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THE CLOCKWORK GOD: ISAAC NEWTON AND THE MECHANICAL UNIVERSE

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In this lecture, I want to explore with you a way of thinking about our universe which emphasises its regularity and orderedness, and think about some of its wider implications – including, of course, its religious dimensions.

Scholars routinely speak of the "scientific revolution" which swept through western Europe during the seventeenth century. It is difficult to say precisely when this revolution began. Some would argue that its origins lie in the work of Copernicus and Galileo; others that it began much earlier, having its roots in trends in late medieval universities, or the new attitudes of the Renaissance.

Others suggest that a fundamental philosophical change lay behind the scientific revolution. The work of Francis Bacon (1561-1626) argued that knowledge began with experience of the world. The proper starting point of scientific knowledge is observation of phenomena, which is followed by the attempt to derive general principles to explain those observations. Despite these difficulties of definition, there is virtually universal agreement that Sir Isaac Newton (1642-1727) played a pivotal role in the scientific revolution. In this lecture, we shall consider some of his achievements, and their religious implications.

In my previous lecture, I discussed how the emergence of the heliocentric model of the solar system had clarified issues of geometry; issues of mechanics, however, remained unresolved. Kepler had established that the square of the periodic time of a planet is directly proportional to the cube of its mean distance from the sun. But what was the basis of this law? What deeper significance did it possess? Could the motion of the earth, moon and planets all be accounted for on the basis of a single principle? Part of the genius of Isaac Newton lay in his demonstration that a single principle could be seen as lying behind what was known about "celestial mechanics". Such was the force of Newton's demonstration of the mechanics of the solar system that the poet Alexander Pope (1688-1744) was moved to write the following lines as Newton's epitaph:

> Nature and Nature's Law lay hid in Night
>
> God said, let Newton be, and all was Light.

Newton is often presented as a noble monument to rationality and cosmic order, a beacon of scientific orthodoxy in the midst of a still superstitious society. In fact, the reality is somewhat more complicated. Papers which remained undiscovered until the twentieth century offer a more complex picture of Newton as someone of almost pathological loneliness, who came close to madness, was obsessed with alchemy, and was fascinated by theological heresies. Newton may well have ushered in the modern world through his discoveries, but he belonged to the world that has now been left behind.

The most helpful way to understand Newton's demonstration of the laws of planetary motion is to think of Newton establishing a series of principles which govern the behavior of objects on earth, and subsequently extrapolating these same principles to the motion of the planets. For example, consider the famous story of Newton noticing an apple falling to the earth. The same force which attracted the apple to the earth could, in Newton's view, operate between the sun and the planets. The gravitational attraction between the earth and an apple is precisely the same force which operates between the sun and a planet, or the earth and the moon.

Having mentioned this story, I need to say more about it! Let's look at what has become one of the most famous anecdotes in the history of science – Newton and the falling apple. Now as I was told this story at school, it went like this. A young Isaac Newton was happily sitting in his garden when an apple falls on his head. Then there is some kind of moment of devastating illumination, perhaps brought on by the force of the apple striking him, and in a brilliant moment of insight, Newton invented his theory of gravity. It's a wonderful story. And like so many of these stories, there is an element of truth, and a lot of exaggeration. Newton himself, to the best of my knowledge, left no written account of being hit by an apple, or even that observing an apple falling was some kind of epiphanic moment.

We know that Newton had left Cambridge for Woolsthorpe Manor in 1666, wanting to get away from centres of population that had been affected by an outbreak of the plague. While at this rural family retreat, he was considering the problem of gravity, eventually showing that the force of gravity decreased as the inverse square of the distance. But how do apples come into this? If, of course, they come into it at all.

Happily, however, we have several accounts of how Newton devised his theory of gravity after witnessing an apple falling from a tree in his mother's garden at Woolsthorpe Manor, near Grantham in Lincolnshire. None of these were written by Newton himself, and they date from more than 50 years after the event. Here are two of them.

