Does Biology need a new theory of explanation? An investigation into the possibility of moving past the limits of mechanistic and teleological descriptions of organisms.

A thesis presented in partial fulfillment of the requirements for the degree of

Master of Science

in

Ecology

at Massey University, Auckland,

New Zealand.

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2009

Abstract

The problem of how to explain the fundamental nature of organisms for biology commonly falls under two causal systems, mechanistic and teleological. These systems however, fall into fundamental logical problems when put to the test. Many biologists also claim that these systems miss the essential nature of organisms. Historically one of the most important discussions of this problem occurs in Immanuel Kant's *Critique of Judgment*, and this work has been chosen as the basis for an investigation of possible ways to avoid the inherent problems that occur with mechanistic and teleological explanations in current biology. By evaluating Kant's claim, that organisms are not accurately describable by our standard causal explanations, it could be assessed in light of current discoveries whether we have the ability to develop a new causal or acausal system by which to explain organisms.

From this analysis, and in agreement with Kant's investigations of the problems of 'design-like' characteristics in organisms, both causal mechanistic and teleological explanations were found to be inapplicable for use in any comprehensive and accurate understanding of organisms and evolution. They are recommended at best to be considered as heuristics. Following this, an investigation of alternate methods of explanation apparently not prone to the problems of mechanistic and teleological causal explanations were characterised and assessed. This lead to the uncovering the system of extremal principles, a system that claims to be acausal and seems to have direct application to fundamental aspects of biology and evolution.

This acausal system of extremal principles can for example, be used to describe the class of solitons. Types of solitons (biosolitons) exist in organisms and are important aspects of processes such as morphogenesis, DNA replication, self organization in the cytoskeleton, and locomotion to name a few. They also exhibit the properties of the quantum wave-particle fermions. It is proposed that further investigation of the system of extremal principles and their influence in biology through phenomena such as biosolitons can provide the basis for the development of a new acausal system of explanation or an extra aspect for standard causal models. This, it is concluded, will allow a potential avenue for creating a new and logically more consistent explanatory system in relation to fundamental aspects of the phenomenon of evolution, organisms and the environment.

Acknowledgements

Firstly of course I'd like to thank Dave Lambert for showing me that there are really new, interesting and more productive ways to see the world and that more than anything, theories of evolution have to keep evolving and should be elegant, simple and beautiful. Thanks also for writing the best paper I have ever read 'Keywords and Concepts', a paper that really influenced the choice of this study and I feel really lucky you let me take on an investigation that I really felt was important.

Huia, thanks for the support, encouragement, love and making me laugh lots and lots. You are the nicest one.

To Antonio Lima-de-Faria, thanks for the discussions and teaching me so much about the similarity of the organic and inorganic realms, and being a really kind person, (not just because you let me use some diagrams from your books). Brian Goodwin, for all the amazing papers you've written and the feedback and encouragement about the ideas in this thesis. Stan Salthe for the leads, ideas and inspiration, Stuart Kauffman, for providing feedback and interest, Sergei Petoukhov for your assistance and great work on biosolitons. Richard Gordon of course, you deserve a medal for all your hard work. Bob Wicks, thanks for all the great lectures over the years and pointers on Kant. Wayne Waxman, thanks for the clarifications and insights. Peter Wills, I really appreciate your advice and outlooks, and Chris King for the time and assistance towards some of the aspects of math and physics and showing their beauty.

Thanks to my family, particularly my mum for putting up with being in the direct and continuous firing line for all my non-stop ideas and theories and questions on the world since I first learned to talk, and always having as many books around as I could read.

And lastly, to my dad who passed away during the production of this thesis, but took me out into nature at every possible chance as a kid, showed me to look at the bigness as well as the hidden things that most other people didn't even know you could look for and filled our section with more plants and animals than anyone I know :). I'm sure you would have found this pretty interesting. This is especially dedicated to you.

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Chapter 1

Introduction

1.1: Setting the context of the problem

Biology, many will agree who choose to make it their focus, is an engaging and often mysteriously beautiful field to study. Not only do we learn about the nature of the life that exists all around us, we also learn at the same time about the fundamental aspects that we have experienced and intuited, but until that time did not have the words, methods or concepts to describe. Biology can help us, through a mixture of ideas and experimentation to find our connection to, and develop a formalized understanding of both the world of the living and the things we consider non-living. Unfortunately, it will be proposed, that much of the current systems of investigation in the biological sciences have become enmeshed in explaining organisms as either complex 'machines' or as if they were 'designed' with respect to a function, often both at the same time and with little regard or knowledge of the fundamental concepts or causal structure behind these statements. These methods of explanation in turn tend to construct the view of those utilizing them, their keywords and

concepts ending up reinforcing the view that much of biology and evolution have been solved or at least is well understood, and as biologists all we remain to do in the words of Richard Dawkins is 'add footnotes'. This perspective is not however universal and there is also another camp of biologists, often influenced by the work of nineteenth century *Naturphilosophie* that claim that organisms are in fact something much more than this standard viewpoint holds, and in fact require a completely different form of explanation and experimental approach if we are to truly understand their nature and evolution.

The overall aim of this thesis is to examine this possibility of developing a new and more robust explanatory system for biology based around the fundamentals of this alternate framework. A framework that does not fall prey to the logical inconsistencies of the reductionist and functionalist perspective prevalent in current biology, particularly in that which so much of biology claims to be based, the field of evolutionary theory. In short, to take it back to the basics, follow the path as it evolves, and see where we end up.

And it is with this in mind that we will start with Kant, one of the greatest revolutionary thinkers the world has produced. The continental European approach to biology in the nineteenth century was heavily influenced by Kant's *Critique of Judgment*, while the majority of the Anglo-American scientists and in particular biologists took a different approach to their studies of organisms, being based more around the British empiricist school, (Bowler, 1983). As a consequence Kant's work is a relatively untapped resource that may be able to lead us in exciting and productive new directions. It may also allow us to begin to bypass many still current problems found in biology where otherwise we would be trying to re-invent the wheel. There has been a great deal of work on formative figures in English speaking biology for the use of English speaking scientists to help them understand their research process and intellectual heritage, but considerably less from those based on the continent. The recent increase in translations into English of and on their works opens up an exciting range of new outlooks and provides us with a more comprehensive base by which to approach biology and develop new lines of investigation into particular problematic areas.

The first chapter of this thesis develops a base for understanding the importance of Kant's work and *Naturphilosophie* in general and sets the context for

the development of ideas for the proceeding sections. From this, in chapter two an analysis of Kant's investigation into problems of mechanistic and teleological causal explanations of organisms in the *Critique of Judgment* is developed and assessed in relation to contemporary scientific thought and evidence. Based upon the work in chapter two, chapter three examines the contradictions and problems that occur by use of these mechanistic and teleological explanations, and Kant's call for the introduction of a new overriding type of causality into biology by which organisms are truly understandable to the observer. It is investigated whether the limits he placed on this proposed new system of explanation hold up to recent discoveries in the sciences, both in relation to what we can understand as humans, and what has been considered a distinction between the organic and inorganic realms. Chapter four deals with and responds to particular problematic aspects of Kant's theory and works to de-couple them from the primary question presented in the *Critique of Teleological Judgment,* that of the apparent 'design like nature' of organisms and their expression as something more than 'machines or aggregates'. This leads to the introduction and investigation of the system of extremal principles in chapter five which claim to encompass and subsume both the mechanistic and teleological systems of explanation. Finally the results of these investigations are discussed and conclusions drawn in chapter six for a possible move past Kant's limits of our understanding of organisms, or at least to attempt to determine the possibilities of further avenues of investigation.

1.2: Introduction to the principles of *Naturphilosophie*

There are many confusions and inconsistencies in science[1]. The history of science is littered with the remains of theories and ideas that have been cast aside or still wait for their day to surface from the background within which they currently reside. This is one reason that it is important to look, or go back to the basics and investigate it from its foundations. In doing so we may start to set forth on a reformulation of fundamentals of the subject in question, whilst hopefully avoiding much of the

[1] Extensive investigations have been carried out and documented by the likes of Feyerabend, Kuhn, Hull, Løvtrup and particularly for biology and evolution by Marjorie Grene, to name a few.

baggage and pitfalls that have been strewn about the field, or at least increase our understanding of the topic. It may be possible then to reassess or reformulate the subject from a more fundamental base, and relate it to discoveries or ideas that have come to light since much of the 'outdated' or 'outmoded' theories were resigned to the ideological scrap-heap.

It is here then that we may introduce the subject of the nature of the organism, for it is in this question that one of the most fundamental critiques of our understanding of science has in some sense or another been voiced and found a stronghold of sorts. The debate on whether organisms may be seen merely as a composite of parts, or whether there is something more to it than this, either purposeful, beyond our understanding, or within our understanding yet differing from the systems that we currently attempt to employ towards the problem is of course unresolved. However, continual attempts at re-clarification of these questions are not only interesting, but may help with the attempts at systematising our knowledge, and/or developing it. The importance of starting from as solid a base as possible is paramount.

The system and ideas of thinkers such as Gottfried Wilhelm von Leibniz, (1646-1716) Immanuel Kant, (1724-1804) and Johan Wolfgang von Goethe, (1749-1832) like all thinkers were products and expressions of their time, and in particular for this study based around scientific evidence of the time. However, in many cases the ideas presented are malleable enough to be reformed or recast into a more current perspective. Also, ideas 'lost' in time due to a lack of empirical backing, or a lack of favour may be seen again in a new light and with new application to fields that were beyond the dreams of those who first proposed them, but possibly not however, beyond their intuitions of nature.

All three thinkers, (Kant, Leibniz and Goethe) provide an important base for *Naturphilosophie*, the German philosophy of nature, an outlook that lends in many important ways an alternate legacy to that of current Neo-Darwinian based biology. This alternate approach to nature (in particular in biology) has carried through, in a form, to the present, through the rational morphologists of the early 19th century such as Etienne Geoffroy Saint-Hilaire, developmental biologists such as D'Arcy Thompson (particularly notable in his book 'On Growth and Form', 1917, 1942), and to the school of thought known as the biological or process structuralists, (Webster

and Goodwin, 1982).

1.3: Kant in perspective.

The publication of Immanuel Kant's *Critique of Judgment* (which will be abbreviated for references and quotes as 'CJ') in 1790 heralds the start of an important investigation into nature and the organism. This book was preceded by, and developed from Kant's earlier works, in particular for this investigation The *Critique of Pure Reason* (1781) (CPR*), Prolegomena to Any Future Metaphysics* (1783) (PG), and *Metaphysical Foundations of Natural Science*[2] (1786) (MFNS). Throughout these books Kant develops arguments on topics such as the nature of consciousness in speculation (CPR), problems of causality (CPR) purposiveness in nature (CJ), the role of teleology in the understanding of the nature of the organism (CJ), how pure natural science is possible (PG), and dynamics (MFNS). These investigations have particular importance for understanding the basis of much of the thought that developed in *Naturphilosophie* following their publication, and its further development in the sciences to the present day.

In any attempt to understand *Naturphilosophie* it is important to examine the philosophy that it used as the basis for many of its investigations. The most obvious starting point seems to be the above works of Kant. The importance of his self-

[2] It should be noted that the term 'science' was not in common use in continental Europe at the time of Kant. For Kant's works where science is currently used in the translation Kant generally used the term *'Naturwissenschaft'* or *'Naturphilosophie'*. The first use of the term 'scientist' as we now know it was in 1837 by the English Polymath William Whewell in his book '*The Philosophy of the Inductive Sciences, founded upon their history*' where the general English use of the word 'science' at the time was based upon the Aristotelian (i.e. Greek) notion of its derivation. The word 'science' from an etymological analysis is derived through old French from the Latin 'scientia' (roughly: knowledge), which comes from the Greek *skhizein* "to split, rend, cleave, separate". Arguably from this perspective etymologists have inferred that it carries a reductionist perspective implicit within it. Commentators such as Fehr, (2004), Goodwin, in 'Nature's Due: healing our fragmented culture (2007), and Kauffman, in 'Reinventing the sacred: a new view of science, reason and religion' (2008) have pointed out the links between the term science and an inherent reductionist perspective. In summary, it is felt that Kant would not have use the word 'science' in relation to his discussions of organisms and the environment (although he would have for things he would derive purely under efficient cause, (such as Newtonian mechanics)). This non-reductionist stance regarding organisms for Kant is further backed up by his use of Blumenbach's concept of '*Bildungstrieb'*, (which the anti-reductionist *naturphilosopher* Goethe also took on board as a backup to his concept of the archetype), (Brady, 1987).

stated 'Copernican Revolution'[3], initiated by the release of the *Critique of Pure Reason* and the works that followed it, in particular for *Naturphilosophie* that of the *Critique of Judgment* set the tone for much of early 19th century Continental science and its philosophy. Kant's aim in the *Critique of Judgment* was to investigate our ability to make individual judgments, as well to a certain extent to examine how well biology may be reduced to the physics of the time if one wanted to do this. Composed of two parts, the *Critique of Aesthetic Judgment* and the *Critique of Teleological Judgment*, it is this second part that will be primarily examined in relation to Kant's *Naturphilosophie,* and the more current theories of biology.

Kant's *Critique of Judgment*, in particular the *Critique of Teleological Judgment* was an extremely influential work for Continental *Naturphilosophie* and this book acts as the base for much of the rationale for certain aspects of particular schools of thought in biological sciences. Virtually all Continental pre-Darwinian biological thought owes some allegiance to the ideas in the *Critique of Teleological Judgment*, it was extremely influential to its way of seeing nature, and Kant's works are still regularly quoted today by those following aspects of this tradition, for example, Kauffman, (2008), Goodwin, (2007), Salthe, (1996), Margulis and Sagan, (1995), Bohm, (1980). However, outside of continental Europe the *Critique of Judgment* this book remained relatively unstudied, especially in England and America where the empirical approach, such as that of English philosopher David Hume had the 'upper hand'. 'Biological science' outside of the continent was based more around the collection of data from the field, than speculation into more metaphysical terms[4] (Lovtrup, 1987).

In the *Critique of Teleological Judgment* Kant deals with our judgments of things in nature in terms of final causes (teleology, ends, purposes) and the problems of looking at organisms purely in terms of *efficient* cause, (i.e., in terms of a mechanistic framework). By appealing to mechanism alone Kant concludes, science cannot adequately investigate aspects of nature such as organisms, we must incorporate the notion of *final causes.* The problem however, of using both forms of explanation concurrently is that we arrive at a contradiction or as Kant refers to it, an

[3] In the sense that appearance of the external world depends upon the position and movement of its observers, (www.philosophypages.com/hy/5f.htm).
[4] Hume's work may be seen as the beginning of a hostility to 'speculation', Lambert, *pers comm*.

antinomy[5] between the contingent nature of the purpose (final causes), and the necessary nature of the causal connection, (that is mechanistic efficient cause[6]). It is this apparent contradiction that Kant investigates throughout the *Critique of Judgment.* From this he attempts to break down the dichotomy to create a synthesis of these two types of causality, and then postulates the possibility of one encompassing, non-contradictory new form of causality that allows a consistent and non-contradictory explanation of organisms. This overriding form of understanding is posited to be that which may be present in a supersensible intelligence (he points out that this does not necessarily imply this intelligence would be God, nor can we ultimately know what this is, for Kant claims, it is beyond our intellectual abilities).

This then leads to a number of questions that we should ask in relation to Kant's work in the *Critique of Judgment.* Kant sets limits on our knowledge, are these limits plausible or can we surpass these restrictions? Can we come to a system where the antinomy of mechanism and teleology ceases to be? That is, can we develop a new concept of causality that allows us to 'move beyond' or account for the contradictions of mechanism and teleology, and perhaps develop some new form of non-Aristotelian causality[7], or perhaps even an acausal system of explanation? This could be similar to the incorporation of Euclidean geometry into non Euclidean geometry, and in the way that Newton and Kepler's systems became a subset of the explanatory power of Einstein's theory of general relativity, (and these possibly of string theory). This would in effect bypass one of Kant's restrictions, which states that we have no choice, but to use these two contradictory methods of judgment. It only remains to examine whether this is possible, if Kant is correct then we could be searching forever, if not then we may be able to develop our theories in new and interesting directions past his limits. This may allow us to create a deeper and more cohesive understanding of the phenomenon of organisms and evolution.

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[5] An antinomy is defined as a mutual incompatibility between two laws. It stems from the Greek *anti + nomos* (law).

[6] Mechanism was linked in Kant's time with determinism to an extent (e.g. La Place's claim that the universe was in principle completely predictable if one did the calculations). The universe may have been any way before its existence, but once it started it had to follow one particular way, just like clockwork. It should of course be noted that for current theories mechanism does not have to imply determinism, such as with for example aspects of Chaos theory. It should also be noted and will be discussed later in more detail that final causes do also not have to (in a sense) imply purpose (as discussed in Bohm, 1980 regarding implicate order), and that the nature of determinism in the universe is also, as yet undetermined.

[7] And it should be remembered that a non-Aristotelian causality is not necessarily anti-Aristotelian.

In the *Critique of Judgment* Kant is not so much looking at whether teleology is applicable as an explanation to biological organisms, (which he ultimately believes it is not[8]), but whether biology may be reduced to the physics of the day. Is biology, as Descartes believed, just another chapter in the book of a physics based around efficient cause? The amount of information gathered by science in the two hundred years since the *Critique of Judgment* was first published has opened up new pathways into ways we may investigate, it would be an injustice to them not to consider their 'gains' when considering the problems Kant posed, enmeshed as they are in the science of the day. Of course we equally do Kant an injustice by trying him in relation to 'facts' he could have known nothing about. However, as we will see much of his work is still relevant to current discussions, problems and investigations in biology and evolution. Indeed, study of Kant's works may lead us to reinterpreting things in new ways, allowing us to see problems implicit in our current systems. That is, we use it as a base, a base that provides a more scientifically and philosophically robust ground than many of the current models for biology, particularly those that are heavily indebted to mechanistic and teleological explanations. This is perhaps especially so with the *Critique of Teleological Judgment* in relation to current biological science. The debate between teleological and mechanistic explanations, and the associated problems of the notions of design-based terminology; function and adaptation in organisms are still carrying on regularly to this day[9]. In addition many current biologists claim to be using a non-mechanistic, non-teleological framework in their examinations of organisms, as do many physicists. As a consequence it is well worth examining these claims to see how well they hold up, and whether they can give us any leads into the formulation of a natural science that can move past Kant's limits and also provide us with a greater depth of understanding of many of the problems inherent in much of current thought in biology.

[8] "it gives us no information whatever about the origin and inner possibility of these forms, while that is exactly what theoretical natural science is concerned with", (CJ §79: 417).

[9] For example, in the works of Neo-Darwinists such as Dawkins, (1987); Price, (1995); Structuralists such as O'Grady, (1987); Lambert and Hughes, (1988); Theoretical biologists such as Goodwin, (1994), (2007); Kauffman, (2008); Philosophers Grene and Depew, (2004); and Physicists such as Capra, (1982), and Bohm, (1980).

To begin this we should first outline the relevant basis and history in regards to mechanistic and teleological thought. Most importantly for this study and their effect on Kant's work the systems developed by Aristotle and Hume.

1.4 Introduction to Aristotelian Causality, its history, importance, and place in our understanding of the organism

> But suppose that causality, for its past, is veiled in darkness with respect to what it is? Certainly for centuries we have acted as though the doctrine of the four causes had fallen from heaven as a truth as clear as daylight. But it might be that the time has come to ask, Why are there just four causes? In relation to the aforementioned four, what does "cause" really mean? From whence does it come that the causal character of the four causes is so unifiedly determined that they belong together? (Heidegger, The Question Concerning Technology, 1962).

No study on the nature of our explanations of organisms would be complete without reference to Aristotle (B.C.E. 384-323), arguably the father of modern biology and 'the first theoretical biologist', (Grene and Depew, 2004). One quarter of his total works are related to studies of organisms and increasing our understanding of them. His influence on the way the majority of biologists see organisms is still present at some of the deepest levels, (for example in the notions of biological function, or what something (such as 'an eye') is for). Many contemporary biologists carry this legacy in their studies and experiments on nature without being aware of some fundamental logical problems with much of the current explanatory structure. They are also often through no fault of their own aware that there are alternate explanatory systems (including newer readings that focus more on the dynamic nature of his system) that can provide us with results for our investigations that do not require the continual reference to organism from the perspective of a created artwork or artefact.

The introduction of Aristotle's causal system of explanation, as outlined in *Physics*[10] *II 3* and *Metaphysics A 3* was primarily written for the study of nature,

[10] The term 'Physics' in the sense utilised by Aristotle means '*things that grow or develop*' and refers to nature in general, (so including biology). It is related to the Greek word '*phusis*', which is often translated as nature (from the Latin *natura*). *Phusis* is often linked with the ancient Greek verb '*poiesis*', (as in the biological term 'hematopoiesis' and is also the root of our word 'poetry'). In this

(Falcon, 2008) and as a development beyond and expansion of the earlier explanations of nature of the Pre-Socratics in their *Peri Phuseōs*[11] style works and verses, (Naddaf, 2005). Towards this Aristotle developed a system whereby general natural phenomena were to be explained in relation to four types of causes, Material, Formal, Efficient and Final. The importance of doing this, as he states in *Physics,* is '*that without an adequate theory of causality and understanding of it, even though we may achieve important insights we will never be entirely successful in understanding the phenomenon we are investigating'.*

Is it also important to place Aristotle's notion of what in English we now generally read as 'cause'. The word that Aristotle used for his system was '*aition*', (or '*aitia*' in its plural form). This in the original Greek sense of use carries an *explanatory nature* or what 'makes' it factor to it that Humean cause (to be discussed in the next section) does not. That is, it follows more of a verb, dynamic and *'coming-to-be'* nature than that which we obtain from the noun 'cause'.

As stated, the basis of Aristotelian causality is based upon four types of causes or reasons why a thing is as it is that are to be involved with explanations of natural phenomena. These are:

Material Cause – "That out of which a thing comes to be", the *'out of what'.* Subordinate to the other three causes this provides the potentiality for assuming form. Examples of this would be the stone that a statue is carved from, or the flesh of an animal.

Formal Cause – "The form", the *'into what'* or *'logos'* (pattern, ordering, structure, organizational properties). It is important to note that form for Aristotle is not just

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Pre-Socratic, and Aristotelian sense the verb is in the sense of '*an action that transforms and continues the world'*, or as a *'bringing-forth'*, in the sense of moving from one state to another, (such as a caterpillar transforming and coming out of a cocoon as a butterfly, or a the blooming of a blossom). That is, it is inherently dynamic and fundamentally involved in the continual process and '*coming-to-be'* of nature. A more detailed discussion of this and how it relates to our current situation in our scientific investigations can be found in the works of Martin Heidegger.

[11] Aristotle claimed that the Pre-Socratic philosophers (who he called the '*Physikoi*') created the first recorded formalised studies of 'nature' (*phuseōs*) investigated only material and efficient cause to understand nature and its properties, (Parts of Animals 1.1. 640 B4-22). This would in effect make them mechanistic for Kant's system. However, recent studies and re-investigations of their concept of *phusis* as a basis for explanation of nature by Heidegger, (1977) and Naddaf, (2005) lead us to believe that their understanding was more complex than Aristotle had thought and in fact encompasses the origin, process and result of nature. This will later be shown to have important clues that may help us begin to see past the limitations and contradictions of a mechanistic and teleological explanatory system for organisms.

shape but related to the Greek concept *Phusis* – "the sense of origin, process and result" (Naddaf, 2005). In this sense it should be seen as a forming activity or formative potential.

Material and Formal cause are considered fused, that is, while separable in analysis they are not in reality and are also time independent. They tell us how the world is at a given moment. The other two Aristotelian causes, efficient and final have a definite temporal aspect and are described as follows:

Efficient Cause – "The primary source of the change or rest", the mover, *'from what'*. "The producer is a cause of the product, and the initiator of the change is a cause of what is changed", (Physics II.3)

Final Cause – "The end, that for the sake of which a thing is done", *'for what, or towards what'*. Relates to teleology, concepts of purpose, design. It should be noted as well that for Aristotle artefacts are a subset of final cause. The predominant set (and that which we should always think in relation to foremost with final causes) is nature and the organism.

As an example for an artefact, such as a house		
	A question	Explanation
Material Cause	Out of what?	Wood
Formal Cause	Into what?	A particular shape of house
Efficient Cause	From what?	The builder
Final Cause	For what, or towards what?	To provide shelter

Table 1 - As an example for an artefact, such as a house

The final causes of artefacts, (such as artworks) are *external* to these objects.

As an example for an organism, such as a tree		
	A question	Explanation
Material Cause	Out of what?	Wood
Formal Cause	Into what?	The shape or form of a tree, the kind of thing the wood constitutes.
Efficient Cause	From what?	A fully developed tree of the same kind, at the end of generation. That which produces the tree
Final Cause	For what, or towards what?	To continue the existence of the species. The movement towards that which is best for the animal. That which it develops into

Table 2 - As an example for an organism, such as a tree

Formal, Material, and Final cause often coincide in Aristotle's system for natural objects. The final causes of these natural objects (such as trees) are *internal* to those objects.

