

Hybrid Arts and Science Symposium

Thackray Museum Leeds

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Supported by
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Introduction

The symposium took place on Saturday 20 March 2010 and was organised by Paul Digby and Lizz Tuckerman co-organisers of Hybrid Arts and Science Networking Association.

Paul and Lizz are grateful for funding and assistance from Arts Council, England. We would like to express especial thanks to Alison Andrews for her belief in the value of investigation into the relationship between the arts and the sciences. In many ways this symposium is Alison's baby. Thanks also goes to Kelly Amos and Mairead Turner, for their support and assistance with the symposium documents and publicity. Alison and Kelly left the Arts Council during the recent extensive re-organisation. We are sure that they will both be very successful in their new roles.

Many thanks also to Cluny Macpherson, Regional Director of the Arts Council in Yorkshire for his entertaining opening talk and to Doug Sandle, Reader in Visual Studies, Leeds Metropolitan University, for his efficient chairing of the symposium.

We are indebted to our speakers, Siân Ede Director of Arts at the Gulbenkian Foundation in the UK, Mary Midgley poet and philosopher, James Peto Senior Curator, Wellcome Collection and Professor Mike Vanden Heuvel University of Wisconsin-Madison, USA, whose presentations made the day such a success.

Siân Ede is author of *Strange and Charmed*, science and the contemporary visual arts, and two books giving insight into the actual working methods of artists and scientists. *Science not Art*, a collection of ten scientist's diaries, and *Art not Chance*, diaries by nine artists.

'Mary Midgley latest book, *Science And Poetry* takes its epigraph from Richard Dawkins, "Science is the only way we have of understanding the real world", and proceeds to dance all over this apparently reasonable statement. It's not that she considers science a bad way of knowing the real world. But it is only one among many, and one which must be kept in firmly its place.' (*Andrew Brown Guardian 2001*)

The Wellcome Collection is third (after the V & A and the Science Museum) in Spoonfed's best museums to visit in London. 'The Wellcome Collection is an absolutely brilliant place. It's one of those rare places in London that combines museum with gallery, science with art, and serious learning with a healthy dose of fun.' www.spoonfed.co.uk

Professor Vanden Heuvel is currently completing a book on science and theatre (tentatively entitled "*Congregations Rich with Entropy*": *The Emergence of Complexity in Theatre and Performance*) and conducting research into the means by which avant-garde and experimental theatre is circulated in contemporary culture, with special reference to Beckett.

Lastly thanks to the delegates for their enthusiasm, participation and perceptive questions.

On the following pages the texts of presentations were provided by Siân Ede, Mary Midgley and Mike Vanden Heuvel. The presentation by James Peto, and all the question and answer sessions were recorded by Dennis Tuckerman and transcribed by Lizz Tuckerman.

A light echo is a phenomenon observed in astronomy and is produced when a sudden burst of light is reflected off a source, arriving at the viewer some time after the initial flash.

In her illustrated talk Siân Ede tried to investigate how far it could be said that art images reflected the science of their time and indeed, whether it was possible to claim that scientific images picked up on contemporary art images. She reminded the audience of Thomas Kuhn's notion of Paradigm Shifts – the way in which revolutionary changes in scientific discovery altered our view of the world. Obvious examples were the way in which Galileo's heliocentric confirmation in 1610 demonstrated that humans were not at the centre of God's universe. Darwin's Origin of Species in 1859 similarly showed that humans were not in a privileged position. However, both these discoveries were products of their time – Galileo operating at a time of counter-revolution; Darwin at a time when many people were expressing doubts about the authority of religious belief.

She went on to show that within science itself there were two cultures: broadly defined as Platonic idealist, the sense that there was a Reality beyond human perception waiting to be discovered; the other being Aristotlean (an influence on Hume and Enlightenment thinkers, as well as on Darwin) who believed in the empirical evidence of their own senses. While these might recognise the fact that nature is confined by the parameters set by the four forces of physics, the accident of evolution that might lead to the existence of an elephant showed that life evolved to become fit for purpose and was not ideally framed.

She quoted the contrasting views of two scientists; a Platonic minded mathematician,

Marcus du Sautoy who works in an area of mathematics called group theory which tries to understand symmetry. He describes finding consistent mathematical patterns which form palindromes, reading the same from left to right as right to left. *'Knowing that a zeta function has palindromic symmetry would not be so amazing as a result in itself. It's more that it is evidence of some deep and subtle structure at the heart of my subject which I don't yet understand. And it is showing a small bit of its beautiful head by manifesting itself in this functional equation. If I can understand this palindromic symmetry I am convinced it will go hand in hand with revealing a huge vista of structure that we are currently too blind to see.'*

quoted in *Science Not Art: nine scientists' diaries* (Gulbenkian 2003)

and biological taxonomist George McGavin, from the Hope Entomological Unit at the Oxford Museum of Natural History, who is an expert in tropical bugs called treehoppers, species of which mimic thorns or seeds and are therefore hard to see unless you know what to look for.

'Our brains, like those of birds, trout and other hunters dependent on vision, take a little while to form the appropriate "search image",' he writes. 'As a young student I had worked on spiders for a while and then changed my attention to immature plant bugs. For several collecting trips after the changeover all I could see in my net were spiders and yet more spiders. Gradually my brain got used to seeing plant bug nymphs, and the spiders, although still present in large numbers, became almost invisible.' from the catalogue *Dead or Alive* (2002)

Ede then looked at pairs of images from 20th century art and science created around the same time to see if there were parallels, for example between Einsteinian relativity and Cubist art . There were not, in fact. More contemporaneous than Picasso with the General Theory of Relativity was actually Duchamp's *Fontaine* 1917. Perhaps of more interest was the fact that both reflected a breakdown in a central belief system, manifest in the images of destruction in First World War images. Links could be made between surrealism and psycho-analysis and even between modernist imagery and design in molecular biology and X-ray crystallography but such links were made with hindsight or deliberately, as in the famous Festival Pattern Group collaborations made for the Festival of Britain in 1951.

There were, however, some few indications in the past, notable in early Arabic tile structures that reflected an intuitive sense of pattern in the natural world. Ede introduced art historian Martin Kemp's term Structural Intuition, which he has identified in artists who possess an innate sense of natural morphologies, honed through a life of close observation and working hands-on with drawing and materials in the studio

Contemporary examples from late 20th/early 21st century art/science encounters were shown. Pairings examined included, amongst others: [*artist first: scientist second*]

Catherine Yass & William James.

Richard Deacon working on microscopic images at the Department of Physiology, Anatomy and Genetics, University of Oxford;

The work of science imager Felice Frankel;

Sandra McQueen & Fragment of the Organ of Corti , High Resolution light microscope image (Dr M C Holley, dept physiology, University of Bristol);

Rob Kessler's work with electron microscopy at Kew Gardens and Gulbenkian Institute of Science;

Andrea Duncan's residency with the Department of Haematology at King's College Hospital, London on chromosome sorting which reminded her of separated socks in the laundry;

Helen Chadwick's prescient microscopic images from her own body fluids and tissues.

Ede questioned how far science images in their own right could be displayed as art and thought that this would depend on the way they were displayed or installed, for example, as with Chadwick, but also through Kessler's printing of science images on dinner services, or Andrew Carnie using images of dendrites on gauze as part of his mysterious *Magic Forest* installation.

Ede went on to look at neuroscience and the concept of the Embodied Mind, referring to

a Gulbenkian symposium www.gulbenkian.org.uk/.../arts/embodied-mind-symposium

A lot of neuroscientific discovery has been made through observing people with brain *dysfunction*, in order to better comprehend the workings of the 'normal' brain. By contrast, artists, dance and theatre practitioners possess a *superfunction*, training themselves to observe their own processes, attaining often astonishing feats of observation or 'body memory', spatial awareness and unspoken physical communication with each other and with audiences.

Images illustrating this included those of Olafur Eliasson with Boris Oicherman from Dept of Colour and Polymer Chemistry, Leeds University at Ikon gallery Birmingham 2006, as a gallery based experiment to investigate the diversity in seeing colour;
choreographer Wayne Macgregor of Random Dance who has undertaken a great deal of research with neuroscientists working most recently with experts in *mirror neurons*;
Alexa Wright's work with patients with Phantom Limb syndrome;
and images illustrating facial recognition centres in the brain by artists such as Akroyd & Harvey, Tony Oursler and mask expert John Wright.

The Australian performance artist Stelarc believes the human body to be obsolete, dramatically declaring that '*we are at the end of philosophy and human physiology.....we have never had a mind of our own, we often perform – involuntarily, conditioned and externally puppeted*'. In other words, '*bodies are both zombies and cyborgs*.'

Other artists were interested in bio-engineering:

Jake & Dinos Chapman's unsettling *J&D C Zygotic acceleration, biogenetic, de-sublimated libidinal model* 1995;
Eduardo Kac who defines himself as a transgenic artist .

Oron Catts & Ionat Zurr, in collaboration with Guy Ben-Ary, worked with scientists at the Tissue Engineering and Organ Fabrication Laboratory, Massachusetts, to produce an artwork *Pig Wings*. (2000-2001) Using a culture of pig bone-marrow stem-cells transmuted into bioabsorbable polymers, they have grown living pig bone tissue in the shape of three sets of wings, presenting ethical questions.

'This absurd work presents some serious ethical questions regarding a near future where semi-living objects exist and animal organs will be transplanted into humans,' they write. 'What kind of relationships will we form with such objects? How are we going to treat animals with human DNA?'

The paintings of Alexis Rockman take a more genial look at the future. Using a bold sci-fi graphical style he represents the natural world with an accuracy that pushes scientific photo-realism over the boundaries into a fantasy that is nearly plausible.

'I find the very ideas of parody and irony totally idiotic,' he says, 'irony, you know, is a distancing mechanism for pain.'

Artists are increasingly interested in environmental science but it is hard to avoid cliché sometimes. The better work of the Cape Farewell project and the Gulbenkian's Galapagos Artists' Residency programme showed unexpected insights.

The talk ended with a summary of some of the points made. Artists clearly have a fascination with science even though the imagery of science is often repetitive and easily prone to cliché. The more successful artists were inventing new ways of seeing.

Siân Ede

April 2010

I am delighted to be here, I always like hybrid audiences. I 'm pretty hybrid myself and I think a mix of interests and professions is essential to understanding life.

When I was asked to say something for you on the theme of my book Science and Poetry, I thought, 'let's have a look at it'. And when I looked, I was struck once more by a quotation in the first chapter – a passage which was actually what had made me think of writing the book in the first place. It is a scientist's manifesto, saying that science is all that we need. It goes like this -.

Although poets may aspire to understanding, their talents are more akin to entertaining self-deception. They may be able to emphasize delights in the world, but they are deluded if they and their admirers believe that their identification of the delights and their use of poignant language are enough for comprehension. Philosophers too, I am afraid....have not contributed much that is novel until after novelty has been discovered by scientists....While poetry titillates and theology obfuscates, science liberates.

(Peter Atkins in Nature's Imagination, ed John Cornwell, 1995,p123)

This, of course, is not meant as a joke. There are many people who actually do think like this, and perhaps there is a sort of person inside many of us who says. 'yes this is right'. It is not an out of date view. Now I want to draw your attention to the emotive style of this passage, and to the imagery which pervades it. It is a mistake to suppose that scientists are impersonal and abstract, only interested in facts. They have motives of their own and, among other things, they are moved by visions. When I first read this piece, I particularly noticed this remark - '*Philosophers too, I am afraid....have not contributed much that is novel until after novelty has been discovered by scientists*' I thought, 'hang on a minute, where did the vision come from that is still basic to modern science?' And the answer is, of course, that vision came from the Greek atomists.

That is, it came from philosophers - philosophers who were part of that early wave of very abstract thinkers who wanted to find a single factor which would explain the whole universe. Among them, the atomists hit on the idea that the cause of everything was atoms falling through a void, banging into each other and causing everything that happens to occur by pure chance. It is important that this was not actually a scientific doctrine. They had not discovered it by looking through microscopes. Instead, it was primarily a world-view designed to undercut religion. The point of it was to stop people wasting their lives propitiating the gods – to save all this pointless misery by getting the gods right out of the human story.

Of course in the end the vision did prove to be scientifically useful. And no doubt, even in ancient times, its inventors took it seriously as a statement of how the world works. But what made it popular in the ancient world – and still keeps it popular today - was that it made the world impersonal. It relieved people's anxieties by providing a kind of fatalism which gets rid of humanoid fate-figures. Later on, of course, in the seventeenth century, when microscopes turned up, people took it seriously in a quite different way, as literal scientific truth. As they began to see smaller and smaller structures through the microscopes they became excited about the thought that there was indeed a final set of distinct physical units that would ultimately explain everything.