One account of this incident was written down by John Conduitt, the husband of Newton's niece and who became Newton's assistant at the Royal Mint, which Newton directed in his later years. Here's what Conduitt wrote:

> "In the year 1666 [Newton] retired again from Cambridge to his mother in Lincolnshire. Whilst he was pensively meandering in a garden it came into his thought that the power of gravity (which brought an apple from a tree to the ground) was not limited to a certain distance from Earth, but that this power must extend much further than was usually thought."

The second was written by William Stukeley, the author of the first biography of Newton, entitled *Memoirs of Sir Isaac Newton's Life*. Stukeley, who was also a native of Lincolnshire, spent time in conversation with Newton in the 1720s. The two were both fellows of the Royal Society, and on one particular occasion in 1726, they dined together in London. Let me read to you, in modern English, what Stukeley wrote down as a result of that conversation

> "After dinner, the weather being warm, we went into the garden and drank tea under the shade of some apple tree. . . Amid other discourse, he told me, he was just in the same situation, as when formerly the notion of gravitation came into his mind. Why should that apple always descend perpendicularly to the ground, thought he to himself; occasioned by the fall of an apple, as he sat in contemplative mood. Why should it not go sideways, or upwards? But constantly to the Earth's centre? Assuredly the reason is, that the Earth draws it. There must be a drawing power in matter. And the sum of the drawing power in the matter of the Earth must be in the Earth's centre, not in any side of the Earth."

Now this was written down sixty years after the event, and scholars can hardly be blamed for wondering if Newton has creatively embellished the story through retelling it over time. But it makes some sense. By the way, Woolsthorpe Manor is now owned by the National Trust, and visitors to the property are told that the same apple tree still grows to the front of the house, in sight of Newton's bedroom window. In case you are wondering, it is a cooking variety known as "Flower of Kent". But I am not here to persuade you to visit Woolsthorpe Manor, to join the National Trust, or to make a pie out of the "Flower of Kent"! So let's move on.

Newton initially concentrated his attention on uncovering the laws which governed motion. His three laws of motion established the general principles relating to terrestial motion. The critical development lay in his assumption that these same laws could be applied to celestial as much as to terrestial mechanics. Newton began work on his planetary theory as early as 1666. Taking his laws of motion as his starting point, he addressed Kepler's three laws of planetary motion. It was a relatively simple matter to demonstrate that Kepler's second law could be understood if there exists a force between the planet and the sun, directed towards the sun. The first law could be explained if it was assumed that the force between the planet and sun was inversely proportional to the square of the distance between them. This force could be determined mathematically, on the basis of what would later be termed 'the Law of Universal Gravitation', which can be stated as follows: Any two material bodies, *P* and *P'*, with masses *m* and *m'*, attract each other with a force *F*, given by the formula $F = Gmm'/d^2$ (where *d* is their distance apart, and *G* is the Constant of Gravitation).

Newton applied the laws of motion to the orbit of the moon around the earth. On the basis of the assumption that the force which attracted an apple to fall to the earth also held the moon in its orbit around the earth, and that this force was inversely proportional to the square of the distance between the moon and the earth, Newton was able to calculate the period of the moon's orbit. It proved to be incorrect by a factor of roughly 10%. Yet this error was not the outcome of a faulty theory; it rather arose through an inaccurate estimate of the distance between the earth and the moon. Newton had simply used the prevailing estimate of this distance; on using a value which was more accurate, determined by the French astronomer Jean Picard in 1672, theory and observation proved to be in agreement.

Newton's theories were grounded on the basic concepts of mass, space and time. Each of these concepts can be measured, and are capable of being handled mathematically. Although Newton's emphasis on mass has now been replaced by an interest in momentum (the product of mass and velocity), these basic themes continue to be of major significance in classical physics. On the basis of his three fundamental concepts, he was able to develop precise ideas of acceleration, force, momentum and velocity.

