To what extent can a magnetic field be a metaphorical canvas for new artistic perspectives?

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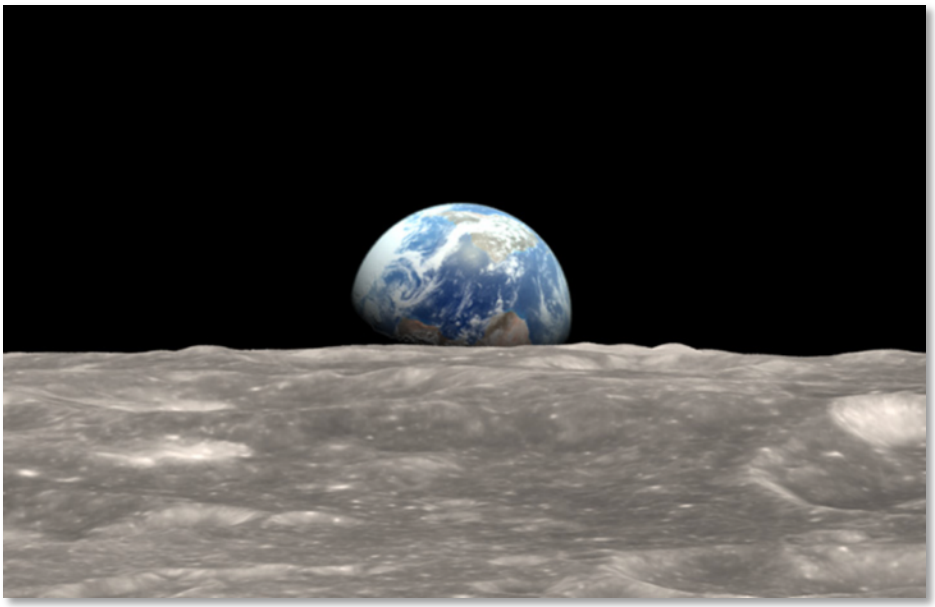
Abstract

Magnetism is a commonly understood phenomenon yet, like water for example, when it is looked at in scientific detail it is of more enigmatic nature. Magnetic fields emanate on cosmic and quantum scales, we are familiar with magnetic fields because we can also observe them on a human scale. Children play with magnets and readily accept this strange, invisible force when first encountered and for many adults it is enough to know that they attract or repel. Magnets are ubiquitous in everyday life, they are in most people's pockets, on their laps, desks, in their ears, and so on. Magnetic fields are like an invisible glue that hold systems together. Without the Earth's magnetic field there would be no life on earth. Without magnetic fields there would be no electricity that powers modern life.

Considering important moments in history that led to the understanding of magnetism and how it then changed the course of science and culture, I will argue that the earth's magnetic field can be seen as a metaphor that can shed light on contemporary culture including the environmental crisis we are watching unfold.



i. `Earth Rise' William Anders 1968 *(NASA)*

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Introduction.

What is so compelling about a magnetic field and is it relevant to contemporary culture?

One of the four forces in physics, a strange force, which has been harnessed to shape our modern world of electronics. A stronger force than gravity, it has come to affect the lives of almost everyone on the planet in a way quite different to the way the same force affects other animals. We generally acknowledge magnetic forces in a subliminal way, we know it's there, like radiation passing through our bodies or oxygen providing fuel to the blood, yet it remains an ethereal 'substance' providing the glue to daily life. I've been aware of the earth's magnetic field since childhood, as the compass detects and shows where North is, and working out the right direction to walk in when used with a map. Plotting and following a route was just another new concept to absorb at school and I have taken it as 'read' ever since.

I now see this force with a new appreciation and how it acts upon quantum and cosmic scales and how it permeates every aspect of our lives. Iron, the most abundant element on earth (35%) and the source of its magnetism is crucial to sustaining life, from the protection that our magnetosphere provides, to the iron in our blood. Our relationship to the earth's magnetic field and how it acts demonstrably upon animal behavior reveals a connection to the earth we humans may have lost and it could be indicative of a greater disconnect we have with our planet.

Earth's magnetic field has helped travelers historically and continues to orient travelers today, guiding us, knowing our place on the earth with the aid of compass technology. As we have no magneto-sense as other animals do, perhaps our strength, and our weakness, is having the confidence to be lost. As the Physicist J.R. Openheimer once said, '*live always on the 'edge of mystery' – the boundary of the unknown."* (Solnit, 2005). The art of getting physically lost may be the route to 'finding our way' in a more profound and connected sense to the natural world.

In some ways my own art practice has been a process of wandering off a path to discover new vistas, getting lost and finding a new path that offers new possibilities. "*The most beautiful experience we can have is the mysterious. It is the fundamental emotion that stands at the cradle of true art and true science."* (Einstein, 1931).

However, when framing the mysteries of magnetism within its wide and all-encompassing effects it might be helpful to view it ontologically, as an object in its own right. Object Oriented Ontology (OOO) is a useful philosophical tool to describe phenomena which have an indirect and non-literal path as a means of access. It might therefore be useful to see all aspects of magnetism as an object to help us get to the essence of its nature without complex mathematics.

A magnetic field is associated with words like; 'navigation', 'map', 'poles', 'compass', 'bearing', 'direction', 'on course', 'off course', 'dead reckoning', etc. which are used literally and metaphorically in language. I will explore these themes in relation to the historic discoveries of magnetism and what it might offer to the making of art in a digital, screen-oriented culture.

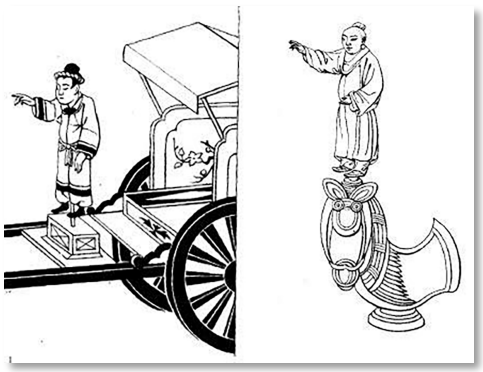
1. Discovery of magnetism

The word magnet came into western thought via the apocryphal story of a Cretan shepherd in Magnesia, first cited by the Roman natural philosopher Pliny the Elder (Jacobus R 1964, p179). As legend has it, while out tending his flock the shepherd found that the nails in his shoes stuck to the rock. This iron rich rock (magnetite) we now call Lodestone [1] is able to hold a magnetic field due to its high iron content. The rock however gets its magnetism not from the earth's relatively weak magnetic field but from the high voltage electrical charge of a lightning strike (P.Wasilewski, G. Kletetschka,1999, p2275–78).

ii. Magnetic lodestone attracting steel pins

Early history is sketchy, but we know that the Chinese were the first to utilise the properties of Lodestone as a navigational aid, the earliest reference is by Emperor Hoang-ti in 2700 B.C (Dill, J.G 2003). The mysterious nature of this heavy magnetic rock led to notions of divine power and having healing properties [2], making it more valuable than pure silver. The idea of the Compass came about initially by wrapping a thread around a Lodestone and marking the side which pointed south, this simple device was used in warfare and divination geomancy also known as Feng Shui (Needham & Ronan 1986, pp. 6, 18).

iii. the earliest compass Lodestone on a thread



iv. Artist impression of in figures mounted on the front of 'south pointing' chariots used in conjunction with a lodestone

The Chinese absorbed Lodestone into its culture and one of the first compasses to be invented was the charming Spoon Compass which is a ladle like deep bowled spoon made of brass with Lodestone moulded into the tip of the handle to point south and balances on a marked plate [3]. It too was imbued with a special power to divine the ways of the winds and waters (Turner, G. 2011, p4).

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[1] lodestone comes from a Middle English word 'lode' which can be traced back as far as Beowulf that means 'way' or 'course' Blundell, S J. Magnetism: A Very Short Introduction OUP, Very Short Introductions, Oxford.