I would like to go back or a moment here to the imagery they used. It is quite interesting that, from the start, scientists often described these particles as working like billiard-balls. (Billiards was very fashionable in the seventeenth century. You may remember in Anthony and Cleopatra, Cleopatra says 'Let's to billiards'), The point of this image is to show everything that happens as impersonal and in particular to show the particles as radically separate. This was a welcome symbol for enlightenment and individualism. The charm of billiards (or of snooker

today) is that it's pure geometry. The balls do not care what happens. They are quite separate and have no motives; they just bang into each other and go where the forces send them. This kind of pure, impersonal fatalism has a beauty of its own, which had already been celebrated artistically by the Roman poet Lucretius. His poem 'On the Nature of Things', which was immensely popular in the Renaissance, describes this chance-governed world of the Greek Atomists in great rolling hexameters - powerful, passionate language which conveys the vast otherness of the physical universe. Thus, this reductive way of explaining the world has always had an attraction which is quite independent of its literal scientific correctness. (Newton?)

What does it mean to call it reductive? Reduction can have various meanings, but the central one involved here is the principle that wholes should always be broken into their parts, because parts are more real than wholes. Reality must always be sought under the microscope. This approach is what I shall be discussing today, because it's a vision that, from that time, has been very important to scientists. Of course physicists now have quite different ideas about what the particles actually are. From the mid eighteenth century on they began to suspect that they were not actually billiard balls, not some ultimate solid that explained everything. They think of them now much more tentatively in terms of waves and forces and fields, and have become much more interested in forces such as gravitation and magnetism which connect these things – in the relationships between them.

Originally, however, it was important that atoms were thought of as inert, quite solid, separate and lifeless. The surprising fact that, in the everyday world, things actually move and have life was accounted for as being God's contribution. God, as spirit, was supposed to be moving them and to have added similar moving spirits to human beings.

Thus the world which Newton and Bacon and the other founders of modern science envisaged was by no means just a material one. It was a twofold system; inert matter joined to life-giving spirit. These scientists did not at all want to get rid of God. What they wanted was a purer god and a passive natural system that stayed quietly in its place – an inert system rather than a living one that might interfere with them. The vision that they painted of this has had remarkable persistence. It has outlived both the religious context that produced it and the physical conception of inert particles that justified it. Thus, Peter Atkins informs us that physical science can explain everything, without any help from other studies, simply by tracing the movement of microscopic particles -

Are the fat and tallow of religious and other forms of philosophical or psychological justification necessary? Science is succeeding without themScience treads everywhere and worms itself under the scabs that religion regards as protecting the special tender patches of human existence..... Science has no need for purpose. All events at the molecular level that lies beneath all our actions, activities, and reflexions are purposeless, and are accounted for by the collapse of energy and matter into ever increasing disorder.....Behaviour also ultimately collapses into disorder, even though that behaviour may on occasion be exquisite

(Peter Atkins, ibid,pp129-127)

What does it mean to say that Science has no need for purpose? The idea here is that Science does not deal with organic wholes, only with the reality that underlies them, which is their smallest elements. Something that seems to be acting with a purpose, like a rabbit trying to get down its hole, only has that purpose as a whole. If you chop it up into cells, or still further into atoms and molecules, you will not find any purpose there. So - if the enquirer has convinced himself that only these tiny units are real - then the purpose must be an illusion.

I know that this sounds silly, but that is what is being said. Richard Dawkins makes a similar but even more surprising claim. He writes -

The universe we observe has precisely the properties we should expect if there is, at bottom, no design, no purpose, no evil, and no good, nothing but blind, pitiless indifference....DNA neither cares nor knows. DNA just is. And we dance to its music.

(Richard Dawkins, River Out Of Eden; a Darwinian View Of Life; 1995, p155)

Thus, though he dismisses the purposes which we do see as non-existent, he seems to find a new, quite different set of real purposes that belong to the molecules in our cells. How could we be said to 'dance to the music' of DNA unless DNA had its own purposes? And how could DNA be said to show 'blind, pitiless indifference', unless it was capable of feeling? Pitiless indifference is a state of feeling like any other; tables don't experience it or show it.

Thus the odd thing about this melodramatic reductionism is that, by making the smallest units somehow responsible for everything, it necessarily makes them into living agents. They have to become independent beings - uncaused causes, if you say that DNA made you do a certain disgraceful thing you are talking as though there is a real agent inside you - namely, the little things in your cells. You yourself are no longer an agent, a subject - the subject is your molecules. So this rhetoric empowers myths which are not officially acknowledged. If you complain to people like Dawkins about these myths, they reply that these are just stylistic devices. They think that rhetoric is just an external coat of paint on the ideas. But painting an idea pink instead of scarlet makes all the difference to its meaning. Their imagery expresses the visions which have shaped their entire thinking.

Here I may be touching on a topic that is more Siân's area, namely where art influences science. I am making the general point that the kind of imagination which builds works of art is also necessarily at work in building science. The vision is universal. And, of course, in forming that vision the art that is current in any age plays its part as well as the current scientific beliefs. Good scientists like Einstein knew about this and point out that their visions are central to their thinking. Not-such-good scientists do not know it; they use their visions without being aware that theirs may be a peculiar way of seeing things. So we should ask; 'if someone says that there is no design, no purpose, no evil, and no good in this universe have they not noticed that they inhabit a planet on which all these things are found?'

Your rabbit runs very hard to get into its hole and if something is in the way it will make great efforts to get round it. An acorn that has been placed under a paving stone won't stop working to get out from under it. If it can't, it will push the paving stone up and grow past it. That's purpose. And that's what Aristotle meant when he explained things by purpose by telos. An organism's aim its telos, is to do what suits it, The acorn is trying persistently to live like an oak tree. That's what it does. It is not trying to make money or to produce any other reward in the future. It is not trying to produce more acorns than another oak tree, it is trying to get the whole career of a proper oak tree - which, of course, includes producing plenty of acorns - and every organism is trying to do the same kind of thing.

This means that, for any organism - including humans - there have to be some things that are evil and some things that are good. It is evil for them to be squashed; it is good to do whatever is part of their species-specific telos, be it flowering, dancing or understanding the world. And if this purposeful activity goes on on this planet, then it's happening in this universe, so the universe is not one devoid of purpose. In fact, purpose is an everyday matter. It's not something alien that we have to invent. Still less is it something that can only be looked for at the microscopic level by examining small units. And it is because people have looked for it in that perverse way that the genes have come to be personified and indeed almost deified. ('Genes are the true immortals' says Dawkins).

What this way of thinking leaves out is, of course, life - life, which is always lived by complex wholes.. The standard dictionary of biology has no entry under the word life - no definition of life. And if you ask a biologist about it they will very likely talk about something else. Life is indeed very difficult to describe. James Lovelock says something quite interesting about this - namely that, because the distinction between living and nonliving things is so important for us, we are endowed with a basic instinctive ability to detect it, and that makes it very hard to think about.

Here is the great evolutionist E.O.Wilson saying the same perverse thing -

The individual organism is only a vehicle [of genes] part of an elaborate device to preserve and spread them with the least possible biochemical perturbation.....The organism is only DNA's way of making more DNA.

(E.O. Wilson, *Sociobiology*, 1976, p3)

Again, the denial of ordinary individuality and purpose is accompanied by the strange, almost superstitious, attribution of purpose - 'elaborate device' - to the molecules of DNA. And, rather earlier, Jacques Monod gave a rather more interesting twist to that same vision by complaining that this enterprise which produces life is all just a mistake -

For modern theory, evolution is not a property of living beings, since it stems from the very imperfections of the conserving mechanism..... The same source of fortuitous perturbations which, in a non-living system, would gradually lead to the disintegration of all structure of is the progenitor of evolution in the biosphere.....thanks to the replicate structure of DNA, that registry of chance, that tone-deaf conservatory, where the noise is preserved along with the music.

(Jaques Monod, *Chance and Necessity*, Collins 1971, p113. Author's emphases)

The message of this myth is that mutations are in a sense something that has gone wrong . By importing arbitrary standards and saying they are wrong - rather than just assuming that they are what usually happens - Monod suggests that life is not only an accident but a sinister one – something that ought not to have happened. Organisms are altogether a kind of mistake. But how can anything be a mistake if no purpose is present? And Monod, who compares all life to a casino, is deeply committed to saying that indeed no purpose is present. To say that all life is a casino is another way of making life seem unimportant. Monod was very much influenced by the existentialist idea that life has no meaning except what we make for it ourselves - which is really a very strange notion when we consider how much is given to us from the start, how much in life is already there for us before we ever start to look for meaning.

Another interesting question about purpose has arisen from the observations of cosmologists. Some decades back, these scientists saw reason to wonder whether perhaps the universe is, after all, perhaps not just a matter of chance. They started to notice coincidences about the four physical forces and their extremely delicate relation to one another. It seems that, if there were any slight shift in the relation between these forces life would be impossible, there could not be organisms - indeed, quite possibly there could not be any of the physical stuff that we now see. To produce this present world, that relation requires very fine tuning.

This was a physical speculation, not a religious one, but of course both religious and anti-religious people have taken a great interest in it. Not only do the organisms form in a certain way, but apparently the matter that forms them follows certain patterns rather than others – natural forms. The idea that there are such forms was originally started by Goethe and developed in the 1920s by D'Arcy Thompson, but neglected during the last century because of the neo-Darwinian insistence that everything must be due to chance. More lately, however, biologists are beginning to suggest that natural things do indeed shape themselves, not only by natural selection but according to a whole lot of patterns that seem to be natural to matter. Fibonacci spirals – the pattern on which buds and shoots arrange themselves in a plants stem – are a well known example. (I have been looking at your picture of the Hybrid plant and worrying about whether its leaves are properly arranged in a Fibonacci spiral, but I'll take it that they are). this is a pattern that is universally found in –plants and that also occurs in spiral nebulae. There are an awful lot of such natural form in the inorganic world - crystals form in a regular manner, so do rainbows, so do snowflakes. This regularity has not been produced by natural selection. I'm not saying that natural selection does not happen, or is not important. The point is that natural selection - chance events followed by trial and error - is not the only source of the forms around us. It is not just chance that a snowflake is like a flower.

Of course this kind of thing – especially the apparent fine-tuning of the cosmos - worries Peter Atkins, but not for long. He is sure he will be able to explain it. As he says -

When we have dealt with the values of the fundamental constants by seeing that they are unavoidably so, and have dismissed them as irrelevant, we shall have arrived at complete understanding. Fundamental science can then rest. We are almost there. Complete Knowledge is just within our grasp. Comprehension is moving across the face of the earth, like the sunrise.

(Peter Atkins, The Creation, 1987, p127, Emphasis mine)

Science, in fact, will shortly have a theory that explains everything. But it hadn't done that in 1987 and – as wiser scientists know – there is no more reason to expect it to now than there was then.

Mary Midgley

April 2010

Questions and Discussion following the talks by Siân Ede and Mary Midgley

Siân Ede It had never stuck me and it's terribly interesting that Monod was influenced by existentialism.

Mary Midgley English scientists had not heard of it in his day and found it very attractive. It's a very melodramatic theory you see - you think of yourself as this wonderful, powerful thing standing alone in the darkness. Monod, of course, was French and was familiar with it.

Question 1. Lizz Tuckerman I would like to ask a question about order, whether there really is order or whether in fact we just have a human need to impose order so that we can have a sense that we can understand what is going on.

Mary Midgley This is a very common approach to this kind of suggestion – that we only find order because we are looking for it. That objection is often right when it's a matter of preferring some detailed pattern, but not, I think, when it concerns something as general as order itself.

Can I make a parallel suggestion? Probably most of us believe each other to be conscious and even believe that we may have some idea of what each other are thinking. Now, is that just because we happen to some sort of eccentric tendency that way? Or is this belief in other people's minds absolutely necessary for our thinking?

It seems to me that, without that general belief we could not think at all, and the same is true of the belief that the world is ordered. The need for order is absolutely basic to any sort of world. It's true of course that this conviction can mislead us because we impute a particular order where it doesn't exist. But what we can do then is to check it by looking at other examples, or looking at it from another angle. The type of order that concerns us here is the sort that resists this sort of investigation – the type that turns out to be present even in a quite different context. There may, of course, be borderline cases. Our checking doesn't always work. But if it does work in all sorts of relevant cases and stands up to investigation then I don't know what anyone means by saying it's just how we think.

Siân Ede I think it might be that it's very fundamental to classify and that even a single cell will say good/bad, good atmosphere/poisonous atmosphere, me/not me. And so the desire to find sense in something is very strong in living things and at a higher level we like classifying in a much more systematic way partly maybe to do with survival. I think it is interesting when Mary talks about the Fibonacci sequence, that we have found those that nature has evolved, those sorts of things, we have evolved to appreciate it. So that there is some kind of delight in it..... there is a delight in it.

Mary Midgley And the delight is not fishy, you see, she is saying that, just because we delight in it that doesn't mean that it is misleading us.

Siân Ede It's a bit like Helen Chadwick working with the embryologists to select the cells with the best morphology as the best ones.

Lizz Tuckerman Except that they have found that they are probably not the best ones, so that may not be the best way of selecting an embryo, so the patterns we look for may change over time. The other thing is that science is part of culture but yet it seems quite often to be regarded as something alien. I've worked in science for a very long time and have hardly ever come across the attitude of a person like Dawkins.