It is not my intention in this lecture to provide a full historical analysis of precisely how and when Newton arrived at his conclusions, nor to set them out in detail. The important point to appreciate is that Newton was able to demonstrate that a vast range of observational data could be explained on the basis of a set of universal principles. Newton's successes in explaining terrestial and celestial mechanics led to the rapid development of the idea that the universe could be thought of as a great machine, acting according to fixed laws. This is often referred to as a "mechanistic worldview", in that the operation of nature is explained on the assumption that it is a machine operating according to fixed rules.

The religious implications of this will be clear. The idea of the world as a machine immediately suggested the idea of *design*. Newton himself was supportive of this interpretation. Although later writers tended to suggest that the mechanism in question was totally self-contained and self-sustaining – and therefore did not require the existence of a God – this view was not widely held in the 1690s. Newton's work was initially seen as a splendid confirmation of the existence of God, as the creator of a structured and regular universe.

Newton's emphasis upon the regularity of the world was one of the reasons behind a significant development in the ways in which God was pictured and understood. Traditionally, Christian theology and iconography drew on biblical images of God, such as a king or shepherd. The Scientific Revolution led to a new image of God capturing the imagination of many during the seventeenth century – namely, God as a clockmaker. One clock in particular was singled out as a worthy analogue of the celestial machine – the great cathedral clock of Strasbourg. This clock, rebuilt in 1574, displayed information about the time, the location of the planets, the phases of the moon, and other astronomical information. These were displayed using a series of dials and other visual effects.

The new emphasis on the divine ordering of the world, which emerged from the "mechanical philosophy" of Newton and his school, was widely seen as offering a form of religion with maximal intellectual plausibility and minimal social divisiveness. God could be thought of as the divine clockmaker, who had constructed a particularly elegant piece of machinery, and made no demands of anyone other than a due recognition of the order and beauty of the creation, and its implications for the stability of the social order. Natural theology thus came to be seen as a potential means of enhancing social cohesiveness in the late seventeenth and early eighteenth centuries, while at the same time being responsive to scientific advance.

The personal role of Newton in catalyzing this development must be fully acknowledged. Indeed, such was the religious and scientific esteem in which Newton was held that some pressed for him to be treated as a saint. Having uncovered the laws governing the behaviour of the solar system, Newton argued that the regulation and maintenance of "this most beautiful system of the sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful Being." Newton was clear that indisputable empirical facts about the physical world, which were open to public observation, demonstrated the existence of God beyond reasonable doubt. The physical ordering of the created order was clear evidence of God's "most wise and excellent contrivances of things." The regular motions of the planets, he argued, "could not spring from any natural causes, but were impressed by an intelligent agent."

Underlying Newton's approach is the fundamental belief that the regularity of the mechanisms of nature point to their origination in the mind of God. The astronomer Johannes Kepler (1571-1630) had earlier been an enthusiastic advocate of this notion, which allowed him to affirm the intellectual synergy of the new astronomy and Christian theology. Kepler regarded geometry as the archetype of the cosmos, coeternal with God as its creator, and therefore taking precedence, both conceptually and chronologically, over the act of creation. In his work *Harmonices Mundi* (1619), Kepler argued that, since geometry had its origins in the mind of God, it was only to be expected that the created order would conform to its patterns:

> In that geometry is part of the divine mind from the origins of time, even from before the origins of time (for what is there in God that is not also from God?) has provided God with the patterns for the creation of the world, and has been transferred to humanity with the image of God.

Newton is known to have held this work of Kepler in high regard, and it is possible that Kepler's emphasis upon the origin of mathematics in the mind of God may have been a theological stimulus to Newton's mathematicization of nature.

The forms of natural theology which emerged from within the Newtonian synthesis tended to emphasise the regularity of the natural order. The existence of "laws of nature" were often held in themselves to indicate, possibly even prove, the existence of a lawgiver – easily identified with, or assimilated to, the Christian notion of God. Although teleological notions could be embedded within this conceptual matrix without difficulty, its prime emphasis lay on the ordering and rationality of nature, rather than the purposes for which such ordering and rationality might have been devised. The growing tendency to think of the universe in mechanical terms made it increasingly plausible to argue from a mechanism to its designer – an approach characteristic of English physico-theology.