[2] Remarkably 'magnetic therapy' is still in use today, this pseudo-scientific practice is testament to the perception of the 'magical' nature of magnets. To buy a Lodestone today you would probably have to go to an 'alternative therapy' or 'crystal healing' website to find one.

[3] The spoon or ladle is of magnetic lodestone, and the plate is of bronze (non-conducting metal). The circular centre represents Heaven, and the square plate represents Earth. The handle of the spoon representing the Great Bear, points south. The plate bears Chinese characters which denote the eight main directions of north, northeast, east, southeast, south, southwest, west, northwest, and symbols from the I Ching oracle books which were correlated with directions. Rather than navigation, these simple direction pointers were likely used for geomancy or Fung Shui, the technique of aligning buildings according to forces of nature. (computersmiths.com : accessed Aug. 2019)

v. Copper spoon compass with Lodestone in handle

It was also the Chinese who later invented the more portable 'needle compass' used as a navigational aid on ships [4], *"sometime before 1050, possibly as early as 850",* 150 years before the English scholar and theologian Alexander Neckam's first European reference to it in 1187 (Needham, J 1986, p.176). It's possible to make a thin iron needle magnetic by stroking it with a piece of lodestone, a process that became known to western mariners as 'feeding the needle' (Fisher, D 1994), something that had to be done often due to the relatively weak magnetic field of the lodestone. The needle was originally pushed into a piece of straw or cork and floated on water, refinements to the needle compass have continued to the present day but is basically the same as it was a thousand years ago. This poem by William the Clerk of Normandy written in 1230 (Turner, G, 2010, p20) shows how knowledge of the compass was spreading and how it began to capture the imagination of this era.

Who would of his course be sure, when the clouds the sky obscure,
He an iron needle must in the cork wood firmly thrust.
Lest the iron virtue lack rub it with the lodestone black,
In a cup with flowing brim let the cork on water swim.
When at length the tremor ends, note the way the needle trends;
Though its place no eye can see – there the polar star will be.

William the Clerk, 1230

vi. Magnetised steel needle floating in cork aligned with the earth's magnetic field

vii. Chinese cork compass, (replica)

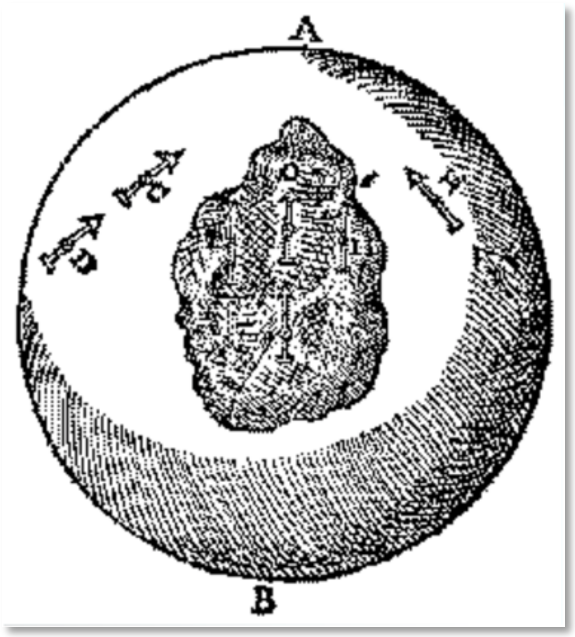
It's not certain how the needle compass came from China to Europe, but the leading theory is via Arab traders and its significance to the development of western civilisations was key to trade and their exposure to different cultures across the world. The golden age of European exploration with famous voyages by explorers Francis

[4] Shen Kuo (1031 -1095) was the first person to put in writing details of the compass and how it could be used for navigation purposes particularly in conjunction with the concept of magnetic north. *(Rees, C .2015, p8)*

Drake (English), Vasco de Gama (Portugese) and Christopher Columbus (Italian), all relied on the humble yet mysterious compass to make them possible.

viii. Examples of 16th century compasses in the collection of the National Maritime Museum, Greenwich

The magical properties of the compass weren't understood until 1600 when the English physician and natural philosopher William Gilbert published '*De Magnete*' showing that the earth was a giant magnet, explaining for the first time, the orientation of the lodestone & compass needle in relation to the earth's magnetic field lines[5]. From then till now, the compass has been a cornerstone for exploration, it is still of cultural value today being used primarily for recreational walking and, by default, entangled with the politics of rights to roam over private land in the UK. However, the days of the compass may be numbered as GPS technology becomes more affordable, the significance of the compass's future obsolescence is something I will come back to later, but first I want to talk about the physical generation of the earth's magnetic field.



ix. Diagram from '*De Magnete*' showing a Lodestone within a spherical earth demonstrating magnetic variation

[5] Magnets had already entered cultural consciousness and even though 'De Magnete' contained abstract concepts, Gilbert's work became a bestseller and magnetism became a fashionable topic of conversation in the early 17th century. Shakespeare's plays contain many references to magnetism and Ben Jonson's final comedy was entitled The 'Magnetic Lady' and was first performed in 1632. It is a tale of the wealthy 'Lady Loadstone' and her magnetically attractive niece 'Placentia Steel.' The cast of characters includes a scholar, Mr. Compass, the niece's nurse 'Mistress Keepe' (magnets were often sold with a keeper that was placed over the pole pieces when the magnet was not in use in order to preserve the life of the magnet), a soldier 'Captain Ironside', and a tailor 'Mr. Needle'. Blundell, Stephen J.. Magnetism: A Very Short Introduction (Very Short Introductions) (p. 5). OUP Oxford.

2. Geo Magnetism

Magnetism is one of the 'four forces' in physics [6], the electromagnetic force has an electric and magnetic effect. It is long-ranged, for example the magnetosphere of the earth, but much weaker than the strong nuclear force of atoms and a stronger force than gravity. It can be attractive or repulsive and only acts between matter carrying an electrical charge, it is the alignment of electrons in a ferrous material like iron. This is what makes it different from gravity, there needs to have been an electrical charge to create a magnetic field, gravity works between two objects of mass made from any material, the bigger the mass, the stronger the attraction. However, gravity can work over longer distances, for example planets in our solar system, whereas magnetic strength diminishes its effect four times more than the effect of gravity, therefore the cosmic effect of gravity is greater (A.A.George,2013).

As gravity pulls us down to the larger mass of the earth there is also an electrical magnetic field being produced by the effects of the spin of the earth and the molten iron beneath our feet. The generated electro-magnetic radiation, by means of a huge geo-dynamo effect, is what makes the earth a big magnet with a north and south pole. The physicist, Einstein, was baffled by the origin of the earth's magnetic field, in the late 20th century a number of experiments since have led to this geo-dynamo theory. Sound waves were 'bounced' through the earth measuring the density of the swirling iron at different depths, this data was modeled in computers and dynamo simulation experiments were carried out, like the ones done by Dr. Dan Lathrop at University of Maryland.

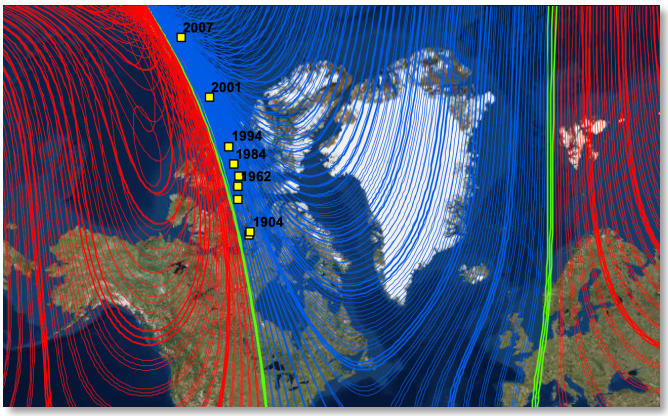
x. University of Maryland Geo-dynamo Lab

The dynamic nature of the swirling outer core led to the understanding of why there is a variation in field strength across the surface of the earth causing the poles to constantly move relative to the axis of the earth. Magnetic variation has been known about in since 1634, the National Oceanic and Atmospheric Administration (NOAA) recently processed the data from ship navigation records dating back to 1731 [7] and plotted the sliding trajectory of the North Pole over time and appears to

[6] The Four Fundamental Forces and their strengths:
1.Gravitational Force – Weakest force; but infinite range.
2.Weak Nuclear Force – Next weakest; but short range.
3.Electromagnetic Force – Stronger, with infinite range.
4.Strong Nuclear Force – Strongest; but short range.