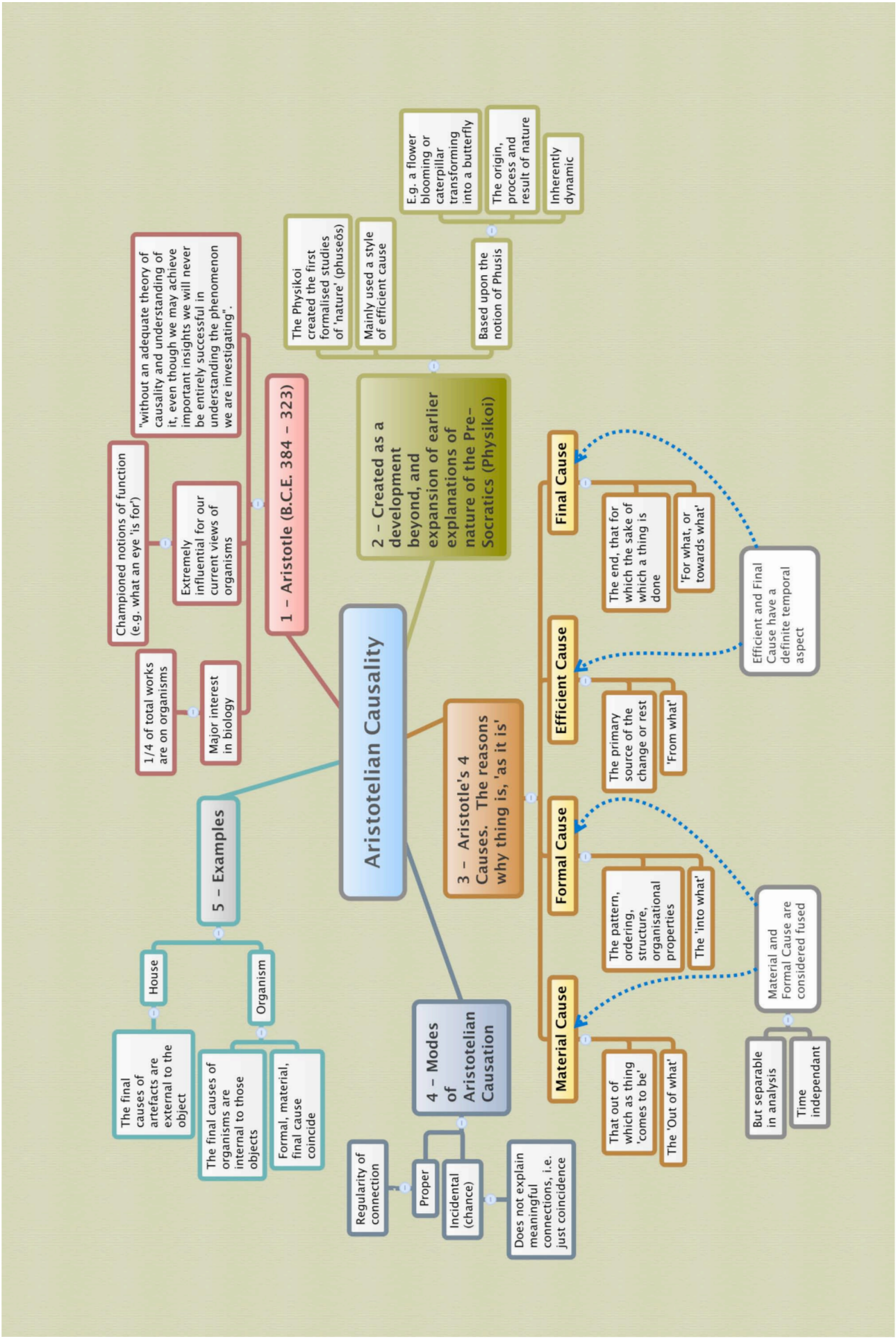
Aristotle also defines two modes of causation, proper and incidental (chance). Proper causation is that such as described in the above examples, there is a regularity of connection and this connection is meaningful in its coming-to-be. Chance for Aristotle does not explain meaningful connections, it is neither a good nor bad result, just a coincidence (Phys, 198 b 21-23).

Mechanistic thought for Kant was based around material and efficient cause and an understanding of causation modeled off of Newtonian physics. However, he felt a purely mechanistic universe failed to account for the *apparent* purposive and design like character of organisms. This was when he believed we had to incorporate teleological causation into our explanations.

With this in mind we can now begin to assess Kant's work in relation to the organism as a 'natural purpose', and his investigations of the contradictions and limits of the mechanistic and teleological explanatory systems and work to introduce something new.

Next page:

Figure 1 – Summary of Aristotelian Causality


Aristotelian Causality
1 – Aristotle (B.C.E. 384 – 323)
"without an adequate theory of causality and understanding of it, even though we may achieve important insights we will never be entirely successful in understanding the phenomenon we are investigating".
Extremely influential for our current views of organisms
Championed notions of function (e.g. what an eye 'is for')
Major interest in biology
1/4 of total works are on organisms
2 – Created as a development beyond, and expansion of earlier explanations of nature of the Pre-Socratics (Physikoi)
The Physikoi created the first formalised studies of 'nature' (phuseōs)
Mainly used a style of efficient cause
Based upon the notion of Phusis
E.g. a flower blooming or caterpillar transforming into a butterfly
The origin, process and result of nature
Inherently dynamic
3 – Aristotle's 4 Causes. The reasons why thing is, 'as it is'
Final Cause
The end, that for which the sake of which a thing is done
'For what, or towards what'
Efficient and Final Cause have a definite temporal aspect
Efficient Cause
The primary source of the change or rest
'From what'
Formal Cause
The pattern, ordering, structure, organisational properties
The 'into what'
Material and Formal Cause are considered fused
But separable in analysis
Time independant
Material Cause
That out of which as thing 'comes to be'
The 'Out of what'
4 – Modes of Aristotelian Causation
Regularity of connection
Proper
Incidental (chance)
Does not explain meaningful connections, i.e. just coincidence
5 – Examples
House
The final causes of artefacts are external to the object
Organism
The final causes of organisms are internal to those objects
Formal, material, final cause coincide

1.5 Hume's account of causality and its influence on Kant

David Hume, (1711-1776) in his works such as *A Treatise of Human Nature* attacked cause and effect to great effect, influencing Kant to carry out his own investigation, for example and in particular, in the *Critique of Pure Reason* and the *Prolegomena.* In these works he attempted to solve this problem by investigating the constitution of experience by a priori concepts and principles of understandings, as well as his development of the synthetic a priori group.

Hume accepted the mechanistic approach and rejected final cause with respect to nature. Only Aristotelian 'efficient cause' has a similarity to Humean cause, and arguably this fact just as well shows Aristotle's view of nature (i.e. that he was heavily influenced from his perspective of the organism and its form).

Kant, and the Naturphilosophers that followed him however, felt that Hume's reduction of causation to a merely a version of Aristotelian efficient cause missed the essential nature of the *coming-to-be*, *what-it-is-to-be* not to mention the seeming 'design-like' nature of organisms. For this they felt we needed something more and hence we come to the *Critique of Judgment* and in particular for this study, *Critique of Teleological Judgment.*

1.6: Kant's *Critiques* as an important 'beginning' for a formalised *Naturphilosophie*; An attempt to solve major problems associated with particular systems

Kant's *Critiques* can be seen as an attempt at a synthesis between the dominant views of the enlightenment, empiricism versus rationalism, a mechanical conception of the world versus an organic dynamic view, and mechanism versus teleology[12].

[12] This debate of mechanism versus teleology is still raging in many discussions related to evolutionary biology. Often this is without the parties involved having a comprehensive philosophical understanding of the fundamentals of these concepts (based from their initial exposition by Aristotle and later development by philosophers such as Descartes, Hume and Kant). This in many cases leads to a range of logically inconsistent 'ad hoc' arguments presented as scientific thought, or to back up experimental investigations. Specific cases from the current literature will be outlined and critiqued in later sections. To briefly summarise, mechanism is the view that all

One of the main concerns for Kant was the systematicity and bringing to unity of laws of nature. We had no reason, he claimed for assuming that nature would be systematic and purposive for our understanding of it. Therefore we had to take this as an *a priori* principle[13]. Without this principle we could never come to a system of empirical laws, to explain nature (which would place Newton's laws of physics in jeopardy). It was Kant's belief or reliance on the applicability of Newtonian mechanics to nature, coupled with his awareness that the Newtonian, Humean and Aristotelian models did not allow us to understand or explain important aspects of material nature that lead to his attempt at a synthesis between the two major competing theories of the time with respect to nature; teleology and mechanism. This can in many ways be seen to parallel Kant's work on a synthesis between empiricism (in particular that of David Hume that influenced his approach so importantly), and the 'dogmatic rationalism'[14] of philosophers such as Rene Descartes, Benedict de Spinoza, and Gottfried Wilhelm von Leibniz from which he felt he came from before producing his *Critiques*.

phenomena can ultimately be explained in terms of simple mechanical relations of cause and effect, (Boyd, *et al* 1993). David Hume's works were a notable proponent of this philosophy in Kant's time. In Aristotelian terms mechanism would only require material and efficient cause. Teleology is the examination of, or appeal to goals or ends as fundamental principles of explanation, (Boyd *et al,* 1993).

[13] A priori propositions have fundamental validity, they are not based on perception, for example '1+1=2'

[14] To use Kant's terminology, (PG, Ak. IV, 260). In *Prolegomena* Kant credits Hume's works, (he is known to have read '*Enquiry Concerning* Human Understanding', and possibly sections of 'Treatise of Human Nature') for having wakened him from his "dogmatic slumber".

Chapter 2
Problems of causal explanations of organisms

2.1: Kant's third *Critique*, the *Critique of Judgment*

Kant hoped for his third *Critique* to introduce a new causality into natural science, to transform/transpose the concept of an organism, which he defined as a 'natural purpose'[15] from a reflective judgment to a determinative judgment, that is, from a

[15] For Kant, organisms are 'natural purposes'. This will be discussed in detail in later sections such as 2.7, but for the meantime here is a basic summary from Kant. *"It is these beings, therefore, which first give objective reality to the concept of a purpose that is a purpose of nature rather than a practical one [such as a work of art or a machine], and which hence give natural science the basis for a teleology, i.e. for judging its objects in terms of a special principle that otherwise we simply would not be justified in introducing into natural science (since we have no a priori insight whatever into the possibility of such a causality"*, (CJ §65: 376). A useful point to remember when reading the *Critique of Judgment* is that Kant uses 'natural purpose' and 'purpose of nature' interchangeably. It is also useful to remember that Kant is often claimed to be one of the most difficult philosophers to read, but also it seems, one of the most important, (especially for those working in the physical and natural 'sciences', to which he dedicates a large portion of his works).

concept of understanding to a concept of reason[16]. This he hoped would allow us to determine and hence derive natures products from their causes.

> Two things fill the mind with ever new and increasing wonder and awe, the oftener and the more steadily we reflect on them: the starry heavens above me and the moral law within me. I have not to search for them and conjecture them as though they were veiled in darkness or were in the transcendent region beyond my horizon; I see them before me and connect them directly with the consciousness of my existence, (CPrR, pg 138).

It is this quote, perhaps Kant's most famous that sums up an important part of the basis of his way of attempting to investigate the nature of the universe[17]. On one hand we have the marvel of the universe and with it the preconceptions based on Newtonian physics of a giant mechanistic machine-like structure, deterministic and ultimately completely predictable all the way into the future[18], and on the other we have the moral law; his ideas of individual human freedom, the moral being, and with it art, seemingly more complex than our scientific knowledge can ever hope to ultimately explain.

The universe as a purely mechanistic phenomenon, that is explainable and understandable purely under or by virtue of a mechanistic framework, raises serious questions for Kant. These concerns parallel in many ways the problems of a moral or free being in a purely deterministic Newtonian universe that were an important concern in the *Critique of Pure Reason*. In the part two of the *Critique of Judgment* Kant reassesses the notion of this purely mechanistic universe in respect to systematically organized beings such as organisms. Organisms seem to exhibit a 'designedness', and seem to contain something more than that which we could expect from a purely mechanistic universe based upon efficient cause, (that is one in

[16] In a reflective judgment one proceeds from the individual to the universal. This is the opposite move to a determinative judgment, (where the move is from a concept (universal) to an intuition (individual)). This is further outlined in section 2.3 and the diagram of section 2.4.
[17] The first sentence of this is quote is inscribed upon Kant's gravestone.
[18] It must be noted that the Newtonian mechanistic universe for all its problems on the larger universal scale is useable at (in relation to the universe) small distances and in limited frameworks. Beyond these limits though we have to develop and use a greater encompassing theory (such as that of Einstein's general theory of relativity, 1916). Equally at the smallest distances such as at the quantum level Newtonian theories also cease to have fundamental relevance to the phenomena observed. Even with this all being the case, the problem of apparent purposiveness in organisms for Kant still applies.

which no effect can in turn be the cause of its cause)[19]. This purposive nature of organisms, Kant claims is similar to that describable by a differing type of causality, that of teleological or final causes. Explanation based solely on a mechanistic system will, he claims, miss for us the essential nature of what it is that makes organisms what they are. This can be seen in a number of sections throughout the work, for example.

> ...the definition of organised beings, is: *An organised product of nature* [natural purpose] *is one in which everything is a purpose and reciprocally also a means*. In such a product nothing is gratuitous, purposeless, or to be attributed to a blind natural mechanism, (CJ §66: 376).

> For the concept of natural purposes leads reason into an order of things that is *wholly different from that of a mere natural mechanism*, which we no longer find adequate when we deal with such natural products, (CJ §66: 377). (emphasis added)

> There is a principle of judgment according to which we cannot accomplish anything by way of explaining such things if we proceed in mechanical terms alone, and hence our judging of such products must always be supported to a teleological principle as well, (CJ §80: 418).

Kant bases this last statement upon the idea that we, as human beings, cannot conceive of the universe as ordered without also conceiving of it as designed, and for this we must incorporate final cause, that is, a teleological perspective. By leading us into teleological based perspectives Kant can break out of the limits of a mechanistic system, that is, it allows him to talk about particular aspects of organisms that it would be impossible to do so under a purely mechanistic model. This he hopes will allow us to eventually come to understand organisms to a greater extent, by formulating or outlining a system that encompasses both systems,

[19] "Our causal connection, as our mere understanding thinks it, is one that always constitutes a descending series (of causes and effects): the things that are the effects, and that hence presuppose others as their causes, cannot themselves in turn be causes of these others. This kind of causal connection is called that of efficient cause (*nexus effectivus*)", (CJ §65: 372). The efficient cause is that whence there is a first beginning of change or rest.

although he continually warns us that teleology is only an approximate guide, and must not be taken as truth, (CJ §68).

2.2 Summary of Kant's ideas

Kant's *Critique of Teleological Judgment* was a landmark investigation for continental based study and ideas of the relations of organisms, 'in the enlightenment the benchmark view of organisms was set by Kant', (Webster and Goodwin, 1982). As such any investigation of the nature of organisms based around the perspective that pervaded in the continent at this time must take account of the directions that Kant set, as well as the limits he imposed. As previously described, Kant attempted to determine the limits of our understanding of nature, in particular by the analysis of antinomies, or apparent contradictions between two claims. In the *Critique of Pure Reason* for example he examines the notion of a mechanistic (and for his system thoroughly deterministic) nature of the universe, and the possibilities of free will. The results of this investigation are important for a number of reasons, but in particular for the *Critique of Teleological Judgment* because it acts as the basis for Kant's claim that we must treat nature as if it were a mechanistic system. Like the problem that free will in relation to a purely deterministic universe presented in the *Critique of Pure Reason*, in the *Critique of Teleological Judgment* it is the problem of the apparent designedness or purposive nature of organisms in relation to a purely Humean [efficient] causal, or mechanistic universe that is considered the problem to solve. That is, an extra type of causality to mechanistic/efficient causality seems to be required, that of teleology, or final causes.

Kant believes that if we are to have any understanding of organisms we must treat them as designed, although we must at all times realise that they are not. We then however, arrive at the contradiction between the mechanistic system (which, Kant claimed states that the universe is completely describable in terms of efficient cause, and that is purely deterministic, (and as much as this seems to be an incorrect view to many, the debate is still open (both in physics as well as philosophy at this

point[20])) and our views of organisms, or self organised, 'purposive' beings (which by his definitions are not describable purely in terms of efficient cause). By investigating these problems Kant hoped to investigate the possibility of introducing a new causality into natural science, that known by a supersensible intuition, that is *transform the concept of a natural purpose from a concept of understanding to a concept of reason.* This supersensible intuition proceeds from "whole to the parts", (CJ §77: 407), and teleology and mechanism are reconciled. Ultimately though he infers that due to the discursive nature of our understanding, that we cannot comprehend the nature of this reconciliation. We will in proceeding sections discuss some of the problems with his postulation and limits of the supersensible intuition, then develop through the question that then begs to be asked for the second half of this discussion, 'in light of current developments of science and thought, are these assumptions or limits still valid, and/or can we re-work them to allow us to take that step closer to the limits of what we can know'?

Next Page:

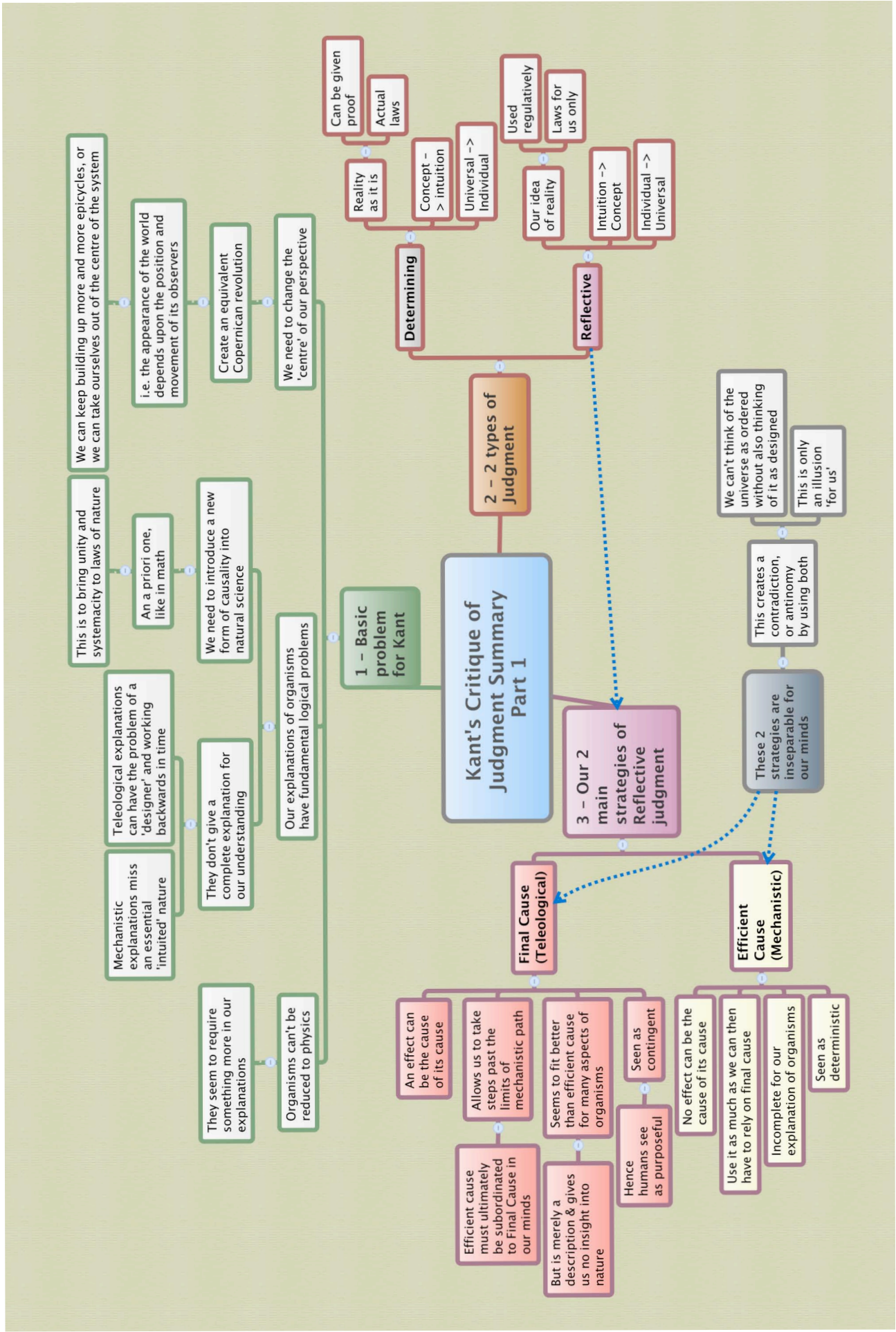
Figure 2 - Kant's *Critique of Judgment* Summary part 1

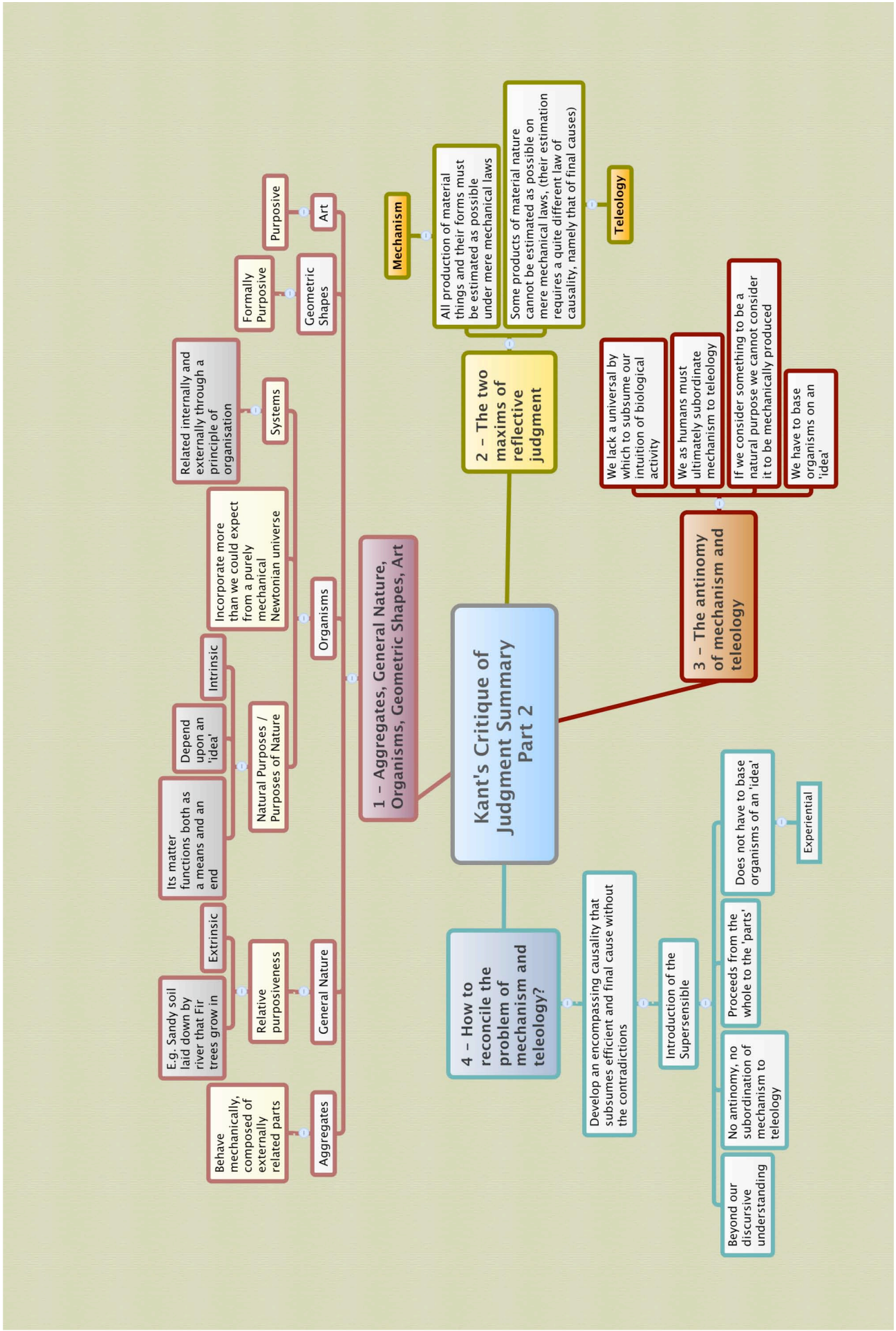
Page after next:

Figure 3 - Kant's *Critique of Judgment* Summary part 2

[20] Stanford Encyclopaedia of Philosophy, (2008). Bohm, (1952) developed an alternate interpretation (or theory) of the Copenhagen Theory (for quantum mechanics, and one of the main arguments for non-determinism) that seems to work equally well, but is entirely deterministic. Non-predictability of a system for us does not necessarily imply non-determinism. The current state of affairs is that even with the work of chaos theory we are still unable to prove whether this is *real* randomness, i.e. that the system is governed by underlying laws, but is chaotic (i.e. has sensitivity to initial conditions). Unfortunately all our best current theories, including general relativity and the standard model of particle physics are too flawed to provide an answer. In summary, many of Kant's concerns as outlined in the *Critique of Judgment* regarding determinism and its relation to nature and organisms are as valid today as they were then.

Chapter 2: Problems of causal explanations of organisms




Kant's Critique of Judgment Summary Part 2
1 – Aggregates, General Nature, Organisms, Geometric Shapes, Art
Aggregates
Behave mechanically, composed of externally related parts
General Nature
Relative purposiveness
Extrinsic
E.g. Sandy soil laid down by river that Fir trees grow in
Organisms
Natural Purposes / Purposes of Nature
Intrinsic
Depend upon an 'idea'
Its matter functions both as a means and an end
Incorporate more than we could expect from a purely mechanical Newtonian universe
Systems
Related internally and externally through a principle of organisation
Geometric Shapes
Formally Purposive
Art
Purposive
2 – The two maxims of reflective judgment
Mechanism
All production of material things and their forms must be estimated as possible under mere mechanical laws
Teleology
Some products of material nature cannot be estimated as possible on mere mechanical laws, (their estimation requires a quite different law of causality, namely that of final causes)
3 – The antinomy of mechanism and teleology
We lack a universal by which to subsume our intuition of biological activity
We as humans must ultimately subordinate mechanism to teleology
If we consider something to be a natural purpose we cannot consider it to be mechanically produced
We have to base organisms on an 'idea'
4 – How to reconcile the problem of mechanism and teleology?
Develop an encompassing causality that subsumes efficient and final cause without the contradictions
Introduction of the Supersensible
Beyond our discursive understanding
No antinomy, no subordination of mechanism to teleology
Proceeds from the whole to the 'parts'
Does not have to base organisms of an 'idea'
Experiential

2.3: Types of Judgments: Determining and Reflective

> Judgment in general is the ability to think the particular as contained under the universal, (CJ IV: 179).

