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# The Poetry of Science: Creativity and Constraint

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Creativity, Inspiration, Passion, Form, Imagination, Composition, Representation – this powerful list of words leads a reader's mind inevitably into the world of the arts. Perhaps it conjures up the shaping of a block of stone into the form of straining limbs and torso, or layering thick and darkly-tinted oil paints onto canvas to tease the eye into imagining a moonlit forest at night. Others may think of a composer scoring a symphony's climax - she summons the horns to descend as from a distant mountain peak onto a harmonically ascending string bass-line to meet in satisfying resolution. A poet at a desk wrestles with his meter and rhyme as they filter the streams of words, metaphors and allusions that clamour for place on the page. The double miracle of art is not only that it allows humans to create meaning, but also that it reaches out to receivers – the listeners, viewers and readers so that they re-create for themselves something new and personal in response. Both in words and wordlessly we are changed, troubled, enriched by art in small ways or great. To engage in it by creation or reception and re-creation is to exercise one of the capacities that make us human. Indeed the study of them falls under the class of disciplines we call the 'humanities'.

Experiment, design, formulation, method, theory, observation, hypothesis, computing, trial, error – another list of words might lead to a different world of activity. These are more associated with disciplines we term 'the sciences'. Their energy seems to be of a different sort – we are not, perhaps, as emotionally moved by theses words, they do not suggest as much wild, unpredictable outcome. Do we think of a laboratory setting – a careful mixing of liquids and a measuring of their temperature? Is the mental picture one of an observer carefully preparing a microscope, or calculating by computer the orbit of a distant planet? If the artistic associations are as likely to disturb as to excite, are the scientific associations more reassuring (the French cubist Georges Braque thought that, '*L'art est fait pour troubler, la science rassure'*)? Or do they disturb in a different way? Very likely this is a world that is unfamiliar and strange, less accommodating than the arts and, dare we admit it, less 'human' in some way (we do not class science as 'humanity' after all).

But there are other voices that choose the same language to talk about art and science, and even in the same breath. Philosopher of science Karl Popper once wrote: '*A great work of music, like a great scientific theory, is a cosmos imposed upon chaos – in its tensions and harmonies inexhaustible even for its creator*'. This richly-layered and dense commentary on music and science will need a lot of unpacking to uncover Popper's meaning, for no other reason than its allusions fail to intersect with the orthogonal word-lists that spring from usual talk of art and science. But it raises suspicions. Is this dualistic division into arts and sci-

ence really faithful to our history, our capacities and needs? Does it spring from a deep understanding of what these twin human projects attempt to do – is it faithful, dare we ask, to their *purpose*? And if not, are we right to ask of our children, 'are they on the science-side or the arts-side?' or to reinforce the well-worn narrative of C.P. Snow that there are 'Two Cultures' at work in our late-modern world, non-overlapping and doomed to conflict? If we are wrong about this, then to make exclusive educational decisions based on such a dualistic assumption will be to atrophy one or other aspect of those children's development, and in adult life to have closed off one or other world of expression, contemplation, creativity, enrichment – of complementary ways of being human.

Doubts intensify about a neat cultural divide if we take the all too unusual step of listening to an artist, or to a scientist, talk candidly about their journeys of labour from early ideas to a finished work. For now the language-clouds of the arts and the sciences start to collide and overlap. I have an intense memory of my first lengthy conversation with an artist (also a professor of fine art at my then home university of Leeds) about our respective experiences of bringing to light new work in art and in science. He spoke of his first experimental attempts to realise an original conception, of the confrontation of his original ideas with the real constraints of material – of paint and photographic print, of the necessary reformulation of the original concept, of the repeat of these frustrated assays not once but many times. I found that I could tell the story of almost any programme of scientific research I had experienced in the same terms. If I had been surprised by the element of experiment and trial in his artistic project, he had not expected so much of my story of science to speak of the role of imagination. Not only that, it became clear to us that not only did the intellectual and technical histories of our projects map closely onto each other, but so also our emotional trajectories of excitement, hope, disappointment, rekindling of hope, and resolution found common language.

Why it is so much less common to discuss the long process of realisation in art than to talk about the final article, composition, theory or painting is hard to say, but maybe it has to do with the tradition of artisan and artist guarding carefully the 'secrets' of their trades, thereby to increase by mystique as well as by wonder the appeal of the finished article. Art has commercial value too, so that finely-honed techniques or formulas, though they are the vehicles not the sources of inspiration, are nonetheless secrets worth keeping. Or perhaps there is less intention to weave a whimsical web of mystery or a prosaic wall of secrecy than a natural reluctance to admit too much of the false starts, errors, spilt ink, confused ideas and dead ends that are the daily experience of any creative activity.