[7] https://maps.ngdc.noaa.gov/viewers/historical_declination/ (accessed: August 2019)

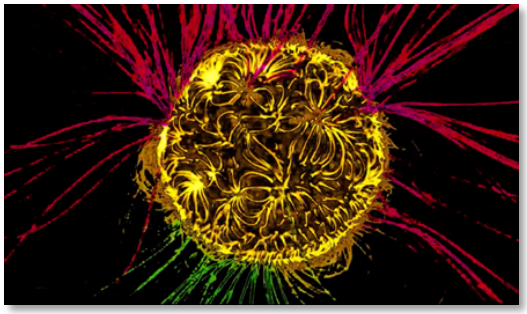
be increasing in speed in recent years[8], currently 40km per year (New Scientist, 29.6.19).



xi. North Pole trajectory plotted using ship navigation records since 1731 (NOAA)

We are now aware that the dynamic nature of our geo-dynamo keeps the north and south pole in flux, it can cause the polarity of the earth to flip, a 180' reversal, south becomes north and vice versa [9]. When it does happen again, it will have serious consequences for life on earth because the magnetic field that creates a shield around the earth, the magnetosphere, stopping harmful radiation from the sun, will be interrupted.

We also know that the earth has variable magnetic field strengths across its surface, at present it is weak between Zimbabwe and Chile, as a result satellites passing above are exposed to the increased solar wind and have to be fitted with extra protection '*to stop their electronics being fried*' (New Scientist, 29.6.19). The implications of this, should our magnetosphere weaken, for our electronic dependency would be catastrophic, especially if we were hit by a solar flare with the strength of magnitude recorded in 1859 [10], there are already examples of solar flares (coronal mass ejections) knocking out power grids in recent years [11]. The sun's electromagnetic field is monitored very closely by astronomers as a result of this constant threat, to the extent that space weather reports are available live online [12].



xii. Colour enhanced Magnetic field lines produced by the sun, from data processed by NOAA

[8] At the time of writing (30th August 2019) compasses at Greenwich point true north for the first time in about 360 years (equal to the number of degrees marked on a compass ring – spooky).
[9] There have been 183 pole reversals in the past 83 million years and if that is averaged then we are well overdue a magnetic pole flip, the last one was 780,000 years ago
[10] Solar storm of 1859, also known as the Carrington Event, one of the strongest recorded
[11] Solar storm of 1989 hit Quebec, the worst where the power grid went offline, 6 million people were immediately deprived of electricity.
[12] https://www.spaceweatherlive.com/en/news (accessed: September 2019)

3. Magnetic Milestones & Emanating Cultural Fields

Shortly after the 'De Magnete' (c.1600) the '*frog leg'* experiments of the Italian physician Luigi Galvani linked electricity with biology leading to the macabre touring shows of his nephew, Giovanni Aldini [13], inspiring recent work by the Irish artist John Gerrard [14].

xiii. Illustration of Galvani experiments

xiv. John Gerrard - 'X.laevis Spacelab' 2017

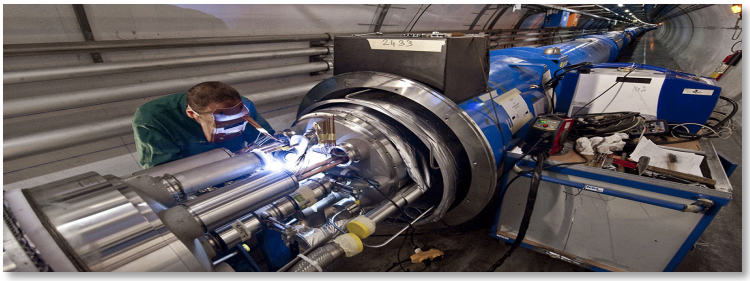
A new understanding of electricity worked its way into the popular imagination resulting in Mary Shelley's novel 'Frankenstein' (1818). The Italian physicist and chemist Alessandro Volta's invention of the battery with its 2 terminals of positive and negative hinted at the similarity to magnets, then in 1820 Hans Christian Oersted, the Danish physicist made a crucial observation, a nearby compass moved its needle when an electric circuit was turned on and off. He experimented further and found that a magnetic field could be induced using electricity which had a direction that circulated around the current of the wire. Hitherto, the only magnetic field known to mankind had been the lodestone, and a new era of science was born. The French physicist André-Marie Ampère in 1826 deduced that a lodestone must have microscopic electric currents running through it and pictured a magnet as 'being alive' and went on to develop the theory electrodynamics. (S. Blundell, pp. 30-31).

From 1826 onwards the first electro-magnets were being produced for the market which came to the attention of the young English scientist Michael Faraday working at the Royal Institute in London. He saw the potential of converting a magnetic force, using electricity produced by a battery into mechanical energy and the first electric motor was invented. Faraday also realized that the process could be reversed so that the mechanical energy of moving a magnet through coils of wire could induce an electrical impulse and thus generate electricity. Later he writes in a rather understated manner, "*I happen to have discovered a direct relation between magnetism and light, also electricity and light, and the field it opens is so large and I think rich."* (M. Faraday,1899).

The impact of these discoveries led to magnets being used in countless ways that have impacted our lives on many levels, from smart phones, magnetic resonance imaging in hospitals to LHC experiments at CERN which rely on 1232 huge magnets.

[13] The tour was a macabre party piece: sets of frogs' legs wired together would flinch in synchrony, and the severed heads of chickens, sheep, and oxen could also be made to twitch under electrical control. Aldini toured Europe with this travelling show, amazing and delighting packed houses. When Aldini's tour reached London in 1803, the body of an executed murderer was taken from the gallows at Newgate Prison and sent to the Royal College of Surgeons where Aldini passed electricity through the corpse's face. It was reported that 'the jaw began to quiver, the adjoining muscles were horribly contorted, and the left eye actually opened'. (Blundell, Stephen p. 25).

[14] John Gerrard's inspired by images of the Galvani experiments showed 'X.laevis Spacelab' at the Welcome Collection in 2017 with reference to the first frog in space in experiments on the International Space Station.



xv. Large magnets being installed at CERN, each 15meters long and weighing 35 tones

The binary world of digital communication is based on the foundations of these early discoveries, including satellite technology which is changing our perception of the earth. Technologies have moved us away from a reliance on the magnetic field for navigation to a screen-based reliance on data gathering by large institutions [15]. The introduction of 5G networks this year (2019 in the UK) are set to make this increasingly prevalent [16].

xvi. 3.5 billion people have a smart phone

The consequences of technology are often called into question after the invention, the German philosopher Heidegger asks, would it ever be possible to see ourselves as post-technological, something we will always have to contend with by being unable to function without it. He forewarns of being "enframed"[17] by technology which, "*threatens man with the possibility that it could be denied to him to enter into a more original revealing and hence to experience the call of a more primal truth*". (Martin Heidegger, 1977, p287).

With Heidegger's warning in mind, are we in the process of shutting out possible physical relationships with the earth, which all life on earth innately experiences, by the increasing use of digital interfaces?

[15] Google, Googlemaps, Amazon, Apple, Governments, NASA, etc.
[16] 5G has also raised ethical concerns with regards to animal and human health due to the high electromagnetic frequencies being emitted *(E.Kelley et.al, 2015)*
[17] Enframing means that way of revealing that holds sway in the essence of modern technology and that it is itself not technological". (Martin Heidegger, "The Question Concerning Technology," Basic Writings Ed. David Farrell Krell (Harper & Row, 1977), 287.)

