Irreducible Complexity as a nexus for an interdisciplinary dialogue between machine logic, molecular biology and theology.

by

M. L. Dickson

Dissertation submitted in partial fulfillment of the requirements for the degree Magister Artium in Dogmatics of the North-West University

Supervisor: Mrs. M.C. de Lange (Faculty of Theology)

Co-supervisor: Prof. P. Pretorius (School for Biochemistry)

2007
Potchefstroom

ABSTRACT

The claim that a principle known as Irreducible Complexity (IC) is empirically discoverable is investigated successively from the perspective of engineering, then molecular biology and finally theology, with the aim of evaluating the utility of IC for an interdisciplinary dialogue between all three. In the process, IC is subjected to the principle objections presented against it in the literature, leading to the conclusion that IC is sufficiently resistant to scientific criticism to be accepted as a true property of certain living systems. The ubiquity of machine descriptors in the professional literature of molecular biology is scrutinised in the context of the role of metaphor in science, as well as in the context of entailment models. A Biblical Theological approach to the Bible is harnessed to establish a framework for estimating the extent to which the story of Christ warrants expectation of first order design formalisms in nature, and whether that story within itself provides any homomorphic exemplification of IC. Additionally, key theological criticisms of IC are evaluated as well as criticisms of the Neo Darwinian revisioning of the Biblical account. The overall conclusion is that a true interdisciplinary dialogue where IC is the nexus holds theoretical as well as experimental promise.

Keywords: Irreducible Complexity, Neo Darwinism, Biblical Theology, design, evolution, molecular biology, engineering, interdisciplinary dialogue, mechanism, machine, metaphor, naturalism, narrative, entailment

OPSOMMING

Die bewering dat 'n beginsel bekend as "Irreducible Complexity" (IC) proefondervindelik ontdek kan word, word agtereenvolgend vanuit die perspektief van die ingenieurswese, die molekulêre biologie, en laastens die teologie, ondersoek, met die doel om die bruikbaarheid van IC vir interdissiplinêre dialoog tussen al drie, te evalueer. Gedurende die proses word IC opgeweeg teen die hoofbesware wat in die lektuur daarteen gemaak word, en dit lei tot die gevolgtrekking dat IC genoegsame weerstand teen wetenskaplike kritiek toon, om aanvaar te kan word as die ware grondbeginsel van sekere lewende stelsels. Die alomteenwoordigheid van meganisme aanwysers in die professionele lektuur van molekulêre biologie word ondersoek in die konteks van die rol van die metafoor in wetenskap, asook in die konteks van verklarende modelle. 'n Bybelse Teologiese benadering tot die Bybel word toegepas om 'n raamwerk daar te stel waarbinne vasgestel kan word tot watter mate die storie van Christus 'n verwagting van eersterangse ontwerpformalismes in die natuur regverdig, en of die storie self enige homomorfiese vryskelding van IC verskaf. Verder word sleutel-teologiese kritiek teen IC, asook kritiek teen die Neo-Darwinistiese hersiening van die Bybelse weergawe, geëvalueer. Die omvattende gevolgtrekking is dat ware interdissiplinêre dialoog waar IC die skakel is, wel teoretiese sowel as eksperimentele belofte inhou.

Steutelwoorde: "Irreducible Complexity", Neo-Darwinisme, Bybelse Teologie, ontwerp, evolusie, molekulêre biologie, ingenieurwese, interdissiplinêre dialoog, meganisme, metafoor, naturalisme, vertelling, beperking.

ACKNOWLEDGEMENTS

A debt of gratitude is owed to God who has provided illumination from the two books via the magnificent person of the Son and His magisterial work. Whilst effort has been expended to minimise any errors of reading or interpretation, those that remain belong to me. Grateful thanks is expressed to the Faculty of Theology at North-West University and in particular to my supervisor Mrs. M.C. de Lange (Faculty of Theology) and my co-supervisor Prof. P. Pretorius (School for Biochemistry).

I wish to dedicate this dissertation to two very important influences in my life: to my parents Rollo and Liz for sending me to university many years ago, and to my wife, Julie, for her love and encouragement.

ABBREVIATIONS

ATPase	Adenosine triphosphate synthase
Col	Colossians
Cor	Corinthians
E. coli	Escherichia coli
Eph	Ephesians
Fib	Fibrinogen
fl	Bacterial flagellar gene
Fl	Bacterial flagellar protein expressed by the gene *fl*
IC	Irreducible complexity
ID	Intelligent Design
mot	Bacterial motor gene
Mot	Bacterial motor protein expressed by the gene *mot*
NIV	New International Version of the Bible
Pet	Peter (the New Testament author)
Plg	Plasminogen
Ps	Psalm
TTSS	Type three secretory system

TABLE OF CONTENTS

CHAPTER 1

Irreducible Complexity as a nexus for an interdisciplinary dialogue between machine logic, molecular biology and theology

1.1 Background and problem statement

1.1.1 Background

For most of the 20th Century, the interdisciplinary dialogue between biology and theology among mainstream scientists has atrophied, to the point of demise in the case of natural theology.[1] The disappearance of the latter as a contender took with it many teleological questions pertinent to the interdisciplinary dialogue especially machine analogies thought to be indicative of extra-natural design e.g. the heart as a pump (Paley, 1810:159)[2]. However, the rise of biochemistry mid-century brought with it a re-introduction of mechanical terminology and machine concepts, ways of speaking and thinking that would be seen as increasingly useful for describing features of molecular biology. A new intersection set had opened up at some level between the domains of biology and engineering, especially in regard to the operation and organization of mechanical machines as applicable to micro-observations in the biosphere. This phenomenon in turn inevitably re-invigorated various strands of theological reflection. As a consequence, there is rich potential for resuscitating and re-developing an interdisciplinary dialogue between three domains *viz.* machines[3], molecular biology and theology (Minnich, 2005:9; Behe, 2004:359).

In 2009 the world will celebrate 150 years since *Origin of the Species* and accompanying that celebration a recognition of the power of Neo-Darwinism over all other contenders. This situation exerts a skewed influence over the direction any proposed interdisciplinary dialogue should take, largely due to the presence of some widely held assumptions. In regard to machines and molecular biology, the suggestion that common ground exists between them would generally be assumed to be unproblematic since it would be taken as a given that the primary focus would have to centre on the use of comparisons and metaphors, though as I

[1] As biologist Athel Cornish-Bowden says: "The final cause remains essential for discussing engineering, but it has largely been banished from the modern scientist's view of the natural world, which has no room for an external designer with definite intentions" (2006:486)

[2] Paley opined that the particular inclusion and arrangement of cardio-parts like valves entailed extra-natural design.

[3] Essentially the world of engineering but from the perspective of the logic of machines, what Rosen (1991) would term 'systems of inferential entailment'.

shall argue, much more is involved than the presence of tropes. Regarding molecular biology and theology, most biologists and many theologians would consider interdisciplinary dialogue between their respective disciplines essentially a negative undertaking haunted as it often is by the story of Galilean persecution. Certainly theology would be viewed in general by molecular biologists as the very much weaker partner, particularly when it comes to epistemology. A similar concern would probably emerge over the suggestion of any intersection between theology and the world of machines since it is widely assumed that Paley's watch lies buried in obscurity.

There are at least three modern positions concerning the science and theology interdisciplinary dialogue as envisaged. The modernistic response is one which views science and theology as 'non-overlapping magisteria' principally because it is claimed that each enjoys an epistemology that is mutually incommensurate or exclusive (Gould,1999). A position such as this does not foster dialogue across interdisciplinary boundaries. A second possible approach arises from a postfoundationalist view where it is argued that no canons for an overarching rationality exist, thereby denying to science or to theology any prospect of commandeering any epistemic higher ground. This prospectus allows for a quasi-traditional starting point within each domain, but insists that via the heuristic of transversality along a selected line of enquiry, a 'transversal space' may open up for new discoveries accompanied by a revision of each domain's initial epistemic focus (Van Huyssteen, 2006:9). A third possible approach is the one which will be advocated. Here the interdisciplinary dialogue amounts to a partial *redivivus* of older questions involving teleology and design such as the empirical detectability of design and the problem of suboptimality[4] but where in each case such questions are reformulated with special attention given to a concept known as *Irreducible Complexity,* a property that is contingent upon the nature of machines and not upon the assumptions of natural theology.

This third line of enquiry could quite easily be thought, mistakenly, to involve a return to some form of foundationalism. A brief defence will be launched that proposes no such connection with what is essentially a Cartesian enterprise particularly if the latter is understood as a project that aims to build up a coherent body of knowledge logically derived from a small set of axiomatic and indubitable beliefs, and where such beliefs are rooted in some sort of rational universality. Instead, what will be sought is the possibility of overlap between three narratives in a narrow intersection labeled 'design'. In the process there will be no appeals to

[4] Dysteleogical issues which involve Darwinian use of theological arguments in counterfactual conditional form e.g. If an extra-natural designer had produced a certain molecular biological system, such a designer would not have done it this way.

postmodern criteria. What should arouse renewed teleological curiosity is the recommendation of engineering design principles for the furtherance of molecular biological research (Alberts,1998:293), the frank admission by some biologists of the existence of detectable design in biology (Dawkins,1986:36) and my own theological reflections, particularly with reference to Biblical Theology.

1.1.2 Problem statement

Professor Jerry Coyne has said: "The argument for intelligent design has a fatal flaw. We have realised for decades that natural selection can indeed produce systems that, over time, become integrated to the point where they *appear* to be irreducibly complex. But these features do not evolve by the sequential addition of parts to a feature that becomes functional only at the end. They evolve by adding, via natural selection, more and more parts into an originally rudimentary but functional system, with these parts co-opted from other structures. Every step of this process improves the organism's survival, and so is evolutionarily possible via natural selection. Consider the eye...at the end of the sequence we have the camera eye which seems irreducibly complex. But the complexity is reducible to a series of small adaptive steps" (Coyne, 2005:13).

This approach to an overturning of irreducible complexity, an approach not uncommon (cf. Padian, 2005:4)[5], is itself hugely problematic since it does not respect the carefully defined terms utilised by its originator in framing the concept. Professor Michael Behe has defined irreducible complexity only at the level of molecular biology, and at the level of simple systems i.e. systems whose parts are polypeptides (Behe, 1996:41). Higher level complexity such as an eye falls outside the scope of the argument. Coyne's argument therefore misses the point.

Irreducible complexity therefore is not fully understood by the molecular biological (and biological) community. A need exists for a careful analysis of the concept in order to demonstrate its viability and importance for molecular biology.

In order to adequately probe the problem as to precisely what irreducible complexity is and its scope of application, several questions need to be answered:

[5] Professor Kevin Padian's views on irreducible complexity formed an integral part of Judge Jones final assessment in the trial of Tammy Kitzmiller *vs.* Dover Schools (Jones, 2005).

1. Is the notion of Irreducible Complexity coherent in the mechanical domain?
2. To what extent are mechanistic language and machine principles already present and functioning within modern molecular biology?
3. Could Irreducible Complexity provide a legitimate design diagnostic for molecular biology?
4. Can Biblical Theology present a normative expectation for detecting design in the empirical world at least where the Christian is concerned?
5. Can the tri-domain intersection provide a dialogue useful for all three disciplines of machine design(engineering), molecular biology and theology?

1.2 Central research question

The fundamental question which requires investigation is this:

> What type of utility could Irreducible Complexity provide as a nexus for an interdisciplinary dialogue between machine logic, molecular biology and theology?

1.3 Aims and objectives

1.3.1 Aims

The aim of the research is to establish whether and to what extent Irreducible Complexity can provide an integrating tri-narratival nexus for an emergent interdisciplinary dialogue between machine logic, molecular biology and theology, and to what extent such a dialogue provides insights relevant to all three domains.

1.3.2 Objectives

In order to achieve this aim, the following objectives will have to be met:

- To research and evaluate the ways in which Irreducible Complexity is entailed in the realm of engineering and machines;

- To research and evaluate the current use of machine descriptors and design concepts in molecular biology;

- To research and evaluate the utility of Irreducible Complexity as a diagnostic of design within molecular biology;

- To research and evaluate the manner in which Biblical Theology entails design detection in the empirical world;

- To evaluate and show what the tri-dialogical implications of Irreducible Complexity for all three domains are.

1.4 Central theoretical argument

Despite vigorous negative critique from the scientific mainstream, Irreducible Complexity remains a demonstrable property in the mechanical and molecular biological domains thereby offering a novel heuristic for reviving interdisciplinary dialogue between machine logic, molecular biology and theology.

1.5 Methodology

- To research and evaluate the ways in which Irreducible Complexity is entailed in the realm of engineering and machines an analysis will be undertaken of literature that has suitable bearing on the subject. Thinkers such as Ruse (2005a:294), Rosen (1991:59), Alberts (1998:293) and Behe (1996:42) will be consulted.

- To research and evaluate the use of machine descriptors and design concepts in molecular biology. Recently published papers and other reports will be consulted covering researchers such as Vale and Milligan (2000:88) and Minnich (2005:9).

- To examine and evaluate the utility of Irreducible Complexity as a diagnostic of design within molecular biology. An analysis will be conducted of the pertinent published literature produced by scientists trained in the life sciences such as Rosen (1991:59), Miller (2004:87), Behe (1996:82).

- To research and evaluate the manner in which Biblical Theology entails design detection in the empirical world. This will be conducted by critically examining the approach to the Biblical Theological discipline as undertaken by Goldsworthy

(1991:60) including concomitant issues regarding teleology in the created order. Exegesis will follow the grammatico-historical method outlined by Goldsworthy (2006:196) and from a Reformed perspective.

- To evaluate and show what the tri-dialogical implications of Irreducible Complexity are for all three domains. The discussion and analysis thus far will be integrated and salient issues weighed.

1.6 Provisional chapters

Chapter 1	Irreducible Complexity as a nexus for an interdisciplinary dialogue between machine logic, molecular biology and theology
Chapter 2	Irreducible Complexity as a design diagnostic in the mechanical world
Chapter 3	Design language and principles already present in molecular biology
Chapter 4	Irreducible Complexity as a design diagnostic in molecular biological systems
Chapter 5	Biblical Theology and design detection in creation
Chapter 6	Irreducible Complexity entailments for the tri-interdisciplinary dialogue
Chapter 7	Conclusion

CHAPTER 2

Irreducible Complexity as a design diagnostic in the mechanical world

> "Today, on the brink of the twenty-first century, we can see that Ryle was right to dismiss the notion of the ghost in the machine - not because there is no ghost, but because there is no machine" (Davies & Gribbin, 1992:303).
>
> "Precisely because one is thinking of the trilobite eye lenses as if designed and created by a real optician, can one find out why they are as they are and how they worked" (Ruse, 2000:229).
>
> "The problem with a simple conclusion that something is designed, is its lack of informativeness. If you tell me that skirnobs are designed but nothing else about them, then how much do I actually know about skirnobs? Of a single skirnob, what can I say? Unless I already know a fair bit about the aims and intentions of skirnob designers, nothing is added to my knowledge of skirnobs by saying that it is designed. I do not know if a skirnob is a good skirnob, fulfilling the design criteria for skirnobs, or not. I do not know how typical that skirnob is of skirnobs in general, or what any of the properties of skirnobs are. I may as well say that skirnobs are "gzorply muffnordled" for all it tells me. But if I know the nature of the designer, or of the class of things the designer is a member of, then I know something about skirnobs, and I can make some inductive generalizations to the properties of other skirnobs" (Wilkins & Elsberry, 2001:721).

2.1 Background

The idea that novel discoveries in a discipline can be formulated by those who are outside that arena of expertise seems counter-intuitive. After all, the value of years of training and experience in grasping the fundamentals of a particular area of study ought not to be under-estimated nor devalued given that the entire human knowledge enterprise requires precisely such qualified individuals to propel everything forward. However, Thomas Kuhn drew attention to the fact that the history of science records an interesting feature about discovery: sometimes important insights into a discipline flash across the minds of thinkers who are outside that discipline precisely because they are outsiders.[6]

In this chapter some new thinking about the nature of machines is explored via the application of a principle observed in certain molecular biological systems. However, for the purpose of this discussion, the exercise of thematic control will not permit comprehensive exploration of the world of engineering via this insight. Instead, the scope of the ensuing discussion will be limited mainly to an investigation as to whether this principle, Irreducible Complexity (IC), is indeed a property of mechanical machines. *En route* it will be necessary to consider some introductory aspects of the machine-like nature of molecular biological systems in order firstly to nuance the attempt to provide a definition of a machine, and secondly to create an awareness of how assumptions about biology affect one's view of machines and vice versa. Given Rosen's objections that the scientific mindset still to this day considers "machines the general and biology the particular" (Rosen, 2000:266), it is

[6] "Almost always the men who achieve these fundamental inventions of a new paradigm have been either very young or very new to the field whose paradigm they change" (Kuhn, 1962:90). This observation is helpful to bear in mind when considering interdisciplinary studies. It does need to be counterbalanced, however, by remembering the tendency of some to view an expert in one field as an expert in all fields.

appropriate not to delay the opportunity to factor in the perspective such objections bring. Whilst the division of opinion over whether machines in principle can truly exhibit key features of living systems they attempt to model will increasingly haunt later chapters, it is important that the concern is introduced at this early stage.

The flow of the chapter will begin with a definition of irreducible complexity as well as some introduction to the scope of the idea, then moving on to an attempt to provide a machine definition, followed by an enquiry into whether irreducible complexity is an actual property of mechanical machines, finally considering briefly the intersection of design and narrative leading to the conclusion.

2.2 Introduction to and definition of Irreducible Complexity (IC)

2.2.1 A design diagnostic

The emergence of a design diagnostic applicable to the domain of engineering would never have arisen within that domain, the simple and obvious reason being that aetiological concerns would be considered irrational, with the possible exception of the design of some household appliances. However, with the conceptualisation of IC, biochemist Michael Behe has identified a property of multi-part machines that has true inter-disciplinary utility: a feature applicable in all realms where machines are identified.

This property was introduced to the public in 1996 with the publishing of *Darwin's Black Box*. In this book Behe provides his definition: "By *irreducibly complex* I mean a single system composed of several well-matched, interacting parts that contribute to the basic function, wherein the removal of any one of the parts causes the system to effectively cease functioning..." (Behe, 1996a:39). There are two crucial aspects to this definition: the specifying of function (easy to do in engineering but controversial[7] when scrutinising systems in the biosphere), and the specification of components (Behe, 1996a:42). *Darwin's Black*

[7] It is controversial because as will be made clear, the moment one says of any living system that it has function X, there are often two hidden assumptions present *viz.* that (i) such a function is achieved in the same way as a similar function would be achieved in a mechanical machine, and (ii) that such a function was not preceded at some previous time in the past by a different but possibly related function W. In short, what one believes about the power and scope of Neo-Darwinian processes greatly influences how one discusses the issue of function though it might well be the case that in the molecular biological examples cited by Behe, disagreements over the way function is understood make no essential difference. The reason for saying this hinges on whether machines in nature are truly present (and therefore technically decomposable and capable of formalised capture), or whether they are only present as a metaphor, a way of seeing.

Box famously harnesses the analogy of a mousetrap[8] to illustrate the principle of IC. The "well matched" components of this mousetrap are proposed by Behe as an adequate demonstration of how a group of parts work in synchrony to achieve an overall function in such a way that the removal of any one part shuts down that function irretrievably. A common mousetrap "consists of the following parts: (1) a flat wooden platform to act as base; (2) a metal hammer, which does the actual job of crushing the little mouse; (3) a spring with extended ends to press against the platform and the hammer when the trap is charged; (4) a sensitive catch that releases when slight pressure is applied, and (5) a holding bar that connects to the catch and holds the hammer back when the trap is charged (there are several assorted staples to hold the system together)" (Behe, 1996a:42). Behe's point is that the non-existence of any component would render the system non-functional. All the parts have to be in place (and joined together) simultaneously for the system to function (Behe, 1996a:39).

It is not generally appreciated that although there is this one fundamental notion harnessed by IC, there is a strong accompanying *inference* which in many ways provides IC (and possibly ID) with its maximum leverage. The inference is that the conceptualisation of a Darwinian *pathway* which has as its end result an IC system, is impossible. From Behe's vantage point "the power of the concept of IC is that it invalidates the step-by-step *process* of evolution, not just the *product*" (Smart, 2003:2). The corollary is that a search within the literature should yield a situation that comports, i.e. a careful scrutiny of the journals and textbooks should demonstrate the non-existence of exactly such developmental pathways. This negative inference presents a challenge to the molecular biological community, suggesting a re-examination of published examples of Darwinian gradualist pathways. Behe has in fact made the controversial pronouncement that his examples of IC systems cannot be matched to any published work by Neo-Darwinians which demonstrate a coherent aetiology via incremental gradualism[9] (Behe, 1996a:176). This pronouncement generated an outcry which we will examine further on. What this means is that Behe as a professional biochemist has vocalised the concern that the empirical basis for believing Neo-Darwinianism to be the true explanation in every case is founded upon ideology rather than detailed scientific analysis and explanation. Further to this there is an implicit call for

[8] Behe writes: "In Canada an academic ran after me with a loaded rat trap, inviting me to stick my finger in it to see if it worked (I use a mousetrap as an example of the sort of system that can't be made by Darwinian processes)" (Behe, 2005:2).

[9] Behe writes: "None of the papers published in the Journal of Molecular Evolution over the entire course of its life as a journal has ever proposed a detailed model by which a complex biochemical system might have been produced in a gradual step by step Darwinian fashion" (1996:176). The key phrase here is 'detailed model'. Behe's complaint is that the kind of pathways supplied in the literature never show even intelligent guesswork as to how a precursor system actually adds the parts *biochemically*.

nuancing current scientific criteria used for assessing the plausibility of any proposed model, as well as an invitation to re-examine the power and scope of natural selection.[10]

2.2.2 IC and interdisciplinarity

It is instructive to note that this particular analysis of multi-part mechanisms in nature is consistent with what used to be called bionics[11], harnessing biology to generate something new for engineering and vice versa. At first blush it might seem that a design diagnostic is of marginal use for engineers. On reflection, however, the relationship between designers and the eventual products of their ideas is of great importance for engineering, machine analysis (reverse engineering), design principles, architecture, philosophy, cultural studies, aesthetics and more.[12] Some of these applications are sociological, but a few of them involve first order scientific analysis. An example would be reverse engineering principles used by molecular and micro-biologists investigating the nature and function of living nano-systems. Prof Scott Minnich who has spent several decades researching bacteria at a molecular level, in his expert testimony submitted in the Kitzmiller vs. Dover School trial argues that the methodology employed in the laboratory is actually based upon design principles. He writes: "This approach using mutagenesis to identify genes involved in a defined process, coupled with biochemistry to essentially rebuild the structures to understand how it works is referred to as reverse engineering. This is much the same technique engineers use when they analyse a machine for which blueprints are missing. In other words, the idea is that you take things apart and put them back together again while in the process evaluating what each component contributes to the whole" (Minnich, 2005a:7).

Minnich also says: "Irreducible complexity, a term coined by Michael Behe in his scientific argument for intelligent design, essentially states that molecular machines are comprised of a core set of components essential for function of that machine. If that component is removed from the machine, there is a resulting overall loss of function. If there is no function

---

[10] Scott Minnich, veteran researcher of bacteria for three decades writes: "Contrary to popular belief, we have no detailed account for the evolution of any molecular machine...We know that intelligent designers can and do produce irreducibly complex systems. We find such systems within living organisms. We have good reason to think that these systems defy the creative capacity of the selection/mutation mechanism. The real problem may not be determining the best explanation of the origin of the flagellum. Rather it may be amending the methodological strictures that prevent consideration of the most natural and rational conclusion—albeit one with discomfiting philosophical implications" (Minnich & Meyer, 2004:6,7).

[11] "As initially conceived bionics involved the interplay between biology and human technology in their broadest sense. Its twin goals...were (1) the employment of biological modes of behaviour and organisation to solve technological problems, to design new and better ways to engineer, and (2) to use technology to illuminate biological processes themselves" (Rosen, 2000:287).

[12] Also implicated is the program known as 'the search for extra-terrestrial life' (SETI).

then there is nothing to select. In biological terms, irreducible complexity implies that mutations in genes encoding pieces of molecular machinery will yield selectable phenotypes based on this loss of function. It is the process of using mutagenesis and devising genetic screens or selections to identify loss of function that has yielded astonishing findings over the last sixty years. Irreducible complexity of molecular machines is the bread and butter of the modern approach to understanding the cell" (Minnich, 2005b:7).

IC can be observed latently in the published analysis of the micro-machines in nature. For example Mallik writes: "...(of interest) to the physicist: Understanding the architecture and function of molecular motors can elucidate basic design mechanisms in nature for implementing functional machines at the size of nanometers" (Mallik, 2005:1).

The value of IC in contributing to a growing conversation between the world of engineering and the world of molecular biology (and indeed the rest of biology by implication) should be clear. This preliminary observation is at variance with the general perception that Behe, Minnich *et al* really only have an interest in IC because they have another motive: they wish to gain metaphysical mileage from this principle in order to promote a religious agenda. The idea that they along with a sizeable group of well qualified scientists[13] have no real interest in science *qua* science but only in taking society back to the dark ages is completely wrong. The reality is that if it is indeed the case that we live in a world that has been designed[14] *at some level or other,*[15] it cannot be ruled *a priori* that a design diagnostic is *un*discoverable in principle. The *a fortiori* upshot is the cross-disciplinary value for such a diagnostic. This aspect apparently escapes the attention of some: "We would contend that Intelligent Design (ID) and IC (but not under those names) are already a feature of research into evolution. They are a facet of the uncompleted, unanswered questions that we still have about our potentially flawed, certainly incomplete, but best-we-have-for-now theory, with its maybe-most-important-maybe-only-one of many mechanisms, natural selection, for explaining the diversity of form and function of life" (Bateman & Ellis, 2007:15).[16] This view which in

[13] Others for example are biologist Dr Paul Chien who is professor of Biology at the University of San Francisco, emeritus biologist Dean Kenyon at San Francisco State University. Kenyon had earlier been an ardent supporter of Neo-Darwinism and has co-authored a major text used in many universities titled "Chemical Evolution" which attempted to show the physical and naturalistic origin of life. However, during the completion of that project Kenyon's doubts grew as to the cogency of the central thesis of his book, and several years later aligned himself with ID.

[14] Of course, if one defines science as an enterprise that is canonically restricted from being able to discover design-by-a-designer, then even the hypothetical contemplation of design would be seen as an appeal to a religious agenda. But science need not be thus defined.

[15] This is one of the assumptions in this dissertation, and defended strongly in Ch5.

[16] Bateman and Ellis write from a Christian perspective and have provided a very insightful article. ID and IC could indeed be seen as 'features of research into evolution' depending on what one means by the phrase. Behe after all is an evolutionist. Certainly it cannot mean that IC possesses no distinctive character of its own and no

essence maintains that there is nothing truly new or distinctive in IC is at variance with the argument here that advocates IC as a design diagnostic.

2.2.3 A caveat

It is appropriate at this point to say something about Intelligent Design (ID). This discussion draws a distinction between ID and IC with the intention of making luminous the scientific utility of the latter, having bracketed the ideology of the former. In the debate, ID and IC are often conflated leading to some widespread misunderstanding. ID is a much broader term referring not only to a concept but also to a movement sometimes called the Intelligent Design Movement (IDM).[17] In addition, the latter is associated with a program for social and political change called "The Wedge". The ideology of both ID and the ID Movement renders both unsuitable as loci for a dispassionate analysis of design, therefore for the purposes of this discussion there will be instead a focus on the concept of IC as an empirically observable formulation. However, the exclusion of ID as a focus does not mean the discussion will exclude the term, particularly since it is the case that members of the ID community are ready-to-hand referents of those who hold to IC.

2.3 Attempting a machine definition

2.3.1 Basic definition

Defining what a machine is would seem quite straightforward to most people. Yet as is the case in all discussion, it becomes important to inspect more precisely what is meant by the terms employed, and where necessary to tighten up the description. The Concise Oxford Dictionary defines 'machine' as "an apparatus using or applying mechanical power and having several parts, each with a definite function and together performing a particular task" (TCOD, 1999:852). Understandably, this summary has in mind the world of everyday

---

separable ability to stimulate interdisciplinary enquiry. Furthermore, IC represents a major stumbling block for the efficacy of natural selection in explaining the etiology of certain micro-systems in the biosphere. It is no response to say that since natural selection is all we have (obviously IC cannot be a replacement since it is not a generative mechanism) that therefore IC should recognise that it is just one more small question mark along with many others already raised by evolutionists. If IC truly demonstrates the failure of natural selection and other non-Darwinian mechanisms to explain the presence of particular machines present in molecular biology, then it is foolhardy to respond by saying that the current Darwinian explanation has to remain "the-best-we-have-for-now." The sentiment expressed by Bateman and Ellis is therefore off-beam and somewhat paternalistic.

[17] The ID Movement is generally perceived as a religious body though its membership criteria do not include subscription to any religious tenets *per se*. Philosopher of biology Paul Nelson says: "The admission price is minimal: one need only allow for the possibility of design" (Nelson, 2000:2). This of course is confusing in the modern arena owing to the fact that many biologists who oppose ID nevertheless talk about detectable design in biology but where the design is due to natural selection and other natural processes (Dawkins, 1988:37).

encounters with engineered systems. This alerts us to the fact that what we wish to say about machines does depend to some extent on the context.

That is why when one moves into the realm of molecular biology, universal definitions require more nuancing. In this context the summary provided by the ordinary dictionary is neither quite clear enough about "the use or application of mechanical power" nor unambiguous when it says that each part has a definite function. The word 'function' itself requires nuancing.[18] In the debate between IC and Neo-Darwinism there is disagreement over whether parts contribute in machine-like manner to an overall function, or whether each part (or group of parts) has (or has had) a function *independent* of the currently observed overall function (Miller, 2004:85,87). One should not think that a question based on this would easily separate the sheep from the goats since there is division among Darwinists as to the nature and role of machine terminology in biology.

In the light of this, the following definition of a machine is proposed: "a system comprised of inter-related parts co-ordinated to perform together at least one major function and where in the execution of that function energy is consumed[19], and work done." This definition is felt to be more nuanced than that of Joachim and Gimzewski: "Machines essentially are arrays of functional components that transform energy (or information) and use this transformation" (2001:2). What is lacking here is some mention of an organisational whole to which the parts belong. Also unsatisfactory is James Barham's definition[20] which requires all machines to

---

[18] Larry Wright observes: "As I have shown elsewhere, a condition of this kind is what the 'natural' functions of biology have in common with the 'consciously designed' functions of artifacts. The function of the grooves in a pneumatic tire tread is to augment wet-weather adhesion and that also explains why the grooves are there. An etiological analysis is capable of unifying the entire field of function ascriptions. And since there is no clear difference in the sense of 'function' in the two contexts (compare "the function of that cover is to keep water off the distributor," with "the function of the epiglottis is to keep food out of the windpipe."), this is a very strong positive consideration: an analysis which can accommodate both kinds of function is vastly to be preferred to one which cannot" (Wright, 1972:514).

[19] Bruce Alberts writes "Modern machines...are often analysed by an energy-based approach.. a mathematical description of the machine is achieved (via a representation) of system energy (.i.e. kinetic or potential energy) and the work done by external forces" (Alberts, 1998:292).

[20] This definition is inferred from the following statement by Barham: "In order for Darwinian reduction to go through, we must assume that an organism's parts are essentially independent variables, each of which is free to change at random with respect to the other parts and with respect to the whole organism's needs. But if organisms were really made of inert, functionally uncorrelated parts, then evolution would be impossible owing to combinatorial explosion. There has simply not been enough time since the Big Bang for even a single protein molecule to be created in this way with any reasonable probability, much less an entire cell...If organisms were literally machines, they would indeed be miraculous - on this point the ID critique of Darwinism is perfectly sound. If organisms were really made out of inert parts bearing no intrinsic relation to function, then we would indeed have to assume that they were designed by a humanlike intelligence, because that is the only conceivable way for functionally integrated wholes made of such parts to come into existence" (Barham, 2004:216). Barham has an implicit definition of what a machine is, and then via bait and switch shows that there is not enough time for a chance combination of such a machine to simply appear fully formed. But the real issue is whether his definition of a machine is sufficiently accurate (which it is not...see argument in the above text), and then whether what is observed in nature fits a better definition. Simply because the parts of *living* machines are

have "inert parts that bear no intrinsic relations to overall function" or "functionally uncorrelated parts" or consisting of "rigidly connected parts" (2004:216,220).

2.3.2 Notions of functionality and machine definitions

What is helpful about Barham's approach is the attention drawn to the question as to whether the individual components in machines bear *in themselves* any relation to overall function. The difficulty is that he assumes a simple 'yes' or 'no' answer to this question which just cannot be the case. When it comes to human built devices, the answer at one level is 'no'. The spring of a mousetrap does not in and of itself have any 'moustrap-ness' about it. At another level though, there are many different kinds of springs of which a good number would be highly unsuitable for use in such a device. Among the criteria for suitability: a certain stiffness so that sufficient rotational potential energy can be stored to break murine vertebrae, yet not too much stiffness to cause injury to humans either when setting the trap or accidentally triggering it (and also so as not to self-destruct the trap upon first use); a configuration that is suitable for integration with other trap parts. The upshot is that although the parts exhibit *in themselves* no 'moustrap-ness', they nevertheless do display an inter-relatedness or as Behe says, the quality of being "well matched" (1996a:39). This means that Barham's phrase: "intrinsic relation to overall function" equivocates. If one is searching for 'moustrap-ness' then of course there is no "intrinsic relation to overall function" but if one is observing organisational functionality then there *is* "intrinsic relation to overall function". Barham only permits the former and therefore cannot see actual machines in living systems.

This in turn leads the discussion to a further consideration. It is possible for an engineer to find a junkyard and rummage around for odds and ends and cobble together a mousetrap. Yet as she does this, what has previously been noted will be made even more luminous. Random pieces lying scattered around have obviously no prior relation to the device into which they are incorporated, yet in the process of incorporation will have to be best-chosen and then configured. It would indeed be miraculous to find exactly the right assortment on the first hunt, and on top of that to find that one need only clip them into position, so serendipitously well tailored they just happen to be.

---

related to each other and related to the bigger whole in ways beyond the capability of current human engineering to duplicate ought not to preclude such arrangements from being true members of the set of machines. "...the crucial concept of self-replication was shown to be consistent with mechanistic hypotheses by John von Neumann as early as 1948...The entailment of replication by the functions of metabolism and repair is, therefore, unlikely to distinguish organisms from machines" (Wells, 2006:51).

The aforegoing also helps alleviate various other difficulties emergent in any discussion that accompanies the study of nano-machines. Joachim and Gimzewski (in the context of talking about designing and making nano-machines), write that "In macroscopic machines whose components are typically much larger than 100 microns, the motion of the parts is governed by classical mechanics...These micro-machines are scaled down versions of the machines in our daily life, using the same principles as, for instance, a steam engine. Even smaller are biological motors that do not function directly according to established engineering concepts or even human intuition...(with)...dimensions on the scale of a few tens of nanometres...(and where such)...biological machines maintain operation within an environment where fluctuations and vibrations exceed the actual motions of the machines and they may actually use or rectify such fluctuations as an operational principle" (2001:2). What is being pointed out in the first place is that living machines that have the analogues of gears, ratchets, springs, rotors and stators are actually very, very small, and typically have the dimensions of nanometres. For example, the basal rotor and stator assembly of the *Escherichia coli* bacterial flagellum is forty-five nanometres across, while the flagellum cross section is twenty-three nanometres (Berg, 1999:3). In the second place, such machinery have ways of operating that are simply not possible for human engineers to harness at a macro level because at the nano scale the machine components are in a thermal bath of molecular activity.

However, what is *not* being said is that these tiny machines defy engineering logic - far from it. It is instead a case of understanding the ways in which degrees of freedom and reservoirs of energy available to a miniature world are harnessed. Therefore, it should be clear that there is a difference between on the one hand learning the novel ways in which nano-machines obtain and transform energy[21], and on the other hand detailing the organisation of their structural components which in many cases do present unmistakable analogues of macro machines. Kenneth Miller describes the *Escherichia coli* flagellum as an "outboard motor" (Miller, 2005b:5). Despite its *energy* operation via proton diffusion, it truly has a rotor, a stator, a hook joint and a propeller. It truly is an outboard motor.

The previous paragraph leads to the following proposal of a principle operating for all objects truly members of the set labeled 'machines', and where the name of the principle could be

[21] This is the meaning of the word 'directly' in Joachim and Gimzewski's phrase "do not function directly according to established engineering concepts". These machines have components that in many cases are co-ordinated (function) just like their macro counterparts but do not harness energy (function)in the same way. The word 'function' enjoys considerable polyvalence to the extent that one could truthfully utter both the following sentences: (i) The parts do not function like those of macro-machines (ii) The parts do function like those of macro-machines.

"machine analogical scale invariance". This makes reference to the fact that no matter how big or how small any machine may be whether in the world of human manufacture or molecular biology, there are always features that correlate the macro and micro situations either isomorphically (i.e. directly) e.g. the nano-bushing for the bacterial flagellum, or homomorphically (i.e. indirectly) e.g. chemotaxis memory.[22] It is this principle that will augment arguments relating to block diagrams in chapter three and help explain the relevance of macro world examples in chapter five given the overall context of molecular machines.

2.3.3 Conclusion

It has been the aim via the intervening discursus to show that the machine definition I formulated earlier is adequate to cover macro and micro examples: "a system comprised of inter-related parts co-ordinated to perform together at least one major function and wherein the execution of that function energy is consumed, and work done."

2.4 Machines in a Philosophical setting

2.4.1 Machines and life: a bifurcation?

Any discussion about machines in the context of living systems will naturally lead to questions about artificial life and artificial intelligence. It should be said again at this point that given the presence of IC on the intellectual landscape it is no longer possible to talk about machines in isolation from the biosphere. This forces the discussion to take more careful cognisance of other research areas where there is an intersection of machines and living systems. This would include questions about the nature of the human mind. The Turing Test[23] is an example of the fruitful epistemic mutuality that can arise from discursive analysis

[22] Memory (apart from natural phenomena like hysteresis) as everyone knows can be created in mechanical or electronic systems. There is unlikely to be a direct correlate in living systems but there is a congruency of function. A block diagram labeled "memory circuit" would cover what the human-designed machine does and it would cover what the biological counterpart does in terms of function.

[23] The Turing Test devised by Alan Turing in the 1950's unwittingly invites people to adopt a particular view of the human mind whereby certain abilities, for example the ability to think, are suggested as being nothing more than sophisticated computation. Accordingly, the Turing Test is simply a small experiment that could be done at any time and set up so that a human could interrogate a partner hidden from view behind a curtain who answers the questions via a printed output. Should the interrogator conclude that the partner was human (even though on lifting the curtain a computer was seen to have been supplying the answers), then an additional conclusion should be that the machine must have been truly thinking. In essence, says the Test, we ought not to deny that a machine is truly doing the same thing as a human is doing if on inspection or interrogation we cannot tell their performances apart. This is a kind of functionalist approach to philosophy of mind, and there are many unsatisfactory aspects to it. Certainly those who uphold the validity of IC in certain living systems would not

of living and machine systems modeling each other. The point being made now, however, goes beyond mere interdisciplinary spin-offs and instead considers the oft hidden philosophical framework which shapes our perceptual apparatus. The Turing Test itself, innocent and simple though it may appear to be, presupposes a certain philosophy of mind which the public by and large seems to have accepted at face value. What this means is that machine models such as these for all their utility, do exert subtle influences. It is quite likely that Turing's language in his seminal 1936 paper where he modeled a human mind via a mathematical machine and where he said of the iterative condition: "The behaviour of the computer[24] at any moment is determined by the symbols which he is observing, and his "state of mind" at that moment" (Turing, 1936:246) actually led to the use of the phrase 'brain states' so common today[25]. Such language harbours within its etymology a reminder of the way in which machine thinking has been a lens through which organisms have been viewed.

These questions cannot be pursued in any depth here but it should be clear that thinking about machines in relation to living mechanisms or indeed entire organisms does in fact draw on a much wider field of scientific and philosophical and theological exploration. This needs to be stressed in order that the relevance of what follows is truly appreciated. It would be quite easy to insist that a discussion about machines as defined in the world of engineering should therefore bracket discussion involving the world of nature. Yet that would be short sighted not only because IC itself has been formulated by a biochemist in the context of molecular machine analysis, but because in many cases this is precisely what thinkers know they have to do, whether they declare it or not. References to Kant further on will show that his thinking about machines is offset against his thoughts about organisms. What is being said here is that it is almost impossible to view any one field in total isolation from any other. Paul Weirich's thinking shows evidence of this. It is quite striking that in a dictionary entry on computer theory, he considers evolutionary biology to be crucial to the conception of computer theory.[26]

---

wish to commit themselves necessarily to a Turing approach bordering as it does on an unrealistic mathematisation of nature.

[24] Turing meant the human doing the computation.

[25] "In the early 1960's Hilary Putnam proposed machine state functionalism: according to this view, mental states are types of Turing machine table states. Turing machines are mechanical devices consisting of a tape with squares on it that are either blank or contain symbols, and an executive that can move one square to the left or one square to the right or stay where it is. And it can either write a symbol on a square, erase a symbol on a square or leave the square as it is" (McLaughlin, 1995:604).

[26] Paul Weirich writes: "...the software and hardware aspects of a computer are somewhat analogous to the human mind and body. This analogy is especially strong if we...consider all information processing in nature and in human organisms, not just the conscious use of language. Evolution has produced a succession of levels of sign usage and information processing: self-copying chemicals, self-reproducing cells, genetic programs directing the production of organic forms...unconscious human information processing, ordinary languages, and technical languages. But each level evolved gradually from its predecessors, so that line between mind and body is vague" (Weirich, 1995:143). There is no doubt that in this approach several human disciplines are made

Related to this is the question of a fundamental dichotomy between machines and biology. What is of particular interest is the division of opinion over whether machines in principle can truly exhibit key features of living systems they attempt to model. Some leading thinkers who say that computers should be able to 'think' are Lenat and Minsky, and on the opposing side who say that even in principle computers cannot 'think' are Searle and Penrose (Casti, 2001:182,183).[27] The point being made all along is that the conception one has of a machine, be it a computer or otherwise, is never formulated simply by consulting an ordinary dictionary, nor is such a conception ever captured merely by one simple definition. What one believes a machine to be is dependent on a much wider setting and perspective.

Therefore, whether computers can fully model the human mind is not central to any arguments in the current discussion. What is worthy of further inspection is the contention among some thinkers that a fundamental divide exists between the intrinsic nature of machines and any living counterparts. A significant aspect of this is the issue of "entailment systems". This terminology arises from the work of mathematical biologist Robert Rosen,[28] and has been built on by complexity theorists like Mikulecky (1999), and systems biologists like Hofmeyr (2007), Wolkenhauer (2002), and Cornish-Bowden (2006).

In Rosen's conception, all machines can be codified as systems of inferential entailment, that is to say, they can be fully captured in propositions or in material equivalents that logically relate. A classic case is that of a mathematical machine such as invented by Turing in 1936 which has subsequently received material realisation in the common computer. Another example would be the construction of an electrical circuit to model a mechanical system (where a capacitor's electrical 'springiness' models an actual spring). These are all inferentially entailed systems. Rosen laboured to establish the idea that all systems of inferential entailment rely on external causes at some point whereas living systems are causally closed (2000:158). In this way Rosen attempted to set up a modeling relation between systems of causal entailment (living systems) and systems of inferential entailment

---

subservient to a prior commitment to evolutionary totalism. An evolutionary biological framework is made to underwrite if not control the understanding of a major dictionary entry on a subject that relates very closely to engineering. This underscores a point that will be made more than once in the main discussion that the story told about engineering is actually controlled by a more fundamental story, and that analysis of anything within the world of engineering ought to take clear cognisance of the way in which engineering concepts are viewed by evolutionary biology or other areas of thought.

[27] John Searle uses his famous Chinese Room argument, and Roger Penrose relies on the Gödel Incompleteness Theorem.

[28] Rosen (1934 -1998) was a mathematical biologist who is viewed by some as the father of complexity theory. Rosen was an evolutionist but very much an independent thinker. Rosen's project was to answer Erwin Schrödinger's question: What is Life? (Rosen, 2000:2).

(all mathematical or scientific attempts to model living systems) (2000:159).[29] Rosen was adamant that the fact that living things exhibit causal closure, that is, do not require external cause for metabolism or repair (he called these "M-R systems") placed them in a unique category that could never be captured or represented by a formal system of inferential entailment (Rosen, 2000:261). In short, no Rosennean machine can model a living system, and no living system can be captured (or modeled or adequately described) by machine representation. For Rosen, machines are extremely non-generic. But more importantly, although he never commented upon Behe's work, for him IC would be nothing else but a superimposition upon living systems of a Cartesian understanding of nature.[30]

"The machine metaphor was first proposed by Descartes in the early 17th Century. It is reported that, as a young man, Descartes was much impressed by some lifelike hydraulic automata. With characteristic audacity, he concluded from these simulacra that life itself was machinelike (rather than that machines could be made to appear lifelike, which was all he was really entitled to conclude)...considered as material systems, machines are still hard to characterise in intrinsic (i.e. epistemological) terms, independent of their origin or history. Yet the idea that the machine, or mechanisms, is the general, and biology only the particular, remains a compelling and fascinating one" (Rosen, 2000:266). In the eyes of some, Descartes' error rested heavily upon humanity until Rosen.[31]

Fundamentally, Rosen's misgivings about the ability of machines to model causally closed systems is based upon his understanding of Gödel's work especially the incompleteness theorem. He concluded from Gödel's results that "a constructive universe, finitely generated, consisting of pure syntax, is too poor to do mathematics in. Gödel's results imply that semantics and impredicativities and meanings are essential to mathematics; they cannot be replaced by more syntactic rules and more lists or algorithms. They mean that mathematical

---

[29] Rosen, for who consult him, is best known for the expression of these ideas in his book 'Life Itself' published in 1991. He had however begun his assault on conventional mechanistic thought in 1962.

[30] There is no a contradiction between Rosen at this point and his dependence on Kant which will be briefly explored later. The Cartesian system closes the ontic gap between self and the world, whereas in Kant the subject manufactures knowledge and never knows things in themselves.

[31] Mikulecky writes: "Unfortunately, when Descartes saw some hydraulically powered manikins and was very impressed by them he said: "Life is like a machine". He should have said "Those machines are lifelike". His mistake set a tone for hundreds of years. It was Robert Rosen who set things straight and in so doing showed the error in the claims of the intelligent design fundamentalists. What Rosen did was to examine the causal differences between machines and living organisms. They are profound. Organisms are causally closed while machines are lacking in causal bases. The Cartesian machine metaphor put reductionist mechanistic science in collusion with religion by giving this false picture of life. If life were a machine, the ID argument has to stand. Machines need cause from outside. Rosen's proof that organisms are distinct from machines in their causal closure destroys this collusion. Unfortunately, most of science is still in the dark ages and subscribes to the Cartesian machine metaphor, handing intelligent design an easy victory. You pays your money and you makes your choices" (Mikulecky, 2005:2).

systems are generically unformalisable; hence it is the formalisable ones that are the special rare cases, and not the other way around...I argue that biology teaches us the same is true about the material world...rather than an organism being just a standard material system plus a list of special conditions, an organism is a repository of meanings and impredicativities; it is more generic than an inorganic system rather than less...if this is so, then organisms possess noncomputable, unformalisable models. Such systems are what I call complex. The world of these systems is much larger and more generic than the simple world we inherit from reductionism" (Rosen, 2000:3,4).

Rosen's approach however appears to go too far. Whilst one could concede that life might never be reducible to an algorithm[32] or shown to belong to a "larger universe of inorganic systems" (Rosen, 2000:3), it is not at all obvious that this entails that living *sub*systems are noncomputable or unformalisable. The Rosennean idea that an *Escherichia coli* flagellum is a causally closed system for metabolism and repair and that this is beyond current engineering construction capability does not convincingly suggest that this subsystem cannot be modeled by a machine. Apparently Rosen did think about this[33] but never articulated it non-polemically. He writes: "Mimesis is based on the idea that if two systems act enough alike, they can be identified. We have explored this idea mainly through the Turing Test, asserting that a properly programmed machine, operating via syntax alone, that behaves enough like a thinking human being *is* thinking. By extension then, the argument is that every subjective property of mind or sentience is in fact present in a sufficiently programmed syntactic device" (Rosen, 2000:124). Rosen here is strongly opposing the Turing Test

[32] Paul Weirich, author of the entry on computer theory in the Cambridge Dictionary of Philosophy, talks about the "philosophy of logical mechanism" which has as its central thesis the notion that "a finite deterministic automaton can perform all human functions, a thesis propounded by Merrillee Salmon in a book titled 'The Philosophy of Logical Mechanism" published in 1990. According to Weirich, this is a plausible thesis and notes that "logical mechanism is a form of mechanism or materialism but differs from traditional forms of these doctrines in its reliance on the logical powers of computers and the logical nature of evolution and its products" (Weirich, 1995:147). Rosen's work is helpful in pinpointing the central concern in an otherwise thorny issue of expecting a purely syntactical system able to capture anything semantic. This places pressure on the phrase "perform all human functions" which will be interpreted differently according to the worldview and presuppositional framework of its readers.

[33] Rosen's daughter Judith writes: "Robert Rosen never said that we can't make a machine that repairs itself or that reproduces itself. He simply said that those machines are not and cannot be alive. The entailment structure underlying the behaviour of any self-repairing/replicating machine is entirely different from that of living organism. The difference between such simulations of life and actual living systems has to do with what entails the repair capability, and with the simultaneous presence of the capability of metabolism, and with what entails it as well. Bear in mind that Robert Rosen defines 'machine' in a very particular way. So by that definition, we will never create a living 'machine' - however, that does not mean he felt it was impossible to create living systems...in that event, what has been created is not 'a machine' regardless of what it is made out of. It is an organism" (Rosen, 2006:1). If one can assume that Judith is following her father carefully, then Robert Rosen's reasoning appears to be circular, and there are epistemic problems present as well. After all, how does one know on Rosennean grounds that a system constructed by humans is alive or not? It sounds like this: if it is a machine then it is not alive, but if it is alive then it is not a machine. This way of expressing matters shows that a prior philosophical distinction is in place underwriting the definitions.

(which as he does so helps clarify the issues), but he does not appear to tackle adequately in any of his writings the issue addressed by IC *viz.* that a living molecular sub-system[34] can be sufficiently modeled by a machine or 'syntactical system' to render the former fully corrigible to engineering analysis and descriptors.

The concept of causal closure requires nuancing too. The notion may have purchase[35] when it comes to complete independent structures like an entire cell, but the concept of causal closure is problematic for analysing something like the building of flagella in the *Yersinia* group of organisms for instance. Minnich and Meyer explain how *Yersinia enterocolitica* senses ambient external temperature which if 37 °C (mammalian body temperature) will cause the bacterium to stop producing flagella, but instead produce a needle-like pump that will secrete virulence proteins into its host. The haploid chromosome is acted on in concert with external thermal information to control genetic expression via various operons. A flagellum or needle pump is constructed distally from the information processing plant. Up to six flagella can be built and a decision-making facility presumably external to the actual motors can switch all flagella into a counterclockwise rotation which co-ordinates them for forward movement (Berg, 1999:2). In addition, the flagellar motor is "hardwired to a sensory apparatus that functions on short term memory (chemotaxis)" (Minnich & Meyer, 2004:2). This means that that the bacterium has some facility *external* to its motors that stores information about the food concentration outside the cell, and sends instructions based on this information (storage lasts for about three seconds) to the motors to provide movement towards a higher concentration (Berg, 1999:2). The point made here is that the mechanically separable motor system is in itself not causally closed, and is in addition operationally controlled from outside.

---

[34] On might wonder whether life can be thought to exist at the molecular level. DNA polymerase is a molecular machine, but is it alive? Are proteins and large organic macro-molecules living entities? Since DNA polymerase does such extraordinary things including error checking and correction, 'feeling' each nucleotide like a bead on a necklace as it is passed under its 'thumb', it seems incautious to label it as non-living. Suffice to say that even if molecular 'machines' are not alive in some sense, that does not impact the central argument of IC.

[35] Curiously the concept of cause in Rosen, and so it seems in much of systems biology today, is derived from Aristotle's four causes (Rosen, 2000:85). Though slightly modified to accommodate the modern realisation that Aristotle's αιτια meant 'explanation' rather than 'cause' nevertheless, it retains much of the original Greek flavour and is found in Hofmeyr(2007:7), Wolkenhauer (2002:5), and Cornish-Bowden (2006:486). The latter writes: "Having presented the problem without reference to Aristotle's four causes, we can now return to it to see how machines and organisms differ in terms of them. As...(has been) explained, we choose different categories of causation according to the answers we give to "why" questions. If we ask why a car engine produces water and carbon dioxide, an answer in terms of fuel and oxygen provides the material cause of the water and carbon dioxide. However, that is not the only possible correct answer: they are also caused by mixing and sparking the starting materials in the carburetor, and this is now an efficient cause. If we ask why the engine mixes fuel and oxygen and then ignites them, then answering that it is to provide power to drive the car forward appeals to a final cause, which for a machine, and indeed for everything else in classical Aristotelian philosophy, is always something outside the machine itself" (2006:486). This resurgence of interest in Aristotelian cause in biology seems due to the influence of Rosen.

As a conclusion to this question of a life/machine bifurcation it does not seem unreasonable to suppose along with Rosen that an organism in its entirety will forever remain beyond total specification via scientific formalism[36], which said another way, is that the Church-Turing thesis is inaccurate. However, Rosen's causal closure formulation (itself a doubtful interplay of Aristotelian efficient and material causes located within living things) lacks clarity at the level of specific living sub-systems, a lack that is readily displaced by first order observation of the machine-likeness of such systems. Once again, it should be noted in a reverse sort of way that the power of engineering principles in identifying and analysing molecular machines shines new light on those very engineering principles. The fruitful two-way relation between machines and life warrants a return to etiological questions. "That we have encountered systems that tax our own capacities as design engineers, justifiably lead us to question whether these systems are the product of undirected, un-purposed, chance and necessity. Indeed, in any other context we would immediately recognize such systems as the product of very intelligent engineering. Although some may argue this is merely an argument from ignorance, we regard it as an inference to the best explanation, given what we *know* about the powers of intelligent as opposed to strictly natural causes" (Minnich & Meyer, 2004:9).

2.4.2 Perception and the way machines are seen

Up till this point there has been an unstated assumption that the world of observation is accessible in a direct way. Everyone (it might have been thought) takes a look at machines or living systems and 'reads' off the data in a theory-neutral fashion. The truth is that not everyone does this, and in some sense none of us can. One's philosophical predilections cannot be ignored even when it comes to providing a definition for a machine. This can be observed in thinkers who under the influence of the philosopher Kant reveal a particular emphasis which impinges on the machine/life debate.

It is worth noting that Kantian styled epistemology has re-surfaced quite strongly among some biologists and its effects are often particularly noticeable wherever interdisciplinary dialogue is broached. A.J. Wells' intriguing critique of Robert Rosen (Wells, 2006:41-65) draws our attention to Rosen's strongly developed indirect realism. Wells makes this clear: "According to Rosen, the self encompasses or contains 'our perceptions, our thoughts, our

[36] Rosen said it well: "We can see that fabrication of an organism is a vastly different thing than the simulation of its behaviour. The pursuit of the latter represents an ancient tradition that used to be called biomimesis, the imitation of life. The idea was that by serially endowing a machine with more and more simulacra of life, one would cross a threshold beyond which a machine would become an organism. The same reasoning is embodied in the artificial intelligence of today, and it is articulated in Turing's Test...This activity is a sophisticated kind of curve-fitting, akin to the assertion that since a curve can be approximated by a polynomial, it must be a polynomial" (Rosen, 2000:269).

ideas, our imaginings, our will, and the actions that spring from them. This is the *inner world*. Everything else is *outside*".[37] That which is other than the self Rosen called the 'ambience' and he thought of science as a kind of relation between the self and the ambience" (Wells, 2006:42). Rosennean man therefore apprehends the inner world directly, but the outer world indirectly, where the latter is mediated or imported into the inner world via science. Wells identifies this as playing a strong role in Rosen's inability to 'know' of mechanisms in actual nature. Rosen makes explicit references to Kant and Kantian terminology but the net effect on his perception of machines is made clear when he says: "The causal relations manifested by a natural system provide the orderliness required of the ambience. Inferential entailment in a formal system is a way of providing the orderliness required of the self. The art of bringing the two into correspondence, through the establishing of a definite modeling relation between them is the articulation of the former within the latter; it is science itself" (Rosen, 1991:59).[38]

It is interesting to note the influence of Kant's thinking upon Rosen's successors. Stellenbosch biochemist Prof. J.H.S. Hofmeyr writes: "Although the term autopoiesis is associated with Maturana and Varela, the concept of self-fabrication has a long and venerable history, and seems to have been first formulated explicitly by Immanuel Kant, who conceived of organisms as dynamic, functional wholes in which all components are made by and for each other, in contrast with a machine in which components exist only for each other but cannot make each other: 'In such a product of nature *every part not only exists by means of the other parts*, but is thought as existing for the sake of the others and the whole, that is as an (organic) instrument. Thus, however, it might be an artificial instrument, and so might be represented only as a purpose that is possible in general; but also *its parts are all organs reciprocally producing each other*. This can never be the case with artificial instruments, but only with nature which supplies all the material for instruments (even for those of art). Only a product of such a kind can be called a natural purpose, and this because it is an organised and self-organising being' " (Hofmeyr, 2007:8). Similarly for Wolkenhauer: "The most concise argument against the machine metaphor applied to cell systems, was provided by the philosopher Kant" (2002:3). Wolkenhauer quotes the Kantian distinction between

[37] Wells informs the reader that this citation comes from Rosen (1991:40-41).

[38] In view of this there is something ironic about Rosen using mathematical mapping to show how living M-R systems (Systems that entail metabolism and repair) harness Aristotelian causation in order to be fully causally closed. One is tempted to wonder about the cogency of a position where its defender having inveighed against the poverty of mathematical or syntactical entailments in being able to fully capture the essence of a living system, then proceeds to use mathematics to demonstrate that such living systems are causally closed. Rosen's answer would probably have been that the mapping of material and efficient causes to show the closed loop of metabolism and repair was not intended to convey anything remotely computable or reducible to an algorithm. Furthermore, since mathematics is a language, it should still be permissible to speak mathematically about systems that are not fully able to be captured within any formalism.

machines and organisms referenced by Hofmeyr, yet goes beyond empirical observation to reveal an implicit dependence on Kant when he says: "One might argue that scientific theories deal with concepts - not reality. Therefore if mathematical models are so formulated as to correspond in some 'useful' way to the real world, modeling and simulation is more an *art* than an objective discovery process" (Wolkenhauer, 2002:6).

In conclusion it is helpful to bear in mind that the strong entertaining of Biblical presuppositions as shown in Ch 5 and developed under the rubric of Biblical Theology provide a basis for escaping Kantian indirect realism. The latter, however, does provide its own caveats most notably a warning of the danger of over-reduction. All in all though, there is no *a priori* warrant for adopting a Kantian approach to the problem.

2.5 The stability of the concept of IC in engineering

It cannot be taken for granted that the concept of IC itself can be anchored in the empirical world. We have to ask whether it is a concept that is psychological in nature which ID theorists are falsely attributing to certain systems or whether it truly is an observable feature of a mind-independent world? To ask these questions is to ask whether IC can remain coherent or stable under close scrutiny.

Given that IC speaks of the 'indispensability of parts that contribute to overall function' it is to be expected that attention would be focused on whether this principle invariably holds true. Dr Kenneth Miller and Dr John McDonald[39] have approached this via an examination of Behe's mousetrap. Because *Darwin's Black Box* made the mousetrap *the* paradigmatic example of IC, the first thing that critics felt was incumbent was to make an attempt in conceptualising a mousetrap that was in fact reducible. Behe himself provided the stimulus for this in his original book: "We need to distinguish between a physical precursor and a conceptual precursor. (My) trap...is not the only system that can immobilise a mouse...in theory at least, one can use a box propped open with a stick that could be tripped...however, this is not (a) physical precursor to the standard mousetrap since it cannot be transformed, step-by-Darwinian-step, into a trap with a base, hammer, spring, catch and holding bar" (Behe, 1996a:43). Behe illustrates further with a discussion about a bicycle being a conceptual precursor to a motorcycle, but not a physical one. He adds that "Darwinian evolution requires physical precursors" (Behe, 1996a:45).

[39] Professor of Biology at University of Delaware, and strong ID critic.

McDonald has produced four precursors to the five piece mousetrap, beginning with a single component device that consists entirely of a single spring (McDonald, 2002:2). Lying on its side like a much bigger version of the spring in a clothes' peg, the ends are bent to join each other and sprung loaded. Should a mouse venture too close, the spring would snap back, perhaps knocking the creature unconscious or even killing it. But this mousetrap is inefficient and hopes are raised that some improvement might materialise. As McDonald envisages matters, what follows is the next sequential step where another single component has been added.. this time the base (or platform). A 3rd mousetrap would appear when the third component is added viz a hammer. The 4th improvement to be added is a hold down bar, and finally the catch is added to complete the device that we all know.

What McDonald feels he has succeeded in doing is portraying an incremental sequence, where original function is preserved at each point along the way, whereby step by step any so-called IC system can be produced. McDonald will have therefore overturned Behe's argument and rendered IC merely as an appearance and not a reality within mechanics or biology.[40] Thus, beginning with a single component, and by 4 small steps, a complete multi-part system is achieved. This is in essence an attempt at depicting the conceptual possibility of a Darwinian pathway.

It should be said at this point that for Behe what is *not* at issue in the argument is whether a simpler *kind* of mousetrap can be envisaged. Whilst everyone agrees that a simpler mousetrap can be made, there is no agreement as to the *significance* of this. The ID perspective feels it is of little consequence for an intelligent agent to take the parts, re-configure and re-shape them into a lesser part trap because the whole point of IC is precisely that one cannot take the five parts *as they are* and re-assemble a subset as a functioning mousetrap. The Neo-Darwinian perspective by contrast insists that the ability by an intelligent agent to construct a version of the trap using a subset of the five parts, their re-shaping notwithstanding, *is* significant. For Neo-Darwinism, what is at issue is *any* ability to demonstrate a step-wise pathway from one device to another showing gradual improvement until finally arriving at a trap which only appears to be IC.[41]

---

[40] The mousetrap series is obviously aimed at saying something about biology and not the world of engineering. There are complications involved here, and it is easy to become confused because Behe's mousetrap is clearly an engineering analogy where it is tacitly assumed that there are no physical precursors. Yet McDonald has shifted the framework from engineering to biology but retains the use of the mousetrap for the purposes of disproving IC. This becomes clear when one asks where in the world one could ever find a series of traps anything like what he is proposing.