Now I need to explain that strange word "physico-theology." Basically, it is another way of speaking about natural theology; however, it refers to a specific form of natural theology which demonstrates or affirms the existence of God on the basis of the regularity and complexity of the natural world. We find this approach in many earlier writers – for example, in the great Roman physician Galen, who saw the complexity of the human body as evidence of divine design. Yet this approach came into its own in England during the late seventeenth and eighteenth centuries, in response to Newton's demonstration of the fundamental ordering of the universe.

A mechanical approach to nature was seen to offer many advantages to Christian theology. Such a model emphasised the regularity and reliability of the universe, allowed a correlation to be established between the wisdom and intentions of a creator or designer and their final outcome, and lent itself easily to the inference of design within the natural world, and hence of a designer. Although English physico-theology of the late seventeenth and early eighteenth century appears to have lacked a rigorous understanding of argumentation by analogy, it is clearly assumed that the mechanical attributes of nature lend some unspecified legitimacy to the use of mechanical models of nature – such as the great cathedral clock of Strasbourg, or a pocket watch.

It is, however, important to appreciate that this shift in conceptualization of nature was not without its critics, still less its problems. Mechanical models of nature were opposed by those who preferred older organic models, which emphasised the organizational unity of the natural world, seeing this as an expression of the wisdom of its creator. Cambridge Platonists such as Henry More (1614–87) and Ralph Cudworth (1617–88), for example, emphasised the coherence and harmoniousness of nature, arguing that nature possessed an "outward frame of things" which pointed to its origins in the "eternal mind" and being of God. The argument, however, is primarily based upon the overall coherence of the natural order, and is perhaps more mystical than rational in its approach. More himself does not, however, treat these two approaches as antithetical. Where writers such as John Wilkins and Robert Boyle were realizing the apologetic potential of the lawfulness of nature, as disclosed by developments in the mechanical and experimental natural philosophy of their day, More preferred to behold nature as a whole, a single entity, reflecting on the theological significance of the harmony of its deeper structures.

Yet whatever the intentions of its original advocates might have been, the approach to natural theology based on mechanical models of the natural world ended up eroding the conceptual space traditionally occupied by God. The amalgam of Newtonian natural philosophy and certain forms of Anglican theology proved popular and plausible in England during a period of political instability and uncertainty. Nevertheless, it was an unstable amalgam – more of a convenient, temporary convergence of vested intellectual and social interests, rather than a resilient, integrated, conceptual fusion. It was not long before what some scholars have named the "estrangement of celestial mechanics and religion" began to set in. The somewhat problematic enterprise of "celestial mechanics" increasingly seemed to suggest that the world was a self-sustaining mechanism which had no need for divine governance or sustenance for its day-to-day operation.

The image of God as a "clockmaker" (and the associated natural theology which appealed to the regularity of the world) came to be seen as leading to a purely naturalist understanding of the universe, in which God had no continuing role to play. God created the world, and then left it to function and fend for itself. The scene was set for the rise of the important religious movement generally known as "Deism".

Newton's emphasis on the regularity of nature is seen by most scholars as one of the factors which encouraged the rise of Deism. The term "Deism" (from the Latin *deus*, "god") is widely used to refer to a view of God which maintains God's creatorship, but denies a continuing divine involvement with, or special presence within, that creation. It is thus often contrasted with "theism" (from the Greek *theos*, "god"), which allows for continuing divine involvement within the world. The term "Deism" is generally used to refer to the views of a group of English thinkers during the "Age of Reason", in the late seventeenth century and early eighteenth centuries. In his influential study *The Principal Deistic Writers* (1757), John Leland grouped together a number of writers – including Lord Herbert of Cherbury, Thomas Hobbes and David Hume – under the broad and newly-coined term "Deist". Whether these writers would have approved of this designation is questionable. Close examination of their religious views shows that they have relatively little in common, apart from a general skepticism about several traditional Christian ideas, such as the necessity of divine revelation. The Newtonian world-view offered Deism a highly sophisticated way of defending and developing their views, by allowing them to focus on the wisdom of God in creating the world.

