

Reality Paradigms, Perception,  
and Natural Science  
*The Relevance of Autopoiesis*

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*Not the truth in whose possession some human being is or thinks he is, but the honest trouble he has taken to get behind the truth is what constitutes the worth of a human being. For it is not through the possession but through the search for truth that his powers expand, and in this alone consists his ever growing perfection. Possession makes tranquil, indolent, and proud.*

G.E. Lessing (1729-1781)

## 1 Delightful Irreverences from Beyond the Pale<sup>1</sup>

There is an ancient philosophical principle which states that Being is prior to Knowledge. That statement, I would suggest, holds little interest for the majority of scientists and technologists, who quite likely would not see the relevance of the remark to their research activities or, indeed, to their lives. Such is the entrenchment in our world view, our perceptual reality-paradigm, that we do not, and indeed almost cannot, recognise that how we see ‘the world’ is dependent on what we are, i.e. on our ontological status. To put it bluntly, seeing the world, for normal science, is the construction of a representation of an external reality by the scientific spectator, which representation must be probed to determine its hidden, primary, mathematically-describable, and fundamentally mechanistic, basis. Such a scientific ‘spectator consciousness’, and the scientific

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<sup>1</sup>The Pale — A term used for the earthen and stone boundary wall, and the region therein enclosed, used in Ireland in earlier times to partition civilized (inside) and uncivilised (outside) regions.

methodology associated with it, is the product of a cultural development which, with its roots in antiquity, found most complete reinforcement in the successes of the mathematical physics of nineteenth century classical science. For the greater part this spectator science remains remarkably unscathed despite the various undermining developments of modern, twentieth century, physics, and is now finding concrete expression in the relatively new discipline of cognitive science, as we assail the question of consciousness - 'just about the last surviving mystery', to quote Daniel Dennett. Along the way, the terrain underfoot of the 'secure stride of science' has been substituted without any enquiry as to its suitability, moving from the physical, to the biological, to the mental, in the quest for absolute certainty, necessity, and completeness, or at least an acceptable approximation to same! However, what is suggested here is that normal science is fundamentally flawed when it is applied to the domains of Life and Mind, and that, furthermore, very much involved in that flaw is our non-recognition of the adopted perceptual reality-paradigm. That is to say, our mis-conception of science has very much to do with our mis-conception of perception. And what is wrong with our conception of science in its application to Life and Mind is that the analytic reductionism which characterises the spectator consciousness stance can never capture the organisational distinctions which characterise living or cognizing beings. Scalpels and microscopes may be useful, but not for the discovery of Life or Mind, for when the analysis is done, that which is essential is gone.

*The philosopher comes with analysis  
And proves it had to be like this:  
The first was so, the second so,  
And hence the third and fourth was so,  
And were not the first and second here,  
Then the third and the fourth could never appear.  
That is what all the students believe,  
But they have never learned to weave.  
Who would study and describe the living, starts  
By driving the spirit out of the parts:  
In the palm of his hand he holds all the sections,  
Lacks nothing except the spirit's connections.*

J.W. Goethe (1749-1832)

In short, what is being mooted here is nothing less than that science is on the wrong tack when it seeks to understand the living and the cognizing with its standard analytic toolbag, for analysis ossifies in its craving for security and certainty. Don't be mistaken. I am not saying that ossified models of Life and Mind are not without use. Nor am I saying that normal scientific methodologies are totally invalid. What I am saying is that just because a particular approach

is useful in one domain does not necessarily bestow it a universal validity. Unfortunately, when a methodology is raised to the level of a creed beyond question, the results attained through its application become immutable fact, even if Life and Mind become in its wake insubstantial shadows of the vital and mental aspects of our experience. All that is essential to Life and to Mind remains beyond discovery because the orthodox dogma of science demands that it must remain forever debarred. However, what I would suggest is that the introduction of the concept of autopoiesis by Maturana and Varela has put a foot in the door which opens on to a much broader perspective view of science in that it draws specific attention to systemic organisation. The emphasis is removed from system structure in that living systems are seen to be defined by their organisation, and explained in terms of relations, rather than component properties. In other words, the 'spirit's connections', the organisation, is now recognised as primary in the definition of what it is to be a living system. It does, however, remain an elusive concept with which science must come to terms.

## 2 Further Irreverences of a More Devious Nature

Quoting poetry, as above, in serious scientific/philosophical tracts is of course a sure sign of a deviant mind. And when such quotations make reference to 'spirit' while at the same time apparently disparaging the holy citadel that is science, 'one' would be prone to question its stability as well as its deviance, wouldn't 'one'? How could we take seriously allusion to spirit and essence in discussions that are supposed to relate to science and cognition? Suchlike judgements are not atypical. In fact, they are probably quite a normal reaction, and they derive from the fact that we of a scientific ilk and training all suffer from paradigmatic conditioning due to the nature of our educational exposure. Whatever our scientific discipline, how we view our domain is something that has been propagated by the structuring of the relevant facts and theories as they were given to us by our mentors. The mechanics of scientific endeavor have been exposed by Thomas Kuhn in his by now very popular 'Structure of Scientific Revolutions', although the ideas therein have a significant heritage. Kuhn propounded that scientific growth is not accretionary and is not achieved by the simple accumulation of facts. He offered a more complex model of scientific evolution which can be schematised as follows:

1. *Pre-Science:*

Having identified a recognisable subject area, a period of confusion over the relevance of facts and experiments ensues. Gradually, different schools of thought crystalize and inter-school rivalry follows until one school emerges

as victorious. This dominant school becomes the paradigm for ‘normal science’.

2. *Normal Science:*

In the pursuit of normal science, the accepted paradigm guides research by indicating problems and methods of solution. Research in this context is like a puzzle solving game, as the paradigm actually defines the answers before the experiments are conducted. Over time, this normal science becomes entrenched, and education becomes paradigm impregnated. Any radical interpretations are banished from the fold. Eventually, however, pressure on the accepted paradigm develops as a result of significant and repeated mismatches between expectations and findings.

3. *Crisis:*

The old paradigm becomes untenable for some of the young bucks who eventually make a concerted challenge on the established order. An old-school – new-school tension then develops ultimately leading to revolution. This can, however, be a slow process, taking a generation for the old school to disappear and for the new school to become the fully accepted paradigm. This stage is much like (1) above.

The development of a scientific discipline therefore progresses with cyclic iteration through stages (1) to (3).

While this outline pertains to specific scientific disciplines, such as geology or cosmology, it is equally applicable to science in general, except that the time scales involved are longer. Science as we know it is not what science was in times past, nor is it likely that so it shall remain for times future. As outlined by Kuhn, the revolutions that take place are not sudden but generally involve a transition period in which the new methods establish their primacy and usefulness. A zoom across the history of science without bifocals shows a broad categorisation into ancient, classical, and modern sciences. In that ancient, or Aristotelian, science was characterised by a ‘substantial’ thinking which sought for the true nature or essence of things as determined by their qualitative characteristics, it is clearly distinguishable from the classical science which emerged post-Renaissance and which was characterised by a ‘functional’ thinking which sought to describe the mathematical relationship between observed quantitative behaviour. However, while modern science, derived from quantum and relativistic insights, is heralded as a veritable revolution in science, there is no clearly defined break between classical and modern approaches. The functional thinking and mathematical formulation which typify classical science have not only been maintained but have even come to dominate modern science. This classical attitude remains because modern science is seen to contain classical science as a first approximation. Neither the objective nor the methodology of

science is deemed to have altered in the transition from classical to modern. The objective remains the attempt to summarise the complexities of experience in simple mathematical laws which are regarded as the causal mechanism behind appearances, while the methodology is something like the following:

1. Observation and measurement of some specific aspects of experience.
2. Hypothesis formation regarding the mathematical relationship between observed quantities.
3. Deduction of possible consequences of the adopted hypothesis.
4. Experimentation and hypothesis test.
5. Falsification of hypothesis?
6. Reformulation of hypothesis if falsified, otherwise extended experimentation.

This more modern Popperian formulation of scientific methodology has as its final product a theory, but a theory based on the solid ground of observed fact rather than speculative conjecture. And here indeed we have one of the paradigmatic presuppositions of what is now our 'normal science'; that, while theory cannot be taken as eternal truth and is therefore always open through the procedure of falsificationism to refinement and reformulation, observed fact remains as the immutable substrate of science, upon which all must be built. This type of presentation would, of course, be regarded as naive by scientific sophisticates who would acknowledge that indeed fact is only fact in context. We do not, they will admit, proceed from the facts to the theory, for our theories colour our observations in that the pervasive theory or paradigm actually guides what we view as fact. As such, fact is theory laden. This kind of acknowledgement is particularly appropriate for those involved in quantum mechanics (which represents the most successful theory in the history of science and which to a large degree actually defines modern science) who are forced to acknowledge that in the quantum world what they observe is in some way shaped by how they observe. However, most quantum physicists go home after a day in the laser lab and happily have their tea in a commonsense macroscopic world, and most who use the methodologies of classical science are not perturbed by any angst regarding the factuality of their observations. What I would like to suggest, therefore, is that modern science has not yet been born! Yes, the pregnancy is obvious and we are disturbed now and then by the implications involved. But we are slow to acknowledge new responsibility and loath to give up our old ways. Modern science has not yet been cleaved from classical science because the modern scientist clings to his old objective spectator world-view. We remain in the transition phase because we as yet refuse to take up in any real, personal sense the required shift to a participatory reality paradigm.