[41] McDonald writes: "I wish to point out that the mousetrap Behe uses as an analogy CAN be reduced in complexity and still function as a mousetrap...Of course, the reduced –complexity mousetraps shown...are intended to point out one of the logical flaws in the intelligent design argument; they're not intended as an analogy of how evolution works" (McDonald, 2002:3). We point out however, that the phrase "reduced in

It is clear that there is equivocation at work, and therefore in order to compare apples with apples what is proposed is an analysis of the argument in terms of quadrants. On the horizontal x axis the LHS (the negative axis) is labeled Biological and the RHS (the positive x axis) is labeled Mechanical. The vertical axis has at the top 'Designer Assumed' and at the bottom 'Natural Selection Assumed'. There are now four blocks which are labeled anticlockwise from one to four beginning with the top right quadrant. The two LHS blocks represent the ID and Neo-Darwinist approach to a macromolecular structure like the eubacterial flagellum, with the former in quadrant two (i.e. Designer Assumed in this biology) and the latter in quadrant three (i.e. Natural Selection Assumed, no designer in this biology). Quadrant four is impermissible because everyone concedes that mousetraps cannot evolve naturalistically; mechanical machines do not evolve on their own (no-one claims this to be the case). This means that our mousetrap or mechanical analogue can only be placed in quadrant one.

Where this becomes interesting is in conducting argumentation in quadrant one that has elements paralleled by quadrants two and three. What therefore needs to be borne in mind is that for all arguments in quadrant one it is illicit to assume *no* designer. This impacts both ID and Neo-Darwinism. Since all mousetraps are clearly designed by a human designer, and since any proposed series of mousetraps rely on the interference of a designer, any attempt to assume 'no designer' will be ruled inadmissible. This applies more to ID than its opponent. Therefore, attempts to invalidate any discussion in this quadrant simply because a designer is required ought to be ruled out of order. So then, one should assume a designer for all arguments in this quadrant and move from there.

It does not matter then whether the argument attempts to construct traps of existing parts or re-shaped parts. If the designer wishes to do this he may without violating the analogy, because the issue no longer has to do with a designer when you're talking about mousetraps in quadrant one. The analogical osculations[42] of similarity between mechanical and biological will therefore lie along other loci. This means that the criteria for evaluating the soundness of the analogy will better be made to rest on the logical steps between various traps. McDonald is therefore within his rights[43] to propose a sub-system of re-configured

---

complexity" as far as McDonald is concerned includes the idea of 're-shaped' or 're-configured'. The question then centres on whether it is logically legitimate to take any of the five components and then make changes to them before re-assembly as a lesser-part machine. I am suggesting that doing this is tantamount to 'tampering with the evidence' unless of course McDonald contradicts himself and admits that in fact the reduced mousetraps have modified parts *just as Darwinian evolution demands.*

[42] i.e. kissing points

[43] Behe responds to McDonald: "Intelligence saturates the whole series...its easy for us to overlook our role in directing the construction of a system, but nature cannot overlook any step at all" (Behe, 2004: 366). Clearly

parts. In the same way, Behe cannot object as indeed he does when proffering a mousetrap analogy for the proposed Neo-Darwinist account of the evolution of the coagulation cascade: "Following Professor Doolittle's example we could propose a route by which the first mousetrap was produced: The hammer appears as the result of the duplication of a crowbar in our garage. The hammer comes into contact with the platform, the result of shuffling several popsicle sticks. The spring springs forth from a grandfather clock that had been used as a timekeeping device. The holding bar is fashioned from a piece of straw sticking out of a discarded Coke can, and the catch is unleashed from the cap on a bottle of beer. But things just don't happen that way unless someone or something is guiding the process" (Behe, 1996a:96). What Behe forgets at this junction is that when making the move from biology across to a mechanical analogy (i.e. when transposing), an intelligent agent is always to be allowed.[44] Only quadrant one is permitted; quadrant four is ruled out. This is a problem that touches on the issue of asymmetry (raised later in section 3.4.2). It bears repeating that what needs to happen in any mechanical analogy is that a construction agent is allowed[45] and in this case permitted to assemble a machine out of bits that are to hand. Furthermore, to be fair, the analogy must attempt to follow Doolittle's *actual* example and *not* attempt to construct an entire trap in a single go. Of course, from an ID perspective, an IC system would indeed have to be formed in a single go. But then in doing this, one is not following Doolittle's outlined scenario (using the Yin and Yang idea) but ID's perspective on the system.

For similar reasons, the Rube Goldberg contrivance[46] appears superficially to serve Doolittle better than it serves Behe, yet there is a sting in the tail. Given that for mechanical comparisons a designer is not merely admissible but demanded, the analogical locus of connection between mechanical and biological has to be the steps. And it is truly the case that Rube Goldberg builds his machines from the bottom up, step by step, picking up

---

Behe can only say this because he has not been able to clarify his thinking in the way our quadrant analysis helps us. In quadrant one a designer is always in view.

[44] The reader may think that this is in fact exactly what Behe is saying, but we claim he is not. Behe thinks he can invalidate Doolittle's yin and yang scenario by providing a mechanical analogy that has no designer. This cannot be done. All mechanical examples have to have a designer. They are always located in quadrant 1. If Doolittle proposes a biological system or scenario which is in quadrant 3, then Behe's mechanical analogue must be in quadrant 1. Similarly we cannot agree with Behe when he writes: "For the mousetrap series to have any relevance at all to Darwinian evolution, then intelligence cannot be involved at any further point beyond the first trap" (Behe, 2004:366).

[45] It must be borne in mind that biochemical systems can self assemble and mutate, and mechanical devices are almost always built by humans (some animals build rudimentary machines e.g. trapdoor spider). Therefore any mechanical analogy must admit a construction agent, and the point of analogical resemblance therefore must be expressed in regard to the loci of construction steps and materials available.

[46] A Rube Goldberg cartoon depicts a contrivance comprised of ready to hand items like a drain pipe, a fidgety dog, a cork etc. which are then assembled into a ridiculous machine capable of harnessing a set arbitrary input (like a drop of water) such that via strings and pulleys (and the butterfly effect) a set purpose is achieved e.g. the automated scratching of mosquito bites (cf. footnote 120).

whatever is lying around and incorporating it into his machine, and where each new part changes the direction and 'design' of the overall mechanism – it almost designs itself - but in the end arrives at a mechanical unity that does the job. It is this lack of obvious blueprint that is probably the most appealing thing for Neo- Darwinism about Rube's cartoons.

Yet there is indeed a sting in the tail: a consideration which is quite simple, yet quite profound and it is three-fold:

Firstly, this kind of machine is even less likely than 'normal' human designs to have sub-function or alternative function until the overall contrivance is complete. In the biological world and from an Neo-Darwinism perspective, whatever is added to an organism must have a definite function. In the case of living things, an added feature with no use could quite easily be fatal, and would be removed by natural selection. It might not be fatal at the first step, but could later prove to be such a few steps further along. Certainly a partly constructed Rube contrivance would have little or no functional value whatsoever. There is a corollary to this: such idiosyncratic 'tinkered' systems are even less likely to show partial or different sub-function than their more real-world mechanical counterparts.[47]

Secondly, the whole point of a Rube cartoon is that we all think we know that *those* parts couldn't possibly be joined together into a functional entity, and we can laugh at the way he proves us wrong by achieving precisely that. However, the very oddness and eccentricity of the 'design' is testimony to extraordinary ingenuity. This is a point overlooked because a common Neo-Darwinist observation regarding biological complexity is that an intelligent creator would never make machines *this* way.[48] But a Rube machine betrays huge intelligence, and in fact *a higher intelligence* because arguably here is a mind capable of producing *that* surprisingly competent function with *these* unlikely parts brought together in

[47] This would counter Dawkins who writes: "What is the use of half an eye?" and "what is the use of half a wing" ..."(they) are both instances of the argument from 'irreducible complexity'. A functioning unit is said to be irreducibly complex if the removal of one of its parts causes the whole to cease functioning...but half a wing could save your life by easing your fall from a tree of a certain height" (Dawkins, 2006:123). What is interesting here is that 'half-a-wing' thought experiments rely on a starting point where one has a conception of the completed wing and then one envisages a certain part of it. This is a top down approach and may have some meagre merit, though in engineering terms half a wheel, or half an axle is only likely to cripple the system. There is in addition an unaddressed difficulty as to what is meant by 'parts' when it comes to a wing. If the feathers were entirely removed, could one say that what was left was in any way a wing at all? And would such an uncomforting appendage do anything to lessen the fall? This aside, one should note of course that Neo-Darwinism favours the bottom up approach, and in this case 'half a wing' doesn't look like half of anything useful or have any meaning. Curiously then, Dawkins uses a top down approach to counter a top down approach. However, imagine saying to the Rube designer: "Here you are, use this: here is half a cup to catch the water (the cup lacks a bottom part and cannot hold fluids). Half a cup is better than no cup".

[48] By what principle does Neo-Darwinism argue that a creator should design machines in a way agreeable to Neo-Darwinist science, and therefore cannot design in many different ways e.g. like a Rube Goldberg machine? Also, this discussion has bearing on the notion of 'tinkering' given that Neo-Darwinism proposes that natural selection tinkers with biological structures in order to produce novelty.

this unusual configuration. Talk about right brain. One could almost say at this point that Doolittle has made a huge mistake in using these cartoons: he's actually promoting theism via biological study but in a backhanded way.[49]

Thirdly, Rube Goldberg obviously has a teleological goal in mind. It is argued that this is permissible in quadrant one which means that Doolittle cannot be criticized at this point. The locus of analogical connection is the ability to incorporate one step at a time a different random item into the contrivance, thereby transforming it into 'a part'...and ID should agree to permit this for the sake of the discussion. However, Rube's almost godlike ingenuity (something that dwarfs Dawkin's comment (2004:182) that "natural selection is a beguiling counterfeiter of deliberate purpose") enables him to start anywhere, then look around and fix his gaze arbitrarily on anything and in a Heideggerian way to 'see it as' the next part and to be able to incorporate into his growing design. But the crunch is 'looking ahead'...not only at the final goal, but in what is at this point denominated as 'reservation'. The Rube designer looks around early on in his growing design, and sees a small dog, and does not select it at this junction, but 'reserves' it for later incorporation, yet will alter the pathway of the choice of items and the way in which they will be made to function so that the scene is set for the later incorporation of that 'reserved' item. Doolittle's biggest flaw in using Rube cartoons is exposed at this point.[50] There is no possibility for biological systems to 'reserve' proteins or protein parts for later critical incorporation.[51] There is no logical way for 'reservation' to be de-clutched from intentionality or teleology.

Neo-Darwinism calls for closer inspection of biological systems on the part of ID, and ID calls for closer inspection of mechanical analogies (or mechanical language for that matter) employed by Neo-Darwinism not merely to score debating points (the least desirable goal) but to reveal the lack of parity between many of the explanations countenanced by the latter and the real world in which we live, and in which these biological marvels exist.

The discussion moves us now to ask a question regarding criterion. What criterion should form the basis for deciding upon a legitimate as opposed to illegitimate series of traps in quadrant one. Perhaps the best solution is one supplied by Darwin himself: "As natural selection acts solely by accumulating slight, successive, favourable variations, it can produce

---

[49] We are arguing that Rube Goldberg ought not to be appealed to in order to demonstrate random assembly. That Doolittle should think otherwise reveals a rather strange outlook on reality.

[50] If Neo-Darwinism objects that natural processes do not have to do this, then we will have to ask whether Neo-Darwinism thinks that Rube Goldberg can assemble his machine *without* doing this. If he cannot, then either Neo-Darwinism must drop the idea of using Rube Goldberg to illustrate Darwinian styled development, or concede that there is a conceptual problem in the Neo-Darwinist explanation itself.

[51] Elsewhere we draw attention to the problem Neo-Darwinism faces where the supposed blind watchmaker boxes himself in with each choice.

no great or sudden modification; it can act only by very short and slow steps. Hence the canon of 'Natura non facit saltum'...but why this should be a law of nature if each species has been independently created, no man can explain...nature moves by graduated steps" (Darwin, 1859:444-445). He also wrote: "for natural selection can act only by taking advantage of slight successive variations; she can only never take a leap, but must advance by the shortest and slowest steps" (Darwin, 1859:224). In Darwin's mind there is an inverse correlation between the number of steps and natural selection. It seems reasonable to propose therefore that in order to overthrow IC in this first sector, there should be a series of working mousetraps, where in effect each mousetrap increases in complexity through the addition of *one part* in *one* step. This would be "the shortest and slowest step" requiring minimal involvement by a designer. Therefore by analogy, this minimum appeal to intelligence increases the possibility of a natural process.

This is precisely Behe's response (Behe, 2004:364). He examines the series of McDonald traps to see if they do indeed demonstrate in each case an increase in complexity *via a simple step.* He notes at least two related difficulties in moving from the one piece to the two piece trap:

(1) On inspection, the introduction of a base is not a mere single step because the spring (in order to take advantage of the platform) has to be re-orientated (in fact, re-configured). This re-alignment must surely constitute an additional step over and above the introduction of the base;

(2) The spring in this new configuration cannot do its work unless it is actually attached to the base. McDonald achieves this with two tiny staples. However, as Behe points out, these fasteners although drawn very small in his diagram nevertheless represent two extra steps.

The net result drawn from (1) and (2) is that on inspection the single component trap has had to make use of four steps (platform, spring orientation, plus two staples) to preserve function whilst increasing in complexity. McDonald presents the transition as a single step, but closer examination reveals at least four steps. Had there been only one step each time then naturalistic possibilities could be entertained. But four steps points strongly to interference from outside, and results in his argument being disqualified in regard to the fourth quadrant.

Behe then makes a similar critique showing the hidden steps concealed in the improvement for each consecutive McDonald trap.

Behe's conclusion is that the McDonald traps have actually shown *inadvertently* the impossibility of conceptualising a true step-wise pathway toward increased complexity for

mechanical devices.[52] If this is so, and there is strong inclination to think it is, it raises an important question about the nature of developmental series presented by Neo-Darwinism, and more specifically what criteria are at work in determining whether such series are inventive constructs or whether they represent a genuine ontology.[53] The McDonald variations clearly belong to the former, and are in fact a collection of 5 separate traps (and actually *unrelated* traps in terms of any physical series) which have merely been arranged in a sequence. That they are 5 *unrelated* traps is patently clear given that they involve more than one step at each point of complexification. Therefore, the number of steps required coupled with the kind of steps involved strongly points not to the interference of a designer (we are still in quadrant one) but to constraints imposed by IC. This is why Behe calls the series conceptual and not physical.[54] The series can be arranged to display a possible development, but the real world imposes a limit that denies any physical connection between individuals in the series.

However, close scrutiny of the McDonald traps calls for close scrutiny of Behe's trap as well. Earlier it was noted that Behe had said that there are only five parts to his mousetrap. He had then added: "There are also assorted staples to hold the system together" (Behe, 1996a:42). What is now discovered is that these staples are more important than was initially conveyed. This new development opens up two routes to explore. Either a way is found to dispense with the staples which would affect both Behe and McDonald in an interesting manner, or the staples could be considered as an additional part or parts, since a removal of a staple could well render the mousetrap non-functional. The latter route is uninteresting because it is unduly prejudiced against Neo- Darwinism.[55]

---

[52] And by implication, biological machines. Neo-Darwinism supporters will object that ID sets the bar too high in requiring full knowledge of each step along the way. Yet in the case of the mousetrap, why should the bar be lowered simply to accommodate a Neo-Darwinian inability to offer a mechanical analogy of what is claimed to be an empirically substantiated biochemical mechanism?

[53] An example from the literature comes from biologist Tim Berra in his 1990 book, *Evolution and the Myth of Creationism* (pg117). According to Berra, "If you look at a 1953 Corvette and compare it to the latest model, only the most general resemblances are evident, but if you compare a 1953 and a 1954 Corvette, side by side, then a 1954 and a 1955 model, and so on, the descent with modification is overwhelmingly obvious. This is what paleontologists do with fossils, and the evidence is so solid and comprehensive that it cannot be denied by reasonable people" (Wells & Nelson, 1997:2). At this junction an instance in the literature is recalled where a zoology professor asked his class of first year university students to arrange an assortment of nails into a developmental order that might be expected in the case where the nails had evolved. The irony in this exercise is that it clearly demonstrates the problem of super-position: conceptualising a series where in fact none exists in physical reality.

[54] A useful development flowing from this would be some articulation of 'machine-logic'. If it is indeed the case that a bicycle cannot be modified to become a motorcycle via simple steps whereby new pieces are added on or existing pieces removed or modified and that "there is no example in history of a complex change in a product occurring in this manner" (Behe, 1996:44) then it would be interesting to attempt a formulation of the logical principles that constrain this.

[55] Judge Jones in his memorandum for the Kitzmiller vs. Dover Schools trial spoke of ID setting the standard too high for Neo-Darwinism to attain: " We find that such evidence demonstrates that the ID argument is dependent

If the former route is chosen, a platform could be imagined which has a type of Velcro surface, and the parts having the matching the Velcro strip. These are not to be thought of as extra parts but as the surfaces of the actual parts.[56] The Behe trap is assembled as before. But the McDonald traps benefit the most from this. The number of steps from trap one to trap two has been halved from four to two *viz.* introducing the platform and re-orientating the spring. The upshot is that this arrangement does indeed come closer to the Darwinian requirement, and certainly close enough to temper ID confidence. Regarding the next trap (trap 3), McDonald is not helped by any change to the staples. But Behe's objection that the hammer requires certain bends to fit just right could be answered by the fact that in biology proteins themselves are tools because they fold into certain shapes.[57] If there are extant hammers bent into this shape and readily available then Behe's objection vanishes. However, there is the more serious problem of joining the spring to the hammer. This looks simple in the McDonald sketch but the difficulties to be surmounted involve the interlocking of spring and hammer (not easily achieved at the biochemical level – a point which cannot be dismissed as disanalogous (by Neo- Darwinism) since what has just been admitted into the discussion is the protein folding concession; and Velcro won't do the job either at the mechanical level), the ability of the spring to extend its flexion – a mechanical spring might put up with this (but a biochemical equivalent in whatever analogical system cannot be assumed to make as flexible an adaptation as this). It must be borne in mind that there is no attempt here to construct a biological mousetrap, but instead an effort to keep the analogical loci between mechanical and biological under control and within reason.

The question therefore remains: When all is considered, is McDonald in a position to assemble his mousetraps using a discrete step between each trap? The answer is still no, even though the complexification differential between some traps has improved. Furthermore, there is the undeniable problem that the first two traps cannot really catch mice. If McDonald insists that they are still up to that task regardless, then it will come as no surprise when reasonable people insist that Neo-Darwinism is setting the bar too low. Neo-Darwinian explanations surely cannot be true *no matter what.*

Keith Robison presented a variation of McDonald's approach. He describes a situation where he assembles a functioning mousetrap out of four components. This he achieves by

---

upon setting a scientifically unreasonable burden of proof for the theory of evolution" (Jones, 2005:78). The ID theorists need to bear this concern in mind.

[56] Behe concedes that in the real world of biology "staples, bends and so forth would be features of molecules, proteins in particular" (Behe, 2000b:7).

[57] Behe writes: "proteins that work in a cell fold up into very precise structures, and that structure can be quite different for different types of proteins. The folding is done automatically...two different proteins can fold into structures as specific and different from each other as an adjustable wrench and a jigsaw" (Behe, 1996:52).

assembling it on the floor, stapling it to the wood (Robison, 1996:2). Quite naturally Behe's response is to point out that the proposal remains in essence a five piece trap since all that has happened is that the wooden floor has been substituted for the wooden platform. Remarkably, Robison replied to Behe saying that the latter had missed the point. Any reader would be anxious to know from Robison what that point is. Robison explains: "...the base-free mousetrap still functions; it simply uses a component of its natural environment in its workings" (Robison, 1996:2). Apparently, Robison is convinced that replacing the wooden platform with the wooden floor actually reduces the number of parts, whilst at the same time he can say that the mousetrap "simply *uses* a *component* of its natural environment" (1996:2). There is a problem with coherence if it is maintained that a system has truly lost a part but to continue functioning replaces that part from the environment without gaining a part. One can of course say this if one decides to equivocate on the word 'part'. One can also say this if the issue at hand is changed and made to hinge on how many parts can be swapped with those lying around. The reality however, is that an IC mousetrap of sorts could indeed be made from four parts lying around in the kitchen and using the floor as a base. How would Robison propose that one moves from these four parts (chosen from the environment) to just three? If one replaced whatever was being used as the catch with a small bent piece of nail in the floor (the environment), would that really count as a three component trap? It seems that Robison will struggle to defend himself against the accusation of incoherence.

Before concluding this section, a brief mention should be made of Behe's admission that his concept of IC had a defect or weakness. This difficulty although explored in more detail in section 3.4.2 is introduced here for the sake of completeness. The issue appears at the conclusion of Forrest and Gross's attempt to apply a final few crippling blows to the scientific credibility of IC (Forrest & Gross, 2004:75). It also surfaced at the Kitzmiller vs. Dover Schools trial. In the light of the a foregoing argument and discussion it should be clear that this admission was groundless, and Behe's subsequently retraction is consistent with our line of argumentation (Behe, 2006:4).[58]

[58] Behe writes: "I 'admitted' this 'defect' in the definition of irreducible complexity in the context of discussing (in passing, in a long article) a zany hypothetical example that Robert Pennock concocted in his book, *Tower of Babel*. Pennock, a philosopher, wrote that a complex watch could be made by starting with a more complex chronometer (a very precise timepiece used by sailors) and carefully breaking it. So therefore a watch isn't irreducibly complex! As I testified I have not bothered to address Pennock's point because I regard the example as obviously and totally contrived - it has nothing to do with biologically-relevant questions of evolution. That the words of my article are quoted by the Court without any reference to the context of Pennock's silly example appears invidious and is certainly confused" (Behe, 2006:3).

In summary, it certainly appears to be the case that the conceptualisation of a step-by-step developmental pathway for a series of modifications of a mechanical device leading from a simple form to one that exhibits what ID theorists would call IC whilst simultaneously retaining original function, is impossible. If this summary is correct, it must be conceded that Behe's mousetrap is truly irreducibly complex, and that therefore insofar as certain living systems can be denominated as 'machines' there exists the possibility of such systems themselves being irreducibly complex. Furthermore, this line of argumentation raises question marks about the sufficiency of Neo-Darwinist series to truly match reality. There does appear to be a difficulty in properly distinguishing between artifact and fact. The ability of agile Neo-Darwinian minds to insist on the validity of a step-wise mousetrap series (i.e. a mechanical series) raises some interesting concerns.[59]

This section has attempted to defend the idea that IC truly is a feature of humanly engineered machines. The attempt from the opposing camp to demonstrate that a series of antecedents to any supposed IC device can be conceptualised has been shown to be fruitless. The conclusion therefore is that IC is an empirically observable and logically defensible property of machines.

2.6 Design and narrative

An attempt to explain new scientific or theological concepts even to someone who is scientifically or theologically literate can nevertheless result in a level of communication and understanding that is quite poor. Visual aids and illustrations can assist, but often what helps the most is knowing the story behind the concept. Those who have had to grapple with the idea of, for example a Turing machine in the absence of the story that relates what occasioned the development of its inventor's ideas, will appreciate what is being said. The accompanying narrative[60] not only deepens the conceptual grasp but also strengthens the

[59] Concern No1 is that biology needs more engineers. Bruce Alberts has raised this (Alberts, 1998:1) at one level, but we are suggesting the need at another *viz.* mechanical intuition. Concern No 2 has to do with psychology: the ability to see a series here, there and everywhere means that the very real difficulties (real world difficulties) associated with such step-wise progressions are being glossed over. Concern No3 has to do with unhealthy effect such thinking has on the overall scientific endeavour which at times appears to suffer from the 'emperor's new clothes' syndrome.

[60] The Turing machine was actually Turing's way of answering one of David Hilbert's challenges repeated in the 1920's. Hilbert's challenge involved the 'decision problem' or 'entscheidungsproblem' which as a German word found its way into the title of Turing's 1936 British paper. His discovery is certainly not to be set apart from the discoveries made by Gödel, nor from the pre-War European and English sentiment that German academic work was better than anywhere else, nor from the subsequent mood that saw syntactical-system incompleteness as the nature of reality. This mathematical machine was invented by Turing to formalise the notion of an algorithm thereby formalising decision issues, following which he made use of Cantor's diagonalisation argument so as to tackle the challenge and show that there were algorithms that were not computable. In the process he showed

memory. Historical augments provide extra insight.[61] Certainly it is helpful to know that as a child Turing was given a book at age ten titled 'Natural Wonders Every Child Should Know' which he later said "opened his eyes to science" and which had a sentence that imprinted itself upon his mind: "For of course, the body is machine...a vastly complex machine...but still after all a machine" (Amos, 2006:30).

In everyday life one's grasp of design is often encountered via a completed artifact at which point the deficiencies are often the first features to be clearly noticed. A machine always tells a story even though the ingenious solving of various problems embedded in the design often pass unacknowledged. Few people pause to appreciate the end product as a process that began with an idea (sometimes the idea is to copy someone else's idea), then after all the feasibilities have been explored, what follows is the drawing up of plans and the partnership of many people. Yet close inspection of a machine can in some cases reveal a lot about the designer: her creativity, her problem solving ability (ingenuity), her understanding of the subject or science (perhaps only intuitively), her understanding (or lack of) of the end user's requirements and possibly even her philosophy of life.[62] In short there is always an engineering 'soundtrack', and the telling of the story of design (including the design and planning of the construction) for any machine is occasionally as important sometimes as the machine itself.[63]

It is has occurred to some researchers especially in molecular biology that the story of Neo-Darwinian evolution is incompatible with the story implied by the intricate nature of *some* of the machines[64] observed under the microscope in certain living systems.[65] The type of

---

that all computable numbers are computable by a Turing machine. In many ways the Turing paper of 1936 reveals the *idea fixe* of the age, and should itself be read in that context.

[61] Any discipline that is studied in the absence of the pertinent history describing how that discipline arose and came to be shaped is likely to be understood incompletely. Those who have later researched the history will know how much their grasp of the discipline has improved. There is also the component of personal history. We like to think sometimes that our grasp of mathematics, physics, astronomy and biology can be adequately articulated merely in theoretical terms, but the truth is that our own path of learning, our own history, has contributed enormously. Insights into science cannot be separated from pathways of study. Similarly for philosophy and theology.

[62] Analysis of a 'toy' mine dropped from the air and designed to appeal to small rural children who are likely to pick it up and then blow off a hand or leg speaks volumes about the mindset and worldview of the designer.

[63] In 2003, a Greek airline called Helios lost a Boeing 737 because a cabin air pressure switch had been set to manual. This switch should have been wired to a warning light (and located under a safety flap). A team of engineers had earlier tested the aircraft and set the tiny switch to manual. The crew later went through their checks not noticing or expecting any changes for the other switches. They later took off and as they ascended the cabin experienced increasingly severe oxygen depletion. Everyone lost consciousness including the pilots. Several hours later the aircraft, after flying on autopilot, ran out of fuel and crashed, killing all on board. The story of the aircraft's design especially the cockpit instrument layout led indirectly to the deaths of about a hundred people.

[64] Kenneth Miller calls them this, and most researchers do. Dawkins uses the language of "living watches" (Dawkins, 1988:5).

developmental account required for what is observed about certain structures in nature is (in the minds of some) not congruent with that told by Neo-Darwinism. This is neatly illustrated in the two ways the Rube-Goldberg illustration is handled. With an eye on engineering design, Michael Behe tells the story of the cartoon inventor (Behe, 1996:75), and yet Russell Doolittle has been telling that story as an illustration of the blind tinkering of natural selection (Doolittle, 1997:2). As has been shown, the blind (and dumb) tinkerer will find it impossible to produce a Rube-Goldberg system. Any machine if it can be shown to exhibit IC (and Rube-Goldberg cartoon machines certainly do), will in that event call for constraint regarding the etiological stories that can be told. Narratives that impact the world of engineering should be examined to see if in fact there is present in them a covert subscription to Neo-Darwinian ideas about machines.[66] The imposition of this constraint ought not to impede science or analysis[67]; on the contrary it sharpens our understanding of the nature of the world under scrutiny, and enables us to seek a better all encompassing story to tell.

2.7 Conclusion

Wilkins and Elsberry's quote at the beginning of the chapter about skirnobs[68] is appropriate to consider briefly here. This is because if a skirnob is handed over for inspection accompanied by the information that it is a designed object, and then after close scrutiny can be seen to be comprised of parts that appear to work together (or could possibly do so because they are inter-connected), then although it may not be clear what it is precisely that skirnobs actually do, it would nevertheless be reasonable to think that it is a machine of some kind, and probably has at least one major function. Using reverse engineering (and IC) the skirnob could be disassembled in an attempt to establish that function. But that is not all.

---

[65] Behe insists that he is not saying this about all living systems, but only some of them.

[66] It is remarkable that Paul Weirich considers evolutionary philosophy crucial to computer theory: "...the software and hardware aspects of a computer are somewhat analogous to the human mind and body. This analogy is especially strong if we...consider all information processing in nature and in human organisms, not just the conscious use of language. Evolution has produced a succession of levels of sign usage and information processing: self-copying chemicals, self-reproducing cells, genetic programs directing the production of organic forms...unconscious human information processing, ordinary languages, and technical languages. But each level evolved gradually from its predecessors, so that line between mind and body is vague" (Weirich, 1995:143). There is no doubt that in this approach several human disciplines are made subservient to a prior commitment to evolutionary totalism. An evolutionary biological framework is made to underwrite if not control the understanding of a major dictionary entry on a subject that relates very closely to engineering. This underscores a point made more than once in the main discussion that the story told about engineering is actually controlled by a more fundamental story, and that analysis of anything within the world of engineering ought to take clear cognisance of the way in which engineering concepts are viewed by evolutionary biology.

[67] It must be conceded, however, that implicit in the machine-as-narrative discussion is a very real concern voiced by Neo-Darwinists *viz.* the fact that when people see something as a machine they see the end product and not the process. The danger is that machine thinking can stifle process thinking. Given the fact that the New Synthesis in biology does indeed deal with real changes via genetic mutation (that is to say, empirically observable discoveries), it should be required by everyone of IC that its mechanistic thinking is not harnessed to shut down Neo-Darwinian research.

[68] A skirnob is a nonsense word for some unknown object that might or might not be designed.

Even if one doesn't know that skirnobs are designed, then so long as it is suspected that they belong to the class of machines and are therefore able to exhibit IC, a designer might be inferred.[69]

This chapter commenced with the stated aim of investigating whether a principle called Irreducible Complexity (IC) is indeed a property of mechanical machines. Beginning with a definition of IC, the discussion moved on to an attempt to provide a machine definition. This led to wider contextual considerations that held promise for a more nuanced understanding of machines. This was followed by an enquiry into whether IC is an actual property of mechanical machines, prior to a brief consideration of the intersection of design and narrative. Having weighed these factors, it would seem reasonable to conclude that given the definition and logical structure of mechanical machines that IC is indeed a real property in the engineering domain.

[69] Wilkins and Elsberry write: "Once we have such knowledge of designers, though, what we can say about them is that they generate regularities of outcomes. We know, for example, what the function was of the Antikythera Device, a clockwork bronze assembly found in an ancient Greek shipwreck, because we know the kinds of organisms that made it, we know the scientific, religious and navigational interests they had, we know about gears, and we know what they knew about the apparent motions of the heavens. Hence we can infer that the Antikythera Device is an astrolabe, used for open sea navigation by the stars, or a calendrical calculator, or both ...But suppose it was found by interstellar visitors long after humans went extinct. What would they know about it? Unless they had similar interest and needs to ourselves, or were already able to reconstruct from other contexts what human needs and interests were, for all they know it might be the extrusion of some living organism (which, in a sense, it is), just like a sand dollar. It might never occur to them to compare it to the apparent motion of the heavens from earth circa 500 BCE" (Wilkins &Elsberry, 2001:731). However, Wilkins and Elsberry have missed an important point which is this: What if *humans* visited another planet and found a skirnob there - some kind of Antikythera mechanism - what could *we* say about it? The answer is: 'a great deal', provided (and here is the crucial point) the device has been constructed to operate in the same universe under the same laws of physics and logic.

CHAPTER 3

Design language and principles already present in molecular biology

> "A bat is a machine whose internal electronics are so wired up that its wing muscles cause it to home in on insects, as an unconscious guided missile homes in on an aeroplane. So far our intuition derived from technology is correct. Our experience of technology also prepares us to see the mind of a conscious and purposeful designer in the genesis of sophisticated machinery. It is this second intuition that is wrong in the case of living machinery. In the case of living machinery, the 'designer' is unconscious natural selection, the blind watchmaker" (Dawkins, 1988:37).

> "The Intelligent Design theorists (like Behe) and the hyper-adaptionists (like Dawkins and Dennett) are taking in each other's laundry when they both use the terminology of design, even as they differ in the source of the design" (Weber & Depew, 2004:175).

> "The Stegosaurus, a large herbivorous dinosaur of the Jurassic period, had an array of bony plates along its back. Were they a solution to the problems of defense, courtship recognition or heat regulation? An engineering analysis reveals features characteristic of heat regulation: porous structure (suggesting a rich blood supply), particularly large plates over the massive part of the body, staggered arrangement along the midline, a constriction near the base, and so on...The question I ask—the question that evolutionary biologists ask—is how did one know in the first place that the fins would or would not be efficient for heat transference? The answer of course is because one has being relying on the metaphor of design. Precisely because one has being thinking of the Stegosaurus' parts as artifacts, that is to say as objects of conscious intention, one has been able to ferret out in which ways they work" (Ruse, 2000:227,229).

3.1 Introduction

The research question focuses the investigation on the utility that Irreducible Complexity could provide "as a nexus for an interdisciplinary dialogue between machine logic, molecular biology and theology". The previous chapter established the rationality and coherence of IC within the mechanical domain, and chapter four will explore a similar theme within molecular biology. What is required between these two chapters is a bridge that examines the necessity and legitimacy of mechanistic language used to describe what is observed in living nanosystems. Dialogue requires talking, and talking involves language. It is therefore important to have some understanding of the linguistic (especially the tropic[70]) dimension of observation and perception when it comes to molecular research.

The plan of this chapter begins with an analysis of the design argument in recent history with particular emphasis of Paley's work, then moves to examples of mechanistic and machine descriptions employed by researchers, followed by an analysis of the kind of referents that are indicated by such language which then leads pen-ultimately to a discussion about differences in approach between IC and Neo-Darwinian thinking, after which a conclusion is presented.

A small caveat is necessary. As stated in the previous chapter, this discussion draws a distinction between ID and IC with the intention of making luminous the scientific utility of the latter having bracketed the ideology of the former. It is worth repeating that although ID is

[70] A trope is a figurative or metaphorical deployment of language.

not central to the focus, the term remains useful since it represents a group of thinkers who uphold the validity of IC.

3.2 The Design Argument in recent Western history

3.2.1 A turning point for the design argument

In 2003 Kenneth Miller expressed a widely held opinion about IC: "Paley's 21st century followers claim that the intelligent design movement is based upon new discoveries in molecular biology, and represents a novel scientific movement that is worthy of scientific and educational attention. Couched in the modern language of biochemistry, Behe's formulation of Paley represents the best hopes of the movement to establish its views as scientifically legitimate...however, it is remarkably easy to answer each of his principal claims" (Miller, 2003:12).

When expressed this way, the impression is created that Paley's thought is outdated and that Behe's notion of IC is nothing more than Paley revisited. However, the ensuing discussion aims to show that Paley's thought has been caricatured and its relationship to IC misunderstood. With the extra details in place, Miller's optimism in finding easy answers to the principal claims in itself becomes remarkable.

Any discussion that touches on teleology in the natural world cannot be undertaken without reference to the work of Anglican minister and scholar, Rev. William Paley. His exposition of natural theology and design was published in 1802, nearly sixty years before Darwin's *Origins* emerged, and exerted enormous influence.

Paley stands at the end of a very long and established tradition. Stretching back to Plato who wrote of an ordering mind behind the world (Ruse, 2004:14), and emerging in Augustine's "silent testimony of the world that it has been created" (Ruse, 2004:15), the argument from design was canonised by Aquinas into a proof of God's existence (Ruse, 2004:15).

Thinkers who had pondered natural theology especially those in England, had spent much time examining biological systems in the hope of finding evidence that a designer had been

active in originating the living world. Scientists[71] of that time like Robert Boyle (1627 – 1691) wrote much that pictured God involved as "creator, designer, sustainer and frequent intervener' and where 'laws of matter and motion would not without the peculiar interposition of God, be able to produce animals of such a compounded nature" (MacIntosh, 1995:101). Natural theology reached a crescendo in the writing of William Paley (1743-1805) where "it was thought incredible that organisms, with their astonishing complexity and superb adaptation of means to ends, could originate strictly through blind mechanical forces of nature. Paley's *Natural Theology* (1802) is largely a catalogue of biological systems he regarded as inexplicable apart from a superintending intelligence" (Dembski, 2004a:67).

Paley, and with him the exercise of his brand of natural theology, is today largely considered to be an historical curiosity, even by many Reformed Christians. However, ID has brought about a renewed interest in natural theology and along with that a desire to re-read Paley.

3.2.2 Understanding Paley

Paley is famous for his use in 1802 of the illustration of finding a watch[72] lying on the ground and inferring that it must have had a maker. What is of considerable interest to this discussion is how Paley's argument compares to the kinds of argument employed by proponents of ID, and in addition whether his approach truly contains precursors of the latter. Of interest too is the possibility that in the light of the modern debate, a re-examination of *Natural Theology* is required in order to assess whether its central arguments were ever properly overturned.

Differing views exist as to the precise nature of Paley's argument. Michael Ruse, in pondering how the watch argument could have been so widely accepted given Hume's attack on the 'world-as-machine' idea, suggests that Paley's argument is not: "The world is like a machine. Machines have designers/makers. Hence the world has a designer/maker" (Ruse, 2004:19). Ruse goes on to say that "Contrary to what many think, this was not really Paley's approach" and points out that instead of harnessing a crude syllogism with its first premise open to Humean attack, the Anglican thinker approached the issue with an inferential chain which argues that "there has to be some causal explanation of the world. All explanations other than the one supposing a designing mind...are clearly inadequate.

[71] The word 'scientist' was not used until the mid 19th Century. Peter Watson writes: "The term scientist was coined by William Whewell in 1833" (Watson, 2005:854). Even up till the early 1800's laboratory equipment like test-tubes etc. were called philosophical instruments.

[72] Alister McGrath says of the watch analogy: "This analogy, like most of Paley's work, was borrowed from other sources. Paley had ruthlessly plagiarised John Ray's writings in his quest for a new natural theology" (McGrath, 2006:183).

Hence...the causal explanation of the world has to be a designing mind" (2004:19). This kind of argument known as 'the inference to the best explanation' (or abduction, or eliminative induction[73]) works by eliminating various possibilities and is therefore insulated against Hume's critique (Ayala, 2004:68). Ruse very aptly produces a literary example of this idea at work in the thinking of the great detective Sherlock Holmes who says to Watson: "How often have I told you that when you have eliminated the impossible, whatever remains, however improbable, must be the truth" (2004:19). It was this approach Ruse suggests that made *Natural Theology* so successful. Richard Dawkins agrees and writes: "what Hume did was criticize the logic of using apparent design in nature as *positive* evidence for the existence of God. He did not offer any *alternative* explanation for apparent design, but left the question open" (Dawkins, 1988:6). Philosopher Elliot Sober comments on this: "Philosophers who criticise the...design argument often believe that the argument was dealt a deathblow by Hume...Biologists often take a different view. Dawkins puts the point provocatively by saying that it was not until Darwin that it was possible to be an intellectually fulfilled atheist. The thought here is that Hume's sceptical attack was not the decisive moment; rather, it was Darwin's development and confirmation of a substantive scientific explanation of the adaptive features of organisms that really undermined the design argument. Philosophers who believe that a theory can't be rejected until a better theory is developed often sympathise with this point of view" (Sober, 2004:114).

However, there are other thinkers who determine a different central thrust in Paley's *Natural Theology*. In their view, what in fact the Anglican teleologist termed 'relation' appears to have passed unnoticed for the seminal idea it truly harboured, and was instead lost in the generalised designation of 'argument from design'. Probably the first to elucidate this was the biochemist Dr. Michael Behe who contends that Paley's argument entails a subtlety that has escaped proper scrutiny by the academy. Until recently, that is. In 1996 Behe claimed he had reworked and renamed Paley's 'relation' using the far more cogent and descriptive 'Irreducible Complexity' (IC). Since then other thinkers including a few ID critics, freshly enabled by Behe's work, more readily detect this different thrust in Paley, though sometimes without acknowledgement. One such thinker is Francisco Ayala to whom we shall turn in a moment.

[73] "Eliminative induction depends on successfully falsifying competing hypotheses." As Dembski points out, this is different to an argument from ignorance where "the lack of evidence for a proposition is used to argue for its truth...e.g. Ghosts and goblins exist because you haven't shown me that they do not exist". Eliminative induction can also be contrasted with Karl Popper's falsification thesis in which "hypotheses are corroborated to the degree that they successfully withstand attempts to falsify them" (Dembski, 2004a:328).

As we shall see more clearly further on, the notion of 'irreducible complexity' is tied up essentially with the analysis of biological mechanisms, particularly looking at the possibility of *removal* of a part without losing overall function. And because of the Neo-Darwinian context, the underlying motive for such analysis is the concern that if it is the case that existing suggested *pathways* of evolutionary development are not satisfactory, alternatives should be sought.

The question is whether Paley says enough to warrant seeing IC in his argument. Certainly ID critic Francisco Ayala thinks so, and, quite likely with the hindsight provided by Behe, writes: "the strength of the argument against chance derives, Paley tells us, from what he calls 'relation', a notion akin to what contemporary authors have called 'irreducible complexity' " (Ayala, 2004:68). Ayala then provides a quote from *Natural Theology*: "When several different parts contribute to one effect, or, which is the same thing, when an effect is produced by the joint action of different instruments, the fitness of such parts or instruments to one another for the purpose of producing, by their united action, the effect, is what I call relation; and wherever this is observed in the works of nature or of man, it appears to me to carry along with it decisive evidence of understanding, intention..." (Ayala, 2004:68). The mention of 'Irreducible Complexity' in this context suggests prior illumination, given that this terminology originates from within the ID movement.

But of course, close scrutiny of Ayala's citation from *Natural Theology* does not reveal 'Irreducible Complexity' *per se.* Paley nowhere seems to hint at this idea as such. One can concede, however, that the IC notion is embedded in what is meant by 'relation' or is logically entailed by it, but in any case the author of *Natural Theology* never teased it out. Furthermore, whilst this concept was well within his power to identify and apply, the opportunity for doing so is virtually precluded by the conceptual layout of his brief. *Contra* Ayala, Paley only discusses 'relation' *en passim* placing it in a small chapter half way through his book.[74] Despite a singular reference earlier on in the work to the idea of 'relation' and further on some further brief allusions, it seem that these are of little consequence. In Chapter 1 in speaking about the watch, Paley writes: "Arrangement, disposition of parts, relation of instruments to a use, imply the presence of intelligence or mind"[75]; and "...parts...determined their order, action, and mutual dependency, combined with their motions into one result...".[76] Further on he talks about "mechanism in animal bodies".[77] Yet

[74] Chapter 15 of 27 chapters. Paley does mention 'relation' in Ch 1(Paley, 1810:11): "Arrangement, disposition of parts, relation of instruments to a use, imply the presence of intelligence or mind".
[75] Paley p11.
[76] *ibid* p12.
[77] *ibid* p146.

Paley does come very close to irreducible complexity when discussing the heart: "The heart, constituted as it is, can no more work without valves than a pump can. When the piston descends in a pump, were it not for the stoppage of the valve beneath, the motion would only thrust down the water which it had before drawn up. A similar consequence would frustrate the action of the heart".[78] Yet even in his chapter on 'relations' Paley approaches the combination of parts from the point of view of their mutual 'suitability'.[79] Consideration of how a watch or other mechanism could function with a part missing is barely present.

None of the above is surprising. It would have been anachronistic[80] were it to have been otherwise. In 1802 the concept of biological evolution although very much in the air[81] (therefore in Paley's mind necessitating *Natural Theology*), did not draw on *natural selection,* a concept that would only emerge in print some sixty years later when Darwin published *Origin*. It is only in the context of naturalistic Darwinian pathways and descent with modification that the question of IC takes shape and becomes moot.

We would conclude that whilst not expressly voiced, IC is indeed logically entailed by Paley's argument, especially in regard to 'relation'. It seems reasonable to assume that *post* Darwin, he would have been forced to articulate something along the lines of IC. His statement: "...design [must have had] a designer...whether the machine immediately proceeded from another machine or not...that other machine may, in like manner have proceeded from a former machine..." loses force in the light of the Darwinian claim that 'slight, successive modifications' naturally produces new machines. Paley would have appreciated this, and it is quite probable that his design argument would have led him to formulate IC.[82]

Nevertheless, IC is not given expression *per se* in the pages of *Natural History.* This may account for its omission on the part of Richard Dawkins until 2006. His book *The Blind Watchmaker* which first appeared in 1988 draws on Paley's famous watch illustration both in its title and content, and in which he presents natural selection as the 'designer' albeit blind and senseless. For those who are naturalistically sighted, it certainly does seem that an

---

[78] *ibid* p159.
[79] *ibid* p262.
[80] However, it seems reasonable to say that it was well within Paley's imaginative powers to have developed this line of thinking had he so wished.
[81] Waller : "Contrary to the textbook view, none of the concepts from which Darwin pieced together his theory of evolution by natural selection was at all novel. Historians now recognise that the core principles of evolution – struggle for survival, selection, heritability, adaptation, even the appearance of random changes to the hereditary makeup – were fairly common themes in Victorian botany and zoology. Darwin's key contribution lay not in overturning this work, but in recasting it into a more coherent whole" (Waller, 2002:180).
[82] Jerry Coyne says with wry humour: "The 'irreducible complexity' argument is not, in fact, entirely novel. It descends, with modification, from British theologian William Paley..." (Coyne, 2005:13).

Intelligent Designer must make way permanently for a blind, naturalistic 'creator', one who makes exquisite 'watches', and who inspires feelings of awe and reverence (Dawkins, 1988:5). But Behe claims that Dawkins "never engaged with Paley's argument...refusing to engage his main point, playing dumb in order to reach a more palatable conclusion" (Behe, 1996a:213). Behe immediately goes on to say that "it is surprising but true that the main argument of...Paley has never actually been refuted" (Behe, 1996a:213). Given the refreshed reading of Paley from within ID and bearing in mind Dawkin's admiration for him, one might have expected more of a response from the Oxford evolutionist in his subsequent books published after Behe's Darwin's Black Box (1996). Only three[83] are candidates: *Unweaving the Rainbow* (1998), *The Ancestor's Tale* (2004) and *The God Delusion* (2006). The first of the trio just mentioned is too early for any felt effect of ID which as it is has been a late developer in England.[84] However, in *The Ancestor's Tale* Paley makes a sole and insignificant appearance in the context of a brief discussion about the bacterial flagellar motor and ID. Dawkins asserts: "This is the ancient 'Argument for Design', also called the 'Argument from Paley's Watchmaker' or the 'Argument from Irreducible Complexity' (Dawkins, 2004:456). A careful reading of Dawkins shows that he crudely lumps these ideas together. He makes no attempt to consider the implications of linking Paley to IC, nor is he willing to acknowledge that ID thinkers may have found something new in the argument from design. His response is only to mock. A brighter moment follows several paragraphs later where he teeters on making the connection that ID feels is moot via an interesting consideration of how future space visitors might harness the design argument while investigating planet earth.[85] The paragraph is suddenly cut short, bringing a promising excursus to an abrupt end.

In 2006 Dawkins brought out *The God Delusion,* a title which gave its author license to devote several pages to ID without fear of sending any covert signals that this new

[83] River out of Eden came out in 1995; Climbing Mount Improbable in1996.

[84] "The debate has been in lively progress for 10 years, but, apart from the Internet, one from which we have largely been excluded in the UK" (Jones & Tyler, 2005:224).

[85] Dawkins writes: "It is perfectly legitimate to propose the argument from irreducible complexity as a possible explanation for the lack of something that doesn't exist, as I did for the absence of wheeled mammals. That is very different from evading the scientist's responsibility to explain something that *does* exist, such as wheeled bacteria. Nevertheless, to be fair, it is possible to imagine validly using some version of the argument from design, or the argument from irreducible complexity. Future visitors from outer space, who mount archaeological digs of our planet, will surely find ways to distinguish designed machines such as planes and microphones, from evolved machines such as bat wings and ears. It is an interesting exercise to think about how they will make the distinction. They may face some tricky judgments in the messy overlap between natural evolution and human design. If the alien scientists can study living specimens, not just archaeological relics, what will they make of fragile, highly strung racehorses and greyhounds, of snuffling bulldogs who can scarcely breathe and can't be born without Caesarian assistance, of blear-eyed Pekinese baby surrogates, of walking udders such as Friesian cows, walking rashers such as Landrace pigs, or walking woolly jumpers such as Merino sheep? Molecular machines - nanotechnology crafted for human benefit on the same scale as the bacterial flagellar motor, may pose the alien scientists even harder problems" (Dawkins, 2004:456).

movement was indeed a worthy opponent, scientific or otherwise. More adamant than ever that no rational or reasonable territory be conceded to ID or IC, Dawkins remains uninterested in any new features in Paley *redivivus.*

By contrast, Behe asserts that Paley's notion of 'relation' cuts to the heart of the design argument and acknowledges that present in this notion is the essence of what in the former's hands would become what is arguably the lead idea underpinning ID viz. irreducible complexity. In *Darwin's Black Box,* Behe says: "Paley writes about discrete systems such as muscles, bones, and mammary glands, that he believes would cease to function if one of several components were missing. This is the essence of the design argument" (Behe, 1996a:212). Yet if it is the case that this truly is the nub of the argument, then it is also the case that that the central thesis of *Natural Theology* has, as Behe claims, not been answered.

How this came about is the burden of Behe's *Darwin's Black Box.* Both Ruse and Dawkins agree that Paley neatly sidestepped Hume with his inference argument. And both agree that it was Darwin's proposal of natural selection that provided a more powerful contender to Paley's divine inference, thus displacing it. But Behe points out that the Darwinian option rested upon an important assumption which has been quietly forgotten. The assumption was that the machine-like appearance of organisms is a macro feature only, and that the unseen (hidden[86] until the 1960's[87]) internal workings of biology on a micro scale would involve a state of affairs beyond any Paleyesce formulation. Yet modern biochemistry has in fact discovered that *that* assumption was in fact wrong: at the micro level the cell is "operated by ...molecular machines" (Behe, 1996a:51). However, the academy senses no need to return to Paley and re-examine his argument, less still any talk of re-admitting his design option. For various reasons[88] the Darwinian solution is preferred by almost all professional biologists. Consequently, it is contended, in agreement with Behe, that though regarded today as thoroughly discredited, Paley has indeed *never had his main argument overturned.* It has not been properly understood by most scientists in general, nor its dismissal recognised as unfair as it ought in the light of modern biochemistry, nor how appropriate its application actually is within modern science, not to mention the possibility of fruitful research.[89]

---

[86] Unseen biology could be thought of as existing in a unopened box, so to speak: a Darwin's Black Box.

[87] The work of Watson and Crick in 1953 combined with the X-ray work of Kendrew in 1958 allowed biochemists "for the first time to...actually know the shapes of the molecules that they were working on. The beginning of modern biochemistry...can be dated to that time" (Behe, 1996:12).

[88] The most important of these would be a commitment to Methodological Naturalism which by definition would exclude a designer from any serious scientific discussion of causality.

[89] The issue of ID and fruitfulness for research will be spoken to further on. Suffice to say at this junction that the peremptory dismissal of ID by thinkers like Dawkins as being nothing other than thinly disguised

Michael Behe sums it up when he says: "Neither Darwin nor Dawkins, neither science nor philosophy, has explained how a...system such as a watch might be produced without a designer. Instead, Paley's argument has been sidetracked by attacks on its injudicious examples and off-the-point theological discussions. Paley, of course, is to blame for not framing his argument more tightly. But many of Paley's detractors are also to blame for refusing to engage his main point, playing dumb in order to reach a more palatable conclusion" (Behe 1996a:213).

This key Paleyesce idea has been refined by Behe[90] and given a technical name: Irreducible Complexity. The author of *Darwin's Black Box* explains: "By *irreducibly complex* I mean a single system composed of several well-matched, interacting parts that contribute to the basic function, wherein the removal of any one of the parts causes the system to effectively cease functioning..." (Behe 1996a:39).

3.2.3 Concluding remarks on IC and Paley

The discussion thus far has attempted to show that there are some misconceptions about Paley and the relationship between his design approach and IC. Firstly, Paley's precise argument is not as straightforward or naive as most people think, and certainly not easily overturned by an appeal to Hume. Secondly, via the concept of 'relation', Paley's argument does appear to entail the notion of IC, yet without clear expression of it. This means that, thirdly, IC is indeed a fresh expression of the design argument and not simply a crude copying of Paley.[91] In the fourth place, Darwin's assumption had been that the machine-like appearance of organisms at the macro level would in the course of further scientific discovery be shown to be non existent at the micro level. Behe points out that this assumption has been overturned by molecular biological research, and that therefore Paley's main argument has never been disproved. It is therefore unacceptable to dismiss IC as nothing more than a 'creationist' appeal to a discredited system of 19th Century teleology.

---

creationism certainly does not encourage the scientific community to provide opportunity for testing. (Dawkins, 2004:456). In fact, Dawkins disallows ID as an entry in the index of *Ancestor's Tale*. Instead he refers the reader to the entry under 'Creationism'.

[90] Dembski writes: "Design has had a turbulent intellectual history. The chief difficulty with design to date has consisted in discovering a conceptually powerful formulation of it that will fruitfully advance science"(Dembski, 2002).

[91] "Like Paley, Behe appealed to his readers to appreciate the intricate complexity of living organisms as evidence of the work of a designer. Unlike Paley, however, he raised the argument to a new level, claiming to have discovered a scientific principle that could be used to prove that certain structures could not have been produced by evolution" (Miller, 2004:83).

3.3 The validity of machine ascriptions for molecular biological systems

At the outset it might be thought that an obvious target for deeper critique ought to be the human propensity for *seeing* a biological system *as* something wholly analogous to a mechanical machine. This was the essence of Hume's attack which was launched against the idea of world-as-mechanism which had emerged in the 17th century as people thought of a clockwork universe. Indeed, this concern surfaced at the Kitzmiller trial where the question was put to ID supporter Dr Scott Minnich: "You are not suggesting, are you, Dr. Minnich, that these are actually machines, are you? You're saying that they're like machines, aren't you?" Dr Minnich replied: "If you read Bruce Alberts' review article, he specifically states (that the reason) why we call them machines (is) because they are machines" (Minnich, 2005c). However, beyond that court room with its particular agenda, a strong impression is created that there is in fact general agreement that nature does exhibit true machines. Foremost ID critic Kenneth Miller[92] describes the eubacterial flagellum as "an ion powered rotary motor" (Miller, 2004:86) and a "complex biological machine" (Miller, 2004:88). He is willing to go even further than this and concede that "the cell contains biochemical machines in which if you...lose a single component it will abolish function" (Miller, 2002). Dembski cites Howard Berg's comment regarding the bacterial flagellum that "it is the most efficient machine in the universe" (Dembski, 2004:216). Berg in speaking about *E. coli* writes: "I am particularly interested in motor mechanics. What makes the motor go? How much torque can it develop at different speeds? How does it change its direction of motion? What are the mechanical interactions between flagellar filaments that coordinate different motors on the same cell?" (Berg, 1999). Richard Dawkins' approach actually canonises the link between biology and machines, even calling artificial machines "honorary living things". For Dawkins, refusal to recognise that nature looks exactly as though an engineer designed it is to shut one's eyes to "living watches" (Dawkins, 1988:5). In his view, all machines whether artificial or living come under the same rubric of specified complexity. In this surprising way, Dawkins is in firm agreement with both Behe and Dembski.

Both Dawkins' *Blind Watchmaker* and Behe's *Darwin's Black Box* even in their titles present an answer to Hume's attack on the design argument. Hume had asked whether complexity in 'creation' finds a true analogy in artificial machines. In Paleyesce terms (though of course the Scotsman wrote against design in 1779 some 23 years before Paley) Hume could have said that the natural complexity of some organism is not at all like a watch, especially on close inspection. In retort Dawkins spends an entire chapter titled 'good design' discussing

[92] Kenneth R. Miller is professor of biology at Brown University. He has a PhD in biology from Colorado State university. He has contributed a chapter in Debating Design (Miller, 2004) where he strongly opposes ID and supports Neo-Darwinism.

echolocation in bats where he says that a "bat is a machine...and gives the appearance of having been designed by a theoretically sophisticated and practically ingenious physicist or engineer" (Dawkins, 1998:36,37) harnessing in some species even the Doppler Effect. Behe's response to Hume is that biochemists have opened Darwin's Black Box and what has been found are machines and more machines *al la* babushka dolls. In a peer reviewed biochemistry paper titled "Mechanical Devices of the Spliceosome: Motors, Clocks, Springs and Things" the authors after mentioning "molecular gadgets" write that "[t]he richness of molecular detail revealed by GTPase structures...suggests that a good mechanical analogy for the mechanism of these proteins is a spring...the spring is compressed with the effector regions latched...hydrolysis unhitches this latch, uncoiling the effector regions to perform work. In the context of a proofreading device, the spring performs the biological function of a clock that commits one of two competing reactions when the spring is sprung" (Staley & Guthrie, 1998:315).[93]

Another paper titled "The Cell as a Collection of Protein Machines" says: "The entire cell can be viewed as a factory that contains an elaborate network of interlocking assembly lines, each of which is composed of a set of large protein machines[94]...[and] since (for engineers) any part of a machine might be modeled as consisting of one or more...basic constituent elements, it seems reasonable to expect that different but analogous approaches could profitably be applied to the protein machines that underlie the working of all living things...why do we call the large protein assemblies that underlie cell function protein *machines*? Precisely because, like the machines invented by humans to deal efficiently with the macroscopic world, these protein assemblies contain highly coordinated moving parts. Within each protein assembly, intermolecular collisions are not only restricted to a small set of possibilities, but reaction C depends on reaction B, which in turn depends on reaction A – just as it would in a machine of our common experience" (Alberts, 1998:291).[95]

Vale and Milligan introduce their paper subtitled *Looking Under the Hood of Molecular Motor Proteins* by saying: "Modern microscopy has transformed our view of the cell interior from a

---

[93] Dr. Jonathan P. Staley is Assistant Professor of molecular genetics and cell biology at the University of Chicago. Staley subscribes to Neo-Darwinism.

[94] See also Nogales and Grigorieff *Molecular Machines: Putting the Pieces Together*: "...It is now clear that most functions in the cell are not carried out by single protein enzymes, colliding randomly within the cellular jungle, but by macromolecular complexes containing multiple subunits with specific functions (Alberts, 1998). Many of these complexes are described as 'molecular machines'. Indeed, this designation captures many of the aspects characterizing these biological complexes: modularity, complexity, cyclic function, and, in most cases, the consumption of energy. Examples of such molecular machines are the replisome, the transcriptional machinery, the spliceosome, and the ribosome" (Nogales & Grigorieff, 2001:1).

[95] Dr. Bruce Alberts is Professor of the Department of Biochemistry and Biophysics at the University of California and president of the National Academy of Sciences. Alberts subscribes to Neo-Darwinism.

relatively static environment to one that is churning with moving components, not unlike the bustling traffic in a metropolitan city" (Vale & Milligan, 2000:88). Researchers do not make these comparisons simply because of convenience or imagination but because of remarkable correspondences, and are often compelled to seek an understanding of their molecular observations by an appeal to the world of human engineering and organization due to sheer similarity of function and intelligent arrangement. Vale and Milligan go on to talk about cellular transport, particularly protein[96] motors which 'walk methodically' down tiny rope tracks stretched across each of our cells carrying cargoes from one end to the other.[97] The paper actually says: "similar to a person walking across a pond along a row of stepping stones" (Vale & Milligan, 2000:89). The motors themselves have the appearance of many tiny people carrying bundles on their heads, buzzing along small tightropes with their feet doing a rotational two step and coiling up their midriffs, twisting as they go.[98] In another paper titled *The Molecular Motor Toolbox for Intracellular Transport* Vale writes: "A cell, like metropolitan city, must organize its bustling community of macromolecules. Setting meeting points and establishing the timing of transactions are of fundamental importance for cell behaviour. The high degree of spatial/temporal organization of molecules and organelles within cells is made possible by protein machines that transport components to various destinations within the cytoplasm" (Vale, 2003:467).

Roop Malik and Stephen Gross write: "Cells are organized with different compartments — the nucleus, the Golgi complex, the endoplasmic reticulum, and so on — that act as factories. Each factory generates a unique set of products, which are then distributed to 'consumers', which could be either end-users or other factories. The distribution system is complex, and uses three sets of molecular transporters: the myosin, kinesin and dynein motors. Intracellular transport occurs along two sets of paths, both of which are similar to rail systems: the more or less randomly oriented actin filaments, used by myosin; and the (typically) radially organized microtubules used by both kinesin and dynein. Transport occurs along each of these when the appropriate motor binds to a cargo through its 'tail' and simultaneously binds to the rail through one of its 'heads'. The motor then moves along the

[96] Made from kinesin (the word obviously etymologically derived form the Greek *kinesis* 'movement'). There are two other known protein motors involved in similar cellular transport: dynein and myosin. According to Malik and Gross myosin moves along tracks or filaments made of actin, whereas kinesins and dyneins move along filaments called microtubules.

[97] The researchers say at the conclusion of their article: "When watching under a microscope one cannot help but feel that the molecular machines generating such activities must be endowed with unique properties. However, as we learn about these molecular motors, they have become more familiar and less magical...and still appearing magical is the way in which protein motors can work with such high efficiency and be carefully tuned to have so many motile properties. These aspects of motor function will no doubt become better understood as the field continues to explore evolution's treasure trove of cytoskeletal motors" (Vale & Milligan, 2000:94).

[98] There is no agreement yet that the stalk in fact does rotate.

rail by using repeated cycles of coordinated binding and unbinding of its two heads, powered by energy derived from hydrolysis of ATP" (Malik & Gross, 2004:971).