If art is shy about the sweat and tears of working out the form of an original idea, then science is almost silent about its epiphanies and moments of inspiration. Popper himself, celebrated for the most detailed modern outworking of a scientific method in his *Logic of Scientific Discovery*, wrote at length on how hypotheses may be refuted, but remained quiet on how they might be imagined in the first place. There is indeed methodological logic in the testing and evaluating of a scientific idea, but none in its conception[1]. If science gathers to itself a narrative more weighted towards method, and art is more vocal about creative origins, then these retellings of partial truths will conspire to drive an illusory distance between them.

The paired trait of silence within the community of science on its imaginative energies, and of art on its workaday reckoning with material reality is not restricted to our own times. William Blake, the eighteenth century poet, artist and engraver famously inveighed against what he perceived was the destructive dehumanising of natural philosophy. He wrote of his own task: 'in the grandeur of Inspiration to cast off Rational Demonstration … to cast off Bacon, Locke and Newton'; 'I will not Reason and Compare – my business is to create'.[2] For Blake, inspiration has no place in Newton's work, and reason none in his own – this in spite of what we know of his own painstaking technical developments in copper engraving.

I frequently find the same unique assignment of inspiration and rationality at work today when working with high-school pupils. When visiting for 'general studies' discussions of science in society or the importance of interdisciplinary thinking, I like to ask advanced students who have not chosen to study science subjects (when from their intellectual engagement with the material it is clear that they could master anything they chose to) why they made that choice. Among the brightest of them, I never receive the complaint that the sciences seem too difficult, but rather that they appear to lack avenues for creativity and the exercise of imagination. The conversation sometimes also reflects the expectation of a more playful engagement with the humanities that contrasts with a scientific seriousness and narrowness. As Sîan Ede[3] writes:

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[1] It might be objected that algorithmic processes for extracting high-level 'hypotheses' from very large data sets constitute counter-examples, *e.g.* King R.D. (2004) 'Functional genomic hypothesis generation and experimentation by a robot scientist', *Nature*, **427**, 247-252. However, these 'hypotheses' are typically confined to the identification of new agents (genes, proteins) within established networks of interaction, and not imaginative re-conceptualisations of nature.

[2] William Blake, *Milton* (1804), book 2, pl. 41; *Jerusalem* (1804), ch 1, pl.10

[3] Sîan Ede, *Art and Science*, London I.B. Taurus (2005)

*Compared with the cool rationalism of science with its material belief in wholeness, the theories employed by thinkers in the arts and humanities seem part of a playful circular game in which the truth is never to be privileged in one direction or another and is always out of reach.*

These faithful echoes of Blake in the words of today's brightest young people are painful to hear. They speak to the urgency of a project that goes beyond the confrontational assumptions of the 'Two Cultures' to deeper levels of human motivation, desire, experience – one that recognises the dual qualities of rationality and inspiration, of seriousness and playfulness, of imagination and constraint, but challenges their automatic alignment with the axes of humanities and sciences, exploring instead how they play out in both.

Admittedly it has never been easy to speak of the moments of imaginative conception. When inspiration eventually comes, articulating the experience faithfully is fraught with difficulty. There is a wordlessness about those moments of vision that initiate the necessary drudgery of the creative process, by planting a germ of energy and a distant impression of what might be accomplished. We know how to desire those moments, but not how to summon, and hardly to describe them. Here is Shakespeare in his 100th Sonnet:

*Where art thou Muse that thou forget'st so long,*
*To speak of that which gives thee all thy might?*
*Spend'st thou thy fury on some worthless song,*
*Darkening thy power to lend base subjects light?*
*Return forgetful Muse, and straight redeem,*
*In gentle numbers time so idly spent;*
*Sing to the ear that doth thy lays esteem*
*And gives thy pen both skill and argument.*
*Rise, resty Muse, my love's sweet face survey,*
*If Time have any wrinkle graven there;*
*If any, be a satire to decay,*
*And make Time's spoils despised every where.*
*Give my love fame faster than Time wastes life,*
*So thou prevent'st his scythe and crooked knife.*