Meanwhiles, back in the lab, not alone do we struggle with accounting, using concepts and terminologies ever more strange, for our observations of physical phenomena, but we forge ahead in the attempt to realise artificial life and artificial intelligence from within our spectator reality-paradigm science. This is the disaster of our Kantian inheritance regarding the investigation of non-physical domains, which, without questioning, assumes that we can achieve the same degree of certainty and security there as we do in matters of billiard balls and planets through application of the scientific method. Let's simply array the phenomena, which, granted, are complex and are going to take time to get to grips with, and then we'll figure out the fundamental mechanism behind them, and, sure, then all we have to do is to build the computer fast enough, with the appropriate degree of parallelism, and program the equations and... *voila*: Life and *ici*: Mind. Well, alright, this is ambitious, but let us not be daunted. Perseverance will surely pay, even if things haven't worked out very well to date. After all AI is only a 40 year old baby and we must remember that they didn't have all the facts we have now when they started. Indeed, we had to rename it as cognitive science in order to take on board the latest advances in neuroscience. What with PETs, SQUIDS, SPECTs, MRIs, and EEGs the mind's, oops! I mean the brain's, mechanics have been revealed as never before. When we get around to incorporating these mechanics in a customized computer architecture it'll just be a matter of programming refinement. And as for artificial life: well, we're only just beginning though, of course, the mechanics of life have been thoroughly grasped. We know it all. Just haven't got around to doing it yet. Actually, when you ponder on it, it is indeed strange, and telling, that artificial intelligence should have been a subject of serious, detailed study before artificial life, for, actually, we never assign intelligence to anything other than living systems. Did the artificial intelligencers simply but quietly assume that when their job was done their artificial intelligence systems would in fact be living systems? Well, probably not. Rather, what is revealed from the adopted sequence of study is the presupposed view of Mind as a disembodied intellectual function. This Cartesian Mind is, of course, a thing quite separate from that other thing, the (living) body, isn't it? But then again there is the brain? Does it belong to the body or the mind? Or, just where does the brain end and the mind begin? And where indeed is this self who refers refers to his brain and his mind? Hmmm!

The real problem, my friends, is arrogance, the intellectual arrogance of a paradigmatic cushyness supported by astounding successes in material manipulation. To escape from that same arrogance, and dare I point out, the disastrous environmental consequences of same, we have to want to escape. Otherwise the alarm bells of our paradigmatic conditioning will deafen us to anything truly new. As it stands the ground is already laid for an expanded view of scientific methodology. We can let go of our notion of the immutability of empirical fact which we assume guarantees the objectivity of science simply because the thesis that science is objective is not, in truth, self-evident at all, nor is it one which

an examination of the history of science supports. The pre-supposition of the objectivity of fact is, again, a paradigmatic bias regarding science derived from our accepted perceptual reality-paradigm. The issues to be dealt with are, then, at least to begin with, the perceptual presuppositions underlying our concept of scientific objectivity. What I would suggest is that when we do escape our paradigmatic conditioning, we afford ourselves a freedom to deal with the physical, the biological, and the mental in terms that we have not really considered to date. We could allow ourselves the liberty to understand the organisational distinctions, i.e. ‘the spirit’s connections’, inherent in our experience rather than merely to know and manipulate material things.

### **3 Facts, Theories, and Veritable Treason.**

Let’s suppose that you have a car and that I know how to drive it. Now then, some of your friends, in recognition of the wondrous possibilities that would be opened to them if they could drive, approach you with a view to borrowing it, whilst fully admitting that they do not yet know how to drive. You, being of a very cautious nature, are naturally slow to hand over the keys. After all that car cost you! But having a generous nature and wishing to share your good fortune with your friends, you undertake to initiate them into the art of driving. Having considered the issue you approach me to assist in the matter. Being a university lecturer with some skill in explaining for the masses, I therefore plan, with the greatest attention to detail, a ‘Course in Driving’. This is to be arranged in a modular fashion beginning with ‘The Overview’ which would examine this thing called driving, and the various functional skills required to traverse the Irish terrain without fear of disappearance into any of the local topographical anomalies which punctuate our roads. But this, of course, by itself falls far short of what I consider thorough. So, I include several submodules to deal with mechanics, dynamics, fluids, and thermodynamics in depth, along with further courses in the required foundational mathematics, with options in French, German, and Italian in case you should travel abroad, the whole thing interspersed with audio-visual presentations such as ‘Rallies I have Known and Loved’ and ‘Advanced Stunts for Wheely Lovers’. Then, at the end of what transpires to be some years of study, I set several sticklers of exam papers to test that your friends really know about driving. Seeing as they all achieve 60% or better, I report back to you that it is now safe to allow them the liberty of the use of your car . But, somehow you experience a strange reticence when it comes to actually giving the keys of the car to the first caller, accompanied by an up-tempo sensation in your chest when you see him take-off ‘bucking-bronco-style’. Subsequent callers are dissuaded from using the car under some pretext or other. And why? Well, in short, you recognise, whether you verbalise it or not, that despite the fact that your friends now have a very considerable knowledge of driving and are all to a man avid readers of AutoWorld magazine and are

keen to discuss the relative merits and demerits of overhead cams, twin-carbs, and in-line engines over a few pints of a Saturday night, they really understand very little. While in common parlance we tend to use the terms knowledge and understanding loosely and often interchangeably there is a very real difference between knowing facts about something and the experience of understanding which we can all recognise in some way or other. Understanding allows us to do and to appreciate the significance of our actions, while knowledge does not bestow any such power. Some knowledge is required in order to understand (This is the clutch. This is the gear stick. To get the car to move you need to do this...), but deepening knowledge by itself does not lead to understanding. Creeping along the road of thought is a highly inefficient method of learning. However, if we supplement our at first basic knowledge of driving with some basic experience of actually driving, and then seek to refine our practical skills through more detailed analysis of the processes involved, and supplement that with more taxing driving experience, and so on, then real progress is possible.

*Thought and action, action and thought, that is the sum of all wisdom, known from time immemorial, practiced from time immemorial, not realized by all. Both must always alternate in life, like breathing out and breathing in. Like question and answer, neither should occur without the other. Whoever takes as his law what the spirit of human reason whispers in the ear of every newborn babe, to test action by thought and thought by action, cannot go astray, or if he should, he will soon find his way back to the right path.*

J.W. Goethe (1749-1832)

Now, to spell it out, the point of this minor interlude on driving is of course to highlight the difference between knowledge and understanding and to indicate the comicality of believing that the assimilation of fact by itself is sufficient for the purposes of arriving at the possibility of useful action. My conviction is, however, that this is the inherent assumption behind the attempts of normal science to discover Life and Mind. We seem to be of the opinion that if we analyze biological processes long enough we will surely get to the point of understanding Life and subsequently of being able to manufacture artificial life systems. Likewise, we seem to believe that if we analyze mental processes in a rigorous scientific way, Mind will surely emerge. If we cannot do it yet it is only because we have not got all the relevant facts. So just give us time. Such is 'The Way of the Tortoise', and it will surely lead to enlightenment - sometime!

To seek to understand is not to abandon detailed analysis but to supplement it with detailed synthesis. This leads not to the ever accelerating quest for more and more facts, but to an attempt to eke out meaning by examining and re-examining, again and again, the facts before us. But this is not likely to make a lot of sense as long as we are of the opinion that fact is objective and

immutable and is acquired immediately through direct observation, which as has been suggested is the basis of normal science as we know it and indeed of our common-sense view of the world. We therefore need to look at the perception of fact a little more carefully before examining the practicalities of different scientific methodologies.

Factuality is a problem. Of course, Everyman is not generally aware that it is a problem. Neither, for that matter, are a lot of scientists. Philosophers are certainly aware of it, but it would appear that they, in the main, have become so lost in conjuring up intellectual means of dealing with the problem that they have forgotten about its implications. From the point of view of science the implications are, firstly, that we cannot really resolve debates about the merit of scientific theory by recourse to ‘the facts’, and, secondly, that the scientific method really has no factual ground on which to base its absolutist stance and hence there may be other methodologies of science of equal or greater validity. And what indeed has happened within the philosophy of science is that the conception of both normal science and normal philosophy of science has been challenged. The logical empiricist tradition characterising classical science and, as I have suggested, still rampant in modern science, has been confronted from several sides with the emergence of ‘a new image of science’, a historical process-oriented view, outlined and examined in detail by Harold Brown in his ‘Perception, Theory and Commitment’. Fundamental to the emergence of this new image is the critical analysis of the logical empiricist view of fact. For logical empiricism, we come to know ‘the world’ through our sensory experience. A disembodied consciousness confronts the external world and receives knowledge through the sensory channels. Consciousness is, as such, a thing among things, an empty container waiting to be filled with knowledge of the world which we acquire through sensory experience. However, although our knowledge of the world is certainly based on sensory experience, it cannot be taken as identical with sensory experience. We do not simply open our eyes and see the world, for knowing even the simplest fact goes beyond the purely sensory, although, of course, neither do we see the world without our visual sense. To quote the philosopher of science Norwood Russel Hanson, ‘There is more to seeing than meets the eye’. If it were not so then there would be an isomorphic relationship between sensory stimulus and perception. But that is simply not the case. Identical stimuli can cause different percepts (perceptual contrasts), while different stimuli can give rise to identical percepts (perceptual constancies). For example, the configurations of lines in Figs. 1 and 2 below can be perceived as representations of three different figures (upward-facing cube, downward-facing cube, and planar pattern, or duck, rabbit, and planar pattern) while the retinal stimulation is the same for each percept, whereas the two horizontal lines in Fig. 3 are perceived as being of equal length while the physical length in each case is, in fact, different. A host of other illusions draw attention to the fact that there is a non-sensory element involved in perception. That we categorise such examples as illusion is yet again a statement which derives from

our paradigmatic conditioning. If it doesn't fit in with my normal conception then it is an illusion. But illusions such as the Necker cube, the Duck/Rabbit, and the Ponzo diagram simply make obvious what is true but not immediately evident for all perception, that being that there is more to perception than sensory stimulation. To see, or should I say appreciate, this we can consider the diagrams in Figs. 4 and 5. Obviously, they can be regarded as random patches of black and white, and for some that is all they might be. However, if we do not come to see a giraffe and a Dalmatian of our own accord we will almost surely do so when we are told that that is what these are representations of. But how is the transition made? Nothing at all changes from the point of view of retinal stimulation. We might perhaps say that the change was effected by some kind of change in our attention but we certainly cannot attribute the change to changes in sensory experience. Hanson says that what changes in such cases is the organisation and points out that this organisation is not something seen in the way we see the lines or shapes, but is in effect 'the way we see'. It is not an element of the retinal stimulation caused by something out there on the page but is rather the way the elements are appreciated. This organisation is the part of seeing which is more than that which meets the eye. Seeing the giraffe and the Dalmatian are cases of 'seeing as' which characterise what Brown calls 'significant perception', as compared with seeing the random black and white pattern which might be regarded as simply 'seeing'.