Kant wanted to 'explain' nature, or at least determine what were the limits of explanation to which we could attain. On the whole in the *Critique of Judgment* he investigates, compares and contrasts the mechanistic view with that of the teleological view, he then attempts to determine the possibility of a synthesis between them. This approach is similar to that in the *Critique of Pure Reason*, where the aim was a synthesis between rationalism and empiricism in respect to reason, which he used to develop and extend the theoretical background of the sciences by the addition and formulation of the synthetic *a priori* group[21].

Kant, in his investigations of the nature of judgment differentiates two types of judgments, determining judgments, and reflective judgments. It is his hope in the *Critique of Judgment* to give a basis by which we can see the logically possible move from the reflective judgments on the nature of organisms to one that is determining, or objective, (that is based upon *a priori* principles). As will be further outlined in the following section the use of a reflective judgment based system in the study of organisms raised serious concerns for Kant, and indeed many other philosophers of his time. It is however, his novel approach to the problem that allowed him to reformulate the problems of the antinomy of reflective judgment, and give the possibility of basing it on an objective or determining framework.

If we are to attempt to make sense of Kant's ideas on the development of a reflective based system for the study of organisms to that of a determinative framework then we must assess his ideas on the meanings of his notions of particular

[21]Kant like earlier philosophers distinguished between two types of propositions, synthetic and analytic. These can be further divided into two other types, *a priori* and empirical.
Synthetic propositions: those propositions that cannot be arrived at by pure analysis, for example 'the cat is on the mat'. In these propositions the predicate is not included in the subject.
Analytic propositions: the predicate is implicate in the subject, for example 'the black cat is black', or 'bachelors are unmarried men'. For analytic propositions the truth is discovered by analysis of the concept itself.
A priori propositions: have fundamental validity, they are not based on perception, for example '1+1=2'
Empirical propositions: depend upon sense perception, for example 'the cat is black', or 'the earth moves around the sun. Humans Kant contends can only judge by what they see and experience, that is by what is empirical.

types of judgment. Determining judgments proceed from the universal to the individual, that is, from concept to intuition. They subsume an individual or event under a schematised category, (M^{c}Farland, 1970). For example, if we are looking for a peppered moth in our field studies, we make a *determining judgment* when we say, "Look, I have found a peppered moth" upon locating the desired individual. In doing so we add further empirical content to the concept of a peppered moth through its affiliation with the individual moth, (the intuited thing), (Wicks, 1994). In contrast, in a reflective judgment one proceeds from the individual to the universal, (that is, from our perception of an individual thing, and then attempts to categorise this under a concept that is suitable for categorising the thing). This is the opposite move to a determining judgment, (where the move is from a concept (universal) to an intuition (individual)).

For example, in the case of our field study, in a *reflective judgment* when we see the individual in question and say "what is that?", we apply various concepts to it in an attempt to unify the sensations under a universal type or concept. So if we then say "that is a peppered moth" in relation to the individual we have made a reflective judgment.

> If the universal (the rule, principle, law) is given, then judgment, which subsumes the particular under it, is determinative (even though [in its role] as [because it is a] transcendental judgment it states a priori the conditions that must be met for subsumption under that universal to be possible), (CJ IV: 179).

> If only the particular is given and judgment has to find the universal for it, then this power is merely reflective. [The] transcendental principle...reflective judgment gives as a law to itself: it cannot take it from somewhere else (since the judgment would then be determinative); nor can it prescribe it to nature, because our reflection on the laws of nature is governed by nature, not nature by the conditions [i.e. our] under which we try to obtain a concept of it that in view of these conditions is quite contingent, (CJ IV: 179-180).[22]

[22] As such reflective judgements cannot give us true (*a priori*) knowledge.

Chapter 2: Problems of causal explanations of organisms

To view something to be a *product of nature* we must supplement our ideas of teleological production with the concept of a mechanism of nature. As such we must, Kant claims, by necessity attempt a reconciliation of the two maxims, but not with the aim of putting one type of production, wholly, or in part in place of the other. One though must be subordinated to the other, (how Kant proposes this is outlined for example in §80, and will be discussed later). This principle to be subordinated is mechanism, and;

> It is...quite undetermined, and for our reason forever undeterminable, how much the mechanism of nature does as a means toward each final intention in nature, (CJ §78: 415).

Mechanism, Kant claims, will always be inadequate and incomplete as an explanation for things that we have recognised as having natural purposes. As a consequence of this our understanding forces us to subordinate the mechanical principles to the teleological ones. However, we should attempt to explain products and events of nature in terms of mechanism as far as we possibly can, always keeping in mind though that the essential character of reason will lead to us ultimately subordinating the "product we are investigating (of our investigation) regardless of the mechanical causes, to a causality in terms of purposes" (i.e., teleology).

Reflective judgments Kant claims are based upon an analogy that we impose upon categorical unity, that is, our idea of reality, not reality as it is. As such we must realise that any laws that we impose by use of this reflective judgment is not a law of nature, but only a law 'for us'. That is, they are neither true nor false, just estimates. These 'laws' are merely heuristics. However, while these reflective judgments cannot be given an independent proof, we must, he claims, presuppose that nature is a unity such as it would be if it had been designed by a creative intelligence. It is this notion of the essential nature, for us, of the incorporation of the concept of design into our attempts to systematise nature into some form of empirical framework, that Kant uses as a basis for his arguments and formulation of an overriding causality, encompassing the two major strategies of reflective judgment, teleology and mechanism.

Reflective judgments, as estimates are only regulatively employed, they 'subsume' particulars under laws not yet given, (as differing from determining judgments, where particulars are subsumed under a law or concept in accordance with a principle). However, they are essential for us to use in our attempts at coming to some form of understanding of the universe, (which Kant claims is in principle understandable, although not by humans, due to the limited nature of our minds). Due to the proposed limits of our minds to understand the universe, (CJ §77: 409-410) Kant believes that we cannot conceive of a totally ordered universe without also conceiving it as designed, hence we must incorporate, and in fact are committed to the concept of teleology. This concept of teleology is linked with mechanism, and is, for us Kant contends ultimately inseparable (CJ §77: 409). Teleology is to be used as a "heuristic principle for investigating the particular laws of nature" (CJ §78: 411), while mechanism is essential for us to incorporate, for without it we cannot judge a product to be a product of nature at all.

While Kant thinks that the two principles are inseparable despite the apparent contradiction he believes that one (mechanism) can be subordinated to the other (teleology, or an intentional technic). *This follows from his insistence that for the things that we recognise as natural purposes mechanism will always be incomplete, and so we must subordinate all the mechanical bases to a teleological one.* But we must, Kant claims, attempt to explain all products and events of nature in mechanical terms (no matter how purposive they appear) as far as we possibly can. We must never lose sight of the fact that we are ultimately investigating under a concept of a principle of reason not understanding, and due to the nature of our reason we must ultimately subordinate mechanism to teleology.[23]

> If we are to have a principle that makes it possible to reconcile the mechanical and the teleological principles by which we judge nature then we must posit this further

[23] This is due to teleology for Kant being a principle of reason, mechanism being a principle of understanding.
A principle of reason is concerned with the infinite. It is a logical and transcendental faculty. It produces 'mediated conclusions' through abstractions. *'The principle of reason applies to this idea [purposes] only subjectively, namely, as the maxim: Everything in the world is good for something or other; nothing in it is gratuitous; and the example that nature offers us in its organic products justifies us, indeed calls upon us, to expect nothing from it and its laws except what is purposive in [relation to] the whole', (CJ §67:379).*
A principle of understanding is concerned with the faculty of rules

> principle in something that lies beyond both (and hence beyond any empirical presentation of nature), but that nonetheless contains the basis of nature, namely *we must posit it in the supersensible*[24], to which we refer both kinds of explanation, (CJ §78: 412). (emphasis added)

It is this positing of the supersensible, something beyond normal, 'sensible' intelligence, that is associated with a new type of causality that sits above, and encompasses both mechanism and teleology, and by which both are understandable in terms of the systems as generalisations, (just as Newton's and Kepler's physics are subordinate to, explained by and encompassed by general relativity) that is perhaps one of Kant's most interesting points in the *Critique of Judgment*. Indeed it would seem that by positing, or invoking this notion of the supersensible Kant is not restricting the universe ultimately to being completely codeable in terms of efficient cause or mechanism, (although in many cases he seems to believe that this may be the case), he seems to leave open the option or possibility of a system that is beyond the notions of and limitations of Aristotelian and Humean cause. However, like Porphyry on the nature of species, he doesn't consider this a question that he is willing to pursue further, but concentrates on assessing and determining the system of limits that we must operate within.

2.4: The antinomy of two maxims of reflective judgment, mechanistic and teleological

> All production of material things and their forms must be estimated as possible under mere mechanical laws, (CJ §70: 387). [Thesis]

> Some products of material nature cannot be estimated as possible on mere mechanical laws, (their estimation requires a quite different law of causality, namely that of final causes), (CJ §70: 387). [Antithesis]

[24] Which is beyond our understanding. This will be discussed in greater detail in chapter 3.

These two statements represent for Kant the two maxims[25] of reflective judgment, that of mechanism (which is based upon efficient cause), and that of teleology (or final cause). This gives rise to an antinomy[26] which Kant spends a great deal of the *Critique of Judgment* attempting to solve. In attempting to reconcile the antinomy between the mechanistic and teleological systems, Kant went about showing that what seemed like an antinomy was an antinomy only for us. By postulating a causality that encompassed the mechanistic and teleological systems where no conflict actually took place, Kant claimed that the antinomy that we experience was only relative. This antinomy only applied to reflective judgment, that is it was not an objective one, (as this over-riding new causality was postulated to be). Any distinction that we believe to be present between mechanism and teleology was, he claimed, only due *to our* incomplete knowledge, (i.e. mechanistic, efficient cause independent from our understanding would be determinative and see the 'purposiveness' of organisms as non-contingent). This attempt to provide a basis for the merging of two types of causality (mechanistic and teleological) into one over riding causality is one of Kant's principle aims in the *Critique of Judgment*. The antinomy that appears to be present between the two major strategies of reflective judgment, teleology and mechanism Kant believes may be reconciled into a new kind of causality, but one that ultimately from his perspective is beyond human discursive understanding.

[25] A maxim for Kant is a subjective principle or rule that the will of an individual uses in making a decision.
[26] An antinomy is defined as a contradiction between two laws, or apparently equally valid principles.

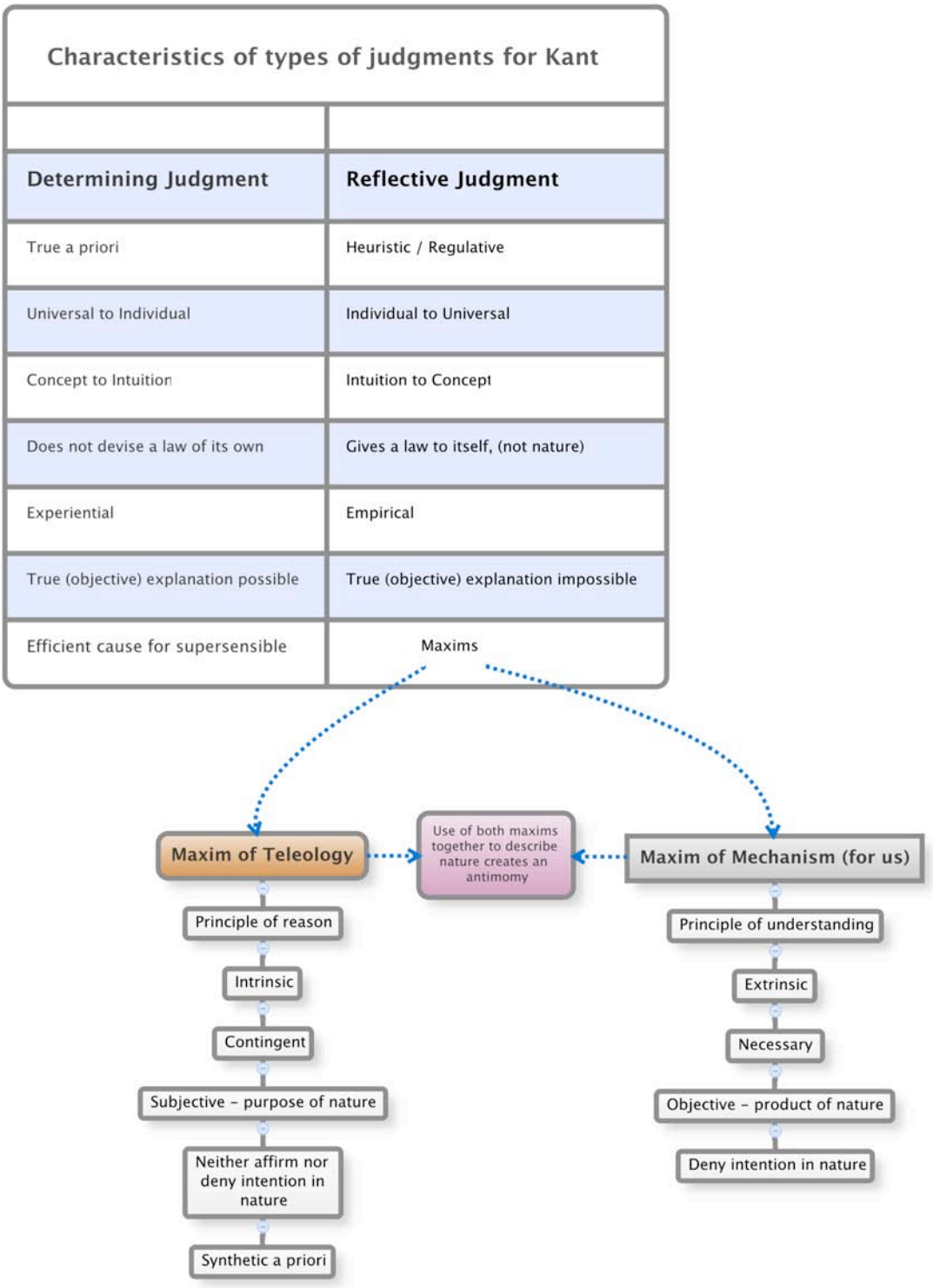


Figure 4 – Summary of determining and reflective judgments and the maxims of reflective judgment

2.5: Kant's ideas on the problems of a purely mechanistic framework
Kant's ideas on the difference between geometric shapes and organisms
Kant's definition of organisms, why for us mechanism alone is incomplete

Kant believes that we must presuppose that nature is purposive for our scientific knowledge, that is *that we must presuppose that nature is a unity such as created by some intelligence that has designed it such that we are able to systematise our empirical knowledge of it.* He stresses that we must take this systematic empirical unity of nature and that we can come to know it as an *a priori* principle, (a synthetic *a priori*). Only by doing this will we ever be able to achieve a system of empirical laws for nature. We must though still realise that we have no objective reasons for believing that there are systematic empirical laws in nature.

Systematic organisation, Kant believes, and relates with his discussion of us finding a hexagon inscribed in the sand (CJ §64: 370) immediately leads us to believe that an intelligence has been at work. Kant's concept of purpose is also important for us to understand if we are to fully comprehend his stance, as well as then allowing us to relate it to current understandings or usages of the term. Kant begins the *Critique of Teleological Judgment* with a discussion of the distinction between geometric shapes, and what he calls their formal purposiveness, and things with material, objective purposiveness, such as "the order and regularity among trees", (CJ §62: 364). As can be seen from various statements in this particular discussion this *formal purposiveness does not Kant claims, require teleology, while material, objective purposiveness does.*

> This [formal] purposiveness is obviously objective and intellectual, and not merely subjective and aesthetic; for it means that the figure is suitable for the production of many shapes that serve purposes, and we cognise this purposiveness through reason [that is it is determinative, not reflective]. And yet this purposiveness does not make the concept of the [geometric] object itself possible, i.e., we do not regard the concept's [i.e., the figure's [such as a hexagon]] possibility as depending on that use, (CJ §62: 362).

This is merely formal as distinguished from material, objective purposiveness.

> This intellectual [intellektuell] purposiveness is indeed objective (rather than subjective, like aesthetic purposiveness); but, as to how it is possible, we can readily grasp this purposiveness, though only in a universal way, as being merely formal (rather than real [i.e., material]), that is, as a purposiveness that does not have to be regarded as based on a purpose and hence *does not require teleology*, (CJ §62: 364) [Emphasis added].

> [With regards to a circular figure]...we are not entitled to regard this purposiveness as based on a *purpose* or on anything else whatsoever, (CJ §62: 364).

> This is different from cases where I find order and regularity in an aggregate, enclosed within certain boundaries, of *things* outside me: e.g., in a garden, order and regularity among trees, flower bed, walks etc. For these cases I cannot hope to infer *a priori* this order and regularity from the way I have bounded a space in accordance with this or that rule. For these are existing things that must be given empirically if they are to be cognised and are not a mere presentation in myself according to an *a priori* principle. Hence the latter (empirical) purposiveness is [not formal but] *real*, and hence is dependent on the concept of a purpose, (CJ §62: 364).

For Kant aggregates of nature behave mechanically, and are composed of externally related parts, whereas systems are related externally and internally through a principle of organisation.

> For it is quite certain that in terms of merely mechanical principles of nature we cannot even adequately become familiar with, much less explain, organised beings and how they are internally possible. So certain is this that we may boldly state that it is absurd for human beings even to attempt it, or to hope that perhaps some day another Newton might arise who would explain to us, in terms of natural laws unordered by any intention, how even a mere blade of grass is produced. Rather, we must absolutely deny that human beings have such insight. On the other hand, it would also be too presumptuous for us to judge that, supposing we could penetrate to the principle in terms of which nature made the familiar universal laws of nature specific, there could not be in nature a hidden basis adequate to make organised

beings possible without an underlying intention (but through the mere mechanism of nature), (CJ §75: 400).

Summary of Kant's types of explanation

	Example	Our Understanding
Efficient Causal	Mechanical aggregates (e.g. rocks)	Empirical
Formal Purposiveness	Hexagon	A Priori
Designed Purposiveness	House, Art	External to the artefact
Natural Purposiveness	Organisms	Internal, (ends and means in itself)

Table 3 – Comparison of types of explanation

Causality acts as the 'quality' that enables a substance (e.g. cells, wood, bones) to give rise to specific characters (that unify and exist as cohesive systems that have a phenomenological intelligibility or are 'mappable').

> And the question remains absolutely unanswerable (for our reason) unless we treat it as follows. We must think of that original basis of things as a simple substance; the quality that enables this substance to give rise to the specific character of the natural forms based on it, namely, their unity of purpose, we must think of as a *causality* (because of the contingency we find in everything that we think possible only as a purpose), (CJ §80: 307).

We now discuss as to why the account of a purely mechanistic universe (i.e. based upon a reductionist perspective) does not seem to conform with the current experimental and theoretical data.

2.6: The place of some of the current theories of physics that argue against a mechanistic system of 'explanation'

One of the questions that we (or Kant) should perhaps be asking is not just whether biological organisms are in fact reducible to the laws and potentially mechanical ordering of physics, but whether the basic laws of physics are in fact mechanical. That is, investigation of organisms may be an important way of reconfiguring our view and questioning the notion of physics as that science which all others must pay their dues to. That is, we may come to a better understanding of the nature of physics by investigating organisms than by investigating physics as the way to understand organisms.

Just as Newtonian mechanics still holds use as a form of 'heuristic' / a short cut to 'explain' for example the motions of the planets in a mechanistic framework so to it may be that organisms may be 'described' using a mechanistic system. However, this should not let us fall into the trap of thinking that these simpler methodologies suffice in all cases. In physics, phenomena such as superfluidity and superconductivity have shown how quantum properties can be significant even at the level of the naked eye, (Bohm, 1969; in: Towards a theoretical biology). There seems no, and perhaps even less reason to suspect that biological structures will exhibit phenomena that will be easily explainable in a mechanistic framework, (or at least to a level deemed 'sufficient'), for example, as our understanding of the class of solitons progresses. Maybe 'physics' hasn't yet 'caught up' with the organism, (i.e., the limitations of the current models of physics may be restricting our notions of perception, the how-we-see). Maybe by turning the tables and instead of trying to base organisms on our current views of the nature of physics, we should try to see physics from the idea of the organism and see where that takes us.

One of the major problems for an understanding of the *what-it-is-to-be* of life is the apparent inconsistency of mechanistic versus non-mechanistic thought. Mechanistic outlooks as previously mentioned have been under criticism since their inception. The main arguments have claimed that mechanism misses out on capturing the essential nature of reality, this reaction has been continually voiced in relation to organisms, for example Goethe's claim,

Chapter 2: Problems of causal explanations of organisms

> Just as the mechanical theory of sound tells us nothing of the quality of the music, so do mechanistic, or atomistic explanations fail utterly to convey the unfathomable inner life of nature as a whole; in short 'they transform the living into something dead', (Goethe in Nisbet, 1972).

Or perhaps to make use of the poetry that Goethe was so famed for;

> Nature is infinite,
> but he who would attend to symbols
> will understand everything,
> though not quite.
> (Goethe, in Richards, 1992).

It is this general concern about the nature of a mechanistic account of reality that has been responsible in many ways for the continual use of teleological principles as a way to capture that which it is claimed, mechanism denies or overlooks. Mechanistic thought with respect to analysis of organisms/life is based on the idea that organisms can be conceived of as a combination of aggregates, and not only can they be seen as a complex of aggregates but they are in fact a complex of aggregates. This was backed up by the strength of the physics of the day for Kant's Critiques. However, in reappraising Kant's conclusion or principles in light of some of the more prevalent aspects of present day physics and mathematics it would seem that the mechanistic viewpoint comes into problems. According to the lines of thought that will be used as the main example base for theoretical physics, the view in current theoretical physics proposes that the notion of a mechanistic model of the universe runs into important disagreements with recent views of the possible nature of reality.

To attempt to assess and develop this argument in relation not only to the works of Kant, but also to our attempts at coming to an understanding on the nature of organisms and nature in general it is important that we define the principles of the mechanistic framework. From here we can begin to investigate the short comings of this system as well as the strengths, not only as a way in which to state 'the nature of reality', but also examine its use as a form of heuristic, or short cut in our explanations in relation to what may perhaps be a more comprehensive but less easy to use system, (as is the current status of Newtonian mechanics in relation to relativity theory).

Firstly then we should define what it is that characterises the mechanistic framework. (Summarised from, Bohm, 1957, 1980; Schubert-Soldern, 1962; Farber, 1986; Feyerabend, 1981a, 1981b; Garfinkel 1991; Trout, 1991).

General principles and characteristics of the atomic theory

- Separability. The parts must be physically and conceptually separable from the whole. They must be capable of independent existence.
- There exist fundamental entities that form the basis of reality.
- The only changes regarded as possible within this scheme are quantitative changes in the parameters or functions defining the state of the system, the system is based around a finite number of things.
- Context-independence. The properties of the parts must remain from one complex situation to another, thus the wholes do not exist in their own right, they are merely composites of the parts.
- Fundamental qualitative changes in the modes of being of the basic entities and in the forms in which the basic laws are expressed are not regarded as possible.
- All these things are assumed to fit into some fixed and limited physical and mathematical scheme, (which could in principle be subjected to a complete and exhaustive formulation).
- All things, both in common experience and in scientific research, can be reduced completely, perfectly and unconditionally (i.e., without

approximation and in every possible domain) to nothing more than the effects of some definite and limited general framework of laws.

- Locality. Particles only interact with other particles in their immediate spatiotemporal vicinity. All interactions are local.
- Allows only one kind of effective causation: efficient causation.

In summary, for the mechanistic view the universe is regarded as constituted of entities that exist independently in different regions of space and time, and interact through forces that do not bring any changes in their essential natures. It portrays every activity performed by a composite thing, even a living organism as nothing other than the compounded activities of the particles which compose it.

> The mechanistic thesis that certain features of our theories are absolute and final is an assumption that is not subject to any conceivable kind of experimental proof, so that it is, at best, purely philosophical in character, (Bohm, 1957).

Throughout the debate on the strengths and weaknesses of a science based purely around mechanistic thought a number of statements have been put forward claiming limitations to the practical use of a scientific system based purely around the application of efficient cause. It is important as a consequence to at least have some form of understanding or knowledge of these claims so their strengths and weaknesses can be realised, that we may hope in turn to avoid making the same, or similar mistakes. These points and some of the main proposed arguments against, and possible counter arguments are summarised from Faber (1986), Bohm, (1957, 1982), and Feyerabend, (1981a, 1981b).

Main arguments against mechanism and counter arguments

- *A whole is more than the collection of its parts*: The atomist is not restricted to just listing the parts, they are also free to relate these in terms of dynamics and law governed interactions.

- *Human behavior, or morals cannot be turned into a branch of applied physics*: This is undecided, however it would more than likely be of little

practical use to talk about these purely in terms of physics if it were shown that we could reduce e.g. morals to physics.

- *The properties of, for example water cannot be explained by the properties of hydrogen and oxygen*: This looks at the problem from the wrong level. The atomist would look at water not as an hydrogen and two oxygen atoms, but in reference to the properties of the neutrons, protons, and electrons that compose the water molecules, that is the water molecule is not treated as the hydrogen and two oxygen atoms but as in effect a 'new' entity. It is these factors that make the properties of water, not the individual properties of hydrogen and oxygen.

Bohm does provide a form of argument against this based on his principles of quantum theory: "...these equations could have solutions in the form of localised pulses, consisting of a region of intense field that could move through space stably as a whole, and that could thus provide a model of the 'particle'. Such pulses do not end abruptly but spread out to arbitrarily large distances with decreasing intensity. Thus the field structures associated with two pulses will merge and flow into one unbroken whole. However when two pulses come close together, the original particle-like forms will be so radically altered that there is no longer even a resemblance to a structure consisting of two particles".
"Ultimately, the entire universe (with all its 'particles')...has to be understood as a single undivided whole, in which analysis into separately and independently existent parts has no fundamental status", (Bohm, 1980, pg174).

- *The parts of a system cannot be understood apart from their membership in the whole*: Interaction does not necessarily imply non-distinction.

- *Reality has no structure of its own*: For this view the structure of the world is imposed upon it by the arbitrary and conceptual categories we employ in our descriptions. From this partitioning the world into atoms is just as valid as partitioning the world into humans as the causal agents. However, we

cannot adopt just any set of descriptive categories, some will be applicable and some will not (i.e., will be falsified).

Criticisms of, or problems for the mechanistic framework.