4. Magneto reception in animals & humans

Electrical impulses found in biological nervous systems are now better understood. From the twitching frog's leg experiments to the discovery of Magneto-Reception in animals took approximately two hundred years. Magneto reception and animal navigation has only been researched and understood for twenty years or so whereas, for millennia different cultures around the world established their own mythical explanations of where the migrating animals came from and went to during the course of a year. Humans have known, at least seasonally, that animals appeared and disappeared, the mechanics of which, until recently, had been a mystery. Author, Charles Morton, struggled with the same question in 1703,

"*Whence come the stork and the turtle, the crane and the swallow, when do they know and observe the appointed time of their coming*?" (Jeremiah 8.7) "*it is as hard for me to persuade myself, that they come from any part of this Earth, as it is to persuade another that they come from the Moon, and therefore if the Moon will not be allowed, some other place must be found out for them."* (Re-pub: Ulan Press 2012)

The mystery of migration gradually became clearer as research has produced an avalanche of science papers over recent years showing that most animals have a sense which can detect the earth's magnetic field, in short, they instinctively know which way is north and south (Henrik Mouritsen, Nature, 2018). Stand out examples of long distance migrations are numerous, one such is the Bar-Tailed Godwit which flies for 7-9 days (non-stop) from Alaska to New Zealand in a straight line for over thousands of miles without any land features for reference [18]. From fruit flies to whales, evidence of magnetoreception has been found in almost every species studied, it is therefore puzzling that humans appear, in an evolutionary sense, to have lost (at worst) or have an extremely weak sense (at best) of the earth's magnetic field. It is a relatively young area of science and we are still not sure how the biological mechanisms work, there are three main contenders [19] and finding out to what degree this sense plays a part in the migration patterns of specific species is still unclear (Nordmann et al. 2017).

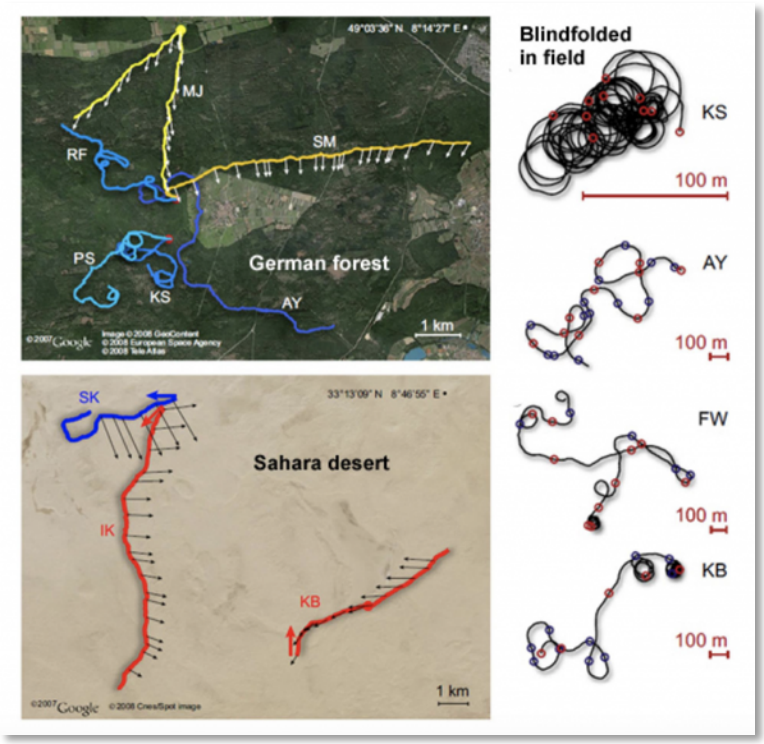
The scientific search for a sixth sense in humans began with Dr. Robin Baker in the late 1970's who conducted a series of experiments based at Manchester University to find out whether or not human beings possess the physical capacity to detect the earth's magnetic field. His experiments were published in the New Scientist in 1980, unfortunately peer reviews later discredited his findings when the repeated experiments were found to be inconclusive.

[18] Long-distance navigation and magnetoreception in migratory animals, Henrik Mouritsen, (Nature 558, 50–59 (2018)

[19] Mechanisms of Magnetoreception in Mammals, Sabine Begall et al. (Advances in the Study of Behavior, Volume 46 # 2014 Elsevier Inc. ISSN 0065-3454 All rights reserved. http://dx.doi.org/10.1016/B978-0-12-800286-5.00002-X)
Summary: 1. Magnetite crystals in cells. 2. Chemical Magnetoreception, cryptochrome protein in the eye. 3. Electromagnetic Induction, quantum dipole spin in nucleus of cells

xvii. Dr.Robin Baker conducting 'Manchester Experiments'

It's clear from human explorations over the centuries that we have needed technical aids to navigate, be it using a compass, the sun or the stars, we can't rely on a natural sense of direction. A study by psychologist Jan Souman, (2007) concluded that a "*drift in the subjective straight ahead [direction] may be the result of accumulating noise in all components of the sensorimotor system*", showing how random our sense of direction can be. Here are some GPS recorded routes of participants in the experiment in a dense German forest and also in the Sahara Desert where visual cues were eliminated. (Jan Souman et. al, 2009).



xviii. Magneto reception results of blindfolded participants tagged by GPS, Souman, 2007

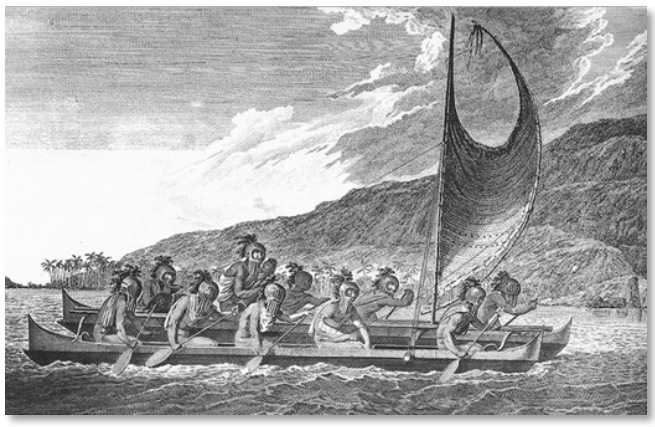
More recent studies over the last ten years have used more controlled environments eliminating all background magnetic fields within an aluminium clad

Faraday cage and sophisticated Electroencephalography (EEG) techniques to record brain activity. Using EEG magnetic sensors American geophysicist Joe Kirschvink, with a long held interest in magneto reception has made bold claims suggesting that humans do possess, a 'lost' or 'primal sense', as he did at the Royal Institute of Navigation in London in 2016 (doi:10.1126/science.aaf5803).

xix. Joe Kirschvink, 2018, in faraday cage with EEG headset

More recently in March 2019 the main researchers working in this area (Kirschvink., et al, 2019) produced the largest collaborative study into the human magneto reception to date, concluding that the brain can register changes in a magnetic field but neurons which might translate that information to what we might call a 'sense' are not evident (ENEURO.0483-18.2019). It seems that we may have lost this sixth sense to evolution after all, the neural pathways have withered to the extent that we, as a species, are disconnected from the earth's magnetic field. However, experiments continue in this area and it may turn out that some people have a weak, latent magneto sense comparable to heightened vision or hearing ability.

It may also be a sense which can be trained as American anthropologist Ben Finney (1995) thought when observing indigenous Polynesians during anthropological studies. Polynesian sailors, hailed as masters of navigation, have been known to travel for 1000's of miles in the Pacific Ocean without sight of land through day and night, in thick fog without rest and still maintaining a true direction. This account may favour magnetoreception in the sailor's 'sense' hierarchy as a matter of survival in particular circumstances. He recorded numerous interviews with Pacific islanders and recounts that many of those interviewed talked of extreme situations where "*they suddenly calmed down and intuitively knew the right course*" (Finney, B. 1995). Perhaps a little too anecdotal but these, along with other studies of isolated communities, do suggest a stronger connection to the earth and navigating on it.



xx. Hawaiian sailors in first contact ritual dress, illustrated by John Webber (artist aboard Capt. Cook's Ship 1781)

At the department of Linguistics and Cultures at the University of Manchester Guy Deutscher, an Israeli linguist, reported in 2010 that particular language structure is a factor in some cultures who have an innate and ingrained a way of thinking about direction. For instance, some indigenous Australian aboriginal people have been found to use the four cardinal directions for spatial reference when describing the location of something in the landscape. For example, go South to the crossroads, head East to the river and follow it North until you see the house. This is in contrast to our own way of using left and right, forwards and back which are an egocentric way of finding our way in the world, we use our individual location in relation to an object. The innate use of geographical constants in moving through space suggests a closer connection to the earth, so when a person from a particular location goes to a completely new unknown area without any familiar references, their linguistic hardwiring literally prevents them from describing the direction of a place [20].