Actually, even the spatiality of seeing the random pattern on the page is already, only at a different level, a case of 'seeing as' and not a primary sensory experience available directly to the eye. If our seeing was pure sensory experience alone then our perception would be one of total multiplicity without any sense of unity whatsoever. All of us, I am sure, have had some experience approaching this state. For example, 'Dermot the Intrepid' is on a train travelling to regions unknown. Looking out the window, he dozes off. A strange rumbly impression gently awakes him sometime later. As he slowly comes around he opens his eyes in what is now a very dark carriage. What assails him first is not a perception that he is on a train looking out at the interior of a long, dark tunnel, but a meaningless blur. Sights, sounds, and tactile impressions are not even differentiated in his experience as he emerges from sleep. A mild sense of panic assails him. What is going on, and where is he? The shock of the unknown stimulates the flow of adrenalin and he awakens further to 'see' what is 'actually' happening as he recollects the fact that he got on a train and is travelling. With relief his heart rate gradually subsides as he escapes from the meaninglessness of his initial experience and his normal order is re-established. Such fleeting experiences are reinforced by the reports of the visual perception of people who have been blind from birth due to cataracts but who received sight in their adult years through surgery. Contrary to what might be expected, their initial post-operative visual experience was not that of immediate sight but rather one of visual meaninglessness. Only with time did coherence emerge.

The 'seeing as' cases of the giraffe and the Dalmatian are experiences of seeing meaning where previously there had only been a meaningless patchwork of black and white. The non-sensory unity which we see when the black and white pattern becomes organized is the meaning giraffe. The giraffe is not the 'meaning of' the black and white pattern as there is no meaning on the page, but rather the giraffe is the meaning which is what is seen. Likewise, the objects of our significant perception are meanings and they arise through the non-sensory organisation of pure sensory stimuli. In that meaning is relative, seeing fact is no different from seeing object. 'I see writing on my computer terminal which is on my desk' is only a more complex situation than that of seeing a pen, and is the apprehension of meaning, albeit a more complex case than that of seeing the pen alone. Likewise, scientific fact is but a higher level condensation of meaning than everyday fact, and is not objective reality out there apprehended by the senses. Thus, fact is condensed meaning, and seeing fact always involves a non-sensory dimension, which for now we might refer to as a dimension of mind. That we do not typically realise this is an artefact of the intentionality of consciousness as realized by Brentano, developed by Husserl, and propagated by Heidegger, Merleau-Ponty and others in the gestation of the Phenomenological Movement. Our normal consciousness always has a structure of intentionality, i.e. it is always directed toward an object. Because it has this directed nature, the dimension of mind involved in significant perception becomes transparent, and the meaning which is what is seen becomes invisible and appears as something other than it is, i.e. a sensory object out there in the external world. Thus the meaning which is what is seen becomes the meaning of what is seen. We then say that we experience retinal stimulation and our brain processes the sensory information to realise the meaning of the sensory data. But this is really a secondary notion of meaning which arises because of our failure to distinguish between the intuitive mind and the analytic mind. Because of the directed nature of consciousness we are blind to the intuitive mind and view ourselves as isolated spectators of the external world rather than participators in the meaning which is our experience. To put it compactly, in normal perception, and consequently in normal science, we identify with recurrent features of our experience and view them as observable, externalised facts rather than condensed meanings. We are, we say, 'conscious of' the world, when in truth we should say that 'consciousness is ' our world. There is fundamentally and primarily 'this experience', and it is only because of the intentionality of consciousness that we have a tendency to divide such experience into things 'out there' which I become conscious of 'in here'. But when we get to examine this we find it is an artificial division which has no absolute basis, for when put upon we cannot even say just where 'outside my consciousness' stops and 'inside my consciousness' begins. My experience is a continuum constituted of meanings and it cannot be divided into external datum and internal representation. It of itself is the only given.

These two aspects of meaning, ‘the meaning of’ and ‘the meaning which is’ need to be looked at carefully in the context of science. As I have suggested, the ‘meaning of’ aspect is really a secondary notion of meaning which is associated with the analytic mind. It is, however, what has come to be the accepted interpretation of meaning due to the prevalence of the spectator view of consciousness. Consequently, it lies behind the paradigm of our normal science. The scientific observer opens his eyes (and possibly, but not usually, his other sensory modalities) and apprehends directly the possibly complex facts of the phenomenon under study. When this is taken as ‘the way it really is’, science becomes the endeavour to realise the meaning of the facts that confront our consciousness. These facts are subsequently organised by imposing an intellectual framework which constitutes the scientific theory. If the theory accounts for the facts and allows effective prediction then it is accepted as being the unifying law which lies behind the appearances. That is, this is the discovery of the unity which lies ‘out there’ behind the deception of the senses.

A pertinent example of this is in the science of colour. Newton purported to show with his experimentum crucis that white light is composed of coloured, or at least colour producing, rays of different refractibility. This he took to be observable fact. It is still propagated as observable fact in all standard physics text books, and because I am now introducing this topic in some sort of questioning way is almost certainly at this very moment causing the arousal of a tension in you out there which is the precursor to the release of paradigm conditioning alarms. Let me state it clearly, then, and get the sirens going. Newton said that light was of a composite nature and that anybody could see that this was a fact by performing his crucial experiment. I am saying that this is not so, and that what the relevant experiment shows is that when light interacts with glass, coloured phenomena ensue. This is known as the modificationist stance by those involved in colour science. Newton and I observe the experiment and we agree that there is a differentiation after refraction. But Newton says that before refraction all the differently refracted rays are present in the white light, while I would deny this and suggest that the colours are produced by the action of the matter of the prism on the light. The composite nature of light is not there to be seen by any observer, and the suggestion that it is is a case of mistaking meaning for sensory fact. But having made that identification, Newton, or more properly the Newtonians following him, proceeded to derive a theory of colour based on the intellectual unification of the theory of the differential refractibility of composite white light. This theory was initially related to a corpuscular theory of light but it has come to be based on spectral analysis and assigns colour phenomena to our sensory reaction to light of different wavelengths. However, whether there is indeed a direct relationship between stimulus wavelength and perceived colour is very far from clear. If it were, then colour science would be greatly simplified. It remains the case, however, that nearly a full spectrum of colours can be perceived with even just two so-called ‘monochromatic’ sources under appropriate conditions. Again,

such colour production might easily be attributed to illusion - a deception of the senses - because it cannot be accounted for by the theory. But what has been taken to have established the theory? An experiment, one crucial experiment, followed by mathematical analysis.

*For it is not number of Expts, but weight to be regarded;  
& where one will do, what need of many?*

I. Newton (1642-1727)

This is actually totally at variance with even a Popperian formulation of scientific method. A crucial experiment can be used to falsify but not to confirm. Nevertheless, this single phenomenon became the foundation of colour science and was taken to establish the truth concerning light and colour and made the science of colour mathematical. Given the total confidence we can have in mathematical analysis, contradictory experimental evidence carries little weight. After all, we are told, the eye can be a very unreliable receiving apparatus, but mathematics provides us with certainty. So the Newtonian theory of light dispenses with the phenomena of colour in favour of a mathematical abstraction, and the scientist's concern is no longer with the direct details of his experience but with the calculational consequences of the theory. In short, the scientific study of the perception of colour which truly belongs to the realm of psychophysics is reduced to physics. The intellectual framework which constitutes the Newtonian theory of colour phenomena is used to turn isolated facts into evidence for the theory which is accepted as being the unifying law, the spirit's connections, lying behind the appearances. And so, Newton is said to have discovered the truth about colour by direct observation of the entirely sensory fact that light is composite.