Mary Midgley I'm sure you are right. The trouble is, it's a noisy attitude but it also does flatter the insecurity of quite a lot of scientists I think. There are quite a lot of them who do talk in this way, even if they don't do it in their work.. In the world today specialisation is coming on in such a disturbing way that people often feel that they are threatened by the neighbouring speciality and have to protect themselves against it by unreal boasting. But thank

you, you are quite right to say that this is not as it were a nation of scientists who go on like that. Yet it is a very influential group.

Siân Ede But the culture of science is so competitive and your paper has to be proven to be accurate. There is a very definite sense of accurate and inaccurate. They won't allow for failure even if your results are interesting. It is a culture that you don't get in the arts.

Question 2 You do get the same sort of institution within in the art market I think. I would like to ask Mary something about the anti-reductionism and the need to see things as a whole? What is the artists 'intervention in this? How does the artist fit in to your scheme of things?

Mary Midgley I should have said that when I mentioned poetry I am trying to mention all the arts. I want to concentrate on the visions that come before science - the ways of seeing the world that the scientist has before he starts. I think he or she will take a lot of them from the culture of the day – including the existing art-forms. Another sort of picture that is immensely influential is the imagery of machines, in the seventeenth century they were getting absolutely fascinated by clockwork – by these new automata which must have seemed like magic. People began to think of everything complex as being like a machine. The word mechanism became very common and has remained so..

Question 3 Could I ask you to say something about complexity science?

Mary Midgley Yes of course. Siân was saying something about the simplifying tendency. That simplifying tendency was basic in the seventeenth century. Because that age was so confused, thinkers were passionately eager to get simple, final explanations. The atomistic approach was one of those. When we complain about that now we are saying that the world has turned out not to be as simple as they hoped. – indeed, to be extremely complex. It is only quite recently that banners have been raised for complexity as such. Fractals, for instance, are an example of a new sort of concept that is only possible once you have abandoned the ideal of simplifying everything. The importance of complexity is absolutely basic to the things that I have been talking about and I suppose this is the direction in which science is moving.

Question 4 Siân you started off talking about neuroscience with a slight degree of cynicism about some of the popular scientists have proved X. I wondered whether you thought that was because it was a new area and you thought it was just early days or a specious thing to study?

Siân Ede I think it is a great thing to be studying and I'm very interested in it. But I think a lot of the claims that they make or maybe not they, but the press make, or gets into the machine say that they have solved something and when you look closely you say well we know that. It's why I'm interested in performance because how we perform we have a huge present experience of performance and also a huge history and I would like to go back and look at the writing of Stanislavsky on performance because I expect you would find in a different language the same things that the neuroscientists say. I am a great friend and admirer of a neuroscientist in cognitive psychology at UCL and he is interested in studying dance. When he first started to do that he was studying the leg movements of the dancer's legs in a particular dance. The Rose dance or something and he was measuring the angle of the dancer's leg over the last century. After all this measurement and data collection he found that her leg was moving higher as time went on. When he showed this result to a room full of arts people they all said 'What is the point of that well we all knew that'. So there is something peculiar about this reductivism really' it was in his own field you have to home in on something small. Well' here is something that he could have asked people about because they knew it. Why didn't he ask Wayne MacGregor? Why didn't he ask a choreographer who deals with this every day? I think that some of this is what I call old wine in new bottles. When I heard about mirror neurones..... let me explain the science. They wired up Macaque monkeys and found that when one monkey looks at another monkey performing a certain action, the observer is geared to perform that action themselves, not just to see it but the connection to the

muscles to enact that action are stimulated. I thought that was terribly interesting and then I thought that we already know this and they call it mimesis and we call it empathy. I only have to look at my children watching television and see them frowning and smiling as various things to realise that I already knew that. Quite nice to have the authentication that mirror neurones are there and I have a kind of glimpse with mirror neurones that something more interesting is going on than we can perceive. Let us arts people stand our ground and say that we know this. Let's be partners.

Mary Midgley Absolutely fascinating I think because since mirror neurones have been discovered psychologists are beginning to admit that sometimes we do know what other people think. Now we have all known that all our lives, this is a fortunate discovery but it shows something dreadfully wrong I think. Psychologists used to say that we infer that other people are conscious because they behave a bit like us. So they must be and this is so mad. Fortunately we are so framed by natural creativity of matter we are so framed that we know and cannot avoid knowing we know that as much as we know that that's a round table but it has dropped out somehow from psychology.

Question 5 Jenny Danson I wonder if you could comment please on the statement in your sixth quote because I find it really disturbing where Atkins says

When we have dealt with the values of the fundamental constants by seeing that they are unavoidably so,

Jenny Danson I'm quite happy with that

and have dismissed them as irrelevant,

Mary Midgley Irrelevant to what? One may ask.

Jenny Danson How can we dismiss the fundamental constants by which I presume he means e , i and π as irrelevant?

Mary Midgley I think he is answering people who have suggested that these coincidences show some sort of purpose or direction in the world, because matter is arranging itself apparently in distinct patterns and there seems no physical reason why those patterns should have been chosen rather than others. He is saying, I think, that future calculations will show some reason why it is physically necessary that these patterns happen. This will explain them – So people will then stop saying that 'the coincidences suggest fine tuning and therefore imply a purpose. That sort of conclusion will then no longer be relevant.

I agree that his answer does not do the job. When I first read this passage I went back and read it again and thought 'where did you say something that meant something here?' You haven't. you know'. He is hoping that when this theory of everything has been discovered it will be complete in itself. It will be some sort of equation that doesn't refer to anything outside as being the source of these patterns.

Paul Davies discusses these things are very well in his book [The Goldilocks Enigma; Why the World is Just Right for Life](#) (the point is that it's like Goldilocks' porridge; not too hot and not too cold). His conclusion is that everything fits together too well to have been the simple result of chance, there must be some kind of fitting going on. Though hesitant about assuming 'some arbitrary God', he thinks it likely 'life and mind are etched into the fabric of universe, perhaps through some half-understood life principle'.. It's to avoid that sort of reasoning that Atkins invokes some supposed future scientific explanation which he hopes will make it irrelevant. Thank you for raising it.

Siân Ede Mary, do you think that this is some sort cultural fascism? Because the language is so dogmatic.

Mary Midgley Well it is indeed far too dogmatic, at least I think so, and the previous speaker is quite right that not all scientists go on like that. The ones who do are certainly trying to conquer. One factor here is that science itself was tremendously respected in the years just after the war, what with going to the moon and DNA and even the

atom bomb. There was a sense that it was something wonderful which was going to save us from everything. This hasn't actually happened, so that people have become a bit disillusioned about it, and this is what upsets people like Dawkins. He evidently expected science to replace religion and it hasn't. Peter Atkins and EO Wilson have reacted similarly, but Wilson has now moved away from this and is busy campaigning for the environment instead. When he wrote Sociobiology he was in the mood to conquer the social sciences by reducing them to branches of biology. That sort of motivation must be allowed for I think.

Question 6 It sounds rather from what you are saying it is as if God designed the universe very carefully but bends over backwards to allow us to doubt him.

Mary Midgley Well if one has this thought that there is a purpose here of course there are any number of directions in which one can go. And what is called deism, meaning which is indeed a God but not exactly the one of Christian theology, has been very common. Tom Paine, when he was a member of the French revolutionary assembly, came very near to being guillotined because he would not accept the official atheism. He said, of course there is a god but not this Christian one. The distinctive thing about Christianity is that you have to have a revelation.

Question 7 I was really intrigued to hear you both mentioning D'Arcy Thompson's Growth and Form and the way in which that was appropriated by art and design education in the 1950's and 1960's in Leeds and Newcastle especially by practitioners such as Richard Hamilton I was wondering in relation to that how far you think art is operating on the level of analogy, on 'looks like', in relation to science.

Mary Midgley Operating on the level of analogy to what?

Question 7 To text's like On Growth and Form so that it is appropriated purely on the superficial level.

Mary Midgley Well I haven't thought about it and I don't know how it ought to be used in art teaching. But I do think that it is important in understanding organisms, because the orthodoxy - and it is still the orthodoxy not just Dawkins - is that natural selection is the main if not quite the only source of change in organisms, Darwin himself said strongly that it was not the only source of change in evolution. Which is totally ignored by these people who call themselves his followers. The point being surely that natural selection is a filter, and filters do not produce coffee. New forms have to come from somewhere. Leaving it to mutations is not really very plausible; they are rare and most of them are destructive anyway. And the amount of order that we have really is not reasonably accounted for in that way.

Now Simon Conway Morris points out how often there is convergence - that is, quite unrelated groups of organisms if they want to solve some similar need take the same way of doing it. It is not necessary from an engineering point of view that they should take the same way, so there seem to be natural tendencies for it. This point about the creativity of matter I think is terribly important because, without that, we do get stuck still with this seventeenth century dismissal of matter as inert. The notion then was that we - these brains these minds - are living in an alien universe of dead, solid items banging against each other. I think this way of conceiving matter has a lot to do with our destroying the world in the way that we have. I think it is a matter of very great general importance. But I really haven't thought about its relevance to art education.

Siân Ede Martin Kemp is very much a proponent of bringing it back into art education. I think as Mary says there are beginning to be a lot of questions about the Dawkins type of genetic evolutionary theory. Only the other day in the Guardian there was an experiment from Norway which showed the inheritance of acquired characteristics in chickens which is astonishing so heavens knows what is going on there but it is not the Darwinian natural selection So there are lots and lots of questions.

The Culture of Medicine Exhibitions at the Wellcome Collection

James Peto

Looking at this image it is very hard to tell what it is. It appears to be some sort of gelatinous gloop at the bottom of a jar. Looking at this however, which is actually of the same thing, it is very clearly a squid albeit one that is very artistically arranged. It is actually a glass model of a squid made by the amateur naturalist glass modellers Leopold and Rudolf Blaschka. By the 1880's when the Blaschkas were working in Dresden, this father and son team of glass makers working on their own alone at home were supplying literally thousands of these models to museums, university study collections, botanical collections and laboratories all over the world. Now they tend to be sitting rather broken in the bottom of a draw in museums as far afield as India, Japan, New Zealand, all over the United States and there are quite a few collections in this country too. The Blaschkas had a catalogue list of over 700 different mainly sea creatures most of which they could supply as glass models on demand. This of course was the era of an unquenchable thirst for scientific knowledge, and also of a deep fascination of the exotic and the unknown. If you wanted in your museum or study collection a teeth bearing tiger or an brightly plumed bird then you could ask someone to hunt it down stuff it and mount it. But vis the gloop in the bottom of the jar, if you wanted an invertebrate sea creature there was no way to show what such a thing looked like until the Blaschkas came along and captured the market. This was one way in glass that it was possible to capture the extraordinary translucent forms and vibrant colours that marine biologists were beginning to discover underwater. Apart from pickling and sticking in a jar this was the best way of trying to give people an idea of what these things really look like. The Blaschkas had this fantastic global market and a team of salesmen travelling the world to sell them. I love these things, we did a little exhibition of them at the Design Museum. I love them not only because they are very beautiful but also because they are uncategorisable. They were described at the time, in the nineteenth century, by a contemporary of the Blaschkas as 'An artistic marvel in the field of science and a scientific marvel in the field of art'. They were sold primarily as an educational aid in the natural sciences but Leopold Blaschka also advertised them as ornaments because he realised that there was a big potential market for what he called decorations for elegant rooms. But these glass models do not fit into any of the conventional pigeon holes of art or science or craft or design, they seem to have a tentacle in each of those categories. It doesn't really matter what you call them. The creatures themselves were fascinating to the Blaschkas they studied them whenever they could find them or get anywhere near to them and they actually built an aquarium in their own workshop outside Dresden to house species that the aquarium could support. Not squid obviously. Clearly the models were intriguing to a very very wide audience who were eager for knowledge of things like this which were hitherto little seen or experienced except dead.

It's also quite hard to tell what this is but luckily I know and it's a toaster. I'll explain a bit more about it in a minute. I should say before I go on that I am not a scientist I studied languages and art history and for most of my working life so far I have worked in galleries and museums or on temporary public art projects in cities. I had a spell at the Design Museum from where I moved to the Wellcome Trust and I now run the temporary exhibitions programme at the Wellcome Collection, a public building that opened about three years ago now. But happily in my job I am able to call on the expertise when needed, which is often, of people who are scientists who we work with to help put together our programmes of exhibitions that have science, especially medical science, at their core. As I say I am not a scientist and like many, although thankfully not all of people working or studying in the arts, I am rather scared of science. I did very badly at it at school and I tended to steer clear of it and I think probably rather lazily assuming that my brain was not wired that way. In this age of super advance technology I think that this is the path I took at this stage and is all too easy to stumble down, that assumption that if you do not immediately find it easy that science is for other people, for very clever people. The kind clever people who dream up how to make that circuitry work in

the tiny space in the back of your iphone if you lucky to have one, or the kind of people who work out how to sequence the genome of a zebra fish. I think that it is very easy, perhaps increasingly easy, to become distanced from or to assume that you are distanced from science. I think of it as something that is sort of invisible, in spaces that you do not normally get to visit. It can almost be otherworldly. What I am interested in and what I hope I shall talk about today is projects that ignore or overcome that sort of estrangement and that can help us /me to understand and rediscover the rootedness of science in the everyday and it's place in society and in culture. I think that there is a sort of shared aim here. Let's look for the common ground and indeed for the common place, the everyday and that might include a toaster, although probably not one that looks like this.