Yet another peer reviewed paper 'Recent Cyanobacterial Kai Protein Structures Suggest a Rotary Clock' by Jimin Wang says that the Kai protein complexes form a clock which operates through *mechanical rotation* switching the cell off at night and on the next day. The surprise is that the clock persists very much longer than cell division. "In fact, these cyanobacterial oscillators in individual cells have a strong temporal stability with a correlation time of several months" (Wang, 2005:1).[99]

Behe points out that "Hume thought that the design argument depended on a close similarity in *accidental details* of biological organisms to (artificially) designed objects" (Behe, 1996a:217). Hume felt that the problem was bound up in the habits of thought and the way in which human beings prefer to see things. But although the great philosopher did not have access to the information we have today, he can nonetheless be criticised for not having had a good enough look at the organized complexity of the world such as it was known then, and which was examined in detail in *Natural Theology.* Hence Dawkin's admiration for Paley (Dawkins,1988:6). The general consensus appears to be that it is quite in order *contra* Hume to conclude that the machine description (i.e. actual function, not simply a metaphor) of certain organised complexity in nature holds good.

Surprisingly, Forrest & Gross in their critique only mention 'machine' *en passim* as they attempt to demonstrate that Behe's work is nothing new.[100] Yet despite the pejorative tone taken by *Trojan Horse* regarding Behe's use of 'machine' (which he could easily have derived from Dawkins)[101], nowhere in their book is the actual legitimacy of applying to biology

[99] Dr. Jimin Wang is in the Department of Molecular Biophysics and Biochemistry at Yale. Wang subscribes to Neo-Darwinism.

[100] Towards the end of their book they write: "And Behe's characterization of cellular structures as machines is now a cliché." They then cite Behe: "What has biochemistry found that must be explained? Machines – literally, machines made of molecules...the flagellum is an outboard motor...it consists of a rotary propeller, motor, and stationary framework, Darwin's theory is completely barren when it comers to explaining the origin of the flagellum or any other complex system" (Forrest & Gross, 2004:280).

[101] A statement made to Behe during the Kitzmiller vs. Dover School District trial: "This inference to design based upon the appearance of a "purposeful arrangement of parts" is a completely subjective proposition, determined in the eye of each beholder and his/her viewpoint concerning the complexity of a system." Behe disagrees with this statement and cites the gist of his reply during that trial: "Darwin's theory is widely touted as explaining the strong appearance of design in biology; if such appearance is just a "completely subjective proposition", what is Darwin's theory explaining? The Court neglects to mention that the "completely subjective" appearance of design is — in the view of the adamantly Darwinian evolutionary biologist Richard Dawkins — "overwhelming". I testified to that, to Dawkins' proclamation that "Biology is the study of complicated things that give the appearance of having been designed for a purpose", and to other similar statements. I showed the Court a special issue of the journal *Cell* on "Macromolecular Machines" which contained articles with titles such as "Mechanical Devices of the Spliceosome: Motors, Clocks, Springs, and

the idea of a 'machine' properly investigated, or any investigation referenced. Instead, they themselves use the terminology *en passim* once or twice.[102] The discovery of just how machine-like cell biochemistry truly is ought to be dealt with in objective terms. The public, even those who are scientifically literate, have little idea of the extent to which micro studies of living organisms are today conceptualised in terms of engineering or mechanistic systems, simply on the basis of observed function. In fact, the utility of an engineer's or physicist's grasp of design is beginning to be recognised as perhaps *the* path forward for all future biophysical if not biological research.[103] In a paper titled 'Motility Powered by Supramolecular Springs and Ratchets' the MIT authors pool resources from mechanical engineering and biology[104] (Mahadevan & Matsudaira, 2000:1).

In summary, this first question about the validity of using 'machine' terms to describe biological function appears to be warranted and generally accepted. Forrest & Gross' implication that Behe has been too reductionistic or facile in this regard can be ignored. In addition, it must be remarked that the growing observation of the almost magical nanotechnology and machine organization (especially groups of machines) evident in cellular structures is rivaled only by the steadfast insistence on the part of Neo-Darwinism researchers to attribute it all to the 'creativity' of natural processes.

A lot is stake even at this level, as Mikulecky[105] writes: "The Cartesian machine metaphor put reductionist mechanistic science in collusion with religion by giving this false picture of life. *If life were a machine, the ID argument has to stand.* Machines need cause from outside.

Things". If strong opponents and proponents of design both agree that biology appears designed, then the appearance should not be denigrated by Judge Jones as subjective" (Behe, 2006:30).

[102] "In artificial (as opposed to natural) parthenogenesis, a certain amount of aberrant visible development usually follows this activation of the egg's metabolic machinery (Forrest & Gross, 2004:91)...Comparative molecular biology has dealt yet another blow to IC: a very recent discovery in the physiology of cynobacteria (blue-green algae) represents beautifully a fully 'Darwinian' pathway to a physiological function that is eventually dependent upon an apparently 'IC' molecular machine. This is the device that controls the circadian rhythm – the biological clock – of these ancient and still ubiquitous micro-organisms. Dvornyk, Vinogradova and Nevo have shown convincingly how the three-gene circadian control system in the modern prokaryotes has 'evolved in parallel with the geological history of the earth, and that natural selection, multiple lateral transfers and gene duplications and losses have been the major factors shaping...that evolution' " (Forrest &Gross, 2004:84).

[103] Prof. Bruce Alberts writes: "Engineers recognise certain fundamental behaviour in nature and then create an idealized element to represent each of those behaviours...young scientists...(must realise) that much of the great future in biology lies in gaining a detailed understanding of the inner workings of the cell's marvelous protein machines" (Alberts, 1998:293).

[104] Mahadevan, L. based in the department of Mechanical Engineering at MIT; Matsudaira, P. based in the Department of Biology at MIT. The authors of the review paper 'Rotary Protein Motors', Oster and Wang , combine molecular biology with applied mathematics respectively (Oster & Wang, 2003:1). The cover of this issue displays a bright yellow Hyundai sports car with a see-through hood showing a molecular motor in place of the normal engine.

[105] Donald Mikulecky is Prof of Physiology at Medical College of Virginia Commonwealth University and is a disciple and exponent of Canadian mathematical biologist Robert Rosen (1934-1998).

Rosen's proof that organisms are distinct from machines in their causal closure destroys this collusion. Unfortunately, most of science is still in the dark ages and subscribes to the Cartesian machine metaphor, handing intelligent design an easy victory" (Mikulecky, 2005:2 my italics). Rosen's ideas have been examined in the previous chapter where in evaluating his thinking it was argued that causal closure at an organism level did not rule out machine correspondence at a subsystem level. Therefore, it is not necessary to talk about life *per se* or for that matter about Descartes. All that is necessary is to detect machines at a molecular level, something which the language of molecular biological research strongly suggests is the reality.

If the entire field of molecular research is couched in engineering language, and if that language betrays an engineering mindset suitable for the furtherance of that research, it would seem unlikely that the reality under investigation could fall short of truly being mechanistic to some degree. It is to this latter contention and to the degree of correspondence between language and reality that the discussion must now shift.

3.4 Machine analogies and symmetries for biological systems.

Precisely what is at issue here is how far one can press the machine analogy. Having established that machine terminology is an acceptable (perhaps unavoidable) way to describe certain biological features, what requires some consideration is the extent to which a man-made machine *models* the behaviour, action and teleological aspects of an ascribed biological counterpart. Many thinkers and scientists at this junction insist that machine language can only be metaphoric or analogical at best.

We will initially present a case for a much stronger position where at a block diagram level in certain biological instances there is a remarkable correspondence to a formal system. This is discussed below under machines and metaphors; it is here where very close *similarities* are explored. Following on from that, our attention will be focused on the issue of analogical dissymmetry, since it is clearly the case that biological systems transcend any attempted mechanical model in a number of ways – it is here where the very real *differences* will be explored. The problem of dissymmetry becomes important in this further discussion because the idea of an incremental developmental history is part and parcel of the Neo-Darwinism perspective on natural systems, whereas for human made machines this is obviously not applicable. However, it should be borne in mind that ID's use of a mousetrap as analogy is in the narrow domain of the property called IC.

3.4.1 Machines and metaphors

Simon Conway Morris writes: "Not only is the integrity and integration of living systems quite astonishing, but attempts to employ machine-like analogies soon run into difficulties. To be sure we refer to motors, switches, transport mechanisms, fluid flow, pumps and electricity, but the reality is that organisms have a subtlety and efficiency far beyond any machine we can build" (Conway Morris, 2006:10). This argument is considered to be unpersuasive owing to a disagreement over what is precisely at issue. Surely the key concern is not the *way* in which living systems achieve function, but instead in the correspondence they enjoy with formal systems. In other words, "subtlety and efficiency" can be viewed as a distraction for the serious investigator, moving his attention away from noticing the extraordinary logical correspondence between certain living systems and machines. After all, whilst it is indeed incredible to contemplate the efficiency of something like the bacterial flagellar motor, what is far more pertinent is the logic of operation and component assembly as both interact with the environment, whether intra- or extracellular. Engineers understand and appreciate this perhaps more readily than others.

This line of thinking readily leads to a consideration of the block diagram. When designing a system, engineers first produce a drawing that details the logic of the proposed system. This is done via an algorithmic arrangement of boxes or blocks each of which is labeled with its contributing function. In essence, such a block diagram details an embodied principle(s) of operation. However, the biological literature does not often make use of block diagram logic to assist in the communication of research into a particular living system. It is suggested that this is because biologists make use of unconscious (and un-thought through) background assumptions regarding close connections between machines and nature. Therefore what is clearly apparent is not only the language of mechanical correspondence, but of the unstated assumption of universal logical principles embodied in both living and non-living machines. Molecular research makes use of this approach all the time as can be observed in the literature e.g. Mahadevan and Matsudaira write that "springs exhibit a conformational bi-stability of latched and unlatched states" and "Just as springs and ratchets can store or release energy and rectify motion in physical systems, their analogs can perform similar functions in biological systems" (Mahadevan & Matsudaira, 2000:1). There is an identity of concept to the extent that the biology is understood in terms of its equivalent in the engineering world. There is a correspondence that is parasitic upon the human world of engineering and without which molecular research would grind to a halt.

A good candidate for consideration is bat echolocation.[106] Dawkins describes the bat as possessing sonar and sets the scene for the development of our argument: "It is technically incorrect to talk about bat 'radar' since they do not use radio waves. It is sonar. But the underlying mathematical theories of radar and sonar are very similar, and much of our scientific understanding of the details of what bats are doing has come from applying radar theory to them" (Dawkins, 1988:23). Our interest is piqued by observing the correspondence between a formal system such as a human designed sonar, and a living system such as bat echolocation. It is this correspondence that underwrites our ability to "apply radar theory" to these flying mammals.

The operation of a formal system can be neatly expressed in a block diagram e.g. explaining how sonar works, and this can therefore be used to model an aspect of a complex system (a living system that cannot be fully modeled). The bat makes use of a system which at the very least performs a major function identical to the formal system. It is surely correct therefore to speak of the bat as possessing sonar even though sonar was formulated prior to any discovery by zoologists. Remote imaging via the reflection of acoustic waves was discovered by engineers using ideas from the world of physics to estimate the depth below a ship. Shortly after this the idea was harnessed to detect submarines, and by changing the emitted waves to radio to track enemy aircraft. In talking like this we are not saying that the sensing apparatus harnessed by bats is exhaustively reducible to sonar (it may perform other important functions, and it may harness other acoustic sensing not yet discovered), but what we are saying is that the actual *function* of remote sensing by acoustic reflection in living systems can indeed be fully modeled by a formal system.

The point that is being made is that this identity of block diagram in both formal and living systems actually signals to us that there is no *mere* metaphor at work here. Bats actually possess and operate a sonar. The principle of operation that is embodied in a human designed sonar is identically embodied in this living system. Once again, it needs to be said that what is *not* at issue for this argument is the *way* in which the blocks in the diagram achieve their function or their connections. However, even if pressed on this point it is arguably the case that the components making up the boxes have themselves more correspondence than might first be recognised. But the emphasis is at the block diagram level.

Therefore, the block diagram detailing a human constructed sonar device should be considered to be identical to the block diagram detailing the bat sonar. Such a diagram

[106] Not all bats use echolocation. Some rely on vision entirely.

displays at the very least a block containing an acoustic transmitter, a block showing an acoustic receiver, a block containing a processor suitable for controlling both transmitter and receiver (for timing the transmission, switching the listening apparatus on and off etc), and a block showing the processor that analyses the information acquired both by the receiver and the other processor.

Discussion as to whether such mechanical descriptions are hangovers from a Cartesian worldview are made irrelevant by the simple fact that what can be seen is an identical correspondence of function. Scientific observers of bats are not resorting to the language of convenience when speaking about bats possessing sonar, but are describing what is actually present within the bat. The principle of echo location, implicit in the formal system, is also implicit in the living system. Careful scrutiny of what bats do is not being skewed here by an unconscious desire to represent the world as a machine. What is observed is that squeaks are emitted, and reflections received and the information processed *at the very least* in the same *logical* way that is outlined by the formal system. It is a mistake to think that human analysis in some way superimposes this block diagram (or the notion embodied in the formal system) onto what bats do. This seems to be what is implied elsewhere by Conway Morris. Of course, the ear of the bat does not operate precisely as a human made acoustic receiver (microphone), though even in this case a formal system could model this too. Instead, when we are told by biophysicists and zoologists that bats use sonar we should understand that despite protestations to the contrary this is not the language of metaphor, but of correspondence.

Michael Ruse expresses matters somewhat more strongly than Conway Morris yet appears to want to close the gap between trope and reality in an objective way whilst simultaneously anchoring the trope in subjective human culture. It is worth quoting Ruse at length: "The machine metaphor specifically has played a very important role in science — it is at the base of much of the epistemic triumph of science. Its more general reading — the world as a machine—is endorsed and accepted fully by the Darwinian evolutionist, although (as for other scientists) in important respects this is now a dead metaphor. The more specific reading - the parts of organisms are to be seen as mechanisms functioning for some end, created by and aiding natural selection - is absolutely crucial to modern evolutionary biology. This sense of the metaphor thrives mightily. It is an essential component of the predictive fertility of Darwinian evolutionary theory, and neither the past nor the present gives one reason to think that it will be eliminated. Thus, to repeat what I said at the end of the discussion of Charles Darwin's own work, the general reading of nature as a machine — nature as a law-bound system of events — lies beneath the justifiable claims of science to

yield objective knowledge. This holds true of Darwin's own theory of evolution through natural selection, even more today than it did in his day. The specific reading of nature as a machine—organisms as composed of contrivances, as made of machine-like mechanisms — likewise thrives in today's (Neo-Darwinian) evolutionary biology. In fact, indirectly it contributes to the epistemic excellence of the science. However, today no less than yesterday, the metaphor is one drawn from culture, and is not a necessary component of human thought or even of evolutionary thinking — although an evolutionary theory without the specific metaphor would be much impoverished. In this regard, because today's evolutionists do use the metaphor, Neo-Darwinian science continues to have its subjective side" (Ruse, 2005a:300).

Ruse is quite evidently facing up to the problem that both the world and a huge number of its subsystems have been and will continue to be described in machine terms. What he cannot countenance of course is the idea that our language is not metaphorical but realistic. His attempt via an analysis of the dual definition of mechanism to articulate how it is that such language should be "at the base of the epistemic triumph of science"[107] and yet simultaneously rooted in human subjectivity, may explain some of the historical aspects of Darwinism but, it is suggested, does not explain how the logical difficulties are overcome. Possibly a much better explanation for the connection between the success of science and the use of machine language is quite simply that with the rise of mechanical contrivances in 16th Century Europe people were better equipped to see what was *actually* present in nature.[108] Ruse at times pursues this line of thought and asks: "How does one design a lens which avoids spherical aberration? In the seventeenth century, Rene Descartes and Christian Huygens discovered the shape of the required lenses. However, nature had beaten them by a long time. The trilobite intralensar bowls are needed for sharp focusing because trilobite eyes functioned in water" (Ruse, 2000:229). A similar line of reasoning accompanies the Stegosaurus quote at the commencement of the chapter. After all, it is easier to understand bat echolocation or even discover it once one knows and understands

[107] Ruse is making the extraordinary statement that science as a way of truthfully knowing about objective reality depends upon machine metaphor.

[108] Peter Harrison suggests another powerful reason: "Part of what Galileo was concerned to assert - and in this he was joined by Kepler and Descartes - was that mathematical relations were divinely instituted, and thus real... The common Aristotelian assumption all the way up to Descartes was that mathematics was a construction of the human mind. In the Aristotelian scheme of things, mixed-mathematical disciplines such as astronomy were granted only an instrumental status and were thus regarded as useful fictions or calculating devices that 'saved the phenomena'...Galileo wished to suggest that mathematics is the divinely instituted language of nature. He left it to others to draw the obvious corollary: it was symbolic associations of the medieval world, and not mathematical relations, that were human inventions" (Harrison, 2006:128). It is important to note that there are links between the rise of both ideas: the world-as-machine (Descartes), and nature-written-in-mathematics (Galileo) not least in that their contemporaneous appearance is in both cases a result of a break with the medieval Aristotelian approach.

human designed sonar. Attempts by Ruse and Conway Morris to de-clutch this language from actual reality throws up all kinds of difficulties e.g. *non sequiters* such as this statement from Ruse: "Seeing nature's parts as machines, as mechanism, as contrivances...is the key heuristic tool for the student of natural selection...(i.e.) think of organisms and their parts as if they were machines, and puzzle out the solution...today this is known revealingly as 'reverse engineering' " (Ruse, 2005a:295). Such difficulties of course have been increased by several orders of magnitude now that 'Darwin's Black Box' has been opened. Discoveries such as Jimin Wang's cell based molecular clock (Wang, 2005:1) that operates via mechanical rotation and switches genetic expression diurnally (i.e. the cell sleeps at night) are if anything likely to strengthen the position being advocated.

In conclusion we assert that Conway Morris' argument that "machine-like analogies run into difficulties because of the transcendent subtlety and complexity of the living systems they attempt to model" is not a valid argument given the constraints of the current discussion precisely because at the level of comparison where it matters, the two systems may be regarded as identical. Whilst freely admitting the transcendence, we can contradict neither the logic nor the powers of observation underwriting Dawkins' statement that the "details of what bats are doing has come from applying radar theory to them" (Dawkins, 1988:23). This is nothing less than cross-system application of a single operational principle embodied in a block diagram.[109]

3.4.2 Symmetries and frameworks

In 2005, Tammy Kitzmiller *et al* sued[110] the Dover School District *et al* for officially disparaging Neo-Darwinism evolution and enforcing the teaching of ID, particularly via the insistence that students be taught from the ID textbook *Of Pandas and People.* The case is interesting because recognised exponents on each side of the issue (e.g. Behe and Miller) submitted an expert report, and most of them were subpoenaed and subject to cross examination.

In his report for the trial, Dembski[111] said: "Those who encounter molecular machines like the bacterial flagellum for the first time but have no prior commitment to Darwinism find it intuitively unconvincing that such systems can be explained in Darwinian terms. But those

[109] This line of thinking was developed and explored in an unpublished paper presented by us at the Annual conference of philosophers of Southern Africa at Stellenbosch in January 2007.
[110] Judge Jones' findings in Dec. 2005 were that ID is not science and to teach it as such contravened the First Amendment. He ruled in favour of Kitzmiller *et al* that ID not be taught in any school in the Dover School District, and that evolution not be disparaged.
[111] Dembski and Meyer submitted expert reports but withdrew from the trial, probably due to legal expediencies.

who have spent decades thinking of all complex cellular machinery in Darwinian terms will not arrive at this intuition just by being shown examples of systems they think they already understand. Hence, for biologists to be convinced that Darwinian explanations are inadequate, they will need to see *compelling new evidence* that Darwinian explanations of these systems really are inadequate. Recent research by Douglas Axe...provides such evidence in the form of a rigorous experimental assessment of the rarity of function-bearing protein sequences. By addressing this problem at the level of single protein molecules, this work provides an empirical basis for deeming functional proteins and systems of functional proteins to be unequivocally beyond Darwinian explanation" (Dembski, 2005:33).

Miller, for purposes suited to those opposed to ID, develops this in his report for the trial: "What Dembski is telling us is that in order to detect design in a biological object one must first come to the conclusion that the object *could not* have been produced by a 'relevant chance hypothesis' (meaning evolution). Then, and only then, are Dembski's calculations brought into play. Stated more bluntly, what this really means is that the 'method' first involves *assuming the absence* of an evolutionary pathway leading to the object, followed by a calculation 'proving' the impossibility of spontaneous assembly. This faulty *a priori* reasoning is exactly the sort of logic upon which the new 'science' of intelligent design has been constructed" (Miller, 2005a:16).

From these quotes it is clear that both Dembski and Miller have pinpointed something fundamental *viz.* framework assumptions. As some people suspect, both ID and Neo-Darwinism rely heavily on a baseline assumption. For the former this assumption is that a Designer cannot (ought not) to be ruled out *a priori* and therefore any Neo-Darwinian explanation should be considered on a case by case basis. For Neo-Darwinism, the assumption is that the official explanation must enjoy primacy until overthrown by another naturalistic theory (and therefore cannot be overthrown by ID) since science by definition (for Neo-Darwinism) is a naturalistic enterprise.

This is particularly relevant to our discussion about machines for the following reasons. Firstly, whilst both ID and Neo-Darwinism have no difficulty using machine ascriptions, this shared usage is in fact quite superficial and leads to a rapid departure from any common ground – a departure noticeable in the context of argumental[112] entailments.

[112] Coinage for the purposes of this discussion.

Secondly, this 'rapid departure' is due in part to prior equivocation not in regard to the word 'machine' *per se* but in regard to the 'idea of machine' settled as it is in the context of human language embedded in a technological milieu.[113] What is being suggested is that the 'idea of machine' is inextricably bound up with human agency, and *a fortiori* bound up with intelligent design. The upshot is that the Neo-Darwinian community should recognise that it makes illicit use of 'the idea of machine' to describe biological function whilst simultaneously insisting that such 'machines' should be thought of as having no designer. In this illicit usage there is obviously no perceived infringement upon the definition of 'machine' as such, but what is being maintained here is that any definition of 'machine' entails more than what the dictionary supplies.[114] Expressed differently, one could say that ID and Neo-Darwinism use similar dictionaries but different lexicons. This explains the noticeable incommensurability which dogs the whole debate, and which leads to either side regarding the other as 'illogical'.

Thirdly, there is not only conceptual equivocation regarding 'the idea of machine' but there is also the problem of juxta-positionary implicationism, especially when time dependencies are considered. What this means is that certain key words or concepts that occur within the context of 'machine' language that *today* have an ordinary meaning, can suddenly in the light of a new discovery cue people to make an unconscious lexical switch. The words 'motor' plus 'wheel' would imply design by a designer unless the context adds 'ATPase' (which is a true rotary motor complete with a tiny wheel found in nature). For Dawkins, 'motor' plus 'wheel' plus 'ATPase" necessarily implies design *without* a designer. However,

---

[113] This constitutes an interesting research topic yet to be undertaken in Philosophy *viz.* the use of the language of technology in labeling or identifying biological objects on the one hand yet on the other the denying to biology consistent application of the underlying hierarchies of ideas implicit in such language. Said differently, the question being posed is one which asks if it is coherent to use the language of machinery in a literal technical way (i.e. not metaphorical or poetic) yet sheered off from its historical, social and logically interconnected roots. To get the sense of what is being conveyed here, it is suggested that most people would experience some consternation in reading Dawkins' *Blind Watchmaker* and successfully attempting to grasp both the logic and word definitions employed in a discussion about a biology that Dawkins claims is designed but not by a designer.

[114] Dawkins writes that "Robert Galambos first reported in 1940 to an astonished conference of zoologists their new discovery of bat echolocation. One distinguished scientist shook Galambos complaining that.. bats could not have anything remotely analogous to the latest developments in military technology" (Dawkins, 1988:35). This reaction while quaint from the modern perspective actually underscores the contention being made here. The world of machines and technologies was not expected to be discovered in the world of biology particularly because the dominant explanation for the latter was and is naturalistic, and it was assumed that naturalistic processes could not produce certain technologies. That increasingly since 1940 we uncover complex systems which can be so readily described in machine and technological language ought to point up a major problem in the Neo-Darwinism framework. As a corollary to all this, one wonders with eager expectation how much bio-technology remains to be uncovered. Along with this is the striking thought (for those who subscribe to ID) that if ID were assumed to be true and first rate people and money were allocated to its research, new technologies and machines might be discovered that current research overlooks. This is a variant of the thesis of Joseph Needham in *The Grand Titration* where he concluded that Chinese technological and proto-scientific discoveries couldn't develop into a fully fledged science because in their framework there was no Mind behind the universe to confer rationality.

the words 'motor' plus 'wheel' plus 'transistor' would for most biologists *today* (i.e. in 2007) imply design by a designer until 'transistor' is used somewhere by a researcher to describe a small component in the cell or other biological structure. Then suddenly Neo-Darwinism would insist that although any machine terminology per *se* is always duly licensed (this is a Neo-Darwinian *de facto*), its use must be accompanied by the required lexical switch if speaking about living systems. The juxtaposition of 'machine' plus 'transistor' implies a designer today but the future discovery of a cellular or animal equivalent would be immediately taken to imply no designer. What is more, failure on the part of biologists to comply in this regard would be labeled by the Neo-Darwinian *status quo* as dangerous or deceptive, yet non-compliance at this point seems to us to be entirely natural if not obvious. This appears to be the situation for ID, and quite possibly natural and obvious for most intelligent people.

Dawkins writes: "...our experience of technology also prepares us to see the mind of a conscious and purposeful designer in the genesis of sophisticated machinery. It is this...intuition that is wrong in the case of living machinery. In the case of living machinery, the 'designer' is unconscious natural selection, the blind watchmaker" (Dawkins, 1988:37). Given the current discussion it is pertinent to ask whether Dawkins is actually entitled to use the phrase "living machinery" in conjunction with "designer" which he defines as natural selection. What he is actually doing, we suggest, is to enforce with customary Neo-Darwinian hegemony the use of the lexical switch via a juxtaposition of the word 'machine' with the word 'living'. It does not take that much imagination to propose other situations where this switch would be clearly seen to be problematic. One instance would involve explorers arriving on an alien world.[115] Another involves the not so distant future when bio-engineers produce nano machines.[116]

---

[115]. An example of this would be if astronauts arrived on a distant planet and found a complex system that had previously arrived there comprised of parts some of which turned out to be organic and others inorganic but just more than half the parts made out of metal, and some made out of silicon which were determined by the astronauts as used by the complex system to amplify electric signals. Furthermore, this system on analysis was found to be IC in the way Miller has agreed to Behe's definition. In addition, because this system was also found to have independent mobility using wheels and the ability to process sensory data and perform actions and do work on the basis of that data, the astronauts decided to radio back home that they had found a sophisticated wheeled biological machine possessing transistors and a computer. One would expect people back on earth to be inclined by this terminology to suspect that a higher intelligence had designed the system. Why would anyone in their right mind suppose otherwise? The notion of self-replication could be added to the thought experiment. On a Neo-Darwinism account, we are faced with a massive epistemic difficulty in all this. How can we know that any machine in the universe owes its existence to natural law or to design? Can Dawkins supply any criteria? If the answer is that we must always assume a natural aetiology then not only is SETI a waste of money, but the scientific fraternity would be laughed at by the general public. If the answer were to move towards a position of agnosticism on this issue, then Neo-Darwinian critics (including ID) might gain the upper hand via a renewed questioning of the epistemic grounds for Neo-Darwinian certainty of the naturalistic origin of biological machines on earth

Fourthly, given the Neo-Darwinian lexical switch required by the juxtaposition of 'machine' with 'living', any analogue such as a mousetrap cannot be allowed by Darwinians to provide 'designer' entailments for biology, nor can they allow a penumbra of logical constraints peculiar to machines to be extended into the biological realm. The problem can be seen more clearly now. Neo-Darwinism legitimises the biological ascription of 'machine' terminology and therefore cannot refuse the argumental use of a machine analogue such as a mousetrap especially in regard to a machine property called IC. Yet, the juxtaposition of 'mousetrap' and 'machine' implies design by a designer whereas for Neo-Darwinism the juxtaposition of 'flagellum' and machine' requires a lexical switch to imply design *without* a designer. This combination is calculated to cause difficulties for both sides, but more especially for Neo-Darwinism because mousetraps (and all human built machines) actually resist any attempt at being 'naturalised' and made to fit into an Neo-Darwinian framework. Neo-Darwinism attempts to achieve this naturalisation[117] in the paragraphs that follow quite rightly appear forced, unnatural and in the end unpersuasive.

Fifthly, there is a deeply paradoxical situation emergent in modern molecular biology. We had said earlier that as some people suspect, both ID and Neo-Darwinism rely heavily on a baseline assumption. For the former (for ID) this assumption is that a Designer cannot be (or ought not to) ruled out *a priori* and therefore any Neo-Darwinian explanation should be considered on a case by case basis. For Neo-Darwinism, the assumption is that the Neo-Darwinian explanation must enjoy primacy until overthrown by another naturalistic theory (and therefore cannot be overthrown by ID) since science by definition (for Neo-Darwinism) is a naturalistic enterprise. The irony is that it can be argued that evolutionary molecular biology cannot function without a methodology that is dependent on ID. The possibility exists that it is the case that *methodological naturalism governs the explanation* whilst *methodological teleology governs the science.* What has just been stated should not be

---

[116] Bustamante *et al* write: "...using a theoretical understanding of motor mechanisms combined with numerous examples of biological molecular motors, it is possible, in principle, to design new motors of our own. The main problem with such "nano-motor engineering" is not the basic principles but the more pedestrian difficulties of protein engineering. A motor requires specific interactions between its parts and a catalytic interaction with its fuel molecule. These necessitate precise control over the final structure of the motor, and this cannot yet be designed de novo with present technology. Eons of evolution remains the best protein engineer. One way to avoid this difficulty might be to assemble new motors from pre-existing "unit machines" - protein domains with known structure and behaviour that can be combined without much change in their properties. Then all that we have learned, both theoretically and experimentally, about microscopic motors can be brought to bear. It seems likely that many new motors, and even basic motor mechanisms, could be built by this approach" (Bustamante, Keller & Oster, 2001:420). Any hypothetical alien visitor in the future analysing molecular motors on planet earth would not be able to distinguish between those of human design and those of 'natural' design apart from contextual clues. As an aside, we draw attention to the language of engineering and motor structure harnessed by these authors.

[117] Attempts are made to create simpler mousetraps that could 'evolve' into more sophisticated ones. This is not say that these simpler traps as proposed by Neo-Darwinism are in any way thought to evolve on their own, but merely that simpler forms can be constructed and placed in a series.

glossed over as it pinpoints perhaps one of the more ironic states of affairs in the history of science. Put differently, it is the observation that whilst machine language betrays the actual method, the discoveries are nonetheless written up as a triumph of Neo-Darwinian assumptions.

Prof Scott Minnich who has spent several decades researching bacteria at a molecular level, in his expert testimony submitted in the Kitzmiller vs. Dover School trial argues that the methodology employed by the discipline is actually based upon design principles. Minnich is worth quoting at length: "This approach using mutagenesis to identify genes involved in a defined process, coupled with biochemistry to essentially rebuild the structures to understand how it works is referred to as reverse engineering. This is much the same technique engineers use when they analyse a machine for which blueprints are missing. In other words, the idea is that you take things apart and put them back together again while in the process evaluating what each component contributes to the whole. So...it is the processes more akin to design that propelled biology from a mere descriptive science to an experimental science, more so than any contribution from evolution...hat we have encountered systems that tax our own capacities as design engineers, justifiably leads us to question whether these systems are the product of undirected, un-purposed, chance and necessity. Indeed, in any other context we would immediately recognise such systems as the product of very intelligent engineering. Although some may argue that this is merely an argument from ignorance, we regard it as an inference to the best explanation, given what we *know* about the powers of intelligent as opposed to strictly natural or material causes. We know that intelligent designers can and do produce irreducibly complex systems. We find such systems within living organisms. We have good reason to think that these systems defy the creative capacity of the selection/mutation mechanism. The real problem, may not be determining the best explanation of the origin of the flagellum. Rather, it may be [the difficulty of] amending the methodological strictures that prevent consideration of the most natural and rational conclusion- albeit one with discomforting philosophical implications. What is ironic about this debate is that the clear relationship between the flagellum and type III secretory systems was recognised on the basis of reverse engineering (i.e. design principles). Early attempts to draw attention to this fact were negated by evolutionary arguments. When the evidence became overwhelming about the relationship between these seemingly 'disparate' systems, it was immediately claimed as evidence for evolution. This example is illustrative of my experience as a scientist which has led me to believe that

evolution is best seen as postscriptive (the tail-lights of biology), while design principles (the headlights of biology) tend to drive scientific inquiry and progress" (Minnich, 2005a:10).[118]

Sixthly, there is a symmetry problem, and this becomes acutely emergent in regard to methodology. To see this it must be borne in mind that both ID and Neo-Darwinism do not argue *to* a position, but *from* a position whilst at the same time both tend to present their methodologies as theory-neutral. Of course, if pressed, there is usually an admission that behind the posture of simply 'reading off' what is discovered in the natural realm, there is indeed a metaphysical assumption. We suggest that ID starts with the *a priori* assumption that there is a supra-terrestrial designer[119] and that therefore features of design such as IC which are found in man-made machines should also be found in nature. It is consistent with this position that having identified a particular machine, the line of reasoning would commence with the fully functional entity and examine difficulties attending any notion of sustaining function in the absence of one or more parts. In a sense, IC as a concept says a lot about the methodology and belief structure of ID. Neo-Darwinism by contrast starts with the *a priori* assumption that natural mechanisms can account for all the complexity of the biosphere and that therefore features of design such as IC which are found in man-made machines are only *apparent* in natural systems. It is consistent with this position that having identified a sequence of forms, the line of reasoning would commence with an ancestral structure and seek to overcome difficulties in explaining an increase in Dawkins'-style specified complexity e.g. from prokaryotes to eukaryotes. Neo-Darwinism therefore finds little need to consider IC at all, regarding it at best as an oddity or a worrying diversion for the public, and at worst causing a loss of confidence on the part of policy makers and those in control of funding. There is an obvious asymmetry here because ID moves from a complete system and attempts a retrospective analysis, whilst Neo-Darwinism moves from an ancestral system and attempts a forward looking analysis using actual fossil or living forms.

This would account for the fact that both ID and Neo-Darwinism make use of Rube Goldberg[120] cartoons[121] to illustrate their respective positions. Behe introduces his chapter

[118] It is worth pointing out that during the trial, Minnich's contentions in this regard were not overthrown, but simply ignored.

[119] For many within ID this would be better expressed as 'supra-cosmic' but a fair number of ID exponents would be more comfortable with merely locating the source of design as lying beyond the earth. There are only two criteria for holding to ID: (i) Agreeing that naturalism is false (ii) Agreeing that [first order] design is empirically detectable (Jones & Tyler, 2005:223).

[120] Michael Ruse points out that Americans think of Rube Goldberg whilst the British think of Heath Robinson. (Ruse, 2005a:286). We recall Professor Brainstorm.

[121] A Rube Goldberg cartoon depicts a contrivance comprised of ready to hand items like a drain pipe, a fidgety dog, a cork etc. which are then assembled into a ridiculous machine capable of harnessing a set arbitrary input

on blood clotting with one such cartoon, explaining that "when you think about it for a moment , the Rube Goldberg machine is irreducibly complex. It is single system composed of several interacting parts that contribute to basic function, and where the removal of any one of the parts causes the system to stop functioning" (Behe, 1996a:76). What Behe didn't do though, was to spend some time explaining how this machine could be *assembled* if a part were missing e.g. if the bird could somehow replace the small dog. This would have helped. In ID, the tendency is to approach machines from the top down (i.e. to challenge anyone to show how the machine could function *without* a part) and then, when switching to biology, to approach matters from the other direction i.e. from the bottom up, challenging Neo-Darwinism to show how parts could be assembled whilst retaining function. It is this asymmetry which is problematic. The question to be asked is whether this is inherent in the conceptual formulation of IC. It is suggested that Behe would have been better off not using this cartoon in the absence of a more thorough inspection, which the quadrant analysis in the previous chapter should have made clear. Doolittle whimsically laments Behe's use of the cartoons: "...what annoyed me most in Behe's book: his use of Rube Goldberg cartoons. Ironically, I have often used Goldberg's contrived linkages as examples of how evolution works" (Doolittle, 1997:5).

The issue of asymmetry warrants further thought. Behe puts it this way: "After defining the term in *Darwin's Black Box*, I went on to argue that irreducibly complex systems are obstacles for Darwinian explanations. An irreducibly complex system cannot be produced directly (that is, by continuously improving the initial function, which continues to work by the same mechanism) by slight, successive modifications of a precursor system, because any precursor to an irreducibly complex system that is missing a part is by definition nonfunctional. However, commentary by Robert Pennock and others has made me realize that there is a weakness in that view of irreducible complexity. The current definition puts the focus on removing a part from an already-functioning system. Thus, seeking a counter example to irreducible complexity, in *Tower of Babel* Pennock writes about a part in a sophisticated chronometer, whose origin is simply assumed, which breaks to give a system that he posits can nonetheless work in a simpler watch in a less demanding environment. The difficult task facing Darwinian evolution, however, would not be to *remove* parts from sophisticated pre-existing systems; it would be to *bring together* components to make a new system in the first place. Thus there is an asymmetry between my current definition of irreducible complexity and the task facing natural selection. I hope to repair this defect in future work" (Behe, 2001:695).

(like a drop of water) such that via strings and pulleys (and the butterfly effect) a set purpose is achieved e.g. the automated scratching of mosquito bites (cf. footnote 45).

But Behe needn't have used the words 'weakness' or 'defect' which of course provided an opportunity too good to miss for the critics who have subsequently attempted to deploy this admission not just against IC but against ID. Oddly enough, the enthusiastic reference to this in *Creationism's Trojan Horse* and Judge Jones' testimony almost hints at relief.[122] Nevertheless, Behe has felt compelled to provide an official explanation where he denies the force given to his words by his critics (Behe, 2006:4). Two problems remain though. First, what Behe is being confronted with is an incongruity in his own particular position which arises as he makes his attempt to incorporate into one theory both ID and Neo-Darwinism together. Behe wishes to make allowance for natural selection to develop and build up certain systems via mechanisms which have no analogues in the world of human built machines. Yet he simultaneously provides for IC in a way which to many thinkers rather seems like an arbitrary imposition from outside science. This is actually a very interesting problem and requires a level of investigation which is beyond the scope of this work. In brief, it can be expressed as a question put to ID asking 'where the line is to be drawn.' The line drawn is the ID demarcation between on the one hand ID-acknowledged micro-evolution which ID agrees[123] does occur due to Neo-Darwinian mechanisms, and on the other hand an ID rejection of other micro-evolution (like a flagellar motor) due to an imposition of what is perceived to be an extra-biological principle. Secondly, an issue which grows out of the previous one is that the definition of IC is *empirically* determined i.e. from observations of machines both mechanical *and biological.* Yet at times it seems that Behe wishes to apply IC in a definitional way and exclude in principle any precursor because *by definition* such a precursor is non functional if it lacks a part.[124]

We feel that the 'weakness' here is that ID critics misunderstand the use of Behe's 'definition' which they read as inferring that IC is a *philosophical* constraint arbitrarily imposed on

---

[122] Of course, as always, there are two perspectives on this. The Neo-Darwinism perspective is that if Behe by self admission expresses a loss of confidence in IC, then perhaps the ID movement will be halted and this will remove the threat to science and progress. What a relief for the Neo-Darwinism camp which understands that the quest for truth and the quest for public confidence are not always won by the same means. From the ID perspective, it looks like the Neo-Darwinism community are pouncing on anything, especially an admission like this, such is their inability to deal with the scientific merit or cogency of IC. By now of course, careful readers will have realised that this latter perspective is skewed.

[123] Not all ID theorists do accommodate Neo-Darwinism at this level or any level.

[124] This is precisely Pennock's objection: "But I'm afraid that Behe is just a bit too swift; his argument is just the same bait-and-switch tactic that IDCs accuse others of using. Look back now to the critical passage where he explains that irreducible complexity can't be reached by a Darwinian process because any precursor which is missing a part is 'by definition nonfunctional'. He baits us in that passage with a conceptual argument: were the mousetrap to lose any of its parts it would not function as a mousetrap, which is indeed true by definition. But then he switches to the *empirical* conclusion, that any irreducibly complex system that lost a part would be nonfunctional" (Pennock, 2000:267).

biology from the outside.[125] This would be reminiscent of Aristotle who believed that women had more teeth than men but never bothered to count them. Of immediate concern is precisely what the term 'outside' is intended to reference. ID insists that it doesn't mean what Judge Jones referred to in the Kitzmiller vs. Dover School District trial as an imposition by fiat[126] on the part of Behe[127] (Jones, 2005:75). This is in essence Robert Pennock's argument in *Tower of Babel* (Pennock, 1999:267). On the contrary, what is being maintained by Behe is that IC is a *universal* principle that, although emergent from empirical observation of human made machines, is nonetheless a principle that should apply across the board. Surely if it is in any way permissible to use mechanistic descriptors of living systems then it should be equally permissible to seek to apply principles of mechanical machines to those same living systems. What is sauce for the mechanical goose is sauce for the biological gander.

So Pennock's accusation that Behe is guilty of bait and switch is not legitimate. Behe has not *baited* with a rationalistic (Platonic?) principle and then *switched* to an empirical principal. All that is happening is that an inductive principle based on empirical observation of machine complexification is being reasonably applied to the realm of living machines. Once again, such an application is all the more reasonable given the obvious machine-like behaviour of the latter evidenced in the use of mechanistic language employed by biologists in their analysis.

---

[125] This is the thinking of Loren Haarsma, a professing Christian and supporter of Neo-Darwinism and who teaches in the Physics Department at Calvin College, USA. He writes: "In the debate over biological evolution, some people have pointed to the analogous features between biological life and intelligently crafted objects, thereby arguing that biological life was crafted and assembled by an intelligent agent. This argument is not strictly speaking scientific. It is a philosophical argument...philosophical arguments have a legitimate role, and sometimes a positive role in science" (Haarsma, 2003:85). Our response is that Haarsma begs the question. He assumes that in the context of evolution what counts as a scientific argument cannot go against the canons of methodological naturalism. Since intelligently crafted objects never occur 'naturally' they can never be the basis of a scientific argument. Therefore, no matter how much empirical evidence one might think one sees in nature in support of mechanism or something like IC, Haarsma enjoys epistemic certainty that such 'evidence' can safely be re-interpreted to fit Neo-Darwinism. Such thinking says Haarsma is merely philosophical which may or may not have any value. A more telling objection has to do with the employment of reverse engineering in biological research. Further, Haarsma's views seem to be ill formed given Ruse's positive exploration of the role machine metaphor in the history of science (see earlier discussion under 2.2.(a)). Finally, my defense of IC as a legitimate property of biological systems should provide an adequate confutation of this line of reasoning.

[126] What is pejoratively called 'fiat' by someone would be called 'definition' by someone else. This happens all the time in science because no-one can work without definitions, and everyone must start somewhere. Robert Rosen's daughter, Judith, writes: "Bear in mind that Robert Rosen defines "machine" in a very particular way. So by that definition, we will never create a living "machine"-- however, that does not mean that he felt it was impossible to create living systems. He told me himself that he was pretty sure he could do it. In that event, what has been created is not "a machine" - regardless of what it is made out of. It's an organism" (Rosen, 2005:1).

[127] Judge Jones writes in his memorandum: "By defining irreducible complexity in the way that he has, Professor Behe attempts to exclude the phenomenon of exaptation by definitional fiat, ignoring as he does so abundant evidence which refutes his argument" (Jones, 2005:75).

There is a double edge to the claim that ID imposes a constraint from the 'outside'. The reverse edge of the blade can cut into Neo-Darwinism too. The force of this can be felt by simply reversing the terms of the question and asking: What empirically established state of affairs is being appealed to if not an *a priori* commitment to naturalistic gradualism in order to invalidate the observation by a biology-trained engineer that a biological system denominated as 'a rotary outboard motor' (even by ID critic Miller)[128] truly displays IC? A highly trained scientific researcher can report that what she sees looks like a machine, functions like a machine, can be analysed with methods consistent with reverse engineering[129], has parts that *conceptually* match human-designed machine parts[130], and observe that the machine is co-ordinated to operate in conjunction with other machines in a highly specified information-rich 'technical'[131] environment. But on the Neo-Darwinism account she is not allowed to conclude that this machine has a designer, because a constraint is imposed from 'outside' that insists that only natural explanations can be invoked for living things. This means that 'genealogical relatedness' is an *a priori* assumption, not something empirically established (Hearn, 1990:1).[132]

Robert Pennock's argument, however, has once again raised the symmetry implications which we expressed previously: mousetraps being top down but biological systems being bottom up. This has value for the debate and should be borne in mind by both ID and Neo-Darwinism, especially to raise awareness that there are philosophical, linguistic and even theological issues that are deeply ingressed on both sides.

In summary we feel that there is warrant in saying that machine language cannot be easily de-clutched from its application to biology merely by highlighting the problem of metaphor. Block diagram correspondence in our view seriously undercuts any dismissal of similarity through Neo-Darwinism appeal to trope failure. Further, dissymmetrical considerations are more apparent than real for the simple reason that these are functions of *a priori* commitments to a metaphysical baseline.

---

[128] Miller at Kitzmiller vs Dover School District trial said: "Some bacteria have little whip like structures called flagellum. You might almost consider them to be outboard motors. And these things whip around at very high rates of speed, and they propel the bacteria through water, or sometimes they pull the bacteria in sort of a screw like motion through the water. So they're marvelous machines. They are acid powered reversible rotary engines. These are marvelous little machines, and they are made of a whole series of protein parts..." (Miller, 2005b).

[129] The ID claim is that reverse engineering is indispensable to molecular biological research i.e. that in fact design (even IC design) is the underlying operating assumption that guides researchers analysing nano-mechanisms.

[130] Rotors, stators, gears, springs, ratchets etc.

[131] Sometime researchers will describe the system as an assembly line, or a factory or a city.

[132] Walter Hearn is pointing out what Denton levels as a criticism .

3.5 Conclusion

The *raison d'etre* of this chapter was expressed at the outset as a bridge that would examine the necessity and legitimacy of mechanistic language used to describe what is observed in living nanosystems. An interdisciplinary dialogue requires that some attention be given to the way language is being used. This remit has been undertaken via a brief overview of Paley's argument, followed by an inspection of the mechanistic language and, by implication, the thought processes of molecular researchers, followed by an analysis of the metaphor problem, leading finally to a consideration of framework assumptions. The mechanistic terminology and engineering approach to molecular biology is remarkable and, as has been argued, a strong indicator of the presence of actual nano-machinery. An examination of the Neo-Darwinian defence of metaphor was shown to weaken in the face of block diagram comparisons where the logic correspondence between formal and living calls for an explanation greater than something based on human subjectivity.[133] The problem of symmetry was addressed where it became clear that foundational assumptions created difficulty for clear, unambiguous communication between positions friendly to IC or hostile to IC. Behe's proposal of IC though empirically defensible nevertheless in his language presupposes an architecturally top down approach, whereas someone like Doolittle or Pennock in defence of Neo-Darwinian processes presupposes an architecturally bottom up approach. However, despite these opposite starting points and resulting communication difficulties, the fundamental *empirical* issue remains: the language of machine bespeaks the reality of machine. If anything, this chapter calls for more attention to the way scientists are speaking and, because of the nature of the nano-world under study, are indeed compelled to speak.

The reference by Ruse to Stegosaurus fins[134] or trilobite eyes are but a few intriguing examples of the unavoidable utility of engineering design for any study of living systems. "The Stegosaurus, a large herbivorous dinosaur of the Jurassic period, had an array of bony plates along its back. Were they a solution to the problems of defence, courtship recognition or heat regulation? An engineering analysis reveals features characteristic of heat

[133] It is at this point that the failure of a dyadic(diadic) epistemology is so luminous. In a dyadic system, there is only knower and known. There is no third entity (e.g. Mind, God etc) in which an external influence can be vested. Aristotelian epistemology thus can only vest mathematics in the knower, since there is no possibility that nature can be mathematical all on its own. Similarly, Ruse has no option but to claim that the similarity between knower-styled-design and known-design is due to something in the language and thinking of the knower viz. metaphor, even if this doesn't make sense in the final analysis. Platonic epistemology is triadic: there is knower, known and Mind(plus Forms). The correspondence between the logic-in-the-knower and the logic-in the-known can readily be ascribed to the action of Mind. Unlike the dyadic system, there is no epistemic incoherence, though the price paid is empirical dissonance with any naturalistic theory.

[134] See the opening reference at the commencement of this chapter.

regulation: porous structure (suggesting a rich blood supply), particularly large plates over the massive part of the body, staggered arrangement along the midline, a constriction near the base, and so on...The question I ask — the question that evolutionary biologists ask — is how did one know in the first place that the fins would or would not be efficient for heat transference? The answer of course is because one has being relying on the metaphor of design. Precisely because one has being thinking of the Stegosaurus' parts as artifacts, that is to say as objects of conscious intention, one has been able to ferret out in which ways they work" (Ruse, 2000:229). In fact, Ruse goes much further and says: "Because, and only because, evolutionary biologists think of organisms as if they were humanly-made artifacts can they produce answers to questions about the ways in which these organisms survive and reproduce.." (2000:230). Biologists and zoologists according to Ruse cannot move science forward unless they approach the objects of their study as though an engineering Mind produced it.

Behe has done just that. He has carefully considered a number of molecular systems from an engineering perspective and discerned a principle (IC) that is entirely consistent with the mechanistic language used by all micro- researchers, and consistent with the mechanistic investigative mindset so necessary to detect the function of various bio-structures. IC finds itself equally fluent in the world of molecular biology as in the world of engineering.

CHAPTER 4

Irreducible Complexity as a design diagnostic in molecular biological systems

> "When watching under a microscope one cannot help but feel that the molecular machines generating such activities must be endowed with unique properties...appearing magical is the way in which protein motors can work with such high efficiency and be carefully tuned to have so many motile properties. These aspects of motor function will no doubt become better understood as the field continues to explore evolution's treasure trove of cytoskeletal motors" (Vale & Milligan, 2000:94).

> "Behe implies that, due to our ignorance, we should declare an end to further research and posit an intelligent designer instead, arguing that we can't conceive of the gradual evolution of these features. But it's too easy to simply declare that we can never understand certain aspects of the natural world because they're too complex. This defeatist approach closes the door on future discoveries. Where would we be in our understanding of the natural world today if the likes of Galileo, Newton, Einstein and Darwin had given up explaining complex problems and instead simply lifted up their hands in defeat, declaring an intelligent designer as the best and only explanation? We would be stuck back in the Dark Ages, that's where" (Smith & Sullivan, 2007:139,140).

4.1 Introduction

The investigation began in chapter 2 with an initial consideration of IC as a machine property within the engineering domain, which was followed by a consideration of the ubiquity and significance of mechanistic language within biology, especially molecular biology.

What will command attention in this chapter is the dialogical value of IC within molecular biology. The question to be asked initially is whether IC is truly defensible in the context of what is believed to be true of Neo-Darwinian processes (see 4.2). The strategy here is threefold: Firstly the clotting cascade, one of Behe's proposed IC systems, will be assessed in the light of Neo-Darwinian thought (see 4.2.1). Secondly, IC will be examined in the context of Darwinian confidence in the ontic status of seriality (see 4.2.2). Thirdly, the strength of exaptation (change of function) as a defeater for IC will be explored (see 4.2.3).

Following that the concern that will be addressed is the nature of the role that IC could perform in molecular research, and by extension to other areas of scientific investigation (see 4.3).

At this point it is worth noting a few caveats before moving further. The first caveat is that many of the systems that are discussed as IC by both sides of the debate do not in fact qualify as IC systems given the criteria laid down by Behe. In fact, IC in the context of living things is only applicable thus far to *molecular biology* and to instances where the parts of the system under scrutiny can be fully specified (Behe, 1996:39,41,46). This needs to be stated

clearly at this junction to quell concerns that the application of IC lacks control. These issues will be fleshed out further on. It should also be said that limiting IC in this way does not entail limiting the *general observance* of machine-likeness to the nano-world, but it does mean that IC as a *formal identification* of machine design is only viable where all the parts and their contribution to function are understood.

The second caveat involves foreclosure on the problem of epistemic dualism. Whereas ID can be accused at times of "dualistic negative deduction"[135] (Bateman & Ellis, 2007:11), IC instead does *not* enjoin an immediate theistic conclusion. Instead, IC arguably leads the investigator to some type of non-dualistic inference. That is to say for any scientist, the suite of options available to explain the aetiology of a system exhibiting IC is far wider than many think, ranging on the one hand from one or more sources located here[136] or elsewhere *inside* the universe,[137] and on the other hand to one or more sources *outside* the universe.[138] This is certainly wider than a crude dualism like 'God' or 'science', and wide enough to include some very real extra-terrestrial possibilities.[139]

It might be objected that life elsewhere would be incompatible with life here. This could be answered by noting strong common denominators: the general agreement that a search for life elsewhere should involve a search for water, and by noting that for Richard Dawkins, re-runs of evolution on this planet show that the process has "inherent reproducibility" (Dawkins,

---

[135] 'Dualistic' because the investigator is presented apparently with one of two choices: God or science; 'negative' because the investigator looks at the evidence and says: "no.. not by natural processes", and 'deductive' in the sense that a rather naive reading of the data appears to leave little room for other conclusions (which on closer inspection, claims Neo-Darwinism, actually is the case) and can therefore support a logical theistic deduction.

[136] 'Here' means here on earth, including the hypothetical possibility of a closed but non-natural aetiological system.

[137] From other cosmic locations (evolution from space - Panspermia - Watson and Crick).

[138] God or gods (speaking from a logical perspective).

[139] If astrobiology and the search for extra-solar planets has a rational underpinning, and if it is genuinely believed that a Martian meteorite could have contained life brought here from the red planet, and if it is mooted that water arrived here via comets, the possibility should not be ruled as inadmissible that certain features of extra-terrestrial life could in fact be integrated in living systems here on Earth and indeed detectable within those systems provided one is willing to look. The meteor discovered in 1984 and named ALH84001 was identified in 1996 as having come from Mars, an identification made via an analysis of gas still trapped in small bubbles in the rock which was then compared with a gas analysis of Martian atmosphere performed by Viking probes. The similarity between the two was felt to be enough to conclude that the rock came from Mars. There was dispute over whether the rock showed fossil remains of ancient life from the 4th planet from the sun. The media announcement of this hypothesis was a high profile event, and many scientists like Dr David McKay and Dr Everett Gibson felt convinced enough to say publicly that Martian life could indeed be shown to have arrived here on earth (Thole, 1997:1). President Bill Clinton described it in this way to the world: "Today, rock 84001 speaks to us across all those billions of years and millions of miles. It speaks of the possibility of life. If this discovery is confirmed, it will surely be one of the most stunning insights into our universe that science has ever uncovered. Its implications are as far-reaching and awe-inspiring as can be imagined. Even as it promises answers to some of our oldest questions, it poses still others even more fundamental" (Clinton, 1996:1).

2000:486),[140] a reproducibility enhanced by similar laws of physics present across the universe.[141] What is being said is that current assumptions about evolution would not be able to rule out at least a modicum of compatibility between life here and life elsewhere.[142] If there is some cogency in arguing that "machines are the direct products of living objects, deriving their complexity and design from living objects, and are diagnostic of the existence of life on a planet..." (Dawkins, 1988:2), then IC (if accepted as valid) may have something to say for example about the hypothesis that Darwinian processes have from time to time received assistance from elsewhere. IC as a limit has the potential to support a negative aetiological statement about *certain* molecular machines that entails an origin not due to incremental development over time as postulated by Neo-Darwinism.

This foreclosure on epistemic dualism should therefore calm some of the disquiet regarding IC because it is felt that it is breaking one of the foundational rules of science "by invoking and permitting supernatural causation" (Jones, 2005:64). IC need not be viewed as only and always invoking the supernatural. Instead, IC could be construed as contradicting the hegemony of terrestrial theories of origin. However, the disquiet cannot be fully dispelled given the presence of 'methodological naturalism' which Judge Jones describes as a "...self-imposed convention of science, which limits inquiry to testable, natural explanations about the natural world..." (Jones, 2005:65). This is a different matter since although self-imposed by scientists, methodological naturalism is nonetheless a philosophical principle which in this context understands 'natural' to mean 'terrestrial' and 'Neo-Darwinian'. By this principle, science is by definition disallowed any discovery of extra-terrestrial life among biosystems past and present here on earth. Clearly IC is at odds with this principle when it (IC) is applied to certain living systems and therefore the partial burden of the following discussion

---

[140] Dawkins writes: "By happy accidents of prolonged geographical isolation, Australia, new Zealand, Madagascar, South America , even Africa , furnish us with approximate reruns of major episodes of evolution...as I look at these natural experiments, mostly I am impressed by how similarly evolution turns out when it is allowed to run twice. We have seen how alike *Thlacinus* is to a dog, *Notorcytes* to a mole, *Petarus* to flying squirrels (2004:484)...we dont have to rely on geographical separation as in the Australian natural experiment to study convergence...It has been estimated that the eye evolved independently between 40 and 60 times around the animal kingdom (2004:486)...it seems that life, at least as we know it on this planet, is almost indecently eager to evolve eyes (2004:488)...echolocation...has evolved at least four times: in bats (and different groups of bats have evolved echolocation more than once independently), toothed whales, oilbirds and cave swiftlets...Not as many times as the eye, but still often enough to make us think it not too unlikely that, if the conditions are right, it will evolve (2004:488)...the physics of electricity is the same on all worlds.." (2004:489).

[141] An objection could be raised that transferring evolution elsewhere does not ease the problem since what is deemed to be IC on earth must therefore be IC everywhere. The answer is that an advanced alien biosphere ahead of any local advancements could by virtue of its own genetic engineering have seeded the cosmos (wittingly or unwittingly) with life components, some of which exhibit IC. This argument is not seeking a majority vote not least because the search for extra-terrestrial life has so far yielded nothing. However, in principle all that is required to be shown here is that IC not be seen as offering a crude choice between God or science.

[142] If life began on earth originally with 'seeds' arriving here as proposed by the theory of Panspermia, further postulated arrivals would help explain the leap forward across the difficult boundary from Prokaryota to Eukaryota.

is to investigate whether IC is a viable principle in science, and if so, whether certain naturalistic assumptions should be revised.

Given that IC has arisen in an evolutionary context having been formulated by an evolutionist who remains committed to Neo-Darwinism, there ought to be more evaluation and less rhetoric. There are many instances in the history of science where a knee-jerk reaction has short-changed everyone. Kimura's Neutral Theory for example was rejected initially. Korthof writes: "In the beginning orthodox Darwinists did not exactly like Kimura's theory, because he was telling the scientific community that all-powerful Natural Selection was not so powerful after all" (Korthof, 2007:1).

4.2. IC as a defensible principle within first order science

4.2.1 The clotting cascade as an IC system

In his memorandum Judge Jones in the Kitzmiller vs. Dover School District case in 2005 concluded that "As expert testimony revealed, the qualification on what is meant by "irreducible complexity" renders it meaningless as a criticism of evolution..." (Jones, 2005). Judge Jones reached his conclusions based on some of the arguments laid out below. The Neo-Darwinian scientific community has achieved no small thing in producing a verdict of this nature in court of law where evidence and argument could be weighed fairly. Yet forensic conclusions can only be as good as the evidence subpoenaed. Recognising the apparent impudence in questioning a verdict of this stature, we nevertheless suggest that a close inspection of the nature of the arguments employed do not actually overturn the main thrust of Behe's approach.

We have just been looking at IC as a property of certain mechanical systems. The question to be faced at this junction is whether in fact examples of *biosystems* designated as IC by Behe and others truly do demonstrate this property. Key opponents of ID particularly in the life sciences claim that most or all of these systems can be shown to function with fewer parts. This has the effect of saying that whilst IC is possibly a stable concept in regard to mechanical devices, it is not at all a viable concept in the biological world. The scientific community via its leading journals and associations has officially propagated this conclusion. New Scientist opinion editor Amanda Gefter writes about "...endless discussions in the media about pseudoscientific concepts such as the 'irreducible complexity' of structures like the flagella of bacteria" (Gefter, 2006:53).

In this section and with an eye on the restriction of our discussion to the stability of IC in living systems, we will be considering the establishment response to what Behe had to say about the vertebrate clotting cascade. First we will consider the criticisms leveled at the diagram of the blood cascade in *Darwin's Black Box,* followed by the role of Hageman factor, and finally the issues emerging from fibrinogen and plasminogen deficient mice.

4.2.1.1 Criticism of Behe's diagram

George Acton responded soon after *Darwin's Black Box* was published claiming that Behe had presented an outmoded diagram of the clotting cascade which already by 1992 had been updated and simplified.[143] Acton claims that the only reason Behe used the older version was to manipulate people who are unfamiliar with the cascade into thinking that it was more complicated than it really is and therefore render them more susceptible to the ID thesis. In his opinion, Behe's schematic "has the effect of telling (lay people) that a moderately complex system is totally impenetrable, rather than that it is approachable and comprehensible. It's as annoying as watching someone try to present arithmetic to schoolchildren using Roman numeral notation" (Acton, 1997:2). However, besides the fact that Acton admits that the cascade in its modern presentation is 'moderately complex' (a statement itself that could mean many things), he has not succeeded in showing that Behe has misunderstood blood clotting or that his portrayal of any of the factors as shown is actually wrong. It seems that Acton is of the opinion that if a complex system can be conceptualised or diagrammatised in an easy-to-understand fashion, then in fact, that means that the system is not so complicated after all, and in addition, has therefore opened the way for all of us to see how such a structure could readily have evolved by Darwinian means. That a category mistake is involved is highlighted by the reference to Roman numerals where Acton shows he has shifted the argument to a discussion about adequate nomenclature (we point out that it is virtually impossible, not merely annoying, to do multiplication with Roman Numerals; a very poor choice of illustration to highlight the need for diagrammatic improvement for the clotting cascade) and in so doing evades the point of the discussion which is the stubborn fact that the system as portrayed by Behe does exist. Simplifying the explanation doesn't simplify reality.[144]

---

[143] Acton cites Furie & Furie (NEJM 326:801, 1992).

[144] This actually does raise a separable issue related to what we wish to call 'object-orientated' explanations where underlying complexity is masked by simplified block diagrams or letters of the alphabet as placeholders for complex chemicals like proteins. It is quite easy to say : A changes to B. However, the complexity involved in making that change may be formidable and if properly laid out for careful scrutiny may result in a loss of confidence in a Neo-Darwinian explanation for the change at that point. There is also a related misuse of Occam's razor whereby it is believed that an explanation that does not appeal to a Designer is much simpler and

Acton's chief complaint eventually emerges: it is Behe's refusal to accept homology as knock down evidence in support of Neo-Darwinism. But this complaint doesn't overturn Behe's thesis, and all Acton succeeds in doing is neatly side-stepping the IC problem.