Here the poet longs for the return of his 'Muse', his personified inspiration, to sing songs to his ear and to guide his pen on the page before Time takes away all opportunity for

further art. Yet, paradoxically he makes this 'time between inspirations', this ostensibly dry season of complaint – into a sublime sonnet. The actual song of the Muse is muffled, and the sight of her hidden, by the humorous complaint of her absence. Unnoticed, the poet's imagined sole source of inspiration, the face of his beloved, is replaced by his rising outrage that the Muse refuses to come at his beck and call. The first stage of creativity – the ostensibly momentary visit of inspiration itself – is unusually for poetry, conflated with the second – in his case the 'skill and argument' of the pen, the long labour that must do battle with Time itself. Ironically, it is the wasting erosion of time that becomes the topic of the final work of art. The poet knows that even if inspiration comes, time is not a friend before a poem results.

After hearing to Shakespeare on inspiration and labour in art, perhaps we ought without delay turn to Einstein on creativity in science (why descend from the summit of Olympus before you have consulted all of the occupiers?). Here is the master and motivator of twentieth century physics on the two components of creativity:

> *The mere formulation of a problem is far more essential than its solution,*
> *which may be merely a matter of mathematical or experimental skills.*
> *To raise new questions, new possibilities,*
> *to regard old problems from a new angle, requires creative imagination*
> *and marks real advance in science.*
> ~
> *I am enough of an artist to draw freely upon my imagination.*
> *Imagination is more important than knowledge. Knowledge is limited.*
> *Imagination encircles the world.*

Both Shakespeare and Einstein, as they open for us the door into their workshops - albeit in very different forms, tell of two phases in the creative process. The first, 'the visit of the Muse', the 'creative imagination' or 'the mere formulation' is the inspiration, the birth of an idea or an inspiration. The second is a longer, more directed process of working from the idea into its 'song' or 'solution'. It is intriguing that Einstein chooses to explain his knowledge of the wellspring of imagination - he 'draws' from it - by describing himself as an artist, by elevating 'imagination' as he demotes 'knowledge'. He wants to make clear that the greater task in science is the 'mere formulation' of the problem in the first place, rather than the application of methods to its solution (by 'mere' he means 'fundamental', 'elemen-

tary' or 'constitutive' rather than 'trivial' of course). The great scientist knows that we find our way to encircling the earth, not principally by experiment, theory, deduction, falsification, or any of those important features of scientific method, but by imagination.

The formulation of the right question, posed in the right way, constitutes the great imaginative act in science. It requires a developed sense of the current age of thought, of timing. Historian and chemist Lawrence Principe[4] has pointed out the appropriateness of asking the question about the structure of the solar system at the turn of the 16th century: with Tycho Brahe's meticulous observations of planetary motion, Kepler's deductions and Galileo's assays in turning the new telescopes towards the heavens, asking about the dynamical consequences of gravity among the sun and the planets became fruitful in a sense that it had not in any previous century. Scientific imagination also needs an element of the discontinuous, of a leap in thinking that receives impulse from some other source than the worthy process of deduction. A generation on from the establishment of the orbits of the moon and planets, the heliocentric structure of the solar system, Newton's great imaginative conception was to contemplate a world in which the fall of an apple sprung from the same universal field of force as the monthly procession of the Moon.

Einstein and Principe point us to the critical role of the well-formulated question in science. Yet the silence of any scientific method on this great creative act tends to mask its pivotal role, as well as dull the perception of scientific creativity. Highlighting it would serve to deepen the level at which the fundamental motivation for science appears within human culture. A literature-search for the question-form when addressed to the natural world also lengthens the historical line over which we can map early stirrings of the desire to understand and contemplate nature. I have elsewhere written at length on the beautiful and profound ancient wisdom poem, the 'Lord's Answer' of the Old Testament Book of Job[5]. A work of over a hundred verses, it assumes the unusual poetic form of the repeated question – but in the light of this discussion appropriately so since its subject matter is the human understanding of nature. The origin of light, the formation of the coastlines and mountains, the provenance of the hail and lightening, the ability of birds to navigate the earth in their migrations – all appear in a grand cosmic sweep of enquiry. One stanza from chapter 38 in particular would have (and maybe did) impress a Newton or an Einstein:

*Can you bind the cluster of the Pleiades, or loose Orion's belt?*

*Can you bring out Mazzaroth in its season, or guide Aldebaran with its train?*

[4] L. Principe, *The Scientific Revolution: a Very Short Introduction* (Oxford University Press 2013)
[5] Tom McLeish, *Faith and Wisdom in Science* (Oxford University Press 2014)

*Do you determine the laws of the heaven?*
*Can you establish its rule upon earth?*

The poet looks at the motions of the stars and constellations across the sky, even noticing that some cluster together while others while visually similar in brightness and hue are separated. The lovely Pleiades is one of the very few 'open star clusters' resolvable to the human eye, with up to six or possibly seven members visible to keen-eyed northern hemisphere observers during autumn and winter nights. An outstretched hand-breadth to the south-west of them lie the linear triplet of bright blue-white stars of 'Orion's belt', far further from each other than the members of the cluster. The presence of a strange class of 'law', to be obeyed not by humans but by the stars themselves, that might contain the statutes that bind some closely together while others are far-flung, that oversee their regular and irregular motions, is an impressive creation of the imagination even now. The conjecture that heavenly and earthly laws might be connected is even more striking.

The presence of the creatively-formulated question in as ancient a source as the Book of Job (undatable other than to place it within the first half of the first millennium BCE) within the Semitic tradition, carries another salutary message to us late moderns. Alongside the complex history of ancient Hellenistic science from 500BCE it surely erodes any idea that science is in any way exclusively modern, beginning rootless at the enlightenment and blowing away the cobwebs of centuries of darkness, magic and alchemy. Sadly much popular narrative of science history has it so, but by claiming science as an exclusive property of the modern world removes the deep and slow cultural development of an imaginative and creative engagement with nature that develops, at least chronologically, alongside the story of art.

The timely question is not the sole province of science. It is surely not coincidental that the literary genre of the novel arises, with Daniel Defoe, alongside early modern science. As Pat Waugh[6] has pointed out, it is the *experimental* medium of artistic creation *par excellence*. In the safe space of the novel, inhabited worlds can be summoned into existence and their dangers and dark places explored. Questions of the relationship of human beings to time and space, to each other and to the earth can be teased out in both internal and external worlds of their characters. The novelist does not experience unconstrained freedom, however, but discovers the multiple moral constraints of the experimental form. Crucially, novelistic writing forces a more intense outward gaze. For Iris Murdoch, novelistic writing

[6] P. Waugh, *Beauty writes literary history* in *The Recovery of Beauty*, C. Saunders, J. Macnaugten Edns (London Palgrave MacMillan 2015)

enables an attention to '… the inexhaustible detail of the world, the endlessness of the task of understanding …, the connection of knowledge with love and of spiritual insight with the apprehension of the unique'[7]. Murdoch supplies us with another glimpse of commonality in the narrative that artists, creative writers and scientists adopt when they are trying to articulate the deepest motivations for what they do. 'The endless task of understanding' and a focus on the 'inexhaustible detail of the world' are the shared delights and common labours of the physicist and biologist also.

Paying close attention to the stories of imagination and workmanship in the creation of art and science will be the first of our tasks in the project of reappraising science through the lens of the humanities. The second task must be a similar reciprocal study of their reception. Neither art nor science can exist in a solipsistic vacuum of their authors. Both must be listened to, observed, received, responded-to. If the current public narratives of creativity are artificially divided into the imagination of art and the logic of science, then the framing of their reception is just as polarised. 'Science is not with us the object of contemplation', complained social thinker Jacques Barzun[8]. The impression is that art appeals to the response of emotion and affect while science connects only to cerebral reason. Such a neat, Kantian, division appeals to a compartmentalised and fragmented structural view of culture, but it reinforces the picture of artificial division of science and art into two realms. Perhaps this is where they do indeed divide – even if both draw at depth on a mysterious creative human energy in their production, might reading, listening and hearing science and art require divergent mental abilities?

If a distorted impression of creativity arises in part from selective silences on the part of their practitioners, then the same is true of their reception. Comment on the effect and the enjoyment of art is commonplace. It speaks of a healthy continuum from artist and performer to receiver and listener. We may not be able to paint or to sing like the great exponents of art and oratorio, but we are not silenced as a result from speaking, or even from critically appraising, paintings or performances. There is understood to be a 'ladder' of participation and reception in the arts. In music, for example, the lower rungs are occupied by those of us who enjoy concerts, who pick up instruments in the company of forgiving amateur friends. We would never presume to perform in public, but nevertheless can confidently express an opinion on which recording of a symphony we prefer. The upper rungs are oc-

[7] Iris Murdoch, *Existentialists and Mystics* p.86
[8] J. Barzun, *Science that Glorious Entertainment*,

cupied by the performers on those recordings. Here is actor Simon Russell Beale[9] talking about his response to Schubert:

> *Schubert can make time stand still. In the last, miraculous months of his life, he expanded his vision of what music could do. His most experimental work is the slow movement of his B flat Piano Sonata. It is as if he has distilled the process of music-making. He takes a harmonic progression, explores it, changes a single note, explores it again; he breaks down a simple melody until only the bones are left and the music is suspended. The result is a play of pure sound, without external reference, that gives us a glimpse of eternity.*

This is a piece of exceptionally high quality comment, to be sure, but it is not unusual in form from someone who is not a professional musician talking at serious critical depth about a piece of music. It is also an example of the type of testimony we met in the case of artistic creators, stories that map rather remarkably onto the rare but honest stories of creative science. Schubert, is, as heard by Beale, experimental, exploratory, even reductionist and abstractionist. Yet he is also sublime. Beale describes an example of a deep property of music – its ability to reconcile us to the passage and structure of time by somehow suspending us from it.

It is harder to find comparable examples of reception and affect of scientific creation. But this is not because of a lack of inherent appeal to human desire and need. The 'ladder of access' that we identified in a creative art such as music is not (as observed by Barzun in different terms) present in our current culture in science as it is in arts. This was not always the case – Shelley, Coleridge and Wordsworth all thought that science could, and would inspire poetry (though Shelley foresaw that the inspirational beauty of science would be a hidden one). So for articulated contemporary reception of science, we must usually listen to the scientists themselves. Here is cosmologist Subrahmanyan Chandrasekhar[10] describing in remarkable terms an example of the moments of transport for which science longs:

> *In my entire scientific life, extending over forty-five years, the most shattering experience has been the realization that an exact solution of Einstein's equations of gen-*

[9] In *Ferocious*, *Tender*, *Sublime*, *The Guardian* 19th March 2012.
[10] S Chandrasekhar, *Truth and Beauty: Aesthetics and Motivations in Science* (University of Chicago Press 1987)

*eral relativity, discovered by New Zealand mathematican Roy Kerr, provides the absolutely exact representation of untold numbers of massive black holes that populate the universe. This 'shuddering before the beautiful', this incredible fact that a discovery motivated by a search after the beautiful in mathematics should find its exact replica in Nature, persuades me to say that beauty is that to which the human mind responds at its deepest and most profound.*

Chandrasekhar's 'shuddering before the beautiful' carries unmistakable resonance with Beale's 'glimpse of eternity'. The cosmologist is speaking of the extraordinary simplicity of the idea of a 'black hole'. For many years pure conjecture, observational evidence from stellar evolution and highly luminous galactic cores has pointed increasingly to the inevitable existence of these bizarre and terrible objects. Black holes are places in the cosmos where the local presence of matter is so great that gravity generates its runaway collapse towards a point where density becomes formally infinite, surrounded by a finite region from which no light can escape. Of an austere beauty, these objects can possess no other properties than mass, spin and electric charge. All other attributes that their original matter once possesses are lost in its infall. The normal role of mathematics within theoretical physics is to provide approximate descriptions of natural objects, but in this case the threefold attribution is complete. The experience Chandrasekhar describes is a rarefied and extreme form of a precious wonder. Einstein put it thus: 'the most inexplicable thing about the universe is that it is explicable' and Eugene Wigner pointed towards it in the title of his celebrated essay *The Unreasonable Effectiveness of Mathematics*. The moment of connection of a constructed pattern of thought, mathematical, pictorial or logical, with the deep structure of the natural world evokes an unparalleled experience of wonder. More than that, it seems to satisfy a need – the creative connectedness, the act of understanding, of re-creating an internalised world patterned on the external. Such reaching out into the world in abstract thought is perhaps a flowering of a human response to the ancient questions of the Book of Job[11].

I suggested that, because of the 'missing rungs' of a scientific ladder of reception, it is lamentably less common for non-practitioners of science to experience this intensely desirable response than for the scientists whose professional training has taken them to higher footholds. But it is not impossible, and could be as common as the learning of a new tune or appreciating an unfamiliar painting for the first time. In a moving personal example, a friend told me of the moment he suddenly saw how the phases of the moon worked. A life of fa-

[11] Tom McLeish, *op. cit.* Ch. 5

miliarisation with the monthly cycle of crescent, half, full and gibbous moon was not equivalent to 'seeing' how these shapes served as the signature of an illuminated orb. One moonlit night shortly after sunset he allowed the two-dimensional screen of the sky to become a three-dimensional space in his mind. The moon became a solid sphere, illuminated by a much more distant sun from different angles on different days, as seen from the centre of its orbit on the earth. The celestial geometry and its circling dynamics found a home in his imagination – and his experience was pure joy. He described feeling present to the world in a deeper sense than before, and knowing that this stronger relationship with the world was, once found, not going to be lost.

Experiences of such reception in science or in art, achieve at their most profound such an intensity of emotion and of felt transformation, that they must draw our exploration to a third level of parallel comparison – that of function and, if we dare talk of it, of purpose. A nest of questions confronts us here: why do art, and early science, arise in pre-history? What do they achieve socially and psychologically today? Where do art and science appear, both explicitly and hidden, in the complex of cultural narratives? How do they receive, and then develop, value and virtue? The humanities discipline of theology comes to aid here, for no other reason than that it is comfortable with the category and narrative of purpose. Recent writers have attempted to articulate a 'theology of' music (Begbie[12]), of art (Wolterstorff[13]), of science (the present writer[14]) and found that this trailhead leads to a fruitful landscape within which these questions of function can be attempted. I have remarked before of the striking reception that critic and literary scholar George Steiner's view of art in this regard has when read from the perspective of science. In his moving critique of the humanities in late modernism *Real Presences*, he writes[15]

> *Only art can go some way towards making accessible, towards waking into some measure of communicability, the sheer inhuman otherness of matter*

speaking at the same time of deep need, and of powerful satisfaction. Steiner describes a human condition 'out of joint' with the world in which humans are immersed. There is a gulf of otherness, of strangeness, with which, for reasons we do not understand, we remain uncomfortable. The divorce is painful. The paradox is heightened when we reflect that the 'sheer inhuman otherness of matter' is the very stuff of which we are composed. Art does

[12] Jeremy Begbie, *Theology, Music and Time*;
[13] Nicholas Wolterstorff, *Art in Action*
[14] Tom McLeish *Faith, Wisdom and Science*
[15] George Steiner, *Real Presences*, London Faber and Faber

indeed go some way towards reconciliation. The creation by paint on canvas of a visual illusion that the observer stands before a riverbank picnic illuminated by mottled sunlight, is achieved only by a deep understanding of the received visual cues by which we reconstruct our surroundings. Or, if another contrast imposed by the 'inhuman otherness of matter' on the human is the appalling possibility of eternity in the face of our own temporality, then the 'glimpse of the eternal' afforded by a Schubert sonata is doing some work. But so too, surely, is the science of the night sky, be it the humble reimagining of the illuminated moon or the severe simplicity of a mathematical black hole that finds connection with a myriad of unseen gravitational wells hidden within the whirling and immense galaxy. Their utter inhuman otherness is to some degree woken 'into some measure of communicability' by the conceived form of mathematical understanding. And if this is the role of art, then what other category remains for science?

Exploration of a possible parallel purpose, at the deepest level, for art and science will steer our trajectory into headlong collision with those who have perceived an irreconcilable antithesis between the two. To navigate these stormy waters will need some historical perspective, for an oppositional framing seems to reawaken, at least in the modern period, with each generation. The generation previous to the late twentieth century combatants of the 'Science Wars' engaged in angry words over the 'Two Cultures'. But half a century before C.P Snow and F.R. Leavis locked horns, a gentler but equally incisive debate, which anticipated some of the later rancour between the arts and the sciences, was engaged by Matthew Arnold and Thomas Henry Huxley. Earlier still, romanticism drove home with force the charge that science does precisely the opposite of (at least narrative and poetic) art in the meeting of human creative need. We have already met Blake's dismissal of reason as the antithesis of creation, but his voice was by no means alone. In his long poem narrating the story of the mythical serpent *Lamia*, John Keats complains of science – for him 'cold philosophy':

> *Do not all charms fly*
> *At the mere touch of cold philosophy?*
> *There was an awful rainbow once in heaven:*
> *We know her woof, her texture; she is given*
> *In the dull catalogue of common things.*
> *Philosophy will clip an angel's wings,*
> *Conquer all mysteries by rule and line,*

*Empty the haunted air, and gnomed mine*
*Unweave a rainbow.*

We need to understand why Blake and Keats, Poe and many others of their nineteenth century contemporaries first perceived science to be the means of desiccation, of demystifying, of replacing wonder by measure, and then why they took up the tools of their trade at their highest energies to inveigh against it. Historical locus is important – retrospective projection of arguments from our own times, that the romantic poets had nothing to worry about concerning the draining of wonder from the world from the perspective of late modern science – will not get to the root of their disquiet, which arises in a different form today. There are shifts in the role of science particular to that period which may be significant. A change in nomenclature, for example – 'natural philosophy' becomes 'science', carries with it all the etymological undercurrents that implies. A Greek declaration of 'love of wisdom of natural things' (*philo* – *Sophia*) is slowly replaced by a Latinate claim to knowledge (*scio*) (Wordsworth's critique – '*we murder to dissect*' uses the term 'science' where Keats and Poe retained 'philosophy'). Science departments and syllabuses began to appear in the universities. William Whewell coined, around 1836, the term 'scientist', which gathered currency first in America and then Britain throughout the century. Momentously, the discoveries and theories of geology (Lyell's gradualist and ancient formation of geological strata) and of zoology (Darwin's evolution by natural selection) were transforming utterly the understood relationships in time and space of the human race to our world and to the other species on earth. The period of romanticism swept in a fragmentation of discipline and a further distancing of 'the inhuman otherness of matter' unprecedented in thought.

Writing in a new voice within stormy cultural change of a different cultural period to our own can easily be misread – in order to gauge the story of science's apparent offensiveness in the nineteenth century we will need to look harder at the context of the criticism. To taste just one example, Wordsworth's contrast of the scientist with the poet, explored in the preface to his *Lyrical Ballards*, centred on the solitude of science, its lack of communicability with others than the lonely investigator,

> *[Science] is a personal and individual acquisition, slow to come to us, and by no habitual and direct sympathy connecting us with our fellow-beings. The Man of Science seeks truth as a remote and unknown benefactor; he cherishes and loves it in his solitude; the Poet, singing a song in which all human beings join with him, rejoices in the*

*presence of truth as our visible friend and hourly companion. Poetry is the breath and finer spirit of all knowledge; it is the impassioned expression which is in the countenance of all Science. Emphatically may it be said of the Poet, as Shakespeare hath said of man, 'that he looks before and after.' He is the rock of defence for human nature; an upholder and preserver, carrying everywhere with him relationship and love. Poetry is the first and last of all knowledge—it is as immortal as the heart of man. If the labours of Men of science should ever create any material revolution, direct or indirect, in our condition, and in the impressions which we habitually receive, the Poet will sleep then no more than at present; he will be ready to follow the steps of the Man of science, not only in those general indirect effects, but he will be at his side, carrying sensation into the midst of the objects of the science itself. The remotest discoveries of the Chemist, the Botanist, or Mineralogist, will be as proper objects of the Poet's art as any upon which it can be employed, if the time should ever come when these things shall be familiar to us, and the relations under which they are contemplated by the followers of these respective sciences shall be manifestly and palpably material to us as enjoying and suffering beings. If the time should ever come when what is now called science, thus familiarized to men, shall be ready to put on, as it were, a form of flesh and blood, the Poet will lend his divine spirit to aid the transfiguration, and will welcome the Being thus produced, as a dear and genuine inmate of the household of man.—It is not, then, to be supposed that any one, who holds that sublime notion of Poetry which I have attempted to convey, will break in upon the sanctity and truth of his pictures by transitory and accidental ornaments, and endeavour to excite admiration of himself by arts, the necessity of which must manifestly depend upon the assumed meanness of his subject.*

It is neither the practice nor the insights of science that Wordsworth sets apart as irrelevant to human sensation and sensibility, but their remoteness from common currency. In far richer language, he has identified the same missing lower echelons of science's ladder of access that still prevent all but the athletic practitioner from climbing it. Then, as now, only someone steeped in the learning of a scientific discipline might 'shudder before the beautiful', as we might all long to do as we read the cosmologist's account of the mathematical connection of black holes to the night sky above us.

A nineteenth century voice that can still be heard, albeit more quietly than the romantic poets, is John Ruskin. His Oxford lectures *The Eagle's Nest*[16] attempt a unified cultural view of art and science. Ruskin's frame is constructed from the cerebral and practical aspects of wisdom – *Sophia* and *phronesis* – that Aristotle conceived as complementary. He is writing as late as it is possible to do so without suffering from the loss of the vocabulary of Wisdom from resonances with science. '*Can anything be more simple, more evidently or indisputably natural and right, than such connection of the two powers?'* Ruskin asks his student audience in the third lecture. We need to confront the reasons why, in the century in between then and now, his voice and Wordsworth's hopes have been lost in the clamour of Keats' complaint.

The cultural history of the nineteenth century suggests another motivation for reappraising the relationship of art and science through the lens of theology, among the other humanities. For there are close parallels between the strained relation of science and religion, and that between science and art. The divisive romantic period saw, for the first time, strident claims of conflict along both axes. Consider the critical language of the romantic poets alongside the later appearance of polemics such as Andrew Dickson White's *A History of the Warfare of Science with Theology in Christendom* (1896). Now recognised as polemic rather than history, of which it makes at best a highly selective reading, its constructed message now circulates without the vulnerability of its flimsy support. The drivers of the oppositional narratives for both art and religion to science, as received a century later, also bear similarities: both are served by presenting science as a cultural newcomer, and as a competitor for cultural territory occupied previously by art, the humanities or by religion. The story of conflict between science and religion is equally served by a superficial understanding of science itself and the scientific motivation, as much as by a distorted view of religion. Furthermore, the entire argument survives only by banishing all teleology, all talk of purpose. I have attempted to subvert the three prior conditions for presenting the case for conflict in the book *Faith and Wisdom in Science*, where I traced the endeavour we now call 'science' back through the renaissance, medieval and late classical worlds into the wisdom writings of our Old Testament texts, in parallel to its philosophical roots in ancient Greece. That journey lead to a recasting of the oppositional 'geometry' of theology *and* science to the mutual encompassing and twinned relationships described by a 'theology *of* science' and a 'science *of* theology'. In resonance with Ruskin's proposal that Wisdom frame art and science together, the narratives of ancient Wisdom appear as the tributaries of science. The parallels of mis-

[16] John Ruskin, *The Eagle's Nest* George Allen, London (1905)

construal, of mutual suspicion and in particular of projection of science through a filter that removes its roots in longing, in creativity in the pain of distance, strongly suggest that we play with equally fresh geometries of relationship between the humanities and the sciences that focuses on the teleology, cultural and theological of both.

A journey into the purpose of science, and of art, must learn from the misunderstandings and the mutual pain of fragmented disciplines. It must, finally, move from talk about relationship into a practice of it. If we do find familial fellowship between science and art in a deeper reappraisal, then we will surely notice a structural imprint of their shared cultural DNA as we proceed. Returning to our first perspective – the comparative practice of creative imagination – suggests the lines of a possible framework. No art results from unconstrained exercise of imagination. The poet's vision and communicated emotion take shape within the constraining form of sonnet or quintain. The composer lets thematic material expand, combine and develop within sonata form or rondo. The painter conjours with light, colour, representation, but only successfully when she observes the material properties of oil on canvas, or of watercolour on board. It is the tension of imagination with constraint, of idea within form, which focusses creative energy into artistic creation itself. The greater the imaginative impulse, the tighter the form is needed to channel and shape it.

Seen in this light, science no longer looks quite so strange. For if its task is to reconceive the universe, to create a mental map of its structure, the interrelationships of force and field, of the evolution of structure and complexity, to understand the patterns of matter from the earliest moments of time to its closing aeons, from the smallest fluctuation of space-time to the immensities of the cosmos, and to reconcile all this inhuman otherness to the finitude of our minds, then what task could possibly call on higher powers of imagination? What could demand a greater act of human creation? But what greater form, what more focussing constraint, could be supplied than the way we observe the universe to be? If writing a sonnet is the collision of creativity with the constraint of form, in expressing with new potency the human experience of the world, then science also becomes the conception of imagination within constraint. We re-create the universe by imagination within the constraint of its own form.

Cousinly creativity with constraint – that is a starting hypothesis for a journey through art and science. It will be one with a listening ear. We need to spend time in the workshops of artists and of scientists; we need to look without prejudice at the way their work is, or could be received emotionally as well as cerebrally. We will need to stand back from our own time and look at longer narratives, and at other ways of differentiating disci-

plines. And we need to test the notion that science can re-weave a rainbow in a way that Keats might have recognised as poetic, true and constitutive of the human.