- Movement is in general *discontinuous,* in the sense that action is constituted of *indivisible quanta* (implying also that an electron, for example, can go from one state to another, without passing through any states in between).

- Entities, such as electrons, can show different properties (e.g., particle-like, wavelike, or something in between), depending on the environmental context within which they exist and are subject to observation.

- Two entities, such as electrons, which initially combine to form a molecule and then separate, show a peculiar non-local relationship, which can best be described as a non-causal connection of elements that are far apart (as demonstrated in the experiment of Einstein, Podolsky, and Rosen, 1935).

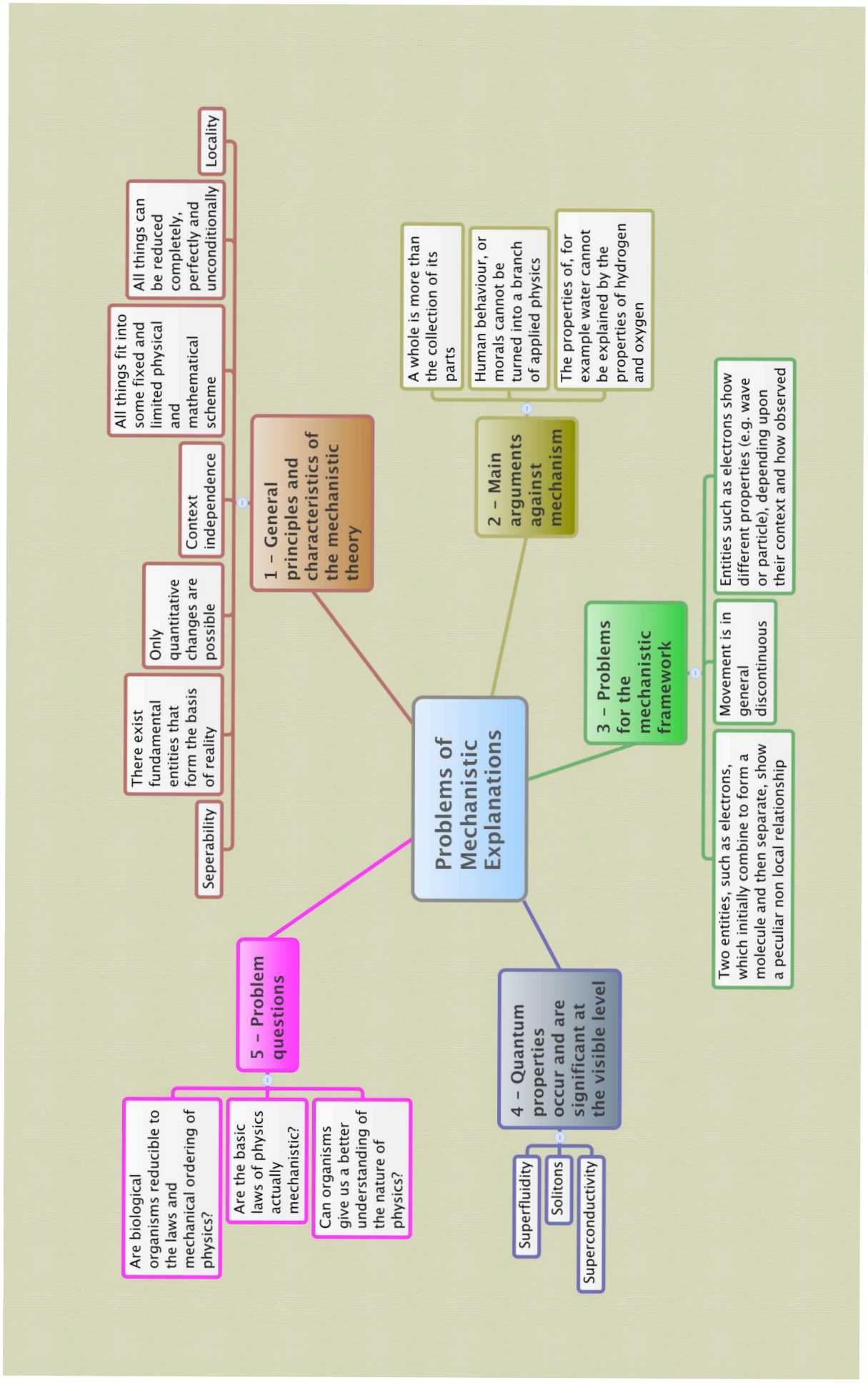
Ultimately a non mechanistic framework can accept the possibility that there may exist an unlimited variety of additional properties, qualities, entities, systems, levels, etc., to which apply correspondingly new kinds of laws of nature. So is there a possibility for a non-mechanistic view of the universe that does not have to add purpose or something external to the system (such as a vital force, or grand designer's hand). Can we develop a system of explanation that allows us to have a higher degree of understanding than can be achieved from the limits we seem to find from a mechanistic approach? Secondly, we must also consider whether any form of understanding can be known or approached by us that bypasses the current state of fusion of mechanistic and teleological thought in science, and the confusion that is created by this antinomy.

We must then ask ourselves, that if this is the case with elementary 'particles', and following the general premise and empirical evidence put forward by

Lima-de-Faria, (1988, 1995) of similarity of forms and actions all through nature, could it be possible that organisms follow similar principles? If we think of or treat organisms as similar to a quantum wave-particle, and that they are fundamentally based upon the same principles, (such as discussed in section 3.4, the solitons that exist in organisms seem to), then it may help move away from a tight atomistic or mechanistic notion and the baggage that this entails, admittedly to another set of baggage, but hopefully one that allows us to travel further. To further explain, by treating organisms in this way we may be able to move beyond the idea of separating organisms from their environment, for it is their environment that is just as important to them as they are, the organism and the environment are indivisible, that is they only may be inferred from the properties of the complete process. Regarding the organism as equivalent to both a particle and a wave, means that the thing that we observe as the organism is merely the stable pattern centering on a wave field. This wave field merges and unites with the whole with ultimately no clear distinction possible in its environment. The atomic view still retains a use however. By centering/focusing on the 'stable centre' of the wave/flow it allows us to obtain a rough approximation of the organism and it's relation to other aspects in its general vicinity. Perhaps it turns out that as Kant proposed teleology be used as an approximation or general guide to our understanding of nature, so mechanism will be relegated to a similar position in relation to the more total system theory of some aspects of current theoretical physics and nature.

Next page:

Figure 5 – Problems of Mechanistic Thought Summary


Problems of Mechanistic Explanations
1 – General principles and characteristics of the mechanistic theory
Seperability
There exist fundamental entities that form the basis of reality
Only quantitative changes are possible
Context independence
All things fit into some fixed and limited physical and mathematical scheme
All things can be reduced completely, perfectly and unconditionally
Locality
2 – Main arguments against mechanism
A whole is more than the collection of its parts
Human behaviour, or morals cannot be turned into a branch of applied physics
The properties of, for example water cannot be explained by the properties of hydrogen and oxygen
3 – Problems for the mechanistic framework
Two entities, such as electrons, which initially combine to form a molecule and then separate, show a peculiar non local relationship
Movement is in general discontinuous
Entities such as electrons show different properties (e.g. wave or particle), depending upon their context and how observed
4 – Quantum properties occur and are significant at the visible level
Superfluidity
Solitons
Superconductivity
5 – Problem questions
Are biological organisms reducible to the laws and mechanical ordering of physics?
Are the basic laws of physics actually mechanistic?
Can organisms give us a better understanding of the nature of physics?

2.7: Kant on why we need to incorporate teleology in our investigations of organisms

Limits and problems of a teleological framework

A teleological explanation is one where the phenomena are explained by the purposes that they serve rather than the postulated causes. It centers on the idea of a pre-set plan involved in the phenomena.

In the *Critique of Judgment* Kant regularly states that teleological judgments do not explain objectively but do explain 'for us'. In addition he claims that the teleological connections that we obtain may help us to determine or see further mechanical connections that otherwise would have remained unknown to us. This may be the case, however the opposite may equally be true, (i.e., that the teleological approach is able to provide connections so quickly and easily that it may lead us away from making more logically consistent connections, or that we think we have discovered all the answers in a flash of brilliant inspiration, pat ourselves on the back and cease investigating, other than the adding the occasional footnote).

Let us then create an example, based upon a series of investigations in biology, which it must be noted are by no means complete or final. This example is merely an abstraction (developed from Lambert *et al*, 1986) from some of the evidence to show potential limitations of a system that gives precedence to a teleological perspective. Imagine a moth species (lets call it the Peppered Moth) and that over the course of the field study (a number of generations) the species is found to become progressively darker in colour. Pollution is also on the increase over the course of this study, resulting in the tree trunks becoming noticeably darker. Now apply a particular form of teleological system to this study, the concept of adaptation as a result of natural selection, (the standard Neo-Darwinian framework). This would state that the purpose or function of the darkening of colour of the moths is to provide protection from bird predators when the moths are resting on the darkening tree trunks. This initially sounds plausible, but shows one of the important consequences on defining an arbitrary purpose or teleological explanation in absence of a more comprehensive, non-teleological study. It should also be noted that this system could construct experiments under its principles, test them and declare them as valid, which they would probably be for this system, as they are

often set up to test its particular assumptions, not if the overall framework is incorrect, (expositions of these problems may be found for example in Lakatos' or in Feyerabend's works, 'Realism, Rationalism and the Scientific Method', and 'Problems of Empiricism', (1981)). However, what if we then discover that the moth is nocturnal, and that it rests during the day in cracks, or under leaves, not on tree trunks and as such are not visible during the day? Secondarily, what if studies of the digestive systems of birds in this area show that birds do not prey on the moths in question. How do we then attempt to explain the phenomena in question? The standard response of biologists is to propose another purpose rather than investigate the deep structure of the phenomenon. As Gould and Lewontin state, (Gould and Lewontin, 1979) "the range of adaptive stories is as wide as our minds are fertile, new stories can always be postulated". Then, what if we discover that the cause of the moths darkening is due to the caterpillars eating leaves covered in pollution, and that the heritability of this purely cytoplasmic effect parallels that of what we would expect for a genetic mutation. The initial assumption of purpose in this case (that of protection from predation) leads to a extremely different line of investigation to that which would result from a more mechanistic, or arguably better, a total system perspective. It is the theory that determines what we can observe, and while this is often cited it is equally often forgotten, particularly with respect to organisms. So a teleological system, while useful in certain cases may often lead us further from the intelligibility of the system, rather than towards it. For some excellent examples showing how this can often be the case see Gould and Lewontin (1979). In many ways also the teleological approach may lead to entire systems of explanation that seem entirely consistent, that is that the system is set up in such a way that it can answer every question put at it, to quote Charles Darwin (1872, pg 395) "great is the power of steady misinterpretation" (a problem that unfortunately the biosciences is inundated with), and like Newton's metaphor of standing on the shoulders of giants, often we unaware that we stand in the ditches dug by giants. Perhaps the classic example is the 'Selfish Gene' concept of Richard Dawkins. In this system all organisms are treated as composed of genes who's sole purpose is to reproduce, this is their primary function, all other associated phenomena are secondary and only there because it suits the purpose of the gene. All phenomena are then analysed or assessed in respect to this hypothesis. Every action that can be proposed is

explainable in terms that it is a selfish action of the gene, and that it suits its ultimate purpose (which is its own reproduction). The particular 'strength' of this argument is in debate, by virtue of the fact that Dawkins can 'explain' every problem put to him virtually instantaneously in terms of the selfish purpose of the gene he can 'defeat' any opponent who bases their system upon for example a more complex or a mechanistic framework[28]. In effect Dawkins is using a framework for interpretation of the world rather than a theory, a framework that explains everything and consequently has no explanatory power or ability to make the phenomenon understandable, (i.e. it explains nothing). Teleology may be useful in certain conditions when examining organisms, but it can also be like an addictive drug that can control us if we are unwary of its dangers. Dawkins examples of the 'selfish gene' are one of the exemplary articles of this addiction that plagues biology.

Throughout his descriptions of organisms Kant relies on particular key words such as based around the notion of organisms as purposes, words such as design, and implications related to adaptation and function[29] (and this sense is carried through in a number of translations of the *Critique of Judgment* available). As these concepts themselves rest on an unsteady ground as to their place or value in talking about organisms and biology (Gould and Lewontin, 1979; Lambert, 1984, 1988; Webster and Goodwin, 1982) it is important for us to examine the alternatives to these words and ways of seeing and determine how well Kant's ideas may be reconfigured into

[28] In his 'Selfish Gene' argument Dawkins is effect proposing a version of teleology mixed with 'psychological egoism' - a position that is at best trivially true, (Stanford Encyclopaedia of Philosophy, Shaver, 2008), falls into problems of circularity, (Feinberg, 1958), and is, from the evolutionary evidence false (Sober and Sloan Wilson, 1999). Dawkins' book 'The Selfish Gene' been immensely popular amongst biologists (currently rated as the second most popular current selling book in the 'genetics' category on Amazon.com, 30 years after its release). This problem arguably highlights the continued importance for biologists to have an understanding of the philosophies that underpin their discipline if they are to enhance their research and conclusion development. To re-quote Darwin, "great is the power of steady misinterpretation" (Darwin, 1872), and it is also worth remembering Einstein's famous quote "It is the theory that determines what we observe".

[29] "When the archaeologist of nature considers these points, he is free to have that large family of creatures (for that is how we must conceive of them if that thoroughly coherent kinship among them is to have a basis) arise from the traces that remain of nature's most ancient revolutions, and to have it so according to the natural mechanism he knows or suspects. He can make mother earth (like a large animal, as it were) emerge from her state of chaos, and make her lap promptly give birth initially to creatures of a less purposive form, with these then giving birth to *others that become better adapted to their place of origin* and to their relations to one another, until in the end this womb itself rigidified, ossified, and confined itself to bearing definite species that would no longer degenerate, so that the diversity remained as it had turned out when that fertile formative force ceased to operate", (CJ §80: 419), (emphasis added).

an alternate and current key word frame work. Definitions of purpose seem to be generally linked with words such as function, if it can be shown that particular use of the word function is not needed in talking about organisms, or at least can be dangerously misleading then the definition purpose in the case of organisms would need to be redefined, (although it would still hold well in many cases (but not all) for things such as houses, which Kant has placed within the 'designed purposiveness' category rather than the 'natural purposiveness' category).

It should also be remembered, and it is important to understand that Kant is saying teleology is used only for humans, so it doesn't necessarily matter that organisms are not purposive. It's just he believes that we don't have any choice other than to treat them as if they are purposive. This doesn't necessarily mean Kant is right, (i.e., we may be able to remove the notion of purpose/function from our investigations of animals/organisms and replace it with an alternate framework). For Kant the teleological maxim holds the status of the synthetic *a priori*. We know that every event in nature follows from some other event in time, but we do not know it's particular cause without recourse to experience. Living things as biological wholes, as far as we [humans] can determine Kant believes, must be viewed as determining their parts. This then creates the problem of the effect causing its cause, which ultimately Kant believes and states cannot be. However, he does believe that we must conceive of it as being intended if we are to make sense of it. It is Kant's attempts at distinguishing 'living things' from 'non living things' in relation to the determining of their parts, (such as his example of an organism regenerating a lost body part) that does though create a confusion. Crystals also exhibit this property, for example ammonium oleate liquid crystals after breaking regenerate into the same pattern, as does an alum crystal, (Lima-de-Faria, 1988, pg 121-22; 1991, pg 281-295). Human societies also seem to operate under the same principles, (Waldrop, 1991), as do ant colonies, (Gordon, 2002). This in many ways seems to undermine his belief that biology is autonomous to the rest of science, (especially physics). Self regulating systems occur throughout nature whether organic or inorganic, matter or waves, (or something in between). Is it just the complexity of the situation or phenomenon in question that leads to the distinction between something being classed as purely causal and purpose driven? In later sections it will be argued that there is more to this situation than the possibility of a

mechanistic description, although explanation in terms of efficient cause still in many cases holds great value.

In continuing with this line of thought Kant defines organisms as organised unites, not mere aggregates. Systematically organised things for our understanding exhibit a kind of purposiveness[30] that mere aggregates do not[31] (although they can be purposively structured by us, CJ §82: 427). However, Kant chooses an unfortunate example, to explain this distinction, particularly that of stone and minerals. This distinction between organisms and 'mere aggregates' creates a form of dualism, that results in problems similar to that of mind body dualism[32]. Kant's continuing insistence that organisms form an exception to a general mechanical view of nature and that as a consequence we must make a distinction is confused by bad examples, that is the things he claims are so different in many cases show great similarity and/or inter connectivity, (for example, the homology of a bismuth crystal with a leaf, a butterfly wing and the leaf insect, (figure 6), or the vertebrate skeletal matrix, (figure 7).

[30] Kant's definition of purposive (from McFarland, pg 90): They are not mere aggregates, (that is could not have been produced by chance) but are systems, and thus *seem to depend upon an idea*. That is, systematically organised things have internal purposiveness, whereas artefacts have external purposiveness.

[31] "If the natural beings on earth formed a purposively ordered whole, the first intentional arrangement would presumably have to be their habitat, the ground or [other] element on [or] in which they were to thrive, [since] that is the foundation of all organic production. But as we become better acquainted with what the foundation is like, we find that it points to no causes other than those that act wholly unintentionally, causes that are more likely to be devastating than to foster production, order and purposes… The shape of the land, its structure and its slope, may now seem very purposively arranged: to receive water from the air, to feed the water veins between diverse veins of soil (each [suitable] for all sorts of products), and to direct the rivers. But a closer investigation of them proves that they are merely the result of eruptions, either of fire or water, or of upheavals of the ocean… So the habitat of all these creatures, the native soil (of the land) and the lap (of the sea), *provides no indication of having been produced by any but a wholly unintentional mechanism"*, (CJ §82: 428). (emphasis added)

[32] 'Dualism contrasts with monism, which is the theory that there is only one fundamental kind, category of thing or principle; and, rather less commonly, with pluralism, which is the view that there are many kinds or categories. In the philosophy of mind, dualism is the theory that the mental and the physical — or mind and body or mind and brain — are, in some sense, radically different kinds of thing', (Robinson, 2007).

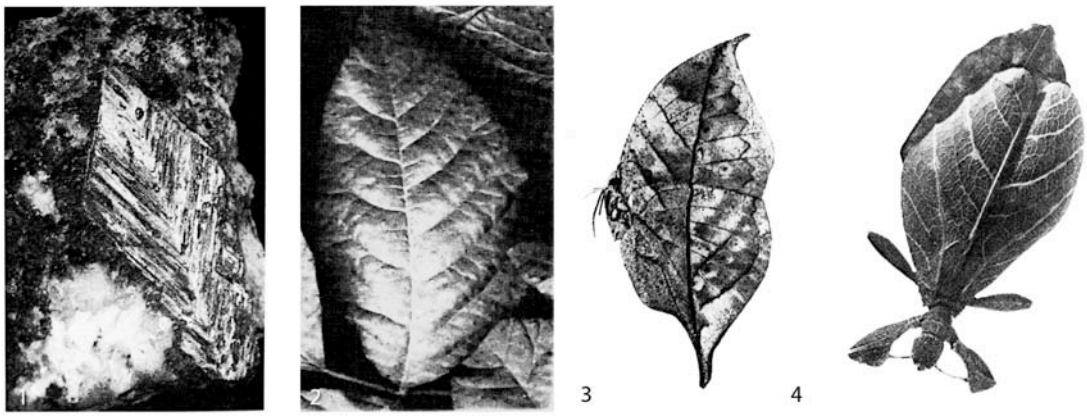


Figure 6 – 1) Bismuth crystal in its native state, 2) Poison ivy leaf, 3) leaf-like butterfly *Kallima,* 4) Leaf like insect *Chitoniscus feedjeanus.*

Image courtesy of A. Lima-de-Faria, (1988)

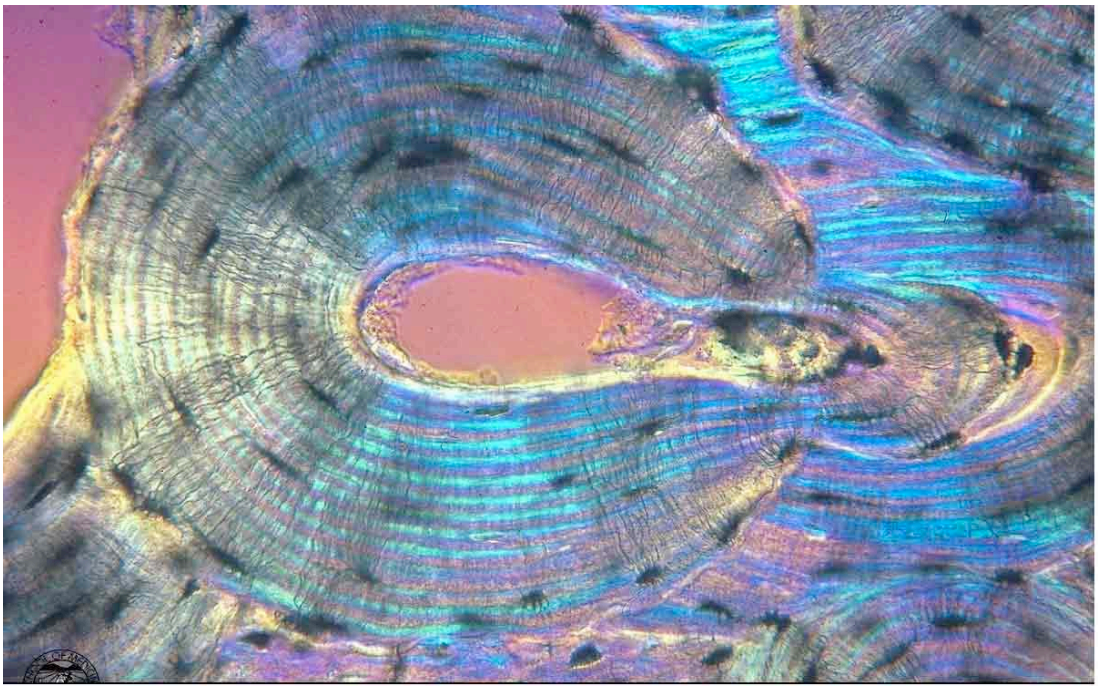


Figure 7 – The vertebrate skeletal matrix – an osteocyte entrapped in bone during the mineralisation process.

Courtesy of http://medocs.ucdavis.edu/CHA/402/studyset/lab5/lab5.htm

As Kant alludes, it may be more a factor of our conditioning that prevents us from seeing organisms and non-organic beings as part of the same system (including separating out and prioritising teleology and the mechanistic/efficient cause and leaving other aspects of causality, such as formative out of the description/investigation). A great many (if not all) of the forms of organisms (which for Kant then imply purposiveness and function) can be found in 'mere

aggregates'. As will be shown in later sections with examples from Thompson (1942) and Lima-de-Faria (1988), there are cases that trained professionals cannot distinguish between the organism and the aggregate, not only that but, these aggregates self regulate and self organise. This does not though necessarily threaten the idea that organisms are more than mere aggregates, but it does lead us then to question whether what have been previously thought of or classed as 'mere aggregates' (and in fact the way we also class organisms), are in fact a whole different mode of interconnected being that biologists are gradually in the process of updating our understanding of. That is, that we may be starting to discover the methods and ways of seeing to bring what Kant thought could only be known by a supersensible intelligence into our perception and understanding of nature and science.

The problem was for Kant that 'the concept of an organised entity is of such a quality that our reason could not make any complete concept of its possibility without a teleological principle in nature' (CJ §68: 382). That is that human intelligence is structured in such a way that we cannot explain organisms purely by mechanistic type of causality (efficient cause, or *nexus effectivus*). As a consequence we have to incorporate or invoke a second type of causality, namely that of final causes (*nexus finalis*), or teleology which brings in the notion of purpose. The type of teleology that Kant based his arguments around was, like those of David Hume's *Dialogues* based around the argument from design, (as opposed to the ontological or cosmological arguments). So, why did Kant and Hume wish to steer away from the ontological and cosmological arguments in preference to the argument from design? The reasons for this may be summarised into two main points. Firstly by the fact that God's existence could not be proved (i.e., we have no way of reaching a theoretical knowledge of God) Kant and Hume were not prepared to use the direct involvement of God in nature (for example, CJ §68: 381). Hume was convinced that purpose and design are found in nature, (M^{C}Farland, 1970 pg 49) while Kant was prepared to use this idea in his investigations but not commit to it as the actual account for nature. Secondly Kant believed that we had to refrain from explaining the order of nature as coming from the will of a supreme being as this would then cease to be natural philosophy. By

incorporating a supreme being into our system we would be 'confessing that we had come to the end of it'.

> From this matter, and its forces governed by mechanical laws (like those of crystal formations), seems to stem all the technic[33] that nature displays in organised beings and that we find so far beyond our grasp that we believe that we have to think a different principle [to account] for it, [that is teleology, or purposiveness], (CJ §80: 419).

Teleological judgments according to Kant do not explain objectively, that is, for the possibility of this kind of things themselves but do explain 'for us', that is they hold only subjectively. To view or judge a thing to be a product of nature Kant claims we must use both teleology and mechanism (CJ §78: 414). However, due to the nature of our consciousness and its limitations, not only do we have to work with two seemingly contradictory systems we must also subordinate one of these principles to the other. *This subordination is Kant claims, an essential character of our reason.*

> Only this much is certain: no matter how far it will take us, yet it must always be inadequate for things that we have once recognised as natural purposes, so that *the character of our understanding forces us to subordinate all those mechanical bases to a teleological principle,* (CJ §78: 415). (emphasis added)

When it comes to our understanding of organisms in relation to mechanistic and teleological thought Kant stresses that the only objective explanation that we are capable of is in terms of mechanical laws (CJ VI 218'). Teleology is to be used merely as a description of nature (CJ §79: 417), it gives us no insight into how organisms are produced[34]. But isn't it by understanding how organisms come about that they in a sense become understandable to us, that is by understanding the deep structure, the developmental rules that they form under that we can further avoid the

[33]Technic in the sense of art as related to craft.
[34] Hence Kant's refusal to utilise the common ancestor argument in our attempts to understand the nature and coming to be, (in the formative sense) of organisms. Kant's argument is summarised in the footnote section of 3.2.

explanatory problems, and its consequent effect on our experimental design from the outset that a teleological perspective is prone to?[35]

> But the universal idea of nature as the sum total of sense objects gives us no basis whatever [for assuming] that things of nature serve one another as a means to purposes, and that even their possibility cannot adequately be understood except [as arising] through a causality in terms of purposes, (CJ §61: 359).