I have dwelt somewhat on the issue of colour science because it is familiar to all in outline at least, because it was, with Newton's Principia, a formative influence for the development of the mathematicisation of science (i.e. of classical science), and because it exemplifies some of the pitfalls of the method of what has become normal science when it seeks to reduce perceptual experience to quantitative law. It is, without doubt, a very powerful tool for handling wavelengths, but that is not at all the same thing as handling perceived colour. What might be surprising to many is that the Newtonian theory is not really all that practical when it comes to predicting colour perception. Issues of lighting, contrast, background, juxtaposition, size, and texture all influence perceived colour. It is for some of these reasons that interior decoration often becomes the exasperating, neck-wrenching, multicoating undertaking it can be, as when having finished painting the room we hear: 'Well, Darling, I know you've spent the last three and a half hours putting it all on, and it is ...different... but somehow it just doesn't look like the sample paint chip on the colour card, ... Darling'! I am being facetious, of course. I don't wish to suggest that home DIY should not be

undertaken without recourse to detailed spectrographic analyses. Rather, the point is that colour perception has a multidimensional nature which cannot be reduced to wavelength measurements. Furthermore, it should be noted that the Newtonian approach to colour science provides no obvious guidelines as to the nature of colour harmony, aesthetic issues being considered completely outside the domain of such a science. All in all, it is therefore salutary to remember that Newton's theory is not based on a solid substrate of observable fact but is an instantiation of a particular way of seeing. It is a case of developing a unifying framework for the multiplicity of sense experience through intellectual analysis. It is therefore a paradigmatic example of the 'theory as an interpretation of the meaning of the sensory facts' version of science, as opposed to 'the theory as understanding' interpretation of phenomenological science.

It is worth while teasing this out somewhat with the aid of some diagrams. What I have suggested is that, in truth, our experience is the only given and that it is a continuum. As such, it might be represented by the double arrowed line in Fig. 6.

At one extreme we might assign a tag 'Outer' and at the other 'Inner', while movement along the Experiential Line from Outer to Inner would constitute a change in the nature of our experience going from the quantitative to the qualitative, from the existential to the essential, where it is to be appreciated that quantity and quality can never be completely separated. The relative balance is a matter of position along my metaphorical Line. As we move inwards, our experience goes from the material, through the vital, to the mental, and possibly beyond. When we are subject to the delusions of the intentionality of consciousness, we introduce a false division in our experience, which might be represented by the directed arrow of Fig. 7.

We say that I in here am conscious of things and events out there. Now, seeing this way does not introduce any great distortion when we are operating around the Outer pole of the continuum of experience. It does, of necessity, have the effect of isolating us from the world and of fostering a secularized science which reduces Nature to a thing to be dominated and used, but such issues are not directly my concern here. My point is that the stance of classical science is very effective when it comes to calculating quantitative relationships between material entities. However, as we move inwards along the continuum towards our more vital experiences, we are in error when we attempt to apply the same method. For example, when we focus on perceptual phenomena per se, as in the case of colour perception, the adopted assumption of a spectator consciousness distorts our experiential reality for we cannot view that experience as being a purely quantitative inner reaction to some external stimulus in the same way as we would view collisions of material objects. That is to say again, attempting to reduce psychophysics to physics is an error deriving from the intentionality of consciousness and from scientific paradigm conditioning. When we move further along inwards on the Experiential Line to mental experiences such as instinct, thought, and emotion, we would be even more in error if we attempted to ap-

Figure 1: Necker Cube.

ply the methodology of classical science to the examination of mental states as things. Psychology can never be reduced to physics, and to look for the hidden mechanism of mind behind the appearances is pure folly reflecting our inability to discriminate between the organisational distinctions inherent in the nature of our experience as we move along the line from Outer to Inner. Kant assumed that the essence, the noumena, behind the appearances, the phenomena, was unknowable because it transcended all possible experience and he was therefore content to offer an anatomy of mind based not on experience but on what must be the case in order to make possible human experience and knowledge. The discovery of the mind for him was to be achieved through science, i.e. classical science, through figuring out the hidden mechanism behind mental experience, and this Kantian way of thinking still persists in, and even dominates, cognitive science. However, what this approach misses completely is the relative, qualitative, organisational, difference that exists between phenomena at different 'points' along the Experiential Line.

If, as I have suggested, the error of these ways derives from an acceptance of a secondary notion of meaning, that of 'the meaning of' what is seen, which is associated with the analytic mind, then it is put upon me to examine what a science based on the primary notion of meaning, that of 'the meaning which is' what is seen, would be. I have suggested previously that this is somehow related to the intuitive mind which becomes transparent due to the intentionality of consciousness. Now, intuition is not as fuzzy a concept as is often suggested. In 'The Mind Field', Robert Ornstein defines intuition clearly as 'knowledge without recourse to inference' whereas the logical or rational mode of knowledge 'involves an analysis into discrete elements sequentially (inferentially) linked'. Thus the intuitive mind 'sees' in quite a different dimension to the way the intellectual

Figure 2: Duck/Rabbit.

Figure 3: Ponzo figure.

Figure 4: Giraffe.

Figure 5: Dalmation.

Figure 6: The continuum of experience.

Figure 7: The intentionality of consciousness.

mind ‘sees’. Whereas the intellectual mind sees the facts sequentially, the intuitive mind sees the whole instantaneously. For the intuitive mind the facts are seen with a depth which defines immediately their relationship and there is no requirement to derive a theory of the hidden mechanism behind the facts. When we see with the intuitive mind we understand, whereas when we see with the analytic mind we simply know and from there we engage in inference. Understanding therefore allows us to do, in the sense of undertaking creative action, in that we have a direct appreciation of the unity of the phenomenon at hand and of the inter-relationships which exist between the facts. Everyone, I am sure, has some experience of this seeing in depth. For example, those involved in debugging software engage their intuitive faculties when they try to identify some problem which might be manifesting in various details of the operation of their program. Typically, they will go over and over the problematic code until they have a ‘mental picture’ of its whole structure, which they will then mull over ‘in their head’. They will certainly involve their intellectual faculties in the analysis of the likely problem, but the realization of the error is usually a flash from the depths, an insight which is immediately, dare I say instantaneously, appreciated as being right. This amounts to seeing some unifying flaw which can be recognised in all the particulars of the manifested problems. Along the way several subsidiary errors might have been seen in the same way, but those insights are not accompanied by the same definite, immediate conviction that this is the solution to all the initial problems. Well, this is my experience of debugging software anyway, but then again I am not a computer scientist! Very much the same procedure is involved in all creative activity. The question at hand is examined repeatedly and from as many different angles as possible until a comprehensive mental picture has been established, after which point any intellectualising has to be abandoned if the creative insight is to be allowed emerge. There are innumerable accounts of this in the literature, which might be caricatured as the ‘what-I-saw-in-a-flash-while-out-fishing-after-a-tough-day-in-the-lab’ experience. All the various facets of the issue are seen as a connected unity and the solution to the problem is immediately obvious. The unity that is seen in depth is not an intellectually imposed framework but an experience of the meaning which is the whole phenomenon. This unity is not out there waiting to be seen, nor is it achieved through any algorithmic procedure involving sequential inference: If p is true then do q, else if r is true then do s, else... . Rather, it is achieved by directly seeing the organisation of the phenomenon, ‘the spirit’s connections’ which are nowhere available to the intellectual mind. This organisation is not just spatial or temporal for it relates to the potentiality involved in the phenomenon, and potentiality does not fit into a space-time framework. It is what might be called a hidden pattern, not hidden behind but rather hidden in the phenomenon, and it remains ever unavailable to the intellectual mind which therefore can only compensate for what is missing by appending some explanatory model of a mechanical nature. Consequently, for the intellectual mind the depth of the phenomenon is conceived as an extended,

physical depth constituted of sensory objects which cannot be accessed directly and whose workings must be figured out. This is like saying that behind the phenomena of our observations lie other phenomena which we cannot see directly but which we could see if we had the right instruments, like a microscope or a spectroscope, for example. And so goes the infinite regress of normal science as it searches for the ultimate ground which lies behind the phenomena behind the phenomena behind the phenomena... . Conversely, when we see with the intuitive mind, the phenomena under observation do not change. They remain the same but the way they are seen to relate changes. We could say that we 'see into' the depth of the phenomena where this depth is an intensive depth and not the extensive depth of the intellectual mind. Thus, the phenomenon is seen standing in its own depth. The meaning which is the phenomenon shows itself. It shows itself to us when we look at it in the right way. And to look in the right way is to escape from the intentionality of the consciousness associated with the analytic mind. When we put attention into the act of seeing (or hearing, or touching etc.) rather than into the object perceived, we start to see detail that escaped us when our attention was all going one way. When I put my attention into the act of seeing a leaf, into active looking rather than passive reception, my experience is very different from the normal generality which I call seeing a leaf - oh, you know, it's kind of green and ovalish. My attention is taken out of intellectual generalising - well, all leaves are green and ovalish, that's what they have in common, isn't it? - and put into seeing the concrete, qualitative differences of detail, i.e. into seeing more of the meaning which is what is presented to me as leaf, for this is the food of the intuitive mind which can only manifest when the intentionality of consciousness is overcome and the intellectual mind has been made subservient. Thus, if we are to understand more then we must begin by enticing the intuitive mind into more active prominence.

