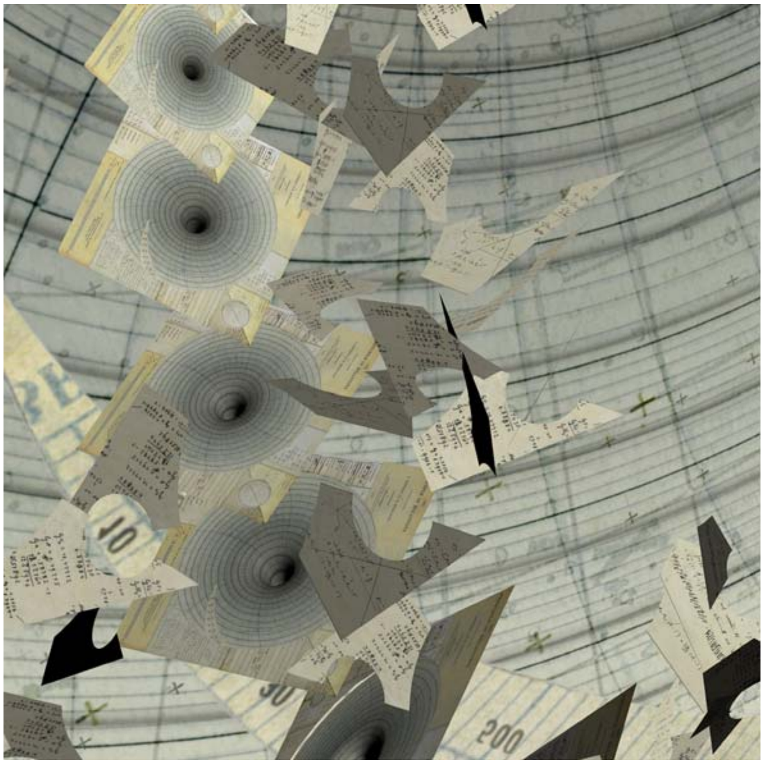

Broken Symmetries:

tensions and connections between art and science

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0. Introduction

0.1 Art and science

In respect to the nature and development of scientific knowledge and issues of abstraction and irrationality in science, there is evidence that the fundamental forms of inspiration and origins of methodology are common to both scientific and artistic research. Also, the results of artistic practice, although far more culturally specific and subjective, are arguably complementary to those of scientific research. What are then the methods used and results obtained when one makes art *about* scientific theories, using technologies derived from the results of scientific research? Furthermore, how does this 'art about science' affect our understanding of the relationship between art and science? These are some of the issues and ideas which I explored in my MA research project works between 2000 and 2005, and which I discuss in this exegesis. Through my research, I constructed a series of works which focused increasingly upon theories in physics and mathematics not only in an attempt to understand and communicate the theories to a wider audience, but also to communicate the historical and philosophical frameworks such theories were based upon. Through this I developed a working methodology which took inspiration from, but also subverted and critiqued the scientific theories and methodologies I was examining. The digital media tools I used, such as video, audio and programmed interactivity, opened up a line of communication between the disparate fields of artistic and scientific inquiry. The result was a series of interactive digital media and installation art pieces that explored various aspects of science, which were exhibited in both art and science spaces, and drew a wide range of responses from the scientific and general community.

1. Exegesis

1.1 The changing nature of empirical science

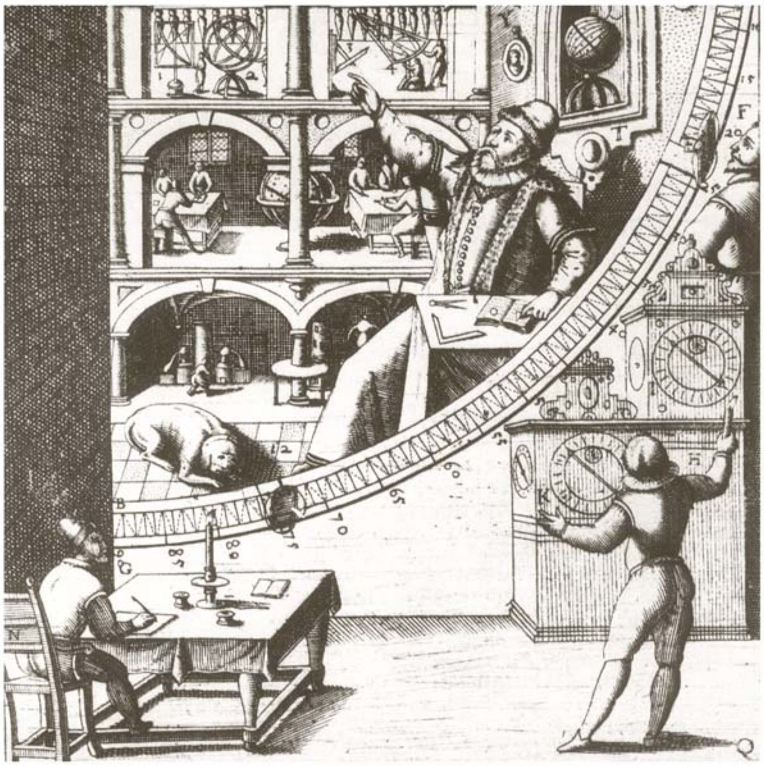


Figure 1. Jan Blaen, 'Tycho Brahe in His Observatory', 16th century, reproduced in H. Robin, *The Scientific Image: From Cave to Computer*, Harry N. Abrahams, 1992, p.81

The tradition of the empirical scientific method of deducing knowledge through observation and controlled experiments began in the 'Era of Enlightenment' of 17th and 18th century Europe, when scientists such as Isaac Newton and Galileo Galilei established simple, formalized laws which could account for a wide range of physical phenomena. Influential figures in the Enlightenment, such as Francis Bacon and John Locke initiated the doctrine of empirical scientific methodologies in the sixteenth century, although the roots of this tradition, based upon philosophical principles of logic, go back to Aristotle and Plato in the 3rd century B.C. During the Enlightenment, scientists sought to gain knowledge from the natural world through observation, experimentation, and testing of hypotheses. In doing so, they sought to reduce all physical phenomena to a series of logical laws and principles, which could thus be understood and ultimately exploited by humanity. This traditional or 'realist' view of science can be defined by four main factors:

> (i) 'Theoretical terms' in scientific theories (i.e. nonobservational terms) should be thought of as putatively referring expressions.
> (ii) Scientific theories, interpreted realistically, are confirmable *and in fact often confirmed* as approximately true by ordinary scientific evidence interpreted in accordance with ordinary methodological standards.
> (iii) The historical progress of mature science is largely a matter of successively more accurate approximations to the truth about both observable and unobservable phenomena.
> (iv) The reality which scientific theories describe is largely independent of our thoughts or theoretical comments.[1]

However, by the 20th century, such a 'realist' doctrine of the scientific process was being criticized by philosophers and scientists. The traditional empiricist doctrine formulates that "factual knowledge must always be ground in experiences"[2]. This works when theories are made from direct observation, yet however, with increases in the use of technology to assist observation of phenomena which exist outside of direct human perception, such a distinction between observable and theoretical entities is not clear. For example, if scientists can confirm theories of electrons, they may be able to employ such theories to design instruments which can detect electrons, and thus prove the theory on which the ‘theory-testing’ instruments were built. Even though the interpretation and conclusions in relation to what has been observed may be sound in relation to a specific theory, the considerations or the logic runs the risk of being ultimately circular, since theory must be built upon other scientific laws that are themselves not absolute. This philosophical bind began to bring into doubt the traditional conception of the objectivity of the empirical method.

In 1934, the influential physicist and philosopher Sir Karl Popper questioned the apparent “simplicity of the world as revealed in the laws of physics”[3]. He describes such 'laws of nature' as being simple as they are human creations: “our inventions; our arbitrary decisions and conventions”[4]. Popper goes on to say:

> "theoretical natural science is not a picture of nature but merely a logical construction. It is not the properties of the world which determine this construction; on the contrary it is this construction which determines the properties of an artificial world: a world of concepts implicitly defined by the natural laws we have chosen. It is only *this* world of which science speaks."[5]

'Conventionalist' scientists such as Popper realized that the actions and operations used in conducting and interpreting scientific experiments are done in accordance with the conventions of deductive reasoning. This basically means that scientific hypotheses being developed and tested by scientists exist within a peer-accepted theoretical and operational framework, or paradigm. Theories must be tested against observable or measurable phenomena to be verified, but problems emerge when a theory or definition can be changed *ad-hoc* in a variety of ways to explain phenomena that it does not comply with. The nineteenth century Scottish physicist and chemist, Joseph Black, wrote: "A nice adaptation of conditions will make almost any hypothesis agree with the phenomena. This will please the imagination but does not advance our knowledge”[6]. Thus Popper introduced the now standard scientific practice of 'empirical falsifiability'. An 'empirical' system is one which can be shown to be false and refuted by other hypotheses and / or experiments:

> "We say that a theory is falsified only if we have accepted basic statements which contradict it...[but]... a few basic statements contradicting a theory will hardly induce us to reject it as falsified. We shall take it as falsified only if we discover a *reproducible effect* which refutes the theory...[and thus another] empirical hypothesis which

describes such an effect is proposed and corroborated."[7]

According to Popper, scientific discoveries are born from processes of stimulation and release of inspiration, which itself is not a scientific or logical process. Popper says that every discovery contains "an irrational element or a creative intuition"[8]. But then the scientist "critically judges, alters, or rejects" this inspiration"[9]. From this process, a new idea or hypotheses may be born, from which conclusions may be drawn by means of logical deduction, which is however not yet justified. This system of conclusions is tested in several ways. Firstly by logical comparison, by which the internal consistency of the system is tested; secondly, the form of the theory is examined to see if it is empirical or scientific (as opposed to tautological or metaphysical forms); thirdly, the system is compared with other scientific theories to see whether it constitutes an advance or development of science; and finally, the system is tested by way of empirical applications of the conclusions which can be derived from it.[10] The final test finds out how far the consequences of the new theory reach in a practical sense, whether in the form of scientific experiments or technological applications. Predictions may be made by a new theory, which are not derivable from a previous theory, or which contradict previous theories and these may be then tested by experiments. If the predictions are verified, then the theory has passed its test; alternately, if the predictions are found to be wrong, the conclusions and thus the theory is falsified and may be discarded. However, says Popper:

> "… a positive decision can only temporarily support the theory, for subsequent negative decisions may always overthrow it. So long as a theory withstands detailed and severe tests and is not superseded by another theory in the course of scientific progress... it is '*corroborated*' by past experience."[11]

Popper also states that he "never assume[s] that by force of 'verified' conclusions, theories can be established as 'true' or even as merely 'probable'"[12]. This has far reaching implications for the epistemology of science. It does away with the traditional empirical concept of objective ‘proof’, and also puts it into a cultural and historical context.