In a non-polemical manner, Miller presents his diagram of the blood clotting cascade (Miller, 2000:1) which admittedly is much simpler than Behe's diagram. Yet his diagram does not show the feedback mechanisms existing in the cascade, mechanisms which naturally complicate any diagram but then again greatly complicate the actual system *in reality*. Nor does he show that Factor VII activates Factor IX (Christmas factor) and not only Factor X (Stuart Factor). There is a trade-off between complexity and comprehension, but then what 'comprehension' means sometimes reflects a prior ideology. ID wishes to adequately portray complexity and invites a 'comprehension' that appreciates how 'not-so-simple' the mechanism is. It should be obvious that in order to demonstrate IC you can't remove too much of the 'C'. Of course, there would be a problem if ID over-complicated or deliberately drew the diagram in order to mislead. But Behe has done neither. On the other hand, Neo-Darwinism wishes to portray the essence of the system simplified as much as possible not just for pedagogic reasons but because a simpler presentation does more readily line up with progressive complexification: the idea of how one thing could be added to another developmentally. Such a diagram invites a 'comprehension' that will more readily accept a Neo-Darwinian explanation.

4.2.1.2 The role of Hageman factor.

There is more to say about diagrams and sub-texts, but we move on now to a similar phenomenon but this time operating via selective quotation. According to Miller, Behe makes a strong claim about the IC nature of the coagulation cascade and the biologist proceeds to cite a few lines from *Darwin's Black Box*: "...none of the cascade proteins are used for anything except controlling the formation of a blood clot. Yet in the absence of any of the components, blood does not clot, and the system fails" (Miller, 2002:1). However, and this is quite significant, in the original description by Behe, this excerpt is preceded nine lines earlier by a limitation: "*Leaving aside the system before the fork in the pathway* where some details are less well known, the blood clotting system fits the definition of IC" (Behe, 1996a:86 ; my italics). In other words, Behe has chosen to look at the cascade from Stuart Factor (factor X) all the way down to the hard form of fibrin, and to view *this* section of the

---

therefore more likely to be true. As an aside the caution of Einstein comes to mind that explanations should be always be as simple as necessary but no simpler.

bigger system as IC simply because not enough is known about the whole.[145] To make sure no-one overlooks this, Behe repeats himself further down that same page listing the components beyond the fork that will be considered as the IC core. That this was clearly in view should have been obvious from the moment Behe begins his description of the cascade several pages earlier because he starts with Stuart factor (Behe, 1996a:82). He specifically excludes from the IC discussion upstream cascade elements like the Hageman factor.

Yet in a public debate with Behe, Miller said: "Now here's the...hard part for me. Remember you said, in the absence of any of the components, blood does not clot and the system fails. One of those components that you've talked about[146] is called factor XII or Hageman factor, and you'd think, if we take it away, the system should fail, so there shouldn't be any living organisms that are missing the Hageman factor, but it turns out,...Lo and behold, that there are some organisms that are missing Hageman factor, I've crossed them off up there, and those organisms turn out to be, dolphins and porpoises,...I assume that statement therefore is incorrect[147] and has to be changed. "A few minutes later Miller concludes this point in the debate by saying: "Okay...so again, your use of that as an irreducible complex system breaks down upon inspection" (Miller, 2002:1). Yet Behe had clearly stated that the section of the clotting cascade he was denominating as IC would *exclude* the factors from Hageman to Factor VIII. One would think that this would temper the National Center for Science Education's[148] enthusiasm in touting this web page as a triumph of Neo-Darwinism over ID.

Two years later Miller still perpetuates this error in his chapter in *Debating Design.* Miller, apparently oblivious[149] to the fact that Behe had carefully delimited the cascade section to exclude the Hageman factor, writes: "...as we have seen , the claim that every one of the components must be present in order for clotting to work is central for 'evidence' for design. One of those components...is factor XII which initiates the cascade. Once again, however, a nasty little fact gets in the way of ID theory. Dolphins lack factor XII...yet their blood clots perfectly well. How can this be if the clotting cascade is indeed IC? It cannot of course, and therefore the claim of IC is wrong for this system as well. I would suggest, therefore, that the

[145] Saying this does not invalidate supplying a complicated drawing of the whole system since the smaller part exists in a bigger context without which humans cannot survive e.g. mutations in factor 8 and 9 produce haemophilia.

[146] Behe complicated this debate by making an earlier reference to factor XII which made his argument vulnerable to attack by Miller. However, the real debate centres on Behe's layout of the problem in his book.

[147] In the context of the debate Miller appears to have the upper hand due to a technicality viz Behe's reference to factor XII. But the real issue of IC in the blood cascade as laid out in Behe's book.

[148] The NCSE: an American body formed to defend the teaching of evolution in public schools.

[149] Judge Jones in his memorandum for the Kitzmiller vs. Dover School District trial reveals the establishment attempt to get past this by claiming that Behe had redefined the blood clotting cascade so that he could "avoid peer reviewed scientific evidence that falsifies his argument as it was not a scientifically warranted redefinition" (Jones, 2005:77).

real reason for the rejection of 'design' by the scientific community is remarkably simple – the claims of the ID movement are contradicted time and time again by the scientific evidence" (Miller, 2004:94). Unfortunately for Miller, in the rush for 'remarkable simplicity' he undermines the noble science he so desperately wishes to defend. And since Ian Musgrave depends upon Miller, he too weakens his argument as he rushes to defend Russell Doolittle[150] (Musgrave, 2005:1-5). Similarly Pete Dunkelberg's refutation whose argument at this point in our view collapses like a cascade for the same reasons[151] (Dunkelberg, 2003:1). Amazingly, Miller still follows this line of argument in the Kitzmiller vs. Dover School trial in 2005[152] (Miller, 2005b:1). It is also worth noting that it is this conclusion that forms part of Judge Jones' memorandum in the Kitzmiller vs. Dover School trial in 2005[153] (Jones, 2005:77).

It is certainly interesting that Cetacea[154] appear to lack one or more of these contact factors though from an ID standpoint, theorists would raise a flag in regard to the word 'lack' [155] as it carries with it certain assumptions. From an ID vantage point a designer could take a land based animal like *Pakicetus* complete with its fully functioning hemostatic system (with factor XII in place), and then modify the genome to fit the animal for an aquatic environment. Such

---

[150] "Miller has pointed out to Behe that whales and dolphins lack the contact pathway (Hageman factor). Furthermore, puffer fish don't have the pathway either. So two groups of vertebrates can live happily without a major arm of the clotting cascade. Behe has not addressed this. This is a larger omission than Doolittle's" (Musgrave, 2005:5).

[151] "And there is evidence to the contrary: whales, mammals like us, lack a key part called Hageman factor but their blood clots anyway. Under questioning at a recent meeting Behe finally agreed that the cascade is not IC after all. Indeed, Acton gives reasons why he never should have thought so. As far as I know, Behe has not 'done his homework' on any of his examples except the mousetrap" (Dunkelberg, 2003:1). Actually, Dunkelberg has outstanding homework too it seems: the 'recent meeting' referred to is the debate with Miller just dealt with.

[152] Miller answers during the trial: "...reference to an article by Robins, Kasting, and Aggeler from Science Magazine, Volume 166, Page 1420, 1969. And you will note a quotation from the abstract of this article saying, The dolphin intrinsic cascade lacks factor XII, unquote. Now, this is from ancient history, as far as we molecular biologists might be concerned today, because 1969 is pre-molecular. So one might wonder, has that result held up? Also in the lower left-hand corner of the slide I have pointed out that a paper published in 1998 by Semba, et al., confirms using genome analysis, that whale Hageman factor XII basically is now a pseudogene in the whale genome. That's why it is not produced. It is, indeed, missing from the clotting cascade. Whales face many problems on this planet. They're over-hunted, they're over-fished, but they don't have any problems with their blood clotting. So blood clots just fine, despite missing the factor."

[153] Judge Jones writes: "...with regard to the blood-clotting cascade, Dr. Miller demonstrated that the alleged irreducible complexity of the blood-clotting cascade has been disproven by peer-reviewed studies dating back to 1969, which show that dolphins' and whales' blood clots despite missing a part of the cascade, a study that was confirmed by molecular testing in 1998...Additionally and more recently, scientists published studies showing that in puffer fish, blood clots despite the cascade missing not only one, but three parts...Accordingly, scientists in peer-reviewed publications have refuted Professor Behe's predication about the alleged irreducible complexity of the blood-clotting cascade. Moreover, cross-examination revealed that Professor Behe's redefinition of the blood-clotting system was likely designed to avoid peer reviewed scientific evidence that falsifies his argument, as it was not a scientifically warranted redefinition" (Jones, 2005:77).

[154] Whales, dolphins and porpoises

[155] Scott Minnich is comfortable saying that human pathogens like *Yersinia Pestis* have lost biosynthetic capacity altogether even though they have the requisite flagellar genes....(and) has mutations in the flagellar master control operon...*Yersinia Pestis* has a single T insertion in *flhD* causing a frameshift mutation" (Minnich & Meyer, 2004:6). Smith and Minnich restored the full function of this gene by inserting the requisite base pairs.

a process would also entail the retrofit of genes coding for other aquatic necessities such as echolocation.[156] Further to this, hemostasis genes need not be removed but simply switched off either by master control or by interrupting the reading frame.[157] In line with this it would be interesting if further research revealed that these animals have some distinguishing features in their coagulation cascades that necessitate different activation factors, a thought that is unsurprising given the aquatic environment and differences in tissue make-up and so on. Of course, it should not be assumed that Hageman factor functions identically in all species, as some researchers point out (Renne *et al,* 2005:277).[158]

However, having said this, it is noteworthy that Semba *et al* did in fact find Hageman factor in the genome of their whale specimen[159] (Semba *et al,* 1998:1). But the researchers found no *expression* of this gene due to several mutations in the DNA, one of which was a single nucleotide insertion that resulted in a frameshift mutation. The existence of a pseudogene for Hageman factor suggests other possibilities. The archetype whale may have had fully functioning factor XII which has subsequently been lost due to genetic mutation. It would be interesting to see if there are any effects *in vivo* following the artificial reactivation of whale Hageman. Leaving whales and turning to human subjects a few things can be said. For us Hageman factor is certainly not redundant. Although individuals who lack factor XII show no phenotypical defects and surprisingly no noticeable blood clotting defects[160] research nevertheless increasingly pinpoints this contact factor as playing a critical role in the way the cascade regulates thrombin: "...although factor XII appears to be dispensable for normal hemostasis, we have demonstrated a central role for factor XII in pathologic thrombus formation *in vivo*. These findings establish factor XII as a promising new target for

---

[156] All Odontocetes (toothed animals...some whales, dolphins and porpoises) possess echolocation.

[157] Neo-Darwinism often objects at this point that this is suboptimal i.e. that this is not good design and is inconsistent with the expertise one would expect from the kind of intelligent agent ID has mind. This issue will be raised again later.

[158] "We cannot exclude the possibility that there are species specific differences in the functions of FXII. This will be an important issue to resolve, as the models used in our studies are widely used for evaluating the importance of blood and blood vessel constituents to thrombus formation, as well as testing prospective antithrombotic agents. FXII-deficient mice, like their human counterparts, have prolonged aPTTs in the absence of a bleeding diathesis. Furthermore, plasma mixing studies demonstrate that murine FXII functions normally in human plasma in vitro, whereas infusion of human FXII into FXII -/- mice results in a phenotype similar to that of wild type mice in thrombosis models" (Renne *et al,* 2005:277).

[159] In one partial sequence of 5 Kilobase pairs, the result was identical to guinea pig Hageman factor. Semba *et al* then deduced what the original Hageman gene would look like and found that its closest terrestrial homolog belonged to the bovine class (Semba *et al,* 1998:1).

[160] "Surprisingly, factor XII deficiency does not lead to abnormal bleeding, even with major surgical procedures or trauma. Although factor XII is part of the complex coagulation chain, a deficiency of factor XII does not appear to be important in "real life" clotting...It does not cause abnormal bleeding. It has been suggested that people with factor XII deficiency may be at increased risk of forming blood clots in the bloodstream when they are not necessitated i.e. thrombosis, but this suggestion remains unproven...factor XII deficiency is usually discovered by accident in a patient through routine coagulation tests done prior to surgery called PT and PTT. These tests measure the time it takes for a clot to form. In the case of factor XII deficiency, the PTT will be markedly prolonged (i.e. coagulation time will be longer) but the PT will remain normal" (CHS, 2004:2).

antithrombotic therapies that might be associated with low or no risk of excessive bleeding" (Renne *et al,* 2005:159).

We have felt that all of the aforegoing discussion is pertinent (and therefore not to be relegated to an appendix) for the following reasons.

Firstly, it illuminates some of the assumptions associated with interspecies 'evidence' i.e. the fact that certain whales lack Hageman factor is not knock down proof that the human coagulation cascade can do without it.[161] From a Neo-Darwinian standpoint, since the human genome expresses this factor it must have been fixed in the population precisely because it conferred greater fitness *for humans.* To say this differently, the complete blood cascade must be necessary for humans, but not for whales. In any form of bloody competition, natural selection would have eliminated those human individuals with a weakened hemostasis. However, arguing from a Neo-Darwinian perspective, perhaps it is the case that ongoing evolutionary development has rendered Hageman factor somewhat obsolete[162] in the modern coagulation system. Having lost its ancestral potency, perhaps today it only retains vestigial properties. In this case, of course, given that the point at issue is not simply the fine tuning of the hemostatic system, we would want to know whether a factor like Hageman is indispensable. This factor might very well be necessary for fine tuning, but does its absence compromise coagulation? The answer is no, but with a qualification: not in our experience *today,* living in modern human society. With due caution then, one might wish to assert that factor XII only provides fine tuning in the vertebrate clotting system.[163] Given the definition by Behe, it would then have to be conceded that the human clotting cascade *in toto* is not IC because the absence of factor XII does not render the system non-functional. This situation has led thinkers sympathetic to IC to postulate the notion of an 'irreducible core'.[164] It is obvious from the consideration of any diagram of the

---

[161] Renne *et al* quite clearly establish that homozygous and to a lesser extent heterozygous mice lacking Hageman factor do show some protection from arterial thrombus formation. They go on to say that this could be taken to suggest that a partial factor XII deficiency in humans could provide protection from stroke or myocardial infarction. They go on to cite Girolami *et al* who followed 21 patients with severe (homozygous) Hageman deficiency for about 16 years and did not observe a thombotic event" (Renne *et al,* 2005:279).

[162] This line of argument needs to bear in mind that we still do not know the complete picture regarding hemostasis. Renne *et al* write: "Although factor XII is activated by a variety of polyanions, including constituents of the subendothelial matrix, sulfatides, nucleosomes and non-physical materials (glass, ellagic acid, kaolin, cilica) the mechanisms responsible for factor XII activation *in vivo* are unknown" (Renne *et al,* 2005:272).

[163] Renne *et al* point out that for more than fifty years, the "pathophysiologic significance of the factor XII-triggered intrinsic pathway of coagulation has been questioned.. based on the important clinical observation that the hereditary deficiency of factor XII is not associated with abnormal bleeding..." but go on to conclude from their research that "factor XII is essential for contact activation" (Renne *et al,* 2005:278).

[164] It appears that Dembski first raised this idea in 2002 in his book *No Free Lunch*: "A system performing a given basic function is irreducibly complex if it includes a set of well-matched, mutually interacting,

coagulation cascade that since the activation of the system takes place through one of *two* pathways (i.e. extrinsic or intrinsic), what is highly suggestive is that the blood factors beyond this junction (in the common pathway) and which result finally in thrombin generation and fibrin formation are the ones that are truly critical to hemostatic function. If this is the case, then the role of Hageman factor is not a good choice to base a refutation of the IC nature of the clotting cascade.

Secondly, IC itself could be viewed within a particular context. A mousetrap may have all its parts, but if the spring for whatever reason acts too slowly then the mouse will have time to escape. In a blood clotting system, one could crudely require only a certain core of parts to perhaps exemplify IC. But in a real world scenario, certainly on a Neo- Darwinian account, merely having the ability to clot blood might not be good enough. What is needed is a faster clotting time. Now *that* is precisely what the coagulation cascade acquired via its extra contact factors. From this perspective then, one could argue that the removal of one part, of Hageman factor say, would render the system non-functional *as far survivability* is concerned. If a part were added to a mousetrap that had the effect of speeding up the spring that on its own was not able to rotate the hammer fast enough, then that part could not be excluded from IC considerations if *function* were defined as catching mice and not simply hammer action. We suggest that there is more than meets than eye in this line of reasoning especially in the light of research where mice without the crucial clotting protein fibrinogen still could survive surgical incisions in the laboratory because of the action of platelets. A system can appear to retain function under certain conditions (in the lab say) when in fact the reality is that in the norm (or in the wild) the retention of true function would require more than a previously designated minimal core. Had Behe therefore defined the *entire* coagulation cascade as IC (which he did not) then at that point what would have become moot is how to make more precise the criterion 'loss of function' since individuals who lose Hageman factor don't lose full hemostatic function, but are nonetheless compromised as any aPTT test will show.

Thirdly, since human blood clots quite well *without* Hageman factor, it would be interesting to consider why Miller, Musgrave, Dunkelberg and others make no mention of this but instead move our attention to whale hemostasis. Of course, Behe never specified human clotting in *Darwin's Black Box* referring instead only to animal coagulation, so it does make sense on the part of those wishing to rebut the IC claim to look for vertebrate systems that lack some

---

nonarbitrarily individuated parts such that each part in the set is indispensable to maintaining the system's basic, and therefore original, function. The set of these indispensable parts is known as the irreducible core of the system" (Smart, 2003:2).

of the blood factors. However, there is not enough evidence to suggest that Cetacea fair better than humans in this regard (that is, those humans who lack Hageman factor), and it is not known if whales originally had factor XII expressed but are worse off *now* because the gene became corrupted. It certainly could be argued that the animals indeed originally possessed an ancestral form of factor XII owing to the current existence of the Hageman pseudogene (Semba *et al* , 1998:31*)*. Therefore to say as Miller, Musgrave and others do, that because whale and dolphin hemostasis apparently works perfectly without Hageman, that therefore the vertebrate coagulation system is not IC, is to draw too strong a conclusion from too little evidence.

Fourthly, we will shortly be engaging with an argument launched by Dr Russell Doolittle that centres on how genetic shuffling can result in an apparent Neo-Darwinian improvement, an idea that has enormous cash value for the New Synthesis. However, precisely what constitutes 'improvement' is open to question. Certainly, homozygous mice lacking factor XII $^{-/-}$ show protection from thrombosis. That is certainly an improvement but in a very narrow way. This is analogous to the protection from malaria enjoyed by those who possess the heterozygous gene that produces sickle cell anemia. Similarly, the heterozygous gene for cystic fibrosis thought to confer protection against cholera (Dawkins 2004:130). Clearly, the 'improvement' comes at an overall fitness cost for these genomes and, in the wild, would be subjected to the weeding out effect of natural selection which would remove these genomes together with their genes from the population.

In summary then, we argue that the refutations of the IC nature of vertebrate hemostasis via an appeal to the role of Hageman in Cetacae do not marshal the knock down power that is required by either ID or Neo-Darwinian community.

4.2.1.3 Fibrinogen and plasminogen deficient mice.

A year after *Darwin's Black Box* appeared, Russell Doolittle published a response in the Boston Review (Doolittle, 1997), particularly taking up with Behe in regard to the way the latter had misrepresented[165] his (Doolittle's) 1993 lecture, and then responding generally to

[165] It is hard to find fault with Behe for not knowing the context which was that the article was originally, as Doolittle explains, a lecture presented to "an audience of mainly clinicians and biotechnologists...hardly conversant in the facts of evolution...(therefore the)...tone was intentionally light and breezy, and...(the) language...casual." (Doolittle, 1997:1). Doolittle admits that it was a talk billed as 'state of the art' and Behe refers to this phrase just once almost in passing, yet Doolittle accuses him of 'reminding his readers over and again that this was a 'state of the art' presentation. Doolittle however did agree to have the article published in the journal *Thrombosis and Hemostasis* and it is *this* journal and *its* readers that Behe is more interested in. Doolittle doesn't even mention the journal except in the source list, harping instead on the inadequacies of the

Behe's claims about blood clotting. Doolittle also spends time discussing gene duplication as a step-wise mechanism for Neo Darwinism, but this we will pick this up again further on.

What is of interest to us at this point is that Doolittle concludes his response to *Darwin's Black Box* by referring to research done on mice. Returning to his eastern religio-philosophical analogy for evolution he writes: "Let me conclude by mentioning that support for the Yin and Yang scenario is now coming from another quarter...Recently the gene for plasminogen was knocked out of mice, and, predictably, those mice had thrombotic complications because fibrin clots could not be cleared away. Not long after that, the same workers knocked out the gene for fibrinogen in another line of mice. Again, predictably, these mice were ailing, although in this case haemorrhage was the problem. And what do you think happened when these two lines of mice were crossed? For all practical purposes, the mice lacking both genes were normal. Contrary to claims about irreducible complexity, the entire ensemble of proteins is *not* needed. Music and harmony can arise from a smaller orchestra. No one doubts that mice deprived of these two genes would be compromised in the wild, but the mere fact that they appear normal in the laboratory setting is a striking example of the point and counterpoint, step-by-step scenario in reverse" (Doolittle, 1997:6).

Once again here is an argument that purports to show that IC is nor a property attributable to living systems. The coagulation cascade says Doolittle, might on the surface appear to be IC, but closer investigation, reveals otherwise.

After a clot has formed and the wound has healed to a certain degree, plasminogen (abbrev. Plg), which is normally an inactive enzyme, is converted to an active form called plasmin which then begins to break down the fibrin strands in the clot. The research article Doolittle refers to is by Bugge *et al* and in their introduction they review previous studies undertaken on mice bred with altered genes so that they either no longer produced plasminogen (Plg) or they produced plasminogen but not one of the activating or inhibiting factors in this sub-

---

international seminar audience, but Behe takes note of the journal's readership who are quite likely to be exactly the sort of people Behe describes them to be *viz*: "...leaders in clotting research (who) know the state of the art". Surely anyone is within their rights to wonder how it can be that a paper published in a peer reviewed journal that seriously (and whimsical Yin and Yang language can still be used in deadly earnest) asks "how in the world did this complex and delicately balanced process evolve...(where)...paradox(ically)...each protein depends on activation by another" and then attempts to answer that question by saying that mechanisms like gene duplication plus chance exon shuffling can account for it." All Behe is saying is that *that* amounts to telling a story and cannot be understood nor accepted as an explanation, still less as a refutation of IC. Doolittle used the Yin and Yang idea in his lecture and takes umbrage over Behe's treatment of it in *Darwin's Black Box*, yet if anything, Behe has improved matters for a more general audience without poking fun at Doolittle or his 1993 lecture. After all, the title of Doolittle's article in the journal was "The evolution of Vertebrate Blood Coagulation: a case of Yin and Yang". Even in his 1997 response to Behe he still uses the language: "Let me conclude by mentioning that support for the Yin and Yang scenario is now coming from another quarter" (Doolittle, 1997:5).

system, or were bred without these in some combination. The researchers report that these mice were "...all born normal in appearance, survived to adulthood, and produced offspring...nevertheless, the consequences of Plg or PA(an activating factor) deficiency are severe and include high mortality, wasting, spontaneous ulcerations throughout the gastrointestinal tract, widespread organ damage, rectal lesions, spontaneous skin ulcerations" (Bugge *et al*, 1996:709). The paper includes a photograph of representatives of the mice, and clearly the mouse without plasminogen is much smaller in size than the control. This points up an interesting feature of most if not all genes in higher organisms: they are pleiotropic. A pleiotropic gene controls more than one feature in the development of the organism e.g. the gene that controls the colour of the mouse coat also has some effect on body size. The pleiotropic effects in the Bugge paper are not just size related, but include wasting and skin defects. The title of the Bugge *et al* paper focuses on this issue of murine pleiotropy: "Loss of fibrinogen rescues mice from the pleiotropic effects of plasminogen deficiency."

What the researchers then go on to report has to do with the action of fibrinogen (abbrev Fib). Fibrinogen, as Kenneth Miller explains so well, is a fibrous soluble protein which could be called 'clot-maker' and which flows around in the in the blood. However it is inactive in that form, but when the enzyme thrombin activates it, it becomes sticky and readily joins with other fibrin molecules to form a fibrous clot.

Behe points out that Suh *et al* (referred to by Bugge *et al*) note that disrupting the gene that produces fibrinogen result in mice that have no clotting, suffer from haemorrhage and experience death in pregnancy. (Behe, 2000a:1). Bugge *et al* do point out explicitly that an "inherent feature of Fib deficiency is haemorrhaging either spontaneously or as a result of injury" (Bugge *et al*, 1996:711).

The interesting part is what happened when mice with disruptions in both genes were interbred. From the Mendelian distribution, offspring were identified that were Plg $^{-/-}$ and Fib $^{-/-}$. The most astonishing thing[166] is that these mice now lacking in both plasminogen and fibrinogen appeared to be rescued from the deleterious symptoms and effects attendant upon having plasminogen deficiency only. There was no longer any premature death, and more surprising still, reasonably quick healing i.e. at much the same rate as Fib$^{-/-}$ mice. Bugge *et al* conclude that to all intents and purposes, these 'double knockout' mice have had

[166] Bugge *et al* present a table showing how, compared to normal mice, there is almost no impact on the haematological profile of any of the three kinds of deficient mice: White blood cells per litre, Red blood cells per litre, Platelets per litre, Haemoglobin percentage etc .. all these are pretty normal. But of course, it all depends on how one is going to score normality.

their 'overall rate of wound healing restored to normal.' However, they also say that all the deficiency groups ($Plg^{-/-}$; $Fib^{-/-}$; $Plg^{-/-}$ / $Fib^{-/-}$) showed "many features of normal repair" including pronounced angiogenesis (blood vessel formation).

Of the many interesting conclusions drawn by Bugge *et al* the one that is most pertinent for our current discussion is when they say: "...these data suggest that the absence of fibrin(ogen) in $Plg^{-/-}$ mice dramatically increases survival but leaves the mice with the same health and reproductive liabilities associated with a total lack of clotting function. The main threat to the health and life expectancy of $Plg^{-/-}$ / $Fib^{-/-}$ mice appears to be the risk of spontaneous or injury-induced haemorrhaging, an inherent feature of Fib deficiency" (Bugge *et al*, 1996:711). Before jumping to conclusions about the inconsistency[167] of top quality research papers, we point out that 'wound healing' can indeed occur in the absence of fibrinogen, because there is redundancy in the system whereby platelets can aggregate and help plug the injury.[168]

This means that carefully made incisions by lab technicians can be healed in these mice, but this notwithstanding their blood cannot clot and so any form of natural injury is extremely deleterious.

A good question to ask at this point is how we are to understand the paradoxical situation that removing a key part in a system results in an improvement, or some restoration of normality? Behe answers this quite adequately and writes: "The probable explanation is straightforward. The pathological symptoms of only-plasminogen-deficient mice apparently are caused by uncleared clots. But fibrinogen-deficient mice cannot form clots in the first place. So problems due to uncleared clots don't arise either in fibrinogen-deficient mice or in mice that lack both plasminogen and fibrinogen. Nonetheless, the severe problems that attend lack of clotting in fibrinogen-deficient mice continue in the double knockouts. Pregnant females still perish. An important lesson exemplified by Bugge *et al.* is that it can be worse for the health of an organism to have an active-but-unregulated pathway (the one lacking just plasminogen) than no pathway at all (the one lacking fibrinogen, which exhibited

[167] Bugge *et al* have just said the mice blood cannot clot, yet they also said that these mice have 'normal' wound healing.

[168] Ian Musgrave explains: "Not only do the $Fib^{-/-}$ mice fail to die catastrophically after birth, but they fail to bleed to death from full skin thickness incisions. Remember, that fibrin is the ultimate product of the clotting pathway, yet these mice are coping well in the laboratory (in the wild they would probably be dead rapidly, researchers with scalpels are kinder than cats, pointy sticks and other natural hazards). Why is this so? Almost certainly because platelets are plugging the blood vessels and slowing the bleeding until ordinary serum proteins glob up. This is of interest because this is basically the mechanism that primitive chordates such as tunicates use" (Musgrave, 2005:1).

fewer overt problems). This emphasizes that model scenarios for the evolution of novel biochemical systems have to deal with the issue of regulation from the inception of the system. Most important for the issue of irreducible complexity, however, is that the double-knockout mice do not merely have a less sophisticated but still functional clotting system. They have no functional clotting system at all. They are not evidence for the Darwinian evolution of blood clotting. Therefore my argument, that the system is irreducibly complex, is unaffected by that example" (Behe, 2000a:3).

We should recall at this junction that when we quoted Doolittle a few paragraphs earlier he had said: "And what do you think happened when these two lines of mice were crossed? For all practical purposes, the mice lacking both genes were normal. Contrary to claims about irreducible complexity, the entire ensemble of proteins is *not* needed. Music and harmony can arise from a smaller orchestra. No one doubts that mice deprived of these two genes would be compromised in the wild, but the mere fact that they appear normal in the laboratory setting is a striking example of the point and counterpoint, step-by-step scenario in reverse."

Ian Musgrave, anxious to defend Doolittle, makes sure the point is amplified: "Plasminogen/Fibrinogen double knockouts gain weight almost at the rate normal mice do, have wound healing almost indistinguishable from normal mice and live for virtually the same time as normal animals. They do have a few pathological changes, but as Doolittle says, "for all practical purposes" these animals are normal...Now, let me emphasize again that these animals fail to bleed to death catastrophically or do any of the horrible things that one would expect from Behe's "irreducibly complex" scenario. As Doolittle says, this shows the Yin/Yang aspect of coagulation, with checks and balances that can be built up step by step" (Musgrave, 2005:1).

It is understood therefore that Doolittle and Musgrave are adamant that the results from the Bugge *et al* paper show that the double knockout mice are normal, and that IC has been defeated. But surely the bar for normality is being set too *low* by Neo-Darwinism here? The analogy with the mousetrap would be to unwind the spring substantially until it had very little ability to store rotational energy. If one lowered the bar of normality one could still call this trap 'normal' owing to the fact that it can still be set and sprung after a fashion. The only problem is that it can no longer kill mice. It has lost primary function.

A mammalian coagulation system lacking plasminogen and fibrinogen cannot do the job. The fact that platelets and serum proteins can plug carefully made incisions is a ridiculous argument and would not be tolerated in any other forum by the Neo-Darwinian camp.

And how could anyone construe the Yin and Yang partnership between Plg and Fig as being anything more than just that...a mutual dependence? It seems quite bizarre that any serious thinker should deem it possible to be able to squeeze from these results any notion of a perichoretic evolutionary dance whereby Yin and Yang produced an upward spiral of partnerships till the whole clotting system was in place. The philosopher Hegel might have appreciated this idea and lent it his endorsement, but empirical science ought to exercise greater explanatory discrimination. The empirical community should recognise that the bar has been set too low.

We claim that Behe is right. The mice are not normal, and that therefore the poetic triumphalism of 'music and harmony from a smaller orchestra' is premature. A violin concerto would not sound normal if a knockout condition rendered all violins without two strings (or worse, without violins at all) and left the orchestra without a conductor. You would certainly get some music and harmony but it would not be a normal rendition of a violin concerto, not by any stretch. Therefore we submit that thoughtful people for the most will not accept the Neo-Darwinian mileage that Doolittle *et al* have attempted to gain from the meagre[169] normality outlined by Bugge *et al.* The mice in their paper are not what Neo-Darwinism should accept as normal for the purposes of *this* scientific discussion.[170] These defective mice will indeed suffer all the horrible things *in the wild* that Musgrave wishes to avoid making the nub of the discussion, because the language of the lab report in Bugge *et al* simply cannot bear the Darwinian weight being placed upon it.

Behe's conclusion is that Doolittle must have misread what Bugge meant by 'normal', and Behe said exactly this in 2000 (Behe, 2000a:2). There was no adequate response from Doolittle, and so Behe repeated this in 2004 in his chapter in *Debating Design* (Behe, 2004:362,363). Subsequently, Ian Musgrave obtained a letter Doolittle had written to Mark Perakh which in essence admits that its author, Doolittle, did make a mistake but then almost incredibly goes on to re-assert exactly what he had maintained all along. This has the effect

[169] Meagre for the purposes of our discussion, not meagre at all in terms of their paper.
[170] It appears that among those who hold to a strong form of Neo-Darwinism there is an unspoken rule which is "never yield an inch". One can understand this mentality to some extent when one considers that creationism has a proven track record of seizing any weakness or admission (or even when it wasn't really either of those) and making it look like Darwinism is an easy push over or that Neo-Darwinism has something to hide, or that in any fair confrontation, Neo-Darwinism will come off second best.

of nullifying the apology. Behe no doubt would have made the issue clear to him in the e-mail, and so what on earth could there be to analogize for if he refuses to change his position? We conclude therefore that Doolittle did not misread Bugge *et al.* Despite being a leading scientist, he *genuinely* thinks and reasons like this.[171]

We have reached the end of this section. For the reasons cited, we conclude that IC is a stable concept in the mechanical domain. However, in regard to the biological world, it is obvious that the matter is highly contentious. In fact, Neo-Darwinism *has* to be totally committed to denying IC as a property of any biological machine at whatever cost. There is a simple reason for this. What is feared is that any admission whatsoever that IC is indeed a property of just *one* of the many marvelous living machines, will be an admission that natural processes are not sufficient to account for the complexity of life, and in addition, an admission that there might well be a Designer. An *a priori* commitment to naturalism or methodological naturalism simply cannot ever allow IC any foothold in biology. Period. However, the conclusion being drawn here is that, on balance, Behe is vindicated and that IC indeed can be predicated of certain biological systems or sub-systems.

4.2.2 The existence of a Neo-Darwinian series as a possible defeat of IC.

Another strategy in contraverting IC claims is the one adopted by Jerry Coyne and is possibly the approach most biologists and zoologists would be more immediately comfortable with. In this case all that is felt to be required to demolish Behe's IC is a simple layout of a

[171] It is not entirely uncommon for a great thinker even in empirical science to continue holding to an idea or interpretation even when it has been pointed out as incorrect. All the more if the stakes are high. Regarding the famous 1927 paper where Heisenberg put forward to the world his uncertainty principle, Mara Beller highlights the mistaken use of his key illustration. Heisenberg exemplified his principle via a thought experiment which entailed a photon colliding with an electron, the resultant radiation being detected by a gamma ray microscope thus revealing the location of the electron, but for the observer a corresponding diminution of ability to calculate its momentum. In fact, "the more precisely the position of the electron is determined, the greater the uncertainty of the discontinuous change in the electron's momentum" (Beller, 1999:71). However, both Dirac and Bohr brought to Heisenberg's attention that the thought experiment was flawed because he had treated both the electron and the photon as particles that lacked any wave attributes. As Beller points out, once you do that, you are back in the classical situation where what you have are point particles obeying conservation laws. In other words, given Heisenberg's experiment, one could in fact calculate the electron's momentum precisely. This is what Compton did, and his 'Compton effect' was more or less what Heisenberg's idea amounted to: the bouncing of light quanta off electrons where there was no resulting indeterminacy, but instead exactly calculable changes. Beller says: "That a physicist of Heisenberg's stature should make such a mistake is odd enough, but his refusal to correct the mistake, despite powerful criticism from Bohr, becomes incomprehensible unless he had a vested interest in preferring a misleading description to the correct one. Schrödinger sought to argue that reality consists of waves and waves only, Heisenberg was now taking the opposite stand - that reality consisted of particles and particles only" (Beller, 1999:73). Beller also notes that 'Heisenberg's misleading analysis is often repeated in popular expositions of the uncertainty principle'. In mitigation it should be remembered however, that Heisenberg's view differs from the Copenhagen position in that he regards either particle or wave as a full description since in his mind light is to be treated as a wave and a particle simultaneously.

developmental series. Coyne selects the emergence of the eye, a choice that emulates Darwin. A sequence of eyes can be constructed beginning with a simple proto-eye of few components (e.g. a pigmented spot as seen in flatworms), followed by a chain of examples of eyes that clearly increase in complexity, till finally at the end of the sequence is placed the camera eye which gives every appearance of being irreducibly complex (Coyne, 2005:30).

Superficially, this arrangement has a number of advantages and much to commend it. Firstly, an actual example of each sequential eye can be in fact be adduced from a life form: we see real eyes in the series as opposed to imaginary ones, and it is not as if there are obvious gaps (especially not for those who subscribe to Neo-Darwinism). Secondly, the series is impressive. Thirdly, a dominant function is maintained throughout *viz.* sightedness. Fourthly, the 'camera eye' at the end of the series gives every indication that it can resist being prized loosed from its position in order to underwrite IC. That is to say, the series itself speaks against IC certainly insofar the operation of natural selection is concerned. Fifthly, such a series not only satisfies a basic naturalistic requirement underpinning scientific explanations, but also forecloses on any consideration of intelligent agency. After all, why would an intelligent designer produce such amazing seriality[172] unless of course that designer were a malicious trickster. This latter consideration has a part to play in the whole debate and will be dealt with further on where a brief analysis will be undertaken of theological arguments deployed in the context of ID.

Before attempting a response to Coyne, it is important that the issue of homology should be raised first. Earlier it was deemed worthwhile exploring the validity of calling certain systems in nature 'machines', and in a similar vein, surely the same could be said of the exercise of *seeing* a system in one organism *to be like* a system in another. Yet there is a crucial difference. The former are deemed similar by analogy *when looking at construction material, mechanical linkage, power source etc.* The latter are deemed similar by something much stronger than analogy, *viz.* homology. In regard to the former, a eubacterial flagellar system may be termed a motor or machine because there is an inescapable identity of function achieved in each through the combined action of inter-related parts. However, since it would be absurd to think that there is any physical relationship or link between artificial machines and biological organisms, the motor designation remains analogical *with respect to aetiology.*[173] For living systems on the other hand, mainstream science long ago moved

[172] So asks Michael Roberts: "Why did God create a succession of forms differing only slightly from previous forms" (Roberts, 2004:277).

[173] Language constraints place us in an invidious position: We wish on the one hand to promote the identity at the level of function (block diagram) between human built machines and biological counterparts and establish a non-metaphorical and real classification of certain living systems as machines; on the other hand, we wish to

beyond analogy to homology, an idea that for biologists entails the expectation of seeing similarity due to an actual physical relationship in history *viz.* Neo-Darwinian evolution. Therefore, a comparison of bone structure in the forelimbs of vertebrates is deemed "a splendid example of homology, (where)...the bones of the upper arms, forearm, wrist, hand and fingers can all be matched, bone for bone, in rat, dog, horse, bat, mole, porpoise, or man. The example is all the more telling because the bones have become modified in adaptation to different modes of life but have retained the same fundamental plan of structure inherited from a common ancestor" (Encyclopedia Britannica quoted by Denton, 1986:144).

Molecular homologist Michael Denton[174] wrote in 1986 that "the phenomenon of homology has remained the mainstay of the argument for evolution right down to the present day" (Denton, 1986:144). The problem however is that "homologous structures are often specified by non-homologous genetic systems and the concept of homology can seldom be extended back into embryology" (Denton, 1986:145). What this means is that despite enormous similarity between two structures in two mature organisms, it is often the case that different genes are responsible; and in regard to tracing their development from the embryo stage "organs and structures considered homologous in adult vertebrate cannot be traced back to homologous cells or regions in the earliest stages of embryogenesis. In other words, homologous structures are arrived at by different routes" (Denton, 1986:146). In fact, for Denton, homology fails to substantiate evolutionary claims. He says that "it is possible that many cases of resemblance in nature which are today classified as homologous and taken by evolutionary biologists as implying descent from a common origin, may turn out to be merely analogous" (Denton, 1986:153).

What this means for Coyne's series is that beneath each step along the way from proto-eye to camera eye, a vertical embryological and ontogenetic sequence ought to be drawn. What will then be made visible is the uncomfortable fact that whilst homology can serve to construct a visually satisfying series of mature forms, it is far more difficult to harness or

---

recognise the many distinctions between mechanical and living mechanisms, not least the lack of common originator i.e. human agency for the former, and non-human (ND would say non-intelligent) agency for the latter. We argue however, that this situation is forced upon us by the Neo-Darwinism insistence on homology as proof (or strong inference) of descent with modification.

[174] It is worth mentioning that contrary to what is popularly believed, Denton has not been discredited as a 'creationist' or involved in crank science. Walter Hearn carefully investigated some of the key criticisms of Denton leveled by Kuehn, Spieth and Thwaites. Hearn found that Kuehn's assertion that Denton made "serious errors of logic, synedoches, direct misquotes, gross factual mistakes and even spelling errors" completely unfounded. Hearn did notice however that Kuehn had missspelt "synecdoches" and wondered if the "gross factual mistake" was Denton's inclination to regard ancestral relationships between species *inferences* rather than *facts.* Hearn writes: "I met Michael Denton at a conference on the information content of DNA...I saw no evidence that he was any kind of 'creationist' or any less competent than his reviewers" (Hearn, 1990:1).

observe a horizontal stratigraphic homology across any of the corresponding forms in the vertical embryological sequences beneath.

The observation that not all biologists are happy with the traditional relationship between ontogenesis and phylogenesis can be gleaned from the literature. An example is the introduction to an impressive study on bats by Adams and Pedersen where they urge their fellow biologists to take a new look: "We are not suggesting that adult biased measures of natural history are in any way invalid, but we consider the inclusion of the ontogenetic perspective essential to understanding fully the many aspects of evolutionary and ecological history" (Adams & Pedersen, 2000:4). These editors titled their introduction 'Integrating ontogeny into ecological and evolutionary investigations' and lament that the "adult is often considered an immutable construct into which all of the various organ systems must somehow be packaged during development" (Adams & Pedersen, 2000:3). What makes for scintillating reading however, is the candid treatment of some of the cladistic problems associated with mega- and microchiroptera.[175] At one point in the book[176] the authors say: "A corollary of the homology concept is that for these structures deemed to originate in common ancestry, they would predictably share both a phylogenetic history and a shared developmental similarity. Within the purview of homology known as phylogenetic homology (based largely upon evidence from the fossil record), the evolution of the calcar[177] and the uropatagial spur is evidently a result of parallelism or convergence. Under the concept of homology known as biological (ontogenetic) homology, the picture remains less clear. Ontogenetic data presented herein demonstrate that the developmental origins of the calcar...and the uropatagial spur are topologically distinctive.[178] If homology were the case,

[175] Bats (chiroptera) are divided into two groups: Megachiroptera which generally do not echolocate and are largely frugivorous (though some eat nectar whilst Microchiroptera echolocate and are largely insectivorous, though some species of this latter sub-order feed on beetles, blood or pollen or nectar or fish (Phillips, 2000:261).

[176] In an essay titled "Ontogeny and evolution of the hindlimb and calcar".

[177] The calcar in Microchiroptera (or uropatagial spur in Megachiroptera) is a structure unique to bats and can be composed of one or more of cartilage, bone or calcified cartilage. Extending from just above the foot of the hindlimb, the calcar (or uropatagial structure) is a spur that supports the trailing edge of a small membrane between hindlimb and body that can be used to catch insects. (patagium = membrane; the uropatagium is a secondary membrane).

[178] Adams and Thibault add: "There are clear distinctions between calcar development patterns in micro and megachiropterans. In fact, differences in calcar position and structure between the two suborders are significant enough to compel some investigators to rename the structure in megachiropterans to highlight its uniqueness versus the microchiropteran condition e.g. 'styliform bone', 'tarsal spine' or 'uropatagial spur'. Renaming the 'calcar' in megachiropterans would inherently imply nonhomology with this structure in microchiropterans. Differences in the megachiropteran calcar in terms of developmental position, apparent lack of calcium investment during development, and it intimate nature with the soft tissue of the gastrocnemius bundle instead of a bony element, support the hypothesis of independent origins for the microchiropteran calcar and the megachiropteran 'uropatagial spur'. Hence the calcar, as currently understood, does not meet the assumptions of biological homology...If the calcar in micro and megachiroptera lacks common ancestry, then the apparent size, shape and function of this structure across suborders must be the result of convergence" (Adams & Thibault, 2000:325-326).

one might expect homotopy[179] of cartilage condensations to be evident in both micro- and megachiropterans, with later relocation of the calcar during growth and development. This ...would support the hypothesis...of evolutionary homology. However, the cartilage condensations of the calcar and the uropatagial spur apparently initiate development in different relative positions..." (Adams & Thibault, 2000:327-329). Once again, ontogenesis undermines the adult character set usually harnessed for creating a phylogenetic series.[180]

Keeping the current discussion centred on bats for a further paragraph simply to buttress this point, it is instructive to consider the controversy surrounding chiropteran monophyly vs. diphyly. Speakman writes: "The idea that bats might be diphyletic did not receive much attention until 1986. In that year Pettigrew (1986a) showed that megachiropterans shared with primates not only penile characteristics but also retino-tectal pathways from eye to cortex, which previously had been considered a diagnostic feature of the primates. Pettigrew (1986a, 1986b) strongly advocated the diphyletic origins of the bats. Evidence supporting this viewpoint accumulated over the next few years, culminating in a major review in which 58 different pieces of morphological data were presented that placed the megachiropterans apart from the microchiropterans and, more importantly, close to the primates (Pettigrew *et al.*, 1989). The brain pathway characteristics, in particular, were considered very unlikely to have convergently evolved, and were also likely to be highly conserved given the embryonic structural reorganization that would be necessary to alter them. At this time, the only data that appeared to favour the monophyletic origins of bats were the structures of the wings, which Pettigrew and colleagues suggested were convergent" (Speakman, 2001:121).

Nancy Simmons explains that Pettigrew's 'flying primate' hypothesis is no longer accepted largely based on molecular studies (Simmons, 2000:17). Yet Pettigrew mounted several well motivated criticisms of such studies. This too is instructive as it highlights the assumptions that undergird all of Neo-Darwinian analysis. The general impression most people have is that the characters chosen for creating a series fit a profile that is true of all characters. However, this is not the case, and enough evidence is always extant for proposing an alternative hypothesis. Speakman adds: "...even if one accepts that bats are monophyletic,

[179] Indicating same place (antonym is heterotopy).

[180] This also has bearing on the ability of the 'blind watchmaker' to tinker. Citing sub-optimality, Neo-Darwinism often attempts to push supporters of design onto a back foot by stating that natural processes do not have the luxury of starting from scratch. Instead, such processes 'tinker' with an existing system to produce a novel one that has (so Neo-Darwinism says) all the hallmarks of non-teleology and sub-optimality. However, as Mike Gene points out, "evolution cannot start over and must work with what it is handed. We've heard much about the suboptimal retina. The reason why random mutations coupled to natural selection cannot "fix" it is because it is essentially hardwired in early embryological development. In other words, "choices" made early on in a progressive march of construction not only lack foresight, but constrain what can happen next. The blind watchmaker can box himself in with each new choice" (Gene, 2002:1).

the morphological evidence linking megachiropterans with the primates remains to be explained, and if convergence of the wing structures of mega- and microchiropterans seems unbelievable, it is scarcely less so than the proposed convergence of brain structures between megachiropterans and primates" (Speakman, 2001:122). Even Nancy Simmons admits that bat diphyly remains popular among some researchers (Simmons, 2000:17) which means not only that both ancestral homology and evolutionary convergence are extremely pliable concepts but also that the determinative character set for phylogeny is not unique. In this example of two opposing positions it is clear that what is homology for the one is convergence for the other and *vice versa.*[181] What is being suggested here goes beyond any chiropteran controversy and highlights the possibility that in the absence of a deeply held commitment to naturalism[182], the plausibility of many phylogenetic trees can be called into question.

A biologist at this point might well attempt to counter this with a reference to *Hox* genes. These are a subset of a 180 gene group called the Homeobox. All multicellular animals from worms to mammals (including insects) make use of a similar or homologous set of genes (Dawkins, 2004:350). *Hox* or body-plan genes indeed provide a striking homology across the animal kingdom where "the genes responsible for laying out the fly's body plan have nearly the identical counterparts in many other animals, ranging from crabs to earthworms to lampreys to us. The discovery came as a surprise, since these animals have such different looking bodies. But now scientists generally agree that the common ancestor of all these animals - a wormlike creature that lived an estimated 570 million years ago – already had a basic set of body-plan genes. Its descendants then used those genes to build new kinds of bodies" (Zimmer, 2006:114). Caution should be exercised regarding sweeping appeals to the power of *Hox* genes to support Neo- Darwinism. In the first place there should be cause for concern that whereas the mature series implies a similar large-scale Neo-Darwinian development across the board inclusive of the genetic level, what is now observed is that there is a largely *unchanged* body-plan structure that has been there from the beginning. In

[181] John Polkinghorne, a professing Christian, theistic evolutionist and also no friend of ID, writes that "It is entirely possible that there are holistic laws of nature of an information-generating kind that are unknown to us today. Stuart Kauffman has suggested that concepts of this kind may be especially significant for biology. He thinks that homologies between species that comparative anatomists study may not always, as conventional Darwinism supposes, derive from a remote common ancestor but may arise from the convergent propensity for natural processes to generate certain specific forms of complex structure" (Polkinghorne, 2004:254). In other words, what is seen by some to be homology, is for others convergence due to an unknown force in nature, a kind of *autopoeisis* (also spelled *autopoesis* - "pattern generating propensities in the whole.. not discernible in the properties of the parts"). He briefly cites Conway Morris at this point.

[182] In his attempt to place Behe in perspective, the editor of *Protein Science* Professor Hermodson quotes Bruce Alberts: "In evolution, as in all areas of science, our knowledge is incomplete. But the entire success of the scientific enterprise has depended on an insistence that these gaps be filled by natural explanations, logically derived from confirmable evidence" (Hermodson, 2005:2215).

the second place, these genes operate at the level of blueprint, a fact which strikes a discordant note given the strong Neo-Darwinian insistence that the problem with Behe-styled mechanistic language is that *contra* ID, living systems are formulated via recipe. The issues surrounding the recipe vs. blueprint metaphors will be addressed in the next section (see 4.2.3.1). At this junction it is pertinent to say that the latter idea is therefore quite obviously not invalidated: it should be noted that blueprint considerations are still very much part of the picture given that the actual spatial arrangement of the *Hox* genes matches the spatial arrangement of the parts of the mature body. In the third place, appeals to *Hox* genes does not address the very real discordances between ontogenesis and phylogenesis.

Behe himself is not opposed to the use of homology. Earlier we cited him saying that "Homologies among proteins (or organisms) are the evidence for descent with modification - that is, evolution" (Behe, 2000:4).[183] But the locus of his concern rests not in the recognition of homology *per se*, but in identifying the actual developmental pathway that would explain the homology. Coyne's approach assumes that the mere fact that a sequence can be "strung together", to use his phrase, means that natural selection must have been operating to produce that sequence, or at least a sequence very much like it, and that therefore the sequence infers a plausible ontological correspondence. For Neo-Darwinism, the very fact that anyone can arrange the evidence to display such exquisite seriality compels belief in an ontological correspondence. Coyne explains: "Darwin brilliantly addressed this argument by surveying existing species to see if one could find functional but less complex eyes that not only were useful, but also could be strung together into a hypothetical sequence showing how camera eye might evolve. If this could be done – and it can – then the argument for irreducible complexity vanishes, for the eyes of existing species are obviously useful, and each step in the hypothetical sequence could thus evolve by natural selection" (Coyne, 2005:30).

Richard Sternberg[184], no friend of ID, raises an interesting and neglected concern, one that arises from his particular discipline. He writes: "Structuralism does...provide an important perspective on the origins debate. Structuralists' lack of commitment to an historical theory of biology allows them to explore the historical evidence more objectively. Moreover, because they focus on formal analysis, structuralists are far more open than Neo-Darwinians to the powerful evidence for continuity within species (forms) and discontinuity between and among species. They also allow themselves to wonder about the cause of the amazing

[183] Not all ID theorists are happy with this of course.
[184] Dr Richard Sternberg holds two PhDs in evolutionary biology, one in molecular (DNA) evolution, and the other in systems theory and theoretical biology.

repetition of forms across the biological world rather than being forced by prior commitments to accept a major Neo-Darwinian epicycle known as 'convergent evolution' " (Sternberg, 2004a:1). The mention of 'epicycle' recalls Ptolemy's 'successful' mathematical modeling of the movement of the planets – successful insofar that the mathematics could predict the motion using circles and epicycles, but nevertheless untrue to the real motion. The term 'convergent evolution' is in Sternberg's view merely an *ad hoc* which does nothing to explain the phenomenon. If anything, it obscures it. But 'convergence' highlights a very real problem for the presentation of a Neo-Darwinian series, a problem which in a paradoxical way is best illuminated by those who seem most comfortable with it. Dawkins writes that the 'eye ' has evolved independently between 40 to 60 times. The word 'independent' really means just *that.* In other words, the proposed Darwinian pathway started from some primitive eye and produced maybe 60 new and separate series resulting in a camera eye for both the frog and the squid.[185] Echolocation, he says, has evolved at least four times: in bats, in toothed whales, oilbirds and cave swiflets. In fact, the general rule is that 'if the conditions are right, it will evolve'. So too with 'true flapping flight' which he says evolved four times. Dawkins calls these natural experiments 'reruns' of evolution (Dawkins, 2004:486-489). What is not explained is what sort of mechanism he has in mind to drive the convergence. After all, in Dawkins' schema, mutation and random processes under the rubric of natural selection (resulting in what some might call an IC system) does not just happen once, but occurs several times in separate independent series where the end result is entirely homologous. To simply call this 'convergent' and think that this will suffice as an explanation is not good enough.[186]

It is problematic to say on the one hand that the homology between a bone structure in two different animals *does* prove descent from a common ancestor, yet the homology between the octopus eye and mouse eye *doesn't* say anything about a common ancestor (since there is no common ancestor for both that has a camera eye), but instead proves 'convergence'. The epistemic warrant for knowing what homology in and of itself proves does not come from

[185] Dawkins writes: "Eyes in the sense of sophisticated image-forming equipment, have evolved many times independently, sometimes converging on similar designs, sometimes coming up with radically different designs" (Dawkins, 1996:128).

[186] If this were not enough, it is equally extraordinary to hear the claim that a land mammal somewhere was ancestral to the line that gradually returned to the sea to become Cetacea (whales etc), and independently there was a carnivore that was ancestral to another line that gradually returned to the sea to give rise to Pinnipedia (seals etc) , and independently a land animal ancestor that gave rise to the sea order that gradually returned to the sea to give rise to Sirenia (Dugong and Manatee), and similarly for several other animals, including reptiles, though now extinct (though insects did not return). And yet no convergence to fish, but in the case of the dugong and manatee even some resemblance (convergence?) to elephants given their "slightly trunk-like nose and small eyes in a wrinkled face to give them a faintly elephantine appearance" (Dawkins, 2004:187). Dawkins however adds that this similarity is probably an accident. But clearly, evolution cannot repeat a 'form' it had previously...and so even evolution evolves (Dawkins, 2004).

observation alone but from a prior framework. Matters have not changed since the time Dobzhansky wrote that in regard to proving macroevolution it could be "proven or disproven only by inference from the available evidence" (Numbers, 2004:95). If one assumes *a priori* that naturalism can account for all biological systems, then homology can never sound a caution that perhaps something is wrong with the assumption. Abigail Lustig notes that "Darwin took the general principle of homology as a central demonstration of the logic of the argument from design" and writes that "the *one long argument* of the *Origin of Species*...recapitulates both the structure and the content of Paley's work." She opines that in regard to the homology argument "Darwin inverts the logic while leaving the argument intact. Parsimony and reason demand that similarity derive from a common origin, not in the original plan of Creation but in common descent...the argument, however, continues to rely for its strength on what Darwin calls "the ordinary view of Creation" in other words, on a series of assumptions about what God would or would not do. The parsimony and therefore the reasonableness of the explanation by common descent rests upon the reader's judgment of Darwin's own implicit atheological view *vis-à-vis* Paley's theological one" (Lustig, 2004:75).

Some remarks should be made concerning yet another rather uncomfortable feature in connection with homology in Darwinian thought. Homology is keyed into two complementary strands: something that changes and something that remains constant. One observer wrote: "An outstanding problem is...the problem of fixity in evolution. What is it that holds so many groups of animals to an astonishingly constant form over millions of years? This seems to me to be the problem now - the problem of constancy, rather than of change. And here one must remember that the genetic systems which govern homologous structures are continually changing. Thus the control system is continually changing but the system controlled is constant and constant over millions of years. This problem seems to me to stick out like a sore thumb in modern evolutionary theory" (Koestler & Smythies as quoted by Strauss, 2006).[187] Strauss himself concludes his paper by saying that "the irony of Neo-Darwinism is that the entire account of *change* is dependent on the joint *universal* and *constant* operation of *mutation* and *natural selection*"

Coyne states the point of his approach: "We do not know the precise order in which the components of the camera eye evolved – but the point is that the appearance of "irreducible complexity" cannot be an argument against Neo-Darwinism if we can document a plausible sequence in which the complexity can arise from a series of adaptive steps" (Coyne,

[187] Strauss notes that this was "a discussion comment after the contribution of Ludwig von Bertalanffy (Change or Law) in the collection edited by A. Koestler and J.R. Smythies' *Beyond Reductionism* published in 1972 by Macmillan (New York)." Danie Strauss is currently (2007) Professor of Philosophy at the University of the Free State, South Africa.

2005:30). Before we anticipate Behe's reply to this we wish to say that it seems to us that what Coyne submits as a conclusive argument against ID is in essence a creative construct that cannot be backed up by any empirical or even conceptual evidence[188] showing a detailed pathway whereby just one of the 'small adaptive steps' on the way to the formation of the camera eye is explained. It is submitted that human ability to create a series drawn from a range of ancestral forms leading up to the eye (or any such complex system) is no substitute for empirical evidence of actual change. And in addition, one can add to this (picking up on Sternberg's concern) the problem of 'convergence' which in the opinion of many thinkers urges a roving spotlight hunting for the existence of another mechanism or causal agent. It is surely no argument to say that IC is less plausible each time a convergence upon such a system is encountered.

Biologist and philosopher Dr Paul Nelson[189] writes: "Without an evolutionary mechanism[190] to explain how one type of organism becomes another distinctively different organism, there's no reason to believe an apparent continuum of morphology (which a whale fossil sequence is) represents an 'actual' continuum of ancestor descendant or cousin-cousin relationship." (Nelson, 1995). This stands in strong contrast to Terry Gray, a professing Christian and evolutionist: "On the basis of deep homologies we are able to establish relationships between animal phyla. We do not need to know the mechanism of evolutionary change in order to establish the relationship. While no doubt there is much theory involved in establishing evolutionary relationships on the basis of these sorts of comparison, these (homologies) signify in part 'the fact of evolution' versus theories about its mechanism(s). I continue to be amazed at sceptics who point to the Cambrian explosion and the 'sudden' appearance of animal phyla" (Gray, 2003:287).

Behe's overall reply to Coyne would probably be to point out that the Chicago evolutionist had misunderstood IC. Coyne maintains: "We do not know the precise order in which the components of the camera eye evolved – but the point is that the appearance of "irreducible complexity" cannot be an argument against Neo-Darwinism if we can document a plausible sequence in which the complexity can arise from a series of adaptive steps" (Coyne, 2005:13). Behe notes that arguments against a Neo-Darwinian series such as the

[188] This is of course vigorously disputed by Neo-Darwinism. The nature of this dispute will be explored more fully in the course of investigating the next few criticisms of IC, but at issue is the contention that despite an ever closer scrutiny the fundamental point maintained by Behe has not be overturned viz the essential non-existence of a step-by-step pathway either conceptually or empirically determined whereby a biochemical system can be shown to be transformed into an IC system (or what appears to be an IC system).

[189] Paul Nelson is an ID thinker with a Ph.D. from the University Of Chicago Department Of Philosophy.

[190] Neo-Darwinism insists there are mechanisms such as gene mutation, recombination and gene duplication . The latter will be discussed further on.

development of the eye are (in his opinion) not likely to enjoy knock-down cogency for the simple reason that such large scale structures embody enormous complexity for which exact specification of all components is not possible. This is why Behe has defined irreducible complexity in terms of a single molecular system where all the parts are known and their contribution to basic function readily ascertained. Coyne therefore cannot overthrow IC by an appeal to a Neo-Darwinian series for the development of the eye. In order to refute Behe's thesis he ought to construct a series of a molecular precursors to such systems as described in *Darwin's Black Box*. Such attempts have not been forthcoming, neither from Chicago nor from anywhere else.[191]

Of course, few defenders of Neo-Darwinism today would be content to argue this matter only at the level of an observed series in the manner described. Modern argumentation would quickly move to questions concerning similarity and homology at a more detailed anatomical level, or even at the micro level and adduce as possible mechanism phenomena such as gene duplication. In point of fact, this is precisely the domain where IC can be engaged. These concerns will be treated further on.

In summary at this junction, we note that a Neo-Darwinian series *per se* cannot by virtue of its construction defeat the concept of IC. Furthermore, the chiropteran excursus highlights some of the difficulties associated with an over hasty appeal to homology, especially where phylogenetic homology is emphasised at the expense of ontogenetic homology.

4.2.3 The possibility that a change of function invalidates IC

An expected next step in criticising IC as Behe has presented it is to focus on the notion of 'function'. What critics attempt to do here is to show that there are two possible kinds of Darwinian pathways, not just one.[192] Up till now what we've had is the scenario of an earlier

---

[191] Forrest and Gross claim that "Behe does count the steps...in some biochemical processes...but the number of steps to make an eye is *vastly* larger...(and) there is solid evidence...for descent with modification" (Forrest & Gross, 2004:82,83). They then go on to cite Coyne. This is an attempt to overthrow IC by an appeal to macro-evolutionary seriality. It is the same argument that is being currently addressed. In essence it is this: "IC cannot be correct because then evolution at the macro level would be incorrect, and that is impossible. Therefore there must be something wrong with IC."