Well, now, this latter material is probably getting to sound a little mumbo-jumboish. It is a criticism often thrown at any descriptions or attempted descriptions of a phenomenological methodology, which is, in effect, what I am attempting to introduce you to here. One of the major difficulties faced by anybody trying to do so is that the subject-predicate-object structure of language is very well suited to functional but not to ontological description. Hence, the somewhat poetic tone in the attempt to convey qualitative distinctions which the intellectual mind will fail to appreciate. 'Well, if you have anything worthwhile to say, you should be able to say it clearly' is a common enough cry. However, in that I believe that there is something worthwhile to say I will continue with my efforts. Anyway, I always liked poetry. It would be wonderful if there were a nice text book with the title 'Techniques and Tactics in Phenomenological Science', but as far as I know it hasn't been written. Daniel Dennett is interesting on this point. To quote from his 'Consciousness Explained':

Philosophers and psychologists often use the term phenomenology as an umbrella term to cover all the items....that inhabit our conscious

experience.....The usage has several distinct ancestries worth noting. In the eighteenth century Kant distinguished phenomena, things as they appear, from 'noumena', things as they are in themselves, and during the development of the natural or physical sciences in the nineteenth century, the term phenomenology came to refer to the merely descriptive study of any subject matter, neutrally or pretheoretically. The phenomenology of magnetism for instance had been well begun by William Gilbert in the sixteenth century, but the explanation of that phenomenology had to await the discoveries of the relationship between magnetism and electricity in the nineteenth century, and the theoretical work of Faraday, Maxwell, and others. Alluding to this distinction between acute observation and theoretical explanation, the philosophical school or movement known as Phenomenology (with a capital P) grew up early in the twentieth century around the work of Edmund Husserl. Its aim was to find a new foundation for all philosophy (indeed, for all knowledge) based on a special technique of introspection, in which the outer world and all its implications and presuppositions were supposed to 'bracketed' in a particular act of mind known as the epoch. The net result was an investigative state of mind in which the Phenomenologist was supposed to become acquainted with the pure objects of conscious experience, called noemata, untainted by the usual distortions and amendments of theory and practice. Like other attempts to strip away interpretation and reveal the basic facts of consciousness to rigorous observation, such as the Impressionistic movement in the arts and the Introspectionist psychologies of Wundt, Titchener, and others, Phenomenology has failed to find a single, settled method that everyone could agree upon.

He then continues to pursue the phenomenology (with a small p) of consciousness in a thorough fashion. Now, while his comments are true to some degree, they hardly represent a damning criticism of Phenomenology. Classical science also took some considerable time in gestation, as recounted by Dijksterhuis, until Newton crystalised its methodology by doing classical science. Likewise, phenomenological (forget about big and small 'p's - I mean Phenomenological) science needs to be done if it is to be developed. And what I would suggest is that a basic methodology for doing phenomenological science has been around for a lot longer than Dennett indicates, and is to be found in the scientific endeavours of Johann Wolfgang von Goethe. That this is the case has, at least to my mind, been brilliantly shown by Henri Bortoft in his little 'Goethe's Scientific Consciousness' to whom and to which I am very indebted. The injunction to invest attention in the phenomena under investigation defines the ground of phenomenological science, that being experience. This is entirely in accord with the realisation that fundamentally, in any science, what we are dealing with

is the meaning which is our experience. Putting our attention into the act of seeing rather than merely into that which is seen only characterises the first or observational stage of a phenomenological method, but it has the important consequence of deautomatizing the analytic mind and of bringing the intuitive mind into focus where previously it had been transparent. The second stage in Goethe's phenomenological method is what he referred to as 'exact sensorial imagination'. The phenomenon is thought in imagination, rather than thought about, in that it is visualized in concrete detail. Furthermore, not only the isolated phenomena, but their temporal development, their coming into being or becoming, is visualized so that the phenomenon is seen as a comprehensive whole. This active, concrete, sensorial imagination has the effect of further deautomatization and of allowing the phenomenon to show itself in its intensive depth. And what is shown ultimately is what Goethe called the Ur- or primal phenomenon, which is the realization of an understanding of the phenomenon in question. For Goethe, the key to the comprehension of everything is development. He felt that the history of man shows us man, and the history of science shows us science. By reliving the historical development of the phenomena of interest in our active imagination we are brought to the point of 'seeing' the Ur-phenomenon, of seeing how the various phenomena of our experience are related or organised, i.e. of actually seeing 'the spirit's connections'. This seeing of the intensive dimension of the phenomenon is the theory, which interpretation of theory is quite at variance with the more usual idea of a set of propositions or a mathematical model, and is much more reminiscent of the original Greek *theoria* which is the 'activity of seeing'. To realize this intuitive seeing, then, requires a twofold methodology. Firstly, there is an analysis of the parts, but an analysis which puts attention into the act of seeing the concrete sensorial detail of the phenomenon rather than into intellectual classification. Secondly, there is an active synthesis in our imagination realized through putting the parts back together again so that we might visualize the whole through the developmental sequence. The objective of undertaking such exercises is nothing other than to see, for the particular phenomena under study, the primal phenomenon which is neither entirely objective nor entirely subjective but something inbetween.

Since all phenomena are meaning at some point along the Experiential Line, all knowledge, from a phenomenological point of view, is seen to be an element of being and not the acquisition of external fact. That is, we cannot separate what we know from what we are. We participate in knowledge at all levels and the state of 'being known' is, in this view, the stage which the phenomenon reaches in human consciousness. It is not just a subjective state of the knower which does not affect the phenomenon in any way. When consciousness is properly prepared, as when the intuitive mind is allowed full vent, it becomes the medium in which the phenomenon emerges. We therefore allow the phenomenon to evolve by our active participation in it. Hence the priority of phenomenology over any physical, biological or psychological science as we know them, which must forever remain with static fact and abstract theory. Its value lies not

necessarily in the bestowing of some manipulative power, but in the achievement of ontological insight. The world view inherent in this is, of course, very much at variance with the spectator reality paradigm, and for that reason difficult to assimilate by those conditioned to seeing the world as a spectator. The structure of intentionality is the condition of consciousness required for us to see the world in a spectator kind of way, and if we are to appreciate a participatory world-view, then consciousness must be re-structured. I have suggested, following Bortoft, that the methodology of phenomenology inherent in Goethean science has the dual function of having this re-structuring effect on consciousness and of then revealing aspects of the phenomena of nature which are invisible to the analytic, intellectual mind and its associated spectator consciousness. Thus a phenomenological science can be seen as a science which concerns itself directly with qualitative distinction. Its subject matter proper is being, and not just the acquisition of knowledge. Phenomenology is, therefore, a fundamental form of ontology, and the phenomena which constitute its subject matter as such are not merely appearances but those things which show themselves to consciousness through participation. Thus, in approaching the phenomena of Life in this way we can come to see the organisational characteristics which define living systems, and in approaching the phenomena of Mind we come to see the ontological necessities of mental processes. But to appreciate what this might mean we need to have a grasp of the significance of being and of how it relates to phenomena.

Before involving ourselves in philosophical considerations relating to a participatory reality paradigm, it is worthwhile examining an application of phenomenological science so that we might come to grasp what it means in a practical sense. The example which I will take is that of Goethe's colour science since it may be seen in contrast to the Newtonian approach. A detailed exposition of Goethe's exploits with colour phenomena would take too long, but a good introduction can be found in Bortoft, while a very thorough, multi-dimensional examination of the issues involved in the Goethean and in the Newtonian theories of colour is presented in Dennis Sepper's 'Goethe contra Newton'. In short, Goethe came to propose that some contrast between light and dark is essential to the production of colour, i.e. he came to see that colours only appear where there is some kind of light-dark boundary. This he realized through following a carefully constructed set of relatively simple experiments which to mere reading appear to be almost trite, but which are in fact intended to elucidate the phenomena by analyzing and comparing them and by organizing them into significant groupings, and they do achieve their aim when they are actually performed. In presenting these experiments, which to most scientists of his time were nothing new, Goethe was not trying to establish a replacement theory of the same nature of that of Newton, but of showing a way of ensuring that the scientist can discover what is intrinsic or essential to the phenomena, i.e. how the scientist can help the phenomena provide their own meaning rather than just confirm an hypothesis. This is fundamentally un-Kantian in that Goethe believed that the scientist is able to ask what and how things are of

themselves, independent of his particular point of view. This, he found, could only be achieved through comprehensive examination, involving both analysis and synthesis, and requiring the direction of attention both inwardly and outwardly as experiment after experiment was brought into play. The experiment as such was not performed to test a theory, nor just to gather items of data which the theory would make sense of, and relate to each other. It was rather a phenomenon which bore in itself a natural relationship to other phenomena which was something which was to be 'read' by the scientist without the intervention of abstract theory. To achieve that, Goethe requires that we put attention into the act of seeing the colours in some experiment so that we really do see what we are seeing instead of simply having a visual impression. Bortoft describes this dramatically as 'plunging into seeing' in which we begin to experience the quality of the colours. So for example, Goethe begins with the whole phenomenal domain of perceived colour, and through a process of progressive experimentation he gradually approaches what will ultimately be seen as the Ur-phenomenon, the phenomenon which arises from the simplest synthesis of conditions necessary for the arising of that phenomenon. For colour phenomena, this is approached when the experimental sequence has been reduced to that of using a prism to view a light-dark boundary in two different orientations of the boundary. When the colour phenomena arising in these conditions are viewed in Goethe's way, they acquire a property of relationship. Black, violet, and blue are seen to belong together, as are white, yellow, and red, in that the violet to blue shades, the cool colours, are seen to be illumined darkness, while the yellow to red, the warm colours, are seen to be darkened light. There is seen to be an inherent unity between them which derives from the nature of their coming into being, of their development. This impression is reinforced when the colours seen are 'replayed' using the technique of exact sensorial imagination which deepens the contact with the phenomena in a way which would not be possible by just thinking about them using the our intellectual faculty. So, we work through the phenomena by analysis and synthesis towards the discovery of an ultimate unification, the primal phenomenon, which is recognisable in all particular instances, and which in this case is seen to be the requirement for the arousal of colour phenomena of an interaction, made possible by some intermediary medium such as glass or air, between light and dark. This is, of course, quite at odds with a Newtonian formulation which postulates that all colours can be seen to be in composite white light, and Goethe's Theory of Colour has been subjected to criticism and ridicule since it was published. However, careful examination, as found in Sepper, shows that there is a lot more to Goethe's theory and to his conception of science in general than would first appear to those trained within the paradigm which defines normal science. This is not to say that it is not without its problems, and that it could not be extended or developed. Indeed, such would be entirely in the spirit of Goethe's endeavour in that his whole orientation was developmental rather than final. Actually, what is really important is not the results per se as presented by Goethe, for we