Aboriginal 'songlines' [21] are primarily an oral tradition and maps are a rarity but when they are used, they "*are not to scale and are not in any sense topographically accurate*" (Peter Sutton, p394), however they convey an innate sense of place.

xxi. One road is a map of trails familiar to the Martulimi tribe, Martumili Ngurra, Courtesy National Museum of Australia, Canberra

[20] the Canadian-American musicologist Colin McPhee, who spent several years on Bali in the 1930s, recalls a young boy who showed great talent for dancing. As there was no instructor in the child's village, McPhee arranged for him to stay with a teacher in a different village. But when he came to check on the boy's progress after a few days, he found the boy dejected and the teacher exasperated. It was impossible to teach the boy anything, because he simply did not understand any of the instructions. When told to take "three steps east" or "bend southwest," he didn't know what to do. The boy would not have had the least trouble with these directions in his own village, but because the landscape in the new village was entirely unfamiliar, he became disoriented and confused. (https://www.nytimes.com/2010/08/29/magazine/29language-t.html : Article by Guy Deutscher – Manchester Uni, accessed Aug 2019).

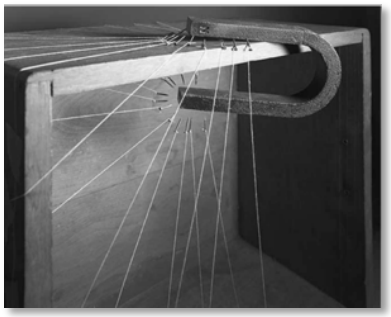
[21] 'Songlines' in aboriginal culture are dreams of paths used to navigate anything from a few kilometres to a few hundred kilometres across the land indicating sacred spots along the way which often have their own song. Listening to the song being recited is the same a travelling through the landscape and acts as an aide-memoire.

5. Magnetic fields in visual art – '*Poetry and beauty in the electromagnetic universe'* [22]

The elusive use of magnetic fields in the history of visual art, it seems to me at least, has been a missed opportunity which is partly why my own work explores the phenomena of magnetism. A retrospective showing work by the Greek sculptor Takis at the Tate Modern, London [23] exhibited sculpture from the 1950's which foregrounded 'energy over form'. He was the first to explore the allure of the magnetism in visual art and has for decades playfully included the dynamic properties of magnets, both permanent and electromagnetic in his kinetic sculptures. Perhaps it is because the interdisciplinary artwork produced by scientists and artists is becoming more widely accepted within the art system that we are now seeing the work in a large art institution.

xxii. Magnetic Fields, Takis, 1969

xxiii. Magnetic Ballet, Takis, 1961



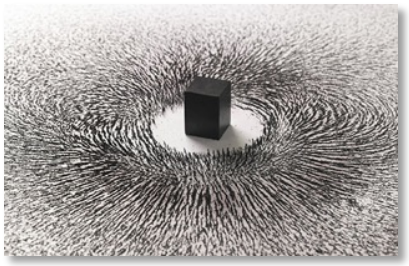
xxiv.Wooden Box with Horseshoe Magnet, 2006, Caleb Charland

xxv. Dancing Trees - David Durlach, 1992

[22] Guy Brett, Takis catalogue at Tate Britain, p13

[23] Takis in the Tate Modern – July 4th till 27th October 2019.

geomagnetic storms recorded during a ten year solar cycle from 1855 –1867. Solar winds of this strength today would cause major disruption to power grids.

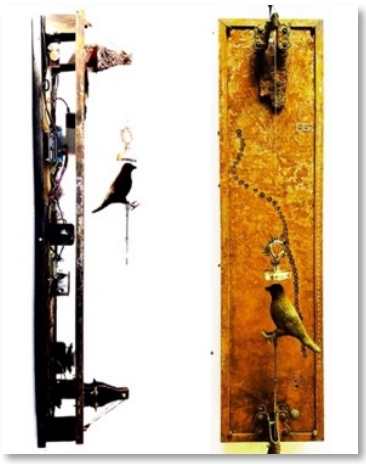


xxvi. Magnetism, 2012, Ahmed Mater al-Ziad

xxvii. 'Untitled 2', 1994 Mona Hartoum

As a general observation, the use of magnets in contemporary art has been exploited largely in a limited, modernist sense, 'being true to materials' rather than being deployed for their properties to explore a broader range of subject matter. Titles have a tendency to be literal rather than metaphorical which may limit their potential poetry and resonance.

For example, I recently used the magnetic field of a neodymium magnet in a kinetic, electronically interactive, sculpture to look at the decline of the Skylark bird population in Britain from 1967 to the present day, called 'Lark Decending' (2019) [24]. The presence of the viewer triggers the waning song of the Skylark and the motion of the bird is held in space by the gap of a force field as it descends through a graph illustrating its decline in the UK. Another piece called 'Dead Reckoning' (2018) is an array of steel balloons floating in space via the force of a magnetic field. A direct reference to the navigational method used by mariners, evoking buoys at sea or barrage balloons in WWII or three-dimensional full stops but non the less defying gravity with a 1cm gap between the balloons and the suspended magnets. Had the pieces been 'Untitled' then the emphasis would have been on materials, effect and the possibility of an unsolvable riddle.



xxviii. Lark Descending, R Paton, 2019

xxix. Dead Reckoning, R Paton, 2018

The potential permanent magnets and electromagnets have in sculpture is, I believe, infinite, if the physics of the material are allowed to penetrate all areas of life

[24] As opposed to the poem "The Lark Ascending" by George Meredith (1881) and set to a Romantic Orchestration by Vaughn Williams 'Lark Ascending' (1920). A film of my more dystopian sculpture in action: http://richardpaton.com/lark-descending/ (accessed November 2019)

and subject matter. Metaphor is a bridge between the physical world and our consciousness which tries to order and understand abstract qualities. Metaphor can help build a perception of the physical world via an image which may already carry other meanings but can be transferred to the new concept. According to the American cognitive linguist George Lakoff, metaphor is central to the cognitive understanding of abstract concepts (Lakoff & Johnson, 1980).

More eloquently, American author Rebecca McClanahan says, "*Effective metaphor does more than shed light on two things being compared. It actually brings to the mind's eye something that has never before been seen. It's not just the marriage ceremony linking two things; it's the child born from the union*." (Dr. Grothe. p269)

I've continued my explorations of the earth's magnetic field in a new series of works which attempt to reinvent the compass. By using a lodestone in recognition of ancient practice and making it central to the function of the compass, the earth and a piece of the earth work together to show us 'the way'. This leads me to the connection with 'journeys' and the rich history of walking, as an art practice in its own right.

xxx. "Food" - R.Paton, 2019. (Variation of the Chinese spoon compass, a wooden spoon floating in a bowl of water with a lodestone aligning with the earth's magnetic field).

6. Walking in the absence of magneto reception

We make countless journeys during our life time, each one usually has a location, destination and route in mind. Each one has a particular motivation and we usually know in advance what to expect from our journeys. The majority of our journeys are often a repeat of one we have done before, just as neural pathways in the brain prefer to travel in a line of least resistance in order to be more energy efficient. In order to be more creative, pursuing other ways to walk which negates expectation could therefore be more fruitful experiences. To travel with a view to being disoriented may reveal more about ourselves and our surroundings, as American writer Rebecca Solnit said, "*to be lost is to be fully present, and to be fully present is to be capable of being in uncertainty and mystery*." (Solnit, 2005, p6). The Vietnamese Buddhist, Thich Nhat Hanh, teaches students to walk with the aim of each walk to be fully present and aware of every moment, the destination is secondary. Meditative or 'mindful' walking is weaving its peaceful way into western cultures. The pre-Socratic philosopher Meno said, '*How will you go about finding that thing the nature of which is totally unknown to you?*' (Solnit, 2005, p4), unless we are prepared to go beyond what we already know and expect from our journeys.

xxxi. 'A line made by walking'
Richard Long, 1967

xxxii. The Collector, 1991-2006
(a magnetic dog pics up ferrous debris from the streets)
Francis Alys, collaborating with Felipe Sanabria

Walking became accepted as an artform as an adjunct to performance art in the 1960's, the solitary walks of British artists Richard Long and Hamish Fulton established a tradition and has inspired many artistic journeys since [25]. Walking as a romantic recreational activity arguably began over two hundred years ago with likes of Swiss philosopher Jean-Jacques Rousseau [26] but walking as a metaphor is ancient. The maze, where choices are presented along a route to a center, is a development of the Labyrinth in which the route is singular but convoluted and presents no navigational challenge.

[25] Janine Antoni, Touch (2000) Bahamas, Hamish Foulton ; Slowalk (in support of Ai Weiwei) , Richard Long, A Line Made By Walking (1967) England, Marina Abramović and Ulay, The Lovers – The Great Wall Walk (1988) China, Francis Alÿs, The Green Line (1995) Jerusalem, Tehching Hsieh, One Year Performance (1981) New York City, Vito Acconci, Following Piece (1969) New York City, Janet Cardiff, Her Long Black Hair (2004) Central Park, Stanley Brouwn, This Way Brouwn #7, (1962), Amsterdam, Stanley Brouwn Pedestrian Footsteps on Paper (1960) Amsterdam, John Nova, Lomax, "The Sole of Houston" map of walks (2010) Houston, Sophie Calle, as well as Nancy Holt, Patti Smith, Michèle Bernstein, Simon Pope, Janet Cardiff to name a few.

[26] 'Reveries of a Solitary Walker' by Jean-Jacques Rousseau first published in 1782

xxxiii. Maze garden at Longleat House

xxxiv. Example of one path of the Labyrinth

Religious pilgrimages are our oldest predefined journey's which place emphasis not on the destination but on the 'rite of passage', what can be meditated upon, and learned from, during the journey itself.

xxxv. Russian pilgrims going to Jericho, late 19th century

xxxvi. Muslim pilgrims at Mecca

Walking as a metaphor has rich possibilities, not least for those who walk to discover things, the nature of which awaits unknown, out of view - around a corner.

The link between navigation and walking is an obvious one, recreational walking is now the pastime of millions of people who explore new territories using a map and a compass. Yet, as I have eluded to earlier with reference to Heidegger's notion of being '*enframed*' by technology, this simple connection to the earth may be about to disappear as digital technology elbows itself into this simple human experience.

7. Conclusions - Earth's Magnetic Field as Metaphor for human disconnect with nature

I have tried to show that magnetic fields are a pervasive force in all our lives and the earth's magnetic field can be viewed as a metaphor for our connection to our planet. Awareness of the earth's magnetic field has developed innumerable cultural connections deriving from the invention of the compass through to understanding electromagnetism. Yet from the early discoveries of magnetism, harnessing complex wayfinding skills and using a compass, we have developed computer technology in conjunction with satellites and digital screens to remove our need to think about where we are in relation to our surroundings. There's an irony in the fact we have removed our awareness of the earth's giant magnetic field in part by surrounding ourselves with smaller magnetic fields that power our digital lives. The dislocation of relative spatial awareness doesn't just produce funny stories of how people get lost in the hands of an inadequate GPS device, it is also symptomatic of a culture which is blindly entrusting decision making to algorithmic data, as writer Nicholas Carr argues in his book "The Glass Cage", sometimes ending in catastrophe [27].

xxxvii. students follow GPS into sea in Australia, 2012

xxxviii. Local flooding signs ignored in Leicestershire following GPS route, 2007

A new smart phone app called 'what3words', uses GPS, it has divided the surface of the planet into 57 trillion 3x3 meter squares. Each of these squares has been assigned three randomly generated words which are fixed to that location forever. This system works by using the existing GPS mapping technology and is being used by governments and emergency services as a user-friendly locating system, rather than grid referencing. The advantages to this system are clear enough and will speed emergency response times, but it is also another step toward an increasing reliance on digital screens and what Carr calls 'automation complacency'.

"*Automation complacency occurs when a computer lulls us into a false sense of security. Confident that the machine will work flawlessly and handle any problem that crops up, we allow our attention to drift. We become disengaged from our work, and our awareness of what's going on around us fades. Automation bias occurs when we place too much faith in the accuracy of the information coming through our monitors. Our trust in the software becomes so strong that we ignore or discount other information sources, including our own eyes and ears. When a computer provides incorrect or insufficient data, we remain oblivious to the error*".

(Nicholas Carr, 2013, p1)

I make a parody of this in a piece of work called 'shopping expedition' (2019), GPS technology guides the shopper to items on a shopping list where they are

[27] In May 2009 an Airbus A330 passenger jet equipped with the latest 'glass cockpit' controls plummeted 30,000 feet into the Atlantic. The reason for the crash: the autopilot had routinely switched itself off. Faced with having to fly the plane themselves, the pilots 'suffered a total loss of cognitive control' and plunged all 228 passengers and crew to their deaths. (Carr, N. The Glass Cage . Random House. Kindle Edition.)

expected to be found in the aisles of a supermarket. Unfortunately, the start location is inaccurate and the route around the supermarket takes place on a remote unpopulated moorland.

xxxix. 'shopping expedition' R.Paton. July 2019. *(GPS, coordinates, shopping basket).*

As British author David Barrie says, "*The arrival of GPS has…brought about an abrupt and fundamental change in our relationship with nature." "The gadgets that seem to have relieved us of a tiresome burden are not only enfeebling us but also distancing us from the natural world*." (D.Barrie, 2019, p247)

He goes on to point out that the adoption of GPS "*has led to a deterioration in wayfinding skills and, more generally, a weakened feel for the land*" (D.Barrie 2019)

xl. Anon experiencing Virtual Reality artwork by Kapoor, Eliasson & Abramovich at Venice Biennale 2019

The increase in speed with each new technological leap leads us to the dangers of being increasingly disconnected from our present environment and location, a screen-based detachment may lead us to seeing reality like a computer game, in essence a technological determinism. With increased investment and technological advances in VR a proportion of the population will endorse this augmented reality in favor of manual sensory interaction with the world. Algorithmic data software sets new parameters in a virtual playing field of mind control or 'eyeballs' as advertisers was once called it, when surfing the internet. There is also evidence of children's brain development being impaired with early over exposure to digital screens during the 'critical stage' of child growth [28] unfortunately this is an increasing problem as children spend more time at the altar of a screen.

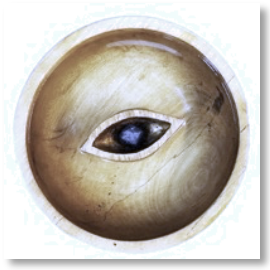
For 300,000 years humans have lived immersed in the natural world alongside other animals, for the last 10,000 we began to withdraw from nomadic life and build villages, towns and cities. Now over 3 billion of us are cut off from the natural world, except for manicured parks and playing fields, many cities globally having very little green space. This means that for the majority of the human population on earth, the

[28] https://www.psychologytoday.com/gb/blog/behind-online-behavior/201604/what-screen-time-can-really-do-kids-brains. (accessed: July 2019)

natural world will no longer even be a memory, knowledge of wilderness will come only via digital screens. The lack of human magnetoreception, a sense of a 'pull' of the earth, an 'alignment' which most other animals (on land, sea and in the air) have, could be seen as a metaphorical disconnection with the earth and its wildlife.

In a piece of work which conjures the antithesis to GPS and AI by questioning where we are heading and why we might want to go there, I call it *Arcas' Compass* (2019). It uses a lodestone, the naturally occurring magnet aligning itself to the earth's magnetic field which floats in a boat always pointing north. Arcas was the King of Arcadia, a mythical, pristine, ancient land [29], this apocryphal compass allowed his travel through a romantic un-spoilt land using the invisible force of the magnetic field lines. The piece is symbolic of loss but also a link to the past and the possible reconnections.

xli. 'Arcas' compass', r paton, 2019.



xlii.. 'Arcas' compass', view from above

I end by reiterating Heidegger and his notion of being 'enframed' by technology which, "*threatens man with the possibility that it could be denied to him to enter into a more original revealing and hence to experience the call of a more primal truth*" (1977).

[29] In Hellenic mythology, arcadia was celebrated as the harmonious wilderness and home to the god Pan, before the destructive forces of a supposed orderliness of civilisation.

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xli. 'Arcas' compass', r paton, 2019. (photo. R.Paton)
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Notes

[1] lodestone comes from a Middle English word 'lode' which can be traced back as far as Beowulf that means 'way' or 'course' Blundell, Stephen J.. Magnetism: A Very Short Introduction (Very Short Introductions) (p. 5). OUP Oxford.

[2] Remarkably 'magnetic therapy' is still in use today, this pseudo-scientific practice is testament to the perception of the 'magical' nature of magnets. To buy a Lodestone today you would probably have to go to an 'alternative therapy' or 'crystal healing' website to find one.

[3] The spoon or ladle is of magnetic lodestone, and the plate is of bronze (non-conducting metal). The circular centre represents Heaven, and the square plate represents Earth. The handle of the spoon representing the Great Bear, points south. The plate bears Chinese characters which denote the eight main directions of north, northeast, east, southeast, south, southwest, west, northwest, and symbols from the I Ching oracle books which were correlated with directions. Rather than navigation, these simple direction pointers were likely used for geomancy or Fung Shui, the technique of aligning buildings according to forces of nature. (computersmiths.com)

[4] Shen Kuo (1031 -1095) was the first person to put in writing details of the compass and how it could be used for navigaton purposes particularly in conjunction with the concept of magnetic north. (Chris Rees.2015, p8)

[5] Magnets had already entered cultural consciousness and even though 'De Magnete' contained abstract concepts, Gilbert's work became a bestseller and magnetism became a fashionable topic of conversation in the early 17th century. Shakespeare's plays contain many references to magnetism and Ben Jonson's final comedy was entitled The 'Magnetic Lady' and was first performed in 1632. It is a tale of the wealthy 'Lady Loadstone' and her magnetically attractive niece 'Placentia Steel.' The cast of characters includes a scholar, Mr. Compass, the niece's nurse 'Mistress Keepe' (magnets were often sold with a keeper that was placed over the pole pieces when the magnet was not in use in order to preserve the life of the magnet), a soldier C'aptain Ironside', and a tailor 'Mr. Needle'. Blundell, Stephen J.. Magnetism: A Very Short Introduction (Very Short Introductions) (p. 5). OUP Oxford.

[6] The Four Fundamental Forces and their strengths:
1.Gravitational Force – Weakest force; but infinite range.
2.Weak Nuclear Force – Next weakest; but short range.
3.Electromagnetic Force – Stronger, with infinite range.
4.Strong Nuclear Force – Strongest; but short range.

[7] https://maps.ngdc.noaa.gov/viewers/historical_declination/ (accessed: July 2019)

[8] There have been 183 pole reversals in the past 83 million years and if that is averaged then we are well overdue a magnetic pole flip, the last one was 780,000 years ago (citation).

[9] Solar storm of 1859, also known as the Carrington Event, one of the strongest

[10] Solar storm of 1989 hit Quebec, the worst where the power grid went offline, 6 million people were immediately deprived of electricity.

[11] https://www.spaceweatherlive.com/en/news (accessed: July 2019)

[12] The tour was a macabre party piece: sets of frogs' legs wired together would flinch in synchrony, and the severed heads of chickens, sheep, and oxen could also be made to twitch under electrical control. Aldini toured Europe with this travelling show, amazing and delighting packed houses. When Aldini's tour reached London in 1803, the body of an executed murderer was taken from the gallows at Newgate Prison and sent to the Royal College of Surgeons where Aldini passed electricity through the corpse's face. It was reported that 'the jaw began to quiver, the adjoining muscles were horribly contorted, and the left eye actually opened'. (Blundell, Stephen p. 25).

[13] John Gerrard's inspired by images of the Galvani experiments showed 'X.laevis Spacelab' at the Welcome Collection in 2017 with reference to the first frog in space in experiments on the International Space Station.

[14] Google, Googlemaps, Amazon, Apple, Governments, NASA, etc.

[15] 5G has also raised ethical concerns with regards to animal and human health due to the high electromagnetic frequencies being emitted (E.Kelley et.al, 2015)

[16] Enframing means that way of revealing that holds sway in the essence of modern technology and that it is itself not technological". (Martin Heidegger, "The Question Concerning Technology," Basic Writings Ed. David Farrell Krell (Harper & Row, 1977), 287.)

[17] Long-distance navigation and magnetoreception in migratory animals, Henrik Mouritsen, (Nature 558, 50–59 (2018)

[18] Mechanisms of Magnetoreception in Mammals, Sabine Begall et al. (Advances in the Study of Behavior, Volume 46 # 2014 Elsevier Inc. ISSN 0065-3454 All rights reserved. http://dx.doi.org/10.1016/B978-0-12-800286-5.00002-X) (accessed: July 2019)
Summary: 1. Magnetite crystals in cells. 2. Chemical Magnetoreception, cryptochrome protein in the eye. 3. Electromagnetic Induction, quantum dipole spin in nucleus of cells

[19] the Canadian-American musicologist Colin McPhee, who spent several years on Bali in the 1930s, recalls a young boy who showed great talent for dancing. As there was no instructor in the child's village, McPhee arranged for him to stay with a teacher in a different village. But when he came to check on the boy's progress after a few days, he found the boy dejected and the teacher exasperated. It was impossible to teach the boy anything, because he simply did not understand any of the instructions. When told to take "three steps east" or "bend southwest," he didn't know what to do. The boy would not have had the least trouble with these directions in his own village, but because the landscape in the new village was entirely unfamiliar, he became disoriented and confused. (https://www.nytimes.com/2010/08/29/magazine/29language-t.html : Article by Guy Deutscher - University of Manchester, accessed: July 2019)

[20] 'Songlines' in aboriginal culture are dreams of paths used to navigate anything from a few kilometres to a few hundred kilometres across the land indicating sacred spots along the way which often have their own song. Listening to the song being recited is the same a travelling through the landscape and acts as an aide-memoire.

[21] Guy Brett, Takis catalogue at Tate Britain, p13

[22] Takis in the Tate Modern – July 4th till 27th October 2019.
geomagnetic storms recorded during a ten year solar cycle from 1855 –1867. Solar winds of this strength today would cause major disruption to power grids.

[23] As opposed to the poem "The Lark Ascending" by George Meredith (1881) and set to a Romantic Orchestration by Vaughn Williams 'Lark Ascending' (1920). A film of my more dystopian sculpture in action: http://richardpaton.com/lark-descending/ (accessed: July 2019)

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[25] 'Reveries of a Solitary Walker' by Jean-Jacques Rousseau first published in 1782

[26] In May 2009 an Airbus A330 passenger jet equipped with the latest 'glass cockpit' controls plummeted 30,000 feet into the Atlantic. The reason for the crash: the autopilot had routinely switched itself off. Faced with having to fly the plane themselves, the pilots 'suffered a total loss of cognitive

control' and plunged all 228 passengers and crew to their deaths. (Carr, Nicholas. The Glass Cage . Random House. Kindle Edition.)

[27] Hellenic mythology, arcadia was celebrated as the harmonious wilderness and home to the god Pan, before the destructive forces of a supposed orderliness of civilisation.

[28] https://www.psychologytoday.com/gb/blog/behind-online-behavior/201604/what-screen-time-can-really-do-kids-brains (accessed: July 2019)

[29] In Hellenic mythology, arcadia was celebrated as the harmonious wilderness and home to the god Pan, before the destructive forces of a supposed orderliness of civilisation.

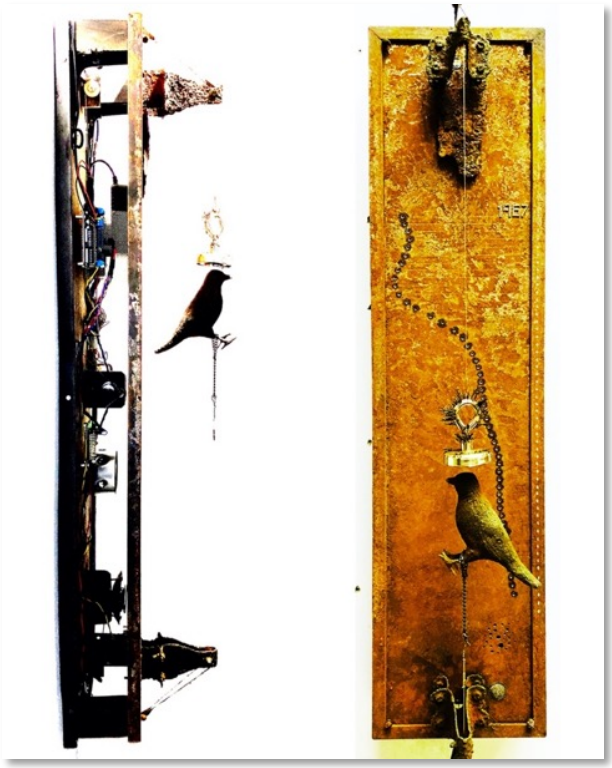
Appendix

A further explanation of my recent work may be useful as it has explored various aspects of magnetism relating to the theme of this essay. From the generation, beneath our feet, of the earth's magnetic field to the magneto-reception found in animals, my interest in magnetism aims to reveal this invisible force through visual art. As I've outlined in chapter four, recent scientific papers have concluded that humans don't have the sense of magneto-reception and are therefore disconnected from the earth's magnetic field where all the other animals so far studied have demonstrated this sense of the earth's magnetic field. For me this has come to represent a grand metaphor for humanity's disconnection to the natural world in general and how we have lot to learn from nature.

I'm inspired by the natural world and the forces at play beyond our daily experience and it is this that motivates the making of new work. Scientific ideas form a bedrock on which to build visual explorations of various materials. The use of magnets in my work have provided a kinetic feature which adds tension to the sculpture because of the inherent technical difficulty in setting up, as the field of the magnet is quite shallow and can break easily. I've been interested in making more digitally interactive as well as mechanically interactive works which explore themes within the dominant cultural narrative of extinction we are watching unfold on our screens.

Two recent works 'Lark Descending' and 'Fields of Influence' are about humanities detrimental impact on the natural world and the catastrophic decline in numbers of species over the last 50 years.

In 'Lark Descending' a magnet suspends a metal Skylark figure mid-air by means of a strong magnet. When someone walks near the Skylark a motion sensor triggers the song of the Skylark as it simultaneously descends, the song fades and gives way to the sound of a tractor revving. The background has a graph showing the startling decline in the UK Skylark population since 1967 (the year I was born), the tractor audio signifies the reason for the bird's population decline, namely intensive farming practises. Farmland isn't left fallow anymore which, in the past, allowed the soil to recover naturally but also allowed birds to forage during the winter months. The use of the magnet is twofold, a reference to magneto-reception but also a sculptural device to add kinetic tension in the work. This piece is a critique of intensive farming practises and its devastating consequences for wildlife.



Lark Descending, 2019 (steel, magnet, electronics, audio)
A video of this can be seen at this address: http://richardpaton.com/lark-descending/

‘Fields of Influence’

‘Fields of Influence’ is an Automaton which also makes reference to the IUCN red list of species in Europe by way of pyrographed images of seven species in decline on the columns below the compasses. A non-ferrous figure holding neodymium magnets is set in motion by someone turning the handle, as the figure rotates the magnets disrupt the magnetic field alignment of the compasses causing them to spin as the figure sweeps past. The compasses signify animal magneto-reception and give a graphic metaphor of humanities disorientating influence on the natural world. The person turning the handle is implicated in the disruption of nature via a medieval looking mechanism with sharp teeth below.

Fields of Influence, 2019 (wood, steel, magnets, copper, brass)

Totems of species on the IUCN Red-list (Europe):

grass snake: meadow fritillary: leatherback turtle: North Atlantic Right Whale: Reindeer: Barn Swallow: Skylark

A video of this can be seen at this address: http://richardpaton.com/fields-of-influence-2019/

Lodestone Compasses

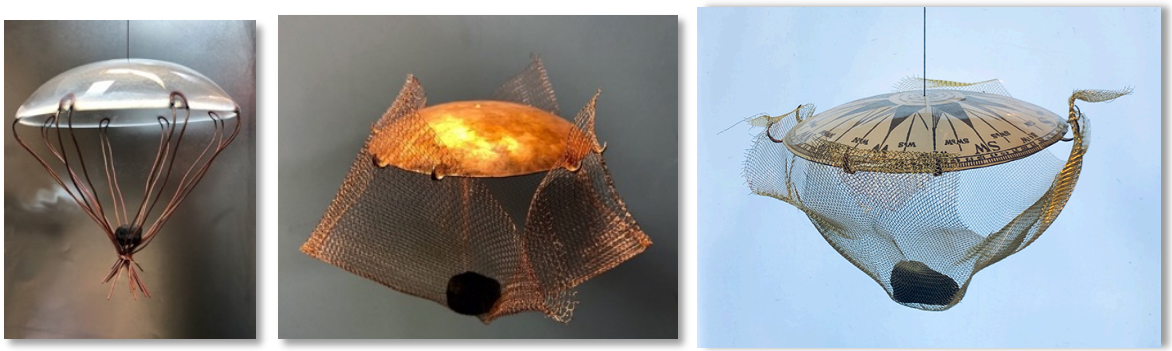
The notion of the compass and navigation talked about in the essay have taken a key role in the making of new work. I looked at how the compass could be reinvented in a way that highlighted the earth's magnetic field via different cultural lenses. Initially I experimented with lodestones to make new compasses, one of which placed a lodestone in the bowl of a Chinese shaped wooden soup spoon so that it floated on water with a non-ferrous pin in the bowl to prevent drifting it would point south. Using an electronic magnetometer, I could work out the strongest magnetic side of the lodestone and therefore calibrate the spoons orientation. I called this piece "Food", as reference to the earliest Chinese compasses acknowledging their discovery but also of Greece's discovery of the Lodestone.

'Food', a spoon compass using lodestone, 2019

The aforementioned 'Arcas' compass' is a more direct reference to Grecian mythology. The carving of a wooden boat being symbolic of the great voyages around the mythic ancient Mediterranean Sea but also a reference to 'arcadia', a utopian vision of an unspoilt wilderness.

Arcas' compass, 2019

Lodestones were also used to make suspended 'Jellyfish Compasses' due to their resemblance but also to acknowledge the magneto-receptive ability of the jellyfish.



'Jellyfish' lodestone compasses, 2019

Planet B

'Planet B' is an extension of 'Dead Reckoning' and the continuation of visual metaphors generated by a floating steel balloon. It took several attempts, experimenting with various materials, to make a ridged steel balloon which wasn't too heavy to break the magnetic field of the neodymium magnet suspended from the ceiling. Planet B makes reference to global warming and the 'Pale blue dot' photograph taken by the Voyager 1 satellite as it left our solar system in 1990.

Planet B, 2019
A video of this can be seen at this address: *http://richardpaton.com/planet-b-2019/*

END