Deism can be regarded as a weaker form of Christianity which placed particular emphasis on the regularity of the world. It rapidly gained a sophisticated following in late seventeenth century England, especially at a time when traditional Christianity was seen as intellectually weak. Deism can be seen as a culturally adapted form of Christianity, which reduced the Christian faith to a reaffirmation of God as creator of the world, and the basis of human morality.

John Locke's *Essay concerning Human Understanding* (1690) developed an idea of God which became characteristic of much later Deism. Locke argued that "reason leads us to the knowledge of this certain and evident truth, that there is an eternal, most powerful and most knowing Being". The attributes of this being are those which human reason recognizes as appropriate for God. Having considered which moral and rational qualities are suited to the deity, Locke argues that "we enlarge every one of these with our idea of infinity, and so, putting them together, make our complex idea of God." In other words, the idea of God is made up of human rational and moral qualities, projected to infinity.

Its critics, however, saw Deism as having reduced God to a mere clockmaker. God wound the world up, like a clock, and then left it to run, unattended. Newton, it must be noted, never suggested that God was unable to intervene in the workings of the universe. He merely noted that there was no reason to suggest that he did. Having established a regular universe, governed by fixed laws, there was no need for special divine action to keep it going.

We see here how the rise of the mechanical worldview (a scientific development) has religious implications. The Newtonian model of the universe seemed to resonate with a particular way of thinking about God. More importantly, it suggested that this god could be known and studied without the need for any specifically religious beliefs, or the study of religious texts, such as the Bible. A religion of nature could be developed, appealing from the regularity of the mechanism of the universe to the wisdom of its constructor.

This line of argument can be found in Matthew Tindal's *Christianity as Old as Creation* (1730), which argued that Christianity was nothing other than the "republication of the religion of nature". God is understood as the extension of accepted human ideas of justice, rationality and wisdom. This universal religion is available at all times and in every place, whereas traditional Christianity rested upon the idea of a divine revelation which was not accessible to those who lived before Christ. Tindal's views were propagated before the modern discipline of the sociology of knowledge created scepticism of the idea of "universal reason", and are an excellent model of the rationalism characteristic of the movement, and which later became influential within the Enlightenment.

The ideas of English Deism percolated through to the continent of Europe through translations (especially in Germany), and through the writings of individuals familiar with and sympathetic to them, such as Voltaire's *Philosophical Letters*. Enlightenment rationalism is often considered to be the final flowering of the bud of English Deism. For our purposes, however, it is especially important to note the obvious consonance between deism and the Newtonian worldview. As we noted earlier, deism owed its growing intellectual acceptance in part to the successes of the Newtonian mechanical view of the world.

If God was being excluded from the mechanics of the world, there were many who suggested that divine design and activity was still to be found in the biological realm. Did not this show evidence of design? One of the most influential writers to suggest that this was the case was John Ray (1627-1705). In his *Wisdom of God manifested in the Works of Creation* (1691), Ray argued that the beauty and regularity of the created order, including plants and animals, pointed to the wisdom of their creator. Ray, it must be emphasised, worked with a static view of creation. He understood the phrase "Works of Creation" to mean "the Works created by God at first, and by Him conserv'd to this Day in the same State and Condition in which they were at first made".

The most famous appeal to God as the designer and maker of the natural world, especially in relation to its biological aspects, was that of William Paley, archdeacon of Carlisle, who compared God to one of the mechanical geniuses of the Industrial Revolution. God had directly created the world in all its intricacy. Paley accepted the viewpoint of his age – namely, that God had constructed (Paley prefers the word "contrived") the world in its finished form, as we now know it. The idea of any kind of development seemed impossible to him. Did a watchmaker leave his work unfinished? Certainly not!

