not intersect.

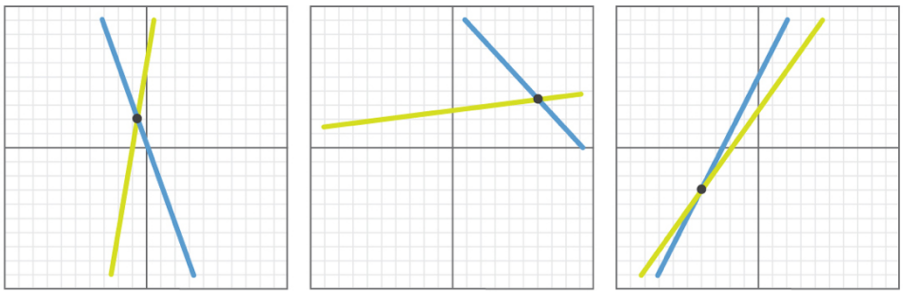
Firstly, we create a model. Let us imagine each line to be in "slope-intercept" form. Therefore, and for the purposes of simplicity, let us assume that every line can be written as an equation:

$$y = mx + b$$

m is the slope of the line (how steep it is) and b is the y-intercept (where it passes through the vertical axis).

The model allows us to create a random line by picking a pair of random numbers, m and b. Thus, we can pick a pair of random lines and test them:

1) Do they intersect?
2) Do they point in the same direction?
3) Does something else happen?



Example of what experimentation might look like.

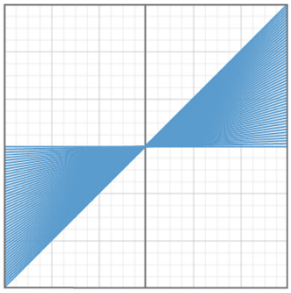
What we see is that the randomly selected lines intersect. If we tried this experiment a million times what we would find in all cases is that the lines would either intersect or be parallel. (all pairs of lines would probably intersect, since it's unlikely that the exact same slope will be chosen for both lines.)

As a result – even after looking at one million examples – it would be seen to be reasonable to come to the conclusion that all the evidence overwhelmingly supports the claim that any pair of lines either intersects or is parallel. You may even feel comfortable that you have expanded your decision space by testing one million times!

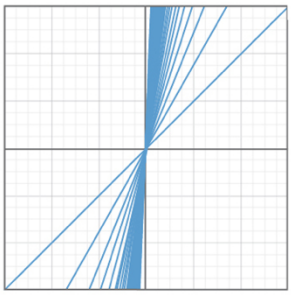
But evidence is only as good as the model. And, as we observe of the real world, modelling can be dangerous. Consequently, what danger have we created for ourselves here?

Firstly, one problem is that certain kinds of lines seem more likely to be chosen than others.

Below is a graph showing 50 lines where $b = 0$ and $0 \leq m \leq 1$.



And here below is a graph showing 50 lines where b = 0 and m ≥ 1.



What we see in these two examples is a quarter of the plane is covered by lines with slopes between 0 and 1. Another quarter of the plane is covered by lines with the slope greater than 1.

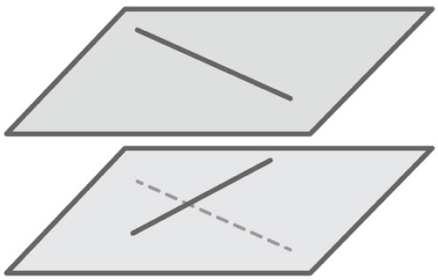
It follows that it would be reasonable to think that the choice of a number larger than 1 is more likely to be chosen than choosing a number between 0 and 1. Upon this it follows that a line is much more likely to be selected from the second plane than from the first. This means certain kinds of lines — those with slopes between 0 and 1 — could be vastly underrepresented in our model. If strange things are happening with lines in that region of the plane, our model is very unlikely to tell us about it.

Furthermore, upon closer inspection of the second graph suggests another problem. As m gets larger, the lines get steeper. The steepest possible line is vertical. What is the slope of a vertical line? By definition, the slope of a vertical line is undefined: there is no number m we could choose to create a vertical line. That means these lines don't exist in

our model, and so we will never be able to experiment with them. Before we even begin collecting evidence, we have excluded these possibilities by design.

And this leads us to the heart of the most serious issue with our model - any two lines either intersect or are parallel - is actually false.

Lines do not only have to either intersect or be parallel. Imagine two hallways running in different directions on different floors of a building. These "skew" lines do not intersect and are not parallel. And, the important fact about skew lines is that they must lie in different planes. But since our model identifies every line with an equation $y = mx + b$, we automatically assume every line is in the same plane. What our model will – only - generate is evidence that supports our conjecture, because if two lines lie in the same plane, it is true that they must either intersect or be parallel. We'll never see any evidence suggesting otherwise. Skew lines don't exist in our model. Just as we saw with vertical lines, our model has excluded what we failed to imagine.



Skew Lines

I fully accept that this is a very simple model with issues such as how we choose random numbers from infinite sets. The point I attempt to illustrate is that no matter how useful and interesting the model, no matter how compelling the evidence collected, if there is a failure to expand the decision space and imagine it in three dimensions, the outcome at best will be sub-optimal – or just what the modeler intended us to see.

Meeting Net-Zero – To be Trusted

To reimagine decisions forces the expansion of the decision space – to be multidimensional as well as multidisciplinary. Accordingly, if net-zero is to stand a chance of being achieved without ambiguity there needs to be a harmonization between fragmented specialisms and how policy and business decisions are made as well as how those decisions are implemented. As a result, we can create quantitative information that internalises externalities and values environmental return on investment. For: *" if you can't imagine it, your model can't capture it, and that means the evidence won't reflect it."*