

GOETHE'S SCIENTIFIC METHOD

Its relevance in a post-mechanistic future

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1. INTRODUCTION

Goethe's greatest legacy to science was not any single discovery but rather his way of seeing. While editing Goethe's scientific works, Rudolf Steiner discovered that Goethe's approach to scientific investigation reflected his own epistemological insights, as set down in the *Philosophy of Freedom*¹. Through Steiner² and subsequent research within the Anthroposophical movement^{3,4,5} Goethe's way of seeing has developed into a 'method' of scientific investigation. To date, it has remained on the fringes of science and its purpose and potential are still not widely appreciated or understood. Goethean science is occasionally practiced rather superficially as a means of merely attaining a pleasant experience of unity with the natural world. But a superficial approach of this kind does Goetheanism a grave injustice and deters more seriously minded people from a committed study and exploration. Goetheanism is both a scientific method and an important undertaking of a spiritual nature, appropriate for the modern age. It requires attention, focus, discipline, a commitment to inner work and a large degree of self-sacrifice and should not be treated as something to dabble in.

In this essay I review the historical background to Goethe's scientific

1 Steiner, R. 1894. *Die Philosophie der Freiheit: Grundzuege einer modernen Weltanschauung*, (Berlin: Emil Felder, 1894)

2 Steiner, R. 1883. *Goethes Naturwissenschaftliche Schriften, Einleitungen*. Allgemeinen Anthroposophischen Gesellschaft. Dornach, Schweiz. GA 001.

3 Bockemühl, J. 1992. *Awakening to Landscape*, Naturwissenschaftliche Sektion. Dornach, Schweiz.

4 Bockemühl, J. 1997. *Aspekte der Selbsterfahrung im phänomenologischen Zugang zur natur der Pflanzen, Gesteine, Tiere und der Landschaft*. Manuscript for a lecture for 'Phänomenologie der Natur-ein Projekt', by Gernot Böhme.

5 Colquhoun, M. and Ewald, A. 1996. *New eyes for plants: Workbook for plant observation and drawing*. Hawthorn Press. ISBN 10-1866989085X.



Figure 1: Hummingbirds from “Kunstformen der Natur” (1899-1904), a collection of lithographic prints by Ernst Haeckel. The images from Haeckel capture the dynamics of life in art.



work and then discuss how it evolved into the ‘method’ we have today. Its potential relevance and application as a spiritual-scientific path, which could heal a fragmented post-mechanistic world is also considered.

2. WHY DO GOETHEAN SCIENCE TODAY?

Goethean science is distinct from present day mainstream science in both methodology and aims, although one could argue philosophically that if the aims of science are to achieve a totality of knowledge of a thing, then those too are the aims of Goethean science. Perhaps the difference is in how one understands the term ‘totality of knowledge’. Every method is already constrained by its own historical and epistemological boundaries and so defines its own criteria of knowledge. The boundaries of modern science lie in the ideals of objectivity, detachment, analytical fragmentation and the constraints of hypothesis testing. Goethean science tries to broaden the boundaries to acknowledge that the observer and the system being observed are in a state of relationship rather than detachment, and that knowledge can emerge out the relationship that is established through accurate observation and subsequent meditative work.

For the biologist in particular, there is the question of whether a fragmenting, detached, mathematised way of thinking is appropriate to the study of life? Let us start with the question of whether an organism can be measured objectively or not. To measure anything it is necessary to define its boundaries, to know where it begins and ends. But how is it possible to define the boundaries of a living creature when it is in a constant state of change? For example, the material that makes up the living substance is in a more or less rapid state of continuous transformation or flow into and out of the body. So is the boundary defined by the outer layer of living cells, the outer layer of dead cells,

the surface of the cuticle, the skin or fur on a mammal, the feathers on the bird, the layer of secreted mucilage, the vapour zone of volatile oils around the shoots of a plant, etc. To define the boundary, subjective choices and approximations are made by the observer. Additionally, at what stage of development should an organism be measured? At what stage can an organism be said to have reached completion when in fact it is as an entire unbroken movement from fertilization to death. There is no end state for an organism existing within the life process between birth and death. However, biologists again make a subjective choice to treat the reproductively mature stage as an end point and define an organism in those terms. It is therefore very clear that complete objectivity with respect to defining living organisms, which have no static qualities or properties, is not possible. Life is not easily calculable.

As organisms are in a continual state of change they can be viewed more appropriately as systems in flow in space and time. As such they are non-fragmentable and not given to the same kind of analysis as non-living systems. Today, the idea of living organisms as complex processes in flow is acknowledged more commonly by mathematicians than biologists, and with the use of statistics and computing power it is supposed that the research follows the detached and objective methods of the current scientific paradigm. However, the use of computers also involves fragmentation and the mathematics is based on statistics emerging from subjective choices and approximations of what and when to measure. It must therefore be accepted that to speak of true objectivity in the life sciences is impossible, and to base knowledge of life on classical scientific methods is incomplete.

The practice and methods of Goethean science attempt to widen the boundaries of research beyond the fragmentable and measurable, and to addresses organisms as systems in flow existing in relationships to other systems in flow.

The scientific investigator is not a detached observer but an active participant in the process entering into special relationship with the organism under observation. Research questions are then addressed within the living relationship that is established between the observer and organism. The process is described in more detail here in sections 6 and 7.

3. GOETHE THE SCIENTIST

Historically, Johann Wolfgang von Goethe (1749–1832) is better known as a poet, playwright and artist but he also extended his interests to a range of scientific subjects. In the field of optics he famously came into conflict with the established ideas of Newton⁶ while in the biological



6 Sepper, A.E. 2003. *Goethe contra Newton: Polemics and the project for a new science*

sciences he made lasting contributions such that his work is cited in academic publications up to the present day.

Goethe's science emerged from a particular way of observing nature, which was strongly influenced by his artistic abilities.

Figure 2: Sea anemones from "Kunstformen der Natur" (1899–1904) by Ernst Haeckel.



He was able to grasp the 'big picture' of phenomena simultaneously with the eyes of an artist and the rigour of a scientist, perceiving the totality or 'wholeness'⁷ of phenomena in a dynamic way. In biology, this gift lay behind a number of significant discoveries, including a description of the premaxillary bone in humans⁸ and his work *The Metamorphosis of Plants*⁹ is firmly established within botanical literature. Amongst other things, he described the conditions in plants known as heterophylly and heteroblasty, in which a variety of leaf shapes are present on the stem of an individual plant appearing as a "metamorphic progression".¹⁰ Another of Goethe's famous discoveries, that all the visible organs of flowering plants are structurally related to leaf-like structures, is fully affirmed by orthodox science. Charles Darwin himself referred to Goethe's botanical studies in *Origins of Species*: "It is familiar to almost everyone, that in a flower the relative position of the sepals, petals, stamens, and pistils, as well as their intimate structure, are intelligible in the view that they consist of metamorphosed leaves, arranged in a spire."¹¹

4. GOETHE'S SEARCH FOR THE ARCHETYPE

The proposition that nature displays certain archetypal patterns is called 'typology'. It is generally understood as a form of static idealism of Platonic origin. Today, this idea is generally rejected after being

of colour. Cambridge University Press. ISBN 0521 531322

7 Bortoft, H. 1996. *The Wholeness of Nature: Goethe's way toward a science of participation in nature*. Lindisfarne Books. ISBN 0-940262-79-7.

8 von Goethe, J.W. 1784. *Dem Menschen wie den Tieren ist ein Zwischenknochen der odem Kinnlade zuzuschreiben*. Sämliche Werke, 2, 530-545. The paired premaxillary bones (also known as the intermaxillary, or the "Goethe" bones) bear the upper incisor teeth in most mammals. In humans they are only present as tiny structures in the late foetal stages and occasionally in early childhood. As the human being grows and develops, the sutures (borders) of the premaxillae fuse with the maxillary bones (those forming the upper jaw) and apparently disappear. In later years they are not usually seen as separate entities. In contrast, many other vertebrate animals have very prominent premaxillae and, for a long time before Goethe, the absence of this bone was thought to be a determining human characteristic, separating Man from the animals. By discovering the premaxillary bones in the developing human, Goethe unified the physical human form with that of animals, establishing Man's intimate connection with the natural world.

9 von Goethe, J. W. 1790 *Versuch die Metamorphose der Pflanzen zu erklären*. Gotha: Carl Wilhelm Ettinger.

10 von Goethe, J.W. 1817. *Zur Naturwissenschaft überhaupt, besonders zur Morphologie*. Stuttgart, Tübingen.

11 Darwin, C. 1859. *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life*. 1st Ed: John Murray. ISBN 1-4353-9386-4.

challenged and overturned by the ascension of ‘evolutionism’, the idea that species are able to change.

Goethe’s search for the archetype, though perhaps initially rooted in traditional Platonic typology, later evolved into something else.

It is essential to understand what Goethe’s archetypes really are because the notion of archetypes as activities and processes lies at the core of the Goethean method.

Goethe’s search for an underlying ‘type’ (typus) in nature began as a concept of a concrete entity, with the potential to develop into the multiplicity of shapes and forms. Then, out of the experience of his research, Goethe evolved and transformed this concept. At first he imagined it might be possible to come across a plant that fully embodied the ‘type’. He searched for this ideal form amongst Mediterranean plants on his Italian Journey (1786-1788) but did not find it. He was forced to conclude that the ‘type’ as an organism did not exist in nature. As he progressed further, Goethe came to propose the leaf as a ‘type’ for various organs of plants. As already mentioned (see Section 3, above), this idea is accepted in mainstream biology, though the word ‘type’ is generally not used. With respect to flowers, the various parts of the flower structures (sepals, petals, pistil, carpel) are in fact transformed leaf shapes.

Having thus imagined a ‘type’ for the plant kingdom, Goethe set about trying to find a similar form for animals – and proposed the vertebra¹². Unlike his ‘leaf theory’ of plants, Goethe’s ‘vertebral theory of animal forms’ was not accepted by the establishment, because of a misunderstanding of what was actually meant by ‘type’. For his contemporaries, it was fairly easy to see the underlying leaf like structure of plant organs but it was harder to visualize how the bones of a skeleton could be derived from a structure like a vertebra. Indeed, embryological evidence contradicted the idea altogether.¹³

5. MISUNDERSTANDING GOETHE’S ARCHETYPE

Intensive study of *The Metamorphosis of Plants*⁹ and subsequent works reveals the way Goethe made his discoveries^{2,7} and sheds light on what he really meant by ‘type’. One of the major errors of interpretation of Goethe’s ‘type’, is to think of it as a ‘common subunit’, a ‘building block’ or a simple physical entity from which a variety of more complex things arise. This idea is prevalent within the relatively new biological discipline

¹² von Goethe, J.W. 1824. *Schädelgrüst aus sechs Wirbelknochen aufgebaut. Zur Morphologie*, Band 2, Heft 2.

¹³ Filler, A. 2007. *The upright ape: A new origin of the species*. New Page Books. ISBN-10: 15641 49331.



Figure 3: Skull and partial skeleton of *Parasaurolophus walkeri*, a North American ornithomimid dinosaur from the Royal Ontario Museum (ROM 768).

The specimen shows a metamorphic sequence of vertebrae. This is the “holotype” specimen, the standard “benchmark” to which others of the same species are compared.

known as ‘evo-devo’ (a contraction of ‘evolution’ and ‘development’).¹⁴ Recent discoveries in embryology, using the latest techniques from molecular biology, show that in animal development there are common morphological body plans that manifest early in the embryonic stages of many, if not all, species.^{14 15} These body plans later specialise into the various different recognizable animal forms, as growth and development proceeds. Some scientists are seeing these discoveries in the light of Goethe’s vision of common ‘type’ and are hailing his ideas as prescient.¹³ However, wonderful as these discoveries are, Goethe’s archetype is a different ‘thing’ altogether. In fact it is no thing at all, but a process. It is not a simple structure containing the potential to develop into more complex forms but something much more subtle, and its perception is intimately connected with Goethe’s way of seeing.

When Goethe looked at the growth of a plant he not only recorded the various stages of its development, but also built a concept of the formative principles shaping the plant as a totality: from seed to seedling, leaf growth to bud, flower to seed. Metamorphosis in Goethe’s sense is not merely the outward change of a plant, but describes the essential form a plant assumes over time. What is seen is condensation and

14 Carroll, S. 2005. *Endless forms most beautiful: The new science of evo-devo and the making of the animal kingdom*. W.W. Norton & co. ISBN 14051 19500.

15 Kurtani, S. and Schilling, T. 2011. *Head segmentation in vertebrates*. *Integrative and Comparative Biology*, 48, 604-610.

expansion, a spiral progression and refinement of form. But to physical eyes the primal plant can never appear because the physical eyes cannot see the sequence of time, only its sedimentation in specific appearances. Nevertheless, it is possible to build the concept of changes and to perceive the flow of life through the capacity of human imagination.

6. THE PRACTICE OF GOETHEAN 'SEEING'

The practice of Goethean 'seeing' engages a 'mobile concept' and is not something subjective and personal to Goethe. It is something that can be learnt and applied by anyone. It is best demonstrated as an observation exercise, the aim of which is to see form as movement. Some practitioners of Goethean science demonstrate the principle using plants^{3,4,5} (see Figure 4). As a tribute to Goethe's osteological work, a vertebral column will be taken here as an example of an object of study.

If one observes a vertebral column in its structural totality, ignoring initially any biological function it may serve, it is clear that there is a uniting 'theme', a movement or progression running through it. The theme is expressed in the sequence of its component elements, the vertebrae. The vertebrae all have a clear structural similarity to one another and also a number of differences.

However, the unity of movement within the column cannot be derived from any single vertebra, when regarded in isolation from the rest. If we choose one of the simplest vertebrae in the series e.g. a tail vertebra, we can see that alone it holds little information leading to the structure of the more complex elements. Similarly, by isolating one of the structurally more complex vertebrae e.g. a thoracic (chest) vertebra, the forms of the other vertebrae, preceding or following it can only be derived by a process of deletion or addition. In either case, studying a single vertebra in isolation from the rest causes the perception of progression to be lost.



Figure 4: Common Groundsel (*Senecio vulgaris*). The plant develops distinct leaf forms during development and retains them in an adult form. The leaves can be arranged in a metamorphic sequence, as shown.

If the vertebral column is disarticulated (taken apart) into its constituent vertebrae, which are then mixed up, the progression can be made to re-emerge again, because the human mind can recognize the relationship between each bone and can infer the correct sequence to re-instate the spinal column. The human mind is able to see the positional information within the structure of the vertebrae, but only when they are viewed in relation to each other. Only then is it possible to see the continuity of movement that enables a correct reconstruction to be made. The individual vertebrae are then viewed as ‘precipitations’ of a continuous, graded movement.

Learning to consciously enter the streams of change in time and to experience metamorphic movements from exact observation and meditation, is the first stage of the Goethean process. However, it does not end there.

Within the context of the whole movement, no single vertebra has greater significance or importance than any other. Each vertebra, from simplest to most complex, is perfect and complete, with respect to the totality, the ‘wholeness’, of the vertebral column. The movement that runs through the column reflects both the similarities and differences between the vertebrae. Each vertebra is contained within the movement and at the most profound level, each vertebra also contains the movement within itself. This is because each component contains the idea of the movement within its structure and position, with respect to the others. If this were not so, the individual vertebrae would not be perfectly integrated into the whole. The progression that appears as the spinal column is a continuum, specifying the individual vertebrae by generating them, as it were, within movement. Individual elements can be seen as arrested stages in this mobile transformation and although they do not manifest the full movement individually, they are governed by it, sculpted and carried in its flow. The movement itself is the ‘law’ determining the forms of the vertebrae.

Human beings are able to perceive the vertebral column as a progressive movement because we can marry the sense perceptible information from viewing the physical structure to an idea or concept of movement. The concept of movement in structure emerges from the mobile capacity of our human imagination.¹⁶ We ‘see’ the movement as arising from the shapes and positions of the vertebrae, but it is not something that is perceptible to the sense organs as such. To become perceptible, it also requires the activity of the imagination working with accurate sensory information.

Here is an example of a situation in which the imagination is used to perceive something objective. Although the capacity to unite concepts in imagination is universal in human beings, it is not usually done consciously. Training in the Goethean method brings this capacity to consciousness and thus it is possible, with practice, to see metamorphic movements consciously, in the way of Goethe. The result is that natural

16 Deikmann, A.J. 1973. “Bimodal consciousness” in *The Nature of human Consciousness*, ed. Robert E. Ornstein (San Francisco: W.H. Freeman)

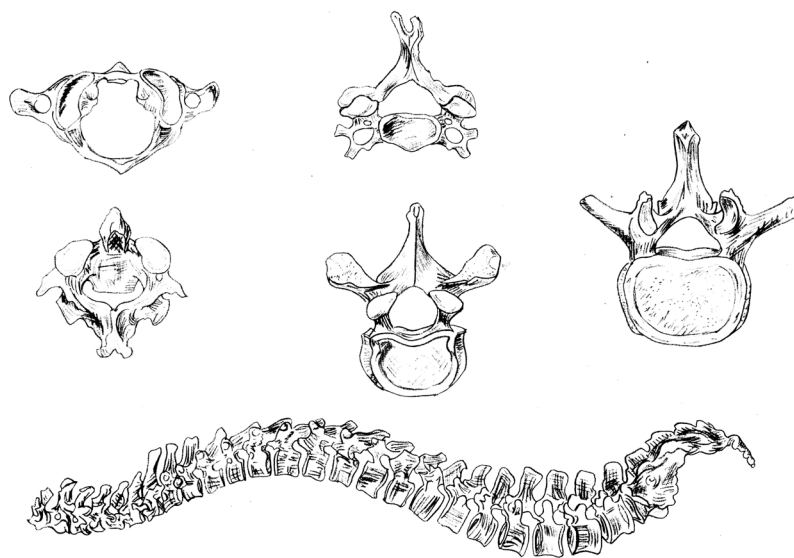


Figure 5: Complete human vertebral column (below) and individual vertebrae (above). Atlas (top left), axis (bottom left), cervical vertebra (top, middle), thoracic vertebra (bottom, middle). Lumbar vertebra (right).

This figure highlights the difference between studying individual vertebrae and observing the metamorphic series in the context of the spinal column.

phenomena suddenly appear as integrated wholes, with intrinsic, qualitative value rather than as fragmented, separate events only to be understood by further dissection.

That Goethe was seeing natural forms in terms of movement is clear from his writings. When he developed his concept of the plant or animal 'type', he was, in the end, speaking of a perception of movement, not a concrete form. Goethe's 'type' is neither a subunit nor, at the other extreme, is it a spiritual abstraction, like a perfect Platonic archetype, standing above and apart from the phenomenon.¹⁷ Goethe's 'type' has no actual form, because it is a spacial-temporal metamorphic movement.

7. METAMORPHIC MOVEMENTS? SO WHAT?

The purpose of the Goethean method is to cultivate a consciousness that can see through the habitual, surface aspects of phenomena and capture more of their being. Meditative exercises uniting exact percepts into metamorphic movements strengthen this ability. Through disciplined meditation it is possible to become aware of the interplay between an individual thing and the universal field of being, to understand the object under study with the relationships it has with its surroundings and with the observer. This is something that is lacking from the analytical mode of working in classical science.

17 Plato's theory of forms asserts that non-material, abstract forms possess the highest and most fundamental kind of reality and the greatest degree of perfection. By extrapolation, this means that all physical manifestations of life are lesser manifestations of their spiritual archetypes. The Goethean view suggests instead that each organism expresses the archetype *in potentia* and that the multiplicity of forms can be perceived within the phenomenon itself.

As we meditate we align our own metamorphic processes with those of the living objects under study. In doing so it is possible to ‘tune in’ to intuitive experiences.

‘Living in the changing forms’ is a particular kind of experience facilitated by Goethe’s epistemology. It expresses a new perception and conception of process, form and participation, which is reached through engaging in the practice of Goethe’s method bringing with it a depth of understanding that conventional science cannot achieve. By focusing on the physical manifestations of form in organisms and performing metamorphic transformations in meditation, it is possible to come to a point where change and development cease to be spacial expressions of temporal processes. It is then possible to have an experience of time without space. In the realm of time it is also possible to enter the dynamics of the metamorphic principle working in living processes. When we call up the forms of animals and plants in meditation, imaginatively setting these forms in motion, we enter into the flow of time and can experience the archetypal activities that exist within it.

Learning to consciously enter the streams of change in time and to experience metamorphic movements from exact observation and meditation, is the first stage of the Goethean process. However, it does not end there. Out of the exact relationships perceived in the imagination, come intuitions. It becomes possible to address research questions in meditation and to receive answers.

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8. IMAGINATION AS A LEGITIMATE TOOL OF RESEARCH

Various ways of practicing the Goethean method can be established but ultimately one must discover the most appropriate way of proceeding for oneself. The important thing is to work out of direct and exact observation of phenomena, to be receptive to universal imaginations and intuitions but to avoid falling into personal fantasies. Goethe called this stage of his method ‘*exakte sinnliche Phantasie*,’ literally ‘exact sensorial fantasy’. It might be better to employ the terminology of Henri Bortoft, who calls it ‘exact sensorial imagination’⁷ thereby avoiding the implications of unreality evoked by the word fantasy.

At this stage the imagination is acknowledged as a legitimate tool of scientific investigation and furthers the understanding of phenomena in its dynamic, temporal dimension. The object is no longer perceived as being frozen in the present, and an awareness of movement, transition and the whole growing process begins to arise. By meditating in this way it is possible to suspend active perception and be totally open and receptive to the object. The phenomenon takes the active role and is beheld against the dynamic awareness achieved through the use of imagination. At this point the observer becomes a vessel for the expression of the phenomenon. At a more advanced stage the human ability to form concepts is put at

the service of the object and the human being becomes a participant in the creative process itself. By following this process a profound sense of the universal meaning and purpose of the studied object as phenomenon can be achieved. It is possible to gain an experience whereby the observer lives within the object and the object reveals itself through the observer. A dynamic, co-creative relationship can arise which, with practice and a sound ethical wisdom, may be useful in building a healthier relationship between the activities of human beings and the natural world.

9. THE POTENTIAL OF GOETHEAN SCIENCE

The way of Goethean science is one possible way of establishing a scientific methodology for the future, one that acknowledges higher dimensions of phenomena. It enables the scientist to consciously transcend the limitations of the senses, which are intrinsically fragmentary in their mode of operation, and enter into the continuum of activity that is the true expression of life.

The Goethean method is effective because it builds on what is perceived by the senses, and through contemplative work activates the imagination, inspiration and intuition.

The activity builds and strengthens organs of spiritual perception through use, such that qualities reveal themselves from within the phenomenon, and not from an abstract, remote, Platonic 'higher world'. It leads to an experience of the authentic wholeness of what is being observed.

Metamorphic transformations of life take place within the stream of time. Working in this way reveals the activities driving the living world of animals and plants, which themselves have a 'beingness'. So the activities can be rightfully described as 'entities' or 'beings'. These are the true archetypes of Goethe. They have no static qualities and are pure activity. At an advanced level of selfless meditation, in which imagination and intuition have been refined, it becomes possible to collaborate with these activities. These are the aims of Goetheanism and the responsibility it carries is great. It is a step towards a future in which the science of biology acknowledges the archetypal activities as spiritual beings. In the more distant future, it could lead to human beings becoming conscious participants in the activity lying behind evolution, rather than blind manipulators of biological material, using techniques and instruments that do not take account of the full dimensions of living processes.

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