2.8: Kant on organisms as self-organised natural purposes

The main important point with which to consider with respect to teleology, more so than that of final causes is that of the notion of purpose (or a more or less anthropomorphic perspective), or whether there is a pre-set plan of any sort involved, that is indication of conscious design. As previously discussed in section 2.4, Kant distinguishes two kinds of purposiveness, intrinsic, (the internal natural purposiveness of an organism where the effect is the purpose) and relative (the extrinsic purposiveness associated with, for example the sandy soil laid down by a river that is ideal for spruce trees to grow on, that is, that other causes employ purposively, i.e. not a natural purpose). Further examples of these are outlined in CJ §63: 368. For Kant a self-organised being is a biological organism, a natural purpose. An organised thing is merely an artefact.

Organisms seem to express a self organized, internal, purposive nature, how are we to explain this? Self organisation for mathematics begins with 'bifurcations', at this stage new configurations become energetically possible and matter spontaneously adopts them, (this will be treated later but for the moment it is useful to keep it in mind). While a purely mechanistic account seemed to fit and be sufficient in the case of (classical) physics and Newton's laws, to obtain an

[35] Alternate versions of teleology have been proposed over the years that claim to bypass the standardly accepted problems associated with teleology. These are most notably, Pittendrigh's 'telonomy' in 1958, (further developed and refined by Ernst Mayr, 1965 and G. C. Williams, 1966) and teleomatic. However, in agreement with Hull, (1982) this merely replaces the word teleology for teleonomy or teleomatic and holds to the same architecture, form and problems. It at best sits as a subset of the fundamental cause, i.e. teleology, and consequently unfortunately does not provide a path to bypass the final cause problem of design like characteristics in organisms as discussed by Kant, (the real issue at hand).

understanding of organisms it seemed to Kant that an extra type of explanation was required, that with respect to the notion of purpose, final causes. This created a major problem for Kant and for biology[36] in general. Kant was averse to ascribing purpose to nature as this lead to the problems of introducing an intelligent guiding force behind the scenes, or external to it, much like in an artwork. This was not something that he wished to do.

So, how for Kant do we determine when there is internal purposiveness present? How do we differentiate ice cracking due to temperature from the flame cells of a flatworm causing the expulsion of water from its system, in regards to a natural purpose?

Kant believes that if we can use or if it seems legitimate to cite *the effect* of a causal relation to explain the cause then purposiveness is present in nature. That is, in the case of the cracking ice (the effect) to explain is why there is a rise in temperature, whereas it seems legitimate to cite the expulsion of water to explain the activity of the flame cells. So for Kant the flame cells are a natural purpose, whereas the ice cracking/temperature rising is not[37]. This purposiveness Kant believes has to be connected with the concept of functionality, that is *a natural purpose has an effect which is a function.*

However, if we return to our previous examples of crystal regeneration in ammonium oleate or alum, as compared to the newt limb regeneration the legitimacy is questionable. These crystals seem also to be exhibiting a 'natural purpose', so can we call this effect a function? Perhaps then Kant could argue that it is not legitimate to call these natural purposes, as they have no function, but this would make the defining of a natural purpose or function of questionable value due to the arbitrary placement of it in relation to some things and not others. Perhaps though Kant can argue that this concept of functionality is, as part of the teleological notion ultimately only a short hand by which to relate in our understanding the nature of a purely causal system that we cannot ultimately comprehend. That is, it acts as an analogy

[36]The term biology was first used in its present meaning by Gotfried Reinhold Treviranus in 1802 which he defined as study of "the different forms and manifestations of life, the conditions and laws under which these phenomena occur, and the causes through which they have been effected." (in Richards, 1992). While at the time of Kant publishing his Critiques the term did not exist in common usage (Kant used terms such as '*Naturphilosophie*' in its place) it will be used here to carry forth and is consistent with the idea Kant was examining.

[37] For further examples see (CJ §82: 428).

between epigenetic wholes and constructed designed artifacts. In effect he is using a probabilistic argument (that an organism and artefact share a certain trait, so we can say it is more or less probable that they are designed), there are though equally good reasons for not making this inference. Perhaps most notably he still misses out on explaining why he considers it is that we view some wholes as being the cause of their parts and others not. This is especially important when we see and become aware of the sameness between the organic and inorganic (something that had been raised around his time in particular by Herder with his Spinozistic styled theory of 'Hylozoism', and more currently by Lima-de-Faria). In this case, Kant rests on the statement that it is an unanswerable question, beyond our human understanding.

This self organising nature of organisms is further discussed, throughout the *Critique of Judgment*. According to Kant *bildungstrieb*[38], (formative impulse), is "the ability of matter in an organised body to [take on] organisation", (CJ 81: 424). Kant seems to infer that this is not purely mechanical, as he outlines below,

> it is distinguished from the merely mechanical *formative force* that all matter has, but stands under the higher guidance and direction, as it were, of that formative force, (CJ 81: 424).

Kant agreed with Blumenbach (CJ §81: 424), that life could not spring from what is lifeless[39], and matter could not mould itself on its own to form a self-preserving purposiveness. It does not though infer in any way that he agreed with Blumenbach's vitalist notions on the nature of this force. It is this formative force that is associated with the idea of an internal free cause, that is in an organism the parts are not only related mechanically to the whole, but are under guidance of, or formed by the whole, (and this seems to link efficient, and final cause through formative). But Kant never picked up on that and developed it further, (Bohm, 1980 has a brief discussion of the possibility). Is it because he didn't apply this through a concept of a 'phase state / implicate order / archetype' notion of whole (rather than a physical one)?

[38] This term was first coined by Blumenbach.
[39] This was in opposition to another main theory at the time, Herders 'hylozoism' (which proposed that life had sprung from what is lifeless). Technically, and in relation to Goethe's development of *bildungstrieb* and the potential of organisms and the inorganic having no fixed boundaries you could just as well apply *bildungstrieb* to both spheres given certain conditions.

Throughout Kant's writings we find the idea continually surfacing that there is some form of inner 'purpose', or pre-figuring of the forms of systematically organised beings. Chance, or mechanical laws he believes, to our understanding are not capable of producing this interrelationship, whether it be in the formation of structures of the animal or its developmental changes over its life , and so organisms must be considered an exception to the general mechanistic treatment of nature (such as with Newton's laws of universal gravitation). Kant's problem seems to rest upon the assumption that may be summarised as follows.

In nature there are things (systematically organised beings) that seem to exhibit a purposive nature, however, mechanistic processes are blind[40], or solely due to chance and so cannot produce this purposiveness. Therefore the only other option that Kant believes is left to us is that of teleology. It is from this standpoint that he develops his investigation into the nature of organisms and the limits of scientific knowledge. However, it must be noted that Kant states that while we may conduct our investigations under the principle of purposiveness to obtain *possible* teleological connections once we have found such connections we must go on to look for the mechanical laws that produce them, (CJ §78: 411). However, this statement while appearing useful can still lead to a number of problems. As was discussed in section 2.7, in relation to adaptations and the concept of the selfish gene, the teleological notion may allow us to create a vision so enrapturing that we lose sight of important aspects of the phenomena that we think we are investigating[41]. As a consequence of this, the ability to develop many of the important causal links may not be considered (due to the flurry of 'connections' we may rapidly draw through the use of the

[40] 'For once we take such an effect as a whole beyond the blind mechanism of nature and refer it to a supersensible basis as determining it, then we must also judge this effect wholly in terms of that principle', (CJ §66: 377).
'We may thereupon judge products as belonging to a system of purposes even if they (or the relation between them, though [perhaps] purposive) do not require us, [so as to account] for their possibility, to look for a different principle beyond the mechanism of blind efficient causes', (CJ §67: 381).

[41] Dawkins flounder example in the Blind Watchmaker is a classic example of a problematic teleological explanation "... bony fish as a rule have a marked tendency to be flattened in a vertical direction.... It was natural, therefore, that when the ancestors [of flatfish] took to the sea bottom, they should have lain on one *side*.... But this raised the problem that one eye was always looking down into the sand and was effectively useless. In evolution this problem was solved by the lower eye 'moving' round to the upper side". As we see from Kant's discussion of the problem of teleological explanations and also compared to critiques from Gould and Lewontin, (1979) this cannot be taken as any form of explanation for the evolution of an organism.

teleological perspective). Ultimately all we may end up doing is playing games in abstract systems.

If we accept Kant's premise that organisms are cause and effect of their own form this still leaves the question why we need to introduce the concept of purpose. The acknowledgement of bi-directional causality does not necessarily force us to assume that the concepts of purpose are involved in our knowledge of the organism. While Kant may believe that this is a limit that we must adhere to there are other possibilities that may also be possible, not just by achieving supersensible intuition, (which by definition is beyond us). It is therefore important for us to investigate postulated types of 'bi-directional causality', or types of 'causality' that may supersede the limits of Aristotelian and Humean causes and hopefully allow us to utilise a system for our investigations of organisms and nature that doesn't fall prey to problems such as Dawkins Flounder example.

2.9: The apparent designedness[42] of organisms

The notion of design in nature is as important for Kant as it was for many of his contemporaries, and indeed is still an important current debate in biology. Throughout the *Critique of Judgment* Kant works from the belief that we must treat nature as if it were designed, even though, due to the nature of our intelligence we cannot ultimately know whether it is or not. Indeed, in his first introduction to the *Critique of Judgment* he claims that for human judgment to be possible at all in particular with respect to nature we must assume that it has been designed.

[42] 'Designedness' is defined as the state or quality of being designed. It is classified as an uncountable noun in that it cannot be used freely with numbers or the indefinite article. Clark Zumbach uses this term in relation to the Critique of Teleological Judgment in his book 'The Transcendent Science', (1984). The term has also been chosen in this section due to the still frequent use of the term 'design' in the biological sciences, 'It is common for authors [of the biological sciences] to slide between claims about function and design as if they accept this principle', (Stanford Encyclopaedia of Philosophy, 2008). This use of the term 'design' and design based thinking rather than Kant's recommendation of 'natural purpose' in biology leads directly to problems that Kant avoided by choosing not to base his arguments on the ontological or cosmological arguments (which would incorporate the notion of a designer). Hence Kant believed that we had to refrain from explaining the order of nature as coming from the will of a supreme being as this would then cease to be natural philosophy (biology). By incorporating a supreme being into our system Kant states, we would be 'confessing that we had come to the end of it'. This has been expanded in section 2.5.

Chapter 2: Problems of causal explanations of organisms

Organisms for many perspectives appear to exhibit a 'designedness', the problem for Kant then becomes where does this designedness come from? That is, how intelligible *for us* can we make it? Kant's earlier claims lead us to the apparent problem of lacking sufficient evidence to state that organisms are actually intelligently designed, and that due to the contingent nature and inexplicability of the mechanistic approach we cannot explain them from this angle either. Kant's belief in the source of this apparent purposiveness is given to us early in the '*Critique of Teleological Judgment*'. In the first section (section 61) he claims that;

> [We] slip the concept of a purpose into the nature of things rather than take it from objects and our empirical cognition, (CJ §61: 360).

> We cannot hope to find *a priori* the slightest basis for that unity unless we seek it beyond the concept of nature rather than in it, (CJ §61: 360).

Kant rejected the two standard arguments used to justify the use of teleology, namely the ontological and the cosmological arguments, (Kant outlines the problems inherent in these in CPR: A607-8/B635-6). Instead he based his ideas on the principle based on the argument from design (CPR: A616-17/B644-5). Like Hume, Kant rejected the Paleyesque watch and its maker analogy[43], due to its reliance in an external creator (God). However the argument from design doesn't necessarily have to include the notion of an external creator and can as Kant realised operate as to a certain level as a heuristic, (and it is to the investigation of the levels and possibilities of this as a heuristic that much of the *Critique of Teleological Judgment* is devoted). If the 'designer' is taken as the organism itself (i.e. as a natural purpose that has

[43] Paley's Watchmaker argument is a classic argument from design for the existence of God, or an intelligent creator in nature. There are a number of variants of this, but the basic argument can be summarised as follows (in relation to organisms complexity).
Watches are complex, watches are made (by a designer – The watchmaker)
Organisms are [even more] complex; therefore they must also be made by a designer (God).
The argument is standardly found to be invalid due to falling into the fallacy of being a '*loaded question*' as well as the fallacy of '*affirming the consequent*', for example:

If P, then Q	If John owns 100 houses, then he is rich.
Q	John is rich.
Therefore, P	Therefore, John owns 100 houses.

Regardless whether the premises are true these arguments do not give a good reason to establish their conclusions. Also in the case of artefacts (e.g. watches) and organisms there is no necessary and sufficient link from which to draw an analogy.

purely intrinsic purposiveness) then Kant believes the argument from design still holds some use in our explanations. The argument from design can then be used to act as a foundation and as a heuristic to guide our investigations and explanations of natural phenomena, although we must be aware to keep our descriptions away from art based talk. "We say far too little", Kant writes, "if we call [organisms] an analogue of art, for in that case we think of an artist apart from nature… The organization [of living things], infinitely surpasses our ability to exhibit anything similar through art" (Kant, in Grene and Depew, 2004).

So, with this Kant's utilisation of a form of the argument from design has laid out his basis for the use as a heuristic for teleology and describing in a sense in terms of purpose for our descriptions of organisms. It then remains for him to see how this teleological system can be related to the notion of a causal (in the sense of efficient cause) world that these organisms exist in. This is of course a major point to investigate. Organisms seem (to our understanding and way of seeing) to exhibit design like characteristics, (such as the relationship and properties of internal organs), yet there is no external designer. As will be outlined in section 3.2, Kant showed that a version of the 'common ancestor' argument held for him no explanatory power in relation the understanding of development and evolution process by which these 'design like' structures came into being and related to each other or the environment that they existed in. That is, all it tells us is that one organism has a connection in time to another at a certain point in history, and not what Kant and the Naturphilosopher's believed was the central aim of explaining living creatures. *The development of these 'design like' structures and how to make these as intelligible as possible to our understanding*, (which for some (such as Schelling) was ultimate understanding, and for Kant was limited by the nature of our finite intelligence).

Chapter 3

Applying Kant's ideas *in situ*

The movement beyond mechanism and teleology

3.1 Discussion of the antinomy of mechanism and teleology: The possible reconciliation of the antinomy by introduction of the principle of supersensible intuition

Kant on the limitations of our knowledge

In his investigations of nature and organisms in the *Critique of Judgment,* once Kant has laid out the limits of the nature of our judgments, (determining and reflective), he explained that the two maxims of reflective judgment (mechanistic and teleological) will always be incomplete for our explanations of organisms, (this is due to the nature of our discursive[44] understanding) and we must use them together when

[44] Discursive understanding is defined by Kant as conceptual, dependant upon reason, and is the way that we explain the world. Our discursive understanding requires contingency, because it must start from the parts, from which the whole is dependant on. For Kant, if with our discursive understanding we attempt to try to understand the parts as dependant on the whole (as an intuitive (archetypal) or supersensible understanding does) we cannot do this and we will only cognise a contradiction, (CJ §77: 407). "If our understanding were intuitive [rather than discursive, i.e., conceptual] it would have no objects except actual ones]", (CJ §76: 402).

studying nature. He then proceeds to show that in our investigations one of these maxims (mechanism) must be subordinated to the other (teleology) if we are to be able to systematise our empirical knowledge of nature. However, the use of both maxims together, these being

For Mechanism:

> All production of material things and their forms must be estimated as possible under mere mechanical laws, (CJ §70: 387). [Thesis]

For Teleology:

> Some products of material nature cannot be estimated as possible on mere mechanical laws, (their estimation requires a quite different law of causality, namely that of final causes), (CJ §70: 387). [Antithesis]

Results in an antinomy, or contradiction between two laws. To deal with this problem Kant postulates a possible reconciliation of the antinomy in a higher principle (since regardless of our limits of understanding nature still exists as it is).

> ...since the basis for this reconcilability lies in what is neither the one nor the other (neither mechanism nor connection in terms of purposes), but is nature's supersensible substrate that we cannot cognise at all, [it follows that] our (human) reason cannot fuse these two ways of conceiving how such objects are possible, (CJ §78: 414).

> ...then we can presume that we may confidently investigate natural laws in accordance with both principles (once our understanding is able to cognise [how] the natural product is possible on the basis of one or the other principle), without our being troubled by the seeming conflict that arises between the two principles for judging that product. For we are assured that it is at least possible that objectively, too, *both these principles might be reconcilable in one principle* (since they concern appearances, which presuppose a supersensible basis), (CJ §78: 413). (emphasis added)

Kant justifies the use of teleology in his investigations by stating the limits of human knowledge. According to Kant we can never come to explain a systematically organised being under a purely mechanistic framework, we must introduce the notion of purpose, (CJ §75: 397-398). He justifies this claim by reference to the possible conjoining of what to human understanding seems to be an antinomy in the 'mind' of a supersensible intelligence. That is, *in this supersensible mind efficient and final cause are not separable, and the apparent purposive nature of organisms sits logically with their apparent contingent mechanistic nature,* (McFarland, 1970). For a supersensible understanding (as differing from our discursive understanding) is, Kant claims intuitive, and "hence proceeds from the synthetically universal (the intuition of the whole as a whole) to the particular, that is, from the whole to the parts", (CJ §77: 407)[45]. It is in this supersensible understanding that both principles (efficient and final cause) are reconcilable in one common higher principle of nature (CJ §78: 413). This reconciliation Kant claims, lies not in either mechanism nor in terms of purposes, but "is nature's supersensible substrate that we cannot cognise at all", (CJ §78: 414). This supersensible principle, by not having to base the possibility of organisms on 'an idea' could Kant contends, see organisms as necessary and not contingent, the result of a higher causality in which teleology and mechanism are united, (M^{c}Farland, 1970; pg 129). That is, he is not denying that there is a whole, but his statements do infer that he believes that it is impossible for the whole to be the cause of its parts. This positing of the supersensible intuition does however lead to some questions in relation to Kant's discussions. If the supersensible intuition is a concept of reason, as is the concept of purposes, (CJ §65: 372) then does this place teleology above mechanism not only for us but also give an indicator of a supersensible intuition that also takes some form of purposiveness over that of a Newtonian mechanistic framework?

> It is reasonable, even praiseworthy, to try to explain natural products in terms of natural mechanism as long as there is some probability of success. Indeed, if we give up this attempt, we must do so not on the ground that it is intrinsically impossible to

[45] This has some interesting potential parallels with Bohm's Holomovement / Hologram theory of the universe (Bohm, 1980) and also extremal principles that will be discussed in later sections regarding a possible avenue to bypass Kant's restrictions, but for the moment is worth keeping in mind.

> find the purposiveness of nature by following this route, but only on the ground that it is impossible *for us* as human beings, (CJ §80: 418).

From this statement Kant follows that if we were to try and find nature's purposiveness by this route we would have to surpass sensible intuition, (into the supersensible) and this being beyond our ability is therefore impossible for us.

> We can have no concept of the supersensible except the indeterminate concept of a basis that makes it possible for us to judge nature in terms of empirical laws; but we cannot determine this basis any further by any predicate, (CJ §78:412).

> Now the principle that mechanical and teleological derivation have in common is the *supersensible*, which we must regard as the basis of nature as phenomenon. But of the supersensible we cannot, from a theoretical point of view, form the slightest determinate and positive concept, (CJ §78: 412-413).

The human mind according to Kant is absolutely unable to unite the two maxims of reflective judgment. If we consider something to be a natural purpose (that is 'explained' using teleological principles) then we cannot consider it to be mechanically produced. This is due to the antinomy that arises due to the nature of these two strategies of looking at organisms. This antinomy gives rise to major problems in our investigations of organisms. We have in the later sections investigated whether this antinomy is really there for our understanding if we investigate nature by using or referring to an acausal system.

While Kant believes that a supersensible intuitive understanding through a universal or concept may be able to know the nature of organisms, this he claims is beyond us due to our lack of a universal by which to subsume our intuition of biological activity. As a consequence we must resort, he claims, to the teleological maxim to gain our understanding of organisms, (as opposed to aggregates such as crystals which are understandable purely under efficient cause).

Figure 8 - How Kant states our human, discursive knowledge sees the world as teleologically and mechanistically in relation to the world, (we are limited to the white boxes)

Figure 9 - The universe as a supersensible intelligence perceives it, (no antinomy, no subordination of mechanism).

Part of the problem in our discussions of the *Critique of Teleological Judgment* still seems to be Kant's unnecessary separation/creation of a dichotomy between what 'we' define as 'organisms' and 'life' and what 'we' define as 'non-organism'/'non life'. So where would Kant go, what would he say if he removed this distinction from his system? Would this allow him to treat all of nature teleologically or mechanistically, or would he need to reconstruct his notions of purposiveness?

The antinomy of mechanism and teleology does create problems for our investigations, and as Kant believes we have to leave it at that and leave the answer to the mind of a supersensible intelligence. But perhaps we could take an alternate approach. The resolution of a paradox or apparent contradiction of something that we can see sitting in front of our eyes is often simple – we are asking the wrong question.

Let us now take Geoffroy Saint-Hilaire's approach and attempt to 'take a step back' from things that from our initial perceptions appear different and see if they can be seen as one[46].

3.2: The organism and its links to the inorganic

> So many genera of animals share a certain common schema on which not only their bone structure but also the arrangement of their parts seems to be based; the basic outline is admirably simple but yet was able to produce this great diversity of species, by shortening some parts and lengthening others, by the involution of some and the evolution[47] of others, (CJ, §80: 418)[48].

[46] Geoffroy Saint-Hilaire was the fundamental investigator who first proposed the 'unity of plan' (what is now called homology) of the vertebrates, [such as between the birds, mammals, reptiles, amphibians and fish skeletal structure, organs and the like] when previously no solid connections had been shown. "Geoffroy's prescient insights foreshadowed some of the most recent discoveries in evolutionary and developmental biology" (Le Guyader & Grene, 2004), and remind us of the importance of studying the history of our field of scientific research as a potential avenue to help bypass current problems.

[47] As a clarification, 'evolution' stems from the Latin *evolvere (to unfold, open out expand)* and originally had a decidedly developmental connotation. Darwin himself was aware of this (he used the word evolution only once in 'The Origin of Species' (1859)), and preferred to use the term 'descent with modification' for his theory. Kant's use of the term 'evolution' in the Critique of Judgment is in the original sense (i.e. pre Spencerian).

Kant states that organisms must be treated differently from the inorganic realm due to what appears to be purposive design. But what reasons does he give to distinguish the nature of this designedness? What is it that distinguishes their apparent designedness from that of something such as crystal formation? In the *Critique of Teleological Judgment* Kant gives mention to the similarity between organisms and crystals[49]. If it can be shown that it seems likely that this apparent 'purposiveness' between organisms and crystals, and non-organic forms is not just apparent but is in fact important, and as such that organisms cannot be meaningfully distinguished from the non-organic then where does this leave Kant, and where can it lead us? It would appear to give us a number of options. It would help to justify Kant's claim that ultimately nature is understandable under the same non-contradictory principle, (that is in his concept of the supersensible intuition). It would also cause us to question the validity of his claims of (for us) a distinction of organic and non organic (i.e. what Kant believes are merely aggregates) forms, and

[48] Kant continues this statement in an interesting fashion (to those interested in the field and history of evolution, in particular similarity to the basis of Darwin's theory). "Despite all the variety among these forms, they seem to have been produced according to a common archetype, and this analogy among them reinforces our suspicion that they are actually akin, produced by a common original mother… that large family of creatures (for that is how we must conceive them if that thoroughly coherent kinship among them is to have a basis) arise from the traces that remain of natures most ancient revolutions", (CJ §80: 419). However Kant choses not to take this explanation further (as Darwin so successfully did for his theory to the minds of the general public), stating. *"And yet, in giving this account, the archaeologist of nature will have to attribute to this universal mother an organization that purposively aimed at all these creatures…But if he attributes such organization to her, then he has only put off the basis for his explanation"*, (CJ §80: 420). To summarise, Kant felt the above approach carried too great a teleological component that could not be ultimately bypassed (and would hence mislead us away from the real question we should be investigating regarding the forms of organisms) to have value in philosophically robust investigations. In short, for Kant an organisms origins and connections historically to other organisms is a sideline (although still important) of the arguably 'deeper' topic of 'what is this thing that we call nature/life, how it unfolds, and how much of it can we come to understand'. As an interesting extra connection to Darwin's theory, Kant (in Anthropology AK. VII 327-328) also wonders whether in one of nature's later epochs, the organs that the orangutan or a chimpanzee uses to walk, feel objects, or talk might have developed into human structures, (Pluhar, 1987).

[49] "For the different animal genera approach one another gradually: from the genus where the principle of purposes seems to be borne out most, namely man, all the way to the polyp, and from it even to mosses and lichens and finally to the lowest stage of nature discernable to us, crude matter. *From this matter, and its forces governed by mechanical laws (like those it follows in crystal formation), seems to stem all the technic that nature displays in organised beings and that we find so far beyond our grasp that we believe that we have to think a different principle [to account] for it [teleology]"*, (CJ §80: 419). (emphasis added)

"Insofar as nature's products are aggregates, nature proceeds *mechanically, as mere nature;* but insofar as its products are systems – e.g., crystal formations, various shapes of flowers, or the inner structure of plants and animals – nature proceeds technically, i.e., it proceeds also as *art*, (CJ VI: 218').

related to this, it may lead us to investigate and examine the possibility of non-organic self-organisation.

As our first example into the investigation of this let us start with the organism, and let us look for instances of crystal type formations in it. If we investigate what seems to be one of the most obvious starting points, the vertebrate skeleton then we will not be disappointed. The bones of vertebrates as seen in figure 7 are composed of a lattice of calcium crystals, enmeshed in this are bone cells (compare now to formations of bubbles and lattices, fig. 10).