This toaster was built by Thomas Thwaites just last year. Thomas was a student on the design interactions course run by the Royal College of Art. A kind of course that falls somewhere between art, design and science, it goes in any direction. This does or at least it can and has once just made toast and Thomas made it from scratch. When I say scratch I mean really from scratch, or at least as close as possible from the basic rules that he set himself at the beginning of the project. He wanted to build it from raw materials and he dug the raw materials up himself, he smelted them, he processed them and he put them together himself. He was fascinated by the way in which consumer goods seem to just kind of materialise on the shelves of our supermarkets almost as if by magic as if they had no history, no past, no origins. So he set out to discover where such things might really come from like a toaster. A toaster that you can extraordinarily enough buy in Argos for £4.97, so he actually purchased a toaster for £4.97 in Argos and as the first part of his quest he took it apart. So this is a bit of reductivism here, although a different kind I think to that which Mary was talking about this morning. And then having taken it apart and studied what he found inside and looked at the different components and different materials he set about making his own, not using any of these parts but starting from scratch. It took him 9 months and he travelled 1,900 miles in the process and it cost him £1,187 and 54 pence to make a new toaster. Here's some of the equipment that he used to carry this process out, on the far left there is a suitcase that he used to carry the iron ore that he mined from an iron mine that still exists in the forest of Dean, you can see in the middle and slightly to the left that chimney pot thing with two hair dryers stuck in it, that's his smelting furnace that he used it to extract iron from the iron ore, but actually it did not work so he had to resort to using a microwave. The kind of Calor gas stove that you see over to the right was, I think, what he used to get plastic out of oil or to make something that resembled plastic out of potato starch, neither of those processes worked and when he tried to dry the potato starch it cracked when he left it outside and most of it got eaten by snails. Eventually he figured out the plastic problem, he needed the plastic to make the kind of moulded casing. Future geologists he reasoned to himself, in many thousands of year's time when they were looking back would be sure to find a strata of the earth's surface that was made of discarded plastic, a strata of polymer. So he thought that it would be OK to cheat a bit and mine some of that plastic now so he went to the local rubbish tip, found some discarded plastic baby's toys, and melted them down. And then he used this, the remains of a tree root from Hyde Park opposite the Royal College, which he used as his injection mould. So he cut the bit of tree trunk in half and made the shape of a toaster and poured the melted plastic baby toys into the mould in order to get his casing which accounts for fact that the finish of the casing is not very highly polished you might say. On the left you can see one of the unsuccessful smelting tools that he tried and the microwave which worked successfully. He worked out very quickly that if you want to extract iron ore in the first part of the 21st century a modern book on the subject is pretty useless. It's not the best place to start, you need 15th century technology. You need in fact *De Re Metallica* by George Agricola translated from the latin by George Hoover and his wife. He worked out that the smaller the scale in which you wish to work the further back in history you need to go, but Thomas did none the less choose to use a hairdryer rather than wood and leather bellows with which to fan his furnace.

A very different kind of project by an artist that Siân also talked about this morning, Marcus Coates. This is a still from an installation by Marcus Coates called Dawn Chorus. He worked on this project over a long period of time with an ornithologist with a grant from the Wellcome Trust, very much an artist and a natural scientist working in collaboration. They recorded the individual songs of nineteen birds during the dawn chorus, then they slowed the

sounds down to human pitch and then recruited nineteen singers to be individually filmed singing their part of the slowed down score and it took some of the singers almost an hour and a half to sing their particular birds part of the score. This guy is the song thrush and you see him in his natural environment, his bedroom, the singers own bedroom. Once they speeded it up again and you hear all these people singing all together not only did it sound to my ears at least exactly like the dawn chorus it also seems, because of the speeded up accelerated film, it sort of accelerates the movements of the singers so that they appear to sort of twitch like birds as they are singing. This guy is the white throat in his living room sitting and singing his part as the white throat and this shot of part of the nineteen birds that make up the full chorus all playing altogether. So you walk into this space and you are surrounded by bird song and your eyes leap from screen to screen as singers sing and twitch. When you see it all together I find it very uplifting. It's also very moving, there is something slightly melancholy about the isolation of these individual humans each alone in their private environments. It's also of course quite funny, it's splendidly absurd, and Marcus Coates himself says that he really enjoys the childlike pleasure of trying to be an animal. Something that you have not really been allowed to do since you were about eight. I don't think that Marcus Coates the artist is suggesting for a moment that we should be trying to get back to being like animals but I do think that there is an intriguing suggestion that we may have much to learn about who we are and why we behave. The way we do if we are very careful as a species not to see ourselves as apart from the natural world. I don't see this as a sentimental cry to get back to nature but perhaps more as an acknowledgement that we have become quite distant from it.

I mentioned my role at the Wellcome Collection. For those of you haven't been there it's a public space now three years old. Free admission, two permanent exhibitions, a very busy program of events, a library, a bookshop and a cafe. Everything we do is funded by the Wellcome Trust, we are incredibly fortunate in that regard. The Wellcome Trust is an independent charity that is supported by proceeds of the sale of the Wellcome part of Glaxo Wellcome, as it was a few years ago. Most of the funding goes into medical research; some goes into supporting the arts and especially into encouraging public engagement with science and also into collaborations between artists and scientists as part of that process of trying to get more people interested in science. The exhibitions in the program that I run with my colleague Ken Arnold, who has a long history of working with Siân and with the Gulbenkian, and with the Arts Council. Together they set up the SciArts Award some years ago. The exhibitions in the programs that I run address subjects that are related in some way to medical science or at least to health and well being. So what we try to do is to bring disciplines together and not to see science as separate from culture but to understand it as an integral part. To ask among other things questions about how developments in scientific knowledge influence our culture and how cultural attitudes influence the progress of science or sometimes the hindrance of science. So when we set up our temporary exhibitions three years ago the heart seemed a great place to start. It's been widely understood as the place where life begins and ends so to speak. It's always featured as an incredibly potent symbol in our religions myths and rituals. Modern medical science has taught us that much of the power and influence that was traditionally attributed to the heart actually lies in the brain. But nevertheless, we remain reluctant to let go of the notion that seems to be deeply rooted in everyday language and imagery, that the heart is somehow the home of our emotions and our true character. So the heart exhibition looked at the evolution of our understanding of what the heart is and what it does and what it means. And we did this through the exhibition of things like anatomical atlases such as this 18th century Italian example, medical equipment, anatomical specimens, mediaeval paintings, religious sculptures and artefacts, documentary film, country and western music, poetry, everyday objects and contemporary art. So just to quickly give you an example of contemporary art, paintings with text by Raymond Pettigou, who has an obsession with the heart. Work by the artist Jordan Baseman who currently has an exhibition at the Baltic, in Gateshead. These two films were originally funded by a Wellcome grant as part of the SciArt scheme that Siân helped to start. Jordan Baseman the artist worked in collaboration with the heart surgeon Patrick Wells at Papworth hospital. The film on the left shows scenes from an open heart surgery procedure, which proved pretty challenging for some people in the audience, and we had to be careful about warning people about this. Not only because the imagery was strong, but because it was overlaid by an extraordinary vivid sound track pieced together

by Jordan from the sermons of the once popular evangelist Billy Graham. The film is called Under the Blood and Billy Graham's language is shot through with incredibly bloody imagery, referring to the blood of Christ, life blood, pumping blood, washing away blood, in this kind of hectoring American evangelist mode of speech. It comes through the film as an orgy of blood soaked religious imagery overlaying the very secular but equally blood soaked images of a clinical procedure. Then much quieter, but equally powerful I think, is a still from another film by Jordan a film called One Plus One Equals One. In which a heart lung transplant patient Patrick Wilkins talks about his experiences of the operation, his dreams and fears in advance, and his feelings about this very radical procedure afterwards. And I was talking earlier about cultural influences or indeed the hindrance on scientific understanding or vice versa, it was very interesting researching this exhibition. For example despite sophisticated anatomical knowledge gains by the Greeks and the Romans in the time of Galen, also in the Arabic world, for many hundreds of years it was not understood that the blood circulated round the body driven by the heart. Anatomical knowledge was greatly hindered by the taboo on human dissection, and without the understanding that the heart is a pump it was hard to shake of the idea that it was also the seat of the soul, the home of love, and whatever else was attributed to it. But by the time we get to the era of open heart surgery, and heart transplantation in particular, when any one of us could be walking around with some else's heart inside us the message from medical science is pretty clear, intelligence and character can safely be located to somewhere higher up the body. But it's hard to shake off those cultural traditions. In the 60's and 70's, the first era of open heart surgery, in Japan for example, there was enormous resistance to touching the heart of another, there was resistance here also. In Jordan's second film you hear how the patient Patrick Wilkins describing how after the operation, even when he knew that this new heart was saving his life, he had to resist the desire to stick his fingers down his throat in order to sick up this alien thing inside him.

In exhibitions we might expect to look to scientific objects for information for leaning and to works of art for more emotional response. Some of the most emotionally resonant exhibits in the Heart exhibition were not art works. This is an early heart lung machine dating back to the 1950's, not the more recent one that we had in the exhibition. If you are unfortunate to have to have open heart surgery your heart will be stopped and a machine like this will take over the function of your heart and lungs. With the advent of heart transplantation the legal definition of death had to be shifted from the cessation of heart beat to the cessation of brain activity. This was initially to allow surgeons to explant a donor heart before it had stopped beating of its own accord, rather than waiting for it to die which would compromise a successful transplant.

We also did an exhibition on the subject of Sleeping and Dreaming and this was the first part of a two part collaboration we did with the Deutsche Vienna museum rather frightening titled German Hygiene Museum in Dresden. Super terrifying but it is actually a fantastic museum with a long and fascinating history initially it meant something much wider than it does today When the Nazis took it over it included racial hygiene. The museum has had to reinvent itself many times during the changes in recent German history. Sleeping and Dreaming opened with them and then came to us, but we curated it together, and then we did another exhibition which I will talk about later. I think that it is important to say that unlike many science museums and especially science centres which often concentrate on the phenomena of science our exhibitions are not trying to explain science. What our exhibitions are trying to do is to intrigue and to provoke questions. And often the exhibitions are as much or even more about what we do not know. We spend a third of our lives asleep, except for Margaret Thatcher who spent a lot less asleep or so she would have us believe, and so did Harold Wilson. But what do we really know about this particular state that imposes itself on our consciousness so frequently. Even answers to relatively simple questions like why do we sleep or what is the function of dreaming definite scientific answers still have not been found. So the exhibitions addressed these and other related questions through the work of biologists and neurologists but also through artists, musicians, film makers, etc. We told the story of how in 1938 Lightman and Richardson two American scientists spent a month away from the natural rhythms of night and day hid themselves away with equipment and a crew in a deep cave in Kentucky where there was no daylight and no changes in temperature, their objective being

to see if the natural 24 hour sleep cycle would change without the triggers of dawn and dusk and without the awareness of time. A very different form of enquiry that formed part of the exhibition, but one which one might argue is quite scientific in its rigour is by the artist Jane Gifford who records her dreams every morning and has done for many years. What you have here is 144 days worth of dream paintings they are about A5 size. They were enormously popular with the public and a fantastic talking point. I really enjoyed walking into the space and standing near them and you would so often hear people saying Yes I've had that one where you are about to go on stage and you don't know what to do when you get there and you fall over and it's all terrible. Or the one where you find yourself naked having a shower on your doorstep and suddenly your husband's parent's turn up. These are all examples of things that are commonly there, commonly recognised. Siân talked this morning a little bit about the work of Catherine Yass. This is a photograph by Catherine after a residency with a sleep scientist, the series was called Sleep, and what she was interested in exploring was that moment when we wake up and do not know whether we are awake or asleep or maybe somewhere in between. Catherine also showed this rather wonderful film, she was a bit embarrassed about it because she was not sure that this was an art work. She felt that it was not quite an art work but it does not matter I think. She made it by setting up a video camera in her bedroom the camera was programmed to come on when her alarm went off, so that she could record her dreams when she woke up. She would be woken up and sit up in bed trying to record to the camera what dreams that she had last night. You had this fantastic film, really tricky to watch someone struggling trying to remember to heave things out of their semi-unconsciousness lurking somewhere deep in their brain, a really intriguing film.

We also did another exhibition, with the Hygiene Museum in Dresden about the relationship between war and medicine. A subject area where conflicting human urges rub uncomfortably together and an area where science does both its worst and arguably its best. As mankind has developed increasingly sophisticated weaponry to harm medicine has had to adapt to cope with the volume and nature of its casualties. What we wanted was a very individual take on medicine and warfare today. After almost 2 years of extremely difficult negotiations with the Ministry of Defence we finally commissioned an artist David Cotterrell to travel to Camp Bastion in Helmand province Afghanistan and also to travel to Sangin where a number of troops have died in the last few weeks. In November 2007 David was the first to get in there and work with the medical forces in Camp Bastion. This was a deeply shocking experience for David, who is fortunately robust and is glad that he went and feels very privileged but it wasn't easy, medics see the worst that war can inflict. While he was there very seriously injured soldiers, British, afghan soldiers, civilians and Taliban were being brought into the field hospital every day. For the exhibition David made 2 film installations the first an immersive massive 5 channel projection relating to a flight that he made on the eve of Remembrance Day 2007 in which he accompanied a critical air support team during a night time evacuation of a critically injured soldier from Camp Bastion to Kandahar. David talks very interestingly about the dislocation in that that the seriously injured probably lost consciousness during battle and do not wakeup until they arrive home at Selly Oak hospital. It was this feeling of dislocation that struck David very forcefully. Dislocation between hospital and battle field, dislocation between Camp Bastion and the country of Afghanistan, and dislocation between Camp Bastion and the reasons for the conflict.