[192] Dembski calls these two pathways "direct" and "indirect". The former describes one overall function being improved, and the latter a change of function along the way (Dembski, 2004a:296,296). He claims that Behe harnesses IC as a logical point which overturns the "direct" scenario, and harnesses a failure in the literature as an empirical point to overturn the "indirect" scenario. The failure is one where evolutionary biology has not published realistic pathways showing how what appears to be an IC system could have evolved. He writes: "If you look at the best confirmed examples of Darwinian evolution in the literature, what you find is natural selection steadily improving a given feature that is performing a given function in a given way. Indeed the very notion of 'improvement' (which plays such an important role in Darwin's 'Origins of the Species') typically

organism exhibiting dominant function A and then acquiring an additional feature incrementally, and in this way becoming an altered mechanism exhibiting virtually the same dominant function yet improved slightly. We could label this improvement as A_1 (i.e. a relatively ineffective mousetrap A becomes a more efficient mousetrap A_1). This is the first pathway, and it displays at least one unchanged function all the way along. Yet it could also be logically argued that the same earlier organism exhibiting dominant function A also acquires additional structures incrementally, and in this way becomes a precursor to an altered mechanism exhibiting dominant function B (e.g. a spring loaded stun mechanism A becomes less what it was and more on its way to becoming something else *viz.* it begins to evidence function B_1, a functionality that would be ancestral to a new series leading eventually to mousetrap B_n). This is the second pathway and it displays the possibility of a change in function that accompanies certain changes in structure.

Darwin gave expression to this idea in 1859: "We should be extremely cautious in concluding that an organ could not have been formed by transitional gradations of some kind. Numerous cases could be given amongst the lower animals of the same organ performing at the same time wholly distinct functions...thus in the Hydra, the animal may be turned inside out and the exterior surface will then digest and the stomach respire. In such cases natural selection might easily specialise, if any advantage were thus gained, a part or organ, which had performed two functions, for one function alone, and thus wholly change its nature by insensible steps" (Darwin, 1859:220).

4.2.3.1 Difficulties for machine analogies

Philosopher Robert Pennock has argued along these lines (Pennock, 1999:267).[193] So too biologist Kenneth Miller. He has said that that a mousetrap is not irreducibly complex owing to the fact that smaller units of the device could have their own individual functions. For example, he says that the holding bar could be used as a toothpick. Other parts could be used as paperweights (Miller, 2003:2*)*. The key strategy being adopted here is to show that

---

connotes that a given thing is getting better in a given respect. Improvement in this sense corresponds to a direct Darwinian pathway. By contrast, an indirect Darwinian pathway (where function gives way to another function and thus can no longer improve because it no longer exists), though often inferred by evolutionary biologists from fossil or molecular data, tends to be much more difficult to establish rigorously...How does one evolve from a system exhibiting a pre-existing selectable function to a new system exhibiting a novel selectable function? Natural selection is no help here, and all the weight is on random variation to come up with the right and needed medications" (Dembski, 2004a:298).

[193] Pennock writes: "However, even if a system is irreducibly complex with respect to one defined basic function, this in no way implies that nearby variations might not serve other nearby functions. Behe claims that there could never be any functional intermediates that natural selection could have selected for on the way to *any* irreducibly complex system, but he can't get the empirical conclusion from his "by definition" conceptual argument" (Pennock, 1999:267,268).

if it is claimed by supporters of IC that the loss of a part of a complex system causes the loss of the overall function of that system, then the obvious solution to the problem of conceptualising a Darwinian pathway leading to such a system is to propose a series that exhibits a change of function along the way. If the attempt to look backwards in time is blocked developmentally speaking – as indeed it would be from the standpoint of an IC system simply because loss of a part signals loss of function, then perhaps 'loss of function' should be re-interpreted as 'change of function'. If a mousetrap is decomposed[194] i.e. disassembled,[195] and four of its parts re-assembled to achieve a different function (e.g. a cheese tray[196] where the spring-loaded hammer holds the cheese in place), then perhaps the random addition of a holding bar, say, would transform the tray into a trap (function A transformed into function B).

Behe's responds to this and writes "Can we evolve a bicycle into a motorcycle? We can move in the right direction by making the seat more comfortable in small steps, the wheels bigger...but a motorcycle depends on a source of fuel, and a bicycle has nothing that can be

---

[194] This term highlights an issue raised by Weber and Depew: "ID theorists, such as Behe, presuppose that the only possible systems are ones that are highly decomposable. This is implicit in the strong analogy they draw between biological or biochemical systems and man-made machines; the latter presume a linear assembly model of systems...what if natural systems are not strongly decomposable but in fact are generated by and composed of parallel processes...that is why well documented processes such as gene duplication are relevant" (Weber & Depew, 2004:175,176). These authors suggest an inadmissibility of the machine metaphor owing to the differences in construction method/sequence between biological systems and man-made machines. This issue will be raised shortly in connection with both Dawkins and Young regarding blueprint versus recipe. Microbiologist Scott Minnich (an ID supporter) counters this by pointing out that the very method used within much of modern microbiology *viz.* mutagenesis, has as its foundational premise that under scrutiny what can be seen are in fact tiny biological machines capable of decomposition. Put another way, what Minnich is pointing out is that if Weber and Depew are correct, mutagenesis ought to be significantly less successful than it is, if indeed possible at all. We are interested to know if Weber and Depew feel that it is coherent on the one hand to agree to label parts of a flagellar apparatus as 'stator' or 'rotor' or 'universal joint' as virtually everyone does (Neo-Darwinians and ID), and on the other hand to claim as they (Weber and Depew) do that the problem is thinking that biological machines can be decomposable. We do not consider this to be coherent. Surely if one can label the parts of a living system using machine nomenclature (not out of convenience but due to observed function), plus if one damages the gene(s) that controls a certain part and then one grows that system (re-creation or re-assembly) so that the designated part is missing, what else can this be if not an exhibition of the possibility of decomposition. What Weber and Depew are arguing of course is that if we are to concede that a system has been developed in a Darwinian fashion then we must also concede that there is a necessary decoupling of any *a posteriori* logic i.e. any observation of design that a system appears to enjoy, or any deductions arising from the success of mutagenesis are disallowed in aetiological debate. We maintain that this reasoning is flawed on the basis that science does not permit the decoupling of empirical observation from any theory of aetiology. This would amount to an insistence that one is not permitted to observe/interpret data that conflict with the assumptions about phylogenesis. In reality we do not actually see Darwinian evolution (*in silico* bootstrapping notwithstanding), but we do use machine labels for observed parts and we do see laboratory success.

[195] We have deliberately said ' a mousetrap disassembled' and not simply begun with the next sentence and said 'some parts assembled' because there is the danger of begging the naturalistic question. This raises the issue of asymmetry which has been discussed earlier. Since Neo-Darwinism cannot say with certainty precisely how an IC system actually evolved step by step, ID must speak of the disassembly of a discrete system and not assume that Neo-Darwinism is correct by simply adopting the Neo-Darwinian language of assembly. What we have is a mousetrap which as a thought experiment can be dissembled and some of its parts re-configured in a way perhaps analogical to a biological counterpart.

[196] Gregory Petsko's suggestion (2001:2).

slightly modified to become a gasoline tank. And what part of the bicycle could be duplicated to begin building a motor? Even if a lucky accident brought a lawnmower engine from a neighbouring factory into the bicycle factory, the motor would have to be mounted on the bike and be connected in the right way to drive the chain. How could this be done step-by-step from bicycle parts?" (Behe, 1996a:44)

But there are some emergent factors in this discussion which Behe has not fully addressed, at least not in the machine analogy[197]. The first is some kind of recognition of the logical 'distance' from a machine with dominant function A to a machine that has dominant function B_n. Clearly the gap from bicycle to motorcycle is quite big. But what if one chose two machines where the gap is not so big e.g. between a hand held egg whisk and an intermediate which lies serially on the way to a motorised egg whisk. It is precisely at this point that a calculus or logic of machines would be helpful in providing some quantification of this distance in 'machine space'.

The second factor homes in on a very real difference between man-made machines and living ones. To use Dawkin's language, we should consider the difference between a blueprint and a recipe. When it comes to building plans, "there is a one-to-one correspondence between blueprint and building.. Each bit of the blueprint corresponds to a matching bit of the building" (Dawkins, 1988:295). Machines designed by humans usually begin as a sketch, then are detailed on the drawing board and finally laid out in a plan. Biological machines, by contrast, arise via a recipe. A recipe is a set of instructions that deals largely with the collection of ingredients and the carrying out of the procedure for baking. More recently Dawkins has re-expressed this: "Embryonic development is controlled by genes, but there are two very different ways in which this might theoretically happen...as blueprint (or as) recipe. A builder makes a house by placing bricks in positions specified by a blueprint. A cook makes a cake not by placing crumbs and currants in specified positions but by putting ingredients through specified procedures, such as sieving, stirring...textbooks of biology are wrong when they describe DNA as a blueprint[198] to change to

[197] What we are about to mention is the idea of 'distance'. Behe does address the issue of 'logical distance' in biology by accepting that some systems can be changed by natural selection. Behe writes that he can "...happily concede that many biological phenomena *are* explained by natural laws...(and)...agree that beak shape and wing color can change under selective pressure, or that different proteins in the same structural class, such as the alpha and beta chains of haemoglobin, may have arisen through Darwinistic mechanisms" (Behe, 2002:3). In regard to a different issue, Behe does acknowledge that "analogies to mousetraps break down somewhat, because parts of a molecular system have to find each other automatically in the cell. They cant be arranged by an intelligent agent, as a mousetrap is" (Behe, 2004:358).

[198] Further on we will discuss Hox genes which really do tend to conjure up the idea of blueprint, certainly in terms of the mapping from chromosomal arrangement to organism morphology or body plan. One writer in discussing Hox genes says: "One good reason for the conservation of the morphology at the phylotypic stage is

another...analogy...embryos construct themselves by following a sequence of origami folding instructions" (Dawkins, 2004:344).

This point has been made by ID critic Matt Young.[199] He writes: "Airplanes and mousetraps are assembled from blueprints. The arrangement of the parts is not a matter of chance. The locations of many of the parts are highly correlated, in the sense that subsystems such as motors are assembled separately from the airplane and incorporated into the airplane as complete units. All airplanes and mousetraps of a given generation are nominally identical. When changes are made they are apt to be finite and intentional. This is one reason...that Michael Behe's mousetrap as an analogy for an irreducible complex organism is a false analogy. Birds and mice by contrast are assembled from recipes, not blueprints. The recipes are passed down with modification and sometimes with error. All birds and mice of a given generation are different. When changes are made, they are apt to be infinitesimal and accidental" (Young, 2002:3).

Some of Young' assumptions as well as some implications of what he says merit further examination and could be examined at another time (e.g. the role of Hox genes and the fact that for many scientists the Homeobox gene set do indeed appear to act like a blueprint in spite of Dawkin's preference). What requires further consideration at this junction though is the observation that the recipe-styled instruction set for ontogenesis provides for changes in the structure of an organism that have no analogy in the mechanical world. Obviously, this point has to be conceded. There is no 'mousetrap' to model this. In larger animals the inherited DNA, chromosomal recombination, the presence of alleles, the possibility of mutation, environmentally triggered genetic switches, lateral gene transfer and so on result in changes that are measurable and often observable in the make-up of the mature animal. *E.coli* can undergo mutation e.g. a gene that codes for a protein necessary for *E.coli* to detect chemicals can become defective. The cell will still swim normally but does not respond to chemical stimuli (Berg, 1999:2). Of course, such an animal cannot survive and therefore this defective gene will not be passed on, but in higher animals defective gene transmission does happen e.g. sickle cell anaemia in man.

The upshot of all this is that it doesn't appear to make sense to pursue a mechanical analogy if the line of argument traces a developmental pathway of forms that change function as they move from step to step. There is no rational way to argue that an agent in quadrant one

---

that this is when these genes have to interact with one another and other genes to sketch out the blueprint for subsequent development" From Talk Origins http://www.talkorigins.org/faqs/wells/haeckel.html.

[199] Dr Young in 2002 was adjunct Prof of Physics Colorado School of Mines.

attempts to assemble a device like a mousetrap by first thinking about toothpick, then thinking about tie-clips and so on. And of course it is pointless to argue that there is no agent in the mechanical domain[200] because we all know that 'mousetraps' irrefragably involve a human designer. We must remember that in quadrant one it is impermissible to dispense with an intelligent assembler. However, the analogical nexus between mechanical and biological does *not* inhere in *agency*. The nexal loci supervene on the numbers of steps governing function change. It is our contention that the function change is too severe for this mechanism[201] and suggest that mechanical analogies should be dropped *only at this point* (i.e. when considering the function change subsection of the debate).[202]

4.2.3.2 Gene duplication as mechanism

What needs to happen next, then, is for the IC defense to ask what mechanism(s) are being proposed that can account for functional alteration *and* upward complexification as parts change function due to incorporation in different or bigger systems. To express it like this highlights what should be a difficulty for Neo-Darwinism. Since there is no mechanistic analogy there is no easy way of picturing how an upward pathway should exhibit causal development except by appeal to the ridiculous i.e. paperweight, then toothpick, then tie-clip (using Miler's analogy). But we are moving too far ahead. For now, the question centres on what sort of biological mechanism could be proposed to produce functional change. The reply more often than not is: Gene duplication. In essence this is what Doolittle relies on for the evolutionary aetiology of the clotting cascade. He is confident that gene duplication[203] is

---

[200] See chapter 2 for the quadrant analysis.

[201] It might be the case that the proposed analogy is instead a car, where an alternator has its own function, a battery its own function, the brake system its own function. The agent assembles these systems to produce an overall unity with a global function. However, there are obvious problems regarding this choice of analogy if it is hoped that it will demonstrate discrete development in a single system. The whole point about the mousetrap is that the individual parts actually do not have and never had individual stand-alone function (as far as the intelligent assembler is concerned).

[202] Mike Gene writes: "But keep in mind that whenever you are dealing with a machine, it is always going to be possible to imagine the various parts existing without the machine, as long as you keep your explanation vague and are free to imagine simpler states with imaginary selective benefits and *ad hoc* functions" (Gene, 2002:4).

[203] Surprisingly, Miller does not reference gene duplication at all in his contribution to *Debating Design* (Ruse, 2004:81-97) even though he had done so earlier in *Finding Darwin's God* published in 1999 (Behe, 2000a:2). Since at the trial Kitzmiller vs. Dover School District he couldn't remember the names of two publications in which his *Flagellum Unspun* had appeared we can assume that precisely what form his argument took at that point was of little concern to him. Nevertheless, regarding the flagellum, Miller's subsequent approach is to concentrate on examples of what he considers to be an independently functional precursor – the TTSS (the system will be discussed further on) - and having abandoned direct references to gene duplication arguments as a basis for disproving the IC of the blood clotting cascade, turns instead to examples of systems that omit a crucial factor (Miller, 2004:94). Miller cites Hageman Factor XII, a crucial component which initiates the clotting cascade, and points out that it is missing from the dolphin's blood clotting system. Miller's logic is that Behe must be tied down and made to refer to the whole clotting system and not a subset, or irreducible core, a restriction clearly outlined in *Darwin's Black Box*, though in that book, Behe does not actually mention the idea of an irreducible core (he does raise the idea however in *Debating Design* (Behe, 2004:359)), in which case, dolphin blood proves very little. Miller says this is a "nasty little fact" that gets in the way of ID theory. But if it

a mechanism that that can produce the required change of function at a molecular level (Doolittle, 1997:1).

Gene duplication[204] provides enormous utility for evolutionary thought because conceptually it makes allowance for an initially stable retention of function in the original gene, whilst providing for the possibility of novel function appearing in the duplicate gene which might be selected at some point in the future thus eventually bringing about the fixing of a new function in the population. In this way, so the argument goes, what appears to Behe as an irreducibly complex system may in fact have arisen from a precursor or ancestral sequence with changed functions. Andreas Wagner expresses the standard position: "The importance of evolution by gene duplication first forcefully advocated in Ohno's visionary book (Evolution by gene duplication,1970) is now universally accepted. More than a third of a typical eukaryotic genome consists of duplicate genes and gene families. Gene duplications are thus a key force of genome evolution" (Wagner, 2001:237). Confident expressions like this quite naturally provoke empirical questions such as how regularly such duplications are observed. The answer is that gene duplication is estimated to be a rare event probably unobserved by anyone. Nic Tamzek however contradicts this and mentions that "adaptive gene duplication has been witnessed in the laboratory" and he cites two studies to back this up[205] (Tamzek, 2002:1). In following up Tamzek's citation of Brown *et al* to gain clarity on the nature of the gene duplication adduced, it was noted that the three researchers write: "We show here that a strain of yeast that has evolved for 450 generations under glucose limitation has multiple tandem duplications involving the high-affinity hexose transport genes *HXT6* and *HXT7.* Restriction site analysis indicates that the duplicated genes have the upstream promoter of the *HXT7* gene and the coding sequence of the *HXT6* gene. These duplications were likely formed by unequal crossovers between the tandemly arrayed *HXT6* and *HXT7* genes during sister chromatid exchange" (Brown *et al,* 1998:937). Having consulted this paper, two saliencies emerged. Firstly, although 'duplication' of sorts has occurred, the outcome is not quite the same as the situation of a working gene plus a duplicate that may over time acquire a new function via mutation. The recombination of promoters and genetic sequences[206] does not appear to support the kind of neutral gene duplication envisaged in the debate. In other words, Tamzek's citation appears to be irrelevant. Secondly, inspection of this research does not overturn but rather strengthens the

---

were this easy, surely Doolittle, the world authority on blood clotting, would have quickly and decisively pointed out to Behe that Hageman factor XII is not a crucial component, and countered Behe's IC that way. But Doolittle does not pursue this line, perhaps because of the lack of cogency.

[204] Robison explored this too (Robison, 1996:2).

[205] (1) Jelesko, J.G study in 1999 gene duplication in Arabidopsis thaliana; and (2) Brown, & Todd, and Rosenzweig study in 1998 on "duplications of yeast hexose transport genes" (Tamzek, 2002:1).

[206] Complete duplication of the *HXT6* gene in its entirety has not been established with total certainty.

impression that flexibility is inbuilt in the genome. That is to say, the yeast genetic library has switches and 'programming' features that together with natural selection will result in populations that have a slightly altered genome capable of surviving (even thriving) in changing environments.[207] What are correctly labeled as 'unequal crossovers' but ascribed to random events can appear to other readers as better ascribed to the action of some sort of hidden genetic switching. According to Meyer, this may be an occurrence of "what John F. McDonald has called a great Darwinian paradox where genes that vary within natural populations affect only minor aspects of form and function, while genes that govern major changes – the stuff of macroevolution – apparently do not vary, or vary only to the detriment of the organism" (Meyer, 2004:382). What we are saying is that there appear to be controls within the organism allowing genetic flexibility only along certain *loci.*[208] Therefore natural selection can only act on those features that emerge via inbuilt genetic controls, controls that are even equipped to handle horizontal genetic transfer.

Disagreeing somewhat with Tamzek, there are several other thinkers who do not consider gene duplication to be an everyday demonstrable event. Lynch and Conery conclude: "These results suggest a conservative estimate of the average rate of origin of new gene duplicates on the order of 0.01 per gene per million years, with rates in different species ranging from about 0.02 down to 0.002. Given this range, 50% of all of the genes in a genome are expected to duplicate and increase to high frequency at least once on time scales of 35 to 350 million years...The rate of duplication of a gene is of the same order of magnitude as the rate of mutation per nucleotide site" (Lynch & Conery, 2000:1154). Dawkins has this to say: "New genes aren't added to the genome out of thin air. They

---

[207] Brown *et al* conclude by saying that "we observe that when cells of the evolved strain are grown in continuous culture, they are somewhat smaller and decidedly more elongated than are those of the parental strain. The evolved strain therefore shows morphological changes that result in a more favourable surface-area-to-volume ratio for substrate uptake. In addition, although the evolved strain consumes 10% more of the total available glucose than does the parent strain from which it was derived, its yields in cell mass and cell number are 2-fold and 2.6-fold greater, respectively. The evolved strain not only transports limiting substrate more rapidly and to lower steady-state concentrations, but also utilizes that substrate more efficiently in the production of biomass. Further work is needed to uncover the genetic bases for these differences in morphology and substrate utilization efficiency as well as for other, yet-to-be-identified, traits that affect fitness in a constant glucose limited environment" (Brown *et al,* 1998:240). Fitness cost is an issue, and along with it the fact that in other organisms strains do not compete well with the wild type under natural conditions and *natural* selection (Brown *et al* engaged in something more akin to artificial selection).

[208] Holmes writes in New Scientist: "This year...evolutionary biologists were treated to not one but several glimpses of evolution in action right before their eyes. Take the little lizard known as *Anolis sagrei.* When researchers introduced a larger predatory lizard onto the tiny Caribbean islands where they olive, *A.sagrei* immediately began to evolve longer legs for speedier escapes. But then the little lizards learned to flee into the branches of shrubs, where the predator couldn't follow - an within six months evolution had changed tack again to favour shorter-legged lizards, which are better climbers. However, such changes are small beer compared with the hard stuff of evolution: making new species" (Holmes, 2006:20). What is suggested instead is that this response of the genome to its environment is not the same type of evolution (if in fact that is the correct way to describe such changes) as the type envisaged for species change.

originate as duplicates of older genes. Then, over evolutionary time, they go their separate ways by mutation, selection and drift. We don't usually see this happening but, like detectives arriving on the scene after a crime; we can piece together what must have happened from the evidence that remains" (Dawkins, 2004:125). However, exactly what constitutes "piecing together" or "the evidence" depends on whether one subscribes to Neo-Darwinism or some other explanation as we shall see further on. A recent Scientific American article reveals how much weight is placed on gene duplication (or rather in this case gene addition), citing it as a mechanism that could explain how the progenitor of both humans and apes acquired trichromatic colour vision when all mammals possess only dichromatic: "Occasionally in the cell divisions that occur during the formation of eggs and sperms, an unequal exchange of parts of chromosomes leads to the production of a gamete that possesses a chromosome containing extra copies of one or more genes. If subsequent generations maintain these extra genes, natural selection may preserve useful mutations that arise in them...the unequal exchange of DNA in a reproductive cell and subsequent mutation of an extra copy of a gene for a pigment sensitive to long wavelengths resulted in the creation of a second long wavelength sensitive pigment, which had a shift in its wavelength of maximum sensitivity" (Goldsmith, 2006:52).

Gene duplication leads to the formation of pseudogenes, but that is not the whole picture. Gerstein and Zheng explain: "Pseudogenes can be borne in two ways, each of which yields a distinctive facsimile of the original parent gene. Just before dividing, a cell duplicates its entire genome, and during that process, an extra copy of a gene can be inserted into the chromosomes in a new location. Alternatively, a new version of a gene can also be created through reverse transcription: during gene expression, the mRNA is copied back into a sequence of DNA that is inserted into the genome. This process is known as retrotransposition" (Gerstein & Zheng, 2006:33). The action of re-integrating a gene copy into the DNA is made possible by a piece of machinery[209] that behaves like a virus. This 'virus' has the ability to make copies of itself which get inserted into the genome, and apparently, any mRNA strands that happen to be nearby when this machinery is active gets "swept up and retrotransposed as well" (Gerstein & Zheng, 2006:33).

The next question that must be posed is *what* happens to these pseudogenes? The answer is that most of them are disabled through copying errors and are not able to be 'read' by the gene expression machinery in the nucleus. In the literature these pseudogenes are viewed as analogous to fossil evidence. Gerstein & Zheng write:

[209] Called a LINE: Long interspersed nuclear element.

"...once consigned to the genomic junk pile,...pseudogenes are released from...selection pressure and are free to accumulate all kinds of mutations, including changes that would be deleterious to normal genes. Scientists can use this tendency to derive a kind of molecular clock from the nucleotide changes in pseudogenes and use it to study the overall dynamics and evolution of the genome. Tracking the evolutionary path of genes and pseudogenes helps molecular biologists to uncover instances of gene birth and death just as the study of mineral fossils tells paleontologist about the creation and extinction of species" (Gerstein & Zheng, 2006:34).

There are of course all sorts of difficulties that present themselves as they do in any science, and this branch is no exception. Quite often however, the difficulties shine a spotlight on the important role played by the baseline assumptions of the researcher. An example would be when a pseudogene shared by two taxonomically unrelated creatures (i.e. across a biological gap that disallows the possibility of a common ancestor) nevertheless displays a set of similar mutations, a situation that suggests that either pseudogenes are not a dependable marker of common ancestry (thus counting against the idea of a clock), or on the other hand the untenable Neo-Darwinian thought that the two creatures do in fact share a common ancestor.

A specific instance of this emerges from a study undertaken by Inai *et al* in 2003 in regard to the GULO gene. This gene is responsible for *in vitro* synthesis of vitamin C, and is functional in most vertebrates except humans, apes, monkeys and guinea pigs. In the vertebrate exceptions just mentioned, GULO is found only as a pseudogene. Inai *et al* performed an *in silico* analysis comparing DNA sequences for several of the exons from the rat GULO gene with similar exons in the human and guinea pig pseudogene equivalent. They write: "When the human and guinea pig sequences (647 nucleotides total) of the regions of exons 4,7,9,10 and 12 were compared, we found 129 and 96 substitutions in human and guinea pigs, respectively, when compared with rat sequences. The same substitutions from rats to both humans and guinea pigs occurred at 47 nucleotide positions among the 129 positions where substitutions occurred in the human sequences. A high percentage of the same substitutions in the total substitutions (36%) indicates that there were many hot spots for nucleotide substitution throughout the sequences examined" (Inai *et al,* 2003:316).

Several thinkers critical of Neo-Darwinism have cited the study by Inai *et al* as conclusive evidence that pseudogenes can arise from mutational hotspots and that therefore it is illegitimate to view pseudogenes as necessarily showing ancestral descent. As a corollary arising from this study, ID supporter David Keller says: "...some Japanese scientists created

a hubbub with regard to the phylogeny of the GULO gene. They showed that guinea pig and human GULO both shared the same set of mistakes relative to a rat's functional GULO gene. This is troubling since guinea pig ancestors and human ancestors were supposed to have had their GULOs incapacitated independently, and any mutational errors accumulating after that point should have been completely random because natural selection does not operate on nonfunctional genes" (Keller, 2006:154).

It is quite illuminating to peruse Neo-Darwinian answers to the Inai *et al* study. Reed A. Cartwright took the trouble to produce some nucleotide comparisons of his own. He selected rat exon number 10, and using a computer program called Clustal X produced alignments for homologous exons in nine other species including guinea pig and human. From his published table it is quite clear that all nine species have reasonably similar mistakes at set places e.g. position 22 where 7 animals have G instead of the rat A. What is perplexing though, is that Cartwright appears to ignore the issue that guinea pigs and humans have similar substitution errors in pseudoGULO, and instead recasts the problem as requiring conformity of errors across all nine species. This means that he can find only one position (at number 81) that stands out as a shared derived trait. Of course, the reason he conducts his approach in this manner is due to an attempt to invalidate the idea of any kind of hotspot, since hotspots should reveal themselves uniformly at set DNA locations across all the animals. Intriguingly, our scrutiny of the table seemed to suggest precisely this since it is quite evident that certain 'mistakes' are indeed clustered at particular points e.g. 1, 22, 31, 58 etc for most of the nine animals though not every animal at every point. Cartwright then makes the astonishing claim that the methodology of Inai *et al* was flawed because they failed to consider that it is in fact the *rat sequences* that have the accumulated mutations.[210] This supposedly occurred after the rat lineage split off from its ancestral path that later gave rise to guinea pigs. Yet we maintain this to be a form of bait and switch. The really interesting issue that remains unaddressed simply has to be that guinea pig and human GULO have similar 'errors', a situation that could not occur given the radically separate phylogenies advocated by Neo-Darwinism. Diverting attention to the possibility of errors in rat GULO, or to the lack of a spot where all nine animals show uniform divergence simply is not good enough. Quite predictably, Cartwright then attempts to discredit the Japanese lab by saying: "I get the impression that molecular evolution is not its primary research focus. I think this is another example of a biochemist not fully understanding how to study molecular evolution" (Cartwright, 2004:4). Properly interpreted, this statement means that no

[210] This type of reasoning does cause problems because one can never know then in molecular phylogeny whether one is looking at a conserved set of nucleotides or an altered set.

biochemist who is really worth anything would publish any research that attempted to show that there is a problem with the standard theory.[211]

However, we must turn now from such questions about the GULO gene to further thinking about our earlier problem regarding gene duplication. What we need to ask now is the following crucial question: *how* does a duplicated gene actually produce new function? (Behe, 2000a:4). The gene copy of course to begin with is really only just that: a copy. A glance at the literature shows that there is certainly no lack of creativity and imagination in attempting to explain how a degenerative mutation could occur, whereas literature detailing with scientific precision exactly how such new functions *could* arise is hard to come by. For a new function to appear somehow the sequences in the gene must be changed (mutated) to code for a new protein or it must be brought under a different controlling element and made to operate in concert with other genes to produce something new. Precisely how this could happen is evidently not known.

The literature is replete with appeals to gene duplication. One can read how a gene copy in a primitive system can lead to a functional change, be fixed in the population, followed by natural selection, then in those selected systems more gene duplication occurs followed by fixing in the population and so on until a primitive system changes in function in a series until it reaches mature complex system. But what you can never read about is *how* the gene that is copied actually acquires its new function, and how that new function is incorporated into the system. Examples of appeals to gene duplication without any thought to the staggering complexity that is entailed can be found in just about every paper that discusses molecular machinery. For instance, Ronald Vale writes: "...Five cargo-carrying motors emerged in primitive eukaryotes[212] and have been widely used throughout evolution. The complexity of these 'Toolbox' motors expanded in higher eukaryotes through gene duplication, alternative splicing and the addition of associated subunits which enabled new cargoes to be transported" (Vale, 2003:467). The point is that there is common appeal to molecular mechanisms that underwrite novelty without careful explanation anywhere that really shows

[211] This kind of intimidation is rife within the scientific community and takes the form of "agree to the consensus opinion or risk being ostracized". Alan Guth being interviewed in a documentary on the Big Bang aired on DSTV in November 2007 said that nearly all scientists accept the Big Bang theory, therefore the only people who do not are crackpots. The general public go along with this given Guth's status but are unaware of the scientific stature of the sizeable minority of astronomers who do not hold to the Big Bang for good scientific reasons.

[212] This emergence is also a problem. How do motors just emerge? Perhaps this will be alleviated partially should there be a discovery of proto-motors in prokaryotes, but even then the problems will not dissolve.

in a convincing way that those mechanisms can in fact really produce that novelty.[213] Behe calls this 'handwaving' (Behe, 2000a:4).

It is at this point that Dawkins accuses ID of failing in imagination and he has produced a parody of the argument from IC which he calls 'the argument from personal incredulity' (Dawkins, 2004:456). He says that this argument can always be detected from the form:
"I personally cannot imagine a natural sequence of events whereby X could come about. Therefore it must have come about by supernatural means."
However, those who support the IC position are within their rights to formulate a reply for their Neo-Darwinian counterparts which asserts that the latter's argument consistently goes like this:
"I know that nothing in nature need be explained in any way by a designer, therefore I will believe that gene duplication (or any other molecular mechanisms) had to have done the job, even if no one has a clue as to how it could possibly have happened." If a top notch biologist believes that a "...subsequent mutation of an extra copy of a gene for a pigment sensitive to long wavelengths resulted in the creation of a second long wavelength sensitive pigment, which had a shift in its wavelength of maximum sensitivity..." then apparently no-one dares think (or at least say in public) that this might be an example of an argument from general acceptance (if not gullibility). This is the flip-side of the gaps problem. The one side of the debate sees gaps that are too big for science currently to explain, and the other side proposes mechanisms to close the gaps that simply cannot do the job[214].

Jones and Tyler defend Behe's approach by returning to the theme of *Darwin's Black Box* and pointing out that many critics "...miss Behe's key contribution, that molecular biology has opened a window into the operation of biochemical systems in living cells. Many of these systems exhibit features that elude Darwinian mechanisms of evolutionary change. The argument is not from credulity, but from an understanding of how cellular systems operate" (Jones & Tyler, 2005:224).

In essence then, we have found our way back to the baseline. Homologies among sequences across the phyla are surprising and interesting, but one views orthologs

---

[213] This lack of published mechanism is sometimes acknowledged. In 2001 Oxford University Press published *The Way of the Cell* by Colorado State University biochemist emeritus Franklin Harold. Harold is a materialist and no friend of ID. Yet he says: "...we must concede that there are presently no detailed Darwinian accounts of the evolution of any biochemical system, only a variety of wishful speculations" (Behe, 2004:356).

[214] Various ideas have been put forward to 'explain' the gap between prokaryotica and eukaryotica. One or more of these explanations may satisfy those whose requirements are only that it must be a Neo-Darwinian explanation, and must be acceptable to mainstream scientists. Yet gene duplication is not really a Darwinian mechanism per se, and some leading scientists like Margulis are unhappy with all the standard explanations.

differently according to one's baseline whether on the one hand it is naturalism (the normative position for Neo-Darwinism) or on the other a non-exclusive position, one that seeks natural processes but not to the exclusion of the possibility of design adjudged on a case by case basis (Behe's position).

This was the substance of Behe's claim that Neo-Darwinian evolution had not truly published. This evoked an angry response and websites were set up to catalogue all the many papers that mention the higher level explanations which cite mechanisms like gene duplication etc. But on another view, Behe is correct. This is because what *he* is looking for actually hasn't been published to date. The retort at this point is that ID is setting the bar too high. The rejoinder is that Neo-Darwinism sets the bar too low.

In the Forrest and Gross analysis of Behe which relies heavily on the standard critics of ID, they defer to Ken Miller who attempts to refute Behe on this publishing issue by citing several papers that supposedly do document the detailed evolutionary pathways. There are some problems with this. Amazingly, each of the papers Miller refers to were published *after* 1996. Aside from the fact that *Darwin's Black Box* was only published in that year, it strikes us as odd that Miller chose to cite such late publications. After all, if Behe is wrong about the situation, the way to refute him is to compile a huge list of the papers available *prior* to 1996 which clearly lay out a Neo-Darwinian portrayal of the detailed pathways that show step by step evolution. Miller, rather tellingly, couldn't do this. Evidently, this is of little consequence for Forrest and Gross who cite Miller and attempt to soften this problem by saying "to be sure, some of the papers cited here by Professor Miller had not yet appeared when Behe made his charge for the first time as early as 1994" (Forrest & Gross, 2004:75). Actually, not 'some of the papers' but *all* eight[215] were technically out of reach as far as any last minute corrections for *Darwin's Black Box* are concerned. It must be pointed out course, that Forrest and Gross rely on a technicality seized upon by Miller when Behe repeated in 2000 his claim of the failure to publish. It does seem somewhat churlish (if not obscurantist), to attempt to overthrow what is a massive claim by pointing to a handful of papers that emerged in the period *after* 1996 and up to 2000. The second problem is that Miller together with Forrest and Gross appear to ignore any acknowledgment of Behe's claim among *their* scientific peers.[216] The third problem is that the papers that Miller cites still do not satisfy the level of detail that Behe is looking for. Forrest and Gross could have cited just one example from the

[215] Miller cites Musser & Chan (1998); Melendez-Hervia (1996); An unnamed paper in 1999; Huynen, Dandeakt and Bprk (1999); Poole, Jeffares and penny (1998); Alberti (1999); Zhang (2000); Copley (2000)
[216] See previous note for Franklin Harold's admission.

vast literature prior to 1996 showing precisely that Behe is in error at the level specified.[217] Yet they do not do this. Finally, if it could be shown (and we think it can) that Behe was correct in his assertion only up and till 1996, that in itself would be a huge revelation. A watching world which had assumed that many years prior to 1996 the requisite evidence had demonstrated overwhelmingly at every level that the evidence for Darwinian evolution was beyond scientific questioning, now discovers that its champions cannot readily overturn a contrary claim, but must instead resort to 'tactics'.

4.2.3.3 The TTSS as empirical evidence of a functional precursor

A television documentary titled 'The War on Science' was compiled in the aftermath of the Kitzmiller trial and aired in South Africa[218] in November 2006, presumably receiving airtime on many networks elsewhere round the world. All the principle players in the debate are featured including Dr Kenneth Miller who presented the substance of his expert testimony: the existence of a functional precursor to the bacterial flagellum.

The documentary records a presentation given by Miller where he says: "The notion of ID or IC makes a prediction that if ID is the proper explanation the parts of these complex machines should be useless on their own because all the parts have to be there to have any function whatsoever." The narrator then goes on to say that "Miller quickly discovered amongst the scientific literature evidence that challenged Behe. Within the flagellum was a simpler functioning mechanism: a bacterial syringe." Miller continues: "This system is missing 40 of its 50 parts - 80 percent - and it is perfectly functional. So the kindest thing one can say about this claim, which is the essential claim of IC and ID is that it is wrong, it is simply wrong on the basis of the science." The narrator concludes this section by saying: "For Miller the prediction of IC was disproved. The flagellum could be broken down in to other simpler biological mechanisms."

However, contrary to these confident pronouncements, no real proof has been supplied that the bacterial syringe or TTSS[219] is a plausible intermediate on the way to the formation of the bacterial flagellar motor. To see this we outline Miller's argument as follows:
Assumption 1: A TTSS is a fully functional machine;

[217] As noted before, if pushed into a corner, Neo-Darwinism will object that ID has set the bar too high. The retort ought to be that Neo-Darwinism has set the bar too low.
[218] SATV channel 2 aired on 7 November 2006 at 21h30. The duration was one hour.
[219] Type Three Secretory System. The literature sometimes describes a bacterial flagellar motor as a TTSS. Here, however, the terminology will be restricted to the syringe that is used as a virulence pump.

Assumption 2: A TTSS (at least the functional transmembrane portion of the TTSS) consists of a smaller subset of proteins used by the bacterial flagellar motor (bacterial flagellar motor);

Conclusion 1: Therefore a TTSS is merely a flagellum that is 'missing' parts (between 40 or 50 – up to 80%), yet is fully functional.

Conclusion 2: Therefore, IC is disproved

Assumption number one is acceptable though the literature indicates that there is complex relationship between the TTSS and the bacterial flagellar motor or flagellar motor. To begin with, it is important to bear in mind that the bacterial flagellar motor itself harnesses a secretory system which it uses to pump proteins through a central tube to build the flagellum. For this reason Scott Minnich actually calls the bacterial flagellar motor a TTSS. Furthermore, there is evidence that the presence of both systems causes interference and the potential loss of one or the other or both. Evidently there is system regulation controlling both machines, a situation not obviously suggestive of one machine being the precursor of the other (Minnich & Meyer, 2004:4). Assumption number two is problematic. Firstly, the protein subset making up the TTSS can be described as *homologous* to some of the proteins in the basal complex of the motor. Therefore they are not identical, but only display similarity.[220] Yet the impression is created in the public domain that the parts are identical. Matters improve when Miller diagrams the comparison (Miller, 2004:86) yet when he says that there are 'extensive homologies' between these proteins the reader is still left with the idea that they can be treated as one and the same. Furthermore, since the problems with homology are seldom addressed by Neo-Darwinism especially in the context of this debate, the idea is conveyed that similarity always proves a Darwinian relationship. Yet the ontogenesis of the TTSS and bacterial flagellar motor are not identical. It is a persistent and annoying feature of the Neo-Darwinian side of the debate that only mature characters are deemed necessary and sufficient, a feature very evident in the Kitzmiller vs. Dover School District trial.

[220] A careful examination of the precise degree of similarity will not produce the same amount of confidence as displayed by Miller. One researcher writes: "There is yet another interesting aspect to all this. Since evolving from some flagellum, the type III transport system appears to have lost its ability to engage in rotary transport. The flagellar motor is composed of five proteins: MotA, MotB, FliG, FliN, and FliM.it is worth pointing out that the type III systems have no homologs for MotA, MotB, or FliM. The Mot proteins are essential components of the motor, as they are membrane proteins that fulfil two functions: they transport ions to provide the energy for rotation and serve as the stator against which the rotor (FliG, FliN, FliM) moves. What's more, the type III rotor components have significantly changed. The type III homolog of FliN shares sequence similarity only with in its C-terminal 80 amino acids. And the sequence similarity between the FliG homologs are almost non-existent. Furthermore, there have been significant changes in FliF. FliF forms the MS ring (the "mounting plate"), which is associated with and above the C-ring composed of FliG, M, and N. FliF in flagella is composed of 500+ amino acids, but in the type III homolog, both the C- and N-terminal domains thought to be involved in forming the MS ring are missing. All that is left in common between them is a central region of about 90 amino acids" (Gene, 2002:4).

Conclusion number one is hugely problematic. Firstly, even if the proteins were identical, removal of one or more parts from a bacterial flagellar motor would not produce a TTSS. Or to state it in Neo-Darwinian terms: adding parts to a TTSS would not produce a bacterial flagellar motor. The gulf of complexity represents too great a jump, a jump way in excess of the step by step modification envisaged by Darwin.[221] Minnich and Meyer however point out a more severe problem: "Even if all the protein parts were available to make a flagellar motor during the evolution of life, the parts would need to be assembled in the correct temporal sequence similar to the way an automobile is assembled in a factory. Yet to choreograph the assembly of the parts of the flagellar motor, present day bacteria need an elaborate system of genetic instructions as well as many other protein machines to time the expression of those assembly instructions. Arguably, this system is itself irreducibly complex" (Minnich & Meyer,2004:7).

Conclusion number two is therefore completely without support. In fact, Miller could prove Behe correct by removing a part from the bacterial flagellar motor and observing the loss of function. Of course, this raises once again the whole problem of asymmetry and baseline assumptions. A Neo-Darwinian approach would never dream of testing IC *that* way. However, the lack of support for conclusion number two centres on the whole question of homology. The fact that a TTSS is built up from some homologous proteins in no way proves a Neo-Darwinian relationship even though a bacterial flagellar motor itself has a similar export apparatus which is used to build up the flagellum. To further strengthen the case, supporters of IC point to the thirty unique proteins (in addition to those harnessed by the TTSS) that are required to build up the bacterial flagellar motor and have posed the question to Neo-Darwinian supporters as to where they think such proteins could have originated? No answer is forthcoming.

More devastating still is the fact that it is highly likely that given a Neo-Darwinism scenario, a primitive flagellum would have had to have emerged first in the light of the fact that the TTSS is used to pump virulence proteins into a host cell. The reason for saying this is that a bacterium like a *E.coli* is a prokaryotic organism whereas the TTSS is harnessed to inject toxins into a eukaryotic cell. Neo-Darwinian theory is adamant that prokaryotica preceded eukaryotica by millions of years, and since bacterial motility is intimately bound up with chemotaxis and the ability to follow a nutrient gradient, it is highly plausible to envisage the bacterial flagellar motor as a prior machine utilised by bacteria for millennia prior to any

[221] Researchers Gophna, Ron and Graur who are committed to Neo-Darwinism write: "Our analysis indicates that the TTSS and the flagellar export mechanism share a common ancestor, but have evolved independently from one another" (Gophna *et al*, 2003:151). The arguments proffered by these researchers are interesting because they show how one sided Miller's approach is.

TTSS appearance. Top researcher Macnab agrees: "[I propose that] the flagellum is the more ancient device since it exists in bacterial genera that diverged long before eukaryotic hosts existed as virulence targets" (Macnab, 2003:95).

Some researchers have attempted to counter any idea that the bacterial flagellar motor is ancestral to the TTSS or the other way around (Gophna *et al,* 2003:151). Intriguingly, they reject the idea that the TTSS could have been derived from the bacterial flagellar motor for several reasons one of which is that the notion "...runs against the progressionist grain that pervades evolutionary thought since the days of Jean-Batiste Lamarck. As was pointed out by Aizawa: "The flagellum is a beautifully designed architecture almost completed in evolution. Why should those sophisticated skills be abandoned to go back to boring soluble proteins" (Gophna *et al,* 2003:161)? It should be pointed out again that there is no theory-neutral territory from which to evaluate any part of this debate, and that here as everywhere Neo-Darwinism relies heavily on naturalistic assumptions licensed either by aesthetics, philosophical criteria or by historical ascendancy. Most of the support is drawn from molecular sequencing and phylogenetic analysis which is regarded as problematic at this point by other researchers like Nguyen and Macnab. Gophna *et al* write concerning Nguyen: "...despite arriving at similar results, the authors chose not to trust their own findings and reverted to the old dogma[222] of the flagellar progenitor of TTSS...Nguyen and their colleagues resorted to four non-phylogenetic arguments" (Gophna *et al,* 2003:162.) What is not appreciated by Gophna *et al* is that *in silico* tree construction methods e.g. harnessing 16S-DNA is not fully trusted by all in the field. More importantly, the Gophna *et al* study does not truly offer an explanation for the bringing into existence of an ancestral prokaryotic TTSS in the absence of eukaryotic hosts except to posit that perhaps "the historical roles played by ancestral TTSS proteins might have been radically different from the host-bacteria interactions mediated by present type III secretion systems" (Gophna *et al,* 2003:161). It is submitted that this is wishful thinking.

In concluding this section, and *contra* Pallen and Matzke who write: "...from our discussion of sequence homologies and modularity it is clear that designing an evolutionary model to account for the origin of the ancestral flagellum requires no great conceptual leap" (Pallen & Matzke, 2006:6), it is noted here that there remain unbridgeable conceptual problems in laying out a step by step evolving scenario terminating in a bacterial flagellar motor. *Contra*

[222] We point out that Gophna *et al* have no problem with 'old dogma' if it is helpful such as 'the progressionist grain that pervades evolutionary thought since the days of Lamarck' that they cited earlier, but 'old dogma' becomes pejorative if it is a decade old majority opinion that runs counter to their position.

Miller, the TTSS does not readily present itself as a hetero-functional intermediary which by a process of exaptation (co-option) formed the basis of a primitive flagellar motor.

In summary it is concluded that the idea that a system that ID calls irreducibly complex cannot be empirically shown (by gene duplication or any other current mechanism) to have evolved through a series that exhibits function change over its developmental history. It is one thing to insist that the bacterial flagellar motor must have had a precursor (an insistence due to a commitment to naturalism) and quite another to show convincingly that it could have.

4.3 The role of IC within molecular biology

The discussion at this point moves to a contentious issue which centres largely upon a concern for the future of science if a 'religious principle' (*viz.* IC) is re-admitted into the scientific enterprise. In the way many scientists see matters, the success of any empirical endeavour is inversely proportional to the role played by religious explanations (Smith & Sullivan, 2007:140). There is honest anxiety that IC could shut down science by labeling systems as designed and in this way introducing foreclosure on any other possible research thereby cutting off avenues of new discovery.

The strategy in answering this is to place the matter in the context of mainstream resistance to new principles, then examine IC at work in the thinking of a molecular researcher to estimate any constricting effect, and then to analyse IC within the broader context of empirical discovery.

4.3.1 Resistance to new principles

The 'acid test' of any scientific principle is whether it has application in the empirical arena.[223] However, a new discovery or theory may require people to first believe in its efficacy in order for its utility to be appreciated. This might appear to be counter-intuitive until it is remembered that science is undertaken by human beings who harbour under an exterior of professional objectivity all the foibles and frailties of their colleagues in other disciplines. It is especially difficult therefore for a novel regulative formulation like IC to gain acceptance when it appears to contradict an existing overarching canon or rule that is believed to underwrite scientific orthodoxy. An example of this problem was evidenced in the reaction to

[223] This includes the 'thought experiment' which although never receives actuation in physical reality nevertheless can still be regarded as empirical.

Motoo Kimura's theory of neutral evolution[224] proposed in 1969. Korthof explains: "In the beginning orthodox Darwinists did not exactly like Kimura's theory, because he was telling the scientific community that all-powerful Natural Selection was not so powerful after all. Natural selection had its limitations. On the molecular level the power of Natural Selection was greatly minimised, if not banished...Randomness took its place. Molecular variation in proteins and DNA was uncovered that had no influence on the fitness of the individual organism: in other words, is selectively neutral. One could even doubt if Natural Selection was of any importance in the traditional areas of morphology and anatomy" (Korthof, 2007:1).

Writing in 1983 one can gauge from Kimura himself the difficulty and hardship he faced over many years in attempting to persuade the scientific community: "Looking back, I think that it is a curious human nature, that if a certain doctrine is constantly being spoken of favorably by the majority, endorsed by top authorities in their books and taught in classes, then a belief is gradually built up in one's mind, eventually becoming the guiding principle and the basis of value judgment. At any rate, this was the time when the panselectionist or 'Neo-Darwinian' position was most secure in the history of biology: the heyday of the traditional 'synthetic theory' of evolution" (Kimura, 1983:22).

Quite incredibly, Dawkins insists that "I have always had a lot of time for the so-called neutral theory associated with the great Japanese geneticist Motoo Kimura...I positively want such theories to be true...this is because they give us an independent chronicle of evolution unlinked to the visible features of the creatures around us...natural selection is all-powerful with respect to those visible changes that affect survival and reproduction...but...changes that pass right under natural selection's radar...can accumulate in the gene pool...(as an) evolutionary clock[225]" (Dawkins, 2004:374).[226]

---

[224] "Neutral (or silent or synonymous) mutations occur when the change of a single DNA nucleotide (A,T,C,G) within a gene does not affect the sequence of amino acids that make up the gene's protein. And the sequence of amino acids usually determines the 3-D structure of the protein, and that determines the function of the protein in the cell. Remarkably, it has been forgotten by most Darwinists, that Charles Darwin distinguished three kinds of variations: advantageous, deleterious, and neutral. He wrote at the beginning of chapter 'Natural Selection' of his *The Origin of Species*: 'Variations neither useful nor injurious would not be affected by natural selection, and would be left a fluctuating element' " (Korthof, 2007:1).

[225] Dawkins points out that "Kimura himself wasn't particularly concerned with the molecular clock idea" (Dawkins, 2004:375).

[226] The quote by Dawkins is preceded by this admission: "Contrary to my rather ludicrous reputation as an 'ultra-Darwinist' (a slander I would protest more vigorously if the name sounded less of a compliment than it does), I do not think the majority of evolutionary change at the molecular level is favoured by natural selection" (Dawkins, 2004:374).

Some Neo-Darwinians today rate Kimura's proposal as "among the biggest, if not *the* biggest, contribution to evolutionary biology in the past 35 years" (Ridley, 2002:223)[227] and cite the final acceptance of neutral theory as proof that that "a critique of Darwinism is possible" (Korthof, 2007:1).[228] Yet what is forgotten is almost a decade and a half of rejection (a big slice out of a career) because of the hegemony of Neo-Darwinian dogma[229] holding sway among scientists.

The point here is that one cannot always gauge from the reaction of the scientific community to a new principle or theory whether the latter has methodological merit or not since the reaction may in fact be saying more about sociology than about empirical rigour.

4.3.2 IC as the 'bread and butter' of molecular research

In the light of the aforegoing, it is interesting to note that at least one cutting edge researcher claims that IC is the 'bread and butter' of microbiological investigation. Dr Scott Minnich who has probed the inner workings of the bacterial flagellum for thirty years is worth quoting at length: "During the last half-century, it is probably fair to say that we have gained a greater understanding of biology than the entire history of efforts in the preceding millennia. The vast inroads we have made in our understanding of the cell came by techniques essential to a design engineer, not elements derived from the theory of evolution. In particular, the mainstay technique of modern biology has made use of the concept of irreducible complexity of the cell's subsystems. Irreducible complexity, a term coined by Michael Behe in his scientific argument for intelligent design, essentially states that molecular machines are comprised of a core set of components essential for function of that machine. If that component is removed from the machine, there is a resulting overall loss of function. If there is no function then there is nothing to select. In biological terms, irreducible complexity implies that mutations in genes encoding pieces of molecular machinery will yield selectable phenotypes based on this loss of function. It is the process of using mutagenesis and devising genetic screens or selections to identify loss of function that has yielded astonishing

---

[227] Ridley adds that "Mayr dismisses it in a short paragraph, as if it (Kimura's theory) were an elementary conceptual mistake" (Ridley, 2002:223).

[228] Korthof's full quote says: "a critique of Darwinism is possible without being ridiculed or ignored by the scientific community. Kimura's 'Neutral Theory' got a firm place in the standard textbooks" (Korthof, 2007:1). Korthof says from the vantage point of 2007 that there is no ridicule or marginalising, but this would not be true at all of the mainstream reaction for almost two decades from 1969 when Kimura published his ideas.

[229] Korthof writes: "Stephen Jay Gould told an interesting anecdote about Ernst Mayr at a meeting of the Evolution Society. Ernst Mayr attacked the claim that single base mutations in DNA that do not result in a different amino acid are not detected by natural selection (neutral mutations or silent mutations). Mayr claimed that such changes could not, *a priori* and in principle, be neutral. These mutations must have some effect on the organism, perhaps energetic, that selection can "see" even if the coded amino acid does not alter. According to Gould this is a clear example of dogmatism" (Korthof, 2007:1)

findings over the last sixty years. Irreducible complexity of molecular machines is the bread and butter of the modern approach to understanding the cell" (Minnich, 2005b:6).

Minnich is in effect reflecting on the power and utility of an interdisciplinary dialogue between engineering and molecular research. Although IC from a Neo-Darwinian perspective is a negative principle[230] it fosters a positive engineering mindset among those eager to dismantle micro-machinery. Minnich is of course talking about a powerful latency which subsequent to Behe's work can be articulated as the principle of IC. The movement from latency to patency is in Minnich's opinion a huge step forward, since it brings into the open a way of seeing, a clarification of approach and the possibility of a sharpening of methodology. The ability to crystallise in unequivocal terms what the central principle is that guides the laboratory cannot be peremptorily dismissed as the ravings of religion. Certainly in the case of Scott Minnich it cannot be said that IC "implies that, due to our ignorance, we should declare an end to further research and posit an intelligent designer instead, arguing that we can't conceive[231] of the gradual evolution of these features" (Smith & Sullivan, 2007:139,140).

4.3.3 IC in the context of wider scientific research

The fertility of a new principle or idea is not immediately obvious to everyone, and certainly less so if the consensus is lined up against it. IC, although very much maligned, has hidden potential not only for fostering an engineering mindset, but also for producing novel experimental ideas.

For anyone willing to acknowledge the presence of IC in certain molecular biosystems, it is not difficult to imagine analogically the existence of higher order[232] structures which reveal an embedded connection of logical elements. This idea could then coupled with the discussion by Gerstein and Zheng which suggests that pseudogenes can be re-activated "when the organism is challenged by a stressful new environment" (Gerstein & Zheng, 2006:37).[233] Flowing from this, an experiment is conceivable whereby one such structure is chosen e.g.

---

[230] Negative because it contradicts Neo-Darwinian gradualism for the etiology of certain nano-systems

[231] Here again is the tension of imagination. The supporters of IC claim that Neo-Darwinians cannot imagine the incremental development of certain structures *at the level of detail required*, and the supporters of Neo-Darwinism claim that IC brings about a loss of much needed imagination *at the level of commitment to methodological naturalism.* Neo-Darwinians feel that they occupy the scientific higher ground since in their view methodological naturalism actually encompasses the essence of modern science.

[232] Researchers working within molecular biology certainly could consider possibilities at the nano-level.

[233] "Recent hints that not all pseudogenes are entirely dead have been intriguing, and some evidence exists for the possibility of pseudogene resurrection-a dead gene turning back into a living one that makes a functional protein product" (Gerstein & Zheng, 2006:37).

sonar, and then after selecting particular species of birds or bats that do not exhibit that ability, a test is constructed whereby the animals are placed in a breeding program within the confines of a darkened chamber mimicking a cave. The aim of the experiment would be to induce the emergence of sonar in subsequent generations of animals on the premise that an instruction set for creating the needed genes[234] resides within the DNA.

If successful, this experiment does not of course prove IC, or ID. Nor would it disprove Neo-Darwinism *per se*. But the idea for such an investigation (or others like it) is unlikely to emerge from the Neo-Darwinian camp since it would be assumed that such evolution would require a great deal of time to allow for genetic mutations, followed by incremental change selected and fixed in populations and for this to be repeated recursively in a fashion not well suited to the time scales of ordinary human observation. The notion of IC however inclines the researcher to consider that living systems ranging from the molecular all the way to the visible might well be associated with latent genetic instruction sets designed to be activated by particular environmental conditions. This latter assumption would open the door to novel experimentation that operates within reasonable chronological constraints.

4.4 Conclusion

Given the general belief held by the scientific community that IC has been discredited, it was important in this chapter to inspect the nature of the evidence and argument employed by those to whom this community defer in order to rationally uphold this belief. One of Behe's IC candidates, the clotting cascade, was examined and the criticism carefully weighed. On balance, Behe's thesis was argued to be defensible since the principle line of dismissal rests upon Doolittle's appeal to the loss of two 'IC parts' *viz.* fibrinogen and plasminogen, an appeal that looked to the murine hemostasis of the Bugge *et al* experiment as a vindication of Neo-Darwinism. This appeal was shown to be flawed. The notion of seriality was subsequently examined and found to be unable to fully escape artefactual criticism, a point made luminous in chiropteran studies where phylogenetic homology is seen to be in conflict with ontogenetic homology at certain points. The uncomfortable co-relative pairing of homology and convergence, which in the case of Pettigrew could be inverted with equal explanatory power, coupled with the mystery of convergence driven along by an unknown force, was shown to be unable to provide a convincing platform from which to overturn IC. Additionally, since IC is postulated as a principle operating at a molecular level where Neo-

[234] This would add a contribution to the notion that new information does arise as new genes are formed. A controlling principle already present in the DNA that guides such a process would cast a different light on the subject. In this way, both Neo-Darwinism and supporters of IC both have an opportunity to contribute to an understanding.

Darwinian's natural selection has in the eyes of some Darwinists beaten a retreat[235], it makes little sense to postulate Neo-Darwinian precursors to Behe's examples for natural selection to operate on. Exaptation was next explored where perhaps the most serious problems for IC were encountered. However, function change via gene duplication was shown to remain shrouded in unknowns and to lack full specification, perhaps even at times mistaken for genetic recombination. As a mechanism, the proposal of gene duplication has not satisfactorily answered Behe's criticism that much is claimed but not enough defined. The net effect is that IC's status as a scientific principle remains essentially intact.

This chapter began with a quote which stated that "Behe implies that, due to our ignorance, we should declare an end to further research and posit an intelligent designer instead, arguing that we can't conceive of the gradual evolution of these features. But it's too easy to simply declare that we can never understand certain aspects of the natural world because they're too complex. This defeatist approach closes the door on future discoveries. Where would we be in our understanding of the natural world today if the likes of Galileo, Newton, Einstein and Darwin had given up explaining complex problems and instead simply lifted up their hands in defeat, declaring an intelligent designer as the best and only explanation? We would be stuck back in the Dark Ages, that's where" (Smith & Sullivan, 2007:139,140). Clearly, the impression that authors like Smith and Sullivan wish to create is that any first order discovery of design would constitute a great danger for science since that would, in their opinion, incline researchers to give up their hunt for naturalistic first order explanations. The approach of researcher Scott Minnich's contradicts this and shows how seamlessly two very different principles can operate together in the laboratory.

Yet more should be said about the argument regarding the Dark Ages and scientists like Galileo and others. The burden of this chapter has been to show that such an argument in the hands of IC antagonists amounts to little more than a straw man. Although cast as defeatist by Neo-Darwinism, what Behe advocates is actually well placed to strengthen the

[235] It is worth comparing Dawkins with Dorit on this issue. Dawkins writes: "Contrary to my rather ludicrous reputation as an 'ultra-Darwinist' (a slander I would protest more vigorously if the name sounded less of a compliment than it does), I do not think the majority of evolutionary change at the molecular level is favoured by natural selection. I have always had a lot of time for the so-called neutral theory associated with the great Japanese geneticist Motoo Kimura...I positively want such theories to be true...this is because they give us an independent chronicle of evolution unlinked to the visible features of the creatures around us...natural selection is all-powerful with respect to those visible changes that affect survival and reproduction...but...changes that pass right under natural selection's radar...can accumulate in the gene pool..(as an) evolutionary clock" (Dawkins, 2004:374). Yet Dorit in a review of Behe's book in *American Scientist* lists what he considers to be the major flaws in Behe's reasoning, the first of which is the fallacy that "there is a boundary between the molecular world and other levels of organization" (Dorit, 1997:1). Bateman and Ellis explain that what they understand Dorit to be saying is that "Behe cannot argue for evolution at one level (eyes, feathers etc) and then claim to be stumped at the molecular/cellular level. The same rules of natural selection apply at all biological levels, and at the molecular level one may even be able to identify particular genes responsible" (Bateman & Ellis, 1997:9).

overall scientific endeavour. It is all too easy to forget that Galileo and Newton (and Einstein to a degree) subscribed to a view of the world and the universe that expected regularity, formulable laws and mathematico-physico aesthetics precisely because their view of reality took as foundational the idea that the world and the universe were the result of an intelligent designer[236]. These fathers of modern science knew only too well that the real problem of the Dark Ages was not belief in intelligent design, but belief in Aristotelian philosophy.[237] They knew that postulating an intelligent designer never meant the closing down of science or of scientific explanation. On the contrary, it meant the opening up of many new possibilities all underwritten by the confidence of a Mind behind a daunting Nature.

[236] "In his book *The God Delusion*, Richard Dawkins propounds my old position that Einstein was an atheist. In doing so, Dawkins ignores Einstein's categorical statement...that he was neither an atheist nor a pantheist...Einstein clearly believed in a transcendent source of the rationality of the world that he variously called 'superior mind' or 'superior reasoning force'...evident in several of his statements: 'I have never found a better expression than 'religious' for this trust in the rational nature of reality and its peculiar accessibility to the human mind. Where this trust is lacking, science degenerates into an uninspired procedure...everyone who is seriously engaged in the pursuit of science becomes convinced that the laws of nature manifest of a spirit vastly superior to that of men, and one in the face of which we with our modest powers must feel humble' " (Flew, 2007:99-102).

[237] "Perhaps the nadir of...Aristotelianism was reached when Cremonini a leading Aristotelian in Padua refused to look through Galileo's telescope because he suspected that what he saw would conflict with his own theories. In the 17th Century Francis Bacon, Galileo and Boyle developed more general attacks against Aristotelianism, accusing it of resistance to scientific method and empirical observation" (Charles, 1995:51).

CHAPTER 5

Biblical Theology and Design Detection in Creation

> "Copernicus complained that in his day astronomers were so 'inconsistent in these [astronomical] investigations, that they cannot even explain or observe the constant length of the seasonal year.' 'With them,' he continued, 'it is as though an artist were to gather the hands, feet, head and other members for his images from diverse models, each part excellently drawn, but not related to a single body, and since they in no way match each other, the result would be monster rather than man'" (Thomas Kuhn, 1996:145).
>
> "Whenever humans have a good idea, zoologists have grown accustomed to finding it anticipated in the animal kingdom. Examples...include echo-ranging (bats), electrolocation (platypus), the dam (beaver), parabolic reflector (limpets), the infrared, heat-seeking sensor (some snakes), the hypodermic syringe (wasps, snakes and scorpions), the harpoon (cnidarians) and jet propulsion (squids)" (Dawkins, 2004:450).
>
> "The God of the Bible is the God of both creation and revelation. Moreover, humans have been made in the image and likeness of God, and are therefore able to understand the truth that is to be found in the created order. It can be shown that this belief was an important one for the founders of modern science in late medieval Europe. In the light of it, we would expect that what we learn of by the study of the created order will relate in some way to what we learn through the Bible" (Lucas, 2005:143).