Paley argued that the present organization of the world, both physical and biological, could be seen as a compelling witness to the wisdom of a creator god. Paley's *Natural Theology; or Evidences of the Existence and Attributes of the Deity, Collected from the Appearances of Nature* (1802) had a profound influence on popular English religious thought in the first half of the nineteenth century, and is known to have been read by Darwin. Paley was deeply impressed by Newton's discovery of the regularity of nature, which allowed the universe to be thought of as a complex mechanism, operating according to regular and understandable principles. Nature consists of a series of biological structures which are to be thought of as being "contrived" – that is, constructed with a clear purpose in mind.

Paley's argument hinges around a controlling analogy – the biological world is analogous to a watch. The apologetic strategy developed by Paley rests upon establishing this vivid analogy, which possesses sufficient imaginative potential to carry his readers along and subvert the evidential force of objections that might be raised against his approach. Paley's analogy of the watch may be derivative; the use he makes of it shows an ingenuity and creativity that cannot be overlooked.

For Paley, the Newtonian image of the world as a mechanism immediately suggested the metaphor of a clock or watch, raising the question of who constructed the intricate mechanism which was so evidently displayed in the functioning of the world. It is an important argument, which ran counter to the growing perception that the Newtonian concept of a mechanistic universe actually eroded the traditional Christian view of God. Surely, many argued, conceiving the universe as a mechanism led to the view of an absent God, a clockmaker whose clock could function without any further need for divine involvement or superintendence? For some, the mechanistic model of the universe implied a cold, lifeless deity and a satanic metaphysics – a universe empty of meaning.

Paley sought to rehabilitate an appeal to mechanism through the notion of contrivance. "Contrivance, if established, appears to me to prove everything which we wish to prove". The notion of contrivance had become an integral component of English natural theology since the time of Newton. Yet it had gained a new plausibility through the growing popular familiarity with, and interest in, machinery. Where Robert Boyle had to illustrate the notion of contrivance with some obscure references to "pneumatic machines" that were clearly unfamiliar to his readers, Paley could appeal to mechanical devices that his readers encountered and experienced in everyday life. England led the way in the Industrial Revolution between 1750 and 1830, developing new mechanical methods of production that rapidly outstripped its economic rivals in Europe. Paley's appeal to the significance of mechanism as indicative of design carried considerable cultural plausibility. His approach to natural theology was crafted with the new cultural environment of the Industrial Revolution in mind.

Writing against the backdrop of the emerging Industrial Revolution, Paley set out to exploit the apologetic potential of the growing popular interest in machinery – such as watches, telescopes, stocking-mills, and steam engines – on the part of England's ruling class. How, Paley asked, could such complex mechanical technology come into being by purposeless chance? Paley develops this point by his appeal to the analogy of the watch. In setting the context, Paley highlights the radical difference between a stone and a watch, when both are encountered while crossing a heath.

> In crossing a heath, suppose I pitched my foot against a *stone*, and were asked how the stone came to be there: I might possibly answer, that, for any thing I knew to the contrary, it had lain there for ever; nor would it perhaps be very easy to show the absurdity of this answer. But suppose I had found a *watch* upon the ground, and it should be inquired how the watch happened to be in that place; I should hardly think of the answer which I had before given, – that, for any thing I knew, the watch might have always been there.

What distinguishes the watch from the stone? The nub of Paley's answer can be summed up in the single word *contrivance* – a system of parts arranged to work together for a purpose, manifesting both design and utility. Paley used the term "contrivance" to convey the dual notions of design and fabrication, appealing to the popular interest in machinery characteristic of the new age of industrialization then emerging in England.

Following through his argument, Paley then offers a detailed description of the watch, noting in particular its container, coiled cylindrical spring, many interlocking wheels, and glass face. All show evidence of design for a specific identifiable purpose. Having carried his readers along with this careful analysis, Paley turns to draw his critically important conclusion:

> This mechanism being observed (it requires indeed an examination of the instrument, and perhaps some previous knowledge of the subject, to perceive and understand it; but being once, as we have said, observed and understood), the inference we think is inevitable, that the watch must have had a maker: that there must have existed, at some time and at some place or other, an artificer or artificers who formed it for the purpose which we find it actually to answer, who comprehended its construction and designed its use.