This is our current exhibition and it is on the impossibly slippery subject of identity. It's not a science exhibition and it's not an art exhibition. I suppose it is about who we are and why we might be the way that we are. Those are questions that are both scientific and philosophical. The exhibition does not try to answer them but enlists the help of scientists and artists who feature in the exhibition in order to ask and pose these questions in, we hope, intriguing ways. We realised very early on that it was impossible to impose some sort of thesis and we could only ever tackle some aspects of the subject. We worked with a freelance curator Hugh Aldersey-Williams who came up with the very good suggestion that we should concentrate on a number of specific individuals and investigate particular aspects of the subject of identity through the lives or work on those individuals. The exhibition was designed by Ben Kelly and you walk into what looks like a rather desolate and empty gallery, populated by these blank fragmented wooden cubes and almost no other exhibits. But when you turn the corner you find yourself inside one of the eight

rooms of the title 'Eight Rooms Nine Lives'. Each room is dedicated to one particular person, the eighth room is dedicated to a pair of twins. In the early stages of the exhibition we had to ask ourselves are we talking about identity objectively, such as the state may ask, who are you? How do I the state identify you from another person? Arguably quite a scientific question. Or the more subjective question. Who really am I? A more philosophical question. We ended up looking at bits of both questions and especially where they overlap and become confused.

For example there is a room about April Ashley one of the first people in this country to have gender reassignment. One of the first people in 1960 to have what was then called a sex change. Happily April had kept a lot of the material of her life, which we were able to show, and she speaks very forcibly about how we go through life having to tick boxes about ourselves including, of course, whether to tick the m box or the f box. And that many people do not feel that they fit that neatly into either. Her room in the exhibition is really about her campaign to have her chosen gender recognised first on her passport and then on her birth certificate. But the room is also about her life, her extraordinary interesting life, she joined the Merchant navy at 15, worked as a female impersonator in a night club in Paris, underwent female hormone treatment in a surgery in Morocco, she worked as a model, and was eventually outed by the Sunday People. She sailed around the world, across the Atlantic, and more besides. It's about her life as well as the issues that her life raised.

There is a room about Francis Galton, the prolific Victorian scientist, who was obsessed by the idea that humans must be divisible into types and using what was then the new technology of photography he photographed some of these types. This is just a small fraction of a huge collection of photographs that he made of prisoners. These were all prisoners in Millbank prison in London which was on the site of what is now Tate Britain. He had several boxes of these photographs. Then he would superimpose them, one on top of the other, hoping that a sort of archetypal murderers face would emerge. He also did this with Westminster public schoolboys and happily, or maybe unhappily, it is extremely easy to tell which is the murderer merge and which is the public schoolboy merge. It's more to do with what they are wearing, I don't think that Galton was on to anything. What Galton did do however was discover that everyone had a unique fingerprint, and he invented a very efficient way of collecting that print and he went around collecting them. His room is twinned with the contemporary scientist Alec Jeffreys who discovered DNA fingerprints, something that is unique to all of us. Here is the first print that he was able to record. Ironically today Jeffreys has a lot to say, he is very vocal critical about the storage of DNA.

Also thinking about identity from the inside out, there is a room about the French artist Claude Cahun who explored her own identity through the medium of self portrait photography, adopting a variety of poses and hairstyles. Incredibly radical in the 1930's to wear trousers and have her head shaved. She also photographed herself in different costumes, different national costumes, a kind of exploring through images, sexuality, and religion. Interestingly from the point of identity she was born into a Jewish family with the name of Lucy Swob which she soon changed and she moved in 1937 with her lover Suzanne Malherb to the island of Jersey. As a Jew and a lesbian this took on a special significance when the Nazis occupied the island and both she and Suzanne were arrested and sentenced to death for producing pamphlets like this, which were designed as if written by a disaffected German soldier, for distribution among the German troops. This one is signed the Unknown Soldier. They managed to escape the death sentence mainly due to extraordinary good fortune.

The exhibits that exist outside the rooms are mirrors, some belonged to famous people who had issues with identity in some way, for example the dressing mirror from the actor David Garrick. Some of the mirrors of Sigmund Freud. This is not actually a mirror it is an art work by a group of artists UVA and it films you as you step in front of it and you immediately see your image, but then it blurs your image with ones that it recorded earlier, so you sort of see your past. An experience that I personally found extremely disturbing.

Lastly I just wanted to flag up an exhibition that we are planning for this time next year, it's a big thematic exhibition on the subject of dirt. A kind of cultural and scientific history looking at our relationship with dirt, with dust, waste, excrement. Bacteria whether good bacteria or bad bacteria. A study, I suppose, on the filthy reality of being human

and being alive. I spoke at the beginning of rediscovering the rootedness of science in the everyday, I suppose the story of our relationship with dirt is not a linear story of progress, and of course is a different story in different cultures, but because it is about everyday life and death I think that it is a really important and fascinating subject for us all to grapple with.

And I will leave you with Thomas Thwaites toaster and here it has magically appeared as if it had no history at all on the shelves of John Lewis except that it cost £1187.54.

(transcribed by Lizz Tuckerman May 2010)

“To Infinity... and Beyond!’ Can Theatre Play with Science?”

Professor Mike Vanden Heuvel

Let me begin by setting two scenes in which science and theatrical performance cross paths. The first comes from the early nineteenth century, during a period of great and widespread uncertainty about what constituted the “natural order” of creation, as pre-darwinian ethnologists and amateur biologists scoured the ends of the earth in search of diversity in all levels of flora and fauna. Responding to a new appreciation of Nature’s tremendous diversity, they were also promoting a powerful and unsettling body of data that seemed to confirm Nature’s promiscuousness and lack of order and hierarchy – its tendency to produce bizarre embodiments and even monstrosities that threatened to challenge the discrete taxonomies invented by Linnaeus in his *Systema Natura* of 1735. Pre-darwinian naturalists, then, were in effect restoring drama to creation by turning mere specimens into “species” that were incessantly relative and unstable, and which therefore presented challenges to the notion of fixed natural order: there was something theatrical, it turns out, in the very diversification of natural form.

In my first example, the performance of science features an oddity advertised as “The Bold Grimace Spaniard,” presented at theatres and fairs around London. Bold Grimace, it was claimed

... lived fifteen years among wild creatures in the mountains, and is reasonably supposed to have been taken out of the cradle as an infant by some savage beast, and wonderfully preserved, until some travelling comedians accidentally passed through those parts, and perceiving him to be of the human race, pursued him back to his cave, where they caught him in a net.

Once displayed, Bold Grimace “performs the following surprising grimaces: he lolls out his tongue a foot long, turns his eyes in and out at the same time, contracts his face as small as an apple, extends his mouth six inches, and turns it into the shape of a bird’s beak, his eyes like to an owl, then licks his nose with his tongue like a cow.”

I call attention not only to the display of phylogenetic hybridity in Grimace Man (he is man and monster), but just as importantly the mixing and hybridity of performance genres: for, after he has completed his contortious excesses, Bold Grimace would sing “wonderfully fine” and accompany himself on a lute. Spectators were not just witnessing the performance of a monstrosity: they were seeing it in the guise of a recognizable performance form,

the variety show. The latest scientific ideas enter performance, in this instance, not masked by rational dialogue or satisfying plot resolutions that either glorify or castigate scientific thought, but with all their roughest and most difficult features – including an incipient racism and imperialism – foregrounded through theatrical means.

My second example comes from Michael Frayn's *Copenhagen*, [1998] likely the best-known science play in the canon: in the scene, the Danish physicist Niels Bohr is discussing, along with his wife, Margarethe, and Werner Heisenberg the so-called Principle of Indeterminacy, which limits one's knowledge of the dynamics of subatomic particles according to the means by which one chooses to perceive them. As well, the scene addresses other key issues in the play, such as the slippery nature of historical reconstruction and the epistemological problem of what one can derive from other people's actions and motives.

Margarethe: It was the cloud chamber that finished you.

Bohr: Yes, because if you detach an electron from an atom, and send it through a cloud chamber, you can see the track it leaves.

Heisenberg: And it's a scandal. There shouldn't be a track!

Margarethe: According to your quantum mechanics.

Heisenberg: There isn't a track! No orbits! No tracks or trajectories! Only external effects!

In the two examples we witness distinctively different performative modes through which scientific ideas and objects are represented for popular consumption. In the first, a popular theatrical form engages with biological variety in a haphazard, even mischievous manner. Jane Goodall provides the example of Bold Grimace Spaniard in her wonderful study of nineteenth century popular entertainment's response to Darwinism, entitled *Performance and Evolution in the Age of Darwin: Out of the Natural Order*. She writes that, whereas nineteenth-century science "controlled the parameters of enquiry in order to stabilize a model of knowledge, popular discourses could engage in explorations without a map, exercising the freedom to invent as well as observe." While the written record establishes the view that Victorians reacted to evolutionary theory simply with moral revulsion, denial, and disbelief, Goodall argues that "a study of popular theory and performance allows no such story to be told. Rather than evidence of shock, what emerges is a picture of eager – even over-eager – receptiveness to new ideas from the realms of science, a fascination with their implications and an alertness to changing directions of speculation, albeit

with a cavalier attitude toward comprehension.” The popular performance modes of the music hall, street pantomime, and variety theatre were the perfect vehicles for embodying what Goodall terms the “alert skepticism and “sense of the ludicrous” that popular performers and their audiences derived from this manner of making sense of new forms of knowledge; using, in Goodall’s apt phrase, “the anarchic rules of humbug.”

In contrast to this engagement with new scientific ideas through performative logics that allow loose play, active speculation, and a willingness to explore the warps, paradoxes, and aporias of scientific truth claims, the second scene I’ve abstracted gives us a glimpse at how theatre today conventionally embodies scientific ideas. Here, a well-educated and exceptionally well-read playwright first researched thoroughly both the sciences and the historical contexts which undergird the action of his play. He arranged these in a realistic theatrical style, even though the play is framed as a post-mortem discussion. Further, Frayn worked with scientific consultants to be certain that he did a credible job of “getting the science right” (even rewriting the play after its initial premiere because he thought he had not achieved a credible level of accuracy), as well as presenting believable characters and a plausible if finally not decidable historical sequence of causes and effects that give rise to the events and action of the drama.

When the play – to Frayn’s lasting surprise – became a huge success, there quickly emerged a pattern of reception and extra-curricular support for the performances that included symposia, public lectures by physicists and historians, post-show discussions about the relative guilt of Heisenberg in the historical events surrounding the play, and so on. Reams of articles responding to the veracity of the play’s depiction of quantum theory and to its historical judgment of Heisenberg appeared – mostly penned by historians and scientists rather than drama or literary critics – finally driving Frayn to write a “Postscript” to the play explaining and justifying his process of researching and writing it, as well as some indications of how he intended the ambivalence of the historical record to operate in synch with the scientific ideas of Uncertainty and Indeterminacy. In a twist that would delight the spirit of Shaw, the “Preface” is now longer than the drama itself.

I hope these two extreme examples may self-evidently indicate a range of possible engagements between theatre and science. I characterize the difference as **“variety vs. veracity,”** the former defining not just the popular performance style of the variety show that shapes the presentation of science but also the open-ended, indeterminate, and partial comprehension it engenders in relation to the science of evolution. This stands, it seems

to me, in stark contrast to the will toward veracity that we impose upon playwrights today who, straight-jacketed into the drama of ideas and its predominantly realist structure, seek to represent scientific ideas and themes in their work only once they have satisfied criteria normally associated with the public display of science: but not necessarily of theatre.

Given the variety of topics and expressive forms available to playwrights and performance artists for referencing science in their work, then, it is natural that various taxonomies will have emerged to render a sense of how works within the genre relate to others. One fact has emerged clearly in this endeavor: the taxonomizing of science plays becomes interesting only when it becomes tendentious. As with all categories, those segregating science plays often assume hierarchical status, and when these are presented prescriptively – as what a good science play ought to do in terms of representing science – they reveal a good deal about the culture’s current attitudes regarding the relations of art and science.