could surely progress from them now with the further technical knowledge available to us, but rather the way of doing science involved. It should be noted, though, that there is a lot more to Goethe's science of colour than just the prismatic experiments I have introduced here. Such is the comprehensiveness of the approach that Goethe can move from physiological, through physical, to chemical, and even to aesthetic aspects of colour perception, all the time employing the same basic phenomenological technique. While it might appear from my very cursory introduction that Goethe's approach is simplistic and of no practical value, it should be pointed out that it does bestow upon its practitioners a considerable predictive capability with regard to perceived colour phenomena which, as I have pointed out, is not really the case for a Newtonian or wavelength approach. Furthermore, this capability is not restricted to physical colour phenomena, as in the projection of prismatic colours, but even allows an appreciation of the rationale of colour harmony - why green and red look nice together, for instance, while purple and red clash. So, I would suggest that this approach is more than a little powerful from a practical point of view and that its power derives from its primacy, from its root in experience alone as the only given, and in its aim of understanding rather than technical manipulation. However, just talking about phenomenological science puts me, and you, back into the 'Driving Course' scenario mentioned earlier. There is really very little that can be conveyed without practical experience, and to be phenomenological scientists we need to do phenomenological science. All I can really hope is that I might incite you to try it.

#### **4 And Just Where Liveth the 'Spirit's Connections'?**

In taking you along the road I have in examining what I believe science is and what science might be, I have introduced various concepts and terminologies without definition. In particular, I am referring to intuitive mind, analytic mind, consciousness, spirit and the like. Such vagueness is irksome to the intellectual mind. So - Just what do you mean by spirit? or Where exactly is the intuitive mind? - are understandable questions. In that I don't believe that there is any real value in dictionary definitions, I will make no attempt at direct explanation. However, all of these terms refer to experiential elements, i.e. they are phenomena which I, and, I think, everybody else, encounter whether or not we label them. Their meaning is related to aspects of the Experiential Line introduced previously. As such, they should become visible if investigated using a general phenomenological methodology - what we might call a Universal Phenomenology. This, I believe, has been done by J.G. Bennett in his 'Dramatic Universe'. Though the style of presentation owes far more to analytic philosophy than to phenomenology, nevertheless, when examined his mode of

enquiry can be seen to have been phenomenological. While it is completely impossible to give a comprehensive outline of the content of Bennett's contribution here, certain relevant abstractions from it can be introduced. To begin with it is necessary for me to point out that because of its very nature as a phenomenological approach to all experience, any attempt to read this work in a piecemeal way is doomed to lead to exasperation. To use a musical analogy, an approach to Bennett requires fugal rather than melodic thinking. Melody has a linear logic and the experience of melody can be appreciated in terms of an inner logical necessity. Fugue has a multi-dimensional nature and the experience of fugue confounds linear, logical appreciation but yet has a multi-dimensional logic which defines its structural necessities. And so, in addressing the presentation in 'The Dramatic Universe' it is as well to be aware at the outset that it does not account for experience as simple melody but as multi-part fugue. We can choose to pay attention to any one line, but we should note that there are also other lines going on which will be influencing the development of the one we are following. The foundation on which everything is constructed is, as Bennett is at pains to bring out and as I have emphasised previously in the context of phenomenology, the only possible foundation, that of experience itself as the only given. Experience is as such a unity, but a unity which may vary in concreteness. To bring this out, I will introduce an analogy which might be useful. It is that of the hologram. When laser light of the correct wavelength is shone through the hologram plate, the holographic image appears. Let us say that this image is the unity or wholeness which is the phenomenon. It is not a thing, for we cannot point to the hologram plate and say look there is the unity. The unity emerges through the interaction of the components. It is the potential inherent in the interference pattern which is visible on the plate, but the degree to which this potential is realized depends on the effectiveness of interaction. If I fragment the hologram plate into a hundred pieces and use one piece in the reconstruction apparatus, what emerges is still the unity of the holographic image, but an image which is very fuzzy compared to that which emerged when the unfragmented plate was used. Also, if I use a laser which is not well focused, or which is not truly coherent, then the holographic image will again be fuzzy, or it may not even appear. So, I can say that the concreteness of the unity which is the holographic image is relative and depends both on the experimental equipment and on the quality of the laser light. For this example, it can be appreciated that the experimental equipment is the most tangible of the elements involved. I can analyze and investigate the details of operation, so that I can come to know it very well. However, in doing so, nowhere will I find, among the lenses, interference patterns and laser diodes, the unity which is the holographic image. It is completely unavailable to me as an item of equipment. The laser beam itself has a quality of being apparently tangible, but not really so. I can affect the laser by manipulating the laser diode but the beam itself is not really a thing as such, but its coherency is crucial if the unity is to emerge in its full potential. Well, so much for analogies. Let's relate it to experience.

Whenever we examine experience, there is always a knowable aspect - the experimental instruments - which we will call function. If we study the functional domain, the goings-on of the world as process, we can come to know and to describe, i.e. function can become part of our knowledge, and we may even come to be able to predict what will happen to some degree. It is relatively easy to talk about this aspect of experience - the world as process. Not so with being - the laser beam. Being concerns the status or quality of experience, the very substance of things and not the bits they are made of. It is potency; the power to organise, and it has degree. The more together the being, the more coherent and concrete the experience. Nowhere, however, can we apprehend being directly. It has, in one sense, an objective side to it which we will refer to as energies, which vary along a qualitative scale according to potency. It should be noted that energy, as an aspect of being, is really unknowable, although we are used to talking about energy as if it were observable. What we know are the results of energy exchanges, which belong to the domain of function, and not the energies themselves. We can also talk of being from an inner, subjective point of view by relating the quality of the laser beam to the quality of awareness or consciousness. The more the being, the more the consciousness, the more concrete the resulting experience of unity. To the unity - the holographic image - we can assign the name will, without any anthropomorphic suggestion that this has to be a someone. Will is the affirmative characteristic in experience in that it dictates what is possible and what is impossible. If there is a hologram of an orange recorded in the interference pattern on the hologram plate, then it is impossible for an image of an apple to emerge no matter what quality of laser beam used. In an objective sense, then, will can be seen as law - that which defines what must be. However, from the more subjective view it is the seeing, the understanding, of the unity which is inherent as potential in the functional parts and brought forth through the degree of participation of the light of being. We can summarise these cursory observations as follows:

| <i>Experience</i> | <i>Subjective</i> | <i>Objective</i> |
|-------------------|-------------------|------------------|
| Function          | Knowledge         | Process          |
| Being             | Consciousness     | Energy           |
| Will              | Understanding     | Law              |

It is almost inevitable that in thinking about function, being, and will, we think of them as three things - there is the function, there is the being, and there is the will over there. A somewhat better way of depicting their inter-relationship would be as in the diagram of Fig. 8 which attempts to convey the inter-relatedness of the different elements. In this light, I can also now redraw the Experiential Line previously introduced as the Experiential Tetrad of Fig. 9. At the Inner extreme there is the Unity apex where all experience attains its maximum organisational coherency. As we move outward, the three elements become more and more separate, and experience becomes more and more disorganised. These models, for such they are, can be applied to all experience

- the Universe - within which we would be but a part, or they can be applied equally well to any part of it, such as our particular experience as human beings. We can look at ourselves as a collection of functional mechanisms for walking, talking, perceiving, thinking, feeling, reproducing, etc., where each mechanism is operating with some particular level or quality of energy and is imbued with some sense of I. We can also apply them to our scientific experience, and thereby gain a more comprehensive appreciation of scientific endeavour. In this context, the Experiential Tetrad may be seen as a representation of the scientist's experience. At the ground FBW plane there is the Outer, quantitative, existential level of experience where function, being, and will are most easily isolated, i.e. where it is easiest to neglect being and will altogether and examine function separately. The naive realism inherent in the logical empiricist version of science which I discussed earlier, and which derives from the intentionality of consciousness leading to the spectator reality-paradigm corresponds to the view that only this level is real. Reality then becomes the observable and measurable aspects of experience, and everything else is assigned to fantasy. A more wholesome view of science could be arrived at by studying this tetrad in the orientation shown in Fig. 10, which Bennett suggests is the orientation corresponding to the Natural Philosophy which searches for a comprehensive knowledge of function. The F apex here represents the ideal of the perfect order of the Universe seen as a single functional mechanism while the three base points give expression to the postulates of natural philosophy: that there is a self-consistency in the natural order (U); that there are omnipresent universal laws (W); that existence is stratified, i.e. that there is a relativity to being (B). This stratification of existence manifests as the different levels of order evident in the phenomena of our experience which derive from their latent potentialities. That is to say, within any given whole in experience there is an assembly of potentialities which corresponds to its potency. Potency therefore represents the limits of possible self-realization prescribed by a given class of wholeness, and the richer and more significant the pattern of potentialities, the higher the level of being the given whole can, but not necessarily does, attain. Potency is thus the criterion of existential level and it is used by Bennett for a systematic classification of the sciences, which is presented in Tables 1 and 2.