5.1 Introduction

Irreducible Complexity as an example of detectable design actually present in the created order raises the question of whether that is the kind of formulation that serious readers of the Bible are led to expect. That question in turn raises the issue of how one should read the Bible. This chapter analyses this nested hierarchy, beginning with the latter question and moving towards the former.

The approach adopted here for reading the Word of God is one that seeks a single story encapsulating the flow of the Bible, and one that could provide epistemic utility for empirical study. The possibility of narratival unity and development is strongly connected to Biblical Theology which, as a technical discipline interested in longitudinal themes from Genesis to Christ, has the potential to clarify such issues. An attractive concomitant is the diminution of argumentation focused solely on Genesis, thus setting the scene for creational observations flowing from the entire sweep of revelation, culminating in a New Testament perspective.

After noting the scriptural inference to observable design, two examples (in addition to that of irreducible complexity) are adduced to buttress the notion of detecting design in a formal manner. In this way, it is hoped that a rationalistic or Platonic reading of phenomena is seen to have been avoided and that what is being advocated is, therefore, not a case of putting on Biblical spectacles but, instead, a case of taking note of first-order formalisms that are truly empirically present in nature for anyone to investigate. In this way, there is a drawing together of narrative and creation; between this particular unique story and ontology.

This investigation reaches its terminus in the examination of a scriptural test case where the question asked is whether there exists a canonical text incorporating an appeal to extra-biological design and which is observable via the way that parts make up the whole.

5.2 Background

Many people would anticipate an approach to a dialogue that touches on science and theology as one that inevitably works its way towards reconciling the Book of Genesis with Neo-Darwinism. By contrast, a Biblical Theological approach, whilst not wishing to marginalise Genesis at all, is instead more caught up with the overall narrative of the scriptures and with the possibility of finding a central theme or interpretative lens by which the Bible's overall unity may be more fully appreciated. This would mean that Genesis is seen as actually part of a bigger story and that therefore any narratival intersection with another discipline must first involve the larger biblical account before engaging its textual components. Within the constraints of a discussion involving design in creation, Biblical Theology would therefore require a broad reflection on the scripturally revealed development of God's purposes in the world before embarking on any deeper engagement with texts that might have specific bearing on the topic. Such an approach bears a superficial resemblance to that of Systematic Theology with the chief divergence centred upon the developmental aspect of revelation and the consequent positional importance of later books and texts over preceding ones, and their relationship to that development.

Opinion differs as to what would constitute project viability, valid methodology and legitimate assumptions underlying the approach outlined, but the *New Dictionary of Biblical Theology* includes a number of introductory essays which afford opportunity for readers to grasp how this is given expression by some leading exponents, e.g. Graeme Goldsworthy and Don Carson. What follows is a brief *tour d'horizon* of the discipline as understood by such thinkers, leading to a more particular focus upon the approach of Goldsworthy himself.

5.3 The Possibility of a Starting Point

Biblical Theology has as its aim the desire "to describe as accurately as possible the given canonical shape of the Bible's theology, or, to put it another way, the manner in which the biblical writers, in interaction with one another, develop and express their own theological concerns" (Webb, 1998:54). Goldsworthy describes Biblical Theology as "providing a basis for understanding how texts in one part of the Bible relate to all the other texts" (1991:37).

"Biblical Theology collates the partial theologies of individual passages and books into an archetypal 'theology' of Israel and the early church (thus integrating the Testaments)" (Osborne, 1991:14). What this means is that Biblical Theology as a discipline aims to have its mandate formulated by the Bible itself and not by any external demands. Van Hoozer says that, "the task of Biblical Theology...is to present the theology of the Bible – the parts and the whole – in a manner that lets the texts, in all their peculiarity and particularity, set the agenda" (2000:53). To the unsophisticated, this formulation sounds straightforward and perhaps even an instance of stating of the obvious. After all, is this not precisely what all serious Bible students do?

Further reflection, however, reveals that Biblical Theology cannot be undertaken in a naive manner and of necessity must answer a number of profound questions if it is to succeed. Most theologians recognise that readers approach the Bible with a prior epistemological framework in place. This concern can be sharpened to the point where questions are raised as to whether the Bible itself can have one over-arching intrinsic theology.[238] After all, the texts do have "peculiarity and particularity" anchored, as they are in vastly different historical and social contexts. Each writer of scriptural text has brought an individual perspective to bear. Then there are questions of hidden outside influences. The collection of the texts into some group or groups (i.e. canon) represents *de facto* an external influence that will shape our reading. It is little wonder then that not everyone is willing to embrace a Biblical Theology along the lines described, and the accusation is made that any project to 'find' a unifying theology of the Bible amounts to little more than a thinly-disguised attempt at harnessing Biblical texts in order to give expression to preferred presuppositions.

Since it is the case that this study adopts a presuppositional stance consistent with Reformed Theology, there is no warrant for pursuing further the questions just considered, except to note their importance in nuancing an orthodox approach. The Reformed churches would take it as an axiom that Old and New Testaments enjoy a unity precisely because of God's revelation of His Son. Goldsworthy writes: "Given the presuppositions of Christian theism, the

[238] The Bible is God's propositional revelation, but it also contains its own theology. Goldsworthy writes: "An evangelical approach to biblical theology (or to any kind of theology for that matter) must begin with the person of Jesus Christ" (1997:34,37). He goes on to say that "according to Mark, the gospel of God which Jesus preached contained certain basic elements (Bible, Mk 1:14,15) of which the most central is that in the person of Christ and in his message is the fulfillment of the entire Old Testament...our basic premise is that all theologising should be controlled by the message of the gospel...and leads to seeking one organising principle...perhaps the kingdom of God...To those evangelical theologians who doubt the viability of such a unified Biblical Theology and who adopt the multiple theologies approach, as well as a multiple theme approach, I have but one question: if all these diverse theologies and themes do not point and centre in the real Christ of all history, to the dying, rising and exalted Christ, where in heaven or earth do they point?" (1997:34,44,45).

unity of the Bible is not a purely empirical assessment, but rather it is an article of faith[239]. This is not to involve ourselves in fideism against all the contrary evidence. But it does mean that what is often taken as evidence for the theological plurality of the Bible must be carefully assessed in the light of the fact that not all the data are available to us.[240] To put it another way, we assert the unity of the Bible, not because it is a matter of empirical observation, but because the teachings of Jesus and the apostles render it unavoidable. Disunity in the Bible is as much a function of the non-theistic presuppositions of Enlightenment thought as unity is a function of theistic presuppositions" (Goldsworthy, 2006:194).

Another expression of biblical unity is given voice by N.T. Wright whose approach is narratological. After distinguishing between "*poetic sequence*, the order of things as they appear in the text" and the "*referential sequence,* the assumed and/or reconstructed order of events within the total narrative world of the author", Wright explains a methodology for reconstructing what he calls the "narrative world of the text" (Wright, 1993:404). Such a methodology makes it possible to analyse a New Testament writer such as Paul and grasp something of the story (or stories) that "give narrative depth to Paul's worldview, [and] which formed an irreducible part of his symbolic universe" (Wright, 1993:404). In this intriguing way, Wright exposes a Pauline referential narrative that views Christ as the goal of the story of creation and the story of Israel. He says: "Paul, like Luke, believed that the End had come and that the End was yet to come. 1 Corinthians 15 is the fullest version we have of his retelling of the still future part of the Jewish story...it is a redrawn apocalypse, which...only makes sense in terms of the story of Israel...It is the Israel-story, fulfilled, subverted and transformed by the Jesus-story, and now subverting the world's stories. In its new form, it generates and sustains a symbolic universe[241], in which the writers of epistles and gospels alike understand themselves and their readers as living: the world in which this fulfilled Israel-drama is now moving towards its closure, its still unreached ending" (Wright, 1993:406,409).

At this junction, a sense of the unity of the scripture is still vulnerable to starting points that launch from individualistic story-telling, *viz.* when someone says: "Here is the Bible as *I* see

---

[239] Here Goldsworthy means that we have to believe what the Bible tells us about itself.

[240] Goldsworthy is saying that our empirical scope is always limited. If more data were available, then the support for more than one theology in the Bible perhaps would enjoy less support.

[241] Wright is not being relativistic or pluralist when he uses the notion of a "symbolic universe". Adopting the methodology of the critical realist, he makes room for a 'bigger take' on the data of observation without compromising on objective reality. Wright offers the following in his conclusion: "The New Testament claims to be the subversive story of the creator and the world, and demands to be read as such...it offers itself as the true story, the true myth, the true history of the whole world" (Wright, 1993:471). Wright also uses 'myth' in the way C.S. Lewis did and consequently can say that the Gospels are myths not because they "describe events which did not happen, but because they describe actual events that are not separated from ultimate significance by an ugly ditch...but...carry their significance with them" (Wright, 1993:426).

it". Ironically, since it is the case that most Christians rely quite heavily on listening to preaching for their grasp of God's Word, the weekly sermons expounding disconnected texts have the effect of creating a postmodern (i.e. pluralistic) mindset. In addition, confessional unity belies a troublesome and often hidden fragmentation whereby each person extracts from the sermon a message *for himself* via an epistemic grid firmly anchored in an unbiblical worldview.

In order to combat this, and in order to properly ground a Reformed grasp of both Biblical Theology and the story of the Bible, Goldsworthy allots a chapter[242] to a discussion about knowledge[243] at the beginning of his book *According to Plan* (1991). There he contends that epistemology must be ultimately dependent upon what God tells us and not upon discovered principles or human observations grounded outside of revelation. This line of reasoning is developed to the point where he says: "we must constantly remind ourselves that presuppositions which come from revelation cannot be proved or authenticated by that which lies outside of revelation. By means of revelation, God gives His interpretation of every fact in existence and therefore it is above every fact" (1991:76).

5.4 Christ as the Hermeneutical Key

The ramifications of having a central principle[244] for reading the many texts of the Bible are profound. When it comes to a consideration of design in the created order, what is of deep significance is the connection made by Biblical Theology between Christ as a hermeneutic for all of scripture on the one hand; and on the other, Christ as the hermeneutic for all of reality (empirical or otherwise). Goldsworthy indicates this in a striking manner: "The relationship of Jesus Christ to the Word of God in Scripture is that He sums it up, brings it to fulfillment and interprets it. Thus, the *Word of God* is Jesus Christ. Every word in Scripture points to Jesus and finds its meaning in Him. Furthermore, John 1:1-3 and Col 1:16 tell us that Jesus Christ is the eternal Word of God by which the universe was created. These two passages indicate that this saving work was not an afterthought because of sin, but was the eternal purpose of God...Upon this plan God created all things. If we can imagine God drawing up the plans for the universe before He created it, and if we could examine those plans, we would not see Adam and Eve in the Garden of Eden, but Jesus Christ in the gospel. The significance of this is worth repeating: Jesus Christ in His life, death and

[242] The chapter is entitled "But how can we know?"
[243] This is not disguised foundationalism. A brief discussion of this issue will emerge towards the end of the dissertation.
[244] And of course, far better than just a principle or 'centre' is the fact that the theological unity of scripture is vested in a person.

resurrection is the fixed point of reference for the understanding of the whole of reality" (1991:75).

Given this perspective, the real meaning of Genesis is located in the revelation of the Son of God. What Biblical Theology therefore affords us is a fresh look at texts which all too often have been read as though they can be dislocated from the grand narrative in which they are embedded. "In doing Biblical Theology as Christians we do not start at Genesis 1 and work our way forward until we discover where it is all leading. Rather we first come to Christ and he directs us to study the Old Testament in the light of the gospel" (Goldsworthy, 1991:69). It is often the case that people think that the biblical doctrine of creation is largely restricted to the Book of Genesis,[245] and they often reason therefore that a successful attack on a literal reading of Genesis[246] will fully undermine the traditional Reformed doctrine of creation. Systematic Theology in some formulations has helped sustain this faulty reasoning by adopting the method of proof-texting. Of course it must be pointed out that even at the proof-text level, the New Testament exhibits several clear instances of holding to literal features of the account of Genesis, e.g. Paul referring to Eve who was not created first[247]. But Biblical Theology goes much further and shows that the doctrine of creation is central to the whole message of the Bible. What is said in Genesis is developed throughout the canon[248]. It is inextricably part of the weave. It is interesting to see this at work in Psalm 8, for example. The author turns his attention (and ours) to the heavens and to the fact that man is dwarfed by comparison with the cosmic luminaries, prompting the question as to why God would bother himself with something so small and puny (Ps 8:4). In essence, this is the Copernican principle[249] and is precisely the problem arising from an empirical starting point that has not

---

[245] "Does this biological theory preclude accepting the description in Genesis? As usual, that depends on the interpretation given to those passages. It does suggest the sudden appearance of modern humanity, but questions the idea of a single pair" (Wilcox, 2003:253).

[246] This is evidenced by professing Christian Dr Francis Collins, director of the human genome project. In his book *The language of God*, he promotes a very strong theistic evolutionary approach to reading Genesis, but seems to give no thought at all to the way in which Genesis is read by the new Testament. For Collins, it is of little moment that the New Testament understanding of sin, death, redemption and new creation is jeopardised if death were present from the beginning and in fact the instrument God 'used' for creating man (Collins, 2007:146-153).

[247] 1 Cor 11:8; 1 Tim 2:13, cf. Acts 17:26,31; Rom 5:12; 1 Cor 6:16; 1 Cor 15:22,47 ; 2 Cor 11:3; Eph 5:31

[248] This has been affirmed by the Presbyterian Church in America (PCA) in a report tabled in 2000: "There is no doubt then, that the New Testament treats Genesis 1-3 as real history. This is hermeneutically decisive for the church, because we acknowledge the inspiration and inerrancy of Holy Scripture. But there is more than the historicity of Genesis 1-3 at stake in the New Testament's interpretation of these texts. The very structure of the covenant plan of redemption is found in Genesis 1-3. Bound up with the biblical revelation in the first chapters of Genesis are the New Testament's teaching on the work of Christ as the eschatological Adam, and its implications for soteriology and the consummation, as well as ethical requirements for the institution of marriage and church order. History is not only born here but sovereignly determined by the prophetic Word of God" (PCA, 2000:VII B).

[249] This is an astronomical principle which says that the Earth (and man) occupies no privileged position in the universe.

been properly referenced to God's Word. The Psalmist, however, answers the question in terms of Genesis and man's original creation which is not expressed as 'a little higher than the beasts' but more strikingly as 'a little lower than God[250] 'and made king and ruler over the earth.' The answer therefore cannot be found simply by observation, but by understanding God's designed purpose for man[251]. It is of significance that the writer is King David who is like a second Adam, and whose kingship in the second Eden fulfills (to some degree) the mandate given at the very beginning. The majesty of God's name is seen in all the earth (Ps 8:9) when God's appointed ruler is seen on the throne ruling over all creation.

Yet Psalm 8 moves into another gear once Christ is revealed. Paul, having understood that everything written about the Son of God in Moses, the Prophets and the Psalms must be fulfilled (Luke 24:44), sees in Psalm 8 a description of the ideal man ruling over the entire created order via the resurrection and ascension to the throne (1 Cor 15:21-28). This was God's purpose and design all along. Even when He created Adam He had in mind His Son, though God-man[252] yet a true man nonetheless, who would be seen to have all created things in submission to Him. In Christ, the true or ideal Adam, we understand Genesis. Correspondingly (almost recursively), in understanding Genesis better, we understand Christ better[253]. And in Christ we can understand the universe.

This understanding can also be seen at a higher more structural level. The way God addresses Israel at Sinai resonates with the primeval address to Adam and Eve (Goldsworthy, 2000:37). This in turn connects with Christ and His assembled people at Mount Zion (Heb 12:22-24).

A further consideration of the inter-connectiveness of this one narrative has implications for science, *viz.* that the gospel can no longer be understood as "simply the 'forgiveness of sins' and 'going to heaven when you die'. The gospel is a restoration of relationships between God, man and the world. The typology of the Bible, and the transformation of Old Testament imagery by the gospel should not be misused to lift us outside the created order...how this fact should affect the Christian's view of the world, politics, culture, the arts, ecology and

---

[250] The Hebrew is: מעט מאלהים i.e. lower than 'elohim'.

[251] This tidies up the earlier reference by Wright to myths whereby the latter 'carry their own significance' - they do indeed, but we require God to speak via His revelation in order that we properly understand our empirical experience whether that experience arises from reading the Bible or from 'reading' the World.

[252] 'God-man' is used to indicate that Christ is fully God and fully man in one person.

[253] Goldsworthy, in commenting on Matthew Chapter 1 and Jesus' genealogy, writes: "Matthew is in effect saying to us on the one hand that we should never try to understand the New Testament apart from the old, and on the other hand that we cannot understand the Old Testament without its fulfillment in Christ" (Goldsworthy, 2000:226).

science, should be our continuing concern" (Goldsworthy, 1981:101). The application of Biblical Theology to science could be felt in a positive way at numerous points, e.g. in the ongoing discussion about the nature and role of teleology in biology. In his book *The Function of Function* Matthew Ratcliffe[254] argues against "grounding biological functions in some feature of the mind-independent world..."and instead argues that "teleology in biology carries no ontological commitment whatsoever to any class of mind-independent entities or properties. Instead, it is best regarded as a methodological device which is used to focus interest, formulate research perspectives and facilitate the structuring of certain questions" (Ratcliffe, 2000:113). The epistemological strategy adopted by Ratcliffe is openly attributed to Kant (Ratcliffe, 2000:119,132) and leads him predictably into an investigation of the cognitive status of the investigator, whereas the strategy arising from a position influenced by Biblical Theology leads to an expectation of objective discoveries in the mind-independent world created by God.

In considering Biblical Theology and design detection in the created order, special note should be taken of this conjunction of narrative and creation. The degree to which there is distortion regarding how creation is understood will therefore correlate with a distortion in understanding regarding the biblical presentation of Christ. It is quite striking to think that when God caused the Genesis text to be written, He had the final revelation of His Son clearly in view. Equally striking is that when He created the world He likewise had Christ in mind.[255] Surely it is correct to say that the Son of God is the *telos* of both the written word as well as the universe. In the same sense that Heidegger could be understood as saying that "physics as physics can say nothing about physics" (1977: xviii) so too science, as an enterprise, is in a profound way at a loss apart from the Word of Christ. "No higher dignity can be given to mankind than that which is expressed in scripture. Of all creation, mankind alone was created in the image of God. Modern godless thinking regards man as the most highly evolved animal, a result of chance plus time. His rule over the other species is the consequence of the survival of the fittest. By contrast, the Bible sees man as the greatest of all God's creatures with the God-given task of ruling all others. The human scientific task began when Adam named the animals and ever since then the quest for knowledge and control of the universe has expressed man's urge to exercise dominion over all things. The Genesis account informs us that the scientific task of humanity is regulated by God's Word. Adam was not left to discover the universe unaided. The reason is simple. God has to reveal Himself by His Word so that Adam would know God and know the universe as it really is: the creation of God" (Goldsworthy, 1987:44,45).

---

[254] In 2000, Matthew Ratcliffe was based in the Department of History and Philosophy of Science at Cambridge.
[255] This is made strikingly clear in the opening verses of the Gospel of John.

What is so striking about Goldsworthy is the noticeable effect of a robust Biblical Theology on the philosophy of science. Goldsworthy explains how the garden of Eden provides an archetypal pattern (1991:127). Although we can see Adam beginning the scientific process as he names the animals, we can also see for ourselves that for Adam empirical observation and rational analysis are not enough. These faculties do not equip him to "deduce his own relationship to God or even to the world" (1991:127). Adam required God's Word for this, and it was a word that explained the nature of his task, one that called him to be a scientist and caretaker rather than a manipulator. The Genesis account reminds us that true science requires God's Word to give it direction, and that insofar any scientific theory disparages biblical notions of personhood and moral value by attributing them to chance, that theory has unmoored itself from true science (1997:127).

It is necessary, at this junction, to clarify what is perhaps an obvious distinction between Christ as hermeneutic for scripture and Christ as hermeneutic for empirical observation and study, i.e. science. For the former, the revelation of Christ provides methodological power for theological unity and application at a first order level[256] (if Biblical Theology is harnessed properly); whereas in science He provides power for methodology, unity and application at a second order level (philosophical/theological). Second order considerations, of course, can and do exert an influence over first order methods of investigation and observation - a situation which in the case of religious assumptions some people fear might lead to the shutting down of science. This fear, which is not unreasonable, will be addressed in the concluding chapter where the value of limits is discussed. Ultimately, there is no escaping a religious influence at a second order level since even methodological naturalism involves metaphysical presuppositions. And since first order research is strongly related to the second order framework, it is necessarily the case that philosophical and theological assumptions will always be at work, influencing the setting up of methodological approach towards and interpretation of experiments.[257]

---

[256] This means that the texts cannot first be understood on their own terms though quite obviously they had real and vital meaning for their first hearers. Failure at this point causes major exegetical problems for people today. This issue is exemplified in Hebrews 11 where we read that Abraham saw a city "whose architect and builder was God", and Moses saw "him who is invisible" i.e. Christ (NIV, Heb 11:10, 27). The point the writer is making in the letter to the Hebrews is not that Abraham saw an actual city, or that Moses really saw Jesus. Clearly they did not. But from the vantage point of the full revelation of Christ, we can see that these patriarchs were in fact gazing at him but not directly. What they actually saw were shadows and types. What this means is that Abraham and Moses cannot be understood properly if they are not exegeted by the New Testament.

[257] Biochemistry PhD John Kramer describes how his participation in important research in the early 1970s into polyunsaturated fats led him to approach his experimentation on rats with some important questions: "Should I approach this problem from the evolutionary point of view of the development of animals to humans, or from the Biblical point of view that animals are created according to their kind? One's 'Weltanschauung' certainly influenced the approach to this research. I chose the latter. Based on a Biblical perspective, I wanted to know

5.5 Detectable Design in Creation

It would be inappropriate to proceed further without some consideration as to what the Bible would expect us to see when we observe the world around us. Certainly from the vantage point of the Reformed perspective it should clearly be the case that when God created everything, He had in view a creation that would be ruled by an ideal man, and therefore undertook to build into it deep features rendering it anthropocentrically corrigible and rule-able. That is to say, woven into the entire fabric of the created order are principles that are conducive to human logic, ordering and management.

Often overlooked in this type of discussion, is the momentous catastrophe entailed by the disobedience of the first couple[258] in Eden. This draws attention to a fundamental discontinuity in the observable order and to the problems associated with incautious retro-extrapolation. We observe a world *now* that exhibits degenerative or contrary features not present at the beginning. What we observe *now* is a universe that has been under a divine curse since earliest times and in many ways does not always appear to be anthropocentrically-orientated in the fashion described. The discontinuity of such a Fall and the subsequent divine curse does indeed impose an empirical limit and would indeed incline us to think that what we see now is how everything has always been. Yet God has revealed in scripture the primeval existence of an un-fallen nature in a pristine universe.

However, having said that, it would be a mistake to imagine that the discontinuities have completely sheared the post-Fall world off from its antecedent. We ought to formulate history (taking seriously the conjunction of narrative and reality)[259] so that it speaks of a world originally constituted to be ruled by man. An example would be the continuity between Adam typology and the animal world: Adam names the animals, the animals approach Noah (a type of Adam) who cares for them in a microcosmic Eden (the Ark), and Christ, having survived

---

the results from a number of different animal species, find a common toxicological denominator, determine its mechanism of action, then determine if a similar process occurred in humans, and above all be super-cautious on extrapolations. I was fully aware that my view was different from that of many others in the group...even though we were all aware of the pitfalls of (evolutionary) reasoning. Thalidomide for example showed no harmful effects in rats, yet showed fetal abnormalities in rabbits, mice and humans. I have often been asked if these two approaches are different. Strictly speaking, they are. However, I have found that scientists do not maintain a strictly evolutionary approach in the biochemistry-nutrition area" (Kramer, 1999:39,40).

[258] Once again it should be noted that an original pair makes its appearance in the New Testament. See Luke 3:38, Acts 17:26, 1 Cor 11:7-10, 1 Timothy 2:13,14.

[259] This conjunction forces a tighter connection between the symbolic universe and onto-public world; a process of connectivity that depends on critical realism. We are therefore in a position to truly access real objective history. This conjunction also legitimises a Genesis account being read as historical where indeed the literary genre provides suitable warrant for the Genesis text to be read as such.

the Adamic temptation by Satan, is "with the wild animals" (Mk 1:13) as a picture of his forthcoming triumph and victorious rule[260] as the Last Adam. Of course, standard naturalistic accounts of the forces that have shaped the history of animal life, culminating in man, will not predispose us to consider the Biblical picture to be anything remotely approaching true history. That is understandable since we do not see creation now as it once was. Yet the strength of the Biblical narrative stretching, as it does, from Genesis to Christ is such that it entails a true historical dimension regarding the Adam-animal motif, encompassing as it does the very real catastrophe of the Fall.

The point being argued is not simply that we should now look for a host of connections between man and the animals in the current milieu (though that exercise would repay serious consideration[261]). What is at issue is that the Bible portrays the creation both historically, currently and in the future in a way that reveals man as the appointed manager and 'structurer' of all that God has made - and, if that were not enough, the Bible shows how in the ideal man, Jesus Christ, this has been realised. In fact, if it were not the case that Jesus is also God, we would see in this man (especially by virtue of His death and resurrection and

---

[260] The great difficulty with scripture is that divine typology is able to invest events and items of the created order with a developmental significance i.e. Christ with the wild animals has a resonance that could tie in to the picture of the anointed one subduing the hostile kings of the earth (wild animals). These attendant symbolic features often wrongly incline the reader to view the underlying historicity as non-existent. But what is often forgotten is that in a sense, all of history is sacred. If every marriage points to the eschatological reality of Christ and His Bride (Eph 5:31,32) and if it is true that the first marriage in Eden was constructed with its ultimate Christological significance in view, then we are ill-advised to attend to the symbolic/typological at the expense of the historical. Readers of the Bible can become so familiar with the ring of well-known verses that the shock conjunction of Eph 5:31 with 5:32 is not noticed. In the compass of a few words, Paul reveals a powerful Biblical Theology at work book-ended, as indeed it should be, by the Beginning and the End. The continuity is breathtaking, as is the development: an original pair in the primeval garden, but a vast community in the New Era stretching to the Last Day. It should be noted that any attempt to undermine the primeval historicity in Eph 5 severely undermines the apostolic argument, and it should not go unnoticed that attempts to scuttle Genesis reality are blocked by strong ties made between 'caring for my body/wife ' and 'Christ caring for the church', ties predicated not upon mere artistic illustration, but upon a deep understanding that the hermeneutic of the physical creation has always been Christ (in God's mind, until revealed to Paul). What is further required is that we read Eph 5 in the light of Eph 1 where Paul shows that the entire created order existed in Christ's mind prior to creation and therefore exists in the here and now in order to be fully brought under His rule not just in behaviour, but in the intellectual sphere as well.

[261] Man's distinctiveness as a being created to manage the world would become more salient e.g. huge language superiority and ability to manipulate symbols and abstract reasoning; the disjunction with the higher primates regarding a left brain vs. right brain ordering and the concomitant handedness, a feature absent in the non-human primates; the long childhood requiring lengthy parental supervision and transmission of knowledge (witness how soon most animals can walk after birth and compare with humans) - to mention just a few. Yet even more interesting is the incredible bond that is able to be formed between man and animals that in the opinion of some transcends any evolutionary explanation. It is almost as though the animal world is under a spell where man is naturally feared, and if that spell is broken, residual elements of an ancestral, primeval friendship once again emerge. An example would be the relationship between dolphins and fishermen in some remote part of the world where the animals once a year appear from nowhere herding shoals of fish towards the shore where the fishermen wait as their forefathers and those before them had done. The whole exercise is a symbiosis and each dolphin generation transmits the practice to the next as do their human counterparts. Besides the inscrutability of how such a relationship got started in the first place, the abiding and near miraculous wonder of the annual event lies in the way man and animal can relate.

heavenly ascent) an 'anthropocentrism' of all things. As Paul says: "For God was pleased to have all His fullness dwell in Him, and through Him to reconcile to Himself all things, whether things on earth or things in heaven, by making peace through His blood, shed on the cross" (Col 1:19, 20 NIV). The entire cosmos is made friendly (reconciled) to man again because when it was conceived in the mind of God prior to its physical existence, He had the God-man Jesus clearly as the blueprint (Goldsworthy, 1991:75). Paul can say what he does about creation and about Christ, not because God simply conferred great honour upon His Son but, because to understand creation correctly (and along with this the status of mere religion - Col 2:8, 16,17) one needs to know that everything came into existence via Jesus Christ's creative act and was purposed to find its meaning and ultimacy in Him, the man, the God-man (Col 1:15-23).

The upshot is that scripture provides a strong basis for *inferring* that design-by-a designer should be detectable in the creation.[262] Human rationality should find many instances of observable correlation between a logical language, arising from what is inbuilt in us, and logical features embedded in the created order that signal to us that what exists in our surrounds has been made-to-be-subdued. It is helpful at this junction to observe a distinction between *formal* and *general* detectability. A *formal* attempt[263] to detect design is deemed different from a *general* attempt. A general approach simply says: "It looks to me that what I see has been designed by a designer". This general approach can of course become quite technical and sophisticated and may employ many interesting and valid second order

[262] Zoologist and Christian author, Oliver Barclay, writes: "God is presented as the one who has deliberately brought into being and maintains a world that can support life. So the state of the world is evidence not only for the existence and power of God but also for his kindness and care for his creation. Does this include an argument for design? Clearly if it is God who has created and rules 'nature', deliberately for the good of living things, including humanity, then his design is *implied* in the way that things are organised. But this is a very different stance from those arguments for design which seek to show that some particular findings of science point to a Great Designer"(2006:52). The question one wants to put to Barclay is to what extent he considers scientific observation and formulation to be a language. If it were the case that any given mathematical equation or logical formulation could be translated into English or other tongue, then to say, as indeed he does (2006:56), that "the fact that birds can navigate thousands of miles of sea and land on as migration to the best feeding grounds, which they have never visited before, without refueling, and then return at the right time to breed in a more suitable climate is truly astonishing" - to *say* this begs explanation as to what law prevents this observation from being formalised via zoological investigation and expressed as the findings of science that not only imply design but perhaps demand it? The *reductio ad absurdum* is that Christians in the academy insist that we can see design in nature but not talk about it as if it were truly there.

[263] Regarding a formal approach, the notion and terminology is drawn from the work of Cantor, Gödel and Turing (to mention a few) and an approach in mathematics known as 'formal systems' or 'formal theory'. An ideal example is Turing's mathematical machine known as a Turing machine. Turing *formalised* the notion of an algorithm and did so in order to answer one of David Hilbert's challenges. He invented a thought experiment that involved what would later be realised as the computer. After harnessing Cantor's famous diagonal argument, he was able to show that problems exist which can never be solved by an algorithm (or computer). It is interesting that Turing's biographer said: "Turing went outside classical mathematical to create a new kind of logical engineering" (Amos, 2006:22).

scientific arguments.[264] It is the case that many people outside the academy[265] have followed an approach of this nature, but its limitation (as with all scientific interpretation) is that its argument relies purely on second order assumptions. A *formal* approach, by contrast, reaches very much into the first order domain.[266] What this approach signifies is an attempt to produce a mathematical or logical construct that can serve a scientific purpose in the laboratory or in theoretical research. In the context of this dissertation, a modern candidate for just such an approach can now be proffered, *viz.* Irreducible Complexity.

Not all thinkers are willing to countenance the *formalising* of living systems. Mathematical biologist, Robert Rosen (1991, 2000), has devoted considerable attention to this issue and is unhappy with the general scientific approach which holds that biological systems can be modelled.[267] Rosen's work has been built on by complexity theorists (e.g. Mikulecky, 1999:1-6) and systems biologists (e.g. Cornish-Bowden, 2006:484-486; Hofmeyr, 2007:9-23; Letelier, Marin & Mpodozis, 2003:265; Wolkenhauer, 2002:2). His central idea is that mathematical systems, since they always involve inferential entailment, must always fall short of modeling living systems which necessitate full causal entailment (full causal closure). A.J. Wells has pointed out some problems in Rosen's understanding of Gödel and Turing, thus weakening the cogency of his modelling relation (Wells, 2006:56-59). The upshot of this weakening is that ongoing attempts to capture certain systems in the biosphere within some type of formalism remain valid. Rosen's concerns, however, make a valuable contribution to this discussion, as do indeed his subsidiary arguments.[268]

---

[264] Or "I have calculated the odds that such and such could combine in this configuration". This assumes that the configuration did not have a less complicated precursor. Irreducible Complexity applies to particular systems where a precursor is very hard to envisage.

[265] There are some examples of leading thinkers within the academy, e.g. Alvin Plantinga (philosophy), John Baumgardner (Geophysics).

[266] A formal approach may of course also harness second order arguments along the way.

[267] Rosen attacks the coherence of the Church-Turing thesis that in principle "...a Turing machine can duplicate not only the workings of mathematical machines, but of nature itself. Turing's view, like that of Descartes before him, was that natural, living systems may be thought of, in essence, as finite-state machines. After all, such devices rely on both an internal state and on any information that they can glean from their environment"(Amos, 2006:29). As will be shown later, it is quite striking that Adleman in 1994 proved that DNA polymerase could function as a Turing machine. Though this does not fully underwrite the Church-Turing hypothesis, it certainly appears to lend support rather than the reverse.

[268] Rosen raises the whole problem of what he calls 'fractionability'. In comparing a bird and an airplane, he writes: "The bird wing...is an *unfractionable* combination of engine and airfoil. We cannot physically segregate these two functions into separate spatial structures. In the airplane, on the other hand, engine and airfoil *are* fractionable one from the other. They are fractionable because that is how an airplane is built - it is a consequence of its own ontology. This last observation is important: we generally construct things sequentially, by accretion, one structure at a time, one function at a time. That is how we build a machine...accordingly we cannot build a bird...we don't build a bird wing because we *can't* build a bird wing; its nonfractionability removes it instantly from the province of things we can build"(Rosen, 2000:291). One response to this is to ask whether every sub-system within a living system must necessarily be nonfractionable. How this could be decided in principle is not adequately dealt with. Another problem for Rosen is that given his own commitment to Neo-Darwinism and the incremental development of complex structures, it seems inconsistent to posit the conceptual impossibility of knowing how such development could ever occur.

A good question to ask is why Christians should exhibit such obvious diffidence when it comes to the idea of a *formal* approach? Why does the church not acknowledge that it is indeed problematic that, given a world known by the Christian to be purposefully created, there should be such a noticeable lack today of *formal* scientific attempts investigating whether there is indeed a type of observable design in nature that cannot be explained away by Darwinism[269] or any other naturalistic approaches or indeed natural law? Is it not strange that whilst the Bible, on the one hand, encourages us to *infer* the existence of observational design in the created order;[270] it is the case, on the other hand, that Christian thinkers who are professional scientists have been unable to challenge the academy by producing *formal* scientific arguments for design? The contention here is that the emergence of Irreducible Complexity is a modern example of an attempt to do just that and is consistent with the Christian worldview of its creator, biochemist Prof Michael Behe.

The answer to the question just posed is not a simple one. Taking us some distance is a consideration of the history of science. It would be a general expectation that as scientific discovery proceeds, so too should the framework of science change. Therefore, for most educated people, it would be deemed anachronistic and indeed wrong to contemplate a return to any bygone ways of seeing the world. With regard to astronomy, the idea of empirically identifiable *formal* structuring outside of any covering law evokes something akin to the Keplerian use of Platonic solids. One does expect, of course, that mathematical physics has powerful application in describing planetary orbits or the behaviour of black holes. But most scientists do not expect *formalisms* that would suggest a non-naturalistic origin of any particular system.[271] Of course, what is being advocated here is not the hope of a revival of Greek physics but an argument for a return to a view of the world that can never become outdated; enshrined, as it is, in the timeless revelation of God in His Word.

---

[269] i.e. resists a naturalistic explanation.

[270] i.e. the Bible develops a mindset among its serious readers - those who have no commitment to any extra-biblical worldview - that embraces an ongoing desire to look at the created order and readily observe design-by-a-designer at some level or other, and even discern creator-wisdom in the ordering of that world or of animal life that could be applied to human affairs. "Go to the ant" (Proverbs 6:6) is instinct with theology, given the observable in-building of design and ordering by God, an ordering that operates across the board, and which therefore has application to us. Were David or Solomon to be told that the advanced biology and socio-biology of ants and other creatures would one day contradict the wisdom of the Kingdom and that many Christians in the future would find no evidence of design-by-a-designer in the creation, they would have been astonished. Likewise Paul who would never have envisaged a pluri-vocal creation that could reveal the power and divine nature of its creator *in spite* of what is observed. For Paul, the possibility of arriving at such a conclusion could only rest precisely upon seeing the handiwork of a designer. It would be bizarre to expect Paul to be content to say that God's invisible qualities are clearly seen because all you can observe is the work of random, undirected forces (Rom 1:18-20).

[271] As Athel Cornish-Bowden says: "The final cause remains essential for discussing engineering, but it has largely been banished from the modern scientist's view of the natural world, which has no room for an external designer with definite intentions" (2006:486).

It is of vital importance at this point to note a key difference between the rationalistic and Biblical approaches. Platonism encourages a type of conceptualisation that arises from logical contemplation or mathematical reasoning which can then be 'read off' from nature. The result is a mathematisation of the observable world that does not comport with actual empirical discovery and becomes more a 'reading into' nature. As such, it can become hostile[272] to actual observation, leading to the oppositional and problematic cry of 'save the appearances'.[273] By contrast, Biblical Theology encourages a rather different strategy. What is proposed here is an ongoing empirical search for ways in which observable systems in the created order can be modelled *formally* in the hope of a construct that indicates design. This is radically different in approach to either traditional rationalistic or empiricist strategies in that the ontological correspondence between formal and natural is neither over-tightened nor over-relaxed.[274] The scientist informed by Biblical Theology is *not* encouraged to engage in a crass parody of Platonism or Aristotelianism, thereby indeed threatening to shut down[275] science as we know it but rather to do what scientists in a previous era, operating within a Christian worldview, sometimes did, which was to conduct their investigation expecting entailment congruence. That is to say, they expected deep correspondence between formal and natural systems of entailment to the extent that the investigator was well-placed to conclude that the formal structure was actually embodied in observable reality. Logic constructs and logically-coordinated machines, capable of being translated into formal syntax, are embedded in nature, thus rendering the observable world highly corrigible to a

[272] In Kepler's case, the theory of Platonic solids actually propelled the astronomer to work tirelessly to discover laws of planetary motion that arguably would have remained hidden for many decades, if not centuries. In contemplating Newton's work in showing the Keplerian laws as deducible from the inverse square principle one needs to bear in mind that Kepler's work had preceded him. Showing laws deducible from other axioms is not the same as deducing them *de novo* though this is not in any way meant to detract from Newton's vast accomplishments either. All that is being said is that the belief that natural realm has been structured in a non-random fashion can lead to useful scientific discovery.

[273] Yet this Aristotelian cry is uttered from the opposite extreme where the epistemic assumption is a dyadic (diadic) knower and known. This dualistic dipole creates problems for the knower who has no third epistemic entity in which to vest non-subjectivity. This means that 'save the appearances' is a poignant insight into a philosophy of science that can only deal with empirical phantoms. What is seen is never known in itself, and what is in the knower can never be posited as existing in any logical way within the known. In a Platonic triad however, knower and known can be related to a third structure perhaps more fundamental than either and via which exists a commonality of logical structure, e.g. mathematical aptitude in the knower, and mathematical relata in the known.

[274] This can be seen as a contrast between "Kant's subjectivism which holds that the logical structure immanent in the physical phenomena is nothing but the creation of the human mind - which would explain the congruence between human reasoning and nature, at the cost of reducing all reality to the realm of the knowing subject...and ...the neo-positivist's claim that nothing can be known except what is perceived, thereby reducing the locus of intelligibility to sense data...[a problem because]...the human being lacks the power to see beyond the immediate and derive intelligible meaning out of naked sense data" (Lee, 1997:79).

[275] Even this requires nuancing given the history of science. Philosopher J.P. Moreland, relying on T.F Torrance, notes that James Clark Maxwell's electromagnetic "field picture was derived metaphysically from his theological convictions of the Trinity and incarnation" (Moreland, 1989:70). This approach is not the one being advocated here. However, this approach of Maxwell would enjoy considerably greater attention were it to be the case that science today generally conceded God's causative interference in creation, and conceded that there would be in all likelihood deliberate rather than accidental links between man's rationality and the created order.

logical or theological mind. Philosophers of science occasionally allude[276] to something like this, e.g. "The most venerable of scientific concepts -- for instance, work, force, and cause -- have theological backgrounds" (Ruse, 2005:48). Whilst such references are often backhanded, what is commonly overlooked is the role that a biblical worldview played in past scientific discovery, shaping, as it does, the way in which we actually search for structure in a world redolent with man-orientated purpose.

The Titius-Bode law[277] is a case in point. John Casti[278] notes that this law, which claims to show what is really a *formal* description of the arrangement of the planets in the solar system (except for the two outermost planets), has "...puzzled astronomers ever since it was first published in 1766 by the astronomer Johann Daniel Titius. One camp clings to the belief that this 'law' is just a coincidence while others feel that it reveals a hitherto undiscovered feature of the solar system...Earlier the Titius-Bode rule placed [a mysterious planet] at 19.2 units [from the sun], astonishingly close to what turned out to be its actual 19 units when Uranus was discovered in 1781. But the law ran into trouble with Neptune and Pluto" (Casti, 2001:10; Matthews, 1994:13). In the time since Casti wrote this, Pluto's status[279] has been downgraded and is no longer to be classed as a planet; a situation that bodes better for the rule. It is interesting that the debate refuses to die and that for most attempts which are

---

[276] The original quote has a different intent: "...the fallacy of 'psychologism' - the confusion of the context of discovery with the context of justification - has some bite. The most venerable of scientific concepts - for instance, work, force, and cause - have theological backgrounds. Indeed, if the eminent historian of physics, Richard S. Westfall (1982), is correct, Newtonian gravitation has its roots in alchemic speculations. But today, one can use these notions without in any sense having to confess that they are still theological or alchemical. In the same way, even if indeed it is the case that law does have its roots in Enlightenment deism, there is absolutely no reason why we cannot ourselves today use in an entirely secular way: the way of the methodological naturalist" (Ruse, 2005:48). It should be noted that Newton's practice of alchemy had less to do with magic and more to do with a world ordered by a transcendent Mind.

[277] The equation formulated by Titius in 1766 gives the distance (D) of each planet from the sun as $D = 0.4+0.3(2^n)$ Au ('n' enumerates the planets and has the values of negative infinity, 0, 1, 2 ,3, 4 etc). n = negative infinity means that the series begins with 0.4 which is pretty close to Mercury's distance from the sun in Astronomical Units (Au). The result is a sequence: 0.4; 0.7; 1(i.e. the earth - if you set n to 1 you get the earth's distance from the sun); 1.6; 2.8. At positions indicated for numbers n = 3, 6 and up there was initially no correlation. A group of astronomers called the Celestial police was set up in the early 1800s to try to find the remaining entities with partial success. "Johann Bode popularized the "law" and he persuaded a group of astronomers to search for a planet at 2.8 Au where the law predicts should be a planet. In 1801 the first of many asteroids were found in what is now known as the asteroid belt located at approximately 2.8 Au. Another boost for Titius-Bode was in 1781 when Uranus was found (by Herschel) at 19.2 Au and the prediction was only off by 0.4 Au." (Leblanc, 1995). An Au or Astronomical Unit expressed in metres is: 1.495 x 10 to the power of 11 and is the distance from the centre of the earth to the centre of the sun.

[278] Casti has copied chunks of text almost word for word at times from the New Scientist article by Robert Matthews, published in 1994 (Matthews, 1994:13). Casti provides no acknowledgment or reference in his text but in the notes section at the end of the book he cites the Matthews article for further reading. This would be hardly necessary since Casti has already reproduced it in his book.

[279] For some time now Pluto has been suspected as not being a true member of the solar system: "Pluto is thought to have been created outside our solar system and the (Titus-Bode) law would therefore not apply to it" (Bass & Popolo, 2004:2). Of course, just because Pluto's status has altered doesn't mean it can be ignored. Any law describing planetary motion would still need to reckon with this outer satellite, and any other more remote candidates, e.g. Zena, named in August 2005 as the 10th planet.

made to explain it in natural terms, i.e. as a derivative of natural law, there is a counter.[280] The fact that astronomers still discuss Titius' equation immunises its exemplification in this context against being yet another Platonic-styled 'reading into'. The point being made here is that for those who consider the possibility of *formal* descriptions (beyond those *formalisms* easily subsumed under a covering law)[281] being present in the created order, it is not too much of a surprise to learn of the existence of such formulations or to learn of their ability to survive in an intellectual atmosphere so unsuited to their core implication. After all, if something is truly there, it won't go away. It borders on obscurantism to insist that since one's own particular view of science involves a prior commitment to the essential non-existence of *formal* constructs suggestive of a non-natural aetiology, that therefore any strong contrary candidates should be ignored. One could hardly imagine the SETI[282] project making headway on such grounds.

It is possible of course that in the future someone will demonstrate to everyone's satisfaction that the Titius-Bode rule is in fact the result of some application of natural law. A recent attempt by two academic physicists might go some way towards this (Bass & Popolo, 2004).[283] Were this state of affairs to actualise, it would certainly diminish the usefulness of this particular law for the kind of argument marshaled here. Having said that, the full picture would still not be clear in the absence of the rule being observed for other satellite

---

[280] This has happened in regard to the proposal of Graner and Dubrelle who say that "the rule is a natural consequence of certain symmetry properties that are almost certain to feature in any planetary system" (Casti, 2001:10). However, Leblanc tested this idea and concludes that he cannot find such properties. Suffice to say, although the academy has in general dismissed the Titius-Bode rule as a numerological curiosity - a dismissal that is in keeping with some sort of nebular hypothesis of planet formation, (i.e. natural law), its appeal remains neverthless, and for some, grows in proportion to the weight given to any doctrine of creation nuanced by the Biblical Theology as described.

[281] An example would be Zipf's law: If you take all the cities in a country and rank them according to their population size, then their actual populations are related by this series: 1, 1/2, 1/3, 1/4, 1/5 etc. So if you take the population of the city of top rank say 100 000, then city of rank 2 will be half of that, rank 3 will be 30 000 and so on. It is inversely proportional to the rank. This can be applied to businesses and their volume of business. Similarly to words in a text: first, one has to count the number of times the words appear in a certain text. These frequencies will then be inversely proportional to rank, i.e. if the top frequency is 100 then the next word will be 50 ...and so on (Gell-Mann, 1994:93). This law seems surprising and the way it arises is not fully understood; yet it is not hard to see it as a feature of various regularities operating within the empirical world. As it stands it does not present a formal construct that bespeaks design at a first order level.

[282] SETI stands for the Search for Extra-Terrestrial Intelligence.

[283] Bass and Popolo model a three body problem, *viz* sun and two planets. They write: "In particular, the most stable situation is achieved (in this idealized model) only when each planetary orbit is roughly twice as far from the Sun as the preceding one, as observed empirically already by Titius (1766) and Bode (1778). Simplifying the problem by reformulating it as a hierarchical sequence of [unrestricted] three body problems, in which gravitational interactions are ignored except between the central body and the body of interest and the next outwardly orbitally adjacent body, it is proved that the resonant perturbations from the outer body will destabilize the inner body [& conversely] unless its mean orbital radius is a unique and specific multiple Beta of that of the inner body" (Bass & Popolo, c2004:1).

systems[284], and also not clear when considering how a solar system that captures a body such as Pluto can retain such a tight mathematical relationship for the postulated millions of years[285] and see only the outer planet (Neptune) affected whilst its inner neighbour (Uranus) remains immune.[286]

Another instance of design *formalism* detectable in nature arises from Leonard Adleman's depiction of DNA polymerase as a Turing machine.[287] This will not be argued to the same extent as the Titius-Bode law but a brief outline is warranted. In 1994 Adleman was able to demonstrate, in a laboratory, the first DNA computation as proof of the principle for molecular problem-solving and parallel-processing (Adleman, 1994:2).[288] When one bears in mind that Alan Turing achieved a mathematical breakthrough by formalising the concept of an algorithm which he did via a model of a human mind performing strict calculations, it is quite striking that Adleman was led to his groundbreaking experiment after realising that DNA polymerase can be depicted as a Turing machine. "Adleman was stirred by the recognition that, since the Turing Machine is universal (i.e. it can compute anything that is computable), then the same could be true for polymerase...He had made a crucial leap of imagination. By interpreting the polymerase enzyme, not as a protein docking with other biological molecules but, as an abstract *machine* for processing strings of information, he began to make the first tentative steps towards a whole new relationship between biology and computer science. It is an exploration of a more intimate connection between two very old sciences: between computer sciences and mathematics (which are in some ways the same thing); and biology" (Amos, 2006:107).[289]

---

[284] Bass and Popolo's model holds promise for the orbital resonance problem cited by Carl Murray (see earlier footnote). However, whilst Bass and Popolo showed via their model that ratios of 2:1, 3:1 or 5:3 are possible, what requires clarification is the observed preference for 2:1 orbital ratios among the moons. Also Carl Murray notes that "Resonances are curiously absent from the Uranian satellite system" (Murray, 2002:1).

[285] The issue of perturbation effects over vast stretches of time is not inconsiderable.

[286] A further explanation required would be how an accretion disk could resolve itself into the kind of system we observe. Even if it were shown that planets occupying a certain 'resonance' might mutually assist in the maintenance of that preferred system, it would still need to be shown what mechanism operates upon the emergence of planets from nebular dust such that they end up in the orbital arrangement we see today.

[287] This approach is not the way Adleman would wish to express the connection between Turing machines and DNA computing. However, there is enough room in the discussion to motivate this as an example of a formalised construct useful at a first order level.

[288] The abstract of Adleman's paper reads: "The tools of molecular biology are used to solve an instance of the directed Hamiltonian path problem. A small graph is encoded in molecules of DNA and the operations of the computation are performed with standard protocols and enzymes. This experiment demonstrates the feasibility of carrying out computations at the molecular level" (Adleman, 1994:2). In effect, Adleman solved a very hard problem for computers (an NP-complete problem) using DNA machinery .

[289] Martyn Amos was awarded the world's first PhD in DNA computing and is based at Manchester Metropolitan University (UK) in the Department of Computing and Mathematics.

It should be added that, perhaps it will be shown in the future that *all* such formulations to date are the result of natural phenomena operating under natural covering laws. Such a possibility cannot be ruled out. However, it surely cannot be the case that in the present, all such discoveries be held at gunpoint until science finds a natural solution. The latter stance is predicated upon the widely-held (but Biblically untenable) idea that naturalistic science will eventually explain everything. In the interim, certain *formal* constructs[290] that imply a non-natural ordering will nevertheless continue to make their presence felt and continue to further 'good' science'.[291]

When it comes to considering the world of living things, part of the problem it seems is that the majority of Christian thinkers in the academy have tacitly assented to read the Bible through Darwinian glasses and the result is that they do not expect that biological design *can* be formulated using the first order methods of science. What this means is that the academy permits Christians to *ascribe* design-by-a-designer to the finished product of what was brought about by natural forces but does not readily permit any *formal* scientific detection of design. If the latter were permissible, it would mean that science could, by its own method, discover an arrangement or ordering within nature that might defy naturalistic aetiology. Since this position is considered untenable and incompatible with good education, anyone attempting a *formal* approach to the detection of design in the biosphere must therefore be viewed as ignorant (willfully or otherwise) of the true nature and advances of science.

Christian thinker and scientist, Dr Francis Collins, director of the human genome project, epitomises this approach of the academy. He lists six tenets of theistic evolution to which he subscribes (2007:200) and under Number 4 says: "Once evolution got underway, no special supernatural intervention was required". From what Collins says it is quite clear that he

---

[290] Another example is the problem of orbital resonance of some of the moons in the solar system. Carl Murray, Prof. of Mathematics and Astronomy at London University has said that it has been known for some time now that the solar system shows a preference for orbital resonance when it comes to its moons. This means that whereas one moon takes 180 days to orbit Saturn, its resonant partner takes 94 days, yielding a resonance of 1:2. The orbits of the moons are not distributed randomly. Round Saturn and Jupiter, a number of its moons have the orbital resonance ratio of 1:2, though Murray cites one pair for Jupiter that has 1:3. Murray attempts to explain why this phenomenon should exist by referring to Kepler's 3rd law and saying that although once distributed at random, planets naturally move into resonance (Murray, 2002:1). However, whilst not wishing to suggest that all astronomers simply ascribe the 'Hand of God' to such mathematical formulisations (that would indeed shut down science), it will do no good to view the solar system only and entirely as the product of natural processes and therefore devoid of any design detectability *in principle*. That will have the opposite effect of shutting down observation and enquiry of any *formal* kind that runs contrary to mainstream theory.

[291] Astronomer Halton Arp (like Graner and Dubrelle) has been prompted by the Titius-Bode rule to consider whether it points to an underlying regularity located within atomic physics. After citing the work of several physicists interested in numerical symmetries arising via scaled laws, he writes: "If scale lengths in a primeval planetary system change in steps, then Kepler's third law would require periods (orbital velocities) to change in steps. The challenge would be to quantitatively evolve the particle physics laws to gravitational physics laws as a function of time" (*1998:222*).

wishes to convey that it is wrong for Christians to think that God's interference should be invoked at any point along the way of the development of any plant, animal or man. What this means is that natural processes, random and undirected (Collins, 2007:205), governed the development of the entire biosphere; processes that are still operating today.[292] This implies that God is still creating and that therefore creation of biological life is not finished; an idea not at all consonant with the New Testament[293] and in the eyes of many Christians, neither with general experience.[294] Also, the fact that we are in the shape (physical or otherwise) that we are in is, according to Collins, entirely accidental. Hence he says that language developed accidentally in humans via random changes in a gene associated with speech[295] (2007:140) and that if the asteroid collision with the earth 65 million years ago had not happened[296], "it might well be that the emergence of higher intelligence would not have come in the form of a carnivorous mammal (Homo Sapiens) but in a reptile" (2007:205). The fact that as humans we find ourselves to be sophisticated language users and that when we look in the mirror we see minimal resemblance to reptiles, apparently cannot be attributed to anything except lucky genetic accidents.[297] A good Biblical Theology, however, would rule out this possibility since we are told that God set out to create with a teleological eye on the end. The Creator had in mind the finish as he set about the beginning. But to think like this one would need to pay serious *a priori* attention to the Bible.

---

[292] This raises the interesting and troubling notion that *in silico* modeling is nothing short of being God's creative work occurring within the computer. If random, undirected processes are in fact to be viewed as the creative hand of God, then our computer-generated molecular phylogeny allows us to glimpse God at work, either now or in the past. So some might think.

[293] Heb 4:3, 10 describes a contrary picture and harnesses an argument which could collapse if God were still busy creating His world. In fact, the Biblical Theology so evident in the book of Hebrews forces the reader to see God's Rest in Genesis as leading ultimately to the Rest in Christ. The writer of Hebrews appears to take Genesis Chapter 2 at face value. Similarly Jesus who in answering the objection that he was working on the day of rest said: "My Father is always at his work to this very day, and I, too, am working" (NIV, John 5:17). Jesus is not contradicting his accusers; he is stretching their minds. Whilst it is true that God completed his work on the 6th day and then rested, it would be wrong to think that creation was the sum total of his work. The creation of the world only inaugurated the plan of the Father who, together with the Son, had continued to work towards the full revelation which had been in their mind (sic) prior to the creative activity described in Genesis Chapter 1 and 2.

[294] Despite claims about new species of micro-organisms arising, the reality is that new animals do not appear and that attempts to create something genuinely new and stable via mutagenesis has not succeeded.

[295] The FOXP2 gene.

[296] This theory is not an established fact and not all scientists subscribe to it.

[297] How different is the picture across the face of the Bible. Man was created to rule over a creation that had *the Man* in mind. The fact that everything was created by Jesus, and for Him and through Him (Col1:16) means that all of life (even the cosmos) was made to be organised, managed and directed by humans. This has important ramifications for the science of ecology. It also has bearing on global warming issues since it is a fundamental premise in the debate that the world has not been designed, and therefore has no flexibility built in to cope with various changes and fluctuations. For those Christians who see scriptural truth as having a bearing on science, the reality of the global flood of Noah provides evidence that the world can recover from catastrophe.

It is worth pausing for a moment to answer the objection that the line of argument being advocated is likely to cast God in the role of deceiver.[298] Since Collins takes it as axiomatic that the created order speaks only of development via random, undirected processes, and adds that it is the case that the Bible tells us that God is Creator, he reasons that to speak of God interfering in any way during the long eons of evolution would clearly imply that God has acted deceptively. God would be a kind of cosmic trickster (2007:175,176) telling us one thing in His Word, but something else when we look at His World. In essence the deceiver argument is another form of the Two Books' argument.[299]

The answer to this is to question whether Collins would countenance any theological problem were matters construed in the way *he* prefers, *viz.* that the creation appears in every respect to us to be *not* the handiwork of an intelligent designer, but instead appears to be a creation that is fashioned entirely by forces that are random and purposeless...and yet all the while to believe that God is actually controlling and directing everything. Is that not also deceptive if not an outright contradiction? It must be borne in mind that Collins is willing to pay the price that strong theistic evolutionism demands, which is that finally one will have to tamper with the orthodox doctrine of God. He writes: "God...had foreknowledge that [our] planet would lead to the development of sentient creatures through the mechanism of evolution by natural selection" (2007:82). Collins envisages God as no longer the active constructor but a passive ratifier of natural law. At bottom, God is constrained by the creation. This quote and others have a nascent ring of an almost ontological relationship between evolution as a principle and the actual being of God.[300] What we have here is a form of natural theology that demands the donning of Darwinian spectacles before reading the Bible and which smuggles into evangelical orthodoxy a very different picture of God and of creation.[301] Goldsworthy identifies the problem: "Theistic humanism assumes there is a God, but in common with atheistic humanism, asserts that man is in control of gaining knowledge. He gains...knowledge from nature through his senses, and reasons on this basis what is the correct approach to the study of the Bible" (1991:54).

---

[298] The issue of divine deceit was raised in 1973 by Theodosius Dobzhansky: "Does the evolutionary doctrine clash with religious faith? It does not. It is a blunder to mistake the Holy Scriptures for elementary textbooks of astronomy, geology, biology, and anthropology. Only if symbols are construed to mean what they are not intended to mean can there arise imaginary, insoluble conflicts. As pointed out above, the blunder leads to blasphemy: the Creator is accused of systematic deceitfulness" (1973:3).

[299] The notion from the time of Galileo that the Book of Nature should agree with the Book of God's revelation since both realms speak of God and what He has made.

[300] It would be an interesting exercise to investigate any possible link between theistic evolution and the rise of Open Theism. Both ways of thinking entail emergence, and both have an ontic ring to them.

[301] It is little wonder that Collins admits his own difficulty in understanding the death and resurrection of Christ in orthodox terms. For him, the work on the cross is God paving the way for us as individuals to be empowered to die to self (Collins, 2007:222).

There is a coda to this problem of divine deception as presented unwittingly by Dr Collins. In fact it is a deception worse than the one he considers young earth creationists[302] themselves to be unknowingly advocating. What is in view here is how the Bible itself portrays the matter *prima facie*. In other words, God actually speaks in His word in such a way as to clearly conjure up the idea that the world and all living things were in fact created by special acts and with specific purpose.[303] Collins may as well accept that for strong theistic evolutionism coupled with a strong belief in the doctrine of scripture, God is a deceiver...there's no way out of it[304] except to weaken one of the two sides of the tension.[305] The solution that most Christians in the academy therefore adopt is one which weakens the doctrine of scripture,[306] a strategy that comes at a high epistemic and theological price.[307]

---

[302] Young Earth Creationists are caricatured as simplistic and unreasonable in most of the published literature that exhibits a Neo-Darwinian stance. The general public would be quite astonished to learn the size of the influential minority of scientists with first class PhDs who hold teaching and research appointments in good universities or research institutions, yet who are Young Earth Creationists, e.g. John R Baumgardner who is on the staff at Los Alamos National Laboratory. He has a PhD in Geophysics and Space Physics form UCLA and he is the developer of the TERRA code, a 3-D finite element program for modeling the earth's mantle.

[303] A colleague, Dr Mervyn Eloff, said: "Whatever we think about the primeval world, it cannot be *less* than what Genesis says. If the first chapter talks about kinds we ought not to say less than that. If there were no distinct kinds intended to remain stable over time, then Adam's task of naming the animals would have been a futile exercise shortly to be obliterated by all the blending and smudging out of differences" (Mentioned by Dr Eloff in private conversation with me in Cape Town, Sept. 2007). Of course, Adam could have gone on naming and naming since there is nothing in the text that suggests he should stop. Yet the tenor of both chapter one and chapter two of Genesis strongly suggests distinct kinds.

[304] A possible way out of the dilemma is a Kantian route where the data of experience and observation conform to mind-dependent categories. However, this strategy will prove unsatisfying to most scientists and theologians alike.

[305] Most scientists in the academy who are Christians are unwilling to distinguish between science and evolutionary science. Since few people are willing to give up science (quite rightly), the only other alternative is to rework the Bible. This is a false dichotomy. The problem turns on what one means by 'science'. Expressed in other words, one can say that the academy insists on a definition of science that involves a metaphysical commitment to methodological naturalism. The metaphysics arises from an *a priori* exclusion of all non-natural causality in the historical and current emergence of life. In the modern debate this is pressed to the maximum and includes even the soul, an entity disallowable owing to its non utility within scientific explanation and therefore disallowable for Christians as an explanation arising out of any Bible text.

[306] A tentative statement produced by the Institute for the Study of Christianity in an Age of Science and Technology (ISCAST) takes this stance: "The principal reason that biological evolution, together with theories of cosmic origins of the universe and geological origins of the earth, are held to be incompatible with scripture is defective hermeneutical method in the approach to scripture. Meanings are read into the literary form of scripture which are beyond the apparent intent of the passages concerned"(ISCAST, 2000:2).