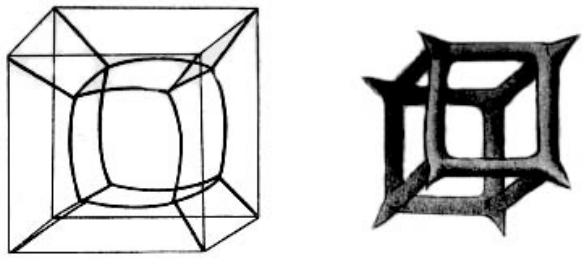


Figure 10 – A bubble suspended within a cubical cage. B. Lithocubus geometricus (from Thompson, 1942; pg 715)

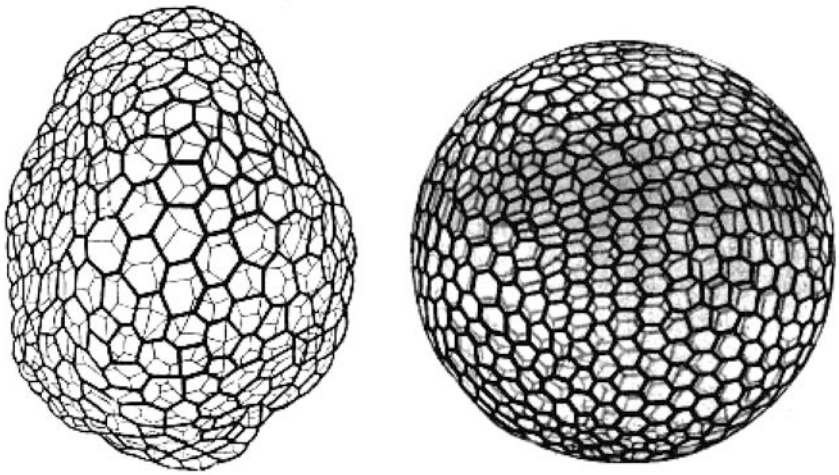


Figure 11 - A "*Reticulum plasmatique.*" B. *Aulonia hexagona*
(from Thompson, 1942; pg 708)

Next to Diatoms such as the Radiolarians (fig 11), a majority of their mass is a silica crystalline lattice, "these owe their multitudinous variety to symmetrical repetitions of one simple crystalline form - a beautiful illustration of Plato's *One among the Many*", (Thompson, 1942, pg 695) and also a reminder to us of Goethe's

notion of the Urpflanze. Indeed, true crystals of celestine[50] have been reported to occur in the central capsules of Radiolaria, such as the genus *Collosphaera*, (Muller in Thompson, 1942, pg 697-698). Next if we turn our observation to the plant kingdom, we discover the occurrence of the druse and raphides, compound crystals composed of calcium oxalate that can be found in epidermal cells. At an even deeper level both DNA and cell membranes are considered liquid crystals, (Calendar and Abedon, 2006, Collings, 2002) Not only is there this evidence of actual crystals being integral components of the organism, but the shapes and forms of organisms are in many cases homologous to mineral formations, and going beyond this also exhibit similarity in shape to processes such as fluid dynamics. Many groups of animals exhibit an extremely similar form/structure to a certain type of crystal structure. The Class echinodermata displays five-fold symmetry just as does the class of quasi-crystals, and many plants, animals and crystals exhibit three-fold symmetry, (Fig 12; Lima-de-Faria, 1988). The structures of plants can be seen to have homologs throughout the mineral kingdom, while the sponges (Class Porifera), are built around a crystalline lattice of spicules, (Thompson, 1942).

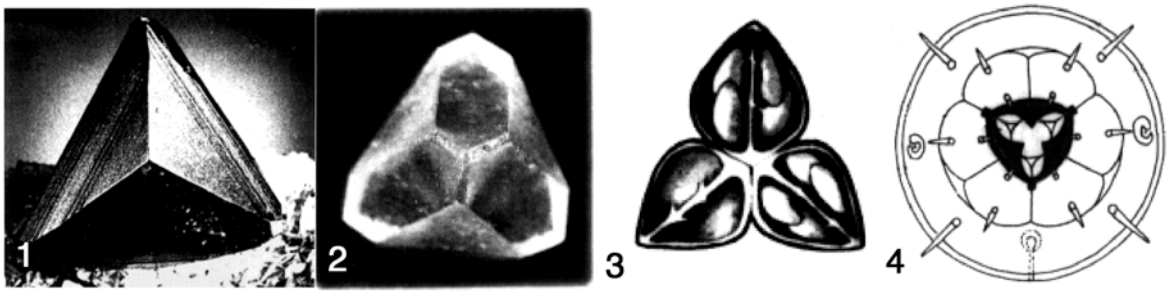


Figure 12 - Threefold symmetry in minerals (1 and 2), plant (3), and animal (4). Image courtesy of A. Lima-de-Faria, (1988)

> Even now the zoologist has scarce begun to dream of defining in mathematical language even the simplest organic forms. When he meets with a simple geometrical construction, for instance in the honeycomb, he would fain refer it to psychical instinct, or to skill and ingenuity, rather than to the operation of physical forces or mathematical laws; when he sees in snail, nautilus, or tiny foraminiferal or radiolarian shell a close approach to sphere or spiral, he is prone of old habit to believe that after

[50]SrSO4 with some BaO replacing SrO

> all it is something more than a spiral or a sphere, and that in this 'something more' there lies what neither mathematics nor physics can explain, (Thompson, 1942).

D'Arcy Wentworth Thompson was one of the first biologists to attempt a synthesis of a study of biological form and mathematics. His place in history, perhaps most noticeably being marked by his book 'On Growth and Form' (1917, 1942). Throughout the book he examines the forms of organisms as well as inorganic forms and gives mathematical descriptions of the relationships, or processes by which these forms may come to be. He shows how complex forms may come about from the nature of relatively simple processes of physics, or basic 'units'. Much of this work seems to owe some form of allegiance not only to Kant, who Thompson regularly refers to, but also to Leibniz. In fact, it in many ways parallels many of Leibniz's ideas and develops a mathematical analysis of these principles. This can be seen in the equation for the shape of a hanging chain which states that a freely suspended chain has the curve of a catenary, that is the centre of gravity is its lowest point. The catenary is what is known as an extremal for the problem of finding a curve joining two given points. Thompson and Leibniz both use this same example as a basis for certain aspects of their ideas that in section 5.1 will be shown are important for this study.

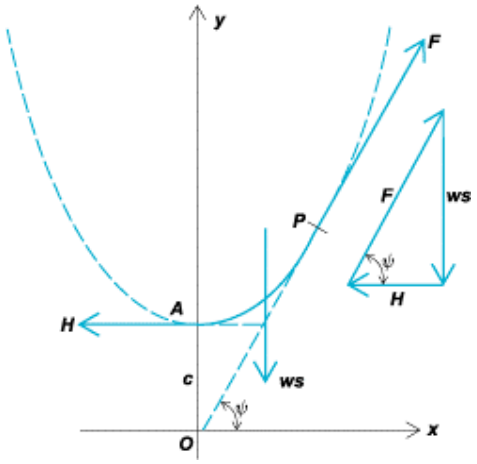


Figure 13 – A catenary

In addition, and perhaps as importantly, Thompson shows the similarities of the organic and inorganic, (for example between a drop of water and a jellyfish), or at least what may be the lack of a clear distinction. This of course then raises interesting consequences for the mechanistic framework. If as it would appear, there is no clear distinction between the organic and inorganic bodies, and that these 'design like natures' do not distinguish between them, this offers us at least two possibilities with regard to the antinomy of mechanism and teleology. Firstly, the view that would probably be proposed by the majority of scientists; that this evidence shows that organisms and 'reality' are ultimately describable purely using efficient cause. But alternately we are also given hope for the basis of a non-mechanistic explanatory system, that is, the link may operate both ways. Consequently this may provide us with a deeper explanatory and ultimately more consistent palette to work with, and also help us break out of the standard ways of seeing that we are enframed[52] within (such as the reductionist or atomist

[52] Heidegger uses this term in his essay 'The question concerning technology" to discuss a state where we lose sight of our revealing and essence. "Heidegger uses the term enframing as a challenging claim on humans. Once things have been revealed to us we place them inside of a 'frame' of understanding, much like a picture frame does to an image. Not only does the image now have a place inside the frame, but we can call it a picture because of the frame which it has around it. Yet it would still be an image without the frame. We do not think of the wall that the picture is mounted on as part of the picture, nor do we think of the room that the picture is in as part of the picture. Nonetheless, the picture is not itself if it is not in its proper place. If we had seen the picture in a different setting, would it have not looked different? Would there be anyway it could look the same? Instead of looking at everything that surrounds it, we just put a frame around the image and it becomes the 'picture'…it drives out every other possibility of revealing. Above all, enframing conceals that revealing which, in the sense of *poiesis* [truth], lets what presences come forth into appearance." (QCT, pg 27). (This quote is taken from www.optdesign.com/Philosophy/Heidegger2.htm)

perspective). If inorganic and organic forms exhibit similarities at this relatively basic level then it may start to provide ways of incorporating these two commonly distinguished/separated things in relation to the non mechanistic systems of, for example quantum physics. Indeed Thompson himself, despite the mechanistic nature of much of his works did not think that mechanism carried with it the ability to explain the entire state of the universe. He believed that it merely operated as a heuristic, allowing us to make general descriptions about connections between forms, for example.

> Like warp and woof, mechanism and teleology are interwoven together, and we must not cleave to the one nor despise the other; for their union is rooted in the very nature of totality, (Thompson, 1942 pg 7).

So it seems that Thompson accepted the possibility of an explanatory system of biology that is based upon a structure where aspects of mechanism and teleology are ultimately one, but did not seem to chance to take the next step of investigating the possibilities of that synthesis further. That is, of working towards a total union of all aspects of causality or a developing a new *acausal* approach that allows us to move beyond the current contradictory system and allow us to actually start to address the fundamental questions in biology and evolution and the organism. If aspects of organisms can be described mechanistically, as can much of the inorganic realm this doesn't necessarily imply that we must defer organisms solely into a mechanistic framework. If the inorganic and organisms can be shown in certain cases to be operating or coming-to-be under processes that are describable under the same mechanistic system, it does not necessarily imply that organisms must ultimately be subsumed under mechanism, (nor the inorganic for that point). This in many ways lends us a number of reasons to encompass organisms and non-organisms under the same system. With the nature of organisms being in so many ways a catalyst for non mechanistic thinking (or even cited as evidence for it), it may allow us a way to subsume mechanism ultimately to another form of causality, not the teleology based on purposes as Kant proposed (CJ §80), but another, 'above', or encompassing mechanism and teleology, but 'below', or within Kant's idea of the supersensible knowledge, (which of course is by definition beyond us). Indeed,

mechanistic thinking may be, like the notion of design in many ways merely an artefact of us concentrating too heavily upon simple systems, or abstracted systems that may easily 'fall into' the notions of mechanism, and that we then try and draw everything else into. Perhaps we may learn from the work showing what would seem to be the innate similarity of the observable universe, and work from the direction to that which many scientists in particular would take. If we attempt to get a sense of these allegedly non mechanistic systems we may be able to reassess these alledgedly mechanistic occurrences in either a non mechanistic way, or reside mechanism to a simplified version of the nature of reality, useful in particular aspects, but fundamentally misleading when we attempt to apply it to the universe as a whole, or as some kind of blanket theory. Equally, it is important to be aware that even if we develop a new form of covering explanation for teleology and mechanism, we should not believe that we have determined the nature of the universe, nor that we are even close to any sort of 'ultimate' explanation.

> My sole purpose is to correlate with mathematical statement and physical law certain of the simpler outward phenomena of organic growth and structure or form, while all the while regarding the fabric of the organism, *ex hypothesi*, as a material and mechanical configuration. This is my purpose here. But I would not for the world be thought to believe that this is the only story which Life and her Children have to tell. *One does not come by studying living things for a lifetime to suppose that physics and chemistry can account for them all*, (Thompson, 1942 pg 14). (emphasis added)

Or again in Thompson's characteristic prose;

> *For one reason or another there are very many organic forms which we cannot describe, still less define, in mathematical terms: just as there are problems even in physical science beyond the mathematics of our age*. We never even seek for a formula to define this fish or that, or this or that vertebrate skull. But we may already use mathematical language to describe, even define in general terms, the shape of a snail-shell, the twist of a horn, the outline of a leaf, the texture of a bone, the fabric of a skeleton, the stream-lines of fish or bird, the fairy lace-work of an insect's wing. *Even to do this we must learn from the mathematician to eliminate*

> *and to discard; to keep the type in mind and leave the single case, with all its accidents alone*; and to find in this sacrifice of what matters little and conservation of what matters much one of the peculiar excellences of the method of mathematics, (Thompson, 1942 pg 1032). (emphasis added)

So, how can we then separate the organisms from crystals or the environment, and retain any semblance of meaning or explanation? What we should seek is the underlying order that all these are based on. Organisms, crystalline structures and non organic forms are inseparable due to the fact that they comprise the same thing in many cases, they flow into one another, just as does the plant kingdom with the animal kingdom, and the bacterial and viral with both, and whos connections and relations are discussed in depth and shown in the works of Lima-de-Faria (1988, 1995). The environment/ecosystem cannot be separated from the organisms purely due to the fact that it is the organisms that compose the environment/ecosystem. To attempt to do so is to remove the intelligibility of the system. In the same way the organs of an organism cannot be treated separately or atomised and still retain the sense in which they exist as organs. This importance of this principle will be discussed in more detail in proceeding sections such as 5.1 in relation to extremal principles.

3.3: The organism and systematic self-organisation
Non-organic, systematic, self-organisation
Two sides of the same coin?

> The Physicist explains in terms of the properties of matter, and classifies according to a mathematical analysis, all the drops and forms of drops and associations of drops, all the kinds of froth and foam, which he may discover among inanimate things; and his task ends there. But when such forms, such conformations and configurations, occur among living things, then at once the biologist introduces his [extra] concepts of heredity, of historical evolution, of succession of time, of recapitulation of remote ancestry in individual growth, of common origin (unless contradicted by direct evidence) of similar forms remotely separated by geographic space or geologic time, of fitness for a function, of adaptation to an environment, of

> higher and lower, of "better" and "worse." *This is the fundamental difference between the "explanations" of the physicist and those of the biologist*, (Thompson, 1942 pg 872-873). (emphasis added)

One of the defining features for Kant of organisms is that they are organised and self-organising beings [systems], (CJ §65: 374), this defines them in his system as natural purposes. We should remember that Kant defines natural purposes as organised and self organising, and as such have formative force[53], "a force that mechanism cannot explain", (CJ §65: 374) and strictly speaking *has nothing analogous to any form of causality known to us*, (CJ §65: 375). Organisms as such, "give objective reality to the concept of a purpose of nature rather than a practical one, and which hence gives natural science the basis for a teleology... [we otherwise] simply would not be justified in introducing into natural science", (CJ §65: 376). So in light of our investigation we should examine whether there are any non organisms that appear to exhibit the property of self organisation. Let us start again with examples provided by D'Arcy Thompson.

> If we mix up a little powdered glass with chloroform, and set a drop of the mixture in water, the glass particles gather neatly round the surface of the drop so quickly that the eye cannot follow the operation. If we do the same with oil and fine sand, dropped into 70 per cent. alcohol, a still more beautiful Rhizopod-shell is formed, but it takes some three hours to do, (Thompson, 1942 pg 706).

[53] *Bildungstrieb*.

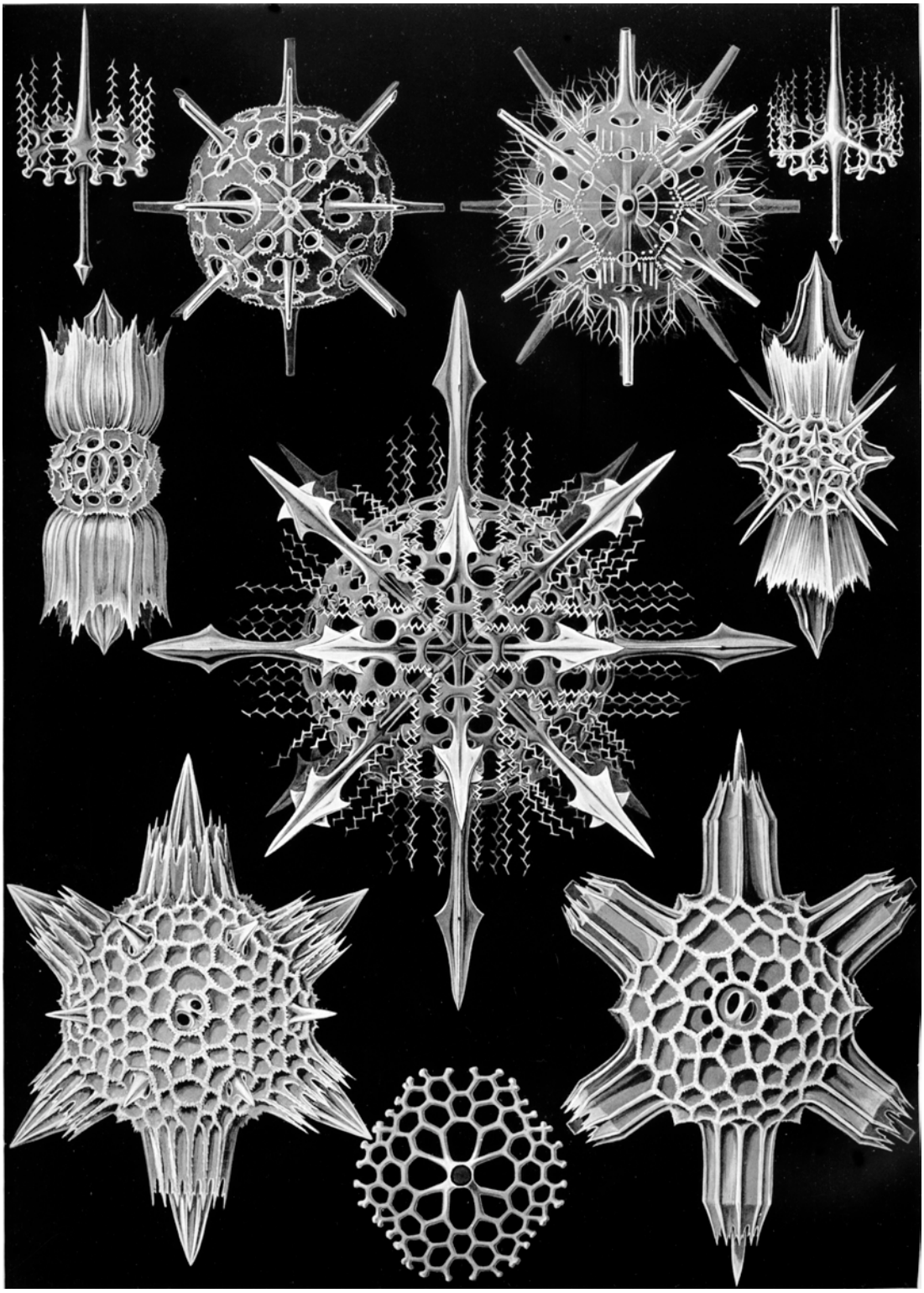


Figure 14 - Rhizopods – Haeckel, (1904).
Courtesy of Wikicommons

> Instead of a spherical drop a pear-shaped one may easily be formed, so exactly like the common *Difflugia pyriformis* [pictured below] that Rhumbler himself was unable sometimes, to tell under the microscope the real from the artefact, (Thompson, 1942, pg 706).

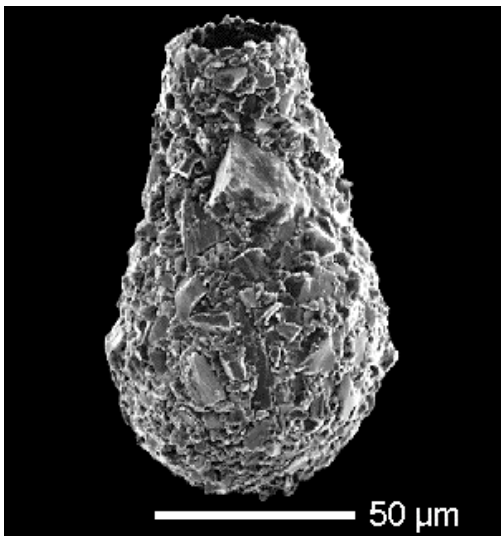


Figure 15 – *Difflugia pyriformis.*
Courtesy of Wikicommons

> The calcified or other skeletal material may tend to overspread the entire outer surface of the cell or cluster of cells, and so tend to assume a configuration comparable to the surface of a fluid drop or aggregation of drops; this, in brief, is the gist and essence of our story of the forminiferal shell, (Thompson, 1942, pg 674).

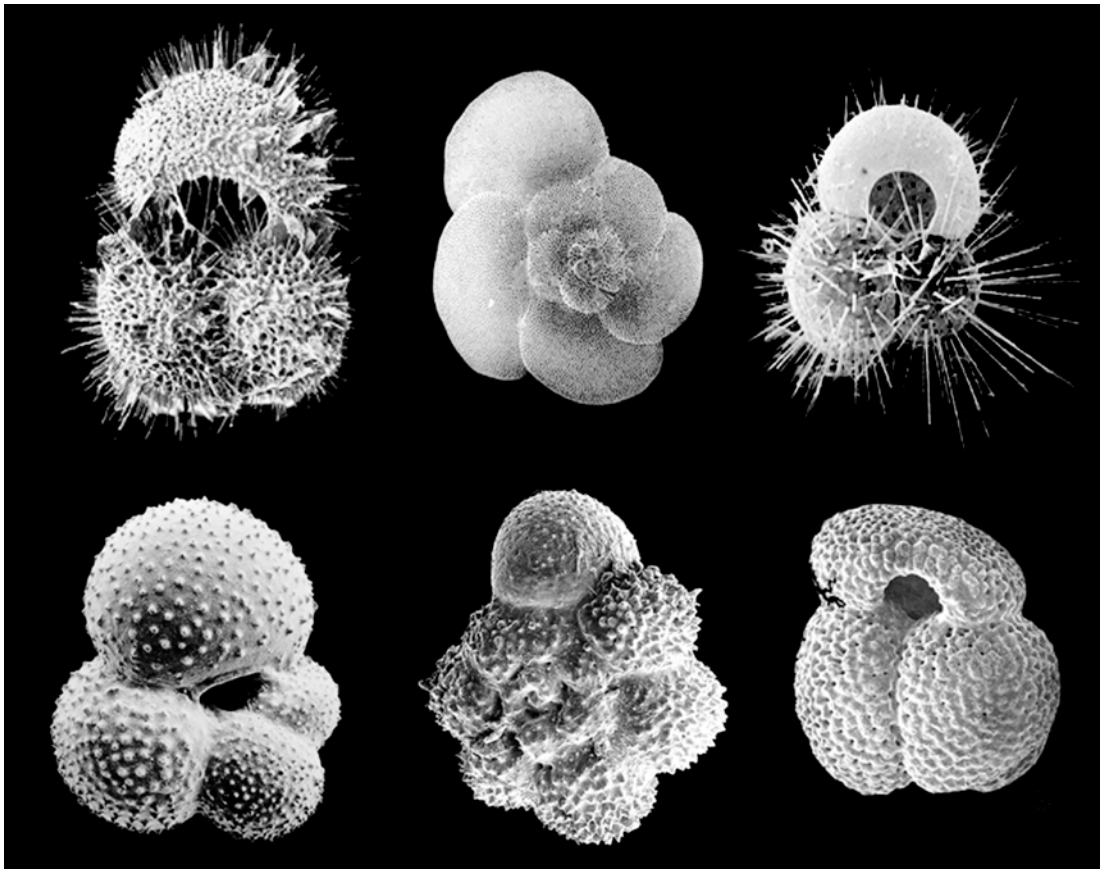


Figure 16 - Forminifera shells.
Courtesy of Wikicommons

It could be argued that these examples are not valid examples due to the human design or influence in them, that this is the reason for the forms in question. However, if we examine the nature of the first example, we can see that it is quite plausible that phenomena of this kind may happen in nature. The particles are forming the structure in question between the layers of two different density mediums. This may also for example be associated with orientation of the electrostatic charge on the sand in relation to the oil and water/alcohol medium, or a position of least energy. It should also be noted though in relation to a possible objection that Thompson does not state the origin or composition of the sand. In many cases sand contains fragments of fauna and flora, and it cannot be ruled out that these may have 'seeded' the structures in question for the sand example. It does not however, explain the similar structure obtained with the glass particles.

The examples showing the importance of surface tension of fluids, and the ability for particles to self-organise also show that self-organisation, or a 'purpose-

like' ordering is not solely confined to crystals[54]. These structures exhibit symmetry, yet to separate out the crystalline from the liquid that it is fundamentally associated is to isolate one 'part' over the other merely due to its more concrete nature.

3.4: Solitons as an introduction to acausal phenomena in organisms

Waves also exhibit properties of self organisation, self propagation and symmetry. For example in the case of solitary waves[55], such as the red spot of Jupiter, or a tsunami, and certain other atmospheric phenomena and even more interestingly, a subset of these, the class of 'solitons' (although in most much of current literature all solitary waves as referred to as solitons as they are considered similar enough). These solitons may spontaneously self-organise out of the atmosphere, merge with others, part and still retain individual identity, that is they are not deformed after collision with other solitons. Solitons are localized solutions of integrable equations and are particularly interesting to this study not just for their existence and importance in organism. They also have the property at the visible, macromolecular level of behaving like elementary particles such as protons and other fermions, (Kruskal and Zabusky, 1962) and are also referred to as 'wave-atoms', (Petoukhov, 2002). That is, they appear as waves or particles depending upon how they are observed, (and in effect show that what may initially appear to be a contradiction to our theories can be understood by subsuming that 'contradiction' into a larger explanatory system, (in this case nonlinear equations and extremal principles)). A particular type of soliton, the *quasi*-soliton[56] has also been shown to be present in

[54] Other examples include the Belousov-Zhabotinsky reaction (which produces soliton-like waves as an aspect of this self-organisation, (Kai, et al, 2000)), the formation of galaxies and spontaneous magnetization.