It is a lack of recognition of the relativity of being which leads to the difficulties in the examination of Life or Mind by 'normal science'. Looking again at the fundamental Experiential Tetrad of Fig. 9 and at the classification of the biological and psychological sciences in Tables 1 and 2, we can say that the phenomena of Life and Mind occur not on the Outer base FBW plane but somewhere in the middle of the tetrad, at levels seven and eight. That is to say, they exhibit, as previously discussed, a more Inner, qualitative nature. It is not so feasible for us to regard them as 'just' function because at their existential level the three aspects of function, being, and will are more tightly bound than at the lower levels. Thus, when Life and Mind are subjected to analytic investigation without any regard for existential level, in the belief that they can be

Figure 8: The unity of function, being, and will.

Figure 9: The tetrad of experience.

Figure 10: The perspective of natural science.

| <i>Potency</i>         | <i>Hypothesis</i>         | <i>Science</i>   |
|------------------------|---------------------------|--|
| Unipotent Entities.    | Existential Indifference. | The framework sciences.<br>Geometry.<br>Arithmetic. Logic.<br>Kinetics of uniform motions.<br>Four-dimensional physics     |
| Bipotent Entities.     | Invariant Being.          | The polar sciences.<br>Forcefields. Dynamics<br>Electro-magnetism.<br>Corpuscles. Light.<br>Five-dimensional physics       |
| Tripotent Entities.    | Identical Recurrence.     | The physical world.<br>Behaviour of rigid and plastic objects.<br>Ultimate particles<br>Six-dimensional physics            |
| Quadripotent Entities. | Composite Wholeness.      | Atomic nuclei.<br>Properties of matter.<br>Exchange processes.<br>Chemistry and Mechanics.<br>Thinghood.                   |
| The First Transition.  | Active Surface.           | Colloid sciences.<br>Polyphase systems.<br>Interaction of levels.<br>Proteins and nucleic acids.<br>Enzymes and catalysts. |

Table 1: The Universal Systematics of Natural Philosophy.

| <i>Potency</i>           | <i>Hypothesis</i>          | <i>Science</i>  |
|--------------------------|----------------------------|---|
| Quinquepotent Entities.  | Self-renewing Wholeness.   | Sub-cellular life.<br>Viral science.<br>Biochemistry.   |
| Sexipotent Entities.     | Reproductive Wholeness.    | The cell world.<br>Cytology.<br>Protozoology.<br>Embryology.  |
| Septempotent Entities.   | Self-regulating Wholeness. | The metazoa.<br>Biological sciences.<br>Development and growth.<br>The Phenomena of birth and death.        |
| Octopotent Entities.     | Self-directing Wholeness.  | Individuation.<br>Psychology.<br>Herd behaviour.<br>Organic sciences.                                       |
| The Second Transition.   | Biospheric Wholeness.      | The biosphere.<br>Ecology and genetics.<br>Origin of species.   |
| Novempotent Entities.    | Sub-creative Wholeness.    | Existence beyond life.<br>The planets.  |
| Decempotent Entities.    | Creative Wholeness.        | The sun and the stars.<br>Functional freedom.<br>Creativity.<br>The solar systems.<br>Cosmic individuality. |
| Undecimpotent Entities.  | Super-creative Wholeness.  | The galaxies.<br>The universal Transformation.  |
| Duodecimpotent Entities. | Autocratic Wholeness.      | The knowable universe.<br>The universal order.<br>Cosmology.  |

Table 2: The Universal Systematics of Natural Philosophy (continued).

understood in terms of their functional behaviour only, an effective projection onto the FBW base plane is undertaken in which severe distortions and loss of content must follow. Study according to the orientation of Fig. 10, which gives recognition to differences in existential levels, represents the investigation of the functional mechanisms of biological and mental phenomena whilst recognising that there is more to Life or Mind than 'just' the observable behaviour. This is a perfectly valid approach and leads, for example, to the detailed knowledge of biological and mental phenomena which makes possible heart transplants and expert systems. It does not, however, represent an exclusive mode of investigation. The phenomenological stance requires a reorientation of the tetrad to the form shown in Fig. 11 indicating the primary interest in being and giving expression to its relativity. Looking at being in terms of consciousness or in terms of energy is a matter of perspective in relation to experience. Rather than relate to a particular subjective centre of experience it is preferable here to talk about being in terms of its more objective pole, that of energies. This has the advantage of allowing functional type of descriptions, but we must not forget that energies belong to the domain of being and are inherently unobservable. Energy corresponds to power to organise. Bennett, in his presentation of the domain of being, develops a systematics of energy which begins by distinguishing between three main types of phenomena - material, vital, and cosmic - all of which are attributable to states or levels of organisation of *hyle*. The concept of *hyle* corresponds closely to our ordinary, albeit somewhat vague, idea of energy as that 'substance' which has the power of doing work. We recognize different forms of energy, such as thermal, mechanical, electrical, and chemical, and we recognize different states of energy such as potential and kinetic, but we tend to regard these distinctions as incidental and assume that the intrinsic properties of energy can be fully expressed in terms of quantity and intensity. This is a presupposition which closely parallels that of the reduction of qualities to quantities embedded in spectator science and predicated on the assumption of a subject-object dualism. In establishing the relativity of existence as a replacement for the normal existential dualism, Bennett also develops a scheme of twelve qualitatively distinct energies, the quality of each of which is distinguishable by its organisational potency. Thus, *hyle* may be regarded as the fundamental ground state energy which can enter into different states or levels of organisation. The qualitative range extends from Heat, or the energy of random motions, up to the Prime Mover of All Existence, with everything that exists in the Universe being attributable to some combination of the different energy levels. Within any qualitative level, there may indeed be distinctions of quantity or kind, but the principle attribute of interest here is that of quality or organisational potency. The table of qualitative energy levels developed by Bennett is as represented in Table 3.

It is worth mentioning that there is a certain correlation between each of the three groups in that the corresponding members exhibit similar properties. Man can experience the full range of these energies or levels of organisation, though

Figure 11: The perspective of phenomenology.

| Material Energies |                     |                                   |
|-------------------|---------------------|-----------------------------------|
| <i>Level</i>      | <i>Name</i>         | <i>Property</i>                   |
| E12               | Dispersed Energy    | Random Motions. Heat              |
| E11               | Directed Energy     | Force-fields and Radiation        |
| E10               | Cohesive Energy     | Aggregation and Agglutination     |
| E9                | Plastic Energy      | Mobility and Elasticity           |
| Vital Energies    |                     |                                   |
| <i>Level</i>      | <i>Name</i>         | <i>Property</i>                   |
| E8                | Constructive Energy | Catalysis and Autosynthesis       |
| E7                | Vital Energy        | Vitality and Reproduction         |
| E6                | Automatic Energy    | Reflexes and Associations         |
| E5                | Sensitive Energy    | Awareness and selective attention |
| Cosmic Energies   |                     |                                   |
| <i>Level</i>      | <i>Name</i>         | <i>Property</i>                   |
| E4                | Conscious Energy    | Universal Experience              |
| E3                | Creative Energy     | Cosmic Polarity                   |
| E2                | Unitive Energy      | Unity of Being                    |
| E1                | Transcendent Energy | Self-sufficiency                  |

Table 3: The Universal Systematics of Energy

the highest two, the unitive and the transcendent, are typically completely beyond him. The four material energies are responsible for all the transformations and structures of non-living matter. They have an objective nature in our experience because they are relatively low on the scale of energies that are involved in human experience. When this is so, it is usually easy to recognise the 'carrier' of the energy as some, what we would call, external object. This becomes increasingly difficult as we scale the ladder of energies. Dispersed energy has a disorganizing influence and is the heat energy studied in thermodynamics. It is the energy of random motion, i.e. motion without direction. Directed energy arises from separation and arises when motion has a consistent direction. It is the energy of force-fields which is recognizable by its polar character. Cohesive energy is what is usually referred to as chemical energy including the lattice energy of crystals, and free surface energy, and it is responsible for producing the familiar world of solids and liquids. Plastic energy is that which allows material objects to change shape without losing identity, which property is obviously a pre-requisite of living bodies.

The life energies are associated with the organisational properties of living things such as self-renewal, nutrition, and reproduction. The constructive energy is the energy of autopoiesis. It is recognizable in the self-synthesizing DNA molecule, and it has the property of allowing a body to maintain itself at a higher level than its environment. Vital energy is associated with the experience of autonomic vitality. It has a goal-seeking quality, which correlates with that of the directed energy in the material energies group, and bestows an assertive character to the living functions such as nutrition and reproduction. Automatic energy is the energy of habit and behavioural patterns. It is also the energy of our senses and our nervous system and can be experienced in the automatic reflexes of all sorts: bodily, intellectual, emotional and others. Sensitive energy is the energy of self-awareness. It gives the possibility of choice and facilitates intelligent interaction with the environment. We can say that it is the energy of noticing, which is above the bare sensing associated with the presence of the automatic energy. In this sense it can be seen to correlate to the plastic energy in that it allows the possibility of adaptation and change.