1.2 Empiricism and irrationalism

The physicists David Peat and David Bohm, the latter a key figure in the development of quantum mechanics, laud the fundamental importance of mental 'play' in connecting seemingly disparate phenomena or ideas in scientific research. They describe the state of mind in developing new ideas in science as being a “poetic equating of very different things [in which there is] a kind of tension or vibration in the mind, a high state of energy”[13].This 'creative perception' allows scientists to see connections between phenomena which appear unrelated, and break away from habitual and commonly accepted ways of seeing and thinking. This is the 'irrational element' that Popper describes. This element also points to a central paradox in the nature of science - a scientist must be highly skilled in the conventions of theory and practice of the field they work in, but must at the same time be able to work and think outside of such conventions. The physicist turned philosopher Thomas Kuhn describes this duality succinctly, saying "Very often the successful scientist must simultaneously display the characteristics of the traditionalist and the iconoclast"[14]. In regards to the tension between tradition and change in science, Kuhn questions how the mature schools of science which have

> "a firm orientation towards an apparently unique tradition can be compatible with the practice of the disciplines most noted for the persistent production of novel ideas and techniques."[15]

The revolutionary 20th century physicist Albert Einstein explains that, in the “search for universal laws... there is no logical path... They can only be reached by intuition, based upon something like an *Einfuhlung* [an intellectual love or sympathetic understanding] of the objects of experience”[16]. Einstein argued against the scientist being "restricted in the construction of his conceptual world by the adherence to an epistemological system"[17]. The physicist turned anarchist Paul Feyerabend went so far as to question the epistemological framework that dictates what scientific knowledge can be:

> "The nature of scientific 'facts' are experienced as being independent of opinion, belief and cultural background. It is thus possible to create a tradition held together by strict rules, and that is also successful to some extent. But is it desirable to support such a tradition to the exclusion of everything else? Should we transfer to it the sole rights for dealing in knowledge, so that any result that has been obtained by other methods is at once ruled out of court?"[18]

In regards to the pursuit of knowledge and understanding about the universe, David Bohm (who worked with Einstein) said:

> "I always felt that, in some deeper sense, the really important figures in science and the arts were fundamentally doing the same thing and responding to the same ultimate origin."[19]

Bohm and Peat refute Popper's exclusive emphasis of the falsifiability of scientific theories. They say that the requirement of new theories having to be almost immediately compared with an experiment to see if it can be falsified makes many new ideas rejected as not being properly scientific.

> "Without the possibility of some immediate 'crucial experiment', the theory is looked on as being 'just metaphysics' and without any particular importance for science. The effect of this climate of opinion is to discourage the mind from free play with ideas."[20]

Bohm and Peat instead advocate the sheltering of fundamental ideas for a while "in the spirit of free creative play", and that this is an "essential phase in the creative action of science." From such free play "the mind enters a very perceptive state of great energy and passion, in which some of the excessively rigid aspects of the tacit infrastructure are bypassed or dissolved"[21].

Bohm and Peat describe the results of such processes as being equivalent to abstraction in the visual arts, where the overall complexity of nature is reduced down, details can be overlooked and certain over-arching forms are brought out in a work. Citing the philosopher Alfred Korzybski, they go on to say that all human thought processes are of a similar nature in that no thought, description, image, formula, etc can be an absolute representation of all the qualities of something in the external universe. In regards to this issue of the limits of the human mind in describing the world, David Bohm says:

> "All this implies that *every* kind of thought, mathematics included, is an abstraction, which does not and cannot cover the whole of reality. Different kinds of thought and different kinds of abstraction may together give a better reflection of reality. Each is limited in its own way, but together they extend our grasp of reality further than is possible with one way alone."[22]

The processes of creativity in the highly formalized scientific disciplines have deep connections with creative processes in the arts. Although the outcomes are very different, they share fundamental traits. Whereas the scientist is bound to rigourous conventions of logic and empirical proof, the artist is in the position to preserve absurd or irrational forms on the strength of their ability to challenge a position, based upon different forms of convention. Thus an investigation of the tensions that exist between the two disciplines, but also the underlying similarities, may lead to the heart of the creative process in both science and art.

1.3 Paradigms in art and science

Fig. 2A. Wassily Kandinsky, 'Sur Les Pointes', 1928, reproduced in J.L. Ferrier (ed.), *Art of our Century*, Prentice Hall, 1988, p.362

Fig. 2B. Marcel Duchamp, 'Nude Descending a Staircase', 1912, reproduced in ibid, p.139

In a complementary sense to empirical procedures, the early 20th century expressionist painter Wassily Kandinsky sought to formalize his aesthetic processes by reductively codifiying his process of image making, and described his methodology in 'Point and Line to Plane'[23]. Through this he sought to find underlying laws within his works which would reveal inner structures and forms, in a way analogous to how scientists develop theories on formal physical properties, and used various examples from observed nature to support his argument ranging from microscopic to cosmic phenomena, relating his geometrical formulas with evident physical laws based on these observations.[24] Akin to the method of scientific falsifiability, Kandinsky then experimentally 'verified' his hypothesis by creating a large number of abstracted formal paintings and drawings based upon his laws of aesthetic logic to see if the effect was aesthetically reproducible (see Figure 2A). Kandinsky's method could be said to be heuristic, in that he is using his art to measure and record his own response (an internal process) to cultural knowledge. His approach echoes the culture of scientific enquiry in that it calls for an art that corresponds with the human senses in a unified way. His approach is also analogous to the scientific method in that he does not enquire so much into the first principles of experiencing visual or sonic phenomena, as much as build on the 'proof' of culturally established systems such as polyphonic orchestral music being an already defined way of organising sound in a rigorous way.

Using a different methodology to Kandinsky, Marcel Duchamp, an artist of the same era, explored the formal properties of reality in a way inspired by scientific empiricism and advances in technology. His 1912 painting 'Nude Descending a Staircase', inspired by Einstein's theory of relativity and the spacetime chronophotographs of Jules Etienne Marey, was an attempt to reproduce an "expression of time and space through the abstract presentation of motion"[25] (see Figure 2B).

The results of inquiry by Kandinsky are obviously very different to those of scientific research in that there is no direct external or physical effect being measured. It is almost the inverse: the work itself is the physical manifestation or externalized measurement of the artists' formal ideas or hypotheses. The works of Duchamp, although more directly inspired by scientific observation and theory, are still manifestations of his own subjectively interpreted ideas of reality. The principle of empiricism "denies that humans have innate ideas or that anything is knowable without reference to experience"[26]. According to this principle, all forms of human cognition, including artistic ideas, are ultimately derived from the perception and interpretation of an external reality, which arguably makes art practice a form of empiricism. But unlike science, the outcomes are subjectively measured by the artist and the viewers of the works, yet even these perceptions are collectively influenced by the underlying learnt framework of culturally accepted conventions. Such cultural influences on the creation and perception of artworks were dubbed 'schema' by the 20th century art critic Ernest Gombrich. He points out that the "inductivist idea of pure observation has proved a mirage in science no less than in art"[27]. Gombrich states that discoveries in the visual arts match Popper's procedure of falsifiability in science:

> "Our formula of schema and correction, in fact, illustrates this very procedure. You must have a starting point, a standard of comparison, in order to begin the process of making and matching and remaking which finally becomes emboldened in the finished image. The artist cannot start from scratch but he can criticize his forerunners."[28]

Like in the sciences, revolutionary developments in the arts overthrow previous 'schema' or ways of perceiving the world and communicating it to others, and to a large extent are deemed successful or not depending on whether they change and thus become part of the tacit cultural framework. Such revolutions in the arts fundamentally affect the cultural view of art and ultimately the way cultures view and communicate about reality.

A major point of difference between art and science is in the value placed upon change and history. In the arts, innovation is a universally expected factor, the new is always either sought after or recognized, especially during periods of social and cultural upheaval, yet previous art movements are still held in high esteem and are seen as fundamental knowledge in art education, not least because art students must come to grips with their participation in this process of change. Conversely, within the arena of scientific practice, if a theory becomes falsified, it is given lesser importance, if not entirely discarded. Additionally, the history of science is rarely taught to science students at a critical or structural level. Bohm and Peat argue against this, and point out that many ideas in science, which were originally dismissed as irrelevant mathematical curiosities, have reemerged as important systems for dealing with current problems in physics.[29] They point out that Popper's falsifiability methodology is unable to see the metaphorical connections between seemingly disparate ideas which have actually been part of many fundamental revolutions in scientific thought.