[55] 'A solitary wave is defined as a spatially confined (localized), non-dispersive and nonsingular solution of a non-linear field theory, i.e. one without superposition principle (possible for example in shallow water but not on a simple string)'. They do not reach thermodynamic equilibrium, (Vongher, 1997). It should be noted however, that the definition of solitons in general has not yet been agreed on and may differ from author to author. Generally there seem to be two kinds of soliton phenomena so far described: 'immortal' solitons that move through each other unaffected, and destructive solitons that dissipate after collisions with one another, (Hichem, et al, 1993).

[56] In the strict sense in organisms they are referred to as *quasi*-solitons, due to the fact that they have a limited life span. For all other intents and purposes they exhibit the same properties as the larger 'immortal' solitons. The types and characters of solitons discovered, first by mathematicians, then

organisms, as, for example, protein backbones and nerve impulses, (de Landa, 1992, Mourachkine, 2004) . As Mourachkine states, organisms are '*stuffed full of solitons*'[57]. Solitons also are fundamental agents in cell differentiation and organism development, appearing in DNA replication forks, (Yakushevich, 2002) self organisation of the cytoskeleton during cell division, (Petoukhov, 1999) and energy transfer in microtubules as a type of kink wave, (Elcio *et al*, 2001). These kink waves seem to sit somewhere between the properties of quasi-solitons and normal waves, in that while a soliton travels through a medium and leaves it actively restored, (i.e. in its original state), a kink wave changes the state of the system, for example in phase transition (such as crystallisation, or chemical transition) and symmetry breaking in morphogenesis of the organism, (Mainzer, 2005). It is also seems that the morphogenesis of organisms can be understood in terms of these 'biosolitons', (Petoukhov, 1999). This also seems to back up Alan Turing's proposal, (Turing, 1952) that from the instability of pure (mechanics free) reaction-diffusion mechanisms, that morphogenesis is controlled by forms of solitons, (such as kink waves). Solitons aren't just restricted to the cellular level in organisms and have also been found to be present in muscle contraction systems, (Davydov, 1982), as blood pressure waves produced by the heart, (Remoissenet, 2003; Rowlands, 1982) and in the locomotion of animals such as worm like animals, millipedes, snakes, and fish (Petoukhov, 1999).

Solitons are described by a system of mathematics known as extremal principles, first formulated by Sir William Rowan Hamilton in 1834 and 1835 in his development of what are known as the Lagrangian equations of motion. These

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experimentally backed up by physicists, and then more recently by biologists continues to expand. In particular for interest in biology the quasi-soliton and dissipative biosoliton types.

[57] The section describing this is found in his chapter 'Non-linear excitations: solitons' and is worth noting. It reads as follows.

"Solitons are encountered in biological systems in which the non-linear effects are often the predominant ones. For example, many biological reactions would not occur without large conformational changes which cannot be described, even approximately, as the superposition of the normal modes of the linear theory.

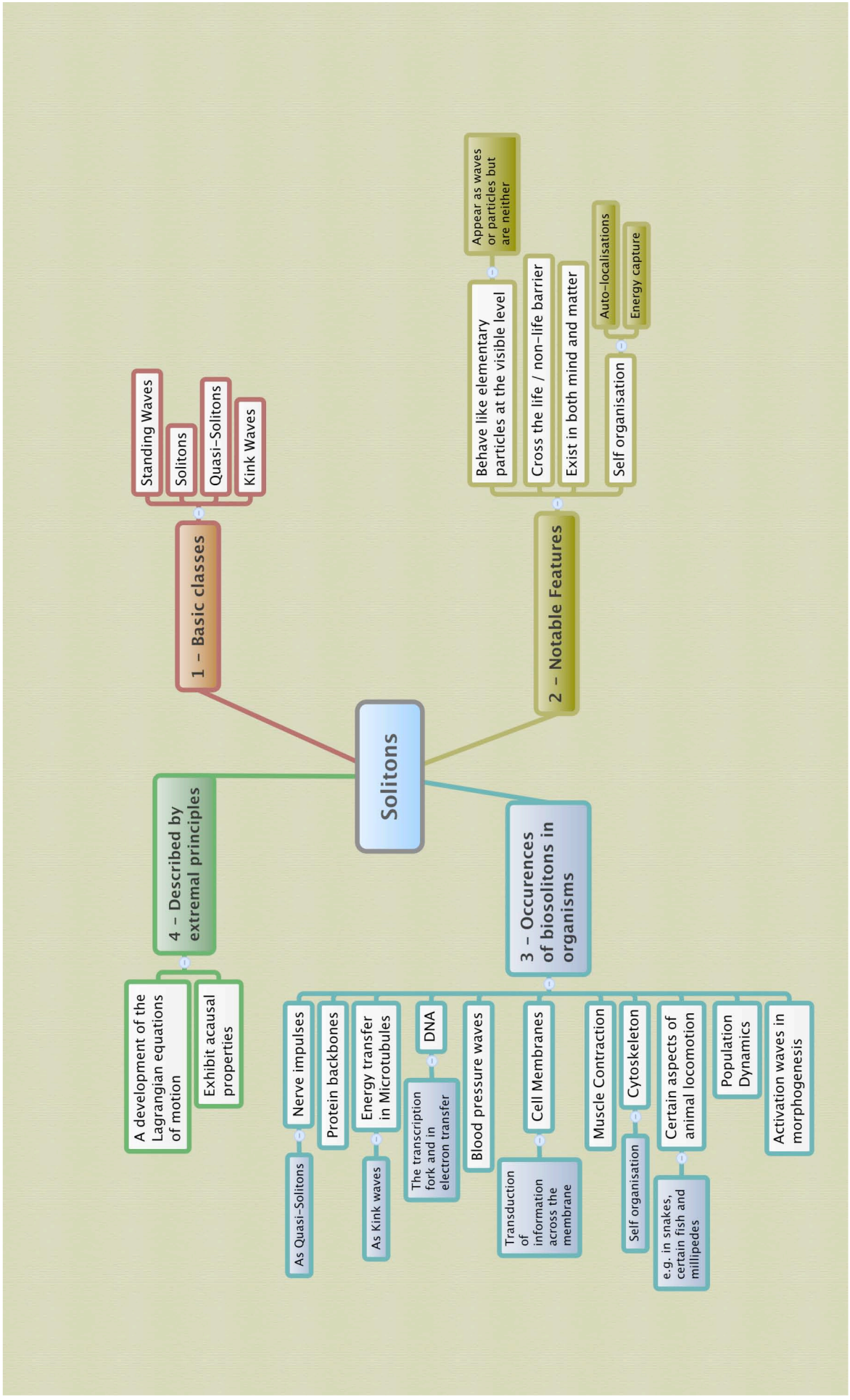
The shape of the nerve pulse was determined more than 100 years ago. The nerve pulse has a bell-shape and propagates with the velocity of about 100 km'h. The diameter of nerves in mammals is less than 20 microns, and in first approximation can be considered as one-dimensional. *For almost a century, nobody realised that the nerve pulse is the soliton. So, all living creatures including humans are literally stuffed by solitons. Living organisms are mainly organic and, in principle, should be insulants – solitons are what keeps us alive".* (emphasis added)

equations form the basis for much of contemporary physics such as general relativity theory and quantum mechanics.

These features of the solitons that exist in organisms, and in nature in general, are important for our study in relation to organisms as they seem to provide evidence of what appears to be non-Aristotelian, non-Humean causal occurrences existing in the organism at a 'visible to the naked eye' level, or measurable in the standard biology laboratory. This may provide us with an experimentally testable phenomenon to start to reformulate, or even bypass Kant's limit for our causal explanations and consequent understanding of organisms. Solitons and the extremal principles that define them may begin to give us an insight into the possibility and necessity of producing an *acausal* explanatory system for organisms where aspects of quantum theory appear to become applicable and relatable at an organismic (i.e. phenomenal) level. In summary, solitons appear to be a significant and commonly occurring aspect of organisms and are not fully explainable by the standard causal model involving mechanism and teleology. This will be investigated and developed further in section 5.1 and in the discussion.

Next Page:

Figure 17 – Solitons Summary


Solitons
1 – Basic classes
Standing Waves
Solitons
Quasi-Solitons
Kink Waves
2 – Notable Features
Behave like elementary particles at the visible level
Appear as waves or particles but are neither
Cross the life / non-life barrier
Exist in both mind and matter
Self organisation
Auto-localisations
Energy capture
3 – Occurences of biosolitons in organisms
Nerve impulses
As Quasi-Solitons
Protein backbones
Energy transfer in Microtubules
As Kink waves
DNA
The transcription fork and in electron transfer
Blood pressure waves
Cell Membranes
Transduction of information across the membrane
Muscle Contraction
Cytoskeleton
Self organisation
Certain aspects of animal locomotion
e.g. in snakes, certain fish and millipedes
Population Dynamics
Activation waves in morphogenesis
4 – Described by extremal principles
A development of the Lagrangian equations of motion
Exhibit acausal properties

Chapter 4

Further responses to Kant's proposals

4.1: Further responses to Kant

In *Critique of Judgment* we may also take an alternate line of investigation to that which is currently followed. If we investigate along the lines that Kant is not so much looking at whether teleology is applicable to biological organisms, (which he thinks it is not), but whether biology may be reduced to the physics of the day we can come to some interesting insights, not only in relation to Kant's works, but also to the intellectual environment of the time. The *Critique of Judgment* in many ways provides not just an important starting point for our investigations of the nature of organisms, but also a commentary on the knowledge, hopes and aspirations of late eighteenth and early nineteenth century European *Naturphilosophie*. It investigates one of the most hotly debated points of the time[58], is biology, as Descartes believed (and Kant attempted to disprove) just another chapter in the book of physics?

[58] And still is today, for example in the work of theoretical biologist and complex systems researcher, Stuart Kauffman, (e.g. in his book - Reinventing the sacred, 2008).

Organisms and inorganic aggregates may be shown to operate under what appear to be the same mechanical principles. This in itself is not a great problem for Kant's system, in many ways it is what he would expect. In many ways he infers that teleology 'holds place' until we determine the mechanistic causes of the phenomenon, it allows us to make connections that would otherwise be near to impossible utilising a mechanistic framework only. Kant's system doesn't necessarily limit him to a mechanistic universe being the fundamental reality and this is his general conclusion from the *Critique of Pure Reason*, he leaves open the possibility that there is something more. And while this 'something more' is, he claims beyond us, that is that "we cannot from a theoretical point of view, form the slightest determinate and positive concept", (CJ §78: 412), this places an arguably unnecessary limit on our understanding or ability to explain. While he limits teleology in its ability to provide explanation, (due to the nature of design in organisms creating many problems that he dismisses early on in his investigations, (such as the links forwards and backwards in time)), he does not address more than fleetingly the possibility of a connection in terms of organization. That is in terms of the link being forwards and backwards in terms of organization. Bi-directional causality does not necessarily imply purpose, just because you invert the normal cause-effect series doesn't mean that you have the right to infer purpose, and use teleology in organic nature. Kant may reply that this is just a limit of our understanding that forces us to do this. However, it still leaves us another potential avenue to investigate.

Organisms appear to express a purposiveness, a pre-determined designedness to our way of seeing (CJ §75: 400). But is this end directedness meaningful? Using the ideas propounded by the continental rational morphologists such as Geoffroy Saint-Hilaire, Goethe, Kant's 'biological advisor' Blumenbach, and their peers of the early 19th century and integrating modern molecular and theoretical biological models/data is it possible that this seemingly goal directed nature can be shown to be merely a consequence of our way of seeing? For example, by seeing organisms more as objects occurring in 'phase space' but with a limited number of options of where they can 'move' from their current position. By organisms being measured by their position in this phase space as well as their velocity we may perceive all changes as rational, and not be required to separate out parts from the

whole to obtain explanation, nor to rely as heavily on historical contingencies as the currently popular Neo-Darwinian model does. Evolution / development of organisms is not a 'random' process (in respect to the idea that any form can come about), the set of available forms is limited or constrained. That is, limited by 'laws' of physics. It is extremely unlikely (at best) for a cow to develop that can naturally jump over the moon. Change and development in organisms is rational, although not necessarily predictable, the available possibilities of form/structures that arise come from a limited, although still potentially infinite set[59], this set being determined as a subset of that from which the previous structure is a part. Taking this to be the case, movements in this dynamic can be made in as many 'directions' as determined by the constraints and properties of the system, not only forward but also backward. No case shows this better than the case of atavars (for example whales born with legs, or humans with rudimentary pharyngeal gill slits) and the studies of teratology[60]. Monsters are merely a re configuration of aspects of the developmental 'history', for example, a chicken with teeth is exhibiting a reptilian 'precursor' (N.B. not even a particular precursor, but a 'phase state' one), as is the whale with feet, a mammal with gill slits, or the ostrich footed people of Africa (in this case showing the field state of the 'pentadactyl' limb)[61], equally then how can we then say that the foot of the ostrich has evolved for it's lifestyle, or as a result of selective pressure or has a function[62]? This work or ideas has many parallels with the principle of least action of Maupertuis[63], (1741, 1744, 1746), now renamed, expanded and called extremal principles.

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[59] After all, some infinities are 'bigger' than others.

[60] Pioneered by Geoffroy Saint-Hilaire and his son Isiodore.

[61] This morphological or 'evolutionary' state change may be in certain case due to a Neo-Darwinian style micro change, (such as gene mutation). But as Kant states in the *Critique of Judgment*, for our understanding, this form of explanation does little more than sign post the change in our history and assign it an arbitrary function *post factum*. For 'use' or existence does not necessarily imply that the structure has a 'function'. What the rational morphologists were interested in was coming to a deeper form of understanding.

[62] Geoffroy Saint-Hilaire proposed a biology without function, (in stark contrast to his contemporary Georges Cuvier, the founder of the 'functionalist' school). For Geoffroy, "Vestigial organs and embryonic transformations might serve no functional purpose, but they indicated the common derivation of an animal from its archetype… Animals have no habits but those that result from the structure of their organs; if the latter varies, there vary in the same manner all their springs of action, all their faculties and all their actions", (www.ucmp.berkeley.edu/history/hilaire.html).

[63] Pierre Louis Maupertuis, (1698-1759) is credited as having invented the principle of least action. This states that in all natural phenomena a quantity called 'action' tends to be minimised. This principle was also developed at a similar time by Fermat in relation to light and is known as the 'principle of least time' which states that "light travels between two given points along the shortest

Assuming that all possible organisms exist in state space (i.e., the set is limited by constraints, though still infinite), and that these potential forms come about by the interaction of basic laws that build up from simplicity to complexity, (much like a fractal) this is not a pre-set plan as this would imply only one possible outcome (although, the pre-set plan could be more general). Perhaps the problem with the argument from design is due to looking at organisms from the wrong causal direction, (or is it is only looking at them from one direction, or indeed from within a causal system at all), that is that the constraints on available forms of/for organisms in this state space and thus the similarities are misinterpreted as the hand of a designer. With design there is no reason that there has to be any order or similarity in organisms, although with an evolutionary system that starts with the creation of the universe and the development of species over time through common ancestors there is arguably more reason (although the opposite is still just as possible under this model).

Kant's problem of separating organism and environment also raises a number of questions. A particular environment containing organisms only makes sense with the organisms that comprise it, it doesn't exist without them (another environment does). For example, if you remove the organisms such as the trees from an Amazonian rain forest environment you end up with a barren piece of land, it is no longer an Amazonian rain forest ecosystem. Correspondingly, focusing on one aspect of a system and abstracting it as a 'part' and separating this part from the system removes the intelligibility of what you were originally talking about.

While in the *Critique of Judgment* Kant investigates what he believes to be the limits of our scientific knowledge he on the whole (and in fact by virtue of the line of thought he is addressing) leaves alone what is probably one of the most important parts of what would have been important for him to investigate further, the similarities between organisms and non organic naturally occurring forms, (or at least the lack of a definite separation). This as a consequence, leaves him open to a

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time route". Maupertuis felt that '*Nature is thrifty in all its actions*', and applied the principle broadly: "*The laws of movement and of rest deduced from this principle being precisely the same as those observed in nature, we can admire the application of it to all phenomena. The movement of animals, the vegetative growth of plants ... are only its consequences; and the spectacle of the universe becomes so much the grander, so much more beautiful, the worthier of its Author, when one knows that a small number of laws, most wisely established, suffice for all movements*", (en.wikipedia.org/wiki/Principle_of_least_action). Leibniz developed these principles further showing that this quantity is likely to be either minimized or maximized in natural phenomena.

number of criticisms. What we must then investigate is the validity or importance of these criticisms, not only in relation to Kant's works alone but to the field and 'intentions' of investigation of the nature of organisms, or as Kant calls it self-organised beings (as opposed to organised things). It is the 'idea' of organisation, the idea of the whole that Kant claims that we can ultimately only ever understand by reference to final causes. This idea determines *a priori* everything that is contained within the organism. This notion however leads to one inconsistency, that is that the idea seems to be contained 'within' the organism, this separation of the organism leads to a confusion that follows through in attempting to understand the nature of the organism. Organisms cannot be meaningfully extracted from and separated from the environment, by treating them as separable a form of fragmentation is created that accentuates the problem that Kant is investigating in the first place, the problem of lack of intelligibility. It is the determination of the 'idea' that is probably most important for biology, and that to which it strives.

In attempting to form a distinction between the organic realm and the inorganic realm Kant falls into the problem that is then used as the basis for his argument. That is, if no meaningful distinction can be shown to exist, or that it is questionable on the basis of empirical evidence then a theory based on the assumption that such a distinction is present may fall into some major problems. It falls into a similar problem of Cartesian dualism. Part of the problem still seems to be the unnecessary separation / creation of a dichotomy between what 'we' define as 'organisms' and 'life' and what 'we' define as 'non-organism'/'non life'. By incorporating the ideas of thinkers who ultimately don't seem to make these distinctions, isn't it logically more consistent if, when we talk about evolution we don't ultimately distinguish between an 'organism' and a mineral formation or fundamental wave-particle. Are they occurring under the same basic principles, (and as Lima-de-Faria, 1988 pg 20-24 says are homologies of one another)? By using this principle as a basis it may be possible to get a better understanding of what it is to be an evolving system. This should also help with an understanding of 'life', both organic and inorganic.

Is Kant's use of language for talking about animals the beginning of his problems with respect to attaining some form of intelligibility? The use of loaded terms that relate to a functionalist perspective such as purpose and design, even when

they are being used in contexts that should work against the notion of design, due to the baggage they carry tilt the field with design influenced assumptions. One of the major problems for Kant in his assessment of organisms is his continual reference to the notion of functionalist based language in regards to them. His overall conclusion that we must talk of organisms 'as if they had been designed', while at the same time realising that they have not, and are to be considered purely mechanistic occurrences seems to be used as a rationale for use of the term and concept of functionalist terms in regards to them. However, it must be noted that the concept of function, used in relation to parts (separated arbitrarily) of organisms leads to ways of seeing organisms that are further reinforced by this concept of function, and leads to further confusion (Hughes and Lambert, 1988). This leads to seeing more and more in terms of function and so strengthens the notion of 'design', which must, it would seem, incorporate at some point perceiving/seeing in relation to the notion of function (even if this is the function of no function, something often proposed in modern biology).

Chapter 5

Proposal for the introduction of a system of acausal explanation for evolution

5.1 Introduction of extremal principles as a possible indicator of a way to move beyond Kant's limit

> Nothing in an organised product of nature is gratuitous, (CJ §66: 376).

> Fermat's principle of geometric optics states that light moving in an inhomogeneous medium chooses the trajectory which minimises the time of passage between given points, (Ioffe and Tihomirov, 1979).

> It can in fact be shown that, when certain very general conditions are satisfied, all quantitative laws can be given an "extremal" formulation… The use of such principles in physical science nevertheless does show that the dynamical structure of physical systems can be formulated so as to make focal the effect of constituent elements and subsidiary processes upon certain global properties of the system taken as a whole, (Nagel, 1979).

Chapter 5: Proposal for the introduction of a system of acausal explanation for evolution

In our studies of the nature of 'reality' with regard to physics there are two main ways understood by which we may attempt an explanation of it. These are using differential equations, (that which the mechanistic account relies upon), and an integral form. The idea of this integral procedure has a long[64], but relatively unstudied history outside physics and mathematics. The importance of these principles should be noted for this study by virtue of claims made for them that they provide a non-mechanistic, non-teleological explanation of reality. This then can be seen to potentially have great value in an argument against, or an attempt at an expansion of Kant's proposed restriction for us to a mechanistic system as the fundamental basis of reality, coupled with the use of purpose based teleology. It also may allow us to justify certain aspects of teleology, (at least to the same extent that we can justify mechanism), because both will serve as useful rules of thumb, or heuristics, a shorthand of sorts. It also provides us with an alternate line of thought by which to test some of the ideas Kant proposes in the '*Critique of Teleological Judgment*'.

The notion of extremal[65] principles provides the basis of much of the current theories of physics. They are based around the Hamilton-Jacobi theory, the action principle Sir William Rowan Hamilton developed in the early nineteenth century. Later refined by Karl Jacobi, branches of physics such as electrodynamics, relativity, quantum theory, quantum mechanics, and quantum field theory have all been developed around this concept, (Ioffe and Tihomirov, 1979; Bohm, 1993; Greenberg, 1967). This then can be seen to be important in our investigations of the nature of organisms, for if these branches of science obtained much of the basis of their non-mechanistic, non-teleological practices from this system it should be important to examine the potential of their application to organisms. It also is applicable in a sense to Kant's theories, which were to a large extent based around the idea of the physics of the time, (that is Newtonian, classical physics).

Extremal principles as mentioned earlier are based around laws of motion described in a particular integral form. As such '*the details are inferred from the*

[64] The first recorded mention of the property is from the 5th century B.C. and is also found in the works of Euclid, (Ioffe and Tihomirov, 1979).
[65] This term originated with Knesser, (1900)

properties of the complete process', the parts are abstracted from the whole (Greenberg, 1967), this is compared or contrasted to a differential form, the basis of the mechanistic philosophy where the process is described in respect to cause and effect, (efficient cause) and the 'whole' is built up from and seen as secondary to the parts. By the nature of these extremal principles (i.e., that they can be seen by their precedence on the whole to imply to an extent some form of grand pattern) they are often linked to teleology, (such as for example in the philosophy of Leibniz[66] and his maximal and minimal principles of physics, or also, Goethe and his notion of the archetype and *bildungstrieb*). This link to teleology however, is misleading, or doesn't take into full account other possible ways of seeing them. Extremal principles do not necessarily imply the application of purposive action. Although the 'whole' does seem to relate to the notion of a grand idea, this seems to be because the causality can be seen to go in bi-directionally, (i.e., up and down in terms of organization, rather than forwards and backwards in time). They do in respect to Kant's discussion then seem to give some form or potential of justification of our subordination of mechanism to the teleological, but also seem to take it one step further. Extremal principles such as the Hamilton-Jacobi theory subsume mechanism, and the purposive notion of teleology to a principle that encompasses both, (Feynman, 1967; Hirschmann, 1988; Bohm, 1992) and in doing so it is proposed can bypass or explain many of the problems. They are not teleological in the Aristotelian sense, or Cartesian intentional sense, but are different from efficient causality, (Yourgrau and Stanely, 1979; Lanczos, 1986).

If, as is stated to be the case there is a form of inter-relationship, or inter-connection between extremal principles and mechanistic explanations then it would not be surprising that the mechanistic approaches have had such success, and that study of organisms as such systems has had such great 'success'. Following this principle the integral form can be seen or described in a mechanistic, or differential form, to a certain extent. In relation to the systems of quantum and relativity theory this mechanistic account serves well as a heuristic but has its limits, (Feyerabend,

[66] It is perhaps interesting to note that the two individuals who developed the mathematics of calculus, Leibniz and Newton, should have come to almost opposing views on the nature of the universe. Leibniz coming to his conclusions on a teleological type system using principles based around integration, whilst Newton using the other aspect of calculus, differentiation lead to the idea of a universe solely based upon mechanism or efficient cause.

1981a; 1981b). The overriding (but in no ways complete or final) description of nature adheres to a form of causality that it is argued is non-Aristotelian, (Feynman, 1967) or would at least appear not to rely on the notion of purpose, or upon description of 'a process from one moment in time to another moment infinitesimally removed from the first, and thence to the next moment, until the motion as a whole has been described', (Greenberg, 1967). This question on the interconnection of extremal principles and mechanistic differentials leads us also to some interesting points in light of Kant's claims as to the nature of the supersensible intuition (there seem to be many similarities between Kant's notion of the knowledge of the supersensible and explanations or investigations of phenomena by extremal principles). In effect extremal principles provide some form of reconciliation of mechanism and teleology's place in our descriptions, it could be argued that this can place teleology on a par with mechanism. However, just because the two systems may be reconcilable in a sense does not necessarily imply that there still is not some form of hierarchy in respect to applicability to phenomenon. In agreement with Kant it is proposed that a mechanistic account in many ways provides a stronger basis for our investigations over that of a teleological. It does though give teleology a new lease of life in our scientific investigations in respect to mechanism, in that particular forms can be treated as 'paths of least action', or local maxima/minima, and that *it is the whole that becomes the focus, not the individual parts, for they are merely abstracted or inferred from the properties of the complete process.* In addition it allows us the notion of a 'grand idea', or to see that which a mechanistic approach denies, or at least considers of a lesser importance in comparison to the aggregate. However, when using a purpose-based teleology we must not as Kant warned take it to be the explanation of the phenomenon. The same though now can also be said to apply to mechanistic efficient cause.

> Nature 'acts in the most determined ways' and that this principle is purely architectonic, (i.e., based on the principle of perfection), (Leibniz's principle of nature, in Hirschmann, 1988).

> discontinuous variations are a natural thing...mutations, occurring on a comparatively few definite lines, or plain alternatives, of physico-mathematical possibility, are likely

> to repeat themselves: that the higher protozoa, for instance, may have sprung not from or through one another, but severally from simpler forms; or that the worm-type, to take another example, may have come into being again and again, (Thompson, 1942, pg 1094-5).