This Vital Group of energies, i.e. the energies of life, have the property of having an increasingly subjective character as we go from constructive to sensitive. They are, as such, experienced as being increasingly within our experience, whereas the Material Group of energies are experienced as outside and objective. The Cosmic or Universal Group of energies are beyond our notion of ordinary existence, and are not subject to the limitations of space and time. It can be said that they have us within them rather than that we have them within us. They are universally pervasive but they can be concentrated and transformed under appropriate conditions. Now, this probably sounds strange, but it must be re-stated that energies are not things. They are not observables. They are not like liquids inside of solid objects, although this is how we might be inclined to think of them. They are potencies - powers to organise. The only analogy

I can think of to reinforce this idea is that of the phenomenon of vibrational resonance evidenced in Chladni patterns. The different energies are like vibrations of different frequencies which have the power to organise material objects, like sand particles on a plate, into resonance patterns, and the higher the frequency, i.e. the higher the level of energy, the more detailed the organisation of the sand possible. And so with the energies, except that as the level of energy increases, these resonance phenomena become increasingly interiorised until we get to the point where, with the transition to the Cosmic Group, we have the sense of becoming a particle of sand being organised from above. This is, of course, analogy. Or, to refer back to the hologram example, we can say that the different energies are like different degrees of coherency of the laser beam. As the beam becomes more coherent, finer details of the holographic image become visible. In the same sense, as the qualitative level of energy increases, different 'flavours' in our experience become evident.

To call the first of the Cosmic Group conscious energy sounds confusing, because in ordinary speech consciousness means the state of being aware of things going on which is attributable to the presence of sensitive energy. It is responsible for the strong sense of 'I' which is experienced in embarrassing situations and which arises through the experience of tension, but in its positive manifestation it gives the enhanced powers of judgement and insight which are involved in authentic original actions. It is a pervasive, connecting energy which facilitates the direct simultaneous seeing of the inner and the outer of our experience. Creative energy is the highest energy which can manifest 'in' man's experience. It has the assertive nature which was previously associated with the directed energy and the vital energy at lower group levels, and is responsible for the sense of true freedom involved in the flashes of experience which we refer to as creative perception and inspired action.

This systematics of energy derived from consideration of the phenomenological orientation of the Experiential Tetrad as given in Fig. 11 represents what might be called an ontological anatomy of our experience. Nowhere in our experience do we find the presence of any one energy. Rather, all are involved in a complex nexus of relationships and transformations which constitutes the web of experience. However, when we focus on some particular aspect of experience it is possible to appreciate the organisational characteristics which are involved through consideration of the energies participating. In any situation the transformation of energies proceeds through the interaction of two different qualities to produce a third and requires a suitable 'apparatus' to contain the interaction, which apparatus can be viewed as the result of an energy transformation at a lower level. This is perhaps rather abstract, but it can be summarised in a Postulate of Interaction as follows: All operations, whether experienced as within, or as presented to, the awareness of a subject require the interaction of at least three levels of energy. Bennett uses the simple example of heat flow to demonstrate this postulate. For heat to flow there must be a source, a sink, and a conductor. That is a functional statement of the requirements, but from an

energy perspective we can say that the potential energy gradient set up by the spatial separation of source and sink has the properties of polarity and direction and therefore comes under the definition of directed energy E11. Heat itself is E12, while the required conductor for heat flow demands the involvement of cohesive energy E10. When these three energies participate, non-directional heat is converted into directional heat flow. We can represent the interactive process as follows (see figure 12).

This highlights the fact that in interaction, a higher organising energy operates on a lower disorganising energy to realize something in-between, which is then available for further interaction with higher and lower energies. This represents a general principle which manifests at all levels of existence. In a similar vein, any phenomenon can be examined in terms of energy relationships and transformations.

Of particular relevance here are the phenomena of autopoiesis, perception, and mind, especially with regard to the distinction between what I have referred to as its intellectual and intuitive capabilities. The organisation in our experience depends on the complete range of catabolic and anabolic energy transformations - higher level transformation processes are nested in lower level transformation processes - and to be thorough we should begin at the beginning and take account of all sub-processes. However, for the purposes of explication the schematic presentation below (see figure 13) shows an abstraction which indicates the stages leading from material inertness, through growth, to sentience, perception, and mind.

Again recall that here we are examining potencies and the interaction of potencies. Reference to things as such is reference to the carriers involved. The examination begins with food which is acted on what is really the outside skin surface in the mouth and alimentary canals by enzymes. For this process to occur some heat must be available. In the transformation process more heat is generated catabolically, but chyme is also anabolically produced. This is ingested into the blood stream where it acts on and is acted on by substances carried in the blood stream. The complexities involved are beyond a non-biologist like me, but it would appear that the generation of the constructive energy which marks the transition to the domain of life is facilitated by growth processes, involving the incorporation of less-ordered material into the more highly ordered living systems, and apparently requiring hormonal interaction and control. Significantly, from this systematics of the processes involved it would appear that the generation of constructive energy, and therefore of life, requires that there be a body which has constructive energy in the first place, i.e. it is generated by replication of the complex self-synthesizing DNA structures, which have been suggested as carriers of E8. Furthermore, for the necessary anabolic processes to take place, a higher level of potency must be involved, which here has been referred to as hormonal interaction. In that the endocrine and the nervous systems are very tightly linked, hormonal structures can be looked upon as carriers indirectly associated with states of electrical polarization of the nervous system.

The transformation of the constructive level can be seen to involve both protein complexes and, significantly, sensory perturbation from the environment, i.e. the evolution of the organisation of life processes demands environmental interaction. Without same, our experience of being alive would cease.

This part of the organisational web of experience, here looked at in terms of contributing energies involved in observable living systems, is the domain of autopoiesis. An autopoietic system is self-producing and its self-production is facilitated by its organisation. To examine the structural characteristics and properties of autopoietic systems is to concentrate on their functional aspects, but to examine their organisation is to take a phenomenological stance and demands that a context, an environment, be referred to. That is to say, to understand the nature of autopoietic organisation requires that both its being and its becoming be considered. What has been suggested here is that it is through a phenomenological methodology, which directly involves both an analysis of being and a synthesis of becoming, that understanding of the organisation of autopoiesis may be derived. What is further suggested is that the systematics of energy, by indicating a context, can greatly assist in this.

Continuing our examination of the energy transformation processes, it is necessary to note again that as we climb up through the energy scale, they become less and less objective. In the case of vital energy, E7, there are the observable electrical phenomena of the nervous system associated with 'tone' and 'well-being' but these are secondary phenomena associated with the presence of a carrier of vital energy which is another manifestation of the group correlation mentioned earlier, in that electrical phenomena are properly associated with the level of directed energy, E11. Transformation of E7 requires that there be a 'body', a system, to contain it and that there be an involvement of the organizing influence of attentive capacities associated with the sensitive energy level. For the consideration of perception in this context it is suffice to say that what follows is entirely dependent on all that has gone previously, i.e. that there must be material energies involved, and that a living body to participate in the act of perception. The external stimulus is at the threshold of awareness and corresponds to the automatic energy E6. The organisation of a large number of stimuli over a short period of time requires energy having the organisational potency of sensitive energy, E5. In order to be aware of this there must be conscious energy, E4. If this is absent then there may be sensation but not perception, i.e. we may see but we will not notice. So, for perception, at least the three energies, E6, E5, and E4, are required, but in truth the act of perception is embedded in the complete anabolic and catabolic web which is the experience we participate in.

In considering mind and intelligence I introduced a distinction between the analytic intellectual mind and the synthetic intuitive mind. But before examining these briefly, I should point out that mind was here used as an inclusive term for the variety of mental experience, such as perception, logical thought, feeling, intuition and so on, and not merely as a reference for rational facility.

The distinction made between analytic and intuitive mind can be seen in reference to the energy systematics presented. The analytic, intellectual mind is the field of interaction of automatic, sensitive, and conscious energies, but in a different relationship than that indicated for perception. The intuitive mind is the field of interaction of sensitive, conscious, and creative energies, and it is the influence of the higher organizing power of the creative energy which allows us the seeing in depth which we called understanding. The very nature of the interactions involved show that the intuitive mind is inclusive of the intellectual mind and not something in isolation. It is also, because of the involvement of members of the Cosmic Energy Group, not directly under our control. We cannot switch it on just when we want, but we can provide the conditions for its operation through involvement in the transformational processes which lead to its concentration. This is the purpose of the phenomenological methodology described earlier. Through engaging in the observation of the concrete detail of phenomena, by 'plunging into seeing', we are exercising our power of conscious disturbance as seen in the diagram above which leads to the generation of sensitive energy, which as can also be seen is very much involved in the catabolic and anabolic transformation of creative energy which bestow the power of understanding, of seeing the spirit's connections. Furthermore, the process of 'exact sensorial imagination' described as the second leg of the methodology requires the exercise of selective attention through bringing and holding the phenomena of interest in mind. This attentional act leads to the generation of automatic energy, which in turn is involved in the transformation of conscious to creative energy which again is the energy of 'seeing'.

To conclude what has been a lengthy but nevertheless cursory exposition of issues in science, phenomenology, and ontology, some summary is required. Primarily, what I have hoped to convey here is the conviction that we can come to understand Life and Mind, but not through the tools of analytic science. The introduction of the concept of autopoiesis has I believe the very great significance of drawing attention to the need to deal with system organisation as well as system structure in addressing the domain of Life and beyond. I have tried to show that organisation cannot be handled in 'normal science', and have introduced phenomenology as a methodology which specifically has as its goal the understanding of system organisation. I have suggested that the scientific contributions of Goethe have much to offer as examples of how to do phenomenological science. It is my conviction that autopoietic organisation can be appreciated in a fuller sense through investigation of the phenomenology of autopoiesis. The philosophical framework of J.G. Bennett can, I also believe, help greatly in formalising the stratification of phenomenological science, and I have attempted to provide, using his concepts, a descriptive model for the ontological scale of phenomenology. My wish is that some of you might find something of value in this, and that through doing phenomenological science you may come to see more of the truth and beauty of this world.

Figure 12: Energy Transformation.

Figure 13: Scale of Energy Transformations.

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