[307] It is instructive to ask theistic evolutionists just what they do take as literally true in the Bible. Since most of them will hold to a conventional Christian view of miracles, belief in Christ's resurrection poses no ostensible difficulty and this prematurely calms the concerns of many. But one can believe in the resurrection of Christ and still not embrace Christian theology or subscribe to a Christian worldview. When quizzed closely there is usually a denial of one or more of the following: a literal Adam and Eve, a denial that Eve was created out of Adam, a denial that human death did not exist prior to Adam (death is part of the mechanism by which natural selection created everything including man), a denial that when Adam and Eve fell that God interfered and introduced in their constitutions a radical and fundamental change (partly genetic?) and similarly for the whole of the cosmos, a denial that antediluvians lived for hundreds of years, a denial that animals were created in kinds (a feature that would render Adam's naming exercise meaningless if this distinction were not built into the creatures), that the animals were exclusively herbivorous prior to the Fall, a denial that there was a worldwide flood and that only eight humans out of the global population survived, a denial that there was only one language prior to Babel and that God at that time introduced a radical interfering change (partly genetic?) that laid the foundation for many new languages and so on. Theistic evolutionists seem to adopt the position that one should

5.6 Detectable Design in Creation in *the Bible*

The argument so far has attempted to show that the scriptures, when read properly lead us to infer the detectability of design in the creation. By 'properly' what has been advocated is a reading of the many texts of the Bible in the light of the revelation of Christ; an approach that ties Genesis and Christ quite tightly together, not only lending historicity to the first book, but also highlighting the recapitulation of Genesis themes in the new Testament. In the person of the son we find Genesis *redivivus.* In this way, we have argued that it is unlikely that any etiological theory of creation can be held without implicating the person and work of Christ, and that theories which block the detection of design are likely to pay a high theological price.[308] It should be clear then at this stage that the oft-encountered strategy of merely seeking to reconcile Genesis with Neo-Darwinian assumptions does not even begin to grapple with the difficulties. Additionally, it has been part of the argument that it is high time that Christians in the academy renew their interest in the possibility of *formal* constructs of design in the created order, owing to the strong biblical insistence that the created order was made-to-be-managed by man. *As* an incentive, we can now see the entire cosmos 'placed under his feet' in the man Jesus Christ. A closer investigation of the world that was *man*-made ought to yield instances of *formal* design, of which a modern example in the biosphere is likely to be the notion of Irreducible Complexity.

What has not been addressed up till now, however, is the question of whether there is in scripture itself the presence of anything *beyond* the strong inference that design ought to be detectable in the created order.[309] What would be of interest is whether there are any actual

---

first allow Darwinian science to feast on the data of observation (including Biblical data) and then any scraps left over can be gnawed on by the theologians...for now. Professional scientists who are theistic evolutionists might be surprised to learn that many scientifically literate professors in tertiary theological training teach their students that the Creed speaks truthfully when it says: "I believe in God, the Father Almighty, *maker* of heaven and earth..." and that those who framed that creed understood "maker" in a way incompatible with Darwinian randomness and non-directionality. The time-honoured truthfulness of Christian doctrine is tarnished by the insertion of unstated *inclusios,* e.g. "...maker of heaven and earth *as consistent with Neo-Darwinian doctrine...*". Furthermore, the Creed brings creation and Christ into close connection and urges reflection on the tight relationship between what the Father has made, and what the Father has achieved in sending His Son. One of the intriguing features of Biblical Theology as presented by Goldsworthy is that it can be harnessed to reveal a robust connection between many of these Genesis 'literalisms' and arguments in New Testament that depend for their cogency on the historical reality of the former.

[308] Unless such theories are held inconsistently. Some Christians appear to want to block any scientific formulation of design but at the same time want to notice and appreciate God's design in nature. For an example of this refer to the earlier footnote on Barclay.

[309] Not explored here is the existence of one book made up of 66 books even though the Bible is truly a member of the set of all things that constitute the physical world. Within the purview of Biblical Theology, the very nature of the uni-plurality of the scriptures is suggestive of design. After all, since no prophecy came about by the prophet's own will but originated in God (2 Pet 1:20, 21), God had a composite book in His mind prior to creation. However, the Bible doesn't anticipate this feature *per se* within its pages, i.e. there is no unambiguous

examples in the Bible that overtly harness observation of the physical world in order to detect design. This would entail instances that exceed examples such as "Go to the Ant" (Proverbs 6:6). Here, as in many other cases, the reader is encouraged to observe the way in which the creation is ordered or functions so as to learn wisdom.[310] The notion of design is, however, implicit although inferences abound. This is well summarised by Schnabel: "Israelite sages sought to understand how life and the world worked, asking questions which today are part of scientific enquiry and philosophical reflection: enquiry into the animate and inanimate world..." (Schnabel, 2000:847). Yet in virtually all of these cases, there is no explicit dissection or analysis of the creation. What would be of assistance is a text that demonstrates the observation of a living system where the parts function together and are seen to be a result of divine ordering.

Such an example can be found in a passage written by the apostle Paul. Out of concern for the Corinthian Christians and their need to be brought back into the apostolic fold and once again brought into submission to the gospel delivered once and for all, Paul is not reticent when requiring support for his arguments to turn to the empirical realm. In Chapter 12 of his first letter to these Greek citizens he attempts to instruct them concerning the Spirit of God and the church. They needed to hear what Paul had to say because in their 'wisdom' (1 Cor 1:22-25, 2:6, 3:18) they had introduced distortions into the Gospel and as a result, were creating divisions in the church, and causing a rift with its founding father. Some of these distortions, no doubt, were drawn from influences present in Greek culture, yet this does not cause Paul to draw back from allusions to the created world: to the ordering of the human body in Chapter 12, and in Chapter 15 to different kinds of 'bodies' - whether of the sun, moon and stars comparatively; or of humans, birds and fish comparatively.

In Chapter 12, Paul chooses to illustrate for his readers (or listeners) the uni-plural[311] nature of the Christian church by referring to the human body.[312] Earlier, he had anchored his

---

verse within the canon that indicates that God would eventually deposit among his people a finished literary work made up of discrete parts where each contributes to the overall function of that work.

[310] Goldsworthy writes: "In Proverbs 6:6 the industry of the ant, by being an example to the lazy man, shows the kind of unity that exists between the man and the insect" (1987:164).

[311] A term from Goldsworthy.

[312] Not everyone is agreed that this reference is to the human body *qua* physical body, and instead asserts that it would have been understood by the Corinthians as a common rhetorical device for drawing attention to political order and hierarchy. Thiselton (2000:992) cites Margaret M. Mitchell and D.B. Martin. "Margaret Mitchell...traces back the use of the term *body* as a rhetorical appeal for *harmony and interdependence* in political life." Mitchell cites Plutarch who speaks of 'the interdependence and mutual benefit of the eyes, ears, hands and feet of the body' and Dionysius of Halicarnassus (c. 30 BC) who wrote: 'If the foot should say *Because I am not a hand, I do not belong to the body...*' ". Thiselton himself inclines to this view which means that Paul effectively wasn't pointing to any human body as such. However, it can be argued that for Paul, the illustration was intrinsically creational and into the bargain an existent part of political rhetoric. At the beginning of his letter, Paul had broached the issue of wisdom which has its zenith in Christ, yet nevertheless

argument theologically in the uni-plurality of the Trinity (1 Cor 12:4-6) but recognised the pastoral value in buttressing his point by turning their attention to a physical example. What is of primary pertinence in the context of design detectability is that Paul writes:
"But in fact God has arranged the parts in the body, every one of them, just as he wanted them to be" (NIV, 1Cor 12:18). This idea is repeated a few verses later: "But God has combined the members of the body and has given greater honour to the parts that lacked it" (NIV, 1Cor 12:24b).

Two features of this passage are worth commenting on in the present context. The first is that Paul evidences few qualms in turning to the visible creation for illustration of spiritual truth. No doubt he had read Dionysius of Halicarnassus who, in about 30 BC, had written: "If the foot should say *Because I am not a hand, I do not belong to the body...*" (Thiselton, 2000:992) and realised that given its Greek status as an illustration it would be doubly useful for showing how a principle of the created order was reflective of a principle in the Trinitarian order (12:4-6). Paul, knowing the Hellenistic propensity for lensing the observable world through discursive theories, loosens from the grasp of the rhetoricians a prized illustration and re-locates it in the created order, now to be understood in connection with Christ. As an aid to grasping certain aspects of the new creation, especially aspects of God's new community, Paul points to the uni-plurality of the first creation as seen in the human anatomy. There is a level of ordering across the face of the creation that enjoys continuity with a level of ordering in the Christian church and in other spiritual matters ultimately because, when God created the world, *it was all conceived in Christ.* Hence Paul's enigmatic οὕτως καὶ ὁ Χριστός ('and thus Christ' - 1 Cor Ch 12:12b) is not simply juxtaposed fortuitously to the earlier part of the verse owing to mere observable correspondence. Instead, the creation *must* show principles that are observable in Christ, if only the Corinthians would look.[313]

---

remains to some degree in the wisdom tradition of observing the creation e.g. Paul planting the seed, Apollos watering it but God making it grow (Ch 3); the planting of vineyards, tending flocks, and muzzling oxen, and the sowing of spiritual things therefore reaping material things (Ch 9), and references to the sun, moon and stars and animal bodies (Ch15). The Corinthians were out of step with God's creation and sought a wisdom from the age, a wisdom suitable to Greek philosophical traditions. Corinthian pneumatology had led to a 'wisdom' that cut them off from how God had ordered his world. They wanted to have their own ordering and timing (eschatology). Yet Paul wishes to drive them back, not merely to the creation in Genesis (1 Cor 6:16; 11:7-8; 12:18; 15:45), but as it is now realised in the second Adam in whom the wisdom of creation is personified (15:22, 49).

[313] The Corinthians probably felt that they were part of a New Creation where the order of the Old Creation was no longer in force. This would have fitted nicely with any devaluing of the material world. They felt that men and women did not need to pay any regard to the creation order in Genesis. Yet Paul insists that in Christ, the Genesis picture is made even more clear (1Cor 11:3). The Christian church is a picture of a creation brought back to its proper system of relationships. In order to understand God's leadership structure for his New Creation, a correct understanding of gender order *at the beginning* is required yet re-orientated to fit in with God's original ordering in Christ.

The second feature has to do with the Pauline encouragement to observe how the parts of the body are arranged or ordered as God intended. An objection at this juncture might be that this text says nothing about the method God may have used and that the Darwinian insistence that God shaped the human body via random, undirected processes is quite consistent with his inscrutable power to will all things. Yet this objection misses the point. Paul urges us to look at the human body and not simply see various parts working in harmony but to see the parts arranged by divine design. This is different to seeing the body as the cumulative result of natural, accidental changes. God, who in himself is a uni-plurality, has built the principle of uni-plurality into the creation *designedly* such that its detection may serve as a basis for expecting organisational unity in the body *politic* of the second Adam. What is being argued here is that Paul's use of the body motif carries us somewhat further than mere *inference.* Here is an example of 'wisdom for the mature' drawing on the observable functional arrangement by the Creator in the 'phenotype' with full recognition of the ultimate functional arrangement in the blueprinted 'genotype' - the eternal Son of God together with his people, for whom he is the pattern. Paul drives this home: "And just as we have borne the likeness of the earthly man, so shall we bear the likeness of the heavenly man" (NIV, 1 Cor 15:49).[314]

5.7 Conclusion

This chapter set out with the aim of establishing a Biblical basis for expecting detectable design in the created order. As a strategy, the unifying and developmental effect of reading the Bible under the rubric of Biblical Theology within the presuppositional framework provided by Reformed Theology has been explored. In this way, a single narrative was brought to the fore. Using Goldsworthy as an exponent of Biblical Theology, connections were explored across the face of the Bible as well as connections between the Bible and the created order. The unity between Genesis and Christ was sharpened in relief and anchored in Christ as hermeneutic. Given the strong scriptural *inference* that the observable world should exhibit design, the question of *formalised* detection was probed. Behe's Irreducible Complexity was presented as a candidate of such *formal* design. The possibility of other such formalisms centred on the Titius-Bode law, supported by brief reference to DNA polymerase as a Turing machine. What required subsequent exploration was the possibility that somewhere within the canon there should exist an indication that extra-biological design is observable from the way that parts make up the whole. This desideratum took the

[314] This is not crude ontology. Certainly what is not being said is that Christ's physical body is to be ontologically identified with the church.

argument to 1 Cor Ch 12 and Paul's reference to the human body. Given the fact that Christ is the hermeneutical key to both scripture and creation, it is interesting that this luminous example can be drawn from the New Testament.

The greater Bible narrative that underwrites a 'referential sequence' clearly creates an expectation that the creation itself should track this story. And indeed it has done so: Eden, the Fall, the present, and the yet-to-come repristination already secured in Christ. The creation which fell through the disobedience of man now awaits the consummation of man's salvation. In Adam the creation fell and in the second Adam it is restored. Consonant with this developmental narrative is an interim picture of man who currently labours as subduer or structurer of this creation and, as he does so, he is addressed by the divine text which underwrites an expectation of order and design. It is significant that Wright's identification of 1 Cor 15 as "the fullest version we have of his [Paul] retelling of the still future part of the Jewish story...a redrawn apocalypse, which...only makes sense in terms of the story of Israel...the Israel-story, fulfilled, subverted and transformed by the Jesus-story, and now subverting the world's stories..." (Wright, 1993:406,409) is in the same data stratum as 1 Cor 12, from which has been drawn a specific case of design detection in the created order.

Therefore, formal detection of design such as Irreducible Complexity, although not to be accepted without rigorous subjection to critical examination, should be seen as logically consistent with the story of the Bible.[315] Biblical Theology, certainly as espoused by Goldsworthy, yields an overall narrative that weaves together creation and redemption in Christ, and in that process establishes a scriptural basis for detecting design.

[315] This conclusion is not far off from that drawn by the Presbyterian Church in America in their special report on creation tabled in 2000: "For the Christian who has been called to a vocation in the sciences, Calvin's words are affirmation that one's labours are helping to expound more fully the content of general revelation, 'as the providence of God is more fully unfolded'. In the last century that content has grown enormously through discoveries in physics, astronomy, biology, mathematics and chemistry. In spite of the reigning paradigm of materialistic naturalism, these discoveries attest to the wisdom of a super-intelligent Designer who has mercifully poured out His blessings on His people through the application of these scientific findings in fields such as medicine and engineering. In the realm of philosophy, a new movement called "Intelligent Design" has begun to challenge materialism and Neo-Darwinism by focusing on the scientific facts—such as the Irreducible Complexity of various biological systems. As we make the connection between the Intelligent Designer of general revelation and the Son of God of special revelation, we reaffirm Paul's statement of Colossians 1:16: 'For by Him all things were created: things in heaven and on earth, visible and invisible, whether thrones or powers or rulers or authorities; all things were created by Him and for Him' " (PCA, 2000:VII C).

CHAPTER 6

Irreducible Complexity entailments for the tri-interdisciplinary dialogue

> "When watching under a microscope one cannot help but feel that the molecular machines generating such activities must be endowed with unique properties. However, as we learn about these molecular motors, they have become more familiar and less magical..." (Vale & Milligan, 2000:94).
>
> "The telescope of Galileo did more to interpret Psalm 96:10...than the pen of the theologian" (Kidner, 1967:31).

6.1 Introduction

The earlier chapters set out to establish the dialogical viability of IC in engineering, molecular biology and theology. What is required at this junction is a brief inspection of the entailments arising from the intersection of these three domains where IC is the nexus.

6.2 Classification of dialogue type in the context of IC

John Haught has proposed a typology that divides up the science/religion dialogue into four approaches: Conflict, Contrast, Contact and Confirmation (Haught, 1995:3,4). The first is the Conflict position where a proper cross disciplinary discussion is difficult to maintain since each conversational partner is convinced that his or her domain is fundamentally at odds with the other. Dialogue is therefore often adversarial and each partner assumes that the position and argument of the other partner competes for truth and is subversive, and needs to be exposed as such.

In the context of a trilogue between engineering , molecular biology and theology, an approach favouring IC will admittedly lean towards the conflict model owing to the fact that the metaphysical assumptions underlying methodological naturalism exclude by definition first order detectable design. However, given the fact that an IC approach is viewed positively by some scientists as an aid to research, and coupled with this the fact that molecular biological descriptions of nano-organisation are redolent with machine language, it would be inaccurate to say that the Conflict model fully characterises the interdisciplinary dialogue.

Haught defines the Contrast position as one involving complete separation. In this situation, theology and science ignore each other believing that each realm is so different that no benefit could possibly accrue from any serious interaction. This position is reminiscent of

Gould's "non-overlapping magisteria" approach. In context, the history underlying the development of IC plus its ability to stimulate a conversation across the boundaries of each domain is a signal that the Contrast model is contradicted by the tri-dialogical nature of the intersection. Therefore, IC as dialogical nexus suggests that the notion of mutually exclusive worldviews for each domain cannot be correct unless IC is, after all, a fiction or artefact.

The third type of approach Haught labels Contact. Among such people there is a tendency to assume that there is at bottom one reality, and any differences in dialogue are due to differences in perspective. In this position theologians feel at liberty to defer to what scientists believe about matters such as origins and are concerned to adjust their theology accordingly. Correspondingly, scientists in this group do not feel threatened by religious belief and for the most consider theologians as important dialogue partners.

However, the arguments in the previous chapters have sought to establish the ontic status of IC.[316] It follows then that the degree to which this has been successful, correlates with the degree to which IC entails a model which speaks of Contact or even Confirmation, the 4th possibility. Once again, difficulties emerge because the assumption held by most scientists is that Neo-Darwinism should be regarded as veridical, in which case there can only be a pseudo-dialogue with an IC position. This means that whether or not the Contact model truly describes the dialogue is dependent on whether first order formalisms of design are allowable. People who uphold the conclusions of Judge Jones that IC as a principle breaks one of the foundational rules of science "by invoking and permitting supernatural causation" (Jones, 2005:64), are unlikely to consider any Contact position as viable. However, as pointed out in a previous chapter[317] the pejorative label of 'epistemic dualism' is unwarranted, and that IC as a limit is well positioned to serve a useful function within science, a function that would be in line with expectations consistent with the Contact model.[318]

---

[316] In other words, IC is an empirically identifiable, semi theory-independent property of certain systems including particular biosystems. The reason for including 'semi' in the description is to accommodate the critically realist fact that only in the perceptual wake of invention of mechanistic machines are humans able to see the machines in living systems. However, since human devices are built with many components that are integrated via laws of logic, the correspondence with similar systems of identical logic embedded in nature speaks of an independence that is not defeated by the time-line of discovery. The upshot of this is the implication that to all intents and purposes, IC is pretty much theory-independent, and may be viewed as a real property of the 'world out there'.

[317] See Chapter 4 under the second caveat in the introduction.

[318] It is also worth noting that among those theologians who favour this model, there are a good proportion who would take issue with the idea that science should be defined so as to exclude supernatural causation, since this would exclude not just God but also the activity of the demonic or of angels. On the surface the issue appears to be solvable by insisting on empirical regularity. Virtually everyone would agree that the demonic is not subject to empirical tests of repeatability. What complicates the problem however, is that when discussing origins (or historical science) scientists themselves do not expect laboratory reproducibility. Therefore, given that in some countries it is illegal to sell a property without disclosure of 'additional features' which might include haunting (a

Finally there is what Haught calls Confirmation. This is a much stronger approach to the dialogue and tends to see the scientific enterprise as something that arose out of religious thought and in some ways remaining dependent upon it. Haught writes: "...the disinterested desire to know, out of which science grows and flourishes, finds its deepest confirmation in a religious interpretation of the universe. Such an approach does not look for or expect in return any scientific endorsement of religion. Rather it simple maintains that a religious vision of reality inherently fosters the scientific exploration of the cosmos[319]...the confirmation approach may be stated as follows: religion's claim that the universe is a finite, coherent, rational, ordered totality, grounded in an ultimate love and promise, provides a general vision of things that consistently nurtures the scientific quest for knowledge and liberates science from association with imprisoning ideologies" (Haught, 1995:22).

Those who support IC as a dialogical pathway also seek to explore something of the Confirmation model. Biblical theology as defined by Goldsworthy treats the story of the Bible as something that enjoys genuine historicity and, as argued, creates an expectation that the creation will be corrigible even to the degree where the detection of design can be encapsulated in first order formalisms. IC is a good candidate for fulfilling this expectation. If it makes Biblical sense to say that the creation was made to reveal the purpose of God in Christ (the God-man) to the extent that the entire created order is steadily being brought into submission to man and to *the* Man, then it also makes sense to say that the application of human analysis to that creation will reveal something of the Mind that created all minds. Chapman observes that "the mechanical clock reflected that mind which had created the very firmament itself...and was sufficiently present in the mortal creation to enable human beings to replicate the very motions of the firmament here on earth" (Chapman, 2002:201). This means that if human minds steeped in the scriptures observe machines in molecular

---

forensic situation that could entail a legal history), it would seem irrational to insist that supernatural causation falls outside the scope of scientific explanation. Eric Goldman, a Professor of Law, writes of a court case in New York: "Stambovsky v. Ackley is the famous 'haunted house' case where the buyers sought rescission because the seller failed to disclose that the house was haunted...Among other remarkable aspects, the court proceeds from the legally unprecedented proposition that the house was haunted *as a matter of law*" (Goldman, 2005:1). At the trial Justice Rubin said: "It should be apparent, however, that the most meticulous inspection and search would not reveal the presence of poltergeists at the premises...therefore, there is no sound policy reason to deny plaintiff relief for failing to discover a state of affairs which the most prudent purchaser would not be expected to even contemplate" (Rubin, 1991:1).

[319] Chapman agrees: "It is the argument of this book that...science not only grew out of religion, but that, as human knowledge became broader and more sophisticated over time, the two developed a creative interaction with each other, each casting light upon different aspects of human experience. For science and religion not only spring from the same intellectual roots in the human psyche, but also stand on similar ground today. For both science and religion stand for reason, as opposed to unreason; for the belief that truth really exists and can be arrived at by disciplined modes of thought, as opposed to merely being a social construct..." (Chapman, 2002:26).

nature, it is highly likely that the inference drawn by those minds will be that such observation is due to the plan and purpose of God[320], and not due to natural, random processes.

A concern that should be voiced at this junction is the danger of viewing the scriptures as a scientific textbook. Haught's doctrinal position is immune to this since he views the Bible as unable to contribute any data to scientific knowledge (Haught,1995:22).[321] However, if the metaphysical construct underlying methodological naturalism is replaced by a theistic construct, and if in addition it is assumed that the word of God speaks in a normative way about history, then it can be argued quite rationally that science neglects to its detriment matters such as the global Noahic flood, original human and large animal vegetarianism, ante-diluvian human longevity etc. This is not to say that the Bible is being treated as a manual on science. Yet the Bible is unique in that it claims to be a book that not only consists of God's very speech, word for word, but also claims not to contain teaching that is mingled with teaching originating from humans, angels or demons[322]. Reformed Christians believe this, and defend this position within a coherent, rational and philosophically mature system of thought that can hold its own in its encounters with the academy.

The *2004 report on creation delivered to the 71st General Assembly of the Orthodox* Presbyterian Church of America refers to a case brought to the Assembly in 1996 involving Dr Terry Gray[323] who wished to teach in the church that Adam had primate ancestors. The report notes that the decision took the line "that the mind of the church was to rule out animal ancestry for Adam's body and to affirm that man was a direct creation from the dust of the ground (Genesis 2:7)...on the whole the mind of the church seemed clearly to proscribe the

[320] The ambiguity is deliberate: God intended that there should be scientific discovery on the one hand; on the other hand, as and when we see molecular machines, we see what could well be ascribed to divine design since the Bible makes no room for another creator. It should be borne in mind of course that IC itself does not entail epistemic dualism, and therefore as an empirical principle presents a wider set of aetiological possibilities. However, approaching the world from a Biblical standpoint does tend to narrow things down.

[321] "Religion does not provide scientists with any information about the universe that science cannot gather all by itself. Religion has no special insights to dish out about particle physics or the genetic code" (Haught, 1995:22). It is quite true that the Bible does not talk about quantum reality *per se* or about the idea that biological information is coded into helical strands of sugar. Yet if the Bible in both old and new Testaments speaks of a worldwide flood, and of a ship that carried various animals and humans to populate the post-diluvian world, why should it necessarily be the case that science should disregard such information? The Biblical account has bearing on issues like ancient ship building, the ability of the ecosphere to recover from a major catastrophe, and the human gene pool. The same could be said for demon possession. Should Christian psychologists in the academy ignore the veridical nature of scriptural reports of such phenomena?

[322] The Bible does of course contain speech uttered by the devil e.g. in the temptation of Jesus in the wilderness. But such speech is recorded in words from the mouth of God so that whilst a truthful, historical, scriptural record exists of sentences actually uttered by an evil spirit being, the way to understand those words and properly interpret them is also given in the text. Therefore, when Matthew in Ch 4 of his gospel reports what the devil said to Jesus, what we hear is God's word on the matter, and not the devil's word, even though demonic speech is faithfully written down. In a proper reading of the Bible therefore, it can be said that neither human nor supernatural beings are heard. God alone is heard, and all other speakers outside of heaven are undone.

[323] See Terry Gray quote on homology on pg96 of section 4.2.2

evolution of man" (Coppes *et al*, 2004:1664). This would certainly be the position held by Goldsworthy and by many other Christian thinkers. The clear implication is that the Bible provides historical data that should be received as factual and true even if it is in conflict with the majority view held within science. The aforementioned report of 2004 as well as the 'Creation Study Report' of 2000 submitted to the Presbyterian Church of America (Barker *et al,* 2000:1) both insist that Genesis texts be read as historical yet both reports do not require an approach to the Bible that views it as a textbook on science.

6.3 Hindrances to IC as a dialogical nexus.

The major obstacle that faces IC as a nexus for an interdisciplinary dialogue has already been mentioned several times *viz.* conflict with methodological naturalism. The arguments marshalled in the previous chapters have attempted to demonstrate that IC is indeed an empirical principle and entirely consistent with certain creational expectations arising from Reformed Biblical theology. Therefore, what is required is a revision of methodological naturalism rather than the insistence that those who champion IC be ignored.

However, there are several other hindrances which should be briefly addressed at this point. These will be dealt with under two major headings, the first touching on scientific concerns, the second theological.

6.3.1 Hindrances motivated by scientific concerns

6.3.1.1 Practitioners of IC have not published whereas practitioners of true science do

In August 2004 an American peer-reviewed biology journal[324] published an essay by Dr Stephen Meyer[325] in which he argued for an alternative explanation for origins. Dr Meyer is key thinker within ID and his paper titled "The Origin of Biological Information and the Higher Taxonomic Categories" argues that "...no current materialistic theory of evolution can account for the origin of the information necessary to build novel animal forms, and proposes intelligent design as an alternative explanation" (Meyer, 2004:213). The article generated enormous protest from certain quarters of the scientific community the burden of which was

[324] *Proceedings of the Biological Society of Washington* (vol. 117, no2, pp213-239) published at the National Museum of Natural History located at the Smithsonian Institute in Washington D.C.
[325] Dr Stephen C. Meyer is Director of Discovery Institute's Centre for Science & Culture. Dr Meyer holds a PhD from Cambridge in the History and Philosophy of Science, a B.Sc. in geology and physics and four years experience as a geophysicist with the Atlantic Richfield Company.

centred on why a scientific journal would publish a 'creationist' article.[326] Dr Meyer's essay made no mention of anything specifically 'creationist' beyond referring to 'design' and 'intelligent design'. The protest eventually led Dr Richard Sternberg who was editor at the time of publication, to post a detailed response on his website.[327] In defence of his actions, Sternberg describes how the Meyer paper "underwent a standard peer review process by three qualified scientists, all of whom are evolutionary and molecular biologists teaching at well known institutions" (Sternberg, 2004b:1). He also mentions that a number of scientists having read the article prior to publication told him that in their opinion "sooner or later the intelligent design issue will have to be debated in a reasoned manner." Sternberg outlined the four kinds of responses he has received stating that an antagonistic influential minority assume that the peer-review process should bar[328] such writing from serious scientific publication.

It is important to say something about the problem of publication at this junction since it would be expected that any serious scientific discussion of new ideas be supported by published articles in accredited journals. If it is claimed, that IC has emerged within *mainstream* science among credible scientists and thinkers, it would be a matter of course to expect a review of the relevant literature. However, there is very little of substance if indeed much at all published in peer-reviewed journals purporting to show how IC is motivated and applied, thus demonstrating its viability as a true scientific principle. This absence is cited by critics as sufficient warrant for denying IC (and ID along with it) any scientific status from the

[326] Sternberg writes that of the four kinds of responses he has received regarding the Meyer article, a small but significant response was "one of extreme hostility and anger that the peer-review process was not barred to a creationist author" (Sternberg, 2004b).

[327] Dr Richard M. V. Sternberg. He has two Ph.D.s: one in evolutionary biology (molecular evolutionary genetics) and another in theoretical biology. He has been in the employ of the National Institute of Health and is based at the National Center for Biotechnology Information (GenBank), where his work and research involves systematics and genome biology. He has published more than 30 papers in peer-reviewed scientific publications. His field is Process Structuralism (Sternberg, 2004b:1).

[328] Lee Smolin, pioneering theoretical physicist and author (no friend of ID *per se*), addresses an even deeper concern which he calls the 'dark underbelly of academic life'. What he is referring to is the way in which peer review works against the hiring of scientists by universities, a state of affairs that would tend to head off publication at the pass. Smolin writes: "Peer review...is a funny name because it differs markedly from the notion of a jury of one's peers, which suggest that you are being judged by people just like yourself, who are presumably fair and objective. There are real penalties - prison - for jurors who conceal a bias. In the academic world, with few exceptions, the people who evaluate you are older than you are and more powerful...and an unintended by product of peer review is that it can easily become a mechanism for older scientists to enforce direction on younger scientists. This is so obvious that I'm surprised at how rarely it is discussed. The system is set up so that we older scientists can reward those we judge worthy with good careers and punish those we judge unworthy with banishment from the community of science. This might be fine if there were clear standards and a clear methodology to ensure our objectivity, but, at least in the part of the academy where I work, there is neither" (Smolin, 2007:333).

outset, and a basis for refusing the new movement permission into the arena as a participant in serious discussion. As it stands it is a noteworthy objection.[329]

However, the publication of a paper by Behe and Snoke (Behe & Snoke, 2004:1) in the peer-reviewed journal *Protein Science* in August 2004 requires consideration. The journal's referees permitted the authors to say among other things: "Although many scientists assume that Darwinian processes account for the evolution of complex biochemical systems, we are skeptical. Thus, rather than simply assuming the general efficacy of random mutation and selection, we want to examine, to the extent possible, which changes are reasonable to expect from a Darwinian process and which are not. We think the most tractable place to begin is with questions of protein structure. Our approach is to examine pathways that are currently considered to be likely routes of evolutionary development and see what types of changes Darwinian processes may be expected to promote along a particular pathway" (Behe& Snoke, 2004:1). One can infer several things from this. Firstly, scientific or technical journals expect that papers submitted should abide by the rules, which means that new theories or ideas are not to be laid out in philosophical/metaphysical form, but argued in scientific terms utilizing currently acceptable scientific mechanisms, with reference to current research and where possible involving empirical data arising from new work. It is presumably the case that ID development of IC has not produced enough material that meets these requirements, a situation which would certainly explain the lack of journal publication. One could hardly blame the Neo-Darwinian scientific community for this. A second inference is that the journals exhibit resistance, quite rightly, to papers that are tendentious or appear to serve a cause. Yet in spite of the fact that everyone knows that Behe is linked to a cause, his article co-authored by Snoke was nevertheless published in *Protein Science* because the article does not attempt to subvert the main goal of the journal. The Behe and Snoke paper, although it expresses scepticism that Darwinian processes can account for biochemical complexity, does not adopt a crass anti-evolution stance *per se* but frames its problematic and its analysis with appropriate scientific concern. The ID movement would benefit from following this publishing pathway.[330]

---

[329] ID supporter Angus Menuge has attempted to explain why it is that there is so almost no peer-reviewed publication of research from the ID community. His reasons are that firstly ID is not so much concerned about new data as it is with the interpretation of existing data; secondly that "many scientific journal editors refuse to publish articles and even letters that explicitly defend ID" (Menuge, 2004:44,45). As a coda he also mentions that ID maintains that Darwinists have themselves not published in important areas especially in providing causally specific reconstructions of the pathways that lead to the formation of what ID call irreducibly complex structures.

[330] It is quite possible to argue that from 2000 up till the Kitzmiller vs. Dover School trial in 2005, journals were perhaps 'lightening up' given the massive debate on the internet. However, it will be interesting to see if this new attitude persists in the wake of the trial. Scientific journal editors would surely feel the need to exercise

There is more to articulate in regard to this important matter of peer review and the publishing process. Certainly something should be said about what is perceived as an increased willingness by journals to publish material that departs from the standard theory. This implies, as just intimated, that there have to be other reasons for the notable lack of research papers harnessing the tenets and methodology of this new approach.

However, the furor over the Meyer paper indicates that the peer review process nevertheless is still expected by the Neo-Darwinian community to achieve more than what is generally acknowledged. It ought to be recognised that a good number of scientists are unwilling to publish material that contradicts the standard theory if they perceive that such publication might negatively impact their careers or their funding.[331] If the analogy of a shark-net may be permitted, the review system at the present time certainly does protect the bathers from undesirable and harmful intruders but at the cost of snagging and killing other useful life. In his attempt to find a definition of science that would help us understand better what *ideally* (but sadly not in actuality most of the time) directs it and drives it forward, Lee Smolin felt he could do no better than quote Richard Feynman: "Science is the organised scepticism in the reliability of expert opinion" (Smolin, 2007:307).

Such matters need to be borne in mind therefore as we review the central features of IC in the context of serious science. The lack of references from leading scientific journals can be attributed in some measure to current scientific hegemony.[332] However, as just pointed out,

---

caution in publishing material that might be perceived to arise from or assisting a movement now officially labeled 'non-science' by a highly publicised trial.

[331] The questions put to Dr Scott Minnich (an ID supporter) during the Kitzmiller trial are illuminating, as are his answers. Question: "Hence the expression, publish or perish, right?" Dr Minnich: "Right. And publish and perish as well." Question: "That's your second very good joke." Dr Minnich: "I'm concerned, you know. There's a risk involved. That paper that I published for the conference proceedings ran a lot of *risk* in terms of the implications and how people would review my work based on the conclusions that I was making. And that's part of the problem, is that, to endorse intelligent design comes with risks, because it is a position against the consensus. And science is not a democratic process. But peer review works both ways. And it is, like I said, it's dangerous. I'm taking a *risk* in putting these ideas out, as well as everybody else in this area that's trying to get published." Question: "And that's because the entire scientific community rejects the idea that intelligent design is science, isn't that correct?" Dr Minnich: "That is correct, at this point. And that is the history of science as well." Question: "And this explains why you have not published any articles on intelligent design in any peer reviewed scientific journals, correct?" Dr Minnich: "By your definition, no. But I have one in a conference proceedings, so I'm willing to put my ideas out there. And, but again, my focus in my laboratory is on pathogenesis. That's my primary concern. And that's what I publish on. And, you know, I have to keep my lab funded" (Minnich, 2005c:1).

[332] The screening effect of peer-review has far reaching ramifications. Not only are many important scientific papers turned down because of conflict with the scientific presuppositions of the peer group, but in addition many scientists do not want to risk their careers by incurring accusations that their work is "unscientific". Such attacks might affect tenure, and there is also the risk of losing funding. Examples of this problem occur in many other fields e.g. cosmology. Over thirty influential scientists many of whom are professional astronomers wrote an open letter to the scientific community published in New Scientist in 2004 protesting the hegemony of Big Bang cosmology. They write: "Today, virtually all financial and experimental resources in cosmology are devoted to big bang studies. Funding comes from only a few sources, and all the peer-review committees that

it does seem that resistance from the establishment is not the whole explanation for this paucity.

6.3.1.2 IC is a negative principle and ineffective as a scientific method

Judge Jones expressed in his final memorandum concerning the Kitzmiller vs. Dover School trial that: "Irreducible complexity is a negative argument against evolution, not proof of design, a point conceded by defense expert Professor Minnich" (Jones, 2005:72). However despite the fact that this is not quite the burden of Prof Minnich's statements during the trial, it is true that IC's primary function is negative since it obviously highlights the inability of a step-wise process to produce a functioning machine that requires all its parts from the outset. Therefore IC is primarily aimed at disproving a Darwinian evolutionary scenario for certain systems.[333]

Yet IC has a positive role that exceeds that envisaged by Dembski. In Dr Minnich's case it informs the actual laboratory mindset and provides a framework akin to that needed by engineers dismantling a device to see how it works (Minnich, 2005a:7).[334] Furthermore, the idea that first order formalisms of design are discoverable provides positive impetus for further work. Also, the idea that IC systems exist brings with it a need to refine existing Neo-Darwinian or other Neo-evolutionary explanations. Finally, IC provides an opportunity for novel experimentation in biology.[335]

---

control them are dominated by supporters of the big bang. As a result the dominance of the big bang within the field has become self-sustaining, irrespective of the scientific validity of the theory" New Scientist May 22-28. 2004. p20 [Web:] http://www.cosmologystatement.org [Date of access: 10 Dec. 2004].

[333] A good question to ask is whether Judge Jones over reaches himself by saying that IC is "not proof of design." On the surface, if one has a choice of only two explanations A or B, and upon investigation one decides that B is not correct, it appears that one is only left with A. Disproving B has the effect of proving A. If IC provides an insurmountable hurdle for evolution, one might think that one is left with little choice but to consider design. Dembski expresses the point this way: "Behe's logical and empirical points are mainly negative: they focus on limitations of the Darwinian mechanism. Behe's explanatory point, by contrast, is positive: it provides positive grounds for thinking that IC biochemical systems are in fact designed...a scientific explanation needs to invoke causal powers sufficient to explain the effect in question" (Dembski, 2004a:296,297). However, Judge Jones does not over reach himself. As dealt with in caveat number 2 in the introduction to chapter 4, IC does not entail epistemic dualism. That is to say, there is not only a binary choice between A and B, but between A,B,C and D, where perhaps D could be the God of the Bible. Just because a system exhibits IC does not automatically entail design by a designer (or the God of the Bible) since there are other logical options.

[334] Minnich writes: "Design criteria have served me well in my own studies and research" (Minnich, 2005a:7). He goes on to relate how as a graduate student tasked with thinking up a rapid method for detecting *Salmonella* in food he devised an approach logically predicated upon design.

[335] See the experiment proposal in 4.3.3

At its inception a decade ago ID promised that it would lay the foundation for a new research program in science (Dembski, 1998:29).[336] Yet despite having a well developed tool in the form of IC, this program has not published *per se* – that is to say, it has not shown how it can move science forward *nor* has it actually moved science forward by producing new work based on IC or other ID principles. Publication in peer-reviewed journals has been minimal and in every case can be shown to lack the detailing of any new empirical research. Whilst it is true that there is reticence by editors to publish 'alternative papers' as explained earlier, this still does not constitute a closing of the door. The problem of course is that the primary thrust is essentially negative. It is a viewpoint seeking scientific acceptance, yet it is a viewpoint that is almost totally taken up with limitology. This means that it is geared for finding ways showing that Neo-Darwinian evolution could *not* have occurred. This kind of critique of course has a role to play, but it does not make the position into a positive science. Behe may well have a positive explanation of the origin of certain systems, but he has not outlined a positive methodology *per se*, nor shown how a research program could develop. Nor has any other ID thinker shown this. And given that there is no research program (which seems hard to envisage even in principle), the overall effect does not recommended itself *as a corrective to the current scientific method.*

Yet the substance of the argument of the preceding chapters is that IC is indeed an empirical feature of the biosphere at the nano level. It would seem then that the only way forward is for those who uphold the notion of IC to continue to demonstrate[337] in what ways the notion can make a difference in actual scientific practice.

6.3.1.3 IC and Behe's scientific competence

It is generally acknowledged that in a debate where the opposition cannot afford to lose, the strength of the arguments used against them can be gauged by the readiness of the opposition to attack the credibility of key individuals in the other party. Robison for example has said in a post on Talk Origins: "That Behe is ignorant of these basic molecular genetic and biochemical facts is a depressing commentary on the level of research that went into his book" (Robison, 1996:2). Behe responded to this and is worth quoting at length: "In this group of posts I am repeatedly said to be "ignorant". That may be true, but I think there is reason to give me the benefit of the doubt. I have a PhD in biochemistry from the University of Pennsylvania (received an award from Sigma Xi for 'Best Thesis'), postdoc'd for four years at the National Institutes of Health (as a Jane Coffin Childs Fund postdoctoral fellow), have

[336] Writing in 1998, Dembski said: "I predict that in the next five years intelligent design will be sufficiently developed to deserve funding from the National Science Foundation" (Dembski, 1998:26).
[337] An example is the paper by Behe & Snoke published in Protein Science (2004:1).

been an academic biochemist for 14 years, have gained tenure at a reasonably rigorous university, have published a fair amount in the biochemical literature, and have continuously had my research funded by national agencies (including a five-year Research Career Development Award from the National Institutes of Health) and currently have research funds. Well, perhaps I am a real biochemist, but am simply "ignorant" of work on the evolution of irreducibly complex biochemical systems? Perhaps. But I am not unaware that evolution is a controversial subject, and certainly tried to cover all bases when researching and writing my book. I have no death wish. I do, after all, have to live with my departmental colleagues, a number of whom are Darwinists. So I searched the literature as thoroughly as I could for relevant information and tried to be as rigorous as possible. Perhaps there are step-by-step, Darwinian explanations in the literature for the complex systems I describe in my book, but if there are I haven't seen them, nor has anyone brought them to my attention" (Behe, 1996b:1).

Prof Lampe took this further. He compiled a list of all of Behe's publications, and ran a check on the number of times his work has been cited. His conclusion was that "based on the evidence, Michael Behe is obviously not a scientist of the first rank and appears not to be doing any serious work at the present time. More to the point, ID creationism is not an important idea in science. Science is a meritocracy where ideas earn their place" (Lampe, 2005:1). It is worth pausing for a moment to reflect on one or two hidden characteristics of this meritocracy. In the discipline of physics, Lee Smolin laments the fact that after three decades there have been no key discoveries in his field. He proposes as a major reason for this state of affairs the fact that the academy enshrines a certain type of meritocracy: one where older scientists keep out of university employment those whose ideas are out of step with the perceived progress of science.[338] Smolin says in a chapter titled "Seers and Craftspeople" that the academy is hostile towards anyone who asks foundational questions, something "seers" like to do. The stance adopted is one where such thinkers are viewed as not being "scientists of the first rank". He writes: "It is a cliché to ask whether a young Einstein would now be hired by a university. The answer is obviously no; he wasn't even hired then" (Smolin, 2007:328). Returning to the world of biology, our response to Lampe is that IC should be evaluated on its own terms and not per the respect accorded its author. In any event, few scientists, even of the first rank, originate paradigm shattering discoveries. IC however holds some promise in this regard, and could possibly open up an entirely new

[338] Attempting to define this noble enterprise Smolin ends his chapter titled "What is Science?" by quoting Richard Feynman who said "Science is the organized skepticism in the reliability of expert opinion" (Smolin, 2007:307).

approach. Also, the size of one's publishing output[339] may be one way, perhaps the best way, to conduct good science, but it is not the only way.[340] Many notable scientists like Hannes Alfvén and Halton Arp have struggled to get papers published due to the 'shark net' of peer review. All in all, it is unwise to adopt a contemptuous attitude to a new idea simply because its advocate is not on a list of top achievers. In addition, there are plenty of examples of thinkers[341] who are indeed achievers but who are marginalised by the scientific community due to their views.

Another critic, John M Lynch[342], posted his blog response regarding the Kitzmiller trial: "One of the highlights of the Dover trial was the takedown of Michael Behe that occurred on day 12, where Behe testified that "the scientific literature has no detailed testable answers on how the immune system could have arisen by random mutation and natural selection" (Lynch, 2006:1) only to be shown such literature by plaintiffs' lead counsel Eric Rothschild. Nick Matzke was instrumental in putting together the literature that Rothschild used, and he and a number of denizens of the Panda's Thumb (Andrea Bottaro and Matt Inlay) have a paper in the current edition of *Nature Immunology* highlighting Behe's idiocy" (Lynch, 2006:1).

Lynch's offensive remarks and overall conclusion though apparently acceptable to the scientific mainstream, are quite uncalled for. Behe can be vindicated because he has never said that the scientific literature lacks creative ideas as to how living systems could have evolved. What he has said is that at the level of detail that interests biochemists, one can never find an explanation that shows how a multipart nano-system could have arisen from a functionally different system of lesser parts via an incremental process. The Neo-Darwinian

---

[339] Smolin writes: "Most academic scientists though they succeed in career terms - get grants, publish a lot of papers, go to a lot of conferences, an so on - contribute only incrementally to science. At least half our colleagues in theoretical physics fail to make a unique or genuinely lasting contribution" (Smolin, 2007:330).

[340] Smolin refers to Julian Barbour writing that he shows "how the career of a successful seer differs from that of a conventional academic scientist. Such a person does not follow fashion...people like this are driven by nothing except a conviction, gained early, that everyone else is missing something crucial...in the furtherance of an academic career there is no output whatsoever. Julian Barbour, when he was ready, changed science more than most academic scientists have, but at an age when most academic scientists are up for tenure, he had absolutely nothing to show for his work" (Smolin, 2007:322).

[341] Brian Josephson, physicist, who won Nobel Prize in 1973 abandoned and renounced conventional physics in favour of something mystical. He wrote papers with titles like "Physics and Spirituality". He maintained that religion was important for science and society. He discovered what has been called the Josephson Junction which is a superconducting circuit, and it produces the Josephson effect which has been harnessed in the building of SQUIDS (Superconducting Quantum Interference Device - used in very sensitive magnetometers) which can detect neural activity in the brain, and faint seismic activity in the earth.

[342] John Lynch is an evolutionary biologist and historian of biology at Arizona State University where he is a Honors Faculty Fellow at the Barrett Honors College and affiliated faculty with the Center for Biology & Society.

community complain that Behe is setting the bar unreasonably high[343], but critics of Neo-Darwinism suspect that the real problem is that the only proof at this level is the assumption of naturalism.

It is worth mentioning at this point that Behe claims in several places to be evolutionist[344], and at times a card carrying believer in Neo-Darwinism. Behe writes: "Intelligent Design can happily co-exist with even a large degree of natural selection. Antibiotic and pesticide resistance, antifreeze proteins in fish and plants, and more may be explained by a Darwinian mechanism. The critical claims of ID is not that natural selection doesn't explain *anything* but that it doesn't explain *everything*" (Behe, 2004:356). In this context, one can understand Behe's assertion that "evidence of common descent is not evidence of natural selection. "For Behe, homologies among proteins (or organisms) are evidence for descent with modification i.e. for evolution. However, natural selection as a proposed mechanism for how evolution might take place "must be supported by other evidence if the question is not to be begged. This of course is a well known distinction (Mayr 1991)" (Behe, 2000a:3).

Behe's experience of hostility resulting from his unwillingness to accept Neo-Darwinian explanations and instead proposing an alternative like IC has been paralleled in the reaction

---

[343] "Some Darwinists accuse me of setting the evidentiary standard so high that it is impossible for them to meet it. The evidentiary standard, however, is not set by me but by the complexity of the biochemical systems themselves. If malfunctioning of the blood clotting cascade or other complex system can cause a severe loss of fitness, then a Darwinian scheme for its evolution must show how this can be avoided. And if the system can malfunction when small details go awry, then the scheme has to be justified at least to the level of those details. Unless that is done, we remain at the level of speculation" (Behe, 2000a:5).

[344] Behe writes: "For the record, I have no reason to doubt that the universe is the billions of years old that physicists say it is. Further, I find the idea of common descent (that all organisms share a common ancestor) fairly convincing, and have no particular cause to doubt it. I greatly respect the work of my colleagues who study development and behaviour of organisms within an evolutionary framework, and I think that evolutionary biologists have contributed enormously to our understanding of the world. Although Darwin's mechanism - natural selection working on variation-might explain many things, however, I do not believe it explains molecular life" (Behe, 1996a:5). "...not to say that random mutation is a myth, or that Darwinism fails to explain anything – it explains micro-evolution very nicely" (Behe, 1996a:22). "Kenneth Miller...is like myself a Roman Catholic, and he makes the point in public talks that belief in evolution is quite compatible with his religious views. I agree with him that they are compatible" (Behe, 1996a:239). "...the skeptic can happily concede that many biological phenomena *are* explained by natural laws. He can agree that beak shape and wing color can change under selective pressure, or that different proteins in the same structural class, such as the alpha and beta chains of haemoglobin, may have arisen through Darwinistic mechanisms. But the believer in the universal application of physical law is stuck. He must maintain, *against the evidence,* that different protein classes, like cyctochromes and immunoglobins, found their way by raw luck through the vast, dark sea of non-functional sequences to the tiny islands of function we observe experimentally" (Behe, 2002:2). "I am sometimes singled out by Darwinists as the most "reasonable" Intelligent Design proponent, because I've written that I think common descent is true. I'm embarrassed to admit that I derive some odd, involuntary pleasure from being thought the "best" of the lot. My reaction is especially irrational because some of my Intelligent Design colleagues who disagree with me on common descent have greater familiarity with the relevant science than I do" (Behe, 2005:2). "I should also point out that, contrary to Professor Orr's assertion, we do not know that swim bladders evolved into lungs *by natural selection.* There is absolutely no evidence for it. It may be likely that lungs are descended from swim bladders, but no experiment has indicated that natural selection can do the trick. In fact, no one even knows at the nuts-and-bolts molecular level what it would take" (Behe, 2000a:3).

felt by others who have taken a similar road. Former Professor of Zoology at University of the Western Cape, Dr Walter Veith, writes of his experience at another university: "The reaction of my colleagues to my change of heart stunned me...the conflict has convinced me that we are not just dealing with scientific paradigms where opposing scientific views and theories are discussed in the spirit of congeniality...I was a senior lecturer at the time, with numerous graduate students working under my supervision, but the tide of bitter opposition[345] and the cold war which I experienced made it impossible for me to continue my work unaffected and I offered to resign" (Veith, 2002:47).

In turn, there are criticisms leveled at the scientific community which can be sharpened by briefly looking at four very significant parameters of Behe's argument:

Firstly, he has stated that in his opinion Neo-Darwinism can indeed account for a number of systems but not all systems. The critics appear to forget that Behe is an evolutionist who considers Neo-Darwinism to hold much by way of merit.

Secondly, he has stated that regarding *basic* biochemical structures such as the bacterial flagellar motor, there are no detailed accounts showing the mechanism by which such a system could have arisen by gradualistic means. Behe is *not* saying that there are no accounts, just that the level of detail which any competent biochemist should require are completely absent from the literature. Subsequently, the situation has come about that in every single case where a list contradicting Behe's claim is presented, close scrutiny shows that this level of detail is *still* not forthcoming. The mechanism that is sometimes adduced is "gene duplication" yet Behe is surely correct to point out that no-one has shown how the newly copied gene acquires its new function. The critics have not understood or perhaps do not *want* to understand what Behe is driving at.

In the third place Behe has also formulated IC for *basic* systems in the context of Darwinian gradualism. Yet many of the critics cite *macro* systems as refutation of IC, a strategy which falls outside of Behe's scope. This is simply a failure to read properly. Additionally, the

[345] Scott Minnich asserts that the Neo-Darwinian community blatantly ignores the fact that some of the research has been undertaken on the basis of design principles, and that any successes are immediately reckoned as a triumph of the Darwinian paradigm. He writes: "What is ironic about this debate [about the TTSS] is that a clear relationship between the flagellum and type III secretory systems was recognised on the basis of reverse engineering (i.e. design principles). Early attempt to draw attention to this fact were negated by evolutionary arguments. When the evidence became overwhelming about the relationship between these seemingly 'disparate' systems, it was immediately claimed as evidence for evolution. This example is illustrative of my experience as a scientist, which has led me to believe that evolution is best seen as postscriptive (the taillights of biology), while design principles (the headlights of biology) tend to drive scientific enquire and progress" (Minnich, 2005a:10).

context of Darwinian gradualism is most interesting because what appears to be the case is that many Neo-Darwinism critics sensing difficulties with their position fall back on *non-Darwinian* mechanisms to bolster their defense. If IC truly does cause problems for Neo-Darwinism explanations, how can it be coherent for Neo- Darwinian supporters to launch a counter attack against Behe that relies on a *non-Darwinian* approach e.g. like gene duplication. Weber and Depew may be content to widen matters and profess that "all we need at present is a plausible naturalistic explanation, whether Darwinian or not" (Weber & Depew, 2004:177) yet that misses the significance of IC's power to block Neo-Darwinian etiology for certain systems. Margulis and Sagan may be correct to say that: "the results of new laboratory and field science contradict, bypass or marginalise...Darwinism except for variations within populations of mammals and other sexually reproducing organisms. The mammals constitute one ten-millionth of all species living today" (Margulis & Sagan, 2002:39). Yet, it is IC which holds promise of producing the clearest logical proof of exactly that contradiction of Neo-Darwinism.

Fourthly, Behe has pointed out that the biological world has forgotten that the Darwinian program proceeded on the 19th Century assumption that the eventual opening of the *Darwin's Black Box* would reveal a simple world. In his 1996 book Behe opines that "the key to persuading people was the portrayal of cells as "simple"...from the limited view of cells that microscopes provided, Haeckel believed that the cell was a "simple little lump of albuminous combination of carbon"...it seemed to Haeckel that such simple life, with no internal organs, could easily be produced from inanimate material. Now of course, we know better" (Behe, 1996:24). Behe is asking questions of a foundational nature, an approach that is disparaged in the academy, but disparagement is not an acceptable response to a very real concern. The wider public who are ultimately the employers of all scientists should be requiring that Neo-Darwinism re-open the case.

Our conclusion at this point is that neither Behe nor his work are worthy of the disparaging remarks entertained by the scientific community. It is our opinion that there has been too much haste in attempting to dismiss or silence IC along with its author, and in the process a number of clear arguments that underwrite it have been overlooked. In addition, those familiar with the tactics deployed by scientists in debate will not be fooled by *ad hominem* rhetoric.[346] Furthermore, the conceptual clarity and formulation of IC, together with its

[346] Beller cites the approach of Max Born and Walter Biem who were highly critical of the physicist Lande who had strongly dissenting views about the reality of wave-particle duality and who in 1968 wrote "using the characteristic rhetorical tactics of discrediting the opponent and appealing to authority." Beller goes on to cite examples: "Lande does not realise the historical origin of the dualistic interpretation" and does not "correctly describe its physical meaning"; he is driven by " prejudice" and "dogma" and he "ignores important physical

application to several basic systems are testimony to the scientific and intellectual ability of its author.

6.3.1.4. The predictive success of Neo-Darwinism contradicts the IC of some systems

In 1997 Russell Doolittle wrote: "On a more modest plane, about ten years ago we predicted that certain of the genes encoding the blood clotting cascade would be absent in jawless fish. This prediction was made on the basis of comparing the sequences of blood clotting factors in mammals and estimating how long it had been since the gene duplications leading to their existence. In particular, we noted that fish should not have both Hageman Factor and Prekallikrein, two of the factors described in Behe's outline of blood clotting in his book. As far as I know, a study aimed at establishing whether these clotting proteins are present in lampreys and hagfish has not yet been undertaken, but I am willing to wager a goodly sum about the outcome. What I want to know, however, is whether Behe will accept such a result as a proof of the concept, or whether he will, in typical creationist style, simply try to find a way out" (Doolittle, 1997:1).

Predictive success is a noteworthy feature of a good scientific theory and does much to strengthen confidence in the correctness of that theory. Yet IC cannot be overturned this easily, one of the reasons in this case being Behe's limitation of IC to the common hemostatic pathway[347] which therefore excludes Hageman and Prekallikrein factors. Furthermore, it is interesting to note that in the vast literature attempting to refute Behe's ideas almost nothing is said about the predictive success of Neo-Darwinism at a biochemical level, or for that matter at any level.

6.3.2 Hindrances motivated by theological concerns

6.3.2.1 IC is inconsistent with suboptimality[348]

It would seem illogical for any critic to produce a dysteleological argument given Behe's careful setting up of boundary conditions. Such an argument takes the form that if it is postulated that there is a designer required to explain the origin of *some* living systems such as those exemplified by Behe, then just one example of failed design in *any* other system(s)

---

discoveries" " (Beller, 1999:241). Beller notes however that Lande's withering counter led to Born and Biem retreating.

[347] See 4.2.1.2

[348] A suboptimal system is one which appears to exhibit poor design or reveals problem solving at a structural level inconsistent with the notion of an all powerful Designer.

overthrows that postulate. Clearly this line of reasoning is fallacious. However, it has enjoyed some acceptance and success probably because most people who are antagonistic to IC or ID assume a false connection between Behe's position and creationism. Certainly the latter position insists that *all* living things have been designed.[349] But Behe's position ought not to be dismissed on the grounds of its perceived links to creationism.

Paul Nelson has produced good work examining the argumentation for dysteleology and suboptimality. He writes: "The imperfection argument for evolution is popular and compelling. It draws on widely shared intuitions about God and the nature and history of the structure of organisms. Discussing the argument with philosophers and biologists, I was struck by how many of them accepted it unreservedly as an impeccable piece of scientific reasoning. Despite its wide appeal, however, the argument is also deeply problematical. The argument employs theological concepts, such as "a wise creator", and aesthetic or teleological notions, "perfection" and "imperfection," that cannot perform the analytical and empirical work required of them. Each premise of the argument is attended with difficulties" (Nelson, 1998:4). Nelson goes on to show that Darwin set the trend by assuming a view of God and perfection that had been determined by English Natural theology. Nelson continues and explains that Gould's reference to the Panda's thumb as being sub-optimal for stripping bamboo is quite tenuous given that many other observers[350] have thought otherwise. Yet even if one grants Gould his claim, one cannot be sure that the Panda never used the thumb for something else originally. Nelson writes: "...The thumb may have some unknown primary function for which it was designed, and the panda has co-opted it secondarily to strip

---

[349] However, even this ought to be nuanced: the original design was located in archetypical forms and allowed via natural processes to produce the immense variety we see today. There would be disagreement within the creationist camp as to what extent such diversity should be understood to occur. Such nuancing generally escapes those with a naturalistic bent. Paul Nelson says: "Hendrik Murris...argues that within the theory of creation, known genetic processes may explain the origin of some, though not all, species of flightless birds. In a related analysis, the German creationists Reinhard Junker and Siegfried Scherer explain the origin of the rudimentary wings of flightless beetles and insects as cases of degenerative microevolution. Junker later authored a systematic treatment of rudimentary organs and atavisms within a creationist framework. In these dynamic theories of creation, extant organic designs are the products not just of original creative intent, but also of the perturbing effects of secondary causes, e.g., natural selection, mutation, or genetic drift. Thus, in any assessment of the optimality of an organic design, the perturbing effects of secondary and natural causes must be separated from original design (if such a historical reconstruction is possible)" (Nelson, 1998:3).

[350] Nelson (1998, 5) cites Schaller *et al* who say that the Panda's thumb works like a successful forceps (Schaller, G., Jinchu, H., Wenshi, P., and Jing, Z. 1986. The Giant Pandas of Wolong, Chicago: University of Chicago Press). Even Philip Kitcher grudgingly admits that the thumb functions sufficiently well as far as the panda is concerned. He writes: "Like other carnivores, they lack an opposable thumb. Instead, a bone in the wrist has become extended to serve as part of a device for grasping. It does not work well. Any competent engineer who wanted to design a giant panda could have done better. But it works well enough" (Kitcher, 1982:139). Common experience in regard to engineering design is that a result that "works well enough" is usually acceptable. Those who have had the opportunity to disassemble machines and appliances will know that certain designs fall considerably short of perfection. If it is argued that in the case of God making things, design should be perfect, the question then moves to the grounds for believing that God is perfect, and the criteria for assessing [perfection in the fallen world.

bamboo. One may have failed to identify the correct reference situation by which to judge the design (perhaps by looking at too narrow a slice of the panda's life history). The flippers of marine turtles, for example, strike us as rather badly designed for digging holes in beach sand to place eggs. The same flippers, however, perform efficiently in the water, where the turtles spend most of their time. Which reference situation takes precedence in an optimality analysis?" (Nelson, 1998:4).

Behe himself in *Darwin's Black Box* addresses this issue which he calls the "argument from imperfection" (Behe, 1996a:222-224). Consider this syllogism:
1 A designer seeking perfection would produce a vertebrate eye without a blind spot.
2 The vertebrate eye has a blind spot.
3 Therefore Neo-Darwinian evolution produced the vertebrate eye.
The most fundamental problem with the argument, says Behe, is to be found in the premise where it is assumed that perfection must of necessity be the primary *desideratum*. However, designer motive could very well preclude the placing of perfection at the top of the list - witness 'built-in obsolescence' in many engineering designs. The next problem with this argument is also to be found in that same premise where critics of design theory assume that the said motives of any proposed designer of biological life are obvious. Behe points out that motive is not always discernible from what is made, and cites Freeman Dyson who in discussing why extra-terrestrial life might build certain structures said "I do not need to discuss questions of motivation, who would want to do these things or why. Why does the human species explode hydrogen bombs or send rockets to the moon? It is difficult to say exactly why" (Behe, 1996a:224). The third problem Behe addresses in this argument has to do with the *non sequitur* entailed by the syllogism. Surely the best deduction that could be sustained by such a syllogism is that the vertebrate eye has not been made by a designer seeking the assumed perfection. It does appear to be churlish to single out one minor "flaw"[351] in a design (a flaw which causes no problems for our vision anyway) and focus on this to the exclusion of the numerous extraordinary design masterpieces that comprise the rest of the eye, and for which Neo-Darwinism is hard pressed to propose a gradualistic aetiology.

Therefore we conclude that dysteleological and suboptimality arguments fail on two counts:[352] they do not consider carefully enough the boundary conditions specified by Behe

[351] Of course, we might yet discover a good reason for designing the eye this way beyond simply considering parsimony.
[352] For the Muslim-Judaeo-Christian position there is also the issue of the Fall. Revelation informs us that God cursed the world, an event that had profound physical results. Suboptimality and dysteleogy would need to be assessed by Muslims, Jews and Christians against this backdrop, which in essence is saying that what we observe

for IC[353], and they rely too heavily on naive presumptions about how a creator would or would not design living systems.

6.3.2.2 IC and ID are dangerous to theology

Kenneth Miller, a professing Christian, concludes his essay "The flagellum unspun" by saying that ID fails because "it thinks too little of God" (Miller, 2004:95). Weber and Depew, also both professing Christians, write that ID "makes natural theology of a certain Paleyesque kind central to Christian theology...The danger of ID considered as a theological position...is that it potentially implies a limiting conception of God while adding nothing to the pursuit of scientific exploration. These facts suggest that from a theological as well as a scientific perspective, the presumption should be in favour of methodological naturalism: the working hypothesis that a scientific explanation for a puzzling phenomenon will be found that does not invoke a source of functional design outside of nature...there is no theological reason to expect nature to be marked with *vestigia dei* that are to be discerned and interpreted by recognising "irreducible complexity" or "explanatory filters" as a basis for inferring design" (Weber & Depew, 2004:185,186).[354]

---

now is not how the creation operated at the beginning. At the Fall, all of life was altered so as to embody principles of danger and decay. For example, zoologist Dr Veith has suggested that poison fangs were not original, but came about through the alteration of existing dental structures. Similarly thorns (Veith, 2002:263, 265). It is noteworthy that type III systems have their genes residing on plasmids, and not the central chromosome of the gram negative bacteria that harness them. It might be the case that the original design of animal systems and perhaps all living systems was undertaken in such a way that such systems could be varied or altered by the insertion of DNA via virus type action or the introduction of new structures via plasmid vectored horizontal gene transfer. A designer cursing his design could introduce or activate 'seeds' in a post Eden world e.g. plasmids etc which would carry genetic instructions not only for devices like type III injection systems, but also for the manufacture of virulence proteins that would subsequently introduce disease. Since plasmids also confer upon bacteria various kinds of resistance including antibiotic resistance, it might well be the case that the designer released into his world bits of 'software' that were calculated to bring about structural and behavioural changes so as to turn an originally perfect creation towards danger, disease, decay and death. This line of reasoning would explain how it is that particular viruses 'know' what to do to protect themselves. Matt Ridley writes: "Human papilloma virus which causes cervical cancer has two genes on board whose job is to switch off TP53 and another tumour–suppressor gene" (Ridley, 2004:241).

[353] Someone might point to an example from nature that to their mind exhibits sub-optimality, and think that this citation overthrows IC. This approach has some merit, but it must be remembered that IC is applicable to simple micro systems, and not to complex systems.

[354] This line of thought is pursued by James P. Hurd , a professing Christian and defender of Neo-Darwinism and who teaches in the department of Anthropology and Sociology at Bethel College USA. He writes: "It is illogical and unbiblical to create a false dichotomy between what the fossil record tells us and what the Bible tells us. In the end there is only one story, God's story, written in his Word and in his Works. Through paleoanthropology, humans can trace the finger of God's works in the world. The God who conceived the universe and spoke it into being is the same God who sustains all its laws and guides all its transformative and emerging processes, including the process of hominid evolution" (Hurd, 2003:230). We point out that the fossil record does not tell us anything that is theory neutral, that is to say, it always "speaks" in a manner consistent with the presuppositional stance of whoever conducts the observation. What Hurd is saying is that there is only one story which on inspection turns out to be a story that has to be consistent with Neo-Darwinism. In the tussle between revelation in the Bible on the one hand (from whence Hurd would claim to know about God) and on the other hand the conformity of the universe to Law and Process, in Hurd's opinion the latter must always be allowed

It is been the burden of the preceding chapters to dissent from this view quite strongly in the main, though concerns ought to be voiced regarding ID's tendency to over-value natural theology. Critics like Weber and Depew would be within their bounds were they to construe certain ID approaches e.g. Dembski's explanatory filter, as leaning too heavily towards proving God's existence. It is one thing to provide various arguments for belief in God. It is quite another to create an algorithm that claims to leave everyone in no doubt. It is maintained, however, that IC is different in that it targets Neo-Darwinian incremental development, but at the same time provides a richer opportunity for inference to the best explanation.

From the outset of this project it has been noted that given such a wealth of propositional revelation in the Bible, it is extraordinary that biblical claims regarding the Creator should be thought by any professing Christian to be unconnected to any direct empirical observation or possible *vestigia dei,* so called. In point of fact, our *tour d'horizon* reveals precisely that such connectedness should be expected by those who show any respect for the Word, an expectation that should lead to a heightened interest in a formulation such as IC rather than a knee-jerk desire to dismiss it. Yet, far above "theological reasons" there exist propositional revelatory reasons exemplified in actual texts which assert that God created his world in a particular way.[355] On top of all of this, it should be noted that "limiting conceptions of God" are not undesirable *per se*, since it is entirely likely that fallen man is prone to imagine a god quite distinct from the true. It is the Bible that places limits upon our conceptions so as to conform them to reality. Ironically, it is precisely that imagination of man that sees the whole universe and God himself as conforming to law that places unwarranted and disturbing limitations both upon God and his creation. It ought to alarm educated and reflective individuals who are acquainted with Scripture that so many who profess faith and hold positions of honour within the academy should make such loud claims that in regard to God's

---

dominance. For Hurd, the Bible should never be allowed to contradict the latest theories in paleoanthropology: this in his view would be illogical and unbiblical.

[355] An example would be the Old Testament and New Testament assertion that the origin of woman was not by descent from any precursor, but a novel creation derived from material taken from an original man. Another example is the clear statement that God gave all the land animals, all the birds and all creatures on the ground, green plants for food (Genesis 1:30). This is repeated several chapters later (Genesis 9:3) where after the flood, God indicates that just as he had given only green plants before, now everything could be eaten. The observation that hardly anyone in the sciences treats this as factual information should not be taken to mean that science has actually disproved this. On the contrary, some have observed the opposite. Zoologist Dr Walter Veith, formerly Professor of Zoology at the University of the Western Cape, has described the observable differences exhibited by carnivores when raised on cereal diets. He points out that lions reared in this way i.e. herbivorously, will later on as mature animals shy away from meat, and display noticeably less aggressive behaviour. He also mentions that in the wild and after the kill, lions prefer to eat the rumen first i.e. the partially fermented plant products in the victim's digestion (Veith, 2002:266).

creation, it is Darwinism that universally confers sight to understand what we see.[356] Actually, the tenor of the inspired text leads us to conclude that apart from God's verbal intervention in the human scientific endeavour, man is inexorably driven to turn away from what the creation is saying about God, and to choose instead an explanation that suits his fallen nature. Therefore, *contra* Weber and *contra* Depew, we would asseverate that what is truly dangerous theologically is to bring all the data of experience and observation to the bar of naturalism.

6.3.2.3 IC makes nonsense of the Biblical idea of design

Anglican author Tony Payne writes: "One can only claim something is "designed" if one can contrast it with something that is "not designed". The examples of irreducible complexity would only point to intelligent design if we accepted that the more ordinary or explicable phenomena were *not* the work of an intelligent designer. But the Bible insists that everything in this world is crafted by its creator. Psalm 19 says that the creation tells forth the glories of its Creator in the everyday, ordinary miracle of day and night, and sunrise and sunset - things which we can now describe scientifically, but which are no less the actions of God being so described" (Payne, 2006:24). It seems that Payne's argument in essence takes the line that since knowledge involves binaries such as "designed/not designed", any situation that supplies experience of only one side of the binary therefore inhibits the ability to observe that distinction in that situation. This argument creates a number of problems, the most prominent centering on the word "design" where there is a failure to note its use in several different situations. A snowflake exhibits design, but such arrangements are readily shown to be the result of laws governing the packing of small molecules. Autopoiesis[357] is to be found everywhere. But Behe's point is that some living designs *cannot* be ascribed to autopoiesis, and cannot be readily ascribed to any other known natural mechanism since they are most resistant to being construed as the end result of a series of ancestral precursors. One wonders whether Payne's argument allows for any recognition of different types of design.

Another problem is that a researcher working in the human world of engineering gains a very good idea of the distinction between what is designed and what is not designed. If that

[356] Haught writes: "We consider evolution to be, at least provisionally, a most appropriate and fruitful scientific framework within which to think about God today. We full endorse the attempt to construct an evolutionary theology" (Haught, 1995:69).

[357] From the Greek αυτο and ποίησις (feminine noun) meaning 'self-made'. The best spelling is therefore "autopoiesis" but the literature sometimes has "autopoeisis" (Weber & Depew, 2004:180), and sometimes "autopoesis" (Polkinghorne, 2004:254)

researcher then scrutinizes a living system such as a molecular machine, it would seem illogical and impractical to insist that the researcher suspend her knowledge of design obtained in the human sphere. This would imply that there is a severe disjunction between the way God goes about design and the way we do. Yet as Michael Ruse has made clear[358], without the engineering metaphor science would be paralyzed (2000:230). Payne's great difficulty, and one shared by so many Christians sympathetic to Darwinism, is that he assumes that when it comes to origins, scientists "read" nature as she is, and are influenced hardly at all by naturalistic assumptions.

Concerning Payne's objection, the line of reasoning presented in previous chapters argues that design is indeed empirically detectable in a first order manner, and that the very use of machine language and concepts by molecular biologists is proof enough that even though the Bible says all of creation is designed, that does not mean such design is beyond scientific detection.

6.4 IC and a constructive vision for dialogue

Limitology has a negative ring to it and sounds unpromising, yet a limit like IC can play a vital role in the knowledge gaining process. Epistemic boundaries exist in science and in the theological consideration of the observable world. It is especially important for Christians to investigate the nature of the limits placed by the word of God upon epistemic ability. Humphreys has surely gone too far when he says: "The account of Exodus...including a burning bush, the ten plagues of Egypt...the Red Sea being forced back...water from the rock...special food called manna...a mountain blazing with fire at the top...I believe that there is a natural explanation for all of these events" (Humphreys, 2003:4,5).[359] However, specifying discursively the precise nature of the epistemic limitation is perhaps an impossible task. It is much easier for scientist to look up from a reading of scripture and speak in general terms and say "only God can reveal God" than to say "secondary causes have ontological reality".[360] Intriguingly, the Bible does not present us with a system that demands that we either "multiply entities"[361] or "save the appearances", but instead presents us with a Creator who made a creation full of kinds (limits) yet quite obviously with inbuilt potential to self-generate vast variety (secondary causation).

---

[358] See 3.4.1 and 3.5.

[359] Humphreys adds that what made "these natural events miraculous was their timing e.g. the River Jordan stopped flowing precisely when the Israelites were assembled on its banks and desperate to cross...I believe that this natural explanation makes this miracle more not less believable" (Humphreys, 2003:5).

[360] In this dissertation it is held that secondary causes do have an ontic foundation in the created order due to God having built 'laws' and logical relationships into reality.

[361] Ockham's Aristotelian objection to Platonic metaphysics.

The wonder of Christian epistemology is that after reading *the* Book we can look away and "read" the other book, and then re-read the first again as faith seeks understanding. Kidner felt this acutely when he wrote: "The telescope of Galileo did more to interpret Psalm 96:10...than the pen of the theologian" (1967:31). The mature Christian is aware that whilst the Word must be prior in interpreting the world, the world (of nature) must be allowed to interpret the Word within a hermeneutical spiral (Wright, 1993:33)[362]

Neo-Darwinian science is convinced that it is impossible to look at the world and find any basis for or encouragement towards an empirical formulation of first order design. Therefore Christians who hold to this way of seeing are compelled to read the Word accordingly. Yet there are those scientists who differ in this, and who experience empirical difficulties with totalistic Neo-Darwinism. People like Michael Behe are convinced that first order formalisms like IC stare out from the observable order. For people like them, a chastened Darwinism means that the Word is readable in ways that are more consonant with orthodox Christianity.

Ideally, a Miller and a Behe should be in constant dialogue together perhaps with the Contact model in mind, and seeking where possible even the Confirmation position. Christians who are fully fledged Neo-Darwinians ought not to think they can do without ongoing dialogue with Christians who are less convinced about the comprehensive power of the New Synthesis, and vice versa. This dialogue should be undertaken for the sake of science and more importantly, for the sake of the Gospel.

An interesting parallel to this can be found in the experience of serious Bible expositors. Those who labour at exegesis often discover that some of the most helpful commentaries are written by people who are very liberal. It almost seems at times that those who are regarded as guardians of dogma are not always the best to seek out for the fruits of exegetical skill, whilst those who have no commitment to the tramlines of orthodoxy are sometimes thus enabled to traverse a different path garnered with fresh insights from the text. The point here is not that mainstream doctrine can be dispensed with, but simply that in the interests of working properly with the data (the Bible) it is beneficial to consult widely.

For individuals in the debate it is likely that in the final analysis the matter will be seen to be what any discussion about creation always is: a wisdom issue. Therefore only after many

[362] Wright says that "one still meets scientists...who believe that what science does is simply to look objectively at things that are there...people assume...that they know things 'straight'...one meets this among naive theologians who complain that while other people have presuppositions, they simply read the text straight" (Wright, 1993:33).

years of Bible reading, and of challenging conversation with opposing viewpoints can the individual attain the required maturity.

CHAPTER 7

Conclusion

> "Th' unwearied Sun from day to day, Does his Creator's power display; And publishes to every land, The work of an Almighty hand.' Thus Joseph Addison in 1712 concluded an article...on Psalm 19:1 - 'the heavens declare the glory of God.' The words pose a question...to what extent do the wonders of the natural world...point beyond themselves, to something or to someone beyond the world that we can see, hear and touch?" (McGrath, 2006:181).

> "Does evolutionary doctrine clash with religious faith? It does not. It is a blunder to mistake the Holy Scriptures for an elementary textbook...Only if symbols are construed to mean what they are not intended to mean can there arise imaginary, insoluble conflicts...the blunder leads to blasphemy: the Creator is accused of systematic deceitfulness...Evolution is a light which illuminates all facts, a trajectory which all lines of thought must follow. This is what evolution is" (Dobzhansky, 1973:129).

> "Narratives are powerful instruments for shaping the way we see, imagine and think about the world. Without biblical narratives, for instance, we might not be able to see the world in its created and covenantal ordering" (VanHoozer, 2000:59).

> "The perception that God cannot be benevolent is very old...the God of traditional Christianity and Islam damns us for eternity if we do not worship him in the right manner. Is this a nice way to behave? I know, I know, we are not supposed to judge God according to human standards, but you see the problem here: If we are not yet convinced of His existence, and are looking for signs of His benevolence, then what other standards can we use?...I am all in favor of a dialogue between science and religion, but not a constructive dialogue. One of the great achievements of science has been, if not to make it impossible for intelligent people to be religious, then at least to make it possible for them not to be religious. We should not retreat from this accomplishment" (Weinberg, 1999:7,8).

7.1 Concluding thoughts on dialogue

7.1.1 Neo-Darwinism and narrative

In the third epigraph, VanHoozer points out the importance of the foundational role stories play (2000:59). The biggest mistake perhaps is to think that the Neo-Darwinian account can be divorced totally from story. Without question it draws intimately upon science, of that there is no doubt. It is a deeply scientific story. But it is not unambiguously written in the fossil record nor anywhere in nature. It is narrated and written by humans attempting to construct a comprehensive account of how everything came about by natural processes unaided by any external or mystical influences. All who tell this story agree that the latter influences are rendered unnecessary at least as far as science is concerned. It is a powerful tale[363], perhaps *the* most powerful in modern history, and strong enough to create the

[363] Dawkins' "The Ancestor's Tale" is inspired partly by Chaucer's Canterbury Tales. Dawkins writes: "Many of Chaucer's Tales have their own prologue, and some have an epilogue too, all written in Chaucer's own voice as narrator of the pilgrimage. I shall occasionally follow his example. As with Chaucer, an epilogue may serve as a bridge from one tale to the next" (Dawkins, 2004:15). Dawkins doesn't of course mean anything more than that he has chosen a literary work to inspire a new telling of what he considers a true theory-independent history

impression for many that here at least there is no underlying made-up story, only facts. This vanishing trick leaving behind a faint Cheshire smile is easily accomplished because children are inducted into the universal narrative as soon as they're old enough to watch television. When you grow up seeing the world this way, all other ways of seeing appear ridiculous, dependent as they so obviously are on a traditional and unlikely story (by contrast). As an attestation of native subversive power, witness the ability of this underlying narrative to conceal itself to the extent that its devotees can undermine other ways of seeing merely by identifying that their principle weakness is a dependence on *story* instead of fact.

Therefore it is hard, often impossible, for Neo-Darwinists who are religious to avoid thinking that evolution is possibly *the* great principle of all reality, towering over everything else including the Bible, even to the point of casting a shadow over God, or at least indicative of some profound attribute present in His nature. This is what Dobzhansky meant by citing Pierre Teilhard de Chardin: "Evolution is a light which illuminates all facts, a trajectory which all lines of thought must follow" (Dobzhansky, 1973:129). Cited from his most celebrated paper titled "Nothing in Biology Makes Sense Except in the Light of Evolution", Dobzhansky was actually insisting that nothing that man can know makes sense except by the light of this foundational principle. It is in short, an evolutionary epistemology. Hence his insistence that no-one should interpret the Bible in any way that would present a clash with this doctrine. This is what van Huyssteen means too when he writes that "...the theological notion of the *imago Dei* will have to be revisioned as emerging from nature itself...by natural evolutionary processes" (van Huyssteen, 2006:xviii, 322). That there is a link between the story of man and the story of God is made tellingly clear: "...sometime in our past our ancestors were part of a remarkable emergence: an emergence into self awareness, with an increasing capacity for consciousness, the possibility for moral responsibility, and the yearning and capacity for aesthetic and religious fulfilment, this fact alone offers fascinating challenges to traditional Christian theology, since it is no longer possible to claim some past paradise in which humans possessed moral perfection, a state from which our species has somehow "fallen" into perpetual decline" (van Huyssteen, 2006:37). Besides the positivistic telling of this story as "fact", the upshot is that if this is indeed true, then the story about Jesus as related in chapter five is most definitely not true. The whole point of Goldsworthy's retelling of Reformed Biblical theology detailed in chapter five is to show that if the Biblical portrayal of Eden is denied, and along with it a denial of sinless and morally perfect human beings walking and talking literally with God, who then rebel and are ejected from their place and

---

of evolution. However, the "Tale of Evolution" as a phrase is evocative, and in its own way is suggestive of the age old human propensity to provide explanations that make sense of what the story teller knows is required by the leaders of the tribe.

from their friendship with God and who come under His curse of death, then not only is the Biblical view of Jesus' death problematic since he is no longer required to undo a curse of death[364], but the entire Biblical explanation of Jesus as the God-man is undermined. And if the story of the Son is altered, then the story of God as told by God is altered. As everyone knows, the Bible takes a dim view of such tampering. But that is a price many Christians are prepared to pay in order to preserve a naturalistic account. Haught is an example of this and writes: "Because of the divine omnipresence, nothing in the universe's story or in life's evolution can occur outside of God's own experience. If Jesus is truly the Incarnation of God, then his experience of the Cross is God's own suffering. By virtue of life's unbroken historical unity Christian theology may be so bold as to assume that the aeons of evolutionary suffering in the universe are also God's own suffering[365]. And this would mean that the whole of nature in some way participates in the promise of resurrection as well" (Haught, 2005:17).

If there is no Fall, then there is no answer to give physicist Steve Weinberg who in essence is asking why a good God would create the mess that is our tortured world. If there is no Fall, then at the heart of both history and the Christian gospel is something profoundly irrational: A Father putting His Son to death on a cross. Why would a good Father sacrifice a sinless and morally perfectly Son if only to reveal at best[366] an ontological principle[367] of suffering or at worst to mystically suffer with the universe in order to redeem it?

---

[364] "Death" in the Neo-Darwinian scheme is God's appointed way of bringing all creatures into existence, including man. If death is part of God's ordained scheme for bringing man into being, Christ could hardly be thought of as dying to deal with death.

[365] Among other difficulties this roots suffering ontologically within God so that God himself is an evolving being who suffers. In addition, death and all that it entails is also made to find ontological correspondence in God.

[366] There is a problem with saying that Christ died for our sins in this context because death for sin cannot be disconnected from God putting Adam and Eve under the sentence of death for their sin. It is true that a court of law can sentence someone to death for a heinous crime and not intend by that sentence to convey the philosophical or theological idea that the court believes that death exists in the world because the first humans rebelled against God. But to say that Christ died for our sins is to talk about a story that unites Genesis with the cross not only because Jesus is called the second Adam, but because of New Testament language that strongly presupposes an original sinless state in the absence of death e.g. "For since death came through a man, the resurrection of the dead comes also through a man. For as in Adam all die, so in Christ all will be made alive" (1 Cor 15:22).

[367] Since both Father and Son are in this case obliged to submit to this principle, it is therefore necessarily the case that God is under the operation of a law formalisable as external to Trinitarian relations, even if such a law is held to be operational within the Godhead ontologically. This means that a fundamental principle within Deity can be expressed as the necessity for the divine persons to cause each other to suffer. This sounds very foreign to orthodox ears, if not indeed unchristian.

7.1.2 Dialogue with IC

In the light of the above, it is logical that any suggestion that first order formalisms like IC are discoverable in nature must be shouted down by those who hold strongly to Neo- Darwinism. Such formalisms must be ruled out in principle because their existence would not only speak of an unacknowledged naturalistic Grand Narrative (something Neo-Darwinians are not happy that science should be able to see), but would also help revivify another story[368], the one told by God. It is worth noting that the conflict model described by Haught (1995:4) owes its existence as much to this evolutionary sentiment as to anything else. Steve Weinberg's paper read at the Conference on Cosmic Design expresses it well: "I am all in favor of a dialogue between science and religion, but not a constructive dialogue. One of the great achievements of science has been, if not to make it impossible for intelligent people to be religious, then at least to make it possible for them not to be religious. We should not retreat from this accomplishment" (Weinberg, 1999:8). This is helpful to bear in mind since it is generally held that the conflict is due to the attitude of fundamentalist believers in creation. Yet on inspection it is clear that the conflict is equally due to fundamentalist believers in evolution.

It might be objected that the attempt to treat IC seriously involves a return to some form of foundationalism. It is hoped that the defence of IC's empirical nature and the attempt to view the dialogue as an intersection of narratives has shown *en passim* that there has been no covert appeal to Cartesian epistemology. The latter project is an historical enterprise that attempted unashamedly to demonstrate the power of human rationality to logically construct all knowledge upon a foundation of indubitable beliefs rooted in a universal rationality. Implicit in the approach of this dissertation has been the desire to investigate in each case a normative story: a narrative normative to engineering, normative to molecular biology and normative to theology; and where each follows a trajectory suggested by the idea of a multi-part whole where loss of a part severely compromises function. In the intersection of the three narratives, a non-foundationalist story emerges that detracts from Neo-Darwinian hegemony.

Despite protestations to the contrary, IC may well be a principle that is empirically observable as argued in the preceding chapters. This idea does stir up conflict, but it also adds a voice

[368] As mentioned several times previously, although IC can be harnessed to this end, its presence in a system does not logically entail always and only design by the God of the Bible, and under naturalistic assumptions could be argued to only entail the failure of a Neo-Darwinian explanation at that point. However, in a three way interdisciplinary dialogue that involves the Bible, it becomes far more likely that detectable IC is in fact due to the action of the God of the Bible.

to an existing conversation that seeks the possibility of a chastened Darwinism co-existing with a chastened creationism. Chastening involves a change of attitude which presupposed a change of heart. Being willing to talk signals a willingness to listen, and a willingness to attempt to see what the other party says it can see. Yet there is more to be said.

The admission that it might be possible for a scientist to see in the observable realm first order evidence of design is an admission that carries a cost just as much as the admission that "well understood genetic mechanisms are capable of producing much more evolutionary change than most creationists are prepared to consider possible" (Darnborough, 1986:245)[369] carries a cost in some circles. There is always a price to pay and there is always benefit. However, one of several positive benefits bears mention.

A major benefit that accompanies dialogue fostered by IC is the production of a mindset that is willing to consider that extra-terrestrial explanations and possibly even design explanations should be re-admitted into science. After all, if the world and the universe can be viewed in the light of God's infallible word as created by Christ and for Him, then it is not unreasonable to expect that there should be a limit to the explanatory power of earth-bound naturalistic theory, and the commensurate likelihood of creatorship being empirically detectable. Patricia Gray notes that "The undersea songs of humpback whales are similar in structure to bird and human songs and prove that these marine mammals are inveterate composers. If songs can be defined as "any rhythmic repeated utterance, whether by a bird, a frog, an insect, a whale or a human being" then humpback whale songs are constructed according to laws that are strikingly similar to those adopted by human composers...most surprisingly, humpback songs contain repeating refrains that form rhymes. This suggests that whales use rhyme in the same way that we do: as a mnemonic device to help them remember complex material" (Gray *et al*, 2001:52). After pointing out numerous other similarities including those with birds[370] she concludes: "It has been postulated that there is an unproven (and probably

[369] Dr Chris Darnborough received his PhD in biochemistry from Cambridge in 1973 and was a research fellow for many years in the department of Biochemistry at Glasgow University working in molecular genetics. He describes himself as a biblical creationist and writes that "the evolution of original created genes is a good model for the origin of modern genomes and observed genetic phenomena" (Darnborough, 1986:241).

[370] "For instance, when birds compose songs they often use the same rhythmic variations, pitch relationships, permutations, and combinations of notes as human composers. Thus, some bird songs resemble musical compositions; for example, the canyon wren's trill cascades down the musical scale like the opening of Chopin's "Revolutionary" Etude. An examination of bird song reveals every elementary rhythmic effect found in human music. There are interval inversions, simple harmonic relations, and retention of melody with change of key. Many birds regularly transpose motifs to different keys. Some birds pitch their songs to the same scale as Western music, one possible reason for human attraction to these sounds. For example, notes in the song of the wood thrush (Catharus mustelina) are pitched such that they follow our musical scale very accurately. The interval between the first and second parts of the song of a ruby-crowned kinglet (Regulus calendula) is often a full octave. The canyon wren sings in the chromatic scale (which divides the octave into 12 semitones) and the

unprovable) concept called mathematical Platonism, which supposes that there is a universal mathematics awaiting discovery. Is there a universal music awaiting discovery, or is all music just a construct of whatever mind is making it - human, bird, whale? The similarities among human music, bird song, and whale song tempt one to speculate that the Platonic alternative may exist - that there is a universal music awaiting discovery" (Gray *et al*, 2001:53).

Gray is acknowledging the discomfort of evolutionary convergence proffered as a satisfactory explanation. In the context of interdisciplinary dialogue fostered by IC and a new mindset that is encouraged to grow, not only can the possibility of supra-natural explanations be envisaged, but more importantly the allowance for theological considerations that can direct attention past Plato's forms and beyond, till that attention is fixed on God-at-the-beginning investing His world with scientifically discernible patterns and principles.

7.2 Concluding Summary

The central research question posed in chapter one was "What type of utility could Irreducible Complexity provide as a nexus for an interdisciplinary dialogue between machine logic, molecular biology and theology?"

The intervening five chapters set out to explore this question. In chapter two, the investigation began with a consideration of IC as a machine property within the engineering domain leading to the conclusion that given the definition and logical structure of mechanical machines, IC is indeed a real property in the engineering domain. In chapter three the ubiquity and significance of mechanistic language used by all micro-researchers within biology, especially in molecular biology, was explored and shown to lead to the summative idea that IC as a principle is entirely consistent with that language, and consistent with the mechanistic investigative mindset arguably necessary to detect the function of various bio-structures. In chapter four, arguments presented against the credibility of the presence of IC in an actual example were assessed and shown to lack sufficient cogency to overturn the concept, leading to the conclusion that IC's status as a scientific principle remains essentially intact. Chapter five investigated the question of whether Biblical Theology creates an expectation of first order formalisms present in the observable world. The conclusion was that because there is a level of ordering across the face of the creation that enjoys close continuity with a level of ordering in the Christian church and in other spiritual matters

---

hermit thrush (Catharus guttatus) in the pentatonic scale (which consists of five different tones within the octave)" (Gray *et al*, 2001:2).

(ultimately because when God created the world *it was all conceived in Christ),* the notion of IC presents itself as a promising candidate of an ordering that is scientifically detectable. The discussion that followed in chapter six assessed the viability and nature of IC as a nexus for tri-disciplinary dialogue. The implicit conclusion was that it had stirred up considerable debate which in the context of wisdom proves its value. However, since worldview concerns deeply affect the way any such conversation is undertaken, there are differences of opinion as to the value of IC and its contribution to any or all of the three domains. Nevertheless, IC has shown itself to be a valuable nexus in stimulating an interdisciplinary dialogue between machine logic (engineering), molecular biology and theology.

Certainly it is the conclusion of this chapter (and of the whole dissertation) that IC has the ongoing potential to stimulate new thought in regard to human-built machines, and in regard to the study of their molecular living homomorphic counterparts (living machines)[371] and in regard to Biblical conceptions of creation including fresh evaluations of the role of Neo-Darwinian thought in theology.

Insofar as IC achieves this, it displays remarkable utility.

[371] Dawkin's phrase (1988:35).

Source List

ACTON, G. 1997. Behe and the blood clotting cascade. [Web:] http://www.talkorigins.org/origins/postmonth/feb97.html [Date of Access: 11 Sep. 2006].

ADAMS, R.A. & PEDERSEN, S.C. 2000. Integrating ontogeny into ecological and evolutionary investigations. (*In* Adams, R.A. & Pedersen, S.C., *eds.* Ontogeny, functional ecology, and evolution of bats. Cambridge : Cambridge University Press. p.1-8.)

ADAMS, R.A & THIBAULT, K.M. 2000. Ontogeny and the evolution of the hindlimb and calcar. (*In* Adams, R.A. & Pedersen, S.C., *eds.* Ontogeny, functional ecology, and evolution of bats. Cambridge : Cambridge University Press. p.316-332.)

ADLEMAN, L.M. 1994. Molecular computation of solutions to combinatorial problems. [Web:] http://www.usc.edu/dept/molecular-science/papers/fp-sci94.pdf [Date of access: 10 Sep. 2007].

ALBERTS, B. 1998. The cell as a collection of protein machines: preparing the next generation of molecular biologists. *Cell*, 92:291-294.

AMOS, M. 2006. Genesis machines. London : Atlantic Books.

ARP, H. 1998. Seeing red: redshifts, cosmology and academic science. Montreal : Apeiron.

AYALA, F.J. 2004. Design without a designer: Darwin's great discovery. (*In* Dembski, W.A. & Ruse, M., *eds.* Debating design: from Darwin to DNA. New York : Cambridge University Press. p.55-80.)

BARCLAY, O. 2006. Design in nature. *Science and Christian Belief,* 18(1):49-61.

BARHAM, J. 2004. The emergence of biological value. (*In* Dembski, W.A. & Ruse, M., *eds.* Debating design: from Darwin to DNA. New York : Cambridge University Press. p.210-226.)

BARKER, W.S., BELZ, M., COLLINS, C.J., DISHMAN, J., DUNCAN III, J.L., DUNCAN, S.J., GRIFFITH, H., PATTERSON, S., RANKIN, W.D., WHITE Jr, J.B., SMITH, M.H., SMITH, W.H. & WARDELL, M.R. 2000. Report of the creation study committee. [Web:] http://www.pcahistory.org/creation/report.html [Date of access: 9 Oct. 2007].

BASS, R.W. & POPOLO, A.D. 2004. Dynamical derivation of Bode's law. [Web:] http://arxiv.org/PS_cache/astro-ph/pdf/0407/0407495v1.pdf [Date of access: 4 Oct. 2007].

BATEMAN, P.W. & ELLIS, J. 2007. Is intelligent design science, and does it matter? *Verbum et ecclesia,* 28(1):1-17.

BEHE, M. 1996a. Darwin's black box. New York : Free Press.

BEHE, M. 1996b. Behe responds to postings in talk origins newsgroup. [Web:] http://www.arn.org/docs/behe/mb_toresp.htm [Date of access: 23 Dec. 2004].

BEHE, M. 2000a. In defence of the irreducibility of the blood clotting cascade: response to Russell Doolittle, Ken Miller and Keith Robison. [Web:] http://www.discovery.org/scripts /viewDB/index.php?command=view&id=442 [Date of access: 3 Aug. 2006].

BEHE, M. 2001. A reply to my critics. *Biology and Philosophy,* 16:685–709. [Web:] http://www.fosep.org/science%20and%20religion/Behe2001.pdf [Date of access: 25 Aug.2006].

BEHE, M. 2002a. Experimental support for regarding functional classes of proteins to be highly isolated from each other. [Web:] http://www.leaderu.com/orgs/fte/darwinism/chapter6.html [Date of access: 23 Dec. 2004].

BEHE, M. 2004. Irreducible Complexity: obstacle to Darwinian evolution. (*In* Dembski, W.A. & Ruse, M., *eds.* Debating design: from Darwin to DNA. New York : Cambridge University Press. p.352-370.)

BEHE, M. 2005. Scientific orthodoxies. [Web:] http://www.godspy.com/issues/Scientific-Orthodoxies-by-Michael-Behe.cfm [Date of access: 17 Oct. 2007].

BEHE, M. 2006. Whether Intelligent Design is science: a response to the opinion of the court in Kitzmiller vs. Dover Area School District. [Web:] http://www.discovery.org/csc [Date of access: 6 Jul. 2006].

BEHE, M. & SNOKE, D.W. 2004. Simulating evolution by gene duplication of protein features that require multiple amino acid residues. *Protein science,* (13):2651-2664.

BELLER, M. 1999. Quantum dialogue. Chicago : Chicago University Press.

BERG, H. 1999. Motile behavior of bacteria. [Web:] http://www.aip.org/pt/jan00/berg.htm [Date of Access: 18 Aug. 2006].

BROWN, C.J., TODD, K.M. & ROSENZWEIG, R.F. 1998. Multiple duplications of yeast hexose transport genes in response to selection in a glucose-limited environment. *Molecular Biological Evolution*, 15(8):931-942.

BUGGE, T.H., KOMBRINCK, K.W., FLICK, M.J., DAUGHTERTY, C.C., DANTON, M.J. & DEGEN, J.L. 1996. Loss of Fibrinogen Rescues Mice from the Pleiotropic Effects of Plasminogen Deficiency. *Cell,* 87:709-719. [Web:] http://icbxw.ethz.ch/woundtransgenic/PDFs/F/Fibrinogen-Plasminogen.pdf [Date of access: 6 Sep. 2006] .

BUSTAMANTE, C., KELLER, D. & OSTER, G. 2001. The physics of molecular motors. *Accounts of chemical research,* 34(6):412-420.

CHS (CANADIAN HEMOPHILLIC SOCIETY). 2004. Factor XII deficiency: an inherited bleeding disorder. [Web:] http://www.hemophilia.ca/en/pdf/13/FactorXII_E.pdf [Date of access: 1 Sep. 2006].

CARTWRIGHT, R.A. 2004. Scurvy, guinea pigs, and you. [Web:] http://www.pandasthumb.org/archives/2004/09/scurvy_guinea_p.html [Date of access: 12 Sep. 2006].

CASTI, J.L. 2001. Paradigms regained. London : Abacus.

CHAPMAN, A. 2002. The gods in the sky. London : Channel 4 Books.

CHARLES, D. 1995. Aristotelianism. (*In* Honderich, T., *ed.* The Oxford Companion to Philosophy. Oxford : Oxford University Press. p.50-53.)

CLINTON, W. 1996. Press release August 7th by the President, South Lawn White House. [Web:] http://clinton6.nara.gov/1996/08/1996-08-07-remarks-by-president-upon-departure.html [Date of access: 2 Nov. 2007].

COLLLINS, F.S. 2007. The language of God: a scientist presents evidence for belief. London : Simon and Schuster.

CONWAY MORRIS, S. 2006. Darwin's compass: how evolution discovers the song of creation. *Science and Christian Belief,* 18(1):5-22.

COPPES, L.J., ESTELLE, B.D., IRONS, C.L., MUETHER, J.R., PONTIER, A.R., STRANGE, A.D. & WALLACE, P.J. 2004. Report of the committee to study the views of creation. [Web:] http://www.opc.org/GA/CreationReport.pdf [Date of access: 9 Oct. 2007].

CORNISH-BOWDEN, A. 2006. Putting the systems back into systems biology. *Perspectives in Biology and Medicine*, 49(4):475-489.

COYNE, J. 2005. The case against Intelligent Design. [Web:] http://www.simonyi.ox.ac.uk/dawkins/jacNR.pdf [Date of access: 11 Aug. 2006].

DARNBOROUGH, C. 1986. Genes, created but evolving. (*In* Andrews, E.H., Gitt, W. & Ouweneel, W.J., *eds.* Concepts in Creationism. Herts : Evangelical Press. p.241-266.)

DARWIN, C. 1859. The origin of species. New York : Random House.

DAVIES, P. & GRIBBIN, J. 1992. The matter myth. London : Penguin.

DAWKINS, R. 1988. The blind watchmaker. London : Penguin.

DAWKINS, R. 1995. A river out of Eden. London : Weidenfeld & Nicolson.

DAWKINS, R. 1996. Climbing mount improbable. London : Viking.

DAWKINS, R. 1998. Unweaving the rainbow. London : Penguin.

DAWKINS, R. 2004. The ancestor's tale. London : Weidenfeld & Nicolson.

DAWKINS, R. 2006. The God delusion. London : Bantam Press.

DEMBSKI, W.A. 1998. Introduction: mere creation. (*In* Dembski, W.A., *ed.* Mere creation. Downers Grove : IVP. p.13-30.)

DEMBSKI, W.A. 2002. The table of contents and preface to William Dembski's upcoming book "No Free Lunch." [Web:] http://www.sunflower.com/~jkrebs/ID/DI/Dembski/No_Free_Lunch.html [Date of access: 30 Dec. 2004].

DEMBSKI, W.A. 2004a. The design revolution. Leicester : InterVarsity Press.

DEMBSKI, W.A. 2004b. The logical underpinnings of intelligent design. (*In* Dembski, W.A. & Ruse, M., *eds.* Debating design: from Darwin to DNA. New York : Cambridge University Press. p.311-330.)

DEMBSKI, W.A. 2005. Expert witness report: the scientific status of intelligent design. [Web:] http://www.designinference.com/documents/2005.09.Expert_Report_Dembski.pdf [Date of access: 1 Sep. 2006].

DOBZHANSKY, T. 1973. Nothing in biology makes sense except in the light of evolution. *The American biology teacher,* 35:125-129 [Web:] http://www.2think.org/dobzhansky.shtml [Date of access: 9 Oct. 2007].

DOOLITTLE, R.F. 1997. A delicate balance. [Web:] http://www.bostonreview.net/br22.1/doolittle.html [Date of access: 1 Sep. 2006].

DORIT, R. 1997. A review of Darwin's black box. *American Scientist.* [Web:] http://www.americanscientist.org/template/AssetDetail/assetid/22794?fulltext=true [Date of access: 6 Nov. 2007].

DUNKELBERG, P. 2003. Irreducible complexity demystified. [Web:] http://www.talkdesign.org/faqs/icdmyst/ICDmyst.html [Date of access: 1 Sep. 2006].

FLEW, A. 2007. There is a God: how the world's most notorious atheist changed his mind. New York : Harper Collins

FORREST, B. & GROSS, P.R. 2004. Creationism's Trojan horse. Oxford : Oxford University Press.

GEFTER, A. 2006. Let's talk evolution. *New Scientist,* 190(2554):53.

GELL-MANN, M. 1994. The quark and the jaguar. London : Abacus.

GENE, M. 2002. Evolving the bacterial flagellum through mutation and cooption. [Web:] http://idthink.net/biot/flag1/index.html. [Date of access: 10 Aug. 2006].

GERSTEIN, M. & ZHENG, D. 2006. The real life of pseudogenes. *New scientist,* 295(2):31-37.

GOLDMAN, E. 2005. Stambovsky v. Ackley case resources. [Web:] http://lawprofessors.typepad.com/contractsprof_blog/2005/11/stambovsky_v_ac.html [Date of access: 12 Nov. 2007].

GOLDSMITH, T. 2006. What birds see. *Scientific American,* 295(1):50-57.

GOLDSWORTHY, G. 1981. Gospel and kingdom. Exeter : The Paternoster Press.

GOLDSWORTHY, G. 1987. Gospel and wisdom. Exeter : Lancer.

GOLDSWORTHY, G. 1991. According to Plan. Leicester : IVP.

GOLDSWORTHY, G. 1997. Is Biblical Theology viable? (*In* Gibson, R. J. *ed.,* Explorations 11 interpreting God's plan: Biblical Theology and the pastor. Carlisle : Paternoster Press. p.18-46.)

GOLDSWORTHY, G. 2000. Preaching the whole Bible as Christian scripture. Leicester : IVP.

GOLDSWORTHY, G. 2006. Gospel-centered hermeneutics: biblical-theological foundations and principles. Nottingham : Apollos.

GOPHNA, U., RON, E.Z. & GRAUR, D. 2003. Bacterial type III secretion systems are ancient and evolved by multiple horizontal-transfer events. *Gene*, 312:151-163.

GOULD, S.J. 1999. Rocks of ages: science and religion in the fullness of life. New York : Ballantine.

GRAY, P.M., KRAUSE, B., ATEMA, J., PAYNE, R., KRUMHANSL, C. & BAPTISTA, L. 2001. The Music of Nature and the Nature of Music. *Science,* 291(5501):52-54.

GRAY, T.M. 2003. Biochemistry and evolution. (*In* Miller, K.B., *ed.* Perspectives on an evolving creation. Grand Rapids : Eerdmans. p.256-287.)

HAARSMA, L. 2003. Does science exclude God? Natural law, chance, miracles and scientific practice. (*In* Miller, K.B., *ed.* Perspectives on an evolving creation. Grand Rapids : Eerdmans. p.72 – 94.)

HARRISON, P. 2006. The Bible and the emergence of modern science. *Science and Christian Belief,* 18(2):115-132.

HAUGHT, J. 2005. The Boyle lecture 2003: Darwin, design and the promise of nature. *Science and Christian Belief,* 17(1):5-17.

HEIDEGGER, M. 1977. The question concerning technology and other essays. New York : Garland publishing.

HEARN, W. 1990. More on Michael Denton. [Web:] http://www.asa3.irg/asa/PSCF/1990/PSCF3-90/Hearn.html [Date of access: 12 May 2006].

HERMODSON, M. 2005. Editorial and position papers. *Protein science,* 14:2215-2216.

HOFMEYR, J.H.S. 2007. The biochemical factory that autonomously fabricates itself: a systems-biological view of the living cell. [Web:] http://glue.jjj.sun.ac.za/~jhsh/FEBS-SysBio2007/SBPF_Hofmeyr_20-01-07.pdf [Date of access: 15 Oct. 2007].

HOLMES, B. 2006. Evolution in action. *New scientist,* 192:13.

HOLMES, S. 2003. Bootstrapping phylogenetic trees: theory and methods. *Statistical science,* 18(2):241-255.

HUMPHREYS, C.J. 2003. The miracles of Exodus. London : Continuum.

HURD, J.P. 2003. Hominids in the garden? (*In* Miller, K.B., *ed.* Perspectives on an evolving creation. Grand Rapids : Eerdmans. p.208-233.)

INAI, Y., OHTA, Y., NISHIKIMI, M. 2003. The whole structure of the human non-functional L-gulono-gamma-lactone oxidase gene – the gene responsible for scurvy-and the evolution of repetitive sequences thereon. *Journal of nutritional science and vitaminology*, 49(5):315-319.

ISCAST (Institute for the Study of Christianity in an Age of Science and Technology). 2000. Statement on creation with reference to evolution: discussion paper (version 2.3). [Web:] http://www.iscast.org.au/pdf/CreationEvolution.pdf [Date of access: 9 Oct. 2007].

JOACHIM, C. & GIMZEWSKI, J.K. 2001. Single molecular rotor at the nanoscale. *Structure and bonding,* 99:1-18. [Web:] http://www.chem.ucla.edu/dept/Faculty/gimzewski/pub/171.pdf [Date of access: 21 Aug. 2006].

JONES, J.E. III. (Trial Judge) 2005. Memorandum opinion: in the United States district court for the middle district of Pennsylvania Tammy Kitzmiller, *et al.* plaintiffs v Dover Area School District, *et al.* defendants, 20 Dec. Case 4:04-cv-02688-JEJ Document 342 [Web:] http://www.sciohost.org/ncse/kvd/kitzmiller_decision_20051220.pdf [Date of access: 4 Sep. 2006].

JONES, A. & TYLER, D. 2005. Engaging with Intelligent Design? *Science and Christian Belief,* 17(2):223-232.

KELLER, D. 2006. The wedge of truth visits the laboratory. (*In* Dembski, W. A., *ed.* Darwin's nemesis. Leicester : IVP. p.153-163.)

KIDNER, D. 1967. Tyndale Old Testament Commentaries: Genesis. Leicester : IVP.

KIMURA, M. 1983. The neutral theory of molecular evolution. Cambridge : Cambridge University Press.

KITCHER, P. 1982. Abusing science: the case against creationism. London : MIT Press.

KORTHOF, G. 2007. How to attack Neo-Darwinism and still end up in evolution textbooks: the neutralist - selectionist controversy. [Web:] http://home.planet.nl/~gkorthof/kortho37.htm [Date of access: 11 Oct. 2007].

KRAMER, J.K.G. 1999. (*In* Ashton, J.F., *ed.* In six days. Sydney : New Holland Publishers. p.34-44.)

KUHN, T.S. 1996. The structure of scientific revolutions. Chicago : University of Chicago Press.

LACHS, J. 1995. Footnotes. (*In* Honderich, T., *ed.* The Oxford Companion to Philosophy. Oxford : Oxford University Press. p.284.)

LAMPE, D. 2005. What kind of scientist is Michael Behe? [Web:] http://www.home.duq.edu/~lampe/BeheCV2.html [Date of access: 3 Aug. 2006].

LEE, K.E. 1997. The correspondence between human intelligibility and physical intelligibility: the view of Jean Ladriere. *Zygon,* 32(1):65-81.

LEBLANC, A.G. 1995. Titius-Bode's law: numerical chance or insight into physical phenomenon? [Web:] http://aci.mta.ca/TheUmbrella/Physics/P3401/Investigations/BodesLawAGL.html [Date of access: 18 Feb. 2003].

LETELIER, J.C., MARIN, G. & MPODOZIS, J. 2003. *Journal of theoretical biology,* 222:261-272.

LUCAS, E. 2005. Science and the Bible: are they incompatible? *Science and Christian Belief,* 17(2):137-154.

LUSTIG, A. 2004. Natural atheology. (*In* Lustig, A., Richards, R.J. & Ruse, M., *eds.* Darwinian heresies. Cambridge : Cambridge University Press. p.69-83.)

LYNCH, J.M. 2006. Stranger fruit. [Web:] http://scienceblogs.com/strangerfruit/www.public.asu.edu/~jmlynch [Date of access: 26 Aug. 2006].

MACINTOSH, J.J. 1995. Robert Boyle. (*In* Honderich, T., *ed.* The Oxford Companion to Philosophy. Oxford : Oxford University Press.)

MACNAB, R.M. 2003. How bacteria assemble flagella. *Annual review of microbiology*, 57:77-100.

MAHADEVAN, L. & MATSUDAIRA, P. 2000. Motility powered by supramolecular springs and ratchets. *Science,* 288:95–99. [Web:] http://www.deas.harvard.edu/softmat/downloads/pre2000-03.pdf [Date of Access: 21 Aug. 2006].

MALLIK, R. 2005. Roop Mallik homepage. [Web:] http://www.tifr.res.in/~roop [Date of access: 15 Oct. 2007].

MALLIK, R. & GROSS, S. 2004. Molecular motors: strategies to get along. *Current biology*, 14:971–982. [Web:] http://bioweb.bio.uci.edu/sgross/DynRevCurrBio.pdf [Date of access: 4 Sep. 2006].

MARGULIS, L. & SAGAN, D. 2002. Acquiring genomes: a theory of the origins of species. New York : Basic Books.

MATTHEWS, R. 1994. The ghostly hand that spaced the planets. *New scientist*, 142(1920):13.

MCDONALD, J. F. 2002. A reducibly complex mousetrap. [Web:] http://udel.edu/~mcdonald/mousetrap.html [Date of access: 16 Aug. 2006].

MCGRATH, A. 2006. Paley memorial sermon. *Science and Christian Belief*, 18(2): 181-187.

MCLAUGHLIN, B.P. 1995. Philosophy of mind. (*In* Audi, R., *ed.* The Cambridge dictionary of philosophy. Cambridge : Cambridge University Press. p.597-606.)

MENUGE, A. 2004. Who's afraid of ID? (*In* Dembski, W.A. & Ruse, M., *eds.* Debating design: from Darwin to DNA. New York : Cambridge University Press. p.32-51.)

MEYER, S.C. 2004. The Cambrian information explosion. (*In* Dembski, W.A. & Ruse, M., *eds.* Debating design: from Darwin to DNA. New York : Cambridge. p.371-391.)

MIKULECKY, D. 1999. Review of 'essays on life itself' by Robert Rosen. [Web:] http://www.people.vcu.edu/~mikuleck/rosrev.html [Date of access: 7 Jan. 2007].

MIKULECKY, D. 2005. Finding the sun: toward a lower higher power. [Web:]

http://www.intothecool.com/blog/2005/11/finding-sun-toward-lower-higher-power.html [Date of access: 10 Dec. 2006].

MILLER, K.R. 2000. The evolution of vertebrate blood clotting. [Web:] http://www.millerandlevine.com/km/evol/DI/clot/Clotting.html [Date of access: 6 Sep. 2006].

MILLER, K.R. 2002. Rebuttal of Dr Michael Behe concluding the debate at the American Museum of Natural History. [Web:] http://www.ncseweb.org/resources/articles/7819_part_07_dr_michael_behe_dr_10_31_2002.asp [Date of access: 1 Sep. 2006].

MILLER, K.R. 2003. Answering the biochemical argument from design. [Web:] http://www.millerandlevine.com/km/evol/design1/article.html [Date of access: 18 Aug. 2006].

MILLER, K.R. 2004. The flagellum unspun. (*In* Dembski, W.A. & Ruse, M., *eds.* Debating design: from Darwin to DNA. New York : Cambridge University Press. p.81-97.)

MILLER, K.R. 2005a. Expert statement: the scientific status of evolutionary theory; biology by Miller & Levine; language of the Dover statement; "Intelligent Design" as a scientific alternative to evolution; Of Pandas and People – brief analysis. [Web:] http://www2.ncseweb.org/kvd/experts/miller.pdf [Date of access: 1 Sep. 2006].

MILLER, K.R. 2005b. Testimony during trial: Kitzmiller v. Dover Area School District transcript, Day 1 September 26 2005 AM Session Part 2. [Web:] http://www.talkorigins.org/faqs/dover/day1pm.html [Date of access: 1 Sep. 2006].

MINNICH, S.A. 2005a. Federal rule of civil procedure 26; disclosure of expert testimony Scott Minnich PhD, in the case of Tammy Kitzmiller, *et al* vs. Dover Area School District and Dover Area district Board Directors. [Web:] http://www2.ncseweb.org/kvd/experts/minnich.pdf [Date of access: 1 Sep. 2006].

MINNICH, S.A. 2005b. Trial transcript: day 21, Nov. 4 AM Session Part 2. [Web:] http://www.talkorigins.org/faqs/dover/day21am2.html [Date of access: 6 Sep. 2006].

MINNICH, S.A. 2005c. Trial transcript: day 21, Nov. 4 AM Session Part 1. [Web:] http://www.talkorigins.org/faqs/dover/day21am.html [Date of access: 4 Sep. 2006].

MINNICH, S.A. & MEYER, S.C. 2004. Genetic analysis of coordinate flagellar and type III regulatory circuits in pathogenic bacteria. [Web:] http://www.discovery.org/scripts/viewDB/filesDB-download.php?id=389 [Date of access: 21 Aug. 2006].

MORELAND, J.P. 1989. Christianity and the nature of science. Grand Rapids : Baker.

MURRAY, C. 2002. Is the solar system stable? [Web:] http://www.fortunecity.com/emachines/e11/86/solarsys.html [Date of access: 9 Oct. 2007].

MUSGRAVE, I. 2005. Clotted rot for rotten clots. [Web:] http://www.pandasthumb.org/archives/2005/03/clotted_rot_for.html [Date of access: 18 Aug. 2006].

NOGALES, E. & GRIGORIEFF, N. 2001. Molecular machines: putting the pieces together. *The journal of cell biology*, 152(1):1-10.

NELSON, P. 1998. Jettison the arguments, or the rule? The place of Darwinian theological themata in evolutionary reasoning. [Web:] http://www.arn.org/nelson [Date of access: 26 Aug. 2006].

NUMBERS, R.L. 2004. Ironic heresy: how young earth creationists came to embrace rapid microevolution by means of natural selection. (*In* Lustig, A., Richards, R.J. & Ruse, M., *eds.* Darwinian heresies. Cambridge : Cambridge University Press. p.84- 100.)

OSBORNE, G.R. 1991. The hermeneutical spiral. Downers Grove : IVP.

OSTER, G. & WANG, H. 2003. Rotary protein motors. *Trends in cell biology,* 13(3):114-121.

PALEY, W. 1810. Natural theology: evidences of the existence and attributes of the deity, collected from the appearances of nature. London : J. Faulder.

PALLEN, M.J. & MATZKE, N.J. 2006. From the Origin of Species to the origin of bacterial flagella. [Web:] http://home.planet.nl/~gkorthof/pdf/Pallen_Matzke.pdf [Date of access: 6 Dec. 2006].

PAYNE, A. 2006. Intelligent Design: concluding thoughts. *The briefing,* 337:24-25.

PCA (Presbyterian Church in America). 2000. Minutes of the 28th General Assembly of the Presbyterian Church in America: report of the creation study committee. [Web:] http://www.pcahistory.org/creation/report.html [Date of access: 9 Oct. 2007].

PENNOCK, R. 2000. Tower of Babel: evidence against the new creationism. Cambridge(USA) : MIT press.

PETSKO, G. 2001. Design by necessity. [Web:] http://genomebiology.com/2001/2/8/comment/1010.1 [Date of access: 11 Aug. 2006].

PETTIGREW, J.D. 1986a. Flying primates? Megabats have the advanced pathway from eye to midbrain. *Science,* 231:1304–1306.

PETTIGREW, J.D. 1986b. Are flying foxes really primates? *Newsletter of Bat Conservation International,* 3:1–2.

PETTIGREW, J.D., JAMIESON, B.G.M., HALL, L.S., ROBSON, S.R., MCANALLY, K.I. & COOPER, H.M. 1989. Phylogenetic relations between microbats, megabats and primates. *Philosophical Transactions of the Royal Society of London,* 325:489-559.

POLKINGHORNE, J. 2004. The inbuilt potentiality of creation. (*In* Dembski, W.A. & Ruse, M., *eds.* Debating design: from Darwin to DNA. New York : Cambridge University Press. p.246-260.)

RATCLIFFE, M. 2000. The function of function. *Studies in history and philosophy of science,* 31(1):113-133.

RENNÉ, T., POZGAJOVA, M., GRÜNER, S., SCHUH, K., PAUER, H., BURFEIND, P., GAILANI, D. & NIESWANDT, B. 2005. Defective thrombus formation in mice lacking coagulation factor XII. *The journal of experimental medicine,* 202(2):271-281 [Web:] http://www.jem.org/cgi/content/full/202/2/271 [Date of access: 6 Sep. 2006].

RIDLEY, Mark. 2002. A popular evolution: an authoritative introduction to the history of life from a respected theorist. *Nature*, 417:223-224.

RIDLEY, Matt. 2004. Genome: the autobiography of a species in 23 chapters. London : Harper Perennial.

ROBERTS, M. 2004. Intelligent design: some geological, historical and theological questions. (*In* Dembski, W.A. & Ruse, M., *eds.* Debating design: from Darwin to DNA. New York : Cambridge University Press. p.275-293.)

ROBISON, K. 1996. Darwin's black box: irreducible complexity or irreproducible irreducibility? [Web:] http://www.talkorigins.org/faqs/behe/review.html [Date of access: 12 May 2006].

ROSEN, J. 2006. Robert Rosen's modeling program. [Web:] http://webmail.unizar.es/pipermail/fis/2006-January/001224.html [Date of access: 15 Jan. 2007].

ROSEN, R. 1991. Life itself. New York : Columbia University Press.

ROSEN, R. 2000. Essays on life itself. New York : Columbia University Press.

RUBIN, J.J. 1991. Stambovsky (plaintiff) vs. Ackley and Ellis Realty (defendants), Supreme Court, Appellate Division, First Department, July 18. [Web:] http://www.brandeslaw.com/Lighter/stambovsky.htm [Date of access: 12 Nov. 2007].

RUSE, M. 2000. Teleology: yesterday, today and tomorrow? *Studies in history and philosophy of biological and biomedical sciences,* 31(1):213-232.

RUSE, M. 2004. The argument from design: a brief history. (*In* Dembski, W.A. & Ruse, M., *eds.* Debating design: from Darwin to DNA. New York : Cambridge University Press. p.13-31.)

RUSE, M. 2005a. Darwinism and mechanism: metaphor in science. *Studies in history and philosophy of biological and biomedical sciences,* 36(2):285-302.

RUSE, M. 2005b. Methodological naturalism under attack. *South African journal of philosophy,* 24(1):44-60.

SCHNABEL, E.J. 2000. Wisdom. (*In* New dictionary of Biblical Theology, 843-848.)

SMART, J.A. 2003. On the application of irreducible complexity. [Web:] http://www.iscid.org/papers/Smart_ApplicationOfIC_060503.pdf [Date of access: 14 Aug. 2006].

SMOLIN, L. 2007. The trouble with physics: the rise of string theory, the fall of a science, and what comes next. London : Allen Lane.

SEMBA, U., SHIBUYA, Y., OKABE, H. & YAMAMOTO, T. 1998. Whale Hageman Factor: prevented production due to pseudogene conversion. *Thrombosis Research,* 90(1):31-37. [Web:] http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=search&Dopt=b&term=9678675 [Date of access: 6 Sep. 2006].

SMITH, C.M. & SULLIVAN, C. 2007. The ten top myths about evolution. New York : Prometheus.

SPEAKMAN, J.R. 2001. The evolution of flight and echolocation in bats: another leap in the dark. *Mammal Review*, 31(2):111-130.

SOBER, E. 2004. The design argument. (*In* Dembski, W.A. & Ruse, M., *eds.* Debating design: from Darwin to DNA. New York : Cambridge University Press. p.98-129.)

STALEY, J.P. & GUTHRIE, C. 1998. Mechanical devices of the spliceosome: motors, clocks, springs and things. *Cell*, 92:315-326.

STERNBERG, R.V. 2004a. Process structuralism. [Web:] http://www.rsternberg.net/structuralism.htm [Date of access: 24 Nov. 2004].

STERNBERG, R.V. 2004b. Home page. [Web:] http://www.rsternberg.net/index.htm [Date of access: 24 Nov. 2004].

STRAUSS, S. 2006. Did Darwin develop a 'theory of evolution': (Neo)-Darwinism – theory mainly rooted in the humanities. (Address delivered 17th January 2007 as part of the Annual Conference of the Philosophical Society of Southern Africa at Stellenbosch University, Hoof Gebou.) Stellenbosch. (Unpublished).

TAMZEK, N. 2002. Response to Casey Luskin. [Web:] http://www.talkorigins.org [Date of access: 20 Dec. 2006].

TCOD (The concise Oxford dictionary.) 1999. Oxford : Oxford University Press.

THISELTON, A.C. 2000. NIGTC: the first epistle to the Corinthians. Grand Rapids : Eerdmans.

THOLE, T. 1997. Exploring the possibility of primitive life on early Mars. [Web:] http://tc.engr.wisc.edu/UER/uer97/author1/content.html#thole [Date of access: 2 Nov. 2007].

TURING, A. 1936. On computable numbers, with an application to the entscheidungsproblem. *Proceedings of the London Mathematical Society, series 2,* 42:230-265.

VALE, R.D. 2003. The molecular motor toolbox for intracellular transport. *Cell,* 112:467-480. [Web:] http://www.mcb.ucdavis.edu/faculty-labs/scholey/vale%202003% 20cell.pdf [Date of access: 4 Sep. 2006].

VALE, R.D. & MILLIGAN, R.A. 2000. The way things move: looking under the hood of molecular motor proteins. *Science*, 288:88-94. [Web:] http://valelab.ucsf.edu/publications/2000valescience.pdf [Date of Access: 21 Aug. 2006].

VAN HUYSSTEEN, J.Wentzel. 2006. Alone in the world?: human uniqueness in science and theology. Grand Rapids : Eerdmans.

VANHOOZER, K. 2000. Exegesis and hermeneutics. (*In* New dictionary of Biblical Theology, 52-64.)

VEITH, W.J. 2002. The Genesis conflict. Canada : Amazing Discoveries.

WAGNER, A. 2001. Birth and death of duplicated genes in completely sequenced eukaryotes. *Trends in genetics,* 17(5):237-239.

WALLER, J. 2002. Fabulous science: fact and fiction in the history of scientific discovery. Oxford : Oxford University Press.

WANG, J. 2005. Recent cyanobacterial Kai protein structures suggest a rotary clock. *Structure,* 13(5):735-741.

WATSON, P. 2005. Ideas: a history from fire to Freud. London : Phoenix.

WEBB, B. 1998. Biblical Theology and biblical interpretation. (*In* Gibson, R. J. *ed.* Interpreting God's plan. Carlisle : Paternoster. p.47-74.)

WEBER, B.H. & DEPEW, D.J. 2004. Darwinism, design, and complex systems dynamics. (*In* Dembski, W.A. & Ruse, M., *eds.* Debating design: from Darwin to DNA. New York : Cambridge University Press. p.173–190.)

WEINBERG, S. 1999. Is there a designer universe? (*In* The American Association for the Advancement of Science: papers read at the Conference on Cosmic Design held in Washington, D.C. in April 1999.)

WELLS, A.J. 2006. In defense of mechanism. *Ecological psychology,*18(1):39-65.

WELLS, J. & NELSON, P. 1997. Homology: a concept in crisis. [Web:] http://www.arn.org/docs/odesign/od182/hobi182.htm [Date of access: 15 Oct. 2007].

WILKINS, J.S. & ELSBERRY, W.R. 2001. The advantages of theft over toil: the design inference and arguing from ignorance. *Biology and Philosophy,* 16:711-724.

WEIRICH, P. 1995. Computer theory. (*In* Audi, R., *ed.* The Cambridge dictionary of philosophy. Cambridge : Cambridge University Press. p.143-147.)

WILCOX, D. 2003. Finding Adam: the genetics of human origins. (*In* Miller, K.B., *ed.* Perspectives on an evolving creation. Grand Rapids : Eerdmans. p.242-255.)

WOLKENHAUER, O. 2002. Simulating what cannot be simulated. [Web:] http://www.sbi.uni-rostock.de/dokumente/dagstuhl_6_2002.pdf [Date of access: 15 Oct. 2007].

WRIGHT, L. 1972. A comment on Ruse's analysis of function statements. *Philosophy of Science*, 39(4):512-514.

WRIGHT, N.T. 1993. The New Testament and the people of God. London : SPCK.

YOUNG, M. 2002. How to evolve specified complexity by natural means. [Web:] http://www.pcts.org/journal/young/young2002a.html [Date of access: 12 May. 2006].

ZIMMER, C. 2006. From fins to wings. *National Geographic,* 210(5):110-135.