To present a small sampling of approaches to categorizing science plays along my continuum of veracity to variety, I’ve chosen first to feature Carl Djerassi, the award-winning scientist-turned-playwright who has established himself as a strong polemicist for what he calls variously “Science-**as**-theatre” and “science-**in**-theatre.” In public lectures, prefaces to his own plays, and published articles (with titles like “When Is Science on Stage Really Science?”), Djerassi argues that, after a period during which playwrights generally included references to science solely in order to critique it and to “express their skepticism about science” (he cites as examples Durrenmatt’s *The Physicists* and Brecht’s later version of *Galileo*), writers eventually began to risk didacticism by using the stage to communicate “real” scientific ideas and “to illustrate how scientists behave.” Pointing first to the success of *Copenhagen*, and marveling at the patience of audiences willing to listen to long set-speeches on quantum science and look in on the dynamics of Bohr’s inner circle of fellow researchers, Djerassi then turns to uncovering earlier science-in-theatre plays that he feels are equally successful in the pursuit of plausibly explaining important scientific ideas without sacrificing interest in character or story. Citing Stephen Poliakoff’s *Blinded by the Sun* (concerning cold fusion) and Hugh Whitmore’s *Breaking the Code* as predecessors, Djerassi then turns to his own work, such as *An Immaculate Misconception*, *Oxygen* and his recent *Calculus: Newton’s Whores*, to explain the differences between plays that use science only for its “intellectually attractive metaphors” – plays like *Arcadia*, which he holds in great esteem – and those like his own that take as their primary pedagogical task the use of drama to communicate

scientific ideas and to present an anthropology of science's "tribal culture." Although sometimes critical of certain aspects of that culture, in general such plays express admiration for the scientific characters they present and for the quest for knowledge in which they are often engaged. Plays that naturally fit Djerassi's favored category would include, then, the likes of Rita Nachtmann's *Thread of Life* (about the role of Rosalind Franklin in the discovery of structure of DNA), Vern Theissen's *Einstein's Gift*, David Auburn's mathematics play *Proof* – and even I suppose Mac Wellman's *Hypatia, or the Divine Algebra*.

As opposed to Djerassi's focus on the content of "science-in-theatre" plays, the next method of categorization addresses not the matter of the work but its forms of enactment and presentation, that is, the different forms of theatrical language and speech acts deployed by a play and the response these will likely engender in spectators. Kirsten Shepherd-Barr has suggested that a number of the most successful science plays tend to be "more traditional, realistic and character-driven plays" that successfully "employ a particular scientific idea or concept as an extended metaphor – they literally *enact* the ideas that they engage." The theatricality of "traditional" science plays such as *Copenhagen*, *Arcadia*, Timberlake Wertenbaker's *After Darwin*, and others is placed in the service of literalizing the scientific concepts operating in the work so that they can act as metaphorical vehicles for the themes of love, moral uncertainty, ethical action, and the like. However, even though the marriage of form and content may be seamless, as in *Arcadia*, the scientific ideas are still heavily mediated, in the sense that they are filtered through discursive language, relatively traditional manifestations of character (often associated with biographical material on the scientist), and plots that, while they may be uncertain, nonlinear, and even chaotic – nevertheless establish strong links between scientific ideas and the metaphors that establish connections to non-scientific themes.

Although the mainly "traditional, realistic and character-driven plays" that use scientific ideas to convey metaphorical associations with other themes are the most well-known, they are not the most radical in their use of form. Standing at the margins of the genre is another category of science plays that are less dependent on such mediation, which work to immerse audiences directly in the experience of temporal and spatial realities that science seeks to explain abstractly and conceptually: hence, the experience of the audience becomes a direct and unmediated confrontation with the science through an enactment of ideas and concepts, rather than about listening to explanations of it from characters and following their stories. Such performance styles, because they dethrone

discursive language, the character as vehicle for meaning, and linear plotting to direct audience interpretation, have been termed “postdramatic” by theatre scholars such as Hans-Thies Lehmann and David Barnett. By nature of the scientific concepts being deployed in such work, the presentations are often themselves fragmented, partial, nebulous, many-layered and incomplete. As Judy Kupferman has written, science plays “usually deal with scientists rather than with scientific ideas. And an idea is not often as effective a protagonist as a human being.” Indeed, Shepherd-Barr argues that the genesis of these plays and performances must circumvent the usual linear sequence of author-director-production team that normally produces plays “about scientists”; instead, artists seeking to avoid relying too much on personalities and characters to carry their plays must explore collective, improvisational and devised forms of creation. Such forms of collective authorship are more likely to branch out in unexpected directions, double back on themselves in feedback loops, absorb both public texts and the private recollections of the company members, and engage in constant transformation and thus complicate the sense of willed formal coherence. As well, the primacy of physical research – acting, movement, choreography-- both as a means to embody scientific concepts and as the use of the body as a site for exploring non-discursive forms of knowledge, used in this category of science play means that the final realization in performance will not be addressed primarily to the intellect nor directed toward clarifying conceptual material. Instead, I want to suggest, such performance styles return us to a postmodern version of the variety show and to the sort of audience’s response evoked by Bold Grimace Spaniard.

Examples of these less-mediated and highly performative engagements with science include Theatre de Complicite’s highly-acclaimed meditation on personal and collective cognition and memory, *Mnemonic* – which has been much written about -- as well as their more recent *A Disappearing Number* concerning the mathematical collaborations between G.H. Hardy and Srinivasa Ramanujan. Even more impressively, an extremely sophisticated body of work produced by Jean-Francois Peyret’s *Feuilleton* Company in collaboration with Alan Prochiantz, a French neuroscientist, investigate stages of artistic and scientific creativity by combining textual fragments from authors like Kafka and Darwin and staging them in spaces undergoing constant transformation, with actors who eschew characterization. Emphasis is placed on the manifestation and experience of just what most science plays leave out as being undramatic – the creative and liminal moments between discovery, when both art and science have not yet codified into “law” or “text.” Those science plays based in narrative – virtually everything I’ve mentioned to this

point -- Peyret feels to be unworthy of the genre: he calls *Copenhagen* "faux theatre" and "*theatre de la morgue*," arguing that if audiences "want to know whether Heisenberg was good or bad, they have access already to the scientific debates if they want them, they don't have to come to see a play. We don't have to do night school."

A final example of non-mediated, postdramatic science play is *Infinites*, a collaboration between the director Luca Ronconi and Cambridge cosmologist John Barrow, who devised the script from scraps of his own writings as well as fragments from Cantor, Nietzsche, Hawking, Borges, Alan Lightman, Marcus Aurelius and others. Ronconi, who developed the piece in conjunction with Milan's Teatro Piccolo in 2002, staged it environmentally in a vast warehouse where La Scala has their massive sets painted, which necessitated an immense number of doors arranged at different heights for the scene painters to step out to cover different sections of the backdrop. This décor allowed space to be treated as a dramatic element equal to or greater in significance to language or the actors. This became especially apparent in the first section of the performance, entitled "Hilbert's Hotel" in reference to the mathematical paradoxes of infinity first explored by the mathematician David Hilbert. Here, a hotel manager in the immense space computes how to accommodate an infinite number of guests in an infinite number of rooms (which sounds like an easy task, but given the complexities inherent in the concept of infinity, it turns out not only to be impossible, but quite likely the catalyst for the end of the universe). Following the opening enactment, spectators may follow their own route through the remainder of the production: some try one sequence, others double back to experience Hilbert's Hotel or another scene multiple times. In another room, the theoretical implications of the self-reflexivity of language and infinite textuality explored in Borges's "Library of Babel" are played out in a mirrored maze of empty bookshelves rising several stories. Text-bearers (there are no actors as such) speak sections from Borges's dismal reflections on language as well as making connections to Palladio's Teatro Olimpico, establishing links between the unexpected infinities produced by the mirrors held up to nature by both language and of theatre. "We must leave at home traditional notions of character, story and plot, and the idea of continuous attention from the audience," says Ronconi: "This kind of theatre is looking for hypotheses, rather than starting with them. We don't know the final answer. The actors aren't above the audience – they don't understand the text that well themselves, and certainly not the math." To get to the essence of the scientific ideas, all biography is left aside, all explanatory armature left incomplete and partial, all the science's "asperity and difficulty" – using Ronconi's phrase – is left to experience through direct theatrical means. Given the rigor of Ronconi's explorations, it is perhaps not

overstating the case to suggest that he is attempting to repolarize Artaud's famous dictum regarding the theatre of cruelty's function to "teach us our metaphysics through the skin." In our post-metaphysical age, with science in the ascendancy, it may be more important to find ways to learn our physics through the skin.

I don't want to insist that postdramatic theatres of science replicate exactly what Goodall called, in relation to the engagement of science through popular performance modes, "exploration without a map." I do believe, however, that in its own imagistic, non-psychologically based way *Infinites* produces something similar to what Goodall intends by the phrase "an alertness to changing directions of speculation, albeit with a cavalier attitude toward comprehension." Like the variety show performers from the last century, Ronconi's company seems not to be so much explicating scientific ideas as "trying ideas on, testing them out through enactment." For this reason such performances are rarely grouped by critics like Djerassi with more conventional science plays directed toward veracity and the transparent communication of ideas. However, I would argue that in the main these postdramatic explorations of scientific ideas creates a better balance between science and theatre than even such celebrated works as *Copenhagen* and *Arcadia* are capable of achieving. Barrow has even commented on the lasting influence of Leonardo as a touchstone for Italian thinking on the relations of art and science, which he contrasts positively to the narrower empirical tradition and hermetic isolation of science from the humanities in England.

I have a longer conclusion here that discusses some of the material conditions of funding for science plays and something of a conspiracy theory regarding its effects on what get produced, but in the interests of brevity I'll just say this: Pirandello suggested playfully that truth doesn't have to be plausible, but fiction does. This profound witticism notwithstanding, the volatile mix of intellectual weight, historical context, and moral questioning that attaches itself to the writing of science plays makes it a genre for which issues of accurate representation, documented and verifiable biography and the like are always going to be active -- a kind of Newtonian empiricism will always to some degree apply. Nevertheless, as science plays explore forms of scientific thought in which uncertainty, paradox, and incompleteness are embedded in the very fabric of the inquiry -- sciences that marry intuition and powerful imagery like those we see in quantum science, n -dimensional and fractal geometries and Feynman diagrams, for instance -- one can only hope that playwrights will not be shackled to traditional narrative and compositional strategies in the project of making provocative and even disorienting ideas clear and easily consumable. So much of the scientific joy in creativity and its almost theatrical dedication to improvisatory thought

would thereby be stunted or even lost. As Ronconi observes, “there is a deep affinity between science and theatre: Setting up an experiment, publicizing observations, opening a scientific discussion are operations not unlike those of a theatre production – in ‘scientific drama’ as well as in theatre, it is a matter of giving concrete form to ideas and realizing that their circulation helps to create a better understanding of the world and of ourselves.”

Despite my great admiration for some character-based science plays where dialogue remains the principal explicator of scientific ideas, I would hazard that it will be the postdramatic work generated by experimental companies like Complicite and *Feuilleton*, and artists like Ronconi, that hold the key to the future success of science theatre. As Dame Gillian Beer wrote in her classic *Open Fields*: “I am not a scientist: my concern is language, representation, and reception. Our special skills do not fall in line with each other. But we do not need to disguise or discard these incongruities [between art and science]. No ‘ingenious transposition’ [in Umberto Eco’s words] is possible from genre to another. But neither should transformations be seen as error or wastage.” Rather than having art and science converge into some perfect grid, the more ambiguous processes of transformation, adaptation and translation seems an apt and welcome alternative to Djerassi’s “science-in-theatre” model. Or maybe it’s just that part of me yearns for the “anarchic rules of humbug.”

Thank you.

Mike Vanden Heuval

April 2010

Questions and discussion following talks by James Peto and Mike Vanden Heuval

Question 1 for Mike It's about your positioning of... the way that theatre I'm interested in how people classify a character narrative play versus a post dramatic approach. However I don't know if to me that seems to be to just specific to science on the stage, because it might be related more to a live discussion about documentary theatre or verbatim theatre against a less narrative approach. I don't know if you had any thoughts about this? Is this just the nature of a debate in theatre about how we engage with fact perhaps rather than fiction?

Mike Vanden Heuval I think that you are right theatre has been a space in which those debates about mimesis and factual representation as opposed to imaginative or speculative fact is long standing. I think that right now we have reached a point in theatre in which there is a great deal of interest in forms like verbatim theatre; David Hare is becoming a spokesperson for that, and the work is becoming better known, and it's not impossible to conceive of that being transformed to a science play at some point. It would be interesting in a sense, because what you might overhear verbatim in a science lab may not translate particularly well to a general audience. Nevertheless I think that what you see in verbatim theatre, as verbatim as it is, is a great deal of spectacle, I mean, there is all kind of projection work going on. The rhythm of the characters arriving on and off stage in something like *The Power of Yes* is very theatrical. So I think the name is applicable to that type of theatre, but it does not to me represent a type of theatre that is absolutely objective in the way that a scientist would seek objectivity. I don't think any form of theatre could be that, if it was completely objective then it would not be theatre anymore, it would not be performance. So I see that as a sort of a dead end on where one would want to take a science play. I would probably promote the willingness to explore with embodied forms of expression as a way of communicating scientific ideas in a very abstract and conceptual way over and above the types of plays that exist in a great number of ways at the present, very hagiographic plays about Einstein and that type of thing, I don't think they do credit to the kind of creativity and imagination that is a part of science. I think that they make it seem sort of deadening and objective and just a matter of gathering of facts and being brilliant about organising, and I think that science is a bit more than that.

Siân Ede Well it was just as a supplement to that question, there are whole areas of theatre that are not proscenium arch text based, much more similarity to the sort of installation based journey.... sort of pilgrimages through using the imagery, that's' a breakdown of things that are happening in theatre at present. I had not thought what a good form it would make for the presentation of science and I think that it is very interesting. But what amused me was that they are like a sort of new young Turks saying that we are it and all the rest of it is rubbish. Whereas *Copenhagen* is actually a very good play, it's a bit old fashioned but it is a very watchable and well constructed play. Could we not have plurality in form?

Mike Vanden Heuval I think that it is fine and I consider *Arcadia* to be my version of *Copenhagen*. I think that *Arcadia* is absolutely luminous. I actually have the opportunity to meet Stoppard when I go to London and I'm bringing my dog eared copy of the play for him to sign and it will be one of my most treasured objects, I think. What led me to take a bit of a tendentious perspective on this myself I think, is that plays that get traditionally promoted and get themselves worked up to the material conditions to get a play on stage, the ones that are funded, the ones that are closest to television and therefore most likely bring in a wide audience, are the realistic psychologically based character driven plays and this other work is presented as if it is almost elitist and yet in a sense it is absolutely not. It's what Ron Corney says, I'm not trying to give you night school and talk down to you and explain to you what the science is I'm trying to give you a direct wonder of the science. I think that there should be a plurality, but I think that the plurality should extend to the support and presentation and production of these works. I should say that *Infinities* played to over 34,000 people before its run was over because they can pack so many people into that warehouse. It has gone to other spaces but they generally look for a large warehouse .

Question 2 For James, I just wondered how easy it is for you to measure the success and the impact that the Wellcome Collection is having on the whole of society or on a specific portion?

James Peto On the whole of society too early...that may never be possible, but on the present audience we do quite a lot of work on it and the most gratifying measure of success is that we have had more than three times the number of visitors as we had hoped and the numbers are going up all the time. We expected 100,000 in the first year and we had 300,000, more than 300,000 in the second, and the numbers are going up and up all the time. So that is promising. On an anecdotal level, and I was thinking of this when I was talking about Jane Gifford's dream paintings I think one of the successes is that a lot of people talk when in the exhibition. I guess sometimes that in a pure art gallery that is kind of frowned upon. In a noisy science museum that is what people do, ours is not a noisy museum, the exhibitions themselves are quite quiet, but people do seem to talk. In terms of the formal evaluation that we have done we found out that at the very beginning it was quite a specialist audience that was coming, it was mostly people that were involved in professions related to science and medicine especially. We are near to UCL and near to big hospitals. Now that we are more established we are getting quite a big art audience. When you ask the question "What other kind of museums have you been to recently?" it tends to be more Tate Gallery or V and A rather than science museum or Dana centre.

Question 3 to James How do you decide what is going to come up? Is it influenced by the audiences that have been in?

James Peto It hasn't been, but it may be broadly because we get lots of proposals, and we get more and more proposals the longer that we are there. So they may have seen things that we have done before so I suppose there is an influence there. We have a lot of things that we want to do ourselves and we get lots of people writing with suggestions and we sift through them all. We do actually have an informal group of people who meet once a year, not a rubber stamping committee, but one in which we talk about the ones that we like best and in that discussion some sort of float to the top and those are the ones that we run with. Wellcome Collection is still slightly separate from the Wellcome Trust, so far we have always been allowed to do what we want to do without anyone in the Trust, who are after all providing the money, saying that 'no you cannot do that'. But the Identity Exhibition, the current one did come from above in that we were almost told that this is a subject that the Wellcome Collection must tackle because the Wellcome Trust is involved in the sequencing of the human genome and because Mark Wolpert* is on various government committees about the storage of data. So it was a very live issue and our first thought was how the hell do you do an exhibition about identity but I think that we got there eventually.

Question 4 I would just like to say I'm a teacher and I take my students to the Wellcome Collection I take secondary school pupils they feel very comfortable there because they feel that it's not as precious as an art gallery and it helps them to engage in a meaningful discussion, and take work back with them that they can then build upon. So I think that it plays a really influential role in education as well as at a professional level in the arts and sciences.

James Peto That's very nice to hear.

***Mark Walport (Director - Wellcome Trust) (Chief Executive)**

Mark Walport was appointed Director of the Wellcome Trust in June 2003. Before joining the Trust, he was Professor of Medicine and Head of the Division of Medicine at Imperial College London, where he led a research team that focused on the immunology and genetics of rheumatic diseases. He was appointed a member of the Council for Science and Technology in 2004.

Group Discussion Facilitated by Alison Andrews, Arts Council England, Yorkshire

Alison Andrews Well, hello everybody it's absolutely fantastic to see you here. And it's great that so many of you have stayed. I thought that maybe by the end we would have this small very intimate group who would want to talk together but I think that we have just about everybody. I did want this to be very much about you, my role as a facilitator is to make this easy. So I want to make it easy for this to be about you and your interests and your aspirations and your engagement with this area, I assume that you are engaged with this area of collaborative interdisciplinary practice. I think that it is an opportunity to look at the aims of Hybrid overall which are about interaction and networking. Interaction not just in the sense of CP Snow's two cultures of science and art but interaction between us all. So it's important in your evaluation that you put your email address on if you want to keep this working. If you don't mind when speaking could you say a little bit about who you are and your work that would be very useful.

James (Peto) you were talking about not being good at science and certainly that was my experience as a school girl. It was very much about categorization of either/or and I was very much the 'not' in terms of science. This business of thinkers/ or doers, male/or female, me/or you. I think that a project like this and the work that we have done and are trying to do in Yorkshire has really been about trying to blast that separation and get some sort of fusion going between the two. My experience was a really unhappy experience where I was categorised very early on as being incapable of conceptual thought, the required calculations in physics and maths and therefore categorised as inept and disinterested in science. I was hurt because I was interested. So I was determined that that should not be the experience of my own children. It was really interesting talking to Mary at lunch time and her optimism that things can change. Given where she started from, when she was born women did not even have the vote, in her long and distinguished career one of the benefits of getting old is that you can look back and really can see empirically, see that things can change and I thought that was fantastic. Yes things can change and we can change them now in this room, this kind of discussion. Although science and art work thanks to people like Sian has been going on for some time we are still in a way in the early stages of going back to where we were in the Renaissance, where there was not a separation between artistic practice and scientific practice. It was about being human; it was about being curious, it was about being engaged with the world.

I just would like to kick off by going back to that business of changing.

Julia Russell I worked at the Serpentine gallery many years ago on the education programme and after a change of career I'm now an art teacher and I'm setting up an art and science program. I teach science through art mainly painting and drawing. What I do is a fusion of art and science and what you do at the Wellcome is that fusion which gives me a platform from which we can work. Education is constantly moving forward and searching and looking for new ideas. I feel quite excited at the moment to be part of that and making it relevant to pupils and making sure that they are constantly questioning. I mean I am constantly questioning.

Alison Andrews Can I just ask you Julia do you feel supported by the greater institution that you are working for in the work that you are doing?

Julia Russell Not always. I think that I am in a very privileged position at the moment because I am given quite a lot of autonomy so therefore I am able to be very creative. I think that is the thing that keeps me enthusiastic about it because my background was from being an artist. I have worked my way through the strange pattern of my career and now I am where I am now and I am able to utilise the knowledge that I have. I am not from a science background but I am now getting more immersed in it. I have had to do some research myself, and make some contact with groups like coming here today but I am naturally interested in doing that. It improves my strength as an educator as

a teacher, and I hope keeps it more alive for the people that I am working with. So that I am just not coming from one dimension. Within my school I am encouraged to take pupils out of the classroom, which I think is good.

Anonymous comment Can I ask what is the bit that you describe as the strange pattern of your career? You went from the Serpentine into being a practicing artist and what was it that took you into the field of encouraging your pupils to think about science and art?

Julia Russell It was the school that I am now working at. In my interview a couple of years ago they said that they were interested in setting it up. I lived near to the Wellcome collection and always found it interesting so I could talk about that.

Anonymous comment But it was partly the school thinking that this was a good direction.

Sandrine Soubes I am postdoctoral student from the University of Sheffield I am a biologist but I do not work at the bench any more. Mainly I work with PhD students I help them with their communications skills, and for the last three years I have done a lot of outreach. I myself go into schools with science workshops and all that and in a way I got bored with all that. Recently I have begun working with various artists. When you go to school as a scientist, you try to say that you are not scary as a scientist you are just a normal person. Two years ago I worked with a theatre company we spent one week in a school, we used dance drama and music and we had a group of scientists from my department either PhD students, postdocs, or researchers working with the artists. It was really enlightening to see how these young children, it was a primary school, they were aged 10 or 11 enormously enjoyed learning about science using their bodies and writing poems. Now basically whenever I do a science workshop in school I never just use the science. I think that even kids that are 8,9 or a 10 years old there are already children who think that science is too hard for them and think that it is boring. From my small experience using drama, art can open the eyes of some children. Science may be hard but that are lots of interesting things to learn about and to play with. Having said that the past week was science week and I spent a whole week in a school. We did some microbiology workshops, and the pupils designed their own bugs, engineered bacteria to do specific jobs. In the drama pieces they dressed up as scientists but still a very large number of them were being the mad Einstein type of scientist with the German accent. Have a French accent, please.

Lizz Tuckerman I think that schools taught like this before the National Curriculum because for a short deluded time I actually did a PGCE and went and taught, all schools in Rotherham taught in topics and we did light. We did everything I mean we did puppet theatres and poems and stories and then they also did experiments and then they dressed up in white coats and they loved it. Then they talked about what they had done just like a real scientist would. A few years after the National Curriculum came in the government thought oops we have forgotten something and we had Creative Partnerships, bring it back in again so in a way we are going round and round in circles. Certainly topic work, where all subjects were taught together under one heading was my children's favourite.

Anonymous comment You may be delighted to hear that in many schools the integrated curriculum is coming back in again. So artists are given good opportunities to come into schools with novel ideas. I'm a visual artist with a background in education and consequently ended up in education working on projects. So there are great opportunities for those integrated approaches that adults and youngsters respond to. Similarly a different context in high schools is working with the university sector with medical school undergraduates, humanities and sciences, a whole eclectic range of disciplines where as an artist we undertake a number of interventions mainly with the staff to encourage them to rediscover their own creativity and use that as a vehicle for passing on the information that they need to get across.

Alison Andrews By Powepoint!! Yes Sandrine wants to come in

Sandrine Soubes One of the things that the Wellcome Trust did that was absolutely inspiring a few years ago was about Biomedical Ethics.

Alison Andrews Can I just ask you Mike? Because you have taken the trouble to come all this way, and we are mostly from Yorkshire, although a few people have come from other places. We have a perspective I suppose around the UK about what is happening in science and art. But how is it where you come from?

Mike Vanden Heuval Well as Paul and Lizz know one of the reasons I am here on an extended stay is to visit various campuses and arts organisations to get feedback on what's working here because there is so little of it where I am from. My university is unique in a sense in that we have several initiatives underway but it's all self generated, there is no curriculum group that's asking us to do this or funding our work in our area it's just done in our own way and our own time. So we have a great deal of difficulty bringing our interests into a practical forum such as education because the metrics by which American school children are evaluated is different compared to what you have here. Given school reform in the last 10 years most primary schools are simply teaching to the task as they say, the only way schools continue to get funding is if their students test higher every year which is a ridiculous concept from the beginning. So we are at a time right now in which I think the more innovative forms of education are having difficulty getting much traction. At the university level of course there is always a bit more autonomy and a bit more interest in doing your own thing. So on my campus, as I said, we have a number of initiatives, some of them are directly connected to the sciences, others are initiated primarily through the arts and then finding common ground between them. It hasn't taken coherent form I think in the US, what I am hoping to do is to pick up some good practices over here and bring them back and see if we can't effect them in the US.

Alison Andrews OK and does anybody feel that they have an example of a particularly good practice that we could offer to Mike straight away?

I mean when you say good practice in terms of its aims what's the vision then that that good practice would elicit?

Mike Vanden Heuval Well on the level of education I think the aims would be very much what you are all speaking about, the broadening of the students experience, acknowledging that there are different ways of knowing, different forms of knowledge, that the disciplinary structure of our schools is in many ways a kind of fabrication and it's one that in an increasingly globalised world where we are aware of the need to make connections that it is simply not adequate any more. It is not even sufficient even for the training of problem solving ways of thinking. So that's what we would strive for. And then there are other things that I am interested in that are happening in the US that are not directly related to education. Where science and arts are coming together to mutually enrich one another in ways that we have heard several really interesting examples today. I was telling Sian earlier at lunch today that we had one of those embedded artist projects where the artist was embedded in the computational science and optics department on our campus and was strictly forbidden to create any images while he was there. This was not about the artist gleaning a little bit from the scientists and then creating a work of art to exhibit. He was there only to interpret visual data for the scientists from the perspective of an artist. And it seemed to have worked remarkably well, the scientists really felt that they learnt about how to look at things, how to make decisions about which pixels to turn on and off when you produce a high resolution image, what colours to use, those kind sort of things. So in the arena of research I think that it happening in ways like that both enriching artist and scientists.

Lizz Sterling I just wondered whether you had set up a residency thing in which a scientist is based in a theatre and drama department. I was thinking about how that exchange could go on. At the Rules of Engagement conference a few years ago there was a comment that how it is predominantly artists not many scientists in residences.

Siân Ede Can I just answer that? The idea of a scientist in residence is actually terribly difficult to achieve because scientists ipso facto are busy bees with phenomenal demands on them. We did have a very successful programme at the ICA a few years ago with Dan Glazer who is now at the Wellcome Trust. He was a cognitive psychologist but he

had taken out sometime during his university degree, I think they had a chance to drop out for a year, this happens on quite a lot of medical courses, to do whatever they want, whether it's philosophy or whatever and he had chosen to do literature and the arts. So he already had that interest and his friend I think was the talks co-ordinator and brought him in and he was a breath of fresh air there because what he did was run a talks programme and he had this amazing authority in chairing them but they were never able to follow it up because he was a very hard act to follow. And very good scientists want to be very good scientists. I am also very friendly with Mark Lythgo who's a neuroscientist who does a lot of popular science talks. He is still director of Cheltenham Festival of Science, he says that if you do anything outside science do not put it on your science CV or they will think that you are frivolous, you will not get the job or the paper. This is not to say that there are not good science communicators who have done a first degree in science or even a post doc who might want that change of career but an active scientist is going to be hard to get.

Anonymous comment You could change the curriculum so that art and science are closer together. Will that effect change later on?

Siân Ede That's your dream and mine. Having Rob Kessler in the Institute of Science in Lisbon, allowing him to be there for six or nine months on and off is unprecedentedly useful and it will open their eyes in a way. That's the guerrilla movement that we are all involved in isn't it? It's a guerrilla movement really. It's succeeds here and it succeeds there and it builds up a picture. So let's keep doing it.

Jenny Tennant Jackson What I was thinking of was that when you were talking earlier you mentioned Koons and I've been doing some work between art and science and I was invited to speak at a conference about something to do with Complexity Science and then the papers were being written up afterwards and I was told don't mention post modernism or the scientists will walk out. I'm just lucky to be working with some scientists who are fairly open, but by and large it's a lack in general, science does not tend to be quite as open strangely enough as art generally is. Although there are plenty of scientists we work with who would like to go and do a residency. I know that it's a generalisation. Anyhow, thank you.

Siân Ede I mean post modernism is a dirty word in science. Because they think anything goes they are really frightened of it. Part of my mission is to try and say to scientists that art is as intellectually challenging as science and as hard and you have to make an effort to understand it.

Paul Digby I was at a science department at the University of Leeds talking about a possible residency there and the conversation that we were having was exactly like that at an art school about perception how you see the object and they were not really stimulated by it other than suggesting the possibility of a residency.

Julie Freeman I am artist in residence at Cranfield University in their nano centre. I am their first artist in residence courtesy of Wellcome Trust funding incidentally. We had a really fruitful and open ended residency scientifically and artistically where I ended up co-authoring a paper that got published about the fundamental definition of what the nano scale really is. Quite remarkable and completely unexpected from my point of view, very challenging on the maths. And work that is not my usual type of work, 2D graphics. I usually work with digital animation and sound. So it kind of set me off in all sorts of different directions.

Siân Ede Did you have your name on the paper?

Julie Freeman Yes I was second author on the paper.

Siân Ede What an achievement.

Lizz Tuckerman And when you exhibited your work did you put the scientists name on?

Julie Freeman Yes

Lizz Tuckerman That's a big concern of mine that very often artists go in and come out with their work and don't put everybody else's name on. Rarely happens with the science, all contributors go on a paper.

Julie Freeman The publication that goes with it, the short stories etc the arts stuff, it's my name and his and the publication, the science it's his name and then mine. It's a very strong collaboration actually. What I'm interested in is sort of experimenting with your audience in a sort of art framework. Because scientists due to ethical restrictions cannot experiment on the public. If you are doing something artistic, I was particularly thinking especially a play or something like that particularly a perambulation play where you could experiment on your audience using an experimental method sort of tenuously and then collect feedback. I thought that maybe Siân might know something like that, where an artist has put the audience into a scientific experiment via an art installation.

Siân Ede Just the Olafur Eliasson project I showed with the colour where the statistics went back to the lab and were used. If that is what you mean.

Julie Freeman The audience are learning through involvement or learning through play and they are being experimented on at the same time.

James Peto I think in the area of neuroscience that happens quite a lot. We get quite a lot of applications from artists working with neuroscientists who are interested in doing exactly that sort of thing. So that there is a kind of two way process.

Julie Freeman What just to get round the ethics?

James Peto No we are very careful about the ethics too. No I don't think the aim is just to get round the ethics. They tend to be genuine and done in the collaborative spirit.

Siân Ede It's not just the ethics though is it? If you are going to use audiences I mean you have to have control groups, random sampling etc etc. It's not an experiment then, it may be a piece of sociology but not a piece of science.

Den Tuckerman I'm just amazed that no-one has mentioned it ... I mean I don't know if it is a British society thing, I have lost count of the number of times that people have said to me 'I can't do maths', they wear it like a badge of honour, but I have never sat down with a group of people and said that 'I can't spell I can't write I leave that to other folks'. I think that that is a huge problem in our society. I'm a blues guitarist with a degree in mathematics by the way.

Alison Andrews You are right and it has come up in work that we have done and we have invited someone to speak haven't we Lizz and they have expressed just that. I guess that it is quite deep in our culture.

Kelly Cumberland I'm an artist based at Patrick Studios and I also teach at Leeds College of Art on the degree program. I have just recently been involved in a 6 month residency at the Haematological Malignancy Diagnostic Service at Jimmy's (St James Hospital) in Leeds, where I was able to go in and work with scientists for 6 months. I made a 10 meter wall drawing as a result of this from the numerous discussions and engagements, it was very much about trying to make a piece of work that was neither an explicit image nor a diagram but something in between. Then as an extension of that the scientist that I was working particularly with came into Leeds College of Art and gave a paper on the current research he was engaged with to a number of students and also talked to them about their work. So it was very much about a real understanding of knowledge and a real engagement. We are hopefully looking at a student competition to take back into Jimmy's again to make the connection that we have started to build. It would be great.

Jenni Danson I just wanted to go back to the 'I can't do maths' bit. I'm a practicing artist with an original degree in maths, I taught A level maths..... and I can feel that you all looking round to see who this person is. There has been

no mention of mathematics all day and it's interesting I think to examine what we mean by science. There has been a lot of medical science, a lot of microscope type science and the only person who has a mathematical element in their work is you Dennis. I think that mathematics fits within the science part of arts and science and we all shy away from it.

Alison Andrews Why do you think that is then?

Jenni Danson Because I looked at what was on in the Hybrid exhibition and I listen to what other people say that they are working on and a lot of it is directly visual so that even if you do not understand the science you can see something.

Alison Andrews Interestinginteresting point.

Christa Askew I just wanted to add to that I'm an art student in Bradford. My work is based on astral physics stuff like that but maths plays such an important role nowadays. I think that maths is an interesting language of science of all kinds of science as well. I think that there is great scope for exploring that language, the rhythm of it, the aesthetics of it. The equations ...even the history of maths could be a very interesting topic. A very interesting topic, I am with you on that one.... it seems that there is a great lack and unfortunately we have not thought about that. What I'm trying to say is that science at a very high level is all about theory not so much about experience nowadays, we have moved on from that. Current high level science is all about involving the imagination involving the 'if that happens what would happen then?'and I think that's a very new territory and a very exciting territory to explore as an artist it's a very interesting area to explore. If anybody in maths can help me with exploring that territory.....please get in touch

Anonymous comment Obviously mathematics is very important in art. One of the speakers mentioned perspective or think of op art Bridget Riley would be nowhere without a few calculations. Equally I think that art is very important in science. Science in a way is an art of making sense of the world and the observations you make of it to a large extent. I remember one of my lecturers when I was an undergraduate 'truth is beauty and beauty truth' Who said that?

Numerous replies Keats

Anonymous comment Meaning that if you have a number of possible theories you choose the most beautiful one, the most aesthetically pleasing providing that the experimental results fit. The really elegant thing is to find the one predictive experiment that will prove or disprove your theory, and if that is not art I do not know what it is.

Siân Ede Yes but beauty and elegance is never used in art. That's the very first thing that struck me when I got involved in science was I thought god the beauty, beauty they talk about it all the time, in the arts they are talking about sadness and death, excitement and

Den Tuckerman You are missing the intellectual snobbery then this is what I am trying to talk about ... however educated people are they will admit to being lacking in arithmetic/maths... dirty. Now I went to a boy's grammar school where at the age of 14 I had to go into Modern or Science and I went into science. So I dropped things like languages, well I did languages to O level, but not after that ...so I don't sit there and say because I did not do a degree in say English literature I do not say that I cannot spell, I cannot put sentences together. That's a huge problem, the way that people perceive science I think.

Siân Ede Absolutely

Alison Andrews That's why I think that a group like this Hybrid project is so important because it's a forum in which we can speak quite freely about these things...challenge each other put people on the spot about mathematics,

and so on and so forth. And also have access to people who within institutions are really doing very exciting things to push those boundaries.

Myra Cheng I wondered what you thought that performance might have to offer in terms of exploring art and science that the other kinds of art form may not have.

Mike Vanden Heuval Well I don't think of it offering anything unique that the other art forms don't offer. It may emphasise some qualities more so than others, and I think central to any act of theatre is play. Exploration in the sense that you are willing to engage with and traverse liminal spaces where nothing solid can be known, nothing certain can be ascertained, and you are willing to manipulate that liminal reality into something interesting. I think to some degree that all arts do that, it's just that in theatre you literally construct spaces in which you can play, and these are called rehearsal spaces and that sort of thing. So I think that the forms of theatre that I ended by speaking about tend to allow more of that capacity of play on the part of the audience as well as the artists. And I think conventional drama, the stuff that precedes the post dramatic, although that is not a term that I use often, it's convenient in this context but I think that it comes with some baggage. Is that when you have a play that is completely written out by a single author, and the company has been disciplined to perform it in a certain way so that it conveys the utmost in terms of its ideas emotion and so on. That the element of play goes out of the experience, you have other responses that are interesting, but it is not the same as feeling that you are making it up as you go because it seems that it has already been predetermined by the author and production team. So the forms that I was talking about at the end I think allow for a bit more of that.

Anonymous comment A quick comment comes to mind Schiller and play that is based on knowledge.

Mike Vanden Heuval Yes in early manifestations of performance theory, which was a discipline that very actively tried to resist incorporation into literature and drama and even theatre, Schiller was evoked very often in that notion that play is something that is essential to being a human being.

Alison Andrews OK now the essence of good facilitation is to finish on time. We do have a couple of more minutes though if anyone out there is thinking ...pshaw wish I had said that....you are not off the hook yet. Is there anything that someone?yes, hurrah.

Christine Allmark I teach communication skills at University of Leeds Medical School. I'm from a background as a teacher I also work with doctors providing quality of life research for cancer patients as I have had cancer myself. What I would like to say is it strikes me that the apparent antipathy between art and science art and maths is all a matter of communication, language. It is about finding a common language, if you like a common discourse, between two different disciplines that actually should overlap. Performance is one way of doing this, you are acting out something you are performing it, music the actual sounds is another, many artists and scientists are musical so share many common areas of experience and communication. And of course art is about visual expression in whatever format. So there are many areas of common interest and expression hopefully projects like this are part of that, having scientists in art schools and art schools having artists in medical schools. We know that science is interesting we only have to see the viewing figures of the Royal Institution Lectures at Christmas, which involve children and scientists who are excellent communicators and teachers who use many visual exercises to underscore and underpin the lessons that they are giving to children. So I think that there is a lot of work to do on areas of joint communication..yes?

Alison Andrews Communication absolutely I think that that is a really good word to finish on. I'm going to end this part before handing over to Lizz to finish. Just to thank you very much from the Arts Council, my colleague Kelly over here. The two of us are actually just about to leave the Arts Council so this is in a way our last public hurrah before going on to do other things, and it has been an absolute joy to work with Paul and with Lizz and it's an absolute

honour to welcome you all here to Yorkshire. So thank you for a fantastic day and I really hope that we can keep this together and I would like to join from the other side. So Lizz....

Lizz Tuckerman OK right I'm going to make this really quick because I have been told that I have to. I have had a request to begin with can the speakers email addresses be made available to the networking list? It's OK that right...yes....and I'd like to thank the speakers it's been excellent I'm really pleased that you came so thank you very much .. and I'd like to thank the helpers...are they here? They are helping. And I'd like to thank all of you for turning up you have been splendid...a really great audience. And I'd like to thank Alison and Kelly, because actually this is really Alison's baby, you have been dying to do this for ages really so it's brilliant that it has been done before you go, shame you are going really my contact at the Arts Council gone!

End of meeting. Discussion was continued at 'The Wardrobe' Leeds.