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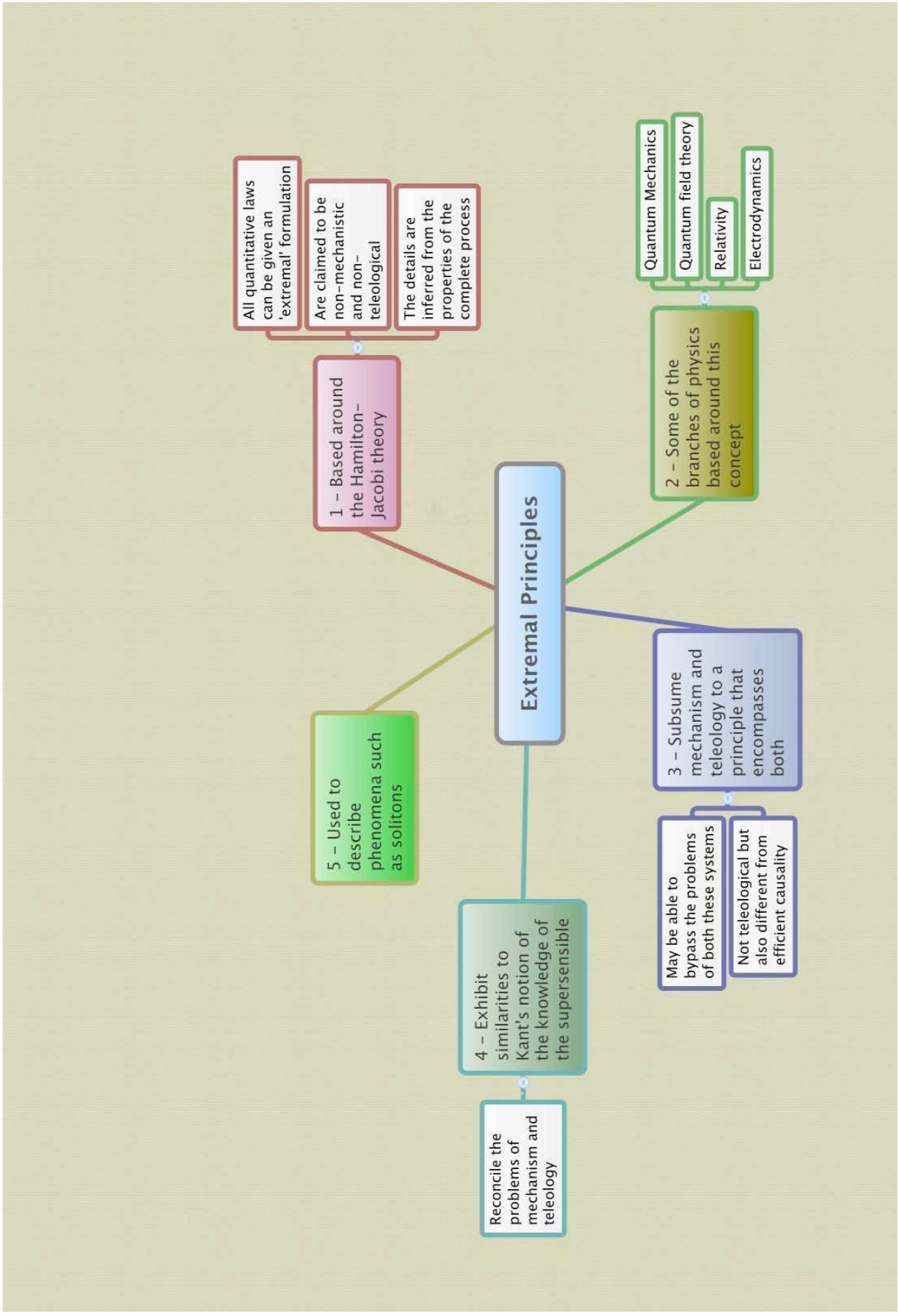
Figure 18 – Extremal Principles Summary

Chapter 5: Proposal for the introduction of a system of acausal explanation for evolution



Chapter 6
Discussion and Conclusions

6.1 Discussion and Conclusions: A move forwards may be a move backwards

The important thing in science is not so much to obtain new facts, as to discover new ways of thinking about them, (W. L. Bragg, 1968).

6.2 A move forwards

I must stress that as the older systems are only special limitations of the new more general ‘non’ systems, it would be incorrect to interpret a ‘non’ system as an ‘anti’ system, (Korzybski, Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics, 1958).

Chapter 6: Discussion and Conclusions

The main subject of investigation in this thesis has been the problems of a mechanistic (or reductionist) view of nature, the relation of this to the teleological notion of design, and the possibilities of a framework that removes the problems implicit not only within each of these systems, but also between them for our understanding of organisms and evolution. This, as has been stated is a major problem in science, and although in many ways it has been centered around biology and the organism, it owes, or partakes just as much in physics as biology[67]. Also in any investigation of Kant's theories on these topics it seems right to investigate it along the lines of current ideas in science, as much of his work was based upon or draws from the physics and biology of the day.

As discussed, Kant's investigation of the problem of the antinomy of mechanism and teleology leads him to posit a type of understanding where "both principles (efficient and final cause) are reconcilable in one higher common principle of nature", (CJ §78: 413). This form of understanding he calls the supersensible, and claims that it is beyond our understanding. This supersensible understanding he claims proceeds from the whole to the parts, (CJ §77: 407) (as opposed to our discursive understanding). However, Kant's theories are based on the idea of a Newtonian mechanistic universe, and as has been shown this assumption is under serious question by current theories of physics. In line with these theories some of the important bases of Kant have been questioned, in particular whether we are restricted to sticking with the antinomy of mechanism and teleology in our investigations of nature. The ideas of extremal principles seem to offer us a way to move past Kant's restrictions, and that of Aristotelian and Humean notions of causality. In effect, it seems to provide us with the beginnings of a move past Kant's limits, and shows many similarities to his idea of a supersensible intelligence, (but obviously it is not). It still though leaves room for the use of a mechanistic and/or teleological framework, these being treated as subsets of, or subsumed to a system that could be developed in relation to, for example, extremal principles. They may act as a shorthand, a simplified version on our new notions of 'reality'.

Overall, as has been shown over the course of this thesis, biology runs into problems attempting to explain the evolution and general nature of organisms using

[67] Physics is, in many cases for science taken as the 'expert', or that which we defer to on the nature of 'reality'.

causal explanations because much of an organisms development, properties and evolution are controlled by an acausal process (solitons) i.e. it is not causal at all.

The development of the conclusion of this study can be summarized as follows -

A - Causal style explanations (mechanistic and teleological) seem to run into major problems with respect to organisms when put to the test.

B - Extremal principles are an apparently acausal method of explanation.

C - Solitons are examples of phenomena that are best described by extremal principles, and so can be described acausally.

D - Solitons also behave at the visible level like elementary particles (such as protons and other fermions), i.e. like wave - particles.

E - Organisms are full of types of solitons (for example as the non-immortal quasi-solitons and kink waves). These solitons are involved in a wide range of processes such as cell division, morphogenesis, activation waves in somite formation, DNA transcription, protein backbones, nerve impulses and also in muscle contraction, blood flow and locomotion.

These acausal systems (solitons) are important aspects of development and the evolving organism, and also that as far as the literature search for this thesis can determine have not yet been addressed to any great extent regarding their role in evolution, and for developing a system of explanation to get biology out of the fundamental problems and limitations that it currently seems to be in. As renowned theoretical biologist Brain Goodwin states 'biology has got well and truly stuck and it's time for a radical move', (*pers comm*).

From the facts uncovered it would seem that we have direct evidence of acausal systems being present and important in the organism at a visible level. That is, this phenomenon is not purely philosophical, it is possible, (as is always so important in the sciences) to test it in the lab. This provides us with a possible alternate framework that may be able to be applied to obtain rigorous and reliable experimentally 'derived' or 'induced' explanations of evolution and forms of organisms. These frameworks have already been shown to increase the depth of knowledge and explanations in other fields of investigation, (such as physics) and may produce a range of surprising new results and lines of investigation.

6.3 A move backwards, or, physics still has a lot to learn from the organism

> It is the organism, not the solar system that should provide our model of nature, (Goethe, in Richards, 1992).

The question of the nature of organisms, not only in relation to what are often claimed to be the presence of design-like qualities, but also in regards to the possibility of a universe composed of individual discrete fundamental entities has occupied the minds of some of the greatest thinkers since at least the beginnings of formalised philosophy and nature.

Kant's investigations in his three *Critiques,* but in particular for this study the *Critique of Teleological Judgment* is a notable example. Its importance as a basis for much of the speculation in *Naturphilosophie,* and its legacy to the present day, makes it, if not essential reading, then at least very high on the priority list if one is to investigate some of the major problems that are present in science. It can provide leads in our investigations that we might otherwise have never had known existed. Even the misinterpretation of a claim may bring forth fruitful results, (for the history of science is full of misinterpretations of an older theory that have then allowed the investigators to travel successfully in a new direction, (although possibly with the blush of slight embarrassment if their mistake comes to light)).

It is perhaps also interesting to note that many of the thoughts of the *Naturphilosophers* of around Kant's time voiced a way of seeing organisms and nature in general that have many similarities to more recent 'discoveries', or currently popular lines of thought in the sciences that did not exist in any notably formalised system at that time. Examples and evidence from these more recent fields such as chaos and complexity theory, and aspects of theoretical physics such as quantum, relativity and string theory have many startling similarities to the ideas of the *Naturphilosophers*[68]. This is of course not to imply that they had some 'divine like' vision of the future, merely that their recognition of the importance of the

[68] For example, Blumenbach's *bildungstrieb*, Goethe's work on plants, and Schelling's development of dialectical logic and a hermeneutic view of nature to name a few.

'intuition[69]' over 'empirical facts', whole in comparison to the 'parts', (such as anti-reductionism) and the similarities between aspects of nature such as organisms and the inorganic (for example Fries' claim that there was no fundamental difference between an organism and the solar system) is similar to many currently popular theories in science. Equally though, we must also realise that these 'older' ideas may have also shaped the way that things are seen now, so in this case it would hardly be surprising to find certain links, or a legacy of sorts. Regardless of whether Kant's discussion of problems of mechanism and teleology are correct in their entirety, it leads us to investigate the possibility and need of alternate causal explanatory systems for organisms beyond the standardly utilised model. We find from this that a fundamental aspect of organisms with respect to their development, day-to-day existence and evolution, (the class of solitons) are best described by an acausal system. That is, they may provide something more than, and can subsume important aspects of our problematic mechanistic and teleological explanations. Consequently, unless we address this problem and develop a new formalised system of understanding and explanation that can account for the action of solitons in the manner by which they actually seem to exist, we risk only telling part of the story of life, organisms and evolution.

The success of these more recent formulations of ideas on the nature of reality over their predecessors (for example relativity theory over Newtonian mechanics, and possibly string theory with both of these) also can be claimed to give the *Naturphilosphers* an important rebirth of sorts. At the very least it should encourage a re-investigation of many of their ideas, for they may give us further clues into possible ways to address as yet unanswered questions. If any of their ideas seem too wild, irrelevant, or just plain wrong they can be left to sit for the while[70], but always left with the possibility that they may be reinvestigated in light of

[69] Schelling's (admittedly extreme) approach to natural science was as follows. "All that is required to understand nature is to sit down and think logically and deductively from true premises reached through intuition…empirical observations lose all interest. One looks at nature from time to time to check that it is following the proper laws, but that is all", (Schelling, 1803). The majority of Naturphilosophers would be unlikely to completely agree with this statement.

[70]For example in the fortuitous 're-discovery' of 18th Century Mathematician Euler's Gamma function that backed up fundamental developments in StringTheory. Geoffroy St. Hilaire's concept of 'one animal' in the early 19th century also has stunning parallels to the current understanding and development of knowledge in relation to Hox genes and morphogenesis, as discussed by Stephen J.

further ‘advances’ in our systems. This is important, for who knows when even a single line written two hundred years ago may set a spark, or let us apprehend a connection and thus saves us hours or years of toil, or at the very least gives us reason to consider the limits of the systems that we operate in.

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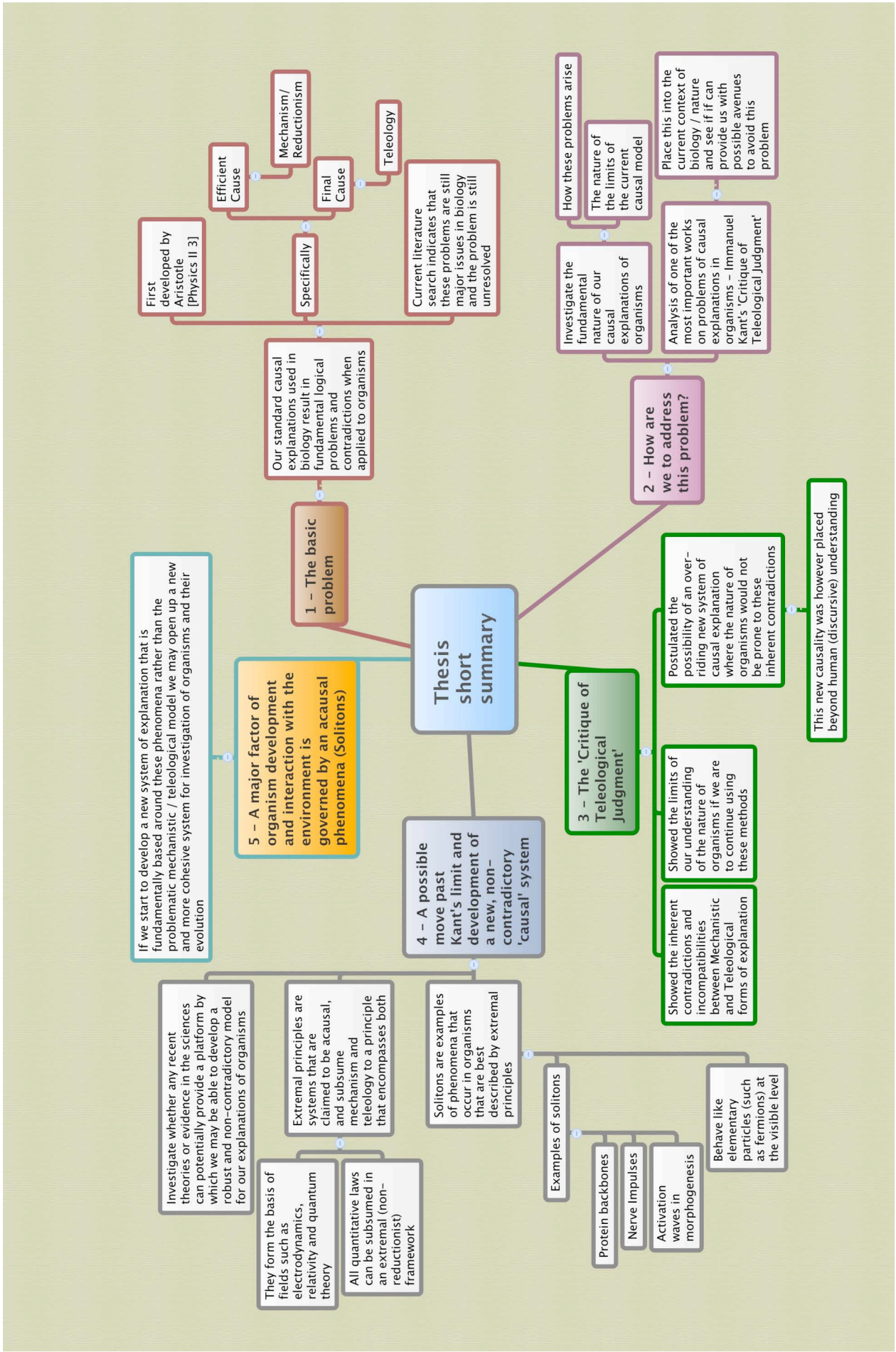
Figure 19 – Thesis short summary

Gould in his paper ‘Geoffroy and the homeobox; the art of finding timeless essences in apparent trifles is the kind of perception that we call genius. (Etienne Geoffroy Saint-Hilaire)’, (Gould, 1985).


Thesis short summary
1 – The basic problem
Our standard causal explanations used in biology result in fundamental logical problems and contradictions when applied to organisms
First developed by Aristotle [Physics II 3]
Specifically
Efficient Cause
Mechanism/ Reductionism
Final Cause
Teleology
Current literature search indicates that these problems are still major issues in biology and the problem is still unresolved
2 – How are we to address this problem?
How these problems arise
The nature of the limits of the current causal model
Investigate the fundamental nature of our causal explanations of organisms
Place this into the current context of biology / nature and see if if can provide us with possible avenues to avoid this problem
Analysis of one of the most important works on problems of causal explanations in organisms – Immanuel Kant's 'Critique of Teleological Judgment'
3 – The 'Critique of Teleological Judgment'
Postulated the possibility of an over-riding new system of causal explanation where the nature of organisms would not be prone to these inherent contradictions
This new causality was however placed beyond human (discursive) understanding
Showed the limits of our understanding of the nature of organisms if we are to continue using these methods
Showed the inherent contradictions and incompatibilities between Mechanistic and Teleological forms of explanation
4 – A possible move past Kant's limit and development of a new, non-contradictory 'causal' system
Solitons are examples of phenomena that occur in organisms that are best described by extremal principles
Examples of solitons
Behave like elementary particles (such as fermions) at the visible level
Protein backbones
Nerve Impulses
Activation waves in morphogenesis
Extremal principles are systems that are claimed to be acausal, and subsume mechanism and teleology to a principle that encompasses both
They form the basis of fields such as electrodynamics, relativity and quantum theory
All quantitative laws can be subsumed in an extremal (non-reductionist) framework
Investigate whether any recent theories or evidence in the sciences can potentially provide a platform by which we may be able to develop a robust and non-contradictory model for our explanations of organisms
5 – A major factor of organism development and interaction with the environment is governed by an acausal phenomena (Solitons)
If we start to develop a new system of explanation that is fundamentally based around these phenomena rather than the problematic mechanistic / teleological model we may open up a new and more cohesive system for investigation of organisms and their evolution

7.0 Glossary

Acausal –

Where a phenomenon does not appear to be able to be defined under the standardly accepted causal model. This occurs in a number of ways:

In relation to efficient cause (the standard use of 'causal' in modern scientific thought) the standard acausal statement often refers to an achronal system. That is that the phenomenon does not seem to follow the standard arrow of time limitations. Cases for this are –

Singularities: The point where an object becomes unable to be defined or cannot be predicted. Solitons may tend towards exhibiting this property in certain circumstances.

Closed Time-like curves: solutions for this already exist in General Relativity (Mathematically).

Quantum Logic: The form and behavior of the quantum 'wave-particles'. This contrasts to the Boolean style logic that is generally the case for the 'macro' world. There is an intimate link between acausal space-times and quantum logic.

Acausal is also used to refer to systems of 'coming-to-be' that are alleged to be different from or something more than or additional to the standard Aristotelian causes of material, formal, efficient and final. A notable recent proponent of this was physicist Richard Feynman.

A priori –

Propositions that have fundamental validity, they are not based on perception, for example 1+1=2.

Antinomy –

A contradiction, the mutual incompatibility, (real or apparent) of two laws.

Argument from Design –

Infers from the intelligent order in the universe that there is a designer (usually taken to be God). Paley's watch argument is one of the classic examples of the argument from design.

Bildungstrieb –

A German term generally translated as 'Formative Force', or 'Formative Drive', in organisms. A term first coined by Blumenbach and used by Kant in the *Critique of Judgment* to indicate a force that 'united the mechanistic with the purposively modifiable'. Goethe further utilised this as important in relation to his notion of the archetype and can also be thought of as like watching a 'movie' of the organisms development forwards and backwards at the same time, (Brady, 1987).

Causality –

The quality that enables a substance to give rise to the specific character of natural forms, (i.e. their unity of purpose we must thing of as a causality).

Types of Causality

Material – What the thing is composed of, that out of which etc (e.g. for a plant, Air, Soil, Sun. The 'raw material').

Formative – the account of 'what-it-is-to-be', the shape, form, process, the shape in relation to the 'production /expression of'. The general laws where the whole is the cause that explains the production of its parts.

Efficient – (e.g. Mechanistic explanations) the primary source of the change or rest (what causes change of what is changed), the principle that produces, the manifestation of a specific 'knowledge' that does not make a reference, implicit or explicit, to desires, beliefs and intentions. The steps that are required, and where there is a 'designer' it is implicitly linked to final cause. The standard, current understanding of cause and effect.

Final – (e.g. Teleological explanations)– the end, that for which the sake of which a thing is done (Volition, Motivation etc). For Kant they act as a regulative principle for reflective judgment and we, as humans can only make sense of organisms by reference to teleology.

Concept of understanding –

Knowledge obtained from empirical studies. Associated with reflective judgments.

Concept of reason –

An experiential knowledge of something, associated with determining judgments. A priori truths are also concepts of reason.

Contingent –

Happening by chance, non predictable.

Cosmological Argument –

A pattern of argumentation that makes an inference from certain alleged facts about contingently existing things in the world (cosmos) for the existence of a being (God).

Designedness –

The state, or quality of being designed. It is classified as an uncountable noun in that it cannot be used freely with numbers or the indefinite article.

Determinative Judgment –

Determinative judgments proceed from the universal to the individual, or concept to intuition. They subsume an individual or event under a schematised category, (M^{c}Farland, 1970). For example, if we are looking for a peppered moth in our field studies, we make a determining judgment when we say, "Look, I have found a peppered moth" upon locating the desired individual. In doing so we add further empirical content to the concept of a peppered moth through its affiliation with the individual moth, (Wicks, 1994).

Universal -> Individual

[Concept] -> [Intuition]

A determinative judgment is a concept of reason.

Discursive –

General human concepts. Knowledge revealed by understanding, that is non intuitive.

Empirical –

Depending upon experience or observation alone. Kant in *Prolegomena* relates it as "empirical judgments, in so far as they have objective validity, are judgments of experience; they, however, in so far as they are only subjectively valid, I call mere judgments of perception".

Fermion –

Particles such as electrons, protons, and neutrons that are the 'constituents' of matter and account for its impenetrability. This is contrasted to bosons, which mediate, or carry, forces between fermions. Examples of bosons would be photons, gravitons, and gluons.

Functionalism –

"A framework of thinking in which parts of the whole perform functions and these functions represent 'biological significance', and within an historical framework, leads to the notion of 'purpose'. Consequently functionalism represents the view that structures result from a 'need' posed by the environment", (Lambert and Hughes, 1989).

Maxim –

A subjective principle or rule, that the will of an individual uses in making a decision.

Mechanism –

The causality whereby the parts of the whole are taken as determining the whole, rather than the whole determining the parts. Related to efficient causality.

Natural Purpose (Purpose of Nature) –

Kant aimed in the *Critique of Teleological Judgment* to turn natural purpose from a concept of understanding to the concept of reason. Organisms are seen as natural purposes, that is they are cause and effect of themselves. That is they have intrinsic purposiveness and exhibit material objective purposiveness. This is contrasted with formal purposiveness, (such as geometric shapes), and external purposiveness, which is material subjective (such as that of an artwork or house).

Naturphilosophie –

The German philosophy of nature, popular in the late 18th and early 19th Centuries. A mixture of biological observation coupled with metaphysical theory and influence by Kant. Notable exponents of Naturphilosophie include Goethe, Herder, Schelling and Blumenbach. Naturphilosophie aimed to reunite humans with nature.

Ontological Argument – An argument for the conclusion that God exists derived from premises of, for example, reason alone. Ontological arguments are composed of only a priori, analytic and necessary premises. Kant chose not to use this for his investigation of the nature of organisms for two reasons, firstly that existence is not a predicate (CPR), and secondly that by incorporating a supreme being into our system we would be 'confessing that we had come to the end of it'.

Purposiveness –

Also see teleology. Types: Formal – shapes, material objective – organisms, material subjective – art.

Purposiveness (relative) –

For example, the nature of a river providing water for trees, (i.e. the river is mechanical process, but its contributing relationship with a living thing, the trees (internal purposiveness) make this relationship a relative purposiveness.

Reductionism –

A philosophical position that a complex system is nothing but the sum of its parts. That is, it can be completely described on account of its individual constituents.

Reductionism as a philosophy has been popular in many branches of the sciences. Reductionism is contrasted with perspectives such as holism, (as defined by Aristotle – 'the whole is more than the sum of its parts') and emergentism, (the way complex systems and patterns arise out of a large number of relatively simple interactions).

Reflective Judgment –

In a reflective judgment one proceeds from the individual to the universal, (that is, from our perception of an individual thing, and then attempts to categorise this under a concept that is suitable for categorising the thing). This is the opposite move to a determining judgment, (where the move is from a concept (universal) to an intuition (individual)). For example, in the case of our field study, in a reflective judgment when we see the individual in question and say "what is that?", we apply various concepts to it in an attempt to unify the sensations under a universal type or concept. So if we then say "that is a peppered moth" in relation to the individual we have made a reflective judgment.

Individual ⇒ Universal

[Intuition] ⇒ [Concept]

A reflective judgment is a concept of understanding.

Solitons –

A self-reinforcing pulse-like wave that can exist in nonlinear systems and maintains its shape while it travels at constant speed. Examples of soliton type waves in organisms are the waves that act in organism development (for example in somite formation), quasi-solitons (as nerve impulses) and in the backbones of proteins. Solitons are best described by extremal principles and exhibit acausal properties similar to fermions such as protons. Solitons were first discovered by John Scott Russell in 1834.

"All soliton equations including the KdV and MKdV equations exhibit some remarkable mathematical features:

- Can be exactly solved by a nonlinear analog of Fourier transforms
- Obey some form of nonlinear superposition principle
- Have two (or more) compatible Hamiltonian structures
- Possess an infinite number of conservation laws and symmetries

- Admit a determinant formula for multi-soliton solutions"

(http://lie.math.brocku.ca/~sanco/solitons/solitonkdv3.html)

Structuralism –

"The doctrine that structure rather than function is important. According to this viewpoint neither the elements nor the whole should be the focus of the attention but the relationship between them. Structuralism attempts to understand the laws and principles of organization which represent the conceptual basis via which we speculate about history", (Webster and Goodwin, 1982, Goodwin, 1982 in Lambert and Hughes 1989).

Subsume –

To encompass, (for example an idea or concept) as a subordinate, to a more inclusive system.

Supersensible –

The concept of something which is beyond our human (discursive) ability to cognise. It is in the supersensible that the antinomies of the world of nature as mere appearance are resolved.

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