Bohm and Peat raise the issue of problems in communication within the increasingly specialized fields of science. Even within the quantum revolution of 20th century physics, there was a breakdown in communication between Einstein's 'relativistic' school of thought and that of the 'indeterministic' quantum theorists, namely Niels Bohr and Werner Heisenberg. Although both sides agreed on the mathematics involved, they were unable to find common ground for defining the terms they used in interpreting the phenomena of the subatomic realm. Even after decades of debate between Einstein and his colleagues, the issues were never resolved because their informal descriptions of the quantum world "implied conflicting notions about the nature of truth and reality and about what is an acceptable type of scientific theory"[30]. This is largely due to the different ways of visualizing the phenomena. Einstein worked from visual models that were subsequently formalized into mathematical formulas, whereas Heisenberg worked on a purely abstract mathematical level to such an extreme that he felt that visual models were in fact "disgusting"[31]. Between these poles, Bohr developed a 'duality' theory from analysis of such detail that he "plumbed the very depths of knowledge to the formation of ideas themselves" and led to the "discovery that visual thinking preceded verbal thinking" From this epistemological realization Bohr argued that visual thinking was the key to "the aesthetic of the symmetry" of his theory. The fate of the physical science ultimately rested on the aesthetics of the individual scientists, not the mathematics.[32]

In contemporary science, these issues still haven't been resolved, and indeed further fragmentation seems to have occurred. Bohm and Peat ascribe this, at least in part, to the "tacit infrastructure of scientific ideas"[33]. Such underlying or unconscious structures inform the way scientists think and work, but due to the changing nature of scientific theory, such infrastructures may become inappropriate or irrelevant. Thomas Kuhn describes these tacit infrastructures as 'paradigms'[34]. According to Kuhn, when members of different schema or paradigms enter into debate about choosing a common theoretical framework for a given field, "their role is necessarily circular. Each group uses its own paradigm to argue in that paradigm's defense"[35]. Kuhn argues that there exists a high degree of incommeasurability between competing paradigms, which aids in the fragmentation of scientific thought. Furthermore, fragmentation of understanding and communication between the scientific and artistic disciplines has created an even greater gulf between the two ways of describing the world. It can be argued that communication breakdowns are becoming so common in an increasingly fragmented contemporary society, to a level of near-Babel proportions. The philosopher and scientist Jurgen Habermas described contemporary global culture as being so complex it has reached a state of total unsurveyability, or '*neue Unubersichlichkeit'*. This inspired 'Polyarticulate', a collaborative art project I worked on in 2002 that gave form to the breakdown in communications by creating a lexical, aural and visual language that had no meaning (see Appendix 1.2).

2. Projects

2.1 Methods of intuitive inquiry

In comparison to the formal methods of reasoning employed by scientists and artists such as Kandinsky, my creative inquiries were directed at the processes of scientific inquiry and its technological outcomes, using a methodology of intuitive 'non-rational empiricism'. These can be described using the analogy of the processes of developing new scientific hypotheses explained above.

My method of creative inquiry seems to start in similar territories to those of the scientific researcher. Some phenomenon or idea, be it something I see or hear or read, will arouse my curiosity to an extent that prompts certain thoughts and images to keep reappearing in my mind. A process may begin in which such thoughts change and develop through various conscious and unconscious processes. These intangible processes are often indescribable, as they exist in a non-verbalized state. They may repeatedly return to consciousness for reflection and analysis, and association with other thoughts. Often this process of analysis is non-rational, however, I can sometimes intuitively see an internal logic which I will seek to clarify and expand to encompass similar thoughts. This is similar to the process of developing a new hypothesis in science, but is not explicitly bound by the laws of logic or other formalized systems. However, it too may be constrained by other external schema derived from the traditions of art practice, aesthetic laws, and current trends and theories in art and culture. Another major constraint and shaping force is that of the practicalities involved in the actual construction or material manifestation of the idea, even before anything physical is constructed. This is analogous to the practicalities involved in designing effective experiments to test new theories, which can affect the formation of the theories themselves.

An idea may emerge after days or months of semi-conscious contemplation, an activity that is hard to explicitly direct and cannot be forced. When it is ready, it will appear, sometimes in a flash of inspiration. An example of this process is my interactive artwork entitled 'HyperCollider', which will be covered in depth later, that appeared to me in an instant when I awoke one morning. I sketched down an illustration of what I 'saw' in my mind and subsequently spent months bringing this 'vision' into material existence (see Figure 3). Often I will have a number of similar ideas in my mind at a time, which I will reduce to one by a variety of means. This may include visually clarifying the variations by scribbling down notes and/or sketching the ideas and associations in order to focus them more. I will examine the common conceptual threads of each idea as a way to try to understand the underlying forms and internal logic of the ideas as a particular set. This is a type of reductive analysis - once the implicit idea becomes clearer, I will concentrate on the variation which conveys this idea the most concisely. I may integrate visual and / or conceptual elements of the other ideas into it. This process is sometimes easy, sometimes exhilarating, but can often be quite a mental struggle, akin to trying to put together a jigsaw puzzle where a myriad selection of possible pieces are still forming![36]

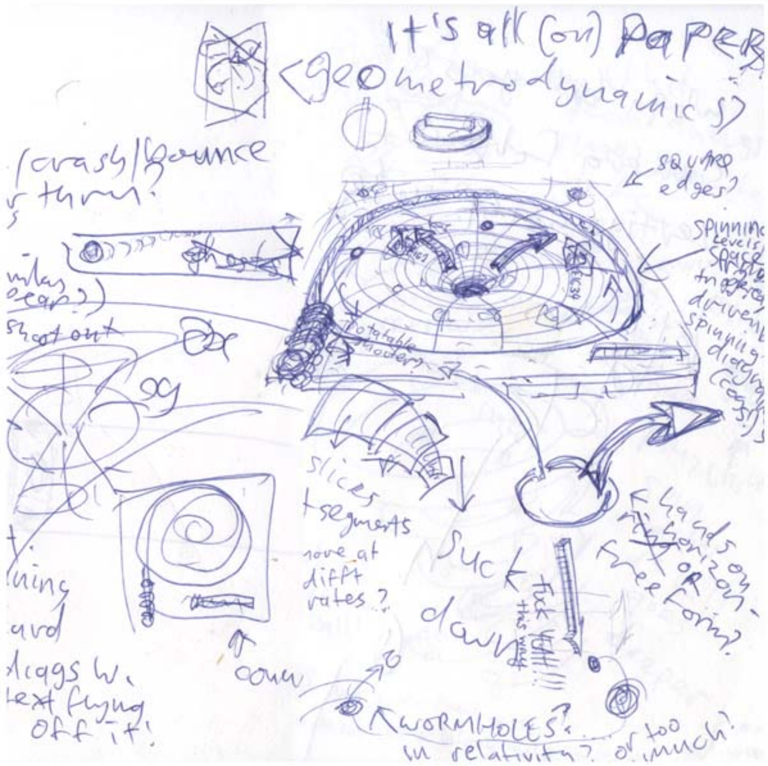


Fig. 3 initial sketch of ideas for 'HyperCollider', February 2004

2.2 Production practicalities, constraints and limits

This creative production process is analogous to the steps taken in the development of a new scientific idea - there is the comparison of the internal consistency of the theory, the examination of the form of the theory, and the comparison with other theories to see if it develops the area of science it relates to. The 'conventionalist' interpretation of scientific development could be equated with that of many art works and styles - both develop an internal self-referential logic acknowledged by a group and structure (Kandinsky and Duchamp were, for example, both building on the representational systems established by the cubism art movement). Like scientific paradigms, such art movements are social constructions, ultimately derived from observation and interaction with the external world. In a similar way to the final test of a scientific theory by experimental application and critical review in the physical world, the creative idea must be brought into the 'physical' world by production / construction, to see whether it actually 'works' in practice (if it even can). Some ideas sound good, and may even look good on paper, but when they are made, they just don't work because:

* They just don't work! Something might seem good in an unrealized mental form, but when they are materialized they lack something fundamental that only becomes apparent after an attempt is made to realize them in material form.
* They don't make any sense to anybody else – perhaps they are untranslatable into the general cultural language or schema, and are not strong or clear enough to form a ‘paradigm-shift’ in other people.
* They are basically impossible to materialize in a way that is practicable whilst still conveying the essence or form of the idea.

These three points are where a certain amount of critical pragmatism is necessary in the production of artworks. This pragmatic analysis of the production processes is another link with the pragmatic nature of empirical science in designing experiments that can test a theory. However, the artist is not bound by the laws and methodologies that provide the framework for empirical science (although they are bound to varying degrees to the cultural schema).

The material nature of traditional art production is sometimes transparent, such as the hyperrealist paintings of Richard Estes, which look like photographs. Yet other artists have chosen to explore these very limits of the physical nature of art making processes - Jackson Pollock's 'Blue Poles' (1953) being a perfect example of a work that brings out the fundamental nature and essence of its medium, breaking down the distinction between the composition and what it is (literally) composed of, the concept and the object and space (see Figure 4).

Fig. 4. Jackson Pollock, 'Blue Poles', 1953, reproduced in I.F. Walther, *Art of the 20th Century*, Benedikt Taschen Verlag, 2000, p. 274

In digital art practice, the limits are very different, at least at the 'making' stage. Material and physical factors are largely replaced by the limitations placed on production by issues of coding, computability, data storage and processing speed. There are also the possibilities and constraints imposed by the software used in the development of ideas. Often these factors will affect the ideas before the computer technologies are even used. The albeit necessary prior knowledge of the various software packages which may be used can unconsciously affect the creative process itself, far removed from those affecting traditional art practice. Such psychological-technological structures can serve both as a practical guide to the necessary technological constraints to work within and an awareness of the production steps which need to be taken, but can also negatively impact upon the development of ideas as to what can be achieved within the constraints of the available technologies. In its extreme form, this can limit the creative mental processes to that of 'select program A and B; use data filters 1, 2 and 3' and so on. This can be seen as a formalization of creative processes, a tacit 'psycho-techno' language if you will. Underlying the constraints of software applications are the restrictions that exist within the algorithmic parameters of the programming, the mathematical and logical limits of the processing and operating systems of the computers, and ultimately the behavior and nature of the electrons which make the computers work. Such fundamental issues are examined in depth in section 3. Then there are the limits in the 'output' chain as well; modes of displaying the visual and sound components, types of interfaces and methods of interactivity for the viewers or audience, even the nature and type of exhibition spaces the final works will be shown in.

Additional to these production-affecting factors, there exists the whole framework of tacitly understood and accepted conventions or schema employed in the creation of artworks. These constraints upon the creative mind are similar to the constraints of working within a given scientific paradigm, and are in essence like that of the difficulties of working within a strongly defined scientific discipline. Like the scientist who must become tacitly familiar with the laws and theoretical framework of the discipline they work within, but must break such laws to make major advances, the artist must become aware of the constraints within their discipline. Digitally mediated art practice has both cultural-historic limitations of schema and is additionally limited by the parameters of the computer software and hardware. Yet as well as limiting some aspects of the creative processes, technology allows artists to do things they had not previously thought of, as well as that which is impossible to do using traditional art media such as paint and canvas. This can lead into interesting areas of creative 'feedback' when the artist uses such technologies to creatively examine the technology itself.

2.3 Noise vs. information

The cultural theorist Katherine Hayles proposed the breaking down of culturally imposed structuralist dichotomies such as pattern versus randomness and information versus noise.[37] David Bohm and David Peat describe events which appear random or meaningless as being of subtle orders of high degree which may not be immediately perceived by the observer. They apply this to language, mathematics and even music, which may "be judged as 'meaningless' or 'offensive' by a listener who does not have the adequate context from which to perceive the whole order of the music and who attempts to understand its meaning in terms of an earlier and outmoded context"[38]. Bohm and Peat use this as a metaphor for scientific research, where the infrastructure of ideas, knowledge and skills needs to be flexible enough to allow "the creative perception of new orders". In the digital domain, the difference between meaningful information and random noise is dependent on the encoding and decoding. One of the fathers of information technology, Claude Shannon, developed the idea of information entropy as a measure for the uncertainty in a message and basically invented the main form of information theory upon which computer technology is based. Shannon developed the theory of information entropy as a measure for the uncertainty in a message, $S = k \log |M|$ (where S is the unit of entropy, measured in 'joule per kelvin', k is Boltzman's constant and |M| is the number of elements of the set of the message space M) and found it to be very similar to the second law of thermodynamics, the formula for entropy, '$S = k \log W$' (where W is the number of microstates). Incidentally, the physicist and novelist Charles Percy Snow remarked that not knowing the second law of thermodynamics is like never having read Shakespeare![39] Shannon's theory created a fundamental link between order and randomness in information with thermodynamics, statistical mechanics and even quantum physics. This "intimate connection between the concepts of entropy and information" led the chemist Martin Goldstein to declare that "Noise is the only music the Universe provides"[40].

I developed an interactive installation, 'Corroded Grooves', that explored the tensions and possibilities created by the relationships between order and noise in the realms of the micro and macroscopic, the analogue and the digital worlds. This was first exhibited at the ‘Sonic Residues’ exhibition and festival at the Australian Centre for Contemporary Art in November 2000 (see Figure 5, and Appendix 1.1 for production and exhibition details).An experimental audio interactive art work that combined electronic and analogue sounds, digital and physical visual forms, rhythm and noise, patterns and textures, was devised to present a formal space where such apparent oppositions and boundaries blurred, forming unstable hybrids. The installation consisted of a computer, monitor, a mixing desk and two antique phono turntables which were reengineered to play a variety of materials including rusty metal discs, sheets of sandpaper, old clock faces, burned out clutch plates, etc - anything of a disc-like nature which served as an uneasy metaphor for a vinyl record. As well as breaking down the structural distinctions between music and noise, the installation also blurred the roles of composer (of the original music samples), performer, audience member and computer (who all recomposed the sound). There is also an implied play on the pop-culture hype that surrounded DJ culture at that time, which can itself be seen as a celebration of the mastery of the DJ over (musical) data and (audio) technology.

Fig. 5. 'Corroded Grooves', 2000

2.4 Scraping art and science

Fig. 6. ‘X-ray box and resistometer’, 2001

The 'Scrape' exhibition, held at the RMIT First Site gallery in October 2001, was my first chance to bring together some of these ideas in project form. This was also my first solo exhibition. The show was loosely grouped around the categories of 'past', 'present' and 'future' - each time period relating to one of the three gallery areas (see ‘Scrape exhibition’ on the Documentation DVD).

Fig. 7. ‘Past zone (the Magician’s Den)’, *Scrape* exhibition, 2001

The 'past' room contained a series of devices relating to pre-digital technologies. Some of the devices I gutted and reconditioned to simulate their original functions. The 'artefacts of obsolete electrical technologies' which were used included a resistometer, electrical demand meters, a ampere meter, a pressure gauge, a signal lamp, an x-ray light box, 10,000 volt Jacob's ladders and a bakelite AM radiogram (see Figures 6 and 7, and Appendix 1.3 for details). Such items are arguably the discarded and forgotten forebears of current digital technologies. Through functional and aesthetic appropriation and reuse, these antique technological items put contemporary technologies (including the ones I used) into a generally overlooked techno-historical context. The installation endeavored to connect and make lateral and ironic connections between the era of 'electrical revolution' of the late 19th century and the current revolution in digital technology. The space was inspired by the theories and practices of the 'electric sorceror' Nikola Tesla, and was an attempt to recall and reinvent his 'magician's den' laboratory, as described in this eyewitness report:

> "The laboratory… bathed in impenetrable gloom [by] heavy black curtains… was literally filled with curious mechanical appliances of every description… snakelike cables ran along the walls, ceiling and floor… in the centre was a table covered with thick strips of black woolen cloth… large brownish globes were suspended from the ceiling… As we awaited developments… exquisitely beautiful luminous signs and devices… began to flash about… the entire room filled with electric vibrations… what impressed us most of all was the simple but cheerful fact that we remained unscathed while electrical bombardments were taking place on every side."[41]

The interactive objects were constructed with buttons on their front faces that had to be pressed for the pieces within the installation to become operational. There were deliberately no arrows pointing to the buttons or signs saying 'press here', as I wished to let people discover the interactivity for themselves - if they physically engaged the works, their curiosity would be rewarded, if not, they missed out. Installed alongside these devices were other pieces of old electrical equipment, which the audience was implicitly encouraged to play with.

Fig. 8. 'Contemporary zone' *Scrape* exhibition, 2001

Gallery 1 contained a selection of prints, and the 'Corroded Grooves' sound installation (see Figure 8). The prints were ten diptychs of photographs taken in Australia, Thailand, India and France between 1996 and 2000, documenting my examination of (and possibly obsession with) tonal, textural and entropic visual qualities.[42] The 'Corroded Grooves' installation acoustically reflected the tonal and textural qualities of the photographic prints, giving a synaesthetic feel to the space.

Fig. 9. 'Future zone', *Scrape* exhibition, 2001

The works in Gallery 3 were the most related to contemporary scientific concepts and thus could be seen as being 'futuristic', featuring lightbox images and projected animated sequences (see Figure 9). The works shown in the light boxes on the northern wall were 'Birth of a Virus', 'Untitled collage (strain 2)', 'Untitled collage (strain 3)' and 'Virusspace', inspired by the 'neomutationism' theory of genetics, where genes evolve according to the laws of hydrodynamics. These works were the starting point for a visual vocabulary I was to use for my other projects. They were also the first art pieces directly inspired by scientific theory and represented four attempts to visualize worlds out of the domain of direct human perception, which I would expand upon in my later interactive pieces. The aesthetic developments I made in these works provided a personal 'quantum leap' in the development of a visual language of abstracted forms and my methods of visualising such ideas. I developed this language and methodology through most of my other works during the Masters Research Project period, although this was not a consciously made decision. See Figures 10 and 11, and Appendix 1.3 for a description of the works and concepts explored.

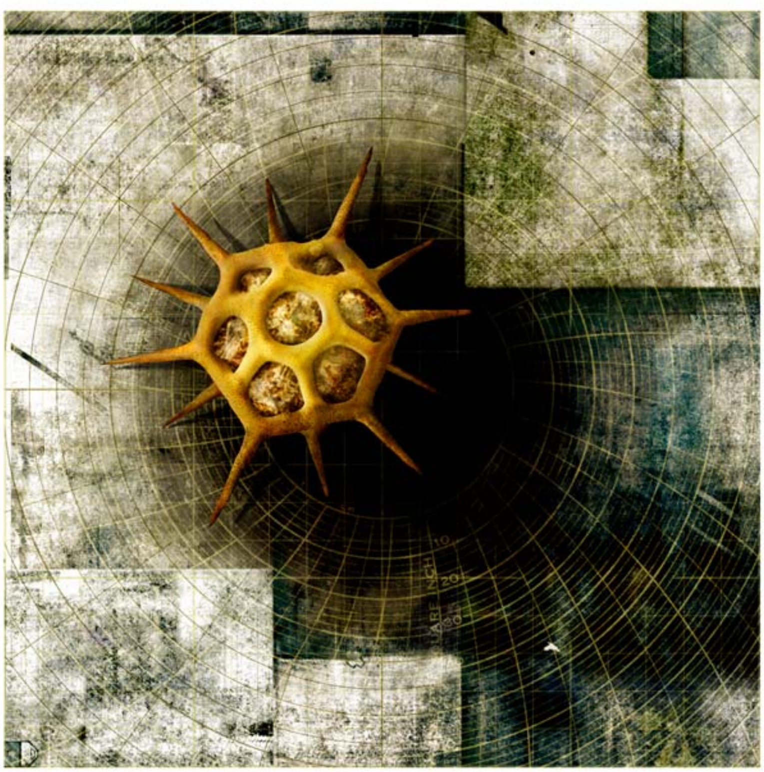


Fig. 10. 'Birth of a Virus', 2000

On the facing wall were works relating to my previous and current practice. 'Infoflotsam' was created from fragments of rusty machinery (taken from my first major interactive work, 'Orchestra of Rust', in 1998) falling through a vertiginous immaterial space. This was an attempt to visually 'deconstruct' my earlier interactive to reveal the immateriality of its digital foundations. The adjoining light-box was also thematically related - called 'Digital Limbo of Obsolete Info', it was my first attempt to visually represent in 3 dimensions the abstract information spaces within the digital 'universe', in particular the forgotten spaces that exist within the hard drives of redundant computers. The final light-box image was titled 'Hyperprism-Antiprism Space'. This was inspired by the mathematical theory of four-dimensional geometry - the concept of 'hypercubes' and other four dimensional polyhedra (of which a hyperprism-antiprism is one) proved to be a fertile topic for my imagination to nurture toward ideas for art works. The image was an attempt to make an intuitive 3 dimensional map of such a space, without trying to be mathematically accurate (especially considering the obsolete 3D modeling software I used didn't have the capabilities). To enhance the sense of depth I added 'entities' that might travel through such a space.[43]

The light-boxes were complemented by a sequence of animations projected onto the far wall, which were developed from the 'Hyperprism-Antiprism Space'. For this, I made a series of digital 3D fly-through animations, which I then re-mapped onto the digital 3D space, creating a 'space within a space'.[44] To enhance the sense of unfolding of the space, and give the gallery an interactive element, I installed a series of laser triggers along the length of the space. So, as one moved deeper into the gallery space, animated loops were successively triggered, which took one deeper into the digital space, until the final animation sequence was triggered, which visually reversed the process and 'spat out' one of the 4 dimensional 'traveling' forms back at the real space. The animations were complemented by a 4 channel 'science fiction' soundtrack created by rock & roll noise guru David Brown, of which the high frequencies and pulsating bass waves were on occasion quite overwhelming and made the room literally vibrate, and were thus perfectly suited to giving the whole space an extra immersivity.

At the near end of the gallery was an interactive work called 'Fracturespace'. This was a screen-based 'self-contained' space, visually defined by topological-forms that one could explore (using a mouse), enhanced by atmospheric sounds from sound artist Darrin Verhagen. Movement was allowed in the horizontal axis in a way that moving left one would eventually 'loop around' the whole space and end up back at the start (akin to traveling around the circumference of a 4 dimensional sphere). In this space were animated diagrammatic 'sprites' that, upon touch (via the mouse), would become dynamically active and make lots of noises (also courtesy of David Brown). Interaction with the sprites would cause gradual changes in the terrain of the space - the more one observed and interacted with the space, the more it changed.[45]

When I was supervising the exhibition, I noticed a wide range of reactions to the interactive works - most people were initially too scared to touch them, until I told them to press the buttons or showed them, then curiosity got the better of them and they tried everything repeatedly (although a few simply refused to touch anything at all, perhaps locked into the ‘don’t touch’ schema of traditional art galleries). Some people spent over half an hour with 'Corroded Grooves' and even created sounds I had no idea how they got out of it, which I found very pleasing. I received some interesting feedback - a few really enjoyed the 'Fracturespace' interactive, saying 'It's totally meaningless - I love it!' A cultural theory lecturer from Monash University said it reminded him of a pinball machine (which perhaps stuck in my mind to reappear later). An article on the show in Beat magazine stated that having seen 'Scrape', the reviewer had since added 'interactivity' to their art vocabulary.[46]

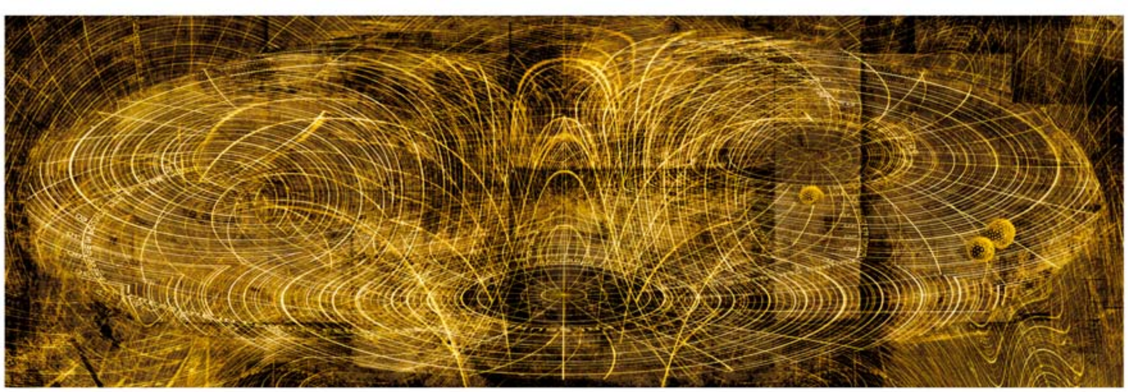


Fig. 11. ‘Virusspace’, 2000

3. Further developments in theory and practice

3.1 Hierarchies of expression

Commencing with the work of such Enlightenment thinkers as Isaac Newton, lexical form, which Kuhn calls "symbolic generalizations", were given to explain observations of nature. Such expressions gave scientists "the powerful techniques of logical and mathematical manipulation" to aid in scientific enterprise.[47] Expressions such as f=ma (where f represents force, m represents mass and a represents acceleration) accurately describe the movement of everyday objects. These reductive forms of explaining the world around us that were established during the Enlightenment, and were increasingly seen as superior to pictorial and other forms of creative expression.

After several centuries of unprecedented visual communication and other artistic processes, contemporary culture still remains largely mired in this rationalist logocentrism, despite its clear reliance on images.[48] Barbara Maria Stafford argues that "cultural bias, convinced of the superiority of written or propositional language… devalues sensory affective and kinetic forms of communication precisely because they often baffle verbal resolution"[49].

The concern in regards to the apparent dissociation between the fields of artistic and scientific inquiry is now evident across the two traditions of scientific and artistic inquiry. Charles Percy Snow brought this issue to light in the early 1960s, when he described a breakdown in communication between the sciences and the humanities. Snow lamented that many scientists had never read such literary classics as the works of Dickens, but that artistic intellectuals were equally ignorant of fundamental scientific principles.[50] According to Snow, this estrangement between artistic and scientific modes of communication has led to a society unable to collectively and constructively deal with many of the issues we now face.

An unwillingness to enter into cross-paradigmatic communication on both sides can still be seen in contemporary society – a recent computer laptop advertising campaign aimed at young cool designer types used the slogan "I don't care how it works". From the scientific front, there still seems much disdain towards art theory, epitomized by the 'Sokal Affair'[51]. The physicist Alan Sokal submitted a hoax paper to a postmodern culture journal, arguing that quantum theory has progressive political implications, to show up the lack of intellectual rigor in the arts. What Sokal himself was evidently ignorant of, is the way in which such seemingly disparate fields as quantum physics and postmodern philosophy can work together on the level of metaphor, providing a key tool in creative thinking in both scientific and artistic practice.

3.2 Fundamental convergences

However, there are signs of convergence in contemporary arts and sciences. Such convergences are largely due to the aforementioned use of electronic technologies made possible through scientific discoveries of the 20th century. This has produced a 'technological revolution' in the methods and results of contemporary art practice. The development of digital art "has been shaped as much by the history of science and technology as by art-historical influences"[52]. Previous revolutions in art have been largely in the way things have been visualized or sonified, yet a large factor of the digital media revolution is in *how* things can now be visualized or sonified, and these processes are ultimately driven by the processes of mathematics and physics.

A survey of media artworks shows many media artists probing the nature of their practice, as mapped out in such surveys as Darren Tofts' *Interzone: Media arts in Australia*.[53] Some artists work with the changing forms of communication, location and presence through the uses of electronic and digital technologies. Others examine the concept-driven and programmatic aspects of art. These themes can be traced back to early digital art forms of the 1960s and 1970s, epitomized in such exhibitions as

‘Scientific Serendipity’ at the Institute of Contemporary Arts in London in 1968.[54] Although the once fringe forms of media art have now entered the mainstream art world, there still seems to be a scarcity of work which explores the mathematical and physical foundations of the media – perhaps this can be attributed to Snow’s aforementioned lack of scientific awareness.

Revolutionary painters such as Jackson Pollock created art that brought to the fore the nature of their materials and tools, namely paint, canvas and paintbrushes. At the fundamental level of the media artists' digital toolkit lies something very different from pigment, cotton and horsehair on wood. Instead there is a microcosmic world of billions of tiny electrical impulses traveling at near light-speeds through a labyrinth of silicon wedges and magnetized polymer coatings on metallic discs. The paths taken by these impulses through the electronic labyrinth are controlled by algorithms and mathematical formulas devised during the twentieth century by mathematicians such as Alan Turing and Claude Shannon, and made possible by the developments in physics led by people such as Richard Feynman and Paul Dirac. Such scientists then could be credited as being ultimately responsible for the technologies that have since been developed which make media art possible. This puts the digital arts in a unique position in the history of art, as never before has art practice been so fundamentally linked to the technological innovations derived from scientific processes and discoveries (although art and science share such relationships throughout history). These factors, as well as my personal interest and background in the physical sciences, inexorably led me to further explore the territories of physics in my art works.

3.3 The quantum universe

The particle physicist Richard Feynman developed the theory of Quantum Electrodynamics (QED) in the 1940s, which is still one of the most accurate theories in the history of science; the theory has been validated by recent experiments to within 1 part per billion. "This accuracy", Feynman wrote, "is equivalent to measuring the distance from Los Angeles to New York... to within the width of a human hair"[55]. The most famous scientific formula is Einstein's "$e = mc^2$", (where e = energy, m = mass, c = speed of light), but another equally important equation is the Fermi - Dirac (F-D) statistics formula, devised in 1926 by Enricho Fermi and Paul Dirac, which describes electron behaviours in metals and led to the development of the transistor.

This formula is:

> $n_i = g_i / (\exp (e_i - \mu) / kT) + 1$
>
> (n_i = number of particles in state i, e_i = energy of state i, g_i = degeneracy of state i (the number of states with energy e_i), μ = chemical potential, k = Boltzmann's constant, T = absolute temperature).

This equation is well known among physicists and electrical engineers, but is generally unknown in the wider community, as opposed to Einstein's mass / energy equation. This is probably due to the 'beautiful' simplicity of $e = mc^2$, not to mention its awesome and terrifying effects (such as the atomic bomb), but on a day-to-day level, the F-D equation has had a far greater effect, as without it there would be no electronics or computers. Interestingly, while Fermi became part of the Manhattan Project team and helped invent the atomic bomb, Dirac's research in subatomic physics led him to the theory of 'quarks', the name of these mysterious particles being taken from the line "three quarks for Muster Mark" in James Joyce's irrational classic 'Finnegans Wake' (which shows Charles Snow that at least some scientists appreciate literature!).

As Snow lamented, many people from the humanities are unable to appreciate the beauty in the simplicity of such formulas as the F-D statistics. To appreciate the poetic qualities inherent in its grandly reductive form also allows one to gain a fundamental insight into physical science. Physicists tend to examine phenomena under tightly controlled conditions on an incredibly localized scale, for example focusing upon interactions between subatomic particles one million millionth of a centimetre in size. Thus they can produce results that are astoundingly precise in relation to the human scale world. Richard Feynman says the theory of QED "describes [almost] all the phenomena of the physical world"[56]. But, Feynman warns that although such theories can in principle explain everything, in practical terms it is impossible to do so:

> "Most phenomena we are familiar with involve such tremendous numbers of electrons that it's hard for our poor minds to follow that complexity...But if we arrange in the laboratory an experiment involving just a few electrons in simple circumstances, then we can calculate what might happen very accurately, and we can measure it very accurately, too."[57]

Using multi-billion dollar particle accelerators, physicists have been able to probe down to the subatomic scale with ultramicroscopic precision, to the scale of 10^{-14} cm, or 0.00000000000001 cm (see Figures 12A and 12B). Yet, perhaps ironically, on this finest scale everything is in a constant state of flux – particles appear and disappear, change into other particles, move forward and backward through time, and annihilate each other in bursts of energy and new particles (see Figure 12C). The fundamental nature of the quantum world is that of randomness and unpredictability, epitomized by Heisenberg's uncertainty principle.[58]

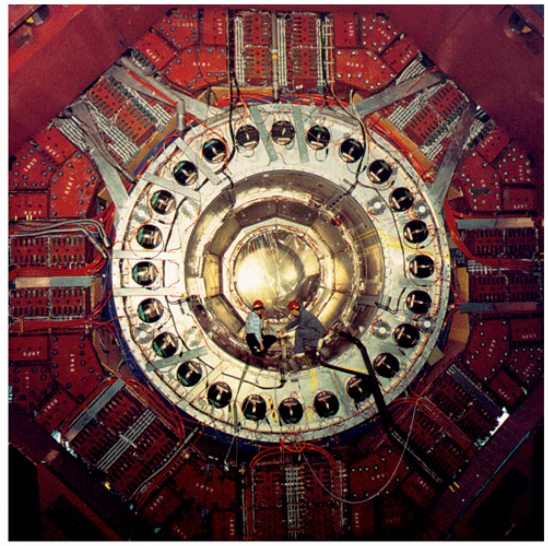
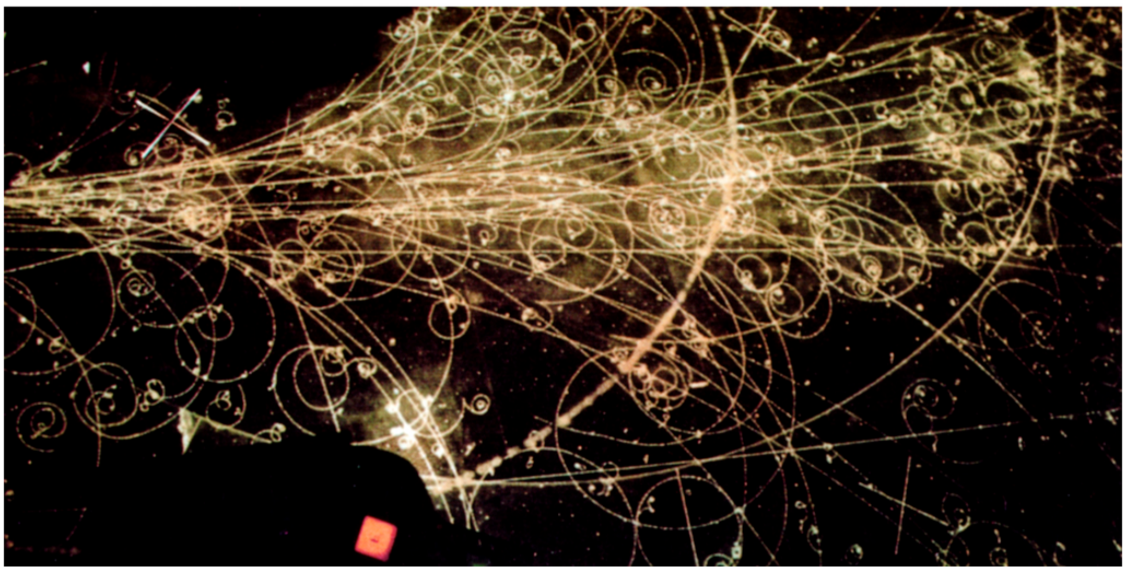




Fig. 12A. Top left, Overview of Fermilab complex

Fig. 12B. Top right, Particle detector, Stanford Linear Accelerator

Fig. 12C. Directly above, Record of Particle tracks in bubble chamber

3.4 Quantum visualizations

The extreme difference in scale between the subatomic and the human worlds make the ultra-microscopic domain become utterly abstract in relation to the everyday social world we live in. This is not to say it does not affect us - it does, and increasingly so through the use of technologies dependant upon on such physics. Aided by digital technology, artists have been able to visualize this invisible world. In 1991 the artist Kenneth Snelson used a Cray supercomputer to create an atom scale landscape, 'Chain Bridge Bodies'. In making such an image, Snelson "challenged the thesis of the founding fathers of quantum theory that no pictorial representation could be devised...of the quantum world of untrackable quarks, interactions among electrons, and mysterious quantum exchanges among particles"[59].

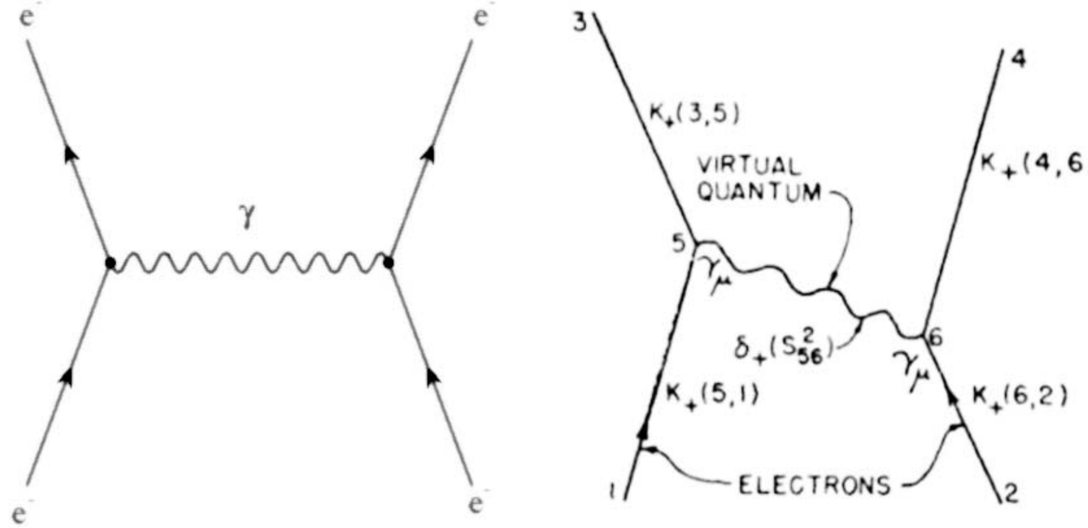


Fig. 13. Feynman diagrams

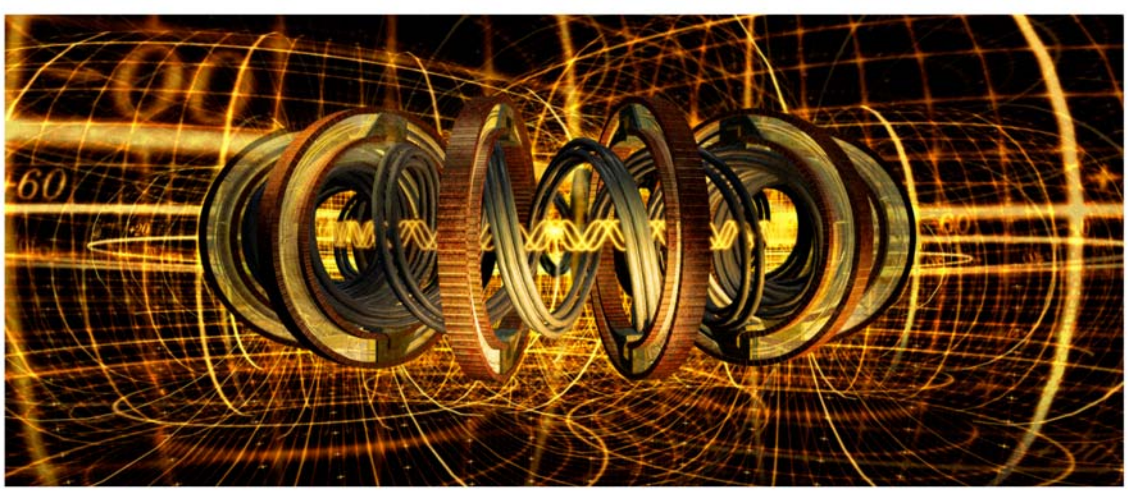


Fig. 14. ‘Feynamn Field & Tesla Coil’, 2002

In my interactive installation 'Feynman Field & Tesla Coil', I used Feynman diagrams to visualize the invisible realm of quantum fields (using a style comparable to that of Snelson, although I was unaware of his work at the time). Invented by Richard Feynman, such diagrams are used for visually performing calculations in quantum field theory (see Figure 13). Even though the mathematical formalism has been experimentally verified to extremely high degrees (as noted above), attempts to describe the actual physical events have been unclear at best.[60] Although they are only meant to be used as a visual aid in calculating hard-to-comprehend particle interactions, I felt that they would be an equally good source as any other diagrammatic representations of subatomic behaviour from which to construct representations of or artistically manifest the apparently unvisualizable subatomic world. The diagrams were mapped three-dimensionally using graphic and textual elements, according to my (uncertain!) understanding of quantum fields and particle interactions.

The 'Feynman Field & Tesla Coil installation' was a combination of 'pseudo-holographic' digital projections of 3D forms, controlled by gestural movement detected by an invisible infra-red beam and distance sensor, complemented by immersive surround sound audio (see Figure 14). I created a sound-based navigation system based on the essence of Heisenberg's uncertainty principle. In devising the installation, I attempted to render visible and audible the invisible quantum world that exists all around us. I interpreted and mapped the features of the quantum fields of electromagnetic energy in a way that their essence and form could be explored by basically anybody, who might even intuitively pick up on aspects of the theory informing the work (see Figure 15). See Appendix 1.4 for an explanation of the project, and the 'Feynman Field & Tesla Coil installation' in the 'Feynman Field & Tesla Coil' section of the Documentation DVD.

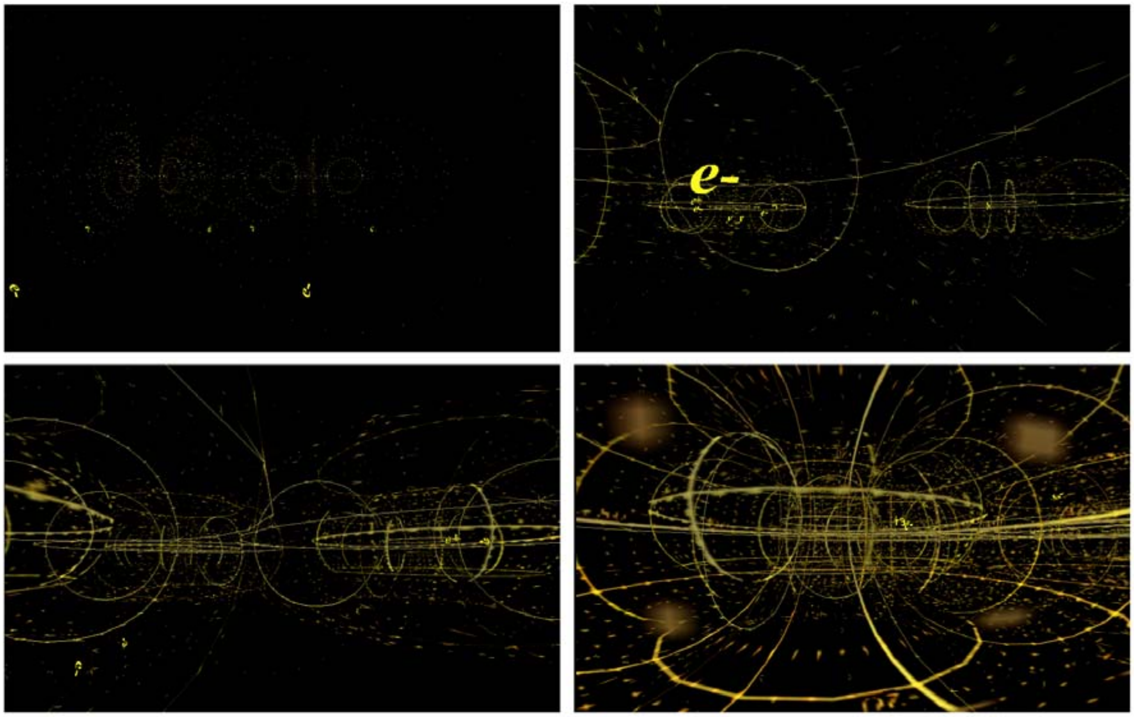


Fig. 15. Sequence from 'Feynamn Field & Tesla Coil', 2002

This piece was shown at the Experimenta 'Prototype' exhibition at the Arts Centre in Melbourne in 2002, and being a true prototype, it seemed to confuse some people, entertain others, and there were even a few, who in apparent moments of revelation, understood what it was all about! An engineer approached me during the show and remarked that it summed up everything he knew about the quantum world, yet ironically he had no idea how I had done it. He went on to say that such toroid forms I based the visuals on appear in a diverse range of physics theories and applications, ranging from the subatomic realm to nuclear energy production to recent theories on the shape of the universe.

3.5 Arrogant revolutionaries

Emboldened by the fruits of technological achievement, some scientists have developed so much faith in their epistemological systems they can reach evangelical states, losing contact with their very human origins[61]. The belief in the "ultimate power of scientific knowledge…[can be] almost comparable with the feelings experienced by those who have an absolute faith in the truths of religion"[62]. Paul Dirac's quantum fervor was described by fellow physicist Wolfgang Pauli in the statement: "There is no God and Dirac is his prophet".

The unwillingness to open one's mind to different fields of inquiry is by no means limited to thinkers and experimentalists from the scientific end of the spectrum. An anecdote about Pablo Picasso[63] claims that he attacked Einstein's rise to stardom following the verification of the theory of relativity, saying "it's not fair that Einstein is famous, because revolutionary visualizations of the world is our domain!" If only Picasso had gotten off his ego-horse, perhaps he would have realized that his revolutionary cubist paintings of 1907 – 1909 (see Figure 16), which broke the classical symmetries of pictorial space, could in fact be read as close visual representations of the space-time continuum that Einstein described in 1905.

Fig. 16. Pablo Picasso, 'Les Demoiselles d'Avignon', 1907, reproduced in I.F. Walther, *Art of the 20th Century*, Benedikt Taschen Verlag, 2000, p. 69

Einstein's breakthroughs in relativity came from various 'visualization experiments', by imagining what things would look like if he was moving at or near the speed of light. He realized that time would stop and allow him to see multiple sides of an object simultaneously, breaking the classical symmetries of Euclidian space. The surgeon-cum-philosopher Leonard Shalin states that the revolutionary works of Picasso and Braque, which broke the classical schema of pictorial space, "demanded a new way to imagine space and time and made its viewers reconsider the nature of reality"[64] as relativity did to the classical notions of Newtonian space. He then rhetorically asks whether this was "some extraordinary random coincidence? Or were these artists in tune with a new way to conceptualize space?"[65] Even though Shalin gives compelling evidence that neither Einstein nor Picasso knew of each other's work in those revolutionary days, and that Einstein didn't even like modern art, he still advocates a prescient connection between them, using the lack of evidence to support his theory (in a very unscientific way)[66]. Although neither Einstein nor Picasso were at the time aware of each other's works, both shared a similar deep understanding of the nature of reality. Perhaps if they had been more open towards each others' fields of inquiry they might have aided each other in further revelations and revolutions.

However, the quantum physicist Niels Bohr was keenly interested in art, and cubism in particular, and was apparently very impressed "that [in cubist paintings] an object could be several things, could change, could be seen as a face, a limb and a fruit bowl"[67] (a point missed by Shalin). It has been said that Bohr's wave-particle duality theory was inspired by such motifs – "depending on how you look at [a subatomic entity] (that is, what experimental arrangement is used), that is what it is"[68]. Such correlations between the revolutions in twentieth century art and science suggest fundamental relationships, but they prove to be uneasy bedfellows (see Figure 17).

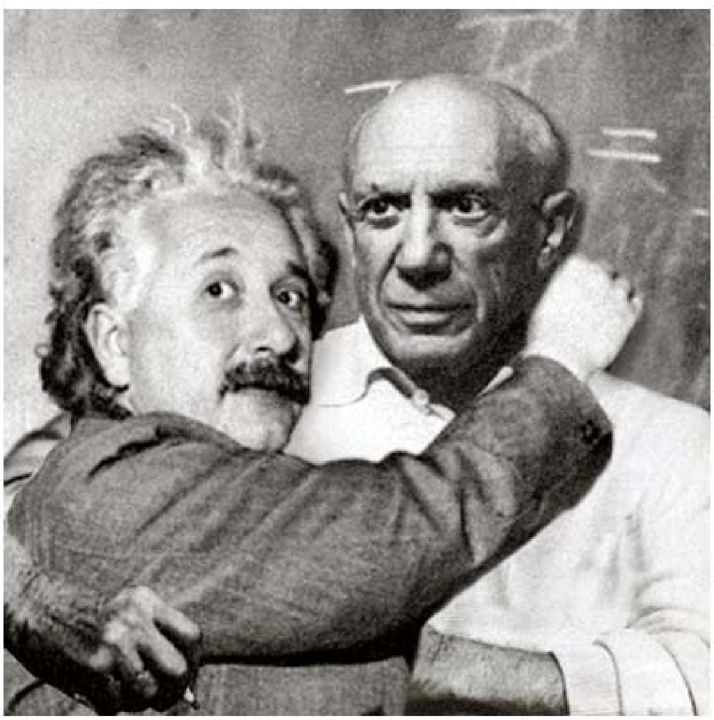


Fig. 17. 'Picasso & Einstein - together at last', 2005

3.6 Visual Science

The revolutions in physics in the early 20th century (as described above) produced theories that were often impossible to visualize even by the scientists that came up with them. Marcel Duchamp, who had a lay interest in physics, came up with some unique ideas and ways of visualizing such theories, although he openly admitted he was "not a mathematician and … really a little too naïve for this kind of work"[69]. However, artworks such as 'Nude Descending a Staircase' demonstrated an intuitive knowledge about the relationship between space and time, and his enigmatic 'The Bride Stripped Bare By Her Bachelors Even' is (among other things) a compellingly accurate visualization of 4 dimensional geometry. His '3 standard stoppages' is a work comprising of a scientific instrument box that contains three wooden 'templates'. Duchamp made these templates by consecutively dropping three one metre lengths of fine wire from a height of one metre, then tracing the shapes they made when they landed, from which he then cut the templates. The templates thus describe movement through all 3 dimensions and time as well, which is a perfect example of Einstein's spacetime continuum, and is also an ironic comment on the relativistic illusion of the idea of an exact metre. As Shalin states,

> "Over and over again, the highly cerebral Duchamp devised mute, concrete constructions that graphically represented complex ideas inherent in the new physics that even the physicists themselves could not put into words."[70]

Radical developments occurred in the mathematical study of complex or nonlinear systems in the late twentieth century that were made possible with computer-based visualization technologies. Using computers as information visualization tools, mathematicians such as Benoit Mandelbrot discovered evolving patterns and complex structures appearing in data sets from such fields as physics, biology, meteorology, even economics and the social sciences. This led to a pictorially derived understanding of new geometric systems in nature and science, and overthrew the classical scientific ideal of regularity and predictability. Thus chaos theory was born, revealing the beautiful forms and patterns in numbers through mesmerizing images[71] which showed that even "the most astutely formal chapters of mathematics had a hidden face: a world of pure plastic beauty unsuspected till now"[72].

Digital visualization tools of the types media artists use are now also being taken up by scientists trying to decipher gigabytes of information in such data-heavy fields as astrophysics, meteorology, engineering, radiology, and molecular biology. The only way to comprehend the billions of pieces of DNA in the human genome, for example, is to rely on visual metaphor and sketch out a "road atlas" of distinct features.[73] Yet, although many scientists still decry the "gap between the accumulation of raw numbers and their transformation into a visual format enabling practical analysis"[74], the field of information visualization is rapidly increasing in breadth, depth and style.[75]

Scientific inspiration sprung from visual images can come in many forms; a well-used tale of such images playing a part in 'eureka' moments of scientific enquiry concerns the nineteenth century German chemist Friedrich Kekule. After years of fruitless research, the molecular structure of the chemical benzene was apparently revealed to him in a dream:

> "Again the atoms were juggling before my eyes… my mind's eye... could now distinguish larger structures of different forms and in long chains, many of them close together; everything was moving in a snake-like and twisting manner. Suddenly… one of the snakes got hold of its own tail and the whole structure was mockingly twisting in front of my eyes. As if struck by lightning, I awoke… Let us learn to dream... and then we may perhaps find the truth."[76]

Yet for every benzene dream, there have been many more scientific advances made solely through pragmatic empiricism and lots of work - Einstein himself said that genius is 10% inspiration and 90% perspiration (a ratio equally applicable to artistic practice). But Einstein also stated that imagination is more important than knowledge. It has already been shown that fundamental revolutions in science have come from irrational imaginative insights outside of accepted empirical frameworks, but irrationality seems to lurk within the most logical of sciences.

3.7 Physics, irrationality and beauty

The contemporary mathematician Gregory Chaitin, who discovered illogical randomness within numbers, brings to light the underlying irrationality within even the most formalized discipline of mathematics. Chaitin states that although mathematicians are generally perceived as being rational, cold and unemotional, he works "completely on the basis of intuition (which is) totally irrational"[77]. When developing new mathematical concepts, Chaitin describes it as being "a magic, mysterious process... just as magical and mysterious as the act of artistic creation"[78]. But he does concede that there follows the rational aspect where the intuitive idea must be verified according to the rigors of mathematical logic. As to the origins of this logic, he believes that "we invent mathematics in an effort to somehow organize our experience of the world"[79]. Chaitin describes good mathematical ideas as having to be "beautiful", even "sexy". Einstein defended the theory of relativity by saying "It's so beautiful it has to be right!" In response to a question regarding his philosophy of physics, Dirac simply wrote on a blackboard "Physical laws should have mathematical beauty". Richard Feynman said "To those who do not know mathematics it is difficult to get across a real feeling as to the beauty, the deepest beauty, of nature"[80]. Although this shows Feynman’s deep passion for his work, it also betrays his arrogance towards other, non-lexical forms of expression – If Chaitin is correct, mathematics is an invention of the human intellect, and if Bohm is correct, underlying it lies an even more fundamental form of visual understanding. In science as in art, 'beauty' is a hard term to define as its very essence transcends textual or verbal categorization, but could be described as having a poetic form that communicates something essential about the world in a way that creates an implicit or non-lexical understanding in the observer, perhaps something akin to

Einstein’s *Einfuhlung*, or innate sympathetic understanding. The contemporary physicist Brian Greene says on this topic:

> “The elegance of rich, complex, and diverse phenomena emerging from a simple set of universal laws is at least part of what physicists mean when they invoke the term ‘beautiful’”[81].

3.8 Black holes, pinball machines and pop music

Einstein's theories of relativity caused such vibrations to resonate in the minds of the scientific world, but also in the minds and hearts of the general public, transcending the language of the specialist and launching Einstein to international stardom. The theory of special relativity, which forever destroyed the classical notions of absolute, fixed space and time, was published in 1905. This was followed ten years later by the theory of general relativity, inspired by a realization that gravity and acceleration were the same thing after talking to a painter who had fallen off a ladder - Einstein later described this as being the "happiest moment" in his life (I wonder if the painter felt as happy)! In 1916 on the Russian front, the German astronomer Karl Schwarzchild was studying Einstein's new theory in between calculating missile trajectories using the equations of classical physics. He realized that if the mass of a star is dense enough and its size small enough, spacetime will warp to such an extent that nothing, not even light, could escape it. Einstein was unable to accept such a 'perversion' of his own philosophy of a balanced, logical, and eternal universe, a philosophy strongly influenced by the writings of the Dutch theologian Bennedict Spinoza. For many years Einstein refused to believe in the 'Schwarzchild solution'. In 1922, another hole appeared in Einstein's symmetrical universe - Alexander Friedmann, a Russian cosmologist and mathematician discovered an expanding-universe solution to the general relativity field equations. Again Einstein refused to accept this implication, and introduced the cosmological constant (λ) into his theory to stop cosmic expansion. When it was proven by Edwin Hubble's telescopic observations that the universe was expanding, Einstein realized that his unconscious biases had blinded him to aspects of the truth revealed by his own theory. He later remarked that the introduction of the cosmological constant was the "biggest blunder" he had ever made in his life.[82]

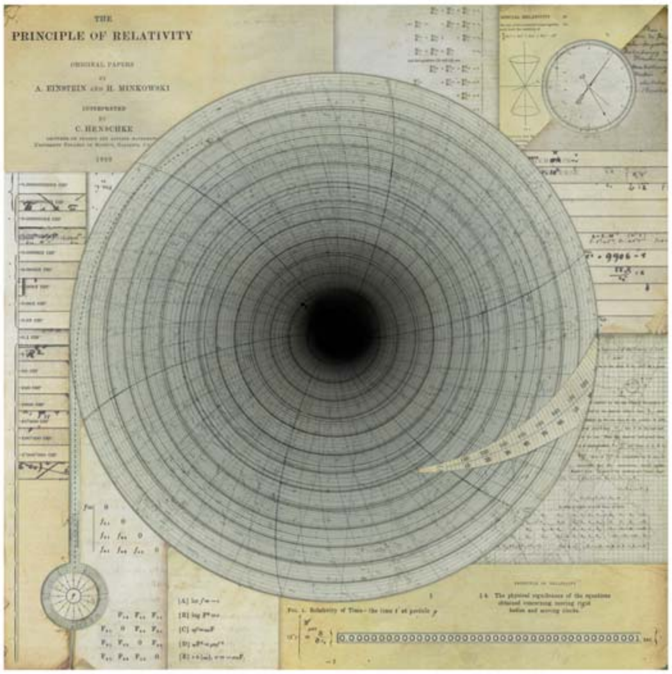


Fig. 18A. 'HyperCollider' collage / interface, 2004
Fig. 18B. 'HyperCollider' interactive, 2004

In response to such issues, I created an interactive artwork called 'HyperCollider' during the inaugural online artist-in-residence with the National Gallery of Australia which I took in March / April 2004 (see Figures 18A and 18B). HyperCollider audio-visually explores the extremes of general relativity and how they disturbed Einstein's philosophical and aesthetic ideals. Thus I attempted to visualize not only the implications of relativity, but also the unease that exists between the macroscopic worlds of relativity and the ultramicroscopic quantum universe and the difficulties Einstein had with his colleagues' theories on quantum theory, summed up by his famous rebuttal of quantum uncertainty: "God does not play dice with the world"[83]. HyperCollider also plays with the seemingly paradoxical phenomena that exist in our universe, and expresses the ironies about how science attempts to understand and explain the world around us, but can in fact further mystify it to the uninitiated. See 'HyperCollider project description' in the 'HyperCollider' section of the DVD.

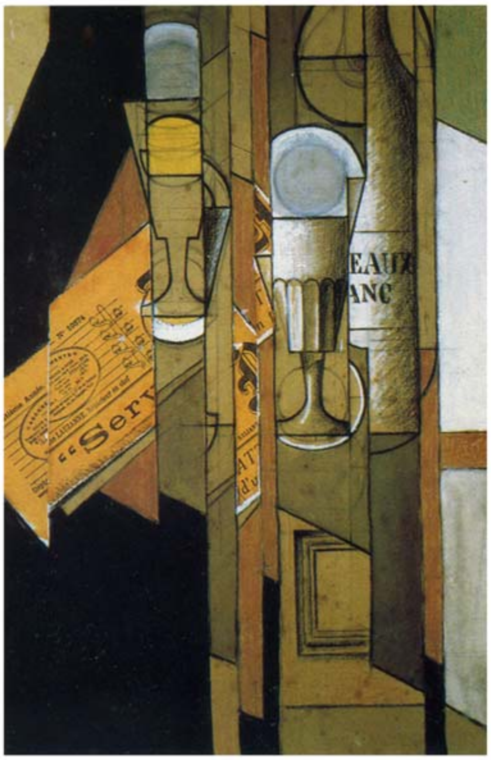


Fig. 19A. Juan Gris, 'Glass Newspaper, and Bottle', 1912, reproduced in J.L. Ferrier (ed.), p.243
Fig. 19B. Kurt Schwitters, 'Mz. 170 Voids in Space', 1920, reproduced in S. Meyer-Buser, *In the Beginning was Merz – From Kurt Schwitters to the Present Day*, Hatze Cantz, 2000, p. 51

The visual component of 'HyperCollider' was inspired by the spatial formalism of cubism and the fragmented-space collages of Kurt Schwitters (see Figures 19A and 19B). The interface was collaged together from diagrams taken from a rare 1920 reprint of Einstein and Minkowski's writings on relativity, copies of Einstein's handwritten notes (which were badly written with lots of scribbles and bits crossed out), an old circular pressure graph and cosmological star charts (see 'HyperCollider source elements' in the 'HyperCollider' section of the Documentation DVD). A hybrid of pinball game, gramophone player and particle accelerator, HyperCollider lets 'players' select 1 of 12 fermions (matter particles), whose basic properties are approximated from experiments in real particle accelerators. These can then be launched into its ‘theoretical universe’ to collide