Paley's extended discussion of the watch is intended to establish a framework of interpretation, capable of being transferred to other objects that appear to show evidence of design. Paley's detailed analysis of the watch mechanism is intended to establish that it is a *contrivance*, showing evidence of being initially designed and subsequently constructed for a specific purpose, and thus indicating the existence of a designer. Paley is quite clear that this "designer" might be a group of people, rather than an individual; and that the present existence of a contrivance is no indication that its designer is still alive. These points will be addressed later in his argument; his concern at this early stage is to move on quickly to apply this framework of interpretation to the contrivances of the natural – especially the biological – world.

Now many objections could be made to Paley's approach. For a start, it could lead to showing the existence of several gods – for example, one who designed, and another who constructed. Or it might lead to inferring a God who has since died, and no longer has any involvement with the world. And what of suffering within the biological realm? At times, Paley seems oblivious to this issue. Consider the following passage:

> It is a happy world after all. The air, the earth, the water, teem with delighted existence. In a spring noon, or a summer evening, on whatever side I turn my eyes, myriads of happy beings crowd upon my view.

But what about apparent defects within the natural world? What about pain? Or evil? Paley is alert to this difficulty, yet argues that the problem lies at the level of implementation of an objective, not the objective itself.

> Contrivance proves design: and the predominant tendency of the contrivance indicates the disposition of the designer. The world abounds with contrivances: and all the contrivances which we are acquainted with, are directed to beneficial purposes. Evil, no doubt, exists; but is never, that we can perceive, the *object* of contrivance. Teeth are contrived to eat, not to ache; their aching now and then is incidental to the contrivance, perhaps inseparable from it: or even, if you will, let it be called a defect in the contrivance: but it is not the object of it.

Paley's argument is that the purpose for which something is created discloses the character of its creator. There is no reason for supposing that God wills evil for his creatures. The object of these divine contrivances is invariably good, even if their implementation may have painful outcomes.

Yet on reading Paley, many cannot help but think of Tennyson's famous lines from his poem *In Memoriam*:

> Man . . .
>
> Who trusted God was love indeed
>
> And love Creation's final law –
>
> Though Nature, red in tooth and claw
>
> With ravine, shrieked against his creed.

Or we might think of John Ruskin's famous description in his *Modern Painters* of a Scottish glen, whose natural beauty cannot conceal evidence of death, decay, and poverty.

> It is a little valley of soft turf, enclosed in its narrow oval by jutting rocks and broad flakes of nodding fern. From one side of it to the other winds, serpentine, a clear brown stream, drooping into quicker ripple as it reaches the end of the oval field, and then, first islanding a purple and white rock with an amber pool, it dashes away into a narrow fall of foam under a thicket of mountain-ash and alder. …
>
> Beside the rock, in the hollow under the thicket, the carcase of a ewe, drowned in the last flood, lies nearly bare to the bone, its white ribs protruding through the skin, raven-torn; and the rags of its wool still flickering from the branches that first stayed it as the stream swept it down. …
>
> At the turn of the brook, I see a man fishing, with a boy and a dog – a picturesque and pretty group enough certainly, if they had not been there all day starving. I know them, and I know the dog's ribs also, which are nearly as bare as the dead ewe's; and the child's wasted shoulders, cutting his old tartan jacket through, so sharp are they.

You see the point. Ruskin is arguing that writers such as Paley pay selective attention to certain aspects of the natural world, and gloss over its less appealing aspects.

But I must end. In this lecture, I have focussed on some ways of thinking about nature which have emphasised its complexity and regularity, and which appeal to mechanical analogies – such as a clock or a watch – to explore this aspect of our world. Personally, I find this helpful, up to a point. My own view is that we need multiple analogies and models of our world, and if we restrict ourselves to any one model, we limit ourselves. Many of you will know the poet Samuel Taylor Coleridge's concern about Newton's vision of the world: it was, he remarked "sheath'd in dismal steel", lacking any appeal to the imagination and failing to emphasise the beauty of the world. Perhaps this criticism also applies to notions of God which are shaped by this way of thinking about the world!