Holistic Science Journal

Vol 1 Issue 2 November 2010 £5

ISSN No ISSN 2044-4370

Turning Leaves

Fritjof Capra ***David Peat*** ***Satish Kumar*** ***Philip Franses***

Ten Ox Herding

I. Searching for the Ox

Alone in the wilderness, lost in the jungle, the boy is searching, searching!
The swelling waters, the far-away mountains, and the unending path;
Exhausted & in despair, he knows not where to go,
He only hears the evening cicadas singing in the maple-woods.

Comment: The ox never has been lost. What need is there to search? Only because of separation from my true nature, I fail to find him. In the confusion of the senses I lose even his tracks. Far from home, I see many crossroads, but which way is the right one I know not. Greed and fear, good and bad, entangle me.

II. Noticing the footprints

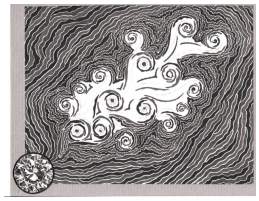
By the stream and under the trees, scattered are the traces of the lost;
The sweet-scented grasses are growing thick -- did he find the way?
However remote over the hills and far away the beast may wander,
His nose reaches the heavens and none can conceal it.

Comment: Understanding the teaching, I see the footprints of the bull. Then I learn that, just as many utensils are made from one metal, so too are myriad entities made of the fabric of self. Unless I discriminate, how will I perceive the true from the untrue? Not yet having entered the gate, nevertheless I have discerned the path.

The ox is the eternal principle of life, truth in action. The Ten Ox represent sequent steps in the realization of one's true nature. An understanding of the creative principle transcends any time or place. The 10 Bulls is more than poetry, more than pictures. It is a revelation of spiritual unfoldment paralleled in every bible of human experience. May the reader, like the Chinese patriarch, discover the footprints of his potential self and, carrying the staff of his purpose and the wine jug of his true desire, frequent the market place and there enlighten others.

(Attributed to Shubun (n.d.) Japan, Muromachi period Handscroll, ink and light colors on paper copyright Shôkoku-ji Temple http://www.shokoku-ji.or.jp.) English translations adapted from the preface by Nyogen Senzaki & Paul Reps www.iloveulove.comof poems by Chinese patriarch Kaku-an(1100-1200AD;bull/ox used interchangeably)

Ariadne's Thread



As part of my work teaching on the Masters in Holistic Science at Schumacher College, I mark the dissertations, each one the outcome of a fantastic and individual journey. These stories are addressed to an active dynamism, caught in the living. When the thesis is delivered, package-like on my desk to be marked, and removed from the living context of its journey, then its colourful arising becomes lacklustre in the scale of grading it.

If one were to see that each work is an act of potential, that is yet to be complete, then one, once more vivifies the connection lived during the writing by the students in community at the college. The lines of imaginative stories cross in vivid consensus. Holistic Science seeks to describe and maintain this focus of potential, in which living secrets may make connections, allowing them to be understood within the whole.

In seeking to give the whole expression, Holistic Science is addressing a potential that is also by definition yet to be complete. It is exactly the striving to give voice to the whole that one wants to embody, without catching it in some half-way definition of what it appears to be. Even in main-stream science, papers are tripping over themselves to make tangible result from a line of inquiry that properly is still in its infancy and needs greater incubation. To have a Holistic Science one needs some framework of potential, in which the activity of the world is assessed at its farthest focus for pattern and meaning.

In Goethe's holistic exploration of the plant, the root beneath the earth is a darkness, which can be any question seeking; the stem of leaves is a watery imaginary knowing that allows the light to play through the leaves; the flower is the airy understanding of the whole resolution; and the fruit completes the cycle returning us again to the fiery potential through the seed.

So accustomed are we to our short term scientific glasses of what things are, it requires a real hard work shift to bring science to see through a focus of what they can become. Even though our everyday activity is full of the imaginative, communicating projects in their potential, we are habituated to setting this down as if its value was already apparent at the surface of things.

The need for this journal is to establish a deep potential reference, in which holistic papers and articles are judged in their collective aspiration. The sculptor, scientist, educator, ecologist and adventurer join easily to tell their own part of the journey to the whole.

The questions of this issue are:

- How does this focus of potential carry into science, art and experience?
- Can we give clarity to complexity theory, systems thinking and quantum theory by seeing them from a dynamic focus?
- Does the focus in the rediscovering of wholeness, change how science relates to the world?

(*Ariadne's thread, in Greek myth, guides Theseus back from the source of confrontation with the shadowy figure at the centre of the maze, to the everyday world where potential can again be encountered in its whole appreciation.*)

Philip Franses

Holistic Science Journal (ISSN: 2044-4370) is published quarterly *(4 issues a year) by Earthlinks UK, which is a registered charity (*No 1133056)

Contributions are welcomed and should be typed clearly or sent by email to ***journal@earthlinksall.com***

Email: journal@earthlinksall.com
Website: www.earthlinksall.com
Cover: *Bristlecone* by Marcia Phillips
Journal Artwork: Marcia Phillips & Shokokuji Temple. Japan

Printer: Kingfisher Print, Totnes Devon
Printed on Evolution paper (75% recycled fibre/ 25% FSC certified virgin pulp), using soya-based inks

Please subscribe!

Holistic Science Journal

To subscribe, click on
www.earthlinksall.com/journal '

or copy and post the form below**.**

Payment ***for 1 year (4 issues)***
In the UK: £25 for the whole year to include P&P **p*ay by UK cheque or pay online***

Overseas subscribers: £30 for the year to include P&P ***please pay online***

Address and correspondence to:
'Earthlinks UK'
(Subscription – Holistic Science Journal)
1 New Houses, Cott Road
Dartington, Totnes TQ96HQ,
Devon, United Kingdom

.

Name:

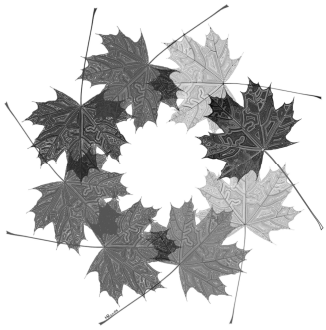
Address:

Country

Payment (please tick appropriate)
Overseas subscription £30 per year

UK subscription £25 per year

Contents



Emma Kidd

The phenomenological approach of Johann Wolfgang von Goethe shows the way to re-cognition of a world which has been long divided into a separated knowledge. The idea of 're-cognition' will form a fundamental part of this writing. My definition of the term is one of a relational whole person cognition or perception - a relational way of 'see-ing' that is not only understanding the world in a different, more holistic, way but a way in which what is 'seen' appears familiar; a deep recognition and understanding, as if waking up to something that we, as adults and as a human race, have seemingly long ago forgotten. Re-cognition allows for a 're-membering' [1] of the wholeness of nature and the nature of wholeness within ourselves, our societies and nature.

Re-cognition allows for authentic, not counterfeit connections to Nature to be made; it dissolves the illusion that we 'know' the world, and allows us to try and dynamically 'understand' it through holistic participation and by see-ing 'relationally'. To develop this re-cognition means employing all of our faculties as human beings, including our intuitive, creative, and emotional ways of 'knowing/understanding', as well as, not instead of, our intellectual, analytical capabilities which have often been overdeveloped in Western civilization and given supremacy, and have led to us see-ing 'separation'.

To explain a little further, here is a summary of the two ways of seeing:

Separation	**Relation**
Knowledge	Re-cognition
Disconnection	Connection
Separate from nature	Part of nature
Realises partial solutions (e.g. sustainability)	Gives resolution (e.g. whole be-ing)

What emerges from Goethe's scientific works, such as his theory of colour and his work on the metamorphosis of plants, is a way of see-ing which, when practised, helps us to 'see' the world in terms of dynamic, intricate webs of relationships and not just a collection of separate, independent, inanimate objects and externally imposed mechanisms. This dynamic approach focuses on process and relationship which in turn allows for intuitive perception, through observation, of a direct understanding of the world.

'Mephistopheles in….Goethe's epic poem, Faust, scoffs at the scholars who try to understand a living organism by the detailed description of its parts,

"Dann hat die Theile in seiner Hand
Fehlt, leider! Nur das gestige Band."
(Then he has all the parts within his hand except sadly, the living bond.)"' [2]

It is this 'living bond', or wholeness, that Goethean methodology allows us to 'see'. By combining in-depth observation and exact sensorial imagination, the idea is to enter into a way of seeing the phenomenon that cannot be reached by using only the intellectual mind. With this way of seeing, relationships between qualities and phenomena can be perceived, rather than being *thought* to be separate instances "This artist's approach to science allows for a more appreciative, qualitative, meaningful and participatory engagement with nature." [3] The holistic perception that is achieved through following Goethe's methodology enables a more dynamic 'relational' way of seeing.

The phenomenological approach of a Goethean way of seeing is a whole person approach to perceiving; in this case to perceiving nature, to awaken the living qualities of thinking that align with, and are learnt from the experience and connection to the phenomenon itself. It focuses on developing the capacity of different ways of knowing within the observer through

experience, by engaging in an actively receptive relationship with what is being observed. These ways of knowing cannot be learnt through any way other than through the experience itself. The process is phenomenological in nature, in that it allows what is being studied to become its own theory; rather than being subject to external theories or judgment, if the process is correctly followed. Whatever is being observed is allowed to speak for itself and to gradually disclose itself to the observer, within the observer, in terms of itself. When practicing, we must have sensitivity to try and form our concepts in relation to what we are actually seeing, and to the process of see-ing itself, not to what we 'think' or 'know' we see.

Through the practice of a Goethean way of seeing inspiration and intuition are developed to perceive qualities and gestures of the parts and the whole, and possibly even the archetypal whole when the phenomenon itself is brought fully to expression to confront you in your experience. "What is experienced as a way of seeing *is* the unity of the phenomenon." [4] I personally find these stages quite hard to describe with words, it feels like you have experienced the thoughts between yourself and what you are observing rather than having actively thought them yourself. I experienced this whilst practicing a Goethean way of seeing, studying a Nettle. After having spent time observing various Nettles, going to and from them, eventually I was returning to them and feeling like I was meeting an old friend. One day I sat down with a particular nettle, sat in a patch of many others, and I felt a really strong 'star'-like quality. It is very hard to describe but it felt like this enormous spreading, shining sensation – like an expanding force of intense energy. I intuited it as a gesture of the wholeness of the plant. A wholeness that I could then recognize in parts of the plant such as the force of the 'sting' that you feel when touching the small syringe like 'stinging hairs'; the shape and expression of the thousands of tiny hairs seemingly bursting out of the plant with this immense energy; the pattern of 'spikes' on the leaf edges which feel like they are dynamically spreading outward with purpose. The whole plant felt like a star that was 'shining'. A wonderful experience to participate in. So, as opposed to actively working your way around what you are seeing and describing it, you remain with a still, open mind that is receptive to what the phenomena has to say to you, rather than what you have to say to it. And with enough patience and practice, without you having to say anything, it may well say something back.

Survey into Goethean Way of Seeing

After having been so inspired by the experience of this 'new' way of seeing , and feeling how deeply it had changed my be-ing in the world, I felt the desire to explore others' experience of this practice. To investigate the potential that the experience and re-cognition that the practice of this Goethean way of seeing may bring, I decided to gather opinions from other people who had already practised by process of a questionnaire. I felt a questionnaire would be most appropriate. It is a container which allows for qualitative information to come into being through the unique expression of each individual.

The individual questions are each formulated to facilitate process and not to restrict the expression of the individual. All questions are open, mainly beginning with 'how' as a pathway into each part of my investigation. I feel that 'how' is more of a holistic use of language than, for example, 'why'. 'How' is an invitation for all types of description of one's experience and does not restrict the individual to a certain way of seeing or replying. The word 'why' suggests an invitation for a more certain response from the participant, this is not holistic and implies a more a logical way of seeing; if one is to be certain that their response is 'a', there is a logical assumption therefore that 'a' cannot also be 'b'. Therefore the use of 'why' may be restrictive to the individual's freedom of creative self expression, which I wanted to encourage not control.

The first two subsections of the questionnaire were on personal experience and transformation. Not only did the participants convey a thorough sense of enjoyment and fascination in practising this way of seeing but there was an overarching feeling, or

emergence, that the relational way of seeing which Goethean methodology requires, leads to the world being 'seen' in a more relational way. Many participants noted throughout responses to various questions that this then enabled them to overcome the notion of separation to nature which occurs within our societies. The majority of participants noted that they had experienced a shift in consciousness during practice, whereas others noted that this shift was in perception or way of seeing. It was also frequently noted by participants that this 'new' way of seeing was reflected in the change in their relationship with the phenomena; they recounted that 'new' aspects of the phenomenon were seen in relation to the 'new' mode of seeing.

Most participants described that they felt practising this way of seeing was a meaningful process. There was a feeling of the importance of 'participation' with nature and 'meaning' emerging through a hermeneutic process of understanding within this participation – occurring as an emergent property through their relationship with the phenomenon studied. Wholeness was felt or 'seen' by the majority of participants in a number of ways, largely through see-ing and understanding the relation between the whole and the part – the interconnectedness of nature and the nature of interconnectedness. These experiences were described within a personal context but also within the wider context of feeling a part of the 'whole'.

In the "Relation to nature" subsection, the majority of participants expressed a sense of connection to nature through their practice, either in a new, intensified or deeper way "a sensation of being part of nature, of being a whole with the environment around you and not a separate entity". Participants noted that through their practice they could now perceive nature in a dynamic, living way and had an increased sense of ethics and responsibility toward nature. The majority felt that their experience had altered their behavior toward nature in positive ways, including being more careful, responsible, aware, respectful and mindful. I feel that this has great implications for the possible connection between a Goethean way of seeing and current 'sustainability' debates. The largest consensus occurred when all participants described that they feel their Goethean practice offered benefits as a way of seeing nature. These included feeling more a part of nature by seeing in a 'new', or different, relational way and overcoming the idea of separation; "working against the tendency of introducing the illusion of separation with the current mainstream science and society".

A feeling also emerges of a highly relational process developing which is able to re-cognize the relational processes in nature and in oneself. Not only did this seem to be an enjoyable, inspiring experience leading to a whole 'new' way of seeing but as the dynamic relation between the whole and the part, and wholeness, was 'seen', it seems to dissolve the notion of 'separation'; leading to a feeling of being part of nature and developing a natural sense of ethical responsibility and value of nature, thus wanting to treat nature with respect and care. This practice seemed to inspire the discovery of the true nature of nature, not just a partial view of nature as offered by our current mechanistic paradigm. Through the process of practising a Goethean way of seeing, the participants did not learn this relational view, they experienced it for themselves whilst in direct relation with nature. They were able to recognize the wholeness of nature through re-cognition; which they collectively described as an enjoyable, fulfilling, inspiring experience of reconnection with the world.

Access to Goethe's methodology, an open mind, discipline and natural phenomenon to observe is all that is needed to develop this new way of seeing. Within this way of seeing there is potential to dissolve the perceived separation between humans and nature, as when the observer is deep in process with the Goethean way of seeing, boundaries between observer and observed become blurred until, at an intuitive level of consciousness, they become one. This research demonstrates that the principles understood from the relation between the whole and the part. It could also have strong potential implications for individuals and societies in every aspect of their life due to the further levels of

consciousness, or ways of understanding, that are developed through this hermeneutic process of observation and participation.

A phenomenological way of see-ing such as Goethe's is neither form nor content, it is dynamic organic process; seeing dynamically, seeing like and aligning with the organic realm, re-cognizing dynamic organic nature which is also the nature of the see-ing itself. When a person re-cognizes life, sees life dynamically in a 'new' way, they become a physical expression of this way of seeing, this wholeness, just like a leaf on a plant; its form is an expression of its process, wholeness and its relation of part to whole. It is a physical expression of its way of 'see-ing' the world that the way of see-ing itself has created. Each new expression of this way of see-ing offers a new possibility for interpretation, a new form of language to be interpreted by the world. It may be a different language that is perhaps understood by a person, or people, who could not understand the variations of this language that were available to them before. And it is through the interpretation of this particular language that they then become able to gradually re-cognize the world around them, thus planting the seed of this new relational, organic, holistic way of seeing. Each person who has started developing (I am not sure it will ever be fully developed) the capacity to see in such a phenomenological way can only express it in *their* own unique way, the same but differently, just as leaves emerging uniquely from a plant; by living and participating in the world that *their* seeing has created.

The individual lyrics they recite may be different, but if lived through this way of see-ing, of *re-cognising*, the resonance of wholeness will remain the same – like a moral within a story and the hermeneutic understanding of a text, the whole or meaning, is never fully present in the text yet it can be understood by reading the parts of the text which are expressions of the whole. By living the way of seeing we bring it into physical expressions of wholeness, whole be-ings, be-ing whole, seeing the dynamic potential of metamorphosis in all. Being ourselves the same but differently like every other organism on earth. We must be ourselves, live our wholeness and whole way of seeing in our own unique way, with confidence, believing in what and how we see, concerning ourselves only with our own path of change in our 'new' way of seeing. Trusting in the universal 'dynamic metamorphosis of the possible', that all others may also find their own path of growth .

Opening windows to 'new' worlds, a Goethean way of seeing enables you to turn a new leaf, and to 'see' things that you have never dreamed of. When see-ing wholeness and the relation between the part and the whole, it puts one's life in a whole new Where before there may have only been separation, re-cognition enables connections to be 'seen', understood and felt, everywhere. Through re-cognition we are no longer a lonely human race separate from the rest of existence, but actually a part of the animate earth which sustains us, the rest of life and even the universe beyond – we are part of nature, nature is part of us. In re-cognizing the wholeness of nature, we are re-cognizing the nature of wholeness and what it truly means to be a part of whole on this earth.

References

1. Re-membering – when one is able to understand the relations between parts they can imaginatively be 'put back together' in ones mind to perceive process and wholeness
2. Mae-Wan Ho (2008) In Search of the Sublime, Science in Society Issue 39, Autumn 2008, pg 6
3. Daniel C. Wahl (2005) "Zarte Empirie": Goethean Scienceas a Way of Knowing", Janus Head,8(1),pg 60
4. Henri Bortoft (1996) "The Wholeness of Nature" Henri Bortoft, pg 34

This paper summarises the dissertation submitted for the degree of Masers in Holistic Science at Schumacher College in August 2009 entitled: ***Re-Cognition – The re-cognition of our connection to Nature through Goethe's way of Seeing****. Now, Emma is exploring practical ways to combine skills in design and embodied principles arising from a holistic way of seeing and out of this has emerged Emiliana Underwear– handmade by Emma - unwanted clothing and fabrics are upcycled into beautiful new underwear.*

www.emilianaunderwear.wordpress.com ***emmakidd81@gmail.com***

Andrew Lacey

☾ ☿ ♀ ☉ ♂ ♃ ♄

'As above, so below'. This is the central tenet and major theme of the 'microcosm/macrocosm'. It is also the simplest way of understanding the cosmos and those materials engendered in it and their influence upon one and other. In short, the microcosm is the world of the small or the minute, whereas the macrocosm is the greater world or the large scale. Both exist in their own right and in some respect know only that of their own world. The German word 'umwelt' (a self-centred world) is an expression of this, and by analogy we can say for example, it is where a rabbit knows the world of the rabbit but can't conceive of the moon. Likewise the moon understands it's cold existence among the stars but knows nothing of the rabbit. The mysterious beauty here is that one is a reflection of the other, and in this case both have the engendered qualities of the other. Therefore to work with one you inevitably work with the other.

To explain this further, let us look into our past, where the people of the world were well aware of the stars. It was only when they started to build the first cities, that we see the structures and texts in which they described the cosmos. The Babylonians named their star constellations forming what we now know as the signs of the Zodiac. These are the 'fixed stars', the unchanging structures of the sky. They also named the 'moveable stars', what we now know to be six planets and the one star of our solar system. Today we are aware of more, but these are the seven classic heavenly bodies as understood historically. So, from an Earth-centred cosmos the Moon came first, then Mercury, Venus, the Sun, Mars, Jupiter and finally Saturn. At this time, the city centres of Ur, Uruk, Sumer and Babylon, built on the fertile plains of the Tigris and Euphrates developed skills and technologies as their civilizations grew. There is no knowing how metallurgy first came about, possibly from accidents in the potters kiln, but when it did it changed the world. As the early metal-smiths began to manipulate the fires that transformed the living rock into metals, some part of them became, if not a god, at least the promethean archetype or 'midwife to nature'. These metals they named, and in naming them understood something of the qualities of each one. Over time, the fine structures of the metals began to be probed so that by the time of the Greek philosophers, ideas about atoms and internal forces came into play. We therefore see the relationships between planet and metal formed around the sympathetic qualities of each counterpart.

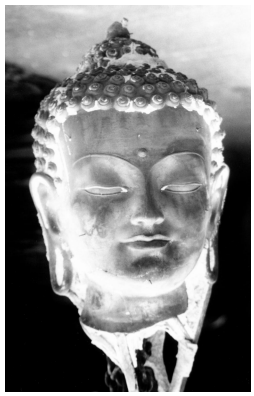
The***Moon*** *with it warm silver hue reflected in the metal* ***silver.***
Mercury *the speedy sublimate of red cinnabar, mirrored the liquid metal* ***mercury.***
In ***Venus****, the celestial beauty we see* ***copper****, warm, soft and yielding.*
The ***Sun's*** *warmth and enduring noble qualities are seen in* ***gold****, king of metals.*
Mars *the red planet of war, makes* ***iron*** *the metal of swords its ideal partner.*
Jupiter *the Roman thunder god and Zeus, his Greek version signify* ***tin****, but it is tin alloyed to copper to form bronze that makes the thunderous tone of bell or the sharpness of the spearhead.*
Saturn *in the form of Chronos, father of the gods who devoured his children,* ***lead*** *in turn devours and corrupts all.*

The combination of alloying all of the above is called an octo-alloy and has specific names in different cultures. This octo-alloy has a potency of its own, which is greater than the sum of its parts and is the subject of much mythology around the world. However, the metallurgy of such an alloy made in equal parts

would in a real sense be impractical. The crystal structure, when forming inside the casting, would counteract any of the good qualities of the individual metals. To prevent any negative reactions, the metals are usually mixed into a host alloy, like bronze (a mixture of copper and tin), in tiny amounts. In reality this should be seen as purely a symbolic process.

Bronze bell made for Emperor Rudolf II using the seven metals and decorated with alchemical symbolism.

The intentions of using metals in this way are many, depending on the belief and philosophical basis of the culture. In its simplest form one can say that this symbolism acts to bring harmony and clarity into the casting of objects, usually in the form of a sculpture or a device of spiritual or religious significance. Objects embodying this type of symbolism are common in the eastern philosophical traditions. However, in the west this philosophy is little heard of after the Renaissance and only a few rare sculptures are known today, e.g. the Gloucester Candlestick. Slowly they are being made anew.



I was recently commissioned to make a bronze cast of a Shakyamuni Buddha for a temple in Paris. !e Lama who commissioned it asked specifically for these metals to be introduced when casting the head of the Buddha, reflecting microcosm/macrocosm principles. The common theme of the alchemical process being that of order, clarity and respect represented in the final form.

[1] The Tibetan name this this octo-alloy is Asta-dhatu. From Lo Bue, E. Statuary Metals in Tibet and the Himalayas: History, Tradition and Modern Use.

References

Alighieri, Dante.(1986) The Divine Comedy: Inferno,Purgatory, Paradiso, 3 vols. Text and translation, AllenMandelbaum. New York: Bantam

Ambix, (1993) The Journal of the Society for the History of Alchemy and Chemistry. Black Bear Press Limited, Cambridge, March.

Bucklow, S. (2009). The Alchemy of Paint, Art, Science and Secrets from the Middle Ages. Marion Boyars, London, New York,

Eco, U. (1986) Art and Beauty in the Middle Ages. New Haven and London: Yale University Press,

Oddy & Zwaalf. (1991.) Aspects of Tibetan Metallurgy: Occasional paper 15, British Museum

---

Andrew Lacey *runs a sculpture studio on the Dartington Estate, Devon and works with his partner Siân, his brother Robin and keen assistant Venetia. He gained an MSc in archaeometallurgy from UCL, is a member of the Society of Historical and Alchemical Chemistry and the Royal Institute in London. Mostly he enjoys the woods.*

www.andrewlacey.com

andrewglacey@me.com

A new optimism

David Peat

As a young student I was always interested in big ideas and one day was taken to one side by an older and wiser scientist who advised me to find a niche in a small field and publish a series of papers on that niche. “Then when you have established your reputation you can begin to investigate wider ideas”. Clearly he felt I should adopt the same attitude as my colleagues and not wander off to think about fundamental questions of physics.

At that time I was part of a research group who were making theoretical investigations of the various properties of metals and other solids. In other words, “solid state physics”. The general approach was to investigate, for example, the vibrations of a crystal lattice, by adding together a series of tiny corrections, a method known as perturbation theory. Its origins stretched back to the mechanics of Isaac Newton, who had shown that while it was possible to find an exact solution to a two body problem - the earth’s orbit around the sun, for example, it was not possible to do the same for the system of sun, earth and moon. Instead astronomers had to add in corrections for the moon’s effect on the earth’s orbit around the sun – in other words, its perturbations of the earth’s orbit. The same principle applied in many other fields, including solid state physics: solve the basic system and then add a series of corrections.
Most of my colleagues were happy to do this, because it fitted so well into the sociology of science and the advice that had already been given to me – find a field and publish papers in that field, each one being a variant of the one that had gone before. In this way one’s publication list grows and becomes the royal road to tenure and promotion. On rare occasions, a voice of caution was raised by one of my colleagues, who pointed out that in principle, the number of corrections could be infinite and while in arithmetic most infinite series converge to a finite answer, on occasions they diverge to infinity. Could the same thing happen in perturbation theory? But this was not the sort of caution people liked to hear and the objection was generally laughed away. Then, towards the end of the 1960s, disaster struck, as we learned about the work of Rene Thom in Paris and what became known as “catastrophe theory”. In other words, while most systems are well behaved, there are some in which a tiny change, a small correction, can blow up into radically different behaviour: what Thom called a catastrophe. From that point on, the face of physics changed rapidly and suddenly chaos theory, with its attendant branches of fractals, complexity theory, self-organization, butterfly effects and strange attractors was upon us. Our world had changed in such a radical way, that it brought a dramatic new meaning to the advice Einstein had once given to the young Heisenberg, “it is the theory which suggests the observables”.

Science is a way of seeing the world; it brings some aspects of nature into sharp focus and causes us to ignore others. It could be compared to the green spectacles given to Dorothy when she entered the Emerald City in the land of Oz. Suddenly everything appeared green to Dorothy. Likewise for decades, physicists had been give a set of tools that enabled them to make calculations about systems close to equilibrium, in balance and subject to slow and gentle changes. In turn, experimentalists would also study such systems and confirm a theoretician’s prediction, and so a whole community of scientists could get on with their job of publishing papers and writing books. Other systems certainly existed – such as shock

waves, violent changes, and systems far from equilibrium, but they tended to be ignored or dismissed.

But then a combination of new mathematical techniques and the development of computers capable of making more advanced calculations suddenly opened up a vast new field. Suddenly self-organization, fractals, order out of chaos and bifurcations were everywhere to be seen. Science had encountered a brave new world. What was of particular importance was that it introduced a new set of principles that could be applied over a wide range of subjects that went far beyond the confines of conventional physics and chemistry: to living systems, social behaviour, ecologies and economic systems. A curious side effect of this new burst of interest is the way in which in the United States, so many of the top graduates in mathematics and theoretical physics chose not to enter academia, but the stock market, where their skills could be applied to creating mathematical models of stock fluctuations which are now recognized as exhibiting fractal self-similarity. A parody of this situation can be seen in Darren Aronofsky's 1998 film *Pi* in which the protagonist, believing that the entire cosmos is described by numbers, seeks to discover its underlying secrets by studying the fluctuations of the stock market.

I feel that there are two important lessons to be learned from this scientific revolution. One, as we have seen, was first pointed out by Einstein that "the theory suggests the observables". In other words that science does not proceed according to the common assumption that observations are made, data collected and hypotheses made, which are later turned into theories. But instead that a theory, or more generally a paradigm, causes science to look in particular directions in which to gather its data and formulate its theories. Moreover, science itself is not a totally objective exercise, but the result of certain social concerns. Take for example, one of the steps in the development of the second law of thermodynamics. Following the French Revolution, French engineers realised that their nation had fallen behind the British in the development of machines. It fell to people such as Sadi Carnot to attempt to make more efficient engines, but they soon discovered that there was a limit to the efficiency of converting heat into work, since some of this heat is always dissipated. In this way Carnot came to an understanding of the nature of entropy and the limitations inherent in converting heat into work. The Second Law of Thermodynamics therefore arose out of social concerns of the time. To what extent is the direction of some areas of present day science an expression of current social values and norms?Another lesson is that our new understanding of self-correcting and sustainable ecological systems can lead to guidelines for healthy ethical behavior in social and economic systems.

a) Transparency and Openness

Self-organized systems survive because of their feedback loops. Positive feedback allows the market to foster innovation; negative feedback protects that which has been established. It is therefore vital that information and meaning should flow through the system and not become blocked. This means transparent accounting, open declarations of intent and action, and coherence between a corporation's public image and ethical statement and its internal culture of trust and respect for others. What is more, each individual corporation has an obligation to foster the health of the system as a whole.

b) Respect for Competition

Natural systems flourish because of their inherent diversity. If any one species begins to dominate then the flexibility of the environment declines. Likewise in a business environment, competition is necessary to keep the entire ecosystem flexible, so that goods, money and information can flow through the system's feedback loops.

c) **The Role of Redundancy**

Natural systems achieve their ends in a number of different ways, which at face value does not appear particularly efficient. However when situations change, or damage occurs to part of a system, redundancy means that it can continue to function. Likewise it is important to accept a level of redundancy in a corporation, for maximizing efficiency could make that business over-rigid and incapable of making quick adjustments when the market changes.

d) Accepting Uncertainty

Uncertainty and limits to control are facts of life that must be accepted within any non-linear system. There will always be a degree of "missing information" which at times may make us uncomfortable. Likewise we may not always be able to control what occurs around us. It is important for us to decide if we are going to view this in terms of insecurity and lack of control, or as doorways into new possibilities and relationships.

.----------

The Pari Center for New Learning

In 1996 ***David Peat*** and Maureen Doolan moved from Canada to the medieval hilltop village of Pari, some 25 km south of Siena, Tuscany. The village and surrounding area was particularly beautiful and the people welcoming, so Pari seemed an ideal place from which to write and think. On the other hand, the village was uncertain of its future. When once it had a population of one thousand, during the 1950s and 60s people began to leave to find work in cities and now there were fewer than two hundred people in the village and the Palazzo, the public building at the top of the village, had been abandoned.
I (David Peat) have always enjoyed discussions with artists in the UK and North America and in 1999 the Arts Council of England invited me to host a weekend encounter between artists and scientists. The meeting was a great success with new works such as Antony Gormley's "Quantum Cloud" emerging out of the discussions. Word began to circulate and I was asked to run a similar meeting on the role of universities. At first I assumed that this should take place in London or New York, but after the ground floor of the Palazzo had been refurbished, I approached the president of the Pari village association and asked if the meeting could be held in Pari.

While conclusions about the present role of the universities was rather bleak, the participants did comment on how much better it felt to meet in a small village than in an anonymous hotel in a large city. They also experienced the great warmth of being fed in the village hall with food cooked by the local women. While they agreed that the universities were certainly here to stay, they saw a need for alternative academies and suggested that Pari was an ideal location for such an academy. Feedback also came from the local people who said how much they had enjoyed seeing new faces. They asked us to organize other meetings, and so the Pari Center for New Learning was born. Over the years we have held conferences on such topics as Business and Ethics, the future of knowledge in the world of the Internet, the dialogue between religion and science, and the life and work of David Bohm. Thanks to support from the Metanexus Institute we also ran a series of talks in Italian for people from Pari and the surrounding villages, on the relationship between religion and science. We were three time winners of the Metanexus Prize for excellence of programming.

In addition to our conferences, we offer three residential courses a year on "New Paradigms, New Science", "Synchronicity: the Bridge between Matter and Mind" and "Art, Science and the Sacred". We also have a visitors program where people come to study, work on a book, engage in an art project or compose music. The Center's website contains a series of "Basic Books in Science and Mathematics" which are free to download and which provide a complete education in science up to university entry level for students living in the Third World. The Center is also bringing out a series of "Pari Dialogues" through Pari Publishing. Volume 1 looks at Science, Religion, Society and the Arts. Volume 2 will explore the relationships between "Traditional Knowledge and Western Scientific Knowledge"
The Center and the village are very much engaged in a win-win situation. Visitors and participants can rent empty furnished houses owned by people in the village, buy provisions in the local shop, have a coffee in the bar and eat at the local restaurants. In return the Center has the use of the Palazzo where its conference room, coffee room, library and office are located.***www.paricenter.com*** . A discussion of David Peat's notion of Gentle Action can be found at ***www.gentleaction.org***

In September 2009, the Center ran a conference/workshop whose theme was ostensibly to explore what the world may look like in 50 or 100 years and how businesses could contribute to a sustainable future. However by the second day the discussion had become much more general and participants, mainly from the world of business, noted that the Center provided a safe container, almost an alchemical vessel, in which new ideas were being be generated. The notion of Pari Dialogues was proposed – that the Center should invite an organization or business that faced particular issues to send representatives to Pari where they would meet with Pari Dialoguers to explore new and creative pathways and solutions. We would invite any organization that would like to participate in a Pari Dialogue to write to ***info@paricenter.com***

Opening the Whole

Wendy Ellyatt

'What I have found to be the problem is not 'holes' but 'wholes' – the notion that a complete, fully definable, space-excluding boundary can exist anywhere at any scale in an evolving biosphere and cosmos. There is no evidence, and can be no evidence [i.e. we could not be aware of it even if it existed] of a discrete limit anywhere and it does not make sound sense to assume that there is one. And yet the whole of definitive - and thereby oppositional and discriminatory - logic depends on it. **' Alan Rayner** (above drawing courtesy Wendy Ellyatt)

We all talk about the importance of 'wholeness' and 'connectivity' now, and yet do we really understand what we mean by this? Language imposes strong, subtle pressures that persuade us to see the world in particular ways. The moment we say the word 'whole' we imagine something definable' and 'complete in itself', i.e. a 'singularity. And yet it is becoming increasingly clear that all manifest objects are undergoing continual flux and change. So there is really no such thing as a definite thing; everything that we call an object is really variably fluid rather than a static form.

I have recently discovered the theory of 'Inclusionality', which has been developed by a small group of pioneers including the English biologist and ecological thinker Alan Rayner. It has been fundamentally informed by the work of the African mathematician Lere Shakunle and his own theory of Transfigural Mathematics. Both suggest a new way of looking at natural systems that resonates with many of the wisdom teachings that I encounter in my own work on Ancient and Indigenous cultures. Inclusionality, as I understand it, is the awareness that we are in the world and the world is in us. There is no absolute separation between what includes us and what is included within us.The way we understand nature and human nature depends very fundamentally on the way that we perceive space, boundaries and centres, that is, the kind of geometry that we think gives shape to the cosmos, the world, our selves and how we live. The logic of orthodox mathematics, science, language and theology, assumes a closed geometry in which space is either localized within or excluded from a fixed structural framework. What inclusionality suggests, however, is that this logic is fundamentally flawed with the receptive space within, between, around and throughout natural form not an uninvolved absence, but instead a vital pooling omnipresence, without any necessary or knowable inner or outer completely definitive limit. This then provides the basis for a fluid dynamic, open space geometry that is more true to how ancient and indigenous peoples understand nature.

Space, as continuous openness in this inclusional geometry, would pervade everywhere, without any necessary definitive, localizing limit. As such, it would be infinite – indivisible into finite quantities – at all scales. It would, however, be distinguishable into four regions, that is, within ('intra'), between ('inter'), across ('trans') and everywhere ('omni'). Omnipresent space would constitute the 'primordial womb' or 'Mother' of Nature, the darkness that is a dynamic inclusion of light. Centres in this geometry, instead of being fixed, dimensionless points of mass or force would instead be *'dynamic relational centres of flow.'*

'Instead of envisaging ourselves as exceptions from or even as parts of Nature as a whole, there is a need for us to open up the imaginary boundary limits that we have been so prone to impose on existence, which deny our dynamic relationship with one another and Nature as all. Most fundamentally, we have to include the meaning of infinity and zero

in our comprehension of the dynamic relational nature of 'self as neighbourhood'. Alan Rayner

What excites me about this is that it ties in so well with so many of the ancient teachings. Many ancient religious texts suggest that all physical appearance in the Universe has a common origin in an omni-pervasive field of infinite energy. Ancient sages professed to have knowledge about the world construction, from the micro cosmos to the universe. The Satkaaryavaada doctrine of the Saamkhya school talks about the manifestation of what was *'potentially present'* and that this potential becomes actual at every moment. Generation and destruction do not actually occur, instead there is only modification and transformation.

The Indigenous scientific approach understands the Universe as continually in motion. Even the particles are "dancing," already moving towards being in flow. Since everything is in motion all the while, any location is in continual flux in relation to everything else. In the modern world we tend to think in a separatist, linear way, focusing on the specifics and often unaware of the flow, whereas ancient and indigenous cultures tend to look at the world in terms of unfolding cycles, presupposing that there is an essential unity to every action. We define things in terms of right and wrong, and present or absent, whereas ancient and indigenous cultures are far more likely to accept that there are diverse ways of being and knowing. Nature demonstrates a dynamic, unfolding beauty and continuity that integrates, differentiates, transforms and grows...a magical mathematical dance of life.

'The Navajo term, alkee na'aashii, expresses dynamic unbroken movement. This is not necessarily the case with western concepts of complementarity. With full complementarity, as defined by Navajo, there is neither hierarchy nor polarity. The emphasis is on perpetual movement between the two (the "two" being what appear on the surface as polar extremes, for instance night and day, violence and non-violence). Both energies are needed for dynamic movement. In the unity of the dynamic movement, the polarities naturally disappear'. There is a *'self-organizing central process that provides unity, coherence and life. It is the spiritual matrix that binds the human with all cosmic forces and energy'.*
Nancy Maryboy – Indigenous Education Institute

Moving the Self-Centre: Human Implications of Open-Space Geometry

An inclusional understanding of nature as a fluid geometry has profound implications for human psychology. With it we can no longer see ourselves as isolated individuals, but need to encompass the idea that we are all in dynamic relationship. Science, philosophy and psychology are linked through the understanding that the universe has a wonderful natural coherence within which all is enfolded and which manifests explicitly as matter and consciousness. Such a synthesis has been sought by many of the world's great thinkers and resonates with the *advaita-vedanta* philosophy of India, Sufism, Taoism, and with Christian mysticism. The Vedic *sastra* entitled *Brahma-samhita* gives a very clear description of a dynamic 'wholeness' that is expressed in each of its 'parts'. This unity consciousness sees everything in the universe as experienced in terms of the underlying reality of a field of pure consciousness. As this field is recognized as the field of one's own Self, everything that one thinks or does takes on a cosmic status.

'This body, Arjuna, is called the field. He who knows this is called the knower of the field. Know that I am the knower of all the fields of my creation; and that the wisdom which sees the field and the knower of the field is true wisdom.(Krishna to Arjuna)'
Bhagavad Gita 13,1-2

Natural systems *seem* to form totalities where the whole, as a dynamic open system, can be *more than* the sum of the separate parts. But this is where language and the thinking underlying the language may become confused. A 'dynamic open system' cannot be defined as a 'whole', a 'totality' with a finite boundary limit. The problem here may lie in the way our visual attention tends to focus on the immediately visible and tangible 'figure' that *appears* to be a finite, autonomous whole, whilst overlooking or taking for granted the infinite spatial 'ground' in which this figure is immersed. This is where, as I will describe

later, the fluid logic and geometry of inclusionality comes to our aid, through acknowledging the dynamic inclusion of infinite space in and beyond all that we might call 'matter' as a fluid configuration of this space. We don't then run the risk of seeming to confuse 'infinity', which cannot be defined or divided, with a 'complete whole', which could be if it actually existed.

'The whole gives form to the parts, it organises the parts so one can say there is a kind of organic process involved. Take life for example. Here we have another form of movement in which all the various functions of the life form are organised to work together to create and maintain the whole organism. We can think of life as an organising energy that is working from within through the movements of its organs, its cells and indeed every molecule and atom, ultimately merging with the universal field of movement, the holomovement.'
B.J. Hiley- Process and the Implicate Order: their relevance to Quantum Theory and Mind

Above we can see evidence of the struggle to articulate the recognition of an underlying organizing influence in Nature in paradoxical terms that objectify whilst seeking to merge visible and tangible form into a continuous universal presence. This is similar to the Hindu concept of Maya - that the world as we experience it is an illusion – and also Indra's net, a mythological web over the god Indra's palace, with jewels at each intersection. Reflected in each jewel of Indra's net is every other jewel - the whole is contained within the parts. The system itself is regarded as open and expanding, which is consistent with inclusionality, but the imagery of a web with intersections – which has also been incorporated into modern 'network theory' – implies a fixed structure from which space has been excluded into the spaces between the threads – like a spider's trap, not a fluid organization. Truly fluid and dynamic networks comprise labyrinthine channels of included space – of the kind found naturally in leaf veins, blood systems and fungal colonies – not a set of solid lines and intersection points.

The Unity of Psyche and Matter?

'Since psyche and matter are contained in one and the same world, and moreover are in continuous contact with one another and ultimately rest on irrepresentable, transcendental factors, it is not only possible but fairly probable, even, that psyche and matter are two different aspects of one and the same thing' Carl Jung

With the rapid advance and integration of physics and psychology, our theoretical understanding of the universe beyond the range of our present consciousness is expanding to the point where we see hints of the identity of psyche and matter at profound levels. In recent years the question of the relationship between the human psyche and matter has been increasingly debated. Jung's exploration of the 'collective unconscious' – that part of the unconscious mind that is common to all humans – convinced him that the seemingly divergent sciences of psychology and modern physics might be approaching a unified world model:

'The unexpected parallelisms of ideas in psychology and physics suggest, as Jung pointed out, a possible ***ultimate oneness*** *of both fields of reality that physics and psychology study. . . . The concept of a unitarian idea of reality (which has been followed up by Pauli and Erich Neumann) was called by Jung the '****unus mundus****' (the one world, within which matter and psyche are not yet discriminated or separately actualized).'* *Marie-Louise von Franz, 1979*

David Bohm emphasized that thought tends to create fixed structures in the mind, which can make dynamic entities seem to be static. For example the paper on which this text is printed appears to have a stable existence, but we know that it is, at a finer level, continually changing and evolving. *'Hence paper would more accurately be called papering--to emphasize that it is always and inevitably a dynamic process undergoing perpetual change' (Sarfatti,J).*

The very process of thinking, when based on drawing an absolute line between 'matter' and 'space' as 'something' and 'nothing', itself persuades us to create a fragmented view in which knowledge and reality are separate. Bohm talks about an 'undivided whole' and yet the moment we visualise this we see something that implies a boundary. It is challenging for us to conceive this whole as openness in perpetual dynamic flux.

'This undivided whole is not static but rather in a constant state of flow and change, a kind of invisible

ether from which all things arise and into which all things eventually dissolve. Indeed, even mind and matter are united: "In this flow, mind and matter are not separate substances. Rather they are different aspects of one whole and unbroken movement" Hayward 1987, 25

Much media attention is currently being paid to something known as 'Zero Point Energy'. This suggests that *a single cubic centimetre of empty space contains more energy than all of the matter in the known universe!* This sea of energy pervades all of space. *'It just happens to be the biggest sea of energy that is known to exist and we're floating inside it' (1999 Thomas Valone)*. Bohm, through his own studies, (1980, 191) concluded that "space, which has so much energy, is *full* rather than empty." But maybe this is a conclusion based on starting out with the assumption that matter can be excluded from space in the first place. If it is true that we all belong in a vast sea, where matter cannot be separated from space, there can be no such things as wholes and parts in splendid isolation: in an inclusional world we are genuinely all pooled together in a dynamic union – or, rather, *communion*, distinct but never definable, as William Wordsworth put it, into absolute, independent singleness.

Why is it, if I am solely part of a whole, that I experience myself as 'I'? Why do I not experience myself much more like a Borg unit in Star Trek - organized as an inter-connected collective with a hive mind and operating towards one single-minded purpose – the pursuit of perfection? Is my sense that each one of us is unique in our experiences and sense of purpose just an illusion? Is there some unseen benefit to this illusion, or is this question itself an irrelevance? Modern science investigates the field of the known, but it does not touch at all the field of the knower and the spontaneous process of knowing. In inclusional thinking boundaries are not non-existent but are key to understanding dynamic relationship. Inclusional boundaries are primarily considered to be 'dynamic interfacings' – manifestations of information that both distinguish and allow communion between inner and outer regions of space. Like the God Janus, they face both ways – outlining inner and in-lining outer – whilst being, to varying degrees, both permeable and dynamic and nested over scales ranging from microcosmic to macrocosmic. Inclusionality allows us to both acknowledge our unique boundaries and to own that they only exist within a vast dynamic communion. By shifting consciousness I can move from the illusion of self as separate to self as dynamic movement in relation to other.

This has profound implications for the way in which we communicate. With an inclusional logic, opposites are transformed into dynamic relational complementarities. Together we co-create our reality. There is no definable right or wrong, but rather a mutual exploration of the field of possibility that we continually create together. Our mutual awareness tunes into those fine creative impulses that are engaged in transforming the field of intelligence into the field of material manifestation. In the change from envisaging absolutely closed to variably open structures, we invite in the possibility of transformation and innovation. When we comprehend our inner and outer worlds, and hence our Selves as relational *places*, expressions of the energy-including space of *everywhere* rather than isolated *objects*, our scientific, artistic and spiritual world views transform and complement one another rather than conflict. This is a dynamic dancing communion rather than a self-contained 'whole'.

*"**Inclusionality** is an awareness that* space*, far from passively surrounding and isolating discrete massy objects, is a vital, dynamic inclusion within, around and permeating natural form across all scales of organization, allowing diverse possibilities for movement and communication. Correspondingly, boundaries are not fixed limits - smooth, space-excluding, Euclidean lines or planes - but rather are pivotal places comprising complex, dynamic arrays of voids and relief that both emerge from and pattern the co-creative togetherness of inner and outer domains, as in the banks of a river" (Rayner).*

"We are all quantum fluctuations. That's the origin of all of us and of everything in the universe."
Dr. John Bahcall – The Inst. for Adv. Study at Princeton

'Science has missed something essential; it has seen and scrutinised what has happened and in a way how it has happened, but it has shut its eyes to something that made this impossible possible, something it is there to express.

There is no fundamental significance in things if you miss the Divine Reality; for you remain embedded in a huge surface crust of manageable and utilisable appearance.
It is the magic of the Magician you are trying to analyze but only when you enter into the consciousness of the Magician himself can you begin to experience the true organisation, significance and circles of the Lila.'
Sri Aurobindo *The Valley of the False Glimmer*

Inclusionality Principles

- There are no such things as independent masses or forces, only dynamic relational influences
- There are neither discrete particles nor waves, only flow-forms
- Space is not distance; space pools all together
- There are no real discrete numbers or groups of numbers, there are only dynamic relational numerical neighbourhoods
- Positive is not opposed to negative as materially additive and subtractive qualities; they are mutually inclusive as responsive and receptive qualities in natural energy flow
- Space, Time, Matter and Energy are not isolable from one another; they are dynamically distinct and mutually inclusive in the natural energy flow of 'place-time'
- Nature has no discrete beginning or ending; it is dynamically continuous
- Nature is not certain and predictable; the only absolute certainty is that there is no complete certainty
- Organisms are not competitive, acting and reacting purely in their individual self interest against others; they are instead dynamic relational flow-forms, receptive and responsive to fluctuations in energy flow.

'A Human Being is part of the whole called by us universe, a part limited in time and space. He experiences himself, his thoughts and feelings as something separated from the rest, a kind of optical delusion of his consciousness. This delusion is a kind of prison for us, restricting us to our own personal desires and to affection for a few persons nearest to us. Our task must be to free ourselves from this prison by widening our circle of compassion to embrace all living creatures and the whole of nature in its beauty.' Albert Einstein

---

*`**Wendy Ellyatt** is a writer, researcher and innovator who has a particular interest in the dynamics of natural systems. She is also known for her work in early years education. She was co-founder of the Ouroboros Research and Education Trust, which itself was a founder member of the World Wisdom Alliance, and is currently developing the website **www.sophos.uk.com** and the educational network*

www.uniquechildnetwork.ning.com.

Featured Artist– Marcia Phillips

geonutt@gmail.com

"I am an artist and a naturalist who started out with a sense of curiosity and wonder about the splendid universe that lives inside of us. Once I would have said "the universe that we live in" but I realized that it is in us, not we in it. You can thank Schumacher College for that, for answering the yearning of a lifetime for connection, for wholeness during my Masters year there in 2009. I studied natural history in college, then worked as a ranger-naturalist in the US National Parks for twenty years. I was then, and still am constantly filled with awe and amazement at the beauty of the world. My journeys through the parks, inspired by a need to connect with real, fundamental qualities, eventually blossomed into artwork, which just flows out of me, unstoppable. It comes from the wholeness that I am and that I am of. The art keeps on flowing, and beauty and life go on."

Philip Franses

Breaking

In the last fifty years, complexity theory and information theory have combined to give an alternative foundation to formative phenomena, based on potential and coherence. Information describes a redundancy in potential that in the mathematics of complexity theory is able to resolve coherently to a whole attractor bounding different possible local trajectories.

It is in the suspension of causality that information resides. Where there is only one causal path universally determined, there is no room in the phenomena for additional information. It is the redundancy of potential paths at the micro-level that allows for additional properties to characterise the whole nature at the macro-level. Thus it requires questioning of an existence to uncover its essential properties, whether this is going deeper into a person's true character or really observing a flower in its delicate composition. No information is apparent at the surface of causal-sufficiency.

Science continues to see information as pools of multiple-possibility residing within an essentially causal landscape of concepts and laws. Information in our view extending this analogy might be more akin to the sea, in primary formative relation to the land of causality.

Quantum theory successfully furnishes a theory where the sea of potential is incorporated implicitly in the description of journey between ports. It allows us to understand potential, as a dark crossing in which no measurement is possible, as an influence upon the arrival and departure of vessels on the land, the illuminations of objects in their knowable properties.

Bohm[1] re-formulates the classical quantum equation through the 'Quantum potential field', a global prescriptive influence upon the behaviour of particles. The particles are guided by a field that allows the freedom of their properties to converge upon a meaningful state with a composite answer to their individual questions of being. Basil Hiley has recently explained this:

'We found that the potential was totally different from any classical potential that we know. It has no external source in the sense that the electric field has its source in a distribution of charges. It does not act mechanically on the system. In this sense it cannot be thought to act like an efficient cause. It is more like a formative cause that shapes the development of the process. Indeed as we explored its properties in many different physical systems it reminded me very much of the morphogenetic field generated in biological systems.

The information field is shaped by the environment in a way that is very similar to the way the development of a plant is shaped by its environment. Thus we can think of the information as active from within giving shape to the whole process and this shape depends on the environment in key ways. In other words the meaning in the wave is expressed through the form that develops.'[2]

Just as Bohr and Heisenberg succeed in entraining the possibility aspect of information into a causal (at least at statistical level) law of classical particles, so Bohm and Hiley suspend causality for the entrance of an informational field that steers free flowing potential.

Material interpretation

- hides phenomena in an elusive world of statistical average;
- causality breaks multiply into infinite possibilities only recovered by a statistical averaging;
- aligns a global nature to permeate the weird world of local phenomena;

- alerts us to the stability of the atomic founded substance over all inducement to change;

Potential interpretation
- celebrates form in wholeness;
- causality breaks singularly and dramatically in the admission of a global information field that restores causality as after-influence;
-local relationships utilise to the maximum the symmetry and exchange of basic properties to allow the potential for a global phenomenon to resonate in its midst
- triumphs momentarily over causality to cohere potential into new form.

The dynamic between element and possibility may realise a dead-inert world of closed energy that has subdued the force of change into part of its own structure; or exhibit how radical creative invention takes breath from the cycle of form secured by its absolute original necessity.

Just as Schrödinger's cat seems to suspend life forever in the minute detail of its demise, so there is an equivalent tale of creation where potential is remixed to startle life into new inhabitancy defying the running down of the causal order. The fluidity for transformation between death and life is born in the same breath as the form in potential is safeguarded.

The two interpretations, when released from their competing rivalry, unite biological form with molecular foundation.

The crossing of the sea of potential can no longer be dismissed by statistical artefact, but holds the creativity of form that coheres in the informational field between the ports of order.

The arrival at causal destinations is filled with the optimum imprint of potential at the moment of encounter of individual with universal that is carried as bounty back into the port of causal law. Instead of a mathematical account holding the detail of a dark passage in the certainty of the sure, the intrinsic coherence and beauty of form is the admirable booty of the journey.

The stability of the atomic account is enriched by the wonder of the informational field that weaves potential into its most articulate forms. Where possibility was included in a shadowy allowance of its disturbance to causal law, now potential in the full light of its capacity, participates in equal measure as the harbinger of form.

Shaping

The medium for this journey is process, which as well as being a template for the categorisation of the world is transparent to the illumination of whole inquiry.

Process is conceived mathematically as a two-fold distinction made in wholeness. An example used by Basil Hiley is how thought is a process rather than a linear causal relationship. A new thought arises from an old thought as a development of the old in the continuity of the new. The new develops from the old without thereby making the starting point redundant: one needs the foundation of an idea to arrive at the completion of a thought. Basil Hiley following on the work of David Bohm has created a mathematics of process, where the present instead of developing by overwriting the past, is inclusive of its future state in its past origin. One can manipulate these processes to show that in their interrelationship one arrives at a structure, called a pre-algebra, from which space and time can be realised as a derived phenomenon (so importantly process is shown as primary).

Basil has played back the development of all categorisations that have together shaped the foundation of the modern mindset of separation/analysis and has reached back to a single cut or division that is as it were the primary process. This original distinction he characterises as breaking the symmetry of wholeness into information from the past and information from the future. Once Basil has made this incision, this distinction of wholeness, then he is able to expand this self-statement about wholeness into all areas of modern physics, space-time relativity, quantum formulations as a necessary corollary.

The information from the past, information from the future is a transparency that allows the whole to be encapsulated mathematically.

Once this categorisation has been made, it can be expanded and formalised into space time, while keeping the window of process on something dynamic, without fixing phenomena into occupying an exclusive present. The interrelationship future: present: past is available as a total area of influence, not made abstract into a point of the present.

Information from: past |>  <| future

Fig. 1 breaking the symmetry of wholeness by distinction

A methodological problem arises when the fluid window given on wholeness is concretised into a formal separation of <past> <future>. The distinction past: future, used to open up wholeness, is also a categorisation by which the resulting space time framework is then explored.

The fact that the world made transparent by the cut past: future has then been analysed through the same tool hides from view the role wholeness plays. This means that in much analytical work, the origin of the wholeness which past: future brought into distinction is lost.

One example of this is light. Light is seen as an absolute existence which can be described by Maxwell's equations as wave or by Feynman as particle. One can look up what light is for there is nothing more to light than its abstract knowledge.

Goethe on the other hand demonstrated that when one goes into the phenomena of looking at the world of colour through a prism, then dark and light are experienced as a distinction within wholeness.

'For Goethe darkness is not the completely powerless absence of light. It is something active. It confronts the light and enters with it into a mutual interaction. Modern natural science sees darkness as a complete nothingness. According to this view, the light which streams into a dark space has no resistance from the darkness to overcome. Goethe pictures to himself that light and darkness relate to each other like the north and south pole of a magnet.' [3]

Dark and light in polarity are available as an alternative distinction by which the world can be explored while keeping in tact the window past: future of process.

As the cut into wholeness has become fixed by its resulting use as a tool of exploration, it is the endeavor of a medium for inquiry called Process and Pilgrimage, to introduce a lighter way of working with process. The reason for joining Process and Pilgrimage is that in both one sets out on a journey with no idea of the destination and that it is the meeting of wholeness en route that gives the journey its identity. A pilgrimage starts at a point of transition, beginning in darkness seeking reconnection, to end in the light of a new self-knowledge and association to Oneness. So the past and the future lightly touch upon the wholeness that redirects the pilgrim how to live forward from his foundations of origin.

Once one uses a different lens, in this case the active polarity of dark-light then a different filter of distinction brings the world into focus. In particular the polarity dark-light, instead of separating wholeness as past: future, articulates wholeness through the journey between the two poles. The world opens up to a transparency, in which categorisation of past: future is fluid to the wholeness from which it originates.

Instead of prescribing a strict interpretation of past and future, we associate the start of the process with darkness, without prescription of wholeness, and the end point of process with light, or the complete integration of wholeness. The process is then a provisional journey, without guarantee that it will complete, and with no fixity in its definition. It has the quality of an informational potential, in that the description contains a great redundancy in it as to if and how it might happen. It belongs in our earlier metaphor with the sea, where everything is in flux.

It has the advantage of associating wholeness with a journey of process itself so that instead of seeing order being born out of some abstract unity, wholeness of being is given birth to in the journey from dark to light, an act of experience. Thus every living thing has its

dark-light journey which asks the question of its being to the world with no surety of an answer.

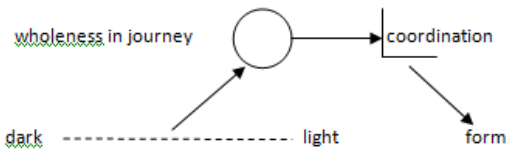


Fig. 2 The dotted line of the sea gives birth to wholeness in its journey

Remaking

There is a dual focus to the world's existence, one the material defined through what has been, and the other the enduring, defined through the potential of what will be. Alongside the material focus driving life, the centre of potential is a justice or beauty at its core. The scales of life, piled as haphazardly and untypically as one wants with matter, hold order in the universal balance of unity remaking.

When individuals experience the universal story of time independently and integrally, they give dimension to the capacity of potential. The world discloses its nature in the dimensions of its experiencing. The fall from historical alignment and renewal into the potential of the possible, freely explored, establishes independent dimensions of experience characterizing the world at a fulfilling of its essential unity. The rebirth into the spirit of what is possible reseeds the world at the unity of its own remaking.

The universality of time is dimensioned into the trilogy of spirit: Re-origination; Fall and Return; Redemption (renewal from unity). The world is judged by the content of experience in the dimensions of the universe's singular renewal. The world offers the capacity for renewal in the weighing of experience's worth.

Light seals experience at the singular point where the universal is remade from its unity. Re-origination challenges the world of experience to differentiate the enduring of participation from that which is passing and transient. At each level, experience reassembles unity through the journeys that are transparent to its enduring quality.

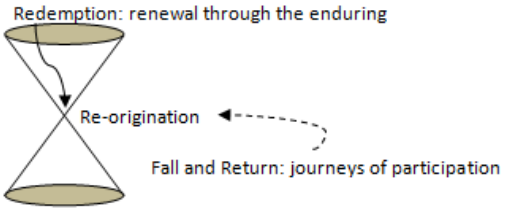


Fig. 3 The light cone remaking the universal in its unity

One meets the universe as if returning from a far mission. The far future comes forward to counteract collapse with blessing.

It is rather like meeting a stranger, a disciple from a foreign land, upon the way and inviting him with all one's heart into the house. He leaves behind a quest. So he passes through the land, visiting others, leaving in the air that suggestion of change working quietly unseen. Until all the threads find each other and weave into a path upon which the future, the white horseman enters. There is a challenge in potential, a demand; in unlocking the gate of the security of our self-walled world, the steps are now of the transforming future arriving in light.

References

1 Bohm D. (1980) **Wholeness and the Implicate Order**; Hidden Variables in the Quantum Theory; Routledge and Keegan Paul

2 Hiley, B. J. (2004). **Information, quantum theory and the brain**. In G. Vitiello (Ed.), **Brain and Being** (Vol. 58, pp. 197-214). Philadelphia: John Benjamins Publishing Company

3 Steiner R. (1897), **Goethe's World View; The Contemplation of the World of Colours**; online at http://wn.rsarchive.org/Books/GA006/English/MP1985/GA006_c03.html

---

Philip Franses *is faculty lecturer in Holistic Science at Schumacher College. From his search to the source of science and spirit, there has flowed a series of presentations, workshops, papers. The Process and Pilgrimage forum, which he began in 2009 using elements of Basil Hiley's mathematics of process and Satish Kumar's philosophy of pilgrimage, has broadened into a widely engaged inquiry.*

philip@schumachercollege.org.uk

III. *Seeing the Ox*

On a yonder branch perches a nightingale
cheerfully singing;
The sun is warm, and a soothing breeze
blows, on the bank the willows are green;
The ox is there all by himself, nowhere
is he to hide himself;
The splendid head decorated with stately
horns -- what painter can reproduce him?

Comment: When one hears the voice, one can sense its source. As soon as the six senses merge, the gate is entered. Wherever one enters one sees the head of the ox! This unity is like salt in water, like color in dyestuff. The slightest thing is not apart from self.

IV. Catching the Ox

With the energy of his whole being,
boy has at last taken hold of the ox:
But how wild his will, how
ungovernable his power!
At times he struts up a plateau,
When Lo! he is lost again in a
misty unpenetrable mountain-pass.

Comment: He dwelt in the forest a long time, but I caught him today! Infatuation for scenery interferes with his direction. Longing for sweeter grass, he wanders away. His mind still is stubborn and unbridled. If I wish him to submit, I must raise my whip.

V. Herding the Ox

The boy is not to separate himself with
his whip and tether,
Lest the animal should wander away into
a world of defilements;
When the ox is properly tended to,
he will grow pure and docile;
Without a chain, nothing binding, he will
by himself follow the oxherd.

Comment: When one thought arises, another thought follows. When the first thought springs from enlightenment, all subsequent thoughts are true. Through delusion, one makes everything untrue. Delusion is not caused by objectivity; it is the result of subjectivity. Hold the nose-ring tight and do not allow even a doubt.

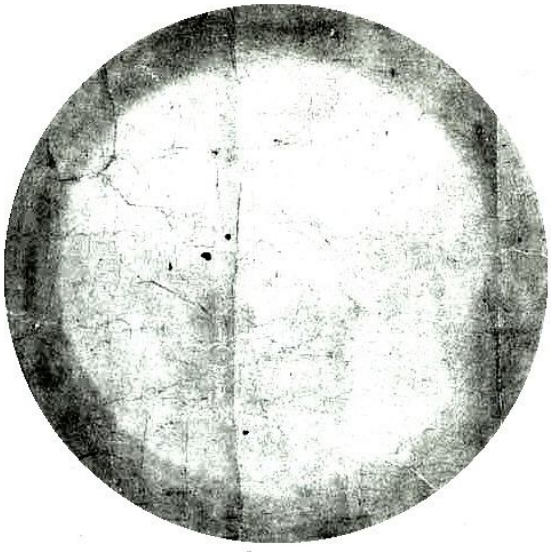
Riding on the animal, he leisurely
wends his way home;
Enveloped in the evening mist, how
tunefully the flute vanishes away!
Singing a ditty, beating time,
his heart is filled with a joy
indescribably!
That he is now one of those who know,
need it be told?

Comment: This struggle is over; gain and loss are assimilated. I sing the song of the village woodsman, and play the tunes of the children. Astride the ox, I observe the clouds above. Onward I go, no matter who may wish to call me back.

VII. The Ox Forgotten, Leaving the Man Alone

Riding on the animal, he is at last back
in his home,
Where lo! the ox is no more; the man
alone sits serenely.
Though the red sun is high up in the sky,
he is still quietly dreaming,
Under a straw-thatched roof are his whip
and rope idly lying.

Comment: All is one law, not two. We only make the ox a temporary subject. It is as the relation of rabbit and trap, of fish and net. It is as gold and dross, or the moon emerging from a cloud. One path of clear light travels on throughout endless time.

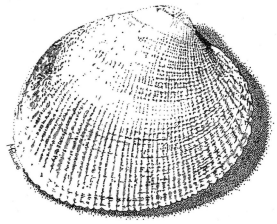


VIII. The Ox and the Man Both Gone out of Sight

All is empty -- the whip, the rope,
the man, and the ox;
Who can ever survey the vastness
of heaven?
Over the furnace burning ablaze,
not a flake of snow can fall:
When this state of things obtains,
manifest is the spirit of the
ancient master.

Comment: Mediocrity is gone. Mind is clear of limitation. I seek no state of enlightenment. Neither do I remain where no enlightenment exists. Since I linger in neither condition, eyes cannot see me. If hundreds of birds strew my path with flowers, such praise would be meaningless.

Fritjof Capra



Leonardo da Vinci, the great master painter and genius of the Renaissance, has been the subject of hundreds of scholarly and popular books. However, there are surprisingly few books about Leonardo's science, even though he left voluminous notebooks full of detailed descriptions of his experiments, magnificent drawings, and long analyses of his findings. Moreover, most authors who have discussed Leonardo's scientific work have looked at it through Newtonian lenses. This has often prevented them from understanding its essential nature, which is that of a science of organic forms, a science of quality, one that is radically different from the mechanistic science of Galileo, Descartes, and Newton. [1]

The empirical method

In the 1460s, when the young Leonardo received his training as painter, sculptor, and engineer in Florence, the worldview of his contemporaries was still entangled in medieval thinking. Science in the modern sense, as a systematic empirical method for gaining knowledge about the natural world, did not exist. Knowledge about natural phenomena, some accurate and some inaccurate, had been handed down by Aristotle and other philosophers of antiquity, and was fused with Christian doctrine by the Scholastic theologians who presented it as the officially authorized creed and condemned scientific experiments as subversive, seeing any attack on Aristotle's science as an attack on the Church. Leonardo da Vinci broke with this tradition:

First I shall do some experiments before I proceed farther, because my intention is to cite experience first and then with reasoning show why such experience is bound to operate in such a way. And this is the true rule by which those who speculate about the effects of nature must proceed.[2]

One hundred years before Galileo and Bacon, Leonardo single-handedly developed a new empirical approach, involving the systematic observation of nature, reasoning, and mathematics — in other words, the main characteristics of what is known today as the scientific method. He fully realized that he was breaking new ground. He humbly called himself *omo sanza lettere* ("an unlettered man"), but with some irony and with pride in his new method, seeing himself as an "interpreter between nature and humans."

For forty years, Leonardo collected his thoughts and observations, descriptions of hundreds of experiments, drafts of letters, architectural and technological designs, and reminders to himself about future research and writing in his celebrated Notebooks. It is believed that the entire collection ran to 13,000 pages when Leonardo died without having sorted them, as he had intended. Over the subsequent centuries almost half of the original collection was lost, but over 6,000 pages have been preserved and translated from the original Italian. These manuscripts are now widely dispersed among libraries, museums, and private collections — some in large compilations known as *codices*, others as torn pages and isolated folios, and a few still as notebooks in their original bound forms of various sizes.[3]

The science of painting

Leonardo was gifted with exceptional powers of observation and visual memory.
He was able to draw the complex swirls of turbulent water or the swift movements of a bird with a precision that would not be reached again until the invention of serial photography. He was well aware of this extraordinary talent and considered the eye as his principal instrument, both as a painter and a scientist.

The eye, which is said to be the window of the soul, is the principal means whereby

sensory awareness can most abundantly and magnificently contemplate the infinite works of nature.[4]

Leonardo's approach to scientific knowledge was visual; it was the approach of a painter. "Painting," he declared, "embraces within itself all the forms of nature."[5] I believe that this statement is the key to understanding Leonardo's science. He asserts repeatedly that painting involves the study of natural forms, and he emphasizes the intimate connection between the artistic representation of those forms and the intellectual understanding of their intrinsic nature and underlying principles. For example, we read in a collection of his notes on painting, known as the "Treatise on Painting" (*Trattato della pittura*),

[Painting] with philosophic and subtle speculation considers all the qualities of forms… Truly this is science, the legitimate daughter of nature, because painting is born of nature.[6]

The nature of life

Painting, then, is both an art and a science for Leonardo — a science of natural forms, of qualities, quite different from the mechanistic science that would emerge two hundred years later. Leonardo's forms are living forms, continually shaped and transformed by underlying processes. Throughout his life he studied, drew, and painted the rocks and sediments of the Earth, shaped by water; the growth of plants, shaped by their metabolism; and the anatomy of the animal body in motion.

Nature as a whole was alive for Leonardo, and he saw the patterns and processes in the microcosm as being similar to those in the macrocosm. In particular, he frequently drew analogies between human anatomy and the structure of the Earth, as in the following beautiful passage:

We may say that the Earth has a vital force of growth, and that its flesh is the soil; its bones are the successive strata of the rocks which form the mountains; its cartilage is the porous rock, its blood the veins of the waters. The lake of blood that lies around the heart is the ocean. Its breathing is the increase and decrease of the blood in the pulses, just as in the Earth it is the ebb and flow of the sea. [7]

This analogy between microcosm and macrocosm goes back to Plato and was well known throughout the Middle Ages and the Renaissance. But Leonardo disentangled it from its original mythical context and treated it strictly as a scientific theory. Today we know that some of the analogies in this passage are flawed, and in fact Leonardo himself corrected some of them late in his life. However, we can easily recognize Leonardo's statement as a forerunner of our contemporary Gaia theory, which sees the planet as a self-regulating and self-organizing living system.[8]

At the most fundamental level, Leonardo always sought to understand the nature of life. This has often escaped earlier commentators, because until recently the nature of life was defined by biologists only in terms of cells and molecules, to which Leonardo, living two centuries before the invention of the microscope, had no access. But today, a new systemic understanding of life is emerging at the forefront of science — an understanding in terms of metabolic processes and their patterns of organization.[9] Those are precisely the phenomena which Leonardo explored throughout his life. The unifying conceptual threads that interlinked his knowledge of macro- and microcosm were life's patterns of organization, its organic structures, and its fundamental processes of metabolism and growth.

A systemic thinker

Leonardo da Vinci was what we would call, in today's scientific parlance, a systemic thinker. Understanding a phenomenon, for him, meant connecting it with other phenomena through a similarity of patterns. This exceptional ability to interconnect observations and ideas from different disciplines lies at the very heart of Leonardo's approach to learning and research.

Leonardo's scientific work was virtually unknown during his lifetime and remained hidden for over two centuries after his death in 1519. His pioneering discoveries and ideas had no direct influence on the scientists who came after him, but during the subsequent five hundred years his conception of a science of forms would emerge again at various times.

During those periods, the problems he had struggled with were revisited repeatedly at increasing levels of sophistication, as scientists advanced in their understanding of the structure of matter, the laws of chemistry and electromagnetism, cellular and molecular biology, genetics, and the critical role of evolution in shaping the forms of the living world.

Today, from the vantage point of 21st-century science, we can recognize Leonardo da Vinci as an early precursor of an entire lineage of scientists and philosophers whose central focus was the nature of organic form. They include Immanuel Kant, Alexander von Humboldt, and Johann Wolfgang von Goethe in the 18th century; Georges Cuvier, Charles Darwin, and D'Arcy Thompson in the 19th; Alexander Bogdanov, Ludwig von Bertalanffy, and Vladimir Vernadsky in the early 20th; and Gregory Bateson, Ilya Prigogine, and Humberto Maturana in the late 20th century; as well as contemporary morphologists and complexity theorists like Brian Goodwin, Ian Stewart, and Ricard Solé.

However, none of the scientists in that lineage were aware that the great genius of the Renaissance had already pioneered many of the ideas they were exploring. While Leonardo's manuscripts gathered dust in ancient European libraries, Galileo Galilei was celebrated as the "father of modern science." One cannot help but wonder how Western scientific thought might have developed, had Leonardo's Notebooks been known and widely studied soon after his death.

Deep ecology

Leonardo did not pursue science and engineering to dominate nature, as Francis Bacon would advocate a century later. His science was a gentle science. He abhorred violence and had a special compassion for animals. He was a vegetarian because he did not want to cause animals pain by killing them for food. He would buy caged birds in the marketplace and set them free, and would observe their flight not only with a sharp observational eye but also with great empathy.

In the designs of his flying machines, Leonardo tried to imitate the flight of birds so closely that he almost gives the impression of wanting to become a bird. He called his flying machine *uccello* ("bird"), and when he drew its mechanical wings, he mimicked the anatomical structure of a bird's wing so accurately and, one almost feels, lovingly, that it is often hard to tell the difference.

Instead of trying to dominate nature, Leonardo's intent was to learn from her as much as possible. He was in awe of the beauty he saw in the complexity of natural forms, patterns, and processes, and aware that nature's ingenuity was far superior to human design. "Though human ingenuity in various inventions uses different instruments for the same end," he declared, "it will never discover an invention more beautiful, easier, or more economical than nature's, because in her inventions nothing is wanting and nothing is superfluous."[10]

This attitude of seeing nature as a model and mentor is now being rediscovered in the practice of ecological design. Like Leonardo da Vinci 500 years ago, ecodesigners today study the patterns and flows in the natural world and try to incorporate the underlying principles into their design processes.[11] When Leonardo designed villas and palaces, he paid special attention to the movements of people and goods through the buildings, applying the metaphor of metabolic processes to his architectural designs. He also considered gardens as parts of buildings, always attempting to integrate architecture and nature. He applied the same principles to his designs of cities, viewing a city as a kind of organism in which people, material goods, food, water, and waste need to flow with ease for the city to be healthy.

These examples of using natural processes as models for human design, and of working with nature rather than trying to dominate her, show clearly that as a designer, Leonardo worked in the spirit that the ecodesign movement is advocating today.

Underlying this attitude of appreciation and respect of nature is a philosophical stance that

does not view humans as standing apart from the rest of the living world but rather as being fundamentally embedded in, and dependent upon, the entire community of life in the biosphere.

Today, this philosophical stance is promoted by the school of thought known as "deep ecology."[12] Shallow ecology views humans as above or outside the natural world, as the source of all value, and ascribes only instrumental, or "use," value to nature. Deep ecology, by contrast, does not separate humans — or anything else — from the natural environment. It sees the living world as being fundamentally interconnected and interdependent and recognizes the intrinsic value of all living beings. Amazingly, Leonardo's Notebooks contain an explicit articulation of that view:

The virtues of grasses, stones, and trees do not exist because humans know them… Grasses are noble in themselves without the aid of human languages or letters.[13]

In view of this deep ecological awareness and of Leonardo's systemic way of thinking, it is not surprising that he spoke with great disdain of the so-called “abbreviators,” the reductionists of his time:

The abbreviators do harm to knowledge and to love...Of what use is he who, in order to abridge the part of the things of which he professes to give complete knowledge, leaves out the greater part of the things of which the whole is composed?… Oh human stupidity!... Don’t you see that you fall into the same error as he who strips a tree of its adornment of branches laden with leaves, intermingled with fragrant flowers or fruit, in order to demonstrate the suitability of the tree for making planks?[14]

This statement is not only revealing testimony of Leonardo’s way of thinking, but is also ominously prophetic. Reducing the beauty of life to mechanical parts and valuing trees only for making planks is an eerily accurate characterization of the mindset that dominates our world today. This, in my view, is the main reason why Leonardo’s legacy is immensely relevant to our time.

As we recognize that our sciences and technologies have become increasingly narrow in their focus, unable to understand our multi-faceted problems from an interdisciplinary perspective, and dominated by corporations more interested in financial rewards than in the well-being of humanity, we urgently need a science that honors and respects the unity of all life, recognizes the fundamental interdependence of all natural phenomena, and reconnects us with the living Earth. What we need today is exactly the kind of holistic science Leonardo da Vinci anticipated and outlined 500 years ago.

References

1. Capra, F. (2007), *The Science of Leonardo*, Doubleday, New York,
2. Ms. E, folio 55r
3. Capra, F. (2007), pp. 299-301, for a complete list of scholarly editions (facsimiles and transcriptions) of Leonardo's manuscripts
4. *Trattato*, chapter 19
5. Ms. Ashburnham II, folio 19v
6. *Trattato*, chapters 6 and 12
7. Codex Leicester, folio 34r
8. Harding, S. (2006), *Animate Earth*, Green Books, UK,
9. Capra, F. (1996),*The Web of Life*, Anchor Books, New York
10. Anatomical Studies, folio 114v
11. Orr, D. (2004) *The Nature of Design*, Oxford University Press
12. Devall, B.,and Sessions, G. (1985) *Deep Ecology*, Gibbs Smith, Layton, Utah
13. Anatomical Studies, folio 153r
14. Anatomical Studies, folio 173

---

www.ecoliteracy.org

The Centre for EcoLiteracy

Fritjof Capra is cofounder and president of the board of trustees of the Center for Ecoliteracy, a nonprofit based in Berkeley, California, dedicated to education for sustainable living. Best known for its pioneering work with experiential learning and integrating sustainability curricula in primary and secondary education, the Center has collaborated with schools and organizations from more than 400 communities across North America and in some 20 countries. Its work arises from the conviction that the best hope for learning to live sustainably lies in schooling that returns to the *real* basics: engaging with the natural world; understanding how nature sustains life; nurturing healthy communities; exploring the consequences of how we feed and provision ourselves; and caring about the places where we live and the people and creatures in them.

The Center was founded in 1995 by Fritjof, Peter Buckley, a philanthropist with a deep passion and concern for the environment and the education of children and Zenobia Barlow, director of the ecological think tank and international network of independent scholars and activists that Fritjof had founded to articulate an ecological paradigm and address problems in business and education from the perspective of systems thinking.

David W. Orr and Gay Hoagland joined the initial board. David, professor of environmental sciences and politics at Oberlin College, had recently written *Ecological Literacy: Education and the Transition to a Postmodern World*. Gay was executive director of the Bay Area Coalition for Essential Schools, a group attempting to bring innovative and equitable policies and participatory community to secondary schools.

When the board met for the first time, in the course of an hour it identified most of the elements that still guide its work. Fritjof advocated teaching ecological knowledge and systems thinking. Peter stressed the need to produce tangible outcomes leading to systemic change. Gay affirmed leadership and recognition that change is an organic process within the context of whole schools. David emphasized understanding the physical and biological patterns and cultural wisdom of particular places. Zenobia spoke for including a reverence for life and nurturing networks of relationships to carry visions to fruition.

The Center's working hypothesis was that applying key concepts of systems thinking can lead to sustainable change. CEL scouted for schools that (1) functioned as whole communities, (2) expressed the spirit of systemic school reform, (3) were committed to teaching ecological knowledge through project-based learning linked to particular places, and (4) desired to integrate curricula through school gardens, habitat restoration, or work with energy, shelter, or environmental justice programs.

The Center soon realized that effective change agents must shift nimbly among the different levels of scale in systems—from individual schools, to districts, to the communities and regions in which schools are embedded. Just as dynamic balance is maintained in healthy living systems, networks of relationships give stability and resiliency to social systems in the midst of continual change.

Out of its work with thousands of educators, the Center for Ecoliteracy has developed a framework for schooling for sustainability called "Smart by Nature," based on four guiding principles: nature is our teacher; sustainability is a community practice; the real world is the optimal learning environment; sustainable living is rooted in a deep knowledge of place. It applies to education the implications of the perceptual shifts that accompany holistic, systemic thinking: from the parts to the whole, from object to relationships, from objective knowledge to contextual knowledge, from quantity to quality, from structure to process, from contents to patterns.

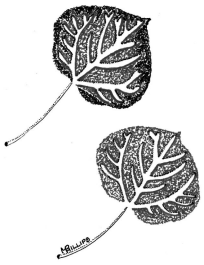
Through its Smart by Nature™ initiative, the Center supports educators advancing sustainability in food practices, building and resource use, community connections, and teaching and learning. It offers seminars, consulting, professional development, and numerous publications, including *Ecological Literacy: Educating Our Children for a Sustainable World* (Sierra Club Books); *Smart by Nature: Schooling for Sustainability* (Watershed Media/University of California Press); and *Big Ideas: Linking Food, Culture, Health, and the Environment* (Learning in the Real World). The Center's website provides much downloadable resource materials, including its popular and newly revised Rethinking School Lunch Guide, curriculum and discussion guides to the films *Food, Inc.* and *Nourish,* essays by leading writers and experts, and stories of schools and organizations engaged in this vital work.

www.ecoliteracy.org

Models of Nature

Science and Sanskrit Grammar

John Doran



Following on from last issue's articles on language and biology by Alyse Takayesu, and Chris Clarke's on Tops Logic, John Doran compares the logic of quantum theory and the grammar of Sanskrit. The article portrays how the logic of the elementary particle world evades causal local description, and how language can serve as a template for the way deeper meaning surfaces in tangible form - editor

Introduction

Western science has taken the physical world as the primary object of its investigation – that is, the material world as experienced by the senses. Centuries of study, thought and imagination have led, by the 20th century, to the sophisticated and beautiful theories of modern physics. These theories are abstract, often strange, seemingly paradoxical, even non-comprehensible in ordinary terms, but astoundingly successful in their purpose, which is the accurate description and prediction of physical phenomena. Science has been guided, and constrained, by the evidence of the world as it presents itself, initially in ordinary experience and eventually in detailed experimentation.

The ancient Sanskrit grammarians took the Sanskrit language as the primary object of their investigation – that is, the language as spoken by the śisas, those who were wise, and learned just for the sake of being so. Centuries of study, thought and imagination led, by the 5th century BC, to the sophisticated and beautiful theory of Pānini, as expressed in his Astādhyāyī. This theory is abstract, but astoundingly successful in its purpose, which is the accurate description of the Sanskrit language. The grammarians were guided, and constrained, by the evidence of the language as it presented itself.

The nature of these great scholarly pursuits, millennia and continents apart, is similar. Each sets out to describe an aspect of human experience – the material world or the Sanskrit language. Each believes, or has believed, its object of study to be divinely given, not created by man – the world created by god, and Sanskrit, the language of the gods.

What emerged are two systems of law – scientific law and grammatical law – systems that seem to define their respective ages. A comparison of these two systems, the system of western science and the system of the Sanskrit grammarians, as formulated by Pānini, is inviting. What kind of models did mankind build to describe his experiences in times of very different priorities and culture? Additional impetus is given to such a comparison by the following statement, by Śrī Śantānanda Sarasvatī:

"The grammatical rules are also the rules of the creation." [1]

There are some simple questions:
We have 'word' on the one hand, and 'that which word names' on the other hand. One is believed to be subject to law – as described in grammar. The other is believed to be subject to law – as described in science.

If 'word' and 'that which word names' are only apparently separate, being one at a deeper level, then the laws describing 'word' and 'that which word names' would be only apparently separate, being one at a deeper level. Is there evidence for this? Do we see something in the laws of each that tends to confirm this intuition? In this paper some preliminary comparisons are made between modern physics and Sanskrit grammar as systems of law, or models of aspects of nature, for the purpose of investigating these questions. What seem (to the present author) to be notable similarities are suggested.

There are, of course, also significant differences between these two systems. The most significant difference is the language in which the systems of law are formulated. In the case of western science the language is mathematics. In the case of Sanskrit grammar it is Pānini's metalanguage, consisting of pratyāhāras, indicatory letters, and well-defined case-ending conventions. Even in this fundamental difference between the two systems we see a striking commonality; in both cases the system derived its success from the invention/discovery of an appropriate 'artificial' language with which to frame its laws. It is hard to imagine western science having progressed in its description of nature without mathematics. Euler's recasting of Newton's Laws from Newton's original wordy Latin expressions into a simple mathematical form was a significant step in the proliferation of modern physics. It is also hard to imagine the science of Sanskrit grammar having progressed to the extent that it did if the laws had to be expressed in ordinary language. Ordinary, or natural, languages are excellent for communication. Artificial languages are excellent for developing systems of knowledge.

For the Greeks, mathematics was prerequisite. For the Indians, grammar was.

"In philosophizing the Greeks made as much use as possible of mathematics. The Indians…made as much use as possible of grammatical theory and argument." Daniel Ingalls[2]

"Just as Plato reserved admission to his Academy for geometricians, Indian scholars and philosophers are expected to have first undergone a training in scientific linguistics, i.e., Sanskrit grammar….Historically speaking, Pānini's method has occupied a place (in Eastern thought) comparable to that held by Euclid's method in Western thought." Frits Staal[3]

In comparing these two systems one must be careful not to push analogies too far, and one must be restrained in making claims of significance. Comparisons between these two systems could be at a detailed level, where a particular grammatical law is compared to a particular scientific law. There may be a danger here of applying too much force to the comparison. Alternatively, comparisons could be at the more general level, looking at the operation of the overall systems. The latter approach is favoured in this paper. That is not to say that the detail is not important; it is of great importance in understanding and developing the overall system; it is in the detail that the formulation of the systems of law begins.

Systems of Law

Physics is a system of law for the material world. Vyākaran (grammar) is a system of law for the Sanskrit language. As a starting point in the comparison of these systems one can ask the question: 'What is a law?' Alternatively, 'what do laws do?' An answer is that 'laws' operate upon 'things'. So what is a 'thing'? A 'thing' is that which is acted upon by a 'law'. There is an essential duality between 'law' and 'thing'. It is hard to conceive of a 'thing' that is not acted upon by a 'law', or of a 'law' that does not act on a 'thing' – it would be a redundant idea.

Other words come into play with regard to 'things'. We think of 'things' as being 'objects' and as having 'properties'. These relate to common experience. It is through the objects and their properties that we have access to the 'things' and thus to the 'laws' that govern them (see Figure 1).

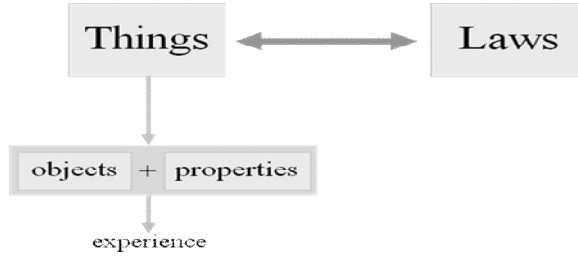


Figure 1

The system of law, or model of nature, consists in identifying the 'things' and the 'laws' that act upon them.

In the system of vyākarana the starting point is to identify the basic objects, which are the

Sanskrit letters. Eventually the letters are organised into groupings according to the properties they share. Pānini begins his grammar with such a grouping of letters, the Māheśvarāni Sūtrāni.

अइउण् । ऋऌक् । एओङ् । ऐऔच् ।
हयवरट् । लण् । ञमङणनम् । झभञ् ।
घढधष् । जबगडदश् । खफछठथचटतव् ।
कपय् । शषसर् । हल् ॥

Figure 2 The Māheśvarāni Sūtrāni

The Māheśvarān i Sūtrān arrangement is a highly efficient way to organise the letters in order to allow naming of the 42 groupings (pratyāhāras) that Pānini uses in his grammar. In fact, it is mathematically proven to be the most efficient possible way in which to organise the letters for this purpose.

The point is that the laws given by Pānini are formulated so as to act on objects (the letters) that have specified properties.

But there are also other properties that the objects (letters) can have that Pānini does not express using pratyāhāras. Letters can be assigned properties that relate to the method of their articulation – sprsta (contact), vivrtta (open), *etc.* – or by the position of articulation in the mouth – kanthya (guttural), osthya (labial), *etc*. – or method of articulation – ghosa (voiced), aghosa (unvoiced), aspirated, unaspirated, *etc*. – or by the duration of the enunciation – hrasva (short), dīrgha (long), pluta (prolonged) – or by the accent of enunciation – anudātta (low), udātta (high), svarita (mixed). When it is convenient, Pānini expresses laws in terms of these properties.

Letters can also have the property of being savarna (of the same 'colour') with a group of other letters, *i.e*., having the same mouth position and the same method of inner articulation. When it is convenient, Panini expresses laws in terms of this property.

The picture that emerges is of a set of objects, the letters, being assigned a host of different properties. Pānini uses these various properties in his system because grammatical laws are readily formulated in terms of them. The different properties are not in mutually exclusive sets, but are overlapping, nested, and definable in terms of each other.

In the system of modern physics the starting point is to identify the basic objects, which are the fundamental particles. (Note: modern physics is not a completed but an evolving model.) The particles are organised into groupings according to the properties they share. The fundamental particles, in the standard model of modern physics, are outlined in Figure 3.

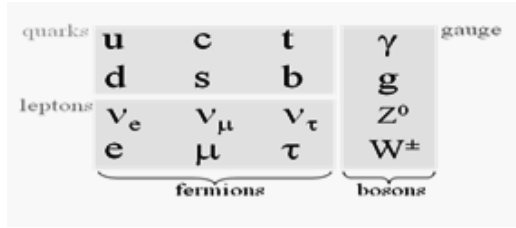


Figure 3 The fundamental particles in the standard model of modern physics.

These particles are arranged into three families: (1) the **quarks** (up-quark (u), down-quark (d), charm-quark (c), strange-quark (s), truth-quark (t), and beauty-quark (b)); (2) the **leptons** (electron (e), muon (□), taon (□), electron-neutrino (□$_e$), muon-neutrino (□$_□$), and taon-neutrino (□$_□$)); and, (3) the **gauge particles** (photon (□), gluon (g), Z-particle (Z^0) and W-particles ($W^{\pm}$)).

These particles are arranged into groups, or families, because they share properties. The quarks and leptons are fermions – they obey scientific laws that are formulated for fermions. The gauge particles are bosons – they obey scientific laws that are formulated for bosons.

There are a host of physical properties that are held by these particles. Particles may have mass, electrical charge, spin, isospin, nuclear colour, baryon number, *etc*. The particles will obey scientific laws that are formulated in terms of these properties.

The picture that emerges is of a set of objects, the particles, being assigned a host of different

properties. Science uses these various properties in its system because scientific laws are readily formulated in terms of them. The different properties are not in mutually exclusive sets, but are overlapping, nested, and definable in terms of each other. For example, quarks have mass, charge, *etc.* Quarks are a subset of fermions. Even the division between the 'object' (particle) and the 'properties' is a convenience, *e.g.*, an up-quark simply represents the manifestation of the set of properties {mass of 4.28×10^{-30} kilograms, charge of 1.07×10^{-19} coulombs, spin of ½, *etc.*}.

The above brief outline of the two systems of law shows a great similarity of general approach. Laws are expressed in terms of various groups of properties that the basic objects have. The properties are named because the laws are readily expressible in terms of them. Whatever is most convenient for expressing a law is chosen to express it.

Another commonality between the two systems lies in the fact that both systems are 'atomistic'. The model presented is of underlying basic objects (the letters and the particles) and that from these basic objects is constructed a hierarchy of composite structures.

Scientific view of the material world

The basic particles, quarks, combine to form nucleons (protons and neutrons). The nucleons combine together to form nuclei. The nuclei combine with electrons to form atoms. Atoms combine to form molecules. Molecules combine in various ways to form gases, liquids and solids. Each level of composition comes about under well-defined scientific laws. Most of the levels of composition are abstract, inventions for the sake of analysis, beyond the range of direct experience. The direct connection with human experience occurs at the level of gases, liquids, solids. The sense experiences of the macroscopic material world are the starting point. Atoms, molecules, quarks, *etc*., are abstractions from that direct experience, invented for the sake of knowing the laws that are at play.

Grammarians view of language

The basic objects, letters, combine to form a range of different composite entities, dhātus (roots), pratyayas (affixes), āgamas (augments), prātipadikas (noun stems), and angas (bases). These composite entities combine to form padas (words). The words combine to form the vākya (sentence). Each level of composition takes place under well-defined grammatical laws. Most of the levels of composition are abstract, inventions for the sake of analysis, beyond the range of human experience. The direct connection with human experience is at the level of the sentence. The sentence is the indivisible linguistic unit, the starting point, expressing a meaning. Dhātus, pratyayas, prātipadikas, even words, are abstractions from the sentence, invented for the sake of knowing the laws that are at play.

These composite schemes are shown in Figure 4.

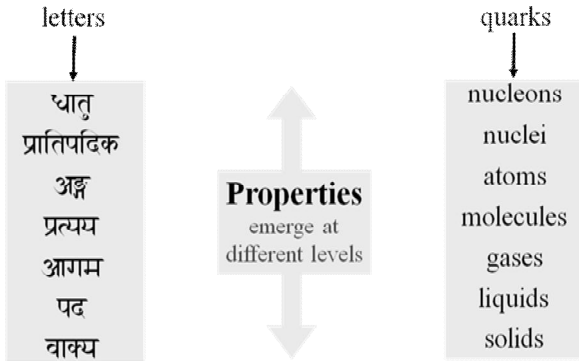


Figure 4 Composite structures in grammar and in science.

At each level of composition there are different families of law operating.

In science there are laws governing quarks (the laws of quantum chromodynamics), laws governing nucleons and nuclei (the laws of nuclear physics), laws governing atoms (the laws of atomic physics), laws governing molecules (the laws of chemistry), laws governing gases (the laws of thermodynamics, aerodynamics), laws governing fluids (laws of fluid dynamics), and laws governing solids (the laws of mechanics, *etc.*). Also, at different levels of composition there are properties that emerge that would have no meaning for deeper levels. For example, a gas may have the property of temperature. At other levels of composition the property of temperature would not have any real meaning, *e.g.*, for a

single atom. A solid can have the property of elasticity, but not a quark. A fluid may be buoyant, but not a molecule. There are also laws that operate at all the levels of composition, *e.g.*, the laws of gravity. An important difference between science and vyākarana is that it is expected that the laws at higher levels of composition are derivable from those at the deeper levels.

Two points emerge from the above analysis: (1) modern scientists and ancient Sanskrit grammarians went about their business in similar ways – inventing, or using, an artificial language – and using that language, in a pragmatic manner, to formulate laws in terms of properties, some of which are intuitive, and some of which are abstract, but always opting for an expression of laws in terms of properties that are convenient for the purpose; (2) modern scientists and ancient Sanskrit grammarians developed an atomistic view of their chosen objects. They both analysed their objects of experience into a multilayered picture, with deeper levels being more abstract and with different families of laws operating at these distinct, but interconnected, levels.

Today we might say that the grammarians adopted a highly scientific approach, that the mind of the ancient grammarian was the same as the mind of the modern scientist. Pānini, had he been able to look forward by two millennia, might say that the mind of the modern scientist was the same as the mind of the grammarian.

The ancient grammarians and modern scientists both devised models of the different aspect of nature that were their respective fields of study – the physical world and the Sanskrit language. In the case of modern science this model of nature has been developed over several centuries of human effort. Several names stand out as having put in place key components of this model – Galileo, Newton, Maxwell, Einstein, Bohr, Heisenberg, and Schrödinger, are a few. Starting out with the experiences of everyday life – How do objects fall? What causes the tides? – over the centuries the model became more sophisticated, more abstract, more concerned with things that are removed from ordinary experience – What is the origin of fluctuations of the cosmic microwave background? What is dark matter? This model is a work in progress, although it may be argued that its essential features have not changed since the early decades of the 20th century, put in place by Einstein, and Bohr and the other quantum theorists.

In the case of Sanskrit grammar, this model of nature was almost certainly developed over centuries of human effort. Several names stand out from that tradition. Pānini refers to earlier grammarians, Śākatāyana, Śākalya, *etc.*, but Pānini brought the model to its (more or less) final form. Others have followed, explaining, modifying and expounding on Pānini's work, but the essential model is attributed to him. Starting out with the linguistic experiences of everyday life – What are the basic phonemes of the Sanskrit language and how are they correctly produced? How can we codify the link between the padapātha and samhitapātha versions of vedic recitation, and thus ensure fidelity of transmission of the Vedas? – over the centuries the model became more sophisticated, more abstract, more concerned with things that are removed from ordinary experience – What is the correct dhātu for ātman, and how would one decide? Does the bahiranga paribhāsa really operate?

Models of Nature

What is the philosophical significance of the models of nature presented to us by the scientists and by the grammarians? Do they have any philosophical significance? There are certainly philosophical principles guiding the development of these models, and applied in choosing from among possible alternatives. That which is most simple, most universal in its explanatory power, most elegantly or economically expressed, and most parsimonious in its use of assumptions, is always preferred. This is true of science, and clearly true of Pānini's grammar. The language can be complex (as mathematics and Pānini's metalanguage sometimes are), but the underlying principles are simple.

But what about philosophical insights arising from the models themselves? A study of Pānini's Astādhyāyī leaves the impression that Pānini does not make philosophical arguments or points. In fact, it would be detrimental to his work if he did so. His job is a different one – it is to construct a model of the language that works. Others may speculate about the philosophical significance of his model, what it suggests about the aspect of nature that he studied. Pānini himself may also have speculated about it – it would be hard to imagine that he did not – but there is no record of that. The same is true of science. The job of the scientist is to build a model of nature that works. The model that results may well provide a picture of nature that is rich for philosophical speculation and insight, and the scientist may enjoy this speculation – some do, some don't – but it is secondary to his main task.

We are fortunate to be able to speculate on the models of nature given to us by both the grammarians and the scientists, and to compare them. It is worth doing because the models are so good, and what they suggest is so interesting. Some such speculation forms the final part of this paper.

As mentioned above, in the construction of models of nature the journey begins with direct human experience. For the scientist the starting point is the experience of the objects of the world, perceived by the senses. The classical scientist conceives the world as being made up of 'billiard balls', things you can see and touch and hear. They move around and collide with each other. From watching them carefully the scientist discovers the principles of conservation of energy, and of momentum, and much more. This works very well for a long time. Eventually the scientist gets around to studying things, like atoms, that he cannot perceive with the senses. But while he can't see, hear, or touch, atoms, he assumes that they are essentially **like** 'billiard balls', just too small to be seen. They are not perceivable, but they are **like** the things that can be perceived. This works well for a while. The atom is conceived of as being made of tiny 'billiard balls' (protons) being orbited by even tinier 'billiard balls' (electrons). Eventually this picture starts to present problems – it doesn't work. With the advent of quantum theory the 'billiard ball' picture is abandoned, and the material of the world is instead thought of as being wave-like. It now becomes necessary to think of entities existing at the atomic level as being sometimes like particles and sometimes like waves. They are no longer even **like** the objects of ordinary experience. They are the 'wavefunctions' of quantum physics, highly abstract entities. In a way they are unknowable, but they are describable (with great precision) in the language of science, *i.e.*, mathematics. This is summarised on the right-hand-side of the Figure 5.

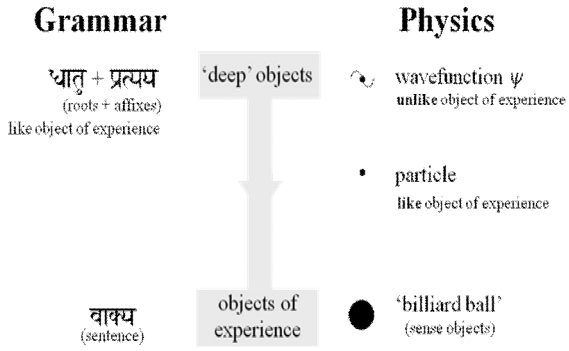


Figure 5 The objects of physics and grammar.

We have a move from the ordinary to the abstract. From that which is experienced to that which, though not perceivable, is easily conceivable, and then to that which is neither perceivable nor conceivable. From the object of experience to the 'deep object'.

The left-hand-side of Figure 5 shows what we find with language. The object of experience, linguistically, is the sentence (vākya). It is the sentence that is the unit of meaning, and it is meaning that is the content of language. Words are abstractions from the sentence. The 'word' (pada) is a useful idea, highly intuitive. Less immediately intuitive are the other inventions/discoveries of the grammarians, affixes (pratyayas), noun-stems (prātipadikas), and roots (dhātus). The object of experience, the sentence, gives way, under the analysis of the grammarians, to a string of roots, affixes, and augments, *i.e.*, to an abstract object. Examples are given further below. Again, we move from the ordinary to the abstract. From the object of experience to the 'deep object'.

This historical, and ontological, move from the object of experience to the abstract 'deep object' has another fascinating aspect. We will see that it illustrates, both in the case of the scientific model of the world, and in the case of the grammatical description of the sentence, a move from diversity in experience to a deeper unity.

Diversity to Unity / Unity to Diversity

The strangeness of quantum physics is well known[5]. The reason it is considered strange is because it says that things can simultaneously have seemingly contradictory properties. It can be both 'here' and 'there', simultaneously 'up' and 'down', *etc*. Let's say that we have a particle. The particle has a physical property that we will indicate as colour, although it's not really colour. The physical property can have two values that we will indicate as 'red' and 'blue'.

Quantum physics tells us that prior to a measurement being made the particle is not either 'red' or 'blue' but is actually a mixture of 'red' and 'blue'. It's not that we don't know which until the measurement is made. It's that it is, in some way, both 'red' and 'blue'. Mathematically, there is a 'red' wavefunction (ψ_{red}) and a 'blue' wavefunction (ψ_{blue}). Prior to measurement the actual wavefunction (ψ) of the particle is an equal mixture (superposition) of these two wavefunctions:

$$\psi = \frac{1}{\sqrt{2}}\{\psi_{\text{blue}} + \psi_{\text{red}}\}$$

Humans don't perceive particles as being simultaneously 'red' and 'blue' (by which is not meant 'purple'!). They see them as either 'red' or 'blue'. This particle is only ever seen as 'red' or 'blue'. So how does the particle change from being the mixed wavefunction ψ to being either ψ_{red} or ψ_{blue}? The answer that quantum physics gives is that the wavefunction somehow 'collapses' upon measurement, *i.e.*, upon observation. This is depicted in Figure 6.

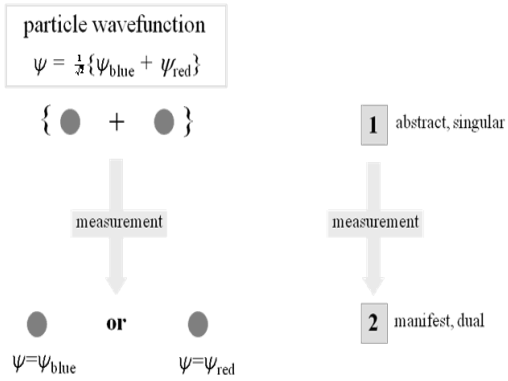


Figure 6 Measurement in quantum physics.

We see that at the 'deep' level there is a single entity, a wavefunction $\psi=\left(\frac{1}{\sqrt{2}}\right)\{\psi_{red} + \psi_{blue}\}$ while at the level of experience (what is directly observed) there is duality, either ψ_{red} or ψ_{blue}. This move from underlying unity to manifest duality comes about by the act of observation.

What is meant by observation here is technically, and philosophically, loaded. Does it mean 'observation by a conscious observer?' Does it mean 'interaction with the thermal bath of a macroscopic measuring device, which decoheres the wavefunction giving rise to the collapse'? These questions remain unresolved. What is clear in the description of the particle offered by quantum physics is that a move is made from something singular to something dual, and that this change comes not from within the physical system itself, but from outside it, by its being observed.

This move from an underlying unity to a manifest duality (or multiplicity) that is seen in the modern physicist's superbly accurate description of the physical world has a stunning analogue in Sanskrit grammar. And it is extremely simple and obvious.

Consider the picture inside the box at the top of Figure 7, and how it relates to language. A function of language is to represent this picture. The speaker means to represent some particular aspect of the picture, and forms a sentence that captures that meaning. In this picture the blue figure is Rāma, and the red figure is Sītā. The arrow indicates that Rāma is

going in direction of Sītā. All of this is happening in the present.

Pānini's grammar generates, in a simple and elegant manner, correct sentences to represent this picture. Words are constructed to represent the main action in the picture (in this case 'going'), and words are constructed to represent the players in that action (in this case Rāma and Sītā). All of these words are constructed from base material (dhātus, *etc.*) under strict grammatical laws. Then the words are put together to form a sentence (vākya), again under strict grammatical law. Of course, the sentence really comes first, but in grammatical construction it can be thought of as the other way around.

Strings of grammatical entities such as above are not a sentence as spoken by humans. In fact, the sentence spoken by humans could come out in two different grammatically correct ways (more than two, actually, but we'll just consider two). It could be:

Rāma goes to Sītā (active voice)

or it could be

Sītā is being gone to by Rama (passive voice)

It is the choice of the speaker that determines which sentence emerges. They are entirely equivalent. They have the same meaning. Only the surface form is different. How is the problem of the move from the abstract 'deep sentence' to the different surface forms solved within the system of Pānini, which sets out to construct, under law, all the grammatically correct sentences of the language?

Pānini builds his model of Sanskrit sentences around the well-known idea of the kārakas, (which are abstract case relations between nouns or noun phrases and the verb). Specifically, he demands that each relevant kāraka must be 'expressed', but that it can only be 'expressed' once. (Pānini uses the term abhihita 'expressed'.) This solves our problem, and many others, in a remarkable way. Once the form of the verb, passive or active, has been chosen by the speaker, then the rest of the sentence falls naturally and simply into place, under Pānini's various grammatical rules. The technical details of this don't need to be outlined here. It is enough to say that the choice of voice, in this case, relates directly to the 'expression' of the kārakas.

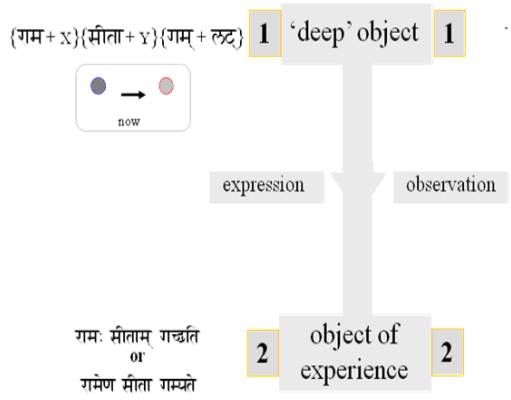


Figure 7 Sentence generation in Sanskrit grammar

We see that at the 'deep' level there is a single entity, an abstract sentence, while at the level of experience (what is directly spoken or heard) there is duality. This move from underlying unity to manifest duality comes about by the act of expression.

What is meant by 'expression' here is technical, but philosophically loaded. Technically, it means 'expression of a kāraka by an affix'. What is clear in the description of the sentence offered by Pānini's Astādhyāyī is that a move is made from something singular to something dual, and that this change comes not from within the grammatical system itself, but from outside it, by its being expressed.

What is presented above outlines the models of nature put forward by modern science and by the Sanskrit grammarians. They both start from the surface experience and move to a deeper level of description. In moving back out again they both face a similar problem. How to make the step from the singular to the dual, and they solve it in similar ways.

In physics there is a deep object, unitary and abstract, which manifests in different forms, as coloured 'billiard balls' experienced by the senses. The step from unity to duality comes by 'observation', or measurement. In Sanskrit grammar there is a deep object, unitary and abstract, which manifests in different forms, as

spoken sentences. The step from unity to duality comes by 'expression'.

In both of these systems, this step does not come about from within the system, but requires an impulse from without, from the conscious acts of observation and expression.

Conclusion

The instrumentalist view of science says that wavefunctions and other abstract entities that arise from theories and scientific model-building have no real significance. They are merely inventions that happen to work well at explaining and predicting the behaviour of the physical world as observed by the senses. The realist view of science is different – it says that these discoveries of science do have real significance; they tell us what actually is underlying the observed world. There will be corresponding instrumentalist and realist views of vyākarana.

It has been seen above that the modern scientist and the ancient Sanskrit grammarian are close cousins. They have been engaged in similar exercises, and have gone about it in similar ways. Their inventions/discoveries are strikingly similar - the artificial languages, the objects with multifarious properties that are acted on by laws, the multi-layered picture of nature from the deep abstract layers to the surface layers of ordinary experience, and, most strikingly, their solutions for moving between these layers by the mediation of the conscious acts of 'observation' and 'expression'.

It is not necessary to settle the argument between the instrumentalist and realist views of these models of nature to be struck by the deep similarities.

References

1. Conversations, 1973.
2. Ingalls, D.H.H (1954) *Journal of Oriental Research*, Vol. 22, pp. 1-11
3. Staal, F. (1965) *Philosophy East and West*, Vol. 15, pp. 99-116
4. The grammarian, operating in an oral tradition, must have a way of expressing properties so that laws can be devised that operate on them. He does this by using vocal devices such as accents and indicatory letters. The scientist, operating in a written tradition, does it differently. Properties are represented using a written device, such as a symbol, or a style of typeface, or a subscript or superscript, *etc*.
5. A good basic introduction to the ideas of quantum physics is *Quantum Physics: Illusion or Reality*, by Alastair I. M. Rae, Cambridge University Press (2004).

_____

The content of this paper was the substance of presentation to the Scientific and Grammatical Law Group in London in June 2009. It first appeared in Sanskrit Review published by St James Schools at Foundation Office foundationoffice@stjamesschools.co.uk

John Doran *obtained a degree in physics, and a PhD in physics, from Trinity College Dublin. He is currently Head of the School of Physics at the Dublin Institute of Technology, where he also carries out research in the Focas Research Institute. He has been studying and tutoring Sanskrit at the School of Philosophy & Economic Science in Dublin for several years.*

Web: http://physics.dit.ie/

Smuts defines 'holism'

Claudius van Wyk

"The highest wisdom has but one science – the science of the whole – the science explaining the whole creation and man's place in it."
Leo Tolstoy - War and Peace

Introduction to holism - from politics to philosophy of science

Family politics brought me to the concept of holism. My father, as parliamentary journalist, followed Smuts as South African prime minister. My uncle, Willem, was Smuts' personal bodyguard. Willem was inspired by Smuts' passion for botany and through what he learned on their long walks on the farm in Irene. He developed a keen interest in trees and would later publish articles on the subject. It was in reading the biography of Smuts by his son, J. C. Smuts that my love affair with the man and his philosophy began. I, like my father, had followed the world of communication and this led to a period in politics. Coming after Smuts, whose focus was moving to greater political unification of the races whilst acknowledging levels of development and cultural diversity, the governing National Party was implementing 'apartheid' – fragmentation. But for me personally, the implications and potential applications of holism began to take shape in my thinking. How could we have unity in diversity?

Smuts' book, 'Holism and Evolution', published in 1926, begins:
"Among the great gaps in knowledge those which separate the phenomena of matter (physical), life (biological) and mind (mental or psychical) still remain unbridged." [1]

Smuts' view was that 'action', rather than physical 'parts', constitute the foundation of existence, both material and non-material. Now scientists recognize complexity and emergence' as being a significant feature of the holistic science Smuts imagined. 'Complexity' describes a non-linearity that cannot be tracked. It is from this non-linearity that emergence presumably takes place – in which 'creation' is to be found – and it is still somewhat beyond our ken. We learned at school that Shakespeare's Hamlet admonishes:
"There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy."

Holistic science acknowledges that there is far more to existence than can be defined in our physics and mathematics, especially through the lens of the Newtonian mechanistic model. And rather than seeing this as a scientific limitation it could be seen as portending a vast new field of understanding. It challenges us to transform our examination of the world from a focus on parts to an observation of wholes and the action and interaction constituting those wholes. Smuts, it is contended, made a key contribution to this understanding.
How did he gain these insights?

Early years

Jan Christiaan Smuts was born in 1870 near Malmesbury in the Cape Colony. His father Jacobus, a farmer, played a leading role in the social and political affairs of the neighbourhood. He was elected as the Member for Malmesbury in the Cape Parliament. Smuts' mother, Catharina, was a woman of some education and culture, having studied music and French in Cape Town. The Smuts family were traditionally Afrikaner. Custom dictated that the first son would carry the family expectations. They would strive to provide the best possible education with the goal of paving the way for his entry into one of the professions. The others would be put to work on the farm, while receiving a rudimentary home education. Jan, the second son, thus remained at the farm.

Farm work combined with lessons from his mother would be Jan's life for his early years.

Too young to be given formal responsibilities, he accompanied the farm labourers as they went about their daily work. He listened to their stories and observed the ways of the land. As his knowledge and confidence increased he began to venture further into the rugged countryside by himself, exploring the hills and valleys. Later, as an older boy, his chief responsibility was as a herd boy of the cattle alone out on the veldt. When at home from the work on the farm, he received rudimentary home schooling from his mother.

On the death of his elder brother in 1882, Jan was sent to school for the first time at the age of twelve. After four years of education, he had made exceptional progress, gaining admission to study at Victoria College in Stellenbosch. He graduated in 1891 with first-class honours in Literature and Science. With this strong academic background he won the Ebden scholarship for overseas study and elected to read Law at Christ's College, Cambridge. Here, much later in life, Smuts would ultimately become chancellor. After further academic success, and being the recipient of many prestigious academic awards, he graduated in 1894 with double first-class honours. After graduating, Smuts passed the examinations for the Inns of Court and entered the Middle Temple. However Smuts' love for Africa saw him eschewing an obvious illustrious legal career and return to Africa soon thereafter. Of his childhood time in the veldt he would write:

"How well I remember the years I spent tending the cattle on the large farm, roaming over all its far expanse of veldt, in which every kloof, every valley, every koppie was endeared to me by the most familiar associations. Month after month I had spent there in lonely occupation — alone with the cattle, myself and God. The veldt had grown part of me, not only in the sense that my bones were a part of it, but in that more vital sense which identifies nature with man ... Having no human companion, I felt a spirit of comradeship for the objects around me. In my childish way I communed with these as with my own soul; they became the sharers of my confidence." [2]

Smuts' initial 'awakening' to a different form of consciousness was a function of experience of the natural environment coupled with the requirement of responsibility and autonomy. He was largely on his own. So the mindset that at a much later stage than normal began to engage with formal education had already been pre-formed through a combination of his own inherent intellectual capacities and his direct experience of nature – a holistic experience. Herein lay the source of the great gift he would bring to the world.

The Origin of Holism

Smuts is generally credited with the introduced of the notion of 'holism' in his book 'Holism and Evolution'. He began writing it after his government was voted out of power in the South African general election of 1922. Smuts was able to overcome this setback and utilize his time in opposition creatively. As a South African Jungian analyst, Roger Brooke (1990), put it:
"The requirement now is a shift from heroic conquest to reverent embrace…" [3]

Smuts was able to do this – his life exemplified a trust in process – holism enabled this, as, for him it was purposive. His capacity to re-engage creatively with the British after the deep humiliation of the Afrikaners during the Anglo-Boer War demonstrated this. So too did his compassion for the conquered Germans after the First World War accompanied by his plea for reconciliation rather than retribution. That plea unfortunately fell on deaf ears and as he predicted, precipitated the Second World War. Holism, for Smuts, was not just a theory to explain the world, it was an objective to be followed and for him it had deep spiritual implications.

Smuts presented his views in his keynote presidential address formally to the scientific fraternity in 1931 at the Centenary Meeting of the British Association for the Advancement of Science. It was on this occasion that he suggested the fundamental structure of the universe was not matter but action. An understanding of the universe would not be found merely in the examination of 'parts' but in the recognition of 'wholes' and the observation of process. And the nature of this process was towards the formation of such wholes in turn constituting ever more complex wholes. Consequently holism was purposive – there was, he suggested, an imminent 'telos'.

Holism and the scientific community

Einstein, Bohr, Haldane and a few others were among the early scientists able to engage with holism. Einstein had already declared, after he studied 'Holism and Evolution' soon after its publication, that two mental constructs would direct human thinking in the next millennium: his own mental construct of relativity and Smuts' of holism. Einstein also said of Smuts that he was "one of only eleven men in the world" who conceptually understood his Theory of Relativity. Smuts' views would serve to impact an expanding array of disciplines. Certainly in respect of epistemology, holism would have an impact, as it called for a transformed ontological understanding of the world as non-materialist process, emergence, organic action in energy and information In respect of formal science. It is recognized as having given rise to systems thinking, contributed to notions of chaos and order, fundamentally influenced the science of complexity, emergence and complex adaptive systems and generally having established the platform for holistic science. In respect of ecological sciences, Smuts is seen as a seminal thinker.

Smuts postulated that the existence of 'wholes' represented a fundamental feature of the world. In his early thinking, he had deeply pondered the question whether there was a 'whole' either conceptually or existentially, and if so, how could it be defined or explained? Was 'it' knowable – and, if so, how?
Some of Smuts' arguments from his keynote 1931 address are now well known and include the following:
- The whole is not resolvable into parts - putting together parts will not produce wholes or account for their character and behaviour.
- The (standard) scientific scheme has been undermined by scientific discoveries in physics and mathematics in which matter is resolved into variable energy - this has challenged notions of the homogeneity of space and time and shaken the basis of fixed standards and accurate measurements
- Holism justified the claim of the spirit in the interpretation of the world.
- Relativity reduced substance to configurations or patterns.
- Structure and pattern are at the very root of the universe and of mind.
- Quantum physics gives indications of indeterminism in nature, which provides the milieu for creativity.
- There are six discernable stages or manifestations of holism – matter, life, mind, personality, society, culminating in absolute values.
-The most important result of the idea of the whole is the appearance of the concept of creativeness.
- It is in the interpenetration of fields that creation evolution arises – hence nature's implicit holistic tendency.
"If we had the mental vision, our object would be to penetrate to that concept of the Whole which is no mere aggregation or sum total or compound of parts, but which is itself one and indivisible, a real vital organic unity of which the multiplicities of the universe are not the constituent parts but aspects, phenomena or manifestations."

Significantly he echoed Leibniz' monadology and anticipated Wolfgang Pauli's holon theory, that the activity of the Whole expressed itself through all space and time in the cosmic process of individuation, as he put it, the continuous creation of lesser wholes in its own image. And he concluded:
"There is one ultimate Whole with ascertainable character, and human personality is the most highly developed form and function of this whole. Our human ideals of thought, conduct and faith follow from the nature of that Whole, and find in terms of that nature their true expression and explanation."

References

1. Smuts, J., C., (1926), *'Holism and Evolution.'* Macmillan & Co., London
2. Smuts, J., C., (1952), *'Jan Christian Smuts.'* Cassell & Co., Cape Town
3. Brooke, R., (1990) in Saayman, G., (Ed.) *'South Africa in Search of a Soul.'* Sigo Press, Boston

---

Claudius van Wyk *is a Master Practitioner of NLP and holds a M.Sc. (Organizational Behaviour) and was awarded a D.Sc. (Alternative Medicine) for his research into a transformed epistemology for applications of holism to mindset and disease. He has a special interest in applications to corporate wellness.*
Website: ***Claudiusvanwyk.com***

Greater Yellowstone

On Hopeful Geographies and Whole Ecosystems

Teresa Wolfenden

The Tetons and the Snake River (1942) Ansel Adams. Photo Courtesy of the National Archives and Records Administration, Records of the National Park Service.

The night of autumn equinox, under a full moon, a friend and I drove out to the edge of the Teton Range, an abrupt juncture where the mountains drop to meet the Snake River valley. We rolled down the car windows and followed the calls of bull elk to a meadow, where the outlines of their dark shapes moved among the night shades of gray. I turned the car off and zipped my coat up to my chin as we listened to the elk sift through the grasses, stopping to lift their necks and release that other-worldly bugle. We could not see their antlers hit, but heard them crack in the night.

This time of year as the world swings us into the dark, we find ourselves alongside these mountains because the cool air expands us, the animals remind us we're animal, and because hope can still be found in geologic time. A Shoshone friend once showed me a fasting spot positioned atop an impossible cliff in these peaks, which makes me think that these mountains have struck us in similar ways for a long, long time.

I am not alone in this sentiment. The names "Yellowstone" and "Grand Tetons" conjure up images of grizzly bears and geysers, great jagged mountains pushing still upward, glacial lakes reflecting their grandeur. In popular American geographical imagination, this part of the world is one reserved for wild, untrammeled lands. An advocate for wilderness, Wallace Stegner wrote, "We simply need that wild country available to us, even if we never do more than drive to its edge and look in. For it can be a means of reassuring ourselves of our sanity as creatures, a part of the geography of hope".[1]

A patchwork of national park, national forest, designated wilderness, tribal, and private lands, the Greater Yellowstone Ecosystem is one of the largest nearly intact ecosystems in the lower 48 United States of America. More conservative ecosystem boundaries (originally defined as the range of *Arcto arcturis*, the grizzly bear, and later expanded) estimate its size as 73,000 km^2, slightly smaller than Scotland[2]. More generous boundaries, or jurisdictional boundaries defined by county lines, scale the ecosystem up to 145,635 km^2, a size larger than England[3]. Either way, its coverage is substantial, extending outward from its hubs: Grand Teton and Yellowstone National Parks.

Yet the ecosystem exists outside of popular imagination. It is *not* just a place where "man himself is a visitor and does not remain" [4] as the Eastern Shoshone and Northern Arapaho tribes well know, along with the 30,000 residents of the city of Bozeman. It is inhabited, managed, explored, and has been for as long as Shoshones positioned themselves on these peaks, perhaps longer.

Two friends of mine, filmmakers who work for National Geographic, admit they spend hours editing out roads, telephone lines, and human structures from their films on Greater Yellowstone. I suspect most tourists, in their digital snapshots, aim away from the roads.

Are we honest with ourselves? Is our romanticism (as "absolutely American" as our national parks[5]) overshadowing our ability to see the ecosystem in its full complexity? In its breadth of human and environmental relationships?

Is it still enough to drive to its edge and look in?

Greater Yellowstone, a Peopled Place

My own early memories of the region are commonplace. I drove north from Denver with my family on summer vacation, 1982, tallying up the number of Wyoming's antelope to pass the time on the great sage plains, watching the oil wells impatiently pull up and down on their black metal ropes. Train cars, which I counted, looked the same and went on forever, just like everything else, and I ranked Wyoming somewhere between the Texas panhandle and Kansas cornfields on the boredom scale. But then we drove over Togwotee Pass and the jagged Tetons appeared over the Continental Divide. As we were descending toward the Snake River, I saw the first moose of my life: a great black bull with algae hanging from its antlers. Dad pulled the car off the road and my sister and I reached for our new Kodak cameras, as did everyone else in the pile up of cars. When, two weeks later, we drove the same roads back to Denver, I'd filled three rolls of film and was sporting a new Yellowstone t-shirt with a little black bear on the front. I'd photographed bears, moose, mudpots, my family next to Grotto Geyser; and best of all, my sister peeling a leach from her thigh.

As mysterious and wild as we imagine it to be, Yellowstone is anything but unknown. Over 3.3 million summer visitors took similar trips between April and August of 2010[6]. Yellowstone's summer visitation exceeded twice the population of Idaho, more than three times the resident population of Montana and six times the population of Wyoming[7]. With an average of just over 26,000 visitors a day in July, people were the second most abundant large mammal in Yellowstone outnumbered by 30,000 elk (wolves number just 100, black bears 500, and bison 4700) [8].

Certainly parts of Yellowstone deserve their remote, untrammeled status, and this remoteness is essential in maintaining populations of, for example, wolves and grizzly bears. Most visitors do not wander far from the main loop roads. Yet the sheer numbers of people, *increasing numbers* of people in the park point out the obvious: this is a peopled place. And here our geographical imagination splits from pure physical geography. Is our relationship with the park what we imagine it to be?

Behind every film on Yellowstone is a film crew filming it; wolf statistics are collected and analyzed by a research crew. Home values tip the scales along the boundaries of public lands; suburbs creep into lodgepole pine forests, which we *know* will burn. As bison that wander out of Yellowstone Park are killed because of conflicting livestock interests, as we struggle between three states to manage sustainable populations of wolves, as rural residential development increased 350% between 1970 and 1999 (and overall population increased 58%)[9] we must consider: is it possible to manage this ecosystem effectively and still imagine it without people in it? Does our inability to reconcile wildness and humanness threaten the ecosystem itself?

And what if we consider the human spirit? What is our world if we imagine it to be pockets of wonder in a known world? What if, like Yellowstone's wolves and bison and bears, we wander beyond our map of ourselves? Have we drawn our boundaries too small?

Greater Yellowstone, a Laboratory

Researchers, and particularly ecologists, biologists, and geologists do their fair share of wearing tire troughs into the endlessly heaving, cracking, constantly deteriorating roads of the national parks. Each summer researchers flock to Yellowstone to better understand its nature. In a quick search of Web of Science, over 1200 articles with the topic "Yellowstone" appear between the years 2005 and 2010 and cover everything from bison to hybridizing cutthroat trout, hydrothermal fluids and blister rust in western trees. Yellowstone is one of the best places to study the way the natural world

behaves without human influence, which becomes increasingly valuable through the repetition of our measurements.

At age 25, I became a member of this cadre of scientists. As a field assistant for a fire ecology research team, I spent a summer field season studying the mosaic of fire across this landscape. Our crew would awaken at five in the morning (to beat the traffic into Yellowstone), eat a fast breakfast as we caught glimpses of the double image of the Tetons and their reflection turning lavender on Jackson Lake, load our equipment, and drive to our research sites, which were sometimes up to three hours away, and still in the parks.

The days were full of measuring, collecting, and counting: the diameter of trees at breast height or identification and coverage estimates of understory. Yet some days stand out: the bear cub following us to the car or the bull bison wandering in and settling down on the far end of our transect, thereby delaying our work. (We drove to Old Faithful, bought a "Moose Tracks" ice cream and watched tourists creep way too near a bison for a photograph: a spectator sport.) I still occasionally dream about a night when I was assigned an all night shift with the infrared gas analyzer. In my dreams, as I recall that night, some lumbering animal comes in closer and closer as I sit there alone in the dark.

That summer was my first real research field experience and I struggled to connect how counting a 50 meter transect of new trees in burned fire stands helped us understand concepts like dynamic equilibrium. Why, exactly, did it matter whether each lodgepole pine tree had open cones or closed cones, and did we *really* need to count so many thousands of them? It is only now, ten years later, and after research of my own that I fully appreciate that work, not for the excitement of bears or bison in our plots, but for the concepts our research directors tried to understand. Monica Turner and Bill Romme, the principal investigators of our research team, were (and still are) central to the American landscape ecology movement (a movement that started in Europe) that complicated the ecological narrative of ecosystem function. Alongside many other scholars, they studied large landscapes and repositioned nonlinearity and threshold dynamics as central to ecosystem process. Ecosystems did not evolve to a certain steady climax; they burned, flooded and heaved. The 1988 fires were, perhaps, not as unusual as they seemed, though they scorched a third of the park. Ecosystems, they found, were dynamic and heterogeneous across a landscape, behaving differently on different scales. Bill Romme went so far as to suggest that equilibrium may never have existed in the fire mosaic of forests in Yellowstone. Despite the human tendency to believe in increasing order, these forests may be part of a nonsteady-state system, fire serving as a repeated, transformative force of change.

This idea was an uncomfortable one. The wilderness of the Rocky Mountains had become my refuge from a world that was too mad and too much. It represented, for me, an unhuman order where even the violence of a wolf devouring an elk calf made sense and maintained a kind of balance. This no longer felt true. The world now struck me as more creative than balanced, and organisms interacted to co-create an uncertain future. Perhaps, in stepping over Stegners edge, I had sacrificed my own equilibrium.

Greater Yellowstone, a Home

Despite my delight in discovering *Vaccinium scoparium* (or, perhaps more accurately, its delicious grouse whortleberries), and discerning the size of the tiny tooth of a leaf that distinguishes *Fragaria vesca* from *Frageria virginiana*, I did not find Dorn's 24 ways to describe the hairs on a plant as riveting as my

colleagues (not to confuse strigose with strigillose, tomentose with tomentulose). Creighton trained to be a botanist, Tania a landscape ecologist, but I took a different turn.

A year later, and as part of my masters degree at Schumacher College in the U.K., I returned to Greater Yellowstone for a different research project. I was hired as an intern to conduct initial research for an initiative at Montana State University intended to build water education programs in tribal communities of the Missouri River Basin. My assignment was to spend the summer with Beau Mitchell, a Chippewa-Cree, as we traveled to American Indian reservations interviewing tribal members about water: what did they want their young people to know. I remember the first long silence of our summer. Beau and I were driving across the sage plains toward the Fort Peck Reservation. He asked me, from the passenger's seat, "So, do you have any Indian friends?" I shook my head and said no. I asked, "Do you have any white friends?" He said, "Not really." I looked back through the windshield at the long two lane road.

On our last trip together that summer, after merging a strong friendship traversing the north of the state, Beau and I followed the well worn roads through Yellowstone and Grand Teton National Parks southward into Wyoming, this time not to photograph or measure attributes of the parks, but to use their roads as a conduit. The same road I took over Togwotee Pass as a child, where we spotted the Tetons and photographed a moose, drops on the Continental Divide's eastern flank and runs through the Wind River Indian Reservation. With Beau, I experienced my first childhood trip in reverse, climbing from the Tetons over the Continental Divide, and winding down through white bark pine and spruce-fir forests into the arid badlands, where the Wind River runs a green ribbon of vegetation through red eroding soils and those same great sage uplands I thought would never end.

The interviews we conducted at Wind River were similar to others that summer, though specifics certainly differed between tribes, among them Blackfeet, Sioux, Assiniboine, Crow, Northern Cheyenne, Gros Ventre, Chippewa-Cree, and (at Wind River) Eastern Shoshone and Northern Arapaho. Despite the growing number of interviews behind us, I was not accustomed to them. Beau and I had watched people cry as they remembered valuable river bottomlands flooded for hydropower by the government in the 1940s and 1950s. We heard, "Water is a gift, not a right," referring to the convoluted water law of the West. But most unsettling to me were the juxtapositions: people would express their concern over the health effects of groundwater contaminated by uranium tailings, and then tell us about the dangers of swimming near water spirits. For the first time in my life in the United States, I stopped at a gas station and asked if I could drink the tap water. The attendant said no, and motioned toward the bottled water. I was astonished. And paranoid. Where, exactly, did the water monsters live?

Flora Crazythunder, Northern Arapaho, photographs the Wind River Basin through her windshield.

An Implicate Order?

At the end of the summer, I loaded my car and drove back southward to Denver, where I would catch a plane back overseas. I stopped in to see my old fire ecology research crew on Jackson Lake the week of the Perseid Meteor shower as I drove south. Dan took out his guitar and we all gathered on the dock as the sun set. His music drifted over the still water of the darkening lake and meteors began to streak their trails of light across the sky. I did not talk much about my summer. Though the Wind River Reservation is located just over one mountain range to the east, the paired research experiences were worlds apart.

As I lay in my sleeping bag outside that night, my discomfort left me sleepless. Why could anyone drink out of a water fountain at Old Faithful but not Fort Washakie? Did the water spirits live only on the east side of the Wind River Range? I'd picked up a brochure at the health clinic on the reservation that said life expectancy that year was 49. Could that possibly be true? Forty-five percent of the community of Arapahoe lived below the poverty line, and 43 percent in Ft. Washakie, the main Shoshone community[10]. The grizzlies and wolves wandered the whole region, but was this really one ecosystem? How could this be one place?

I had been reading Brian Goodwin and Lynn Margulis, but the words of physicist David Bohm comforted me that night, "True unity in the individual and between man and nature, as well as between man and man can arise only in a form of action that does not attempt to fragment the whole of reality." I would spend the next ten years trying to pull these fibers together.

Selective Complexity

Unbeknownst to me that summer, I was to spend the next decade working on the Wind River Reservation and with the tribes. The National Science Foundation fully funded the Native Waters program the next year, and my summer internship of 2000 became an assistant directorship and extended through 2005. I eventually left that program to conduct my own PhD research, an investigation of riparian vegetation along the Wind River. It is only looking back that I realize this research combined those two enormously influential summers of 1999 and 2000: vegetation and water, culture and ecology.

The philosophical questions I grappled with during those summers of 1999 and 2000 are still the ones I struggle with now though I like to think the questions are better articulated. Much has happened in the last decade as I work alongside many, many others to understand the role of people and their unique relationships with place in ecosystem change (or "linked human-ecological systems"). The National Science Foundation now funds several "Native Science" initiatives, recognizing that tribes' ways of investigating their world are different than those of traditional science and just as valid. Conversely, "Traditional Ecological Knowledge" investigations incorporate traditional ways of understanding the environment into Western, more mainstream, ecology. I like to think the two worlds are reaching toward the best of one another.

Ecologists and economists began to publish articles on human-environmental systems and their dynamics of the Greater Yellowstone in the 1990s, finding that private lands in Greater Yellowstone are particularly vulnerable to growth and development. They found that the most significant reasons for locating in these areas were "the environmental and ecological amenities, the scenery, outdoor recreation, and the pace of life" [11]. Proximity to airports and the education level of the general population were also found to be significant, attracting retirees, wealthy young adults and professionals in service industries. [12] "Nothing symbolizes the new West more than a mountain valley formerly used for livestock pasture and/or irrigated hay production, now punctuated with massive log homes perched upon the upper hillsides on parcels ranging anywhere between 10 and 160 acres," write Jackson and Kuhlken[13]. Ecologists have found that the patterns of this amenity migration threaten ecosystem function, since certain populations (from grizzlies to yellow warblers) and disturbance dynamics (for example, fires) extend beyond boundaries of parks and protected areas. Land use change outside protected public lands may "rescale" the ecosystem, decreasing biodiversity and altering ecosystem processes. [14]

This research is essential, and offers a critical analysis of an enormously important component of the ecosystem: ecosystem-wide growth since 1970 (when Landsat imagery became available). This research acknowledges ecological complexity: threshold dynamics, disturbance, the "rescaling" of ecosystems, but social complexity is oversimplified. For example, cited recent human growth patterns are not at all evident on tribal lands, which cover the same area as Yellowstone National Park[15]. Moreover, the tribes regulate hunting

differently on their 2.2 million acres of land, managed for just 1000 hunters; they maintain an area declared roadless years before the U.S. Wilderness Act was passed in 1964 and currently pursue free roaming bison herds on tribal lands, in direct contrast to state policy[`16]. Surely several cultures, lifestyles and preferences exist in a land area the size of Scotland or England, and perhaps their diversity is what's preserved the wildlands and wildlife of this place.

A Hopeful Geography?

Sometimes I think that roaming grizzlies and the prized wildlands and wildlife they represent, may be one of the few things connecting this ecosystem, aside from the roads. Greater Yellowstone is deeply fragmented in our minds and across the land. Its public lands (68 percent of the ecosystem) are managed by the National Park Service, the Forest Service, and three different states; its private lands are urban and rural, ranches and ranchettes that cover almost one third of this place[17]. Even tribal lands can be divided into allotted, tribal and fee. Economically, regions remain distinct, an extreme affluence and extreme poverty of which the grizzly is unaware.

We recognize complexity in ecological systems. We core trees to their center and reconstruct the dynamics of fire. We sense that, on some scales, equilibrium never existed. Yet we fail to recognize that cultural dynamics may operate with their own thresholds, heterogeneity, and disequilibria that must shape ecosystems in the same dynamic way. We are of this world. We are products of ecosystems.

That influential summer of 1999, when I worked with my fire ecology crew in Yellowstone, I drove to a gear store near the base of the Tetons to buy long underwear. On the wall, above the cash register, again was that well-known Wallace Stegner quote attached to a mountainous picture, "We simply need that wild country available to us, even if we never do more than drive to its edge and look in. For it can be a means of reassuring ourselves of our sanity as creatures, a part of the geography of hope." I memorized the quote on the spot, and still keep it nearby in my memory's cache. (Stegner's wilderness letter is a treasure.) But it is not enough. First, protected areas do not provide enough land to sustain many wild populations. Second, they alone do not support the breadth of the human spirit, in which we relate to our world as "part of the environment of trees and rocks and soil, brother to the other animals, part of the natural world and competent to belong in it." [18] In addition to wilderness, where we should not remain, we need to perceive ecosystems as sustainable homes. We cannot live in extreme fragments of reality and strive for an inhabitable future.

Earlier this summer, a friend and I stood in a meadow of Red Rocks Lakes National Wildlife Refuge in the northern part of the ecosystem. In the place where trumpeter swans were saved from extinction, we watched a family of short eared owls in the shadow of a storm growing in the west. The patches of shade cast by the clouds on the mountains were changing, instead, to windows of shrinking light as we watched the owls fly low over the blowing grasses, hunting rodents. An owlet tried to balance on a thistle head as it bobbed in the wind, toppling and regaining equilibrium.

I remembered to myself the Shoshone word for Burrowing owl (din-zy-daysh) "prairie dog's brother in law", a word that indicates that the split between social and ecological is not a given (kingfisher is "water's big brother", sandpiper "coyote's son in law") [19]. If, as Bohm writes, "both observer and observed are merging and interpenetrating aspects of one whole reality, which is indivisible and unanalysable," shouldn't we value perspectives that exemplify these social-ecological links? Shouldn't we, for example and at all costs, ensure the survival of the Shoshone and Arapaho languages as we did the trumpeter swan and grizzly bear in our ecosystem? With less than 150 speakers, Arapaho is expected to disappear from the world in less than 15 years, and Shoshone from the ecosystem.

As we watched the owls, in mid-July, the Arapaho Sundance was taking place, the sacred start of the tribe's new year. I thought of the special summer reservation hunt reserved for

Sun Dance meat and contrasted it with the controversy of whether hunting should be allowed at all on the Red Rocks Lakes National Wildlife Refuge. Do we really know the land if our ethic is leave no trace? Do we know land through our photographs? Do we know land if we look at it? Or if we eat it and hunt in it? Really, what's more sacred, dry meat or a Polaroid? How must we touch our world to know our god(s)?

We cannot envision ourselves separate from nature or separate from one another. Even an ecosystem as large as Greater Yellowstone cannot survive with such severe, and false, distinctions. While certainly parts of the ecosystem must be reserved for wildlife alone, these boundaries, statistically, are not enough. As Michael Pollan writes, "…we need, and now more than ever, to learn how to use nature without damaging it. That probably cannot be done as long as we continue to think of nature and culture simply as antagonists." [20] We *can* touch our surroundings without destroying them. As Yi-Fu Tuan succinctly writes, "The human presence, contrary to the message of the more hysterical environmental literature, has not always and everywhere impoverished the earth." [21] We can co-create a future, among wolves and hunters, immigrants and residents, English and Arapaho, water spirits and fishing holes, bison *and* cows, as long as we recognize and touch one another, difficult and controversial as this may be, dynamically merging and interpenetrating. There may be no predictable future, no single equilibrium. Isn't this a geography of hope?

References

1. Stegner, W.. (1969). The Wilderness Letter in *The Sound of Mountain Water.* Garden City, N.Y: Doubleday
2. Logan, J.A., Macfarlane, W.W.and Willcox, L. (2010). Whitebark pine vulnerability to climate-driven mountain pine beetle disturbance in the Greater Yellowstone Ecosystem. *Ecological Applications* 20(4): 895–902
3. Gude, P.H., A.J. Hansen, and D.A. Jones. (2007). Biodiversity consequences of alternative future land use scenarios in Greater Yellowstone. *Ecological Applications* 17(4):1004-1018.
4. The Wilderness Act: 16 U.S.C. 1131
5. Stegner, W. (1998) The Best Idea We Ever Had in *Marking the Sparrow's Fall: The Making of the American West.* New York: Henry Holt
6. National Park Service (2010) NPS Stats: Yellowstone National Park Summer Report. http://www.nature.nps.gov/stats/viewReport.cfm
7. U.S. Census Bureau. (2010) State and County QuickFacts: http://quickfacts.census.gov/qfd/index.html
8. National Park Service: http://www.nps.gov/yell/naturescience/mammals.htm
9. Gude, P. H., A. J. Hansen, R. Rasker, and B. Maxwell (2006) Rates and drivers of rural residential development in the Greater Yellowstone. *Landscape and Urban Planning* 77 (1-2):131-151
10. U.S. Census Bureau. (2000).American FactFinder: http://factfinder.census.gov
11. Rasker, R., and A. J. Hansen. (2000). Natural amenities and population growth in the Greater Yellowstone region. *Human Ecology Review* 7 (2):30-40
12. Gude, P. H., A. J. Hansen, R. Rasker, and B. Maxwell. (2006). Rates and drivers of rural residential development in the Greater Yellowstone. *Landscape and Urban Planning* 77 (1-2):131-151.
13. Jackson, P. L., and R. Kuhlken. (2006). *A Rediscovered Frontier: Land Use and Resource Issues in the New West*. Lanham, Maryland: Rowman and Littlefield
14. DeFries, R., A. Hansen, B. L. Turner, R. Reid, and J. G. Liu. (2007). Land use change around protected areas: Management to balance human needs and ecological function. *Ecological Applications*
15. Cohn, T. (2010). Settlement, identity, and environment: understanding processes of vegetative change along the Wind River. Dissertation: Montana State University
16. Baldes R. and D. Skates, (2009)U.S. Fish and Wildlife Service, personal communication
Baldes, J. (2009). Draft Management Plan: Reintroduction of Free Ranging, Disease-Free, Genetically Reputable Bison to the Wind River Indian Reservation, Wyoming: Montana State University and USGS Northern Rocky Mountain Science Center
17. Gude, P. H., A. J. Hansen, and D. A. Jones. (2007). Biodiversity consequences of alternative future land use scenarios in Greater Yellowstone. *Ecological Applications*
18. Stegner, W.. (1969). The Wilderness Letter in *The Sound of Mountain Water.* Garden City, N.Y: Doubleday
19. Teran, R., Guina M. Sr. and Haukaas B. (2002-2005)Shoshone Language compilation
20. Pollan, Michael (1991) Second Nature. New York: Grove Press
21. Tuan, Y. (1990). Topophilia. New York: Columbia University Press

---

Teresa Wolfenden *graduated with the MSc from Schumacher College in 2000. She recently received a PhD in Earth Sciences from Montana State University for research involving the cultural, historical, & ecological factors of riparian change along the Wind River on the Wind River Indian Reservation. Her current postdoctoral work involves landscape transformation on Crow & Northern Cheyenne lands & curriculum development for tribal schools through the Center for Learning & Teaching in the West. Teresa additionally serves as a visiting instructor for the University of Utah's Environmental Humanities program & continues to work with the Arapaho language revitalization program on the Wind River Reservation.*
tcwolfenden@gmail.com

Wood for the Trees?

Satish Kumar

Wholeness is as much an ancient concept as it is a contemporary one. As a young man I lived in an ashram where we sang the mantra of wholeness every morning and evening during communal prayers. It was part of my daily practice. The mantra came from the Upanishads which were composed by the sages and philosophers of India some 5000 years ago. Wholeness in Sanskrit is 'Poornam' and the Upanishads talk about all and everything being whole:

Poornamidah, Poornamidam	*"This is whole, that is whole*
Poornat Poornamudachyate	*Whole emerges out of whole*
Poornasya Poornamadaya	*If we take the whole from the whole*
Parnamevavshishyate	*What remains is whole*
Om Shanti Shanti Shanti	*Let there be no discord and let Peace prevail"*

A seed is a whole seed. When the seed sprouts it is a whole plant. The whole plant manifests in a new whole form, which we name as a whole branch, a whole leaf, a whole bud, a whole flower, a whole fruit and a whole seed again. The tree is in the seed and the seed is in the tree.

The whole tree is integral to many other whole forms; the soil, the rain, the sunshine, the space in which the tree stands, the time in which it grows and the air it breathes. Thus, the whole tree emerges out of the whole soil, the whole rain, the whole sun, the whole space, the whole time and the whole air; in fact the whole earth and even beyond the earth – the whole universe and the whole cosmos. The acorn is not only an oak, it is a cosmic capsule.

The principle of wholeness is universal. The Chinese called it Tao, the Aborigines called it Dreamtime, the Africans called it Ubuntu which means 'one is because everything is'. This African ideal may have been the inspiration to General Smuts who was one of the first to use the term 'holism' in the English language. In our own time, Christian theologian, Thomas Berry proclaimed that the universe is not a collection of fragmented objects, but it is a communion of subjects. Thich Nhat Hahn says, "the bread you are holding in your hands is the body of cosmos" he calls this reality the 'principle of inter-being' because, like the example of a seed and the tree, the whole bread embodies the soil, the rain, the sunshine, the farmer, the baker and so on. Thus each whole is made up of other wholes. In other words the text is made meaningful within the context.

The theories of quantum physics, complexity, chaos, Gaia and systems thinking are completely compatible with the wisdom of Poornam, Tao, Ubuntu and Dreamtime. David Bohm's 'Wholeness and the Implicate Order' encapsulates the truth of integrating intuitive wisdom and empirical science. E F Schumacher called upon us, "to look at the world and see it whole". He was able to see the connection between spirituality and economics; his essay on Buddhist Economics is a classic example of seeing the wholeness and interconnectedness of all human activities, be they economic, social or spiritual.

What appears to be fragmented and opposites are, in reality, complementary and two aspects of a single reality; day and night complement and make whole day, above and below together create a whole space, masculine and feminine make a whole humanity. When we transcend dualism and look deeper we can clearly see that matter and spirit are two aspects of one life force, one reality. We call it universe, one cosmic poem. That is why in the ashram we were required to include the mantra of wholeness as part of our daily prayer rather than study it as an academic discipline. Only when we are caught in dualism, fragmentation, division, separation, specialism and reductionism we fail to see the wood for the trees**!**

When only nine years old, Satish Kumar renounced the world and joined the wandering brotherhood of Jain monks. At the age of eighteen, he left the monastic order and became a campaigner, working to turn Gandhi's vision of renewed India and a peaceful world into reality. Fired by the example of Bertrand Russell, he undertook an 8,000 mile peace pilgrimage, walking from India to America without any money delivering packets of 'peace tea' to the leaders of the four nuclear powers. Since 1973, he has been the Editor of Resurgence magazine. ***www.resurgence.org***

IX Returning to the Source

To return to the Origin, to be back
at the Source -- already a false step this!
Far better it is to stay at home,
blind and deaf, and without much ado;
Sitting in the hut, he takes no
cognisance of things outside,
Behold the streams flowing -- whither
nobody knows; and the flowers
vividly red -- for whom are they?

Comment: From the beginning, truth is clear. Poised in silence, I observe the forms of integration and disintegration. One who is not attached to "form" need not be "reformed." The water is emerald, the mountain is indigo, and I see that which is creating and that which is destroying.

X. Into the marketplace

Bare-chested and bare-footed, he comes
out into the market-place;
Daubed with mud and ashes,
how broadly he smiles!
There is no need for the miraculous
power of the gods,
For he touches, and lo!
the dead trees are in full bloom.

Comment: Inside my gate, a thousand sages do not know me. The beauty of my garden is invisible. Why should one search for the footprints of the patriarchs? I go to the market place with my wine bottle and return home with my staff. I visit the wine shop and the market, and everyone I look upon becomes enlightened.

Dear Readers,

A huge thank you to everyone who has contributed towards making the first issue a success! Your response has been amazing and very encouraging! The results of all our work with new added features, is this second issue ***Turning Leaves.*** *Word of mouth is the best way to promote the Holistic Science Journal so please do encourage all those you know who would like to read it to subscribe.*

In the coming issues we plan to add many more aspects and sections to the journal. This is YOUR journal. It will grow and change and become what you want it to become. Please let us know what suggestions and comments you have for it.

Please SUBSCRIBE to help us keep it coming to you! www.earthlinksall.com/journal

A selection of comments for First Light….

Congratulations on publishing your first issue! I like it very much.
Fritjof Capra

I think you've done a great job!
Mark Burton

I love the new journal. Just love it!!
Margaret Wheatley

Thrilled by its content!
Henri Bortoft

Vey well done - a great selection of articles, intellectually profound
Satish Kumar

If there is then something eternal in a man, it must be able to exist and to be grasped within every change. *Soren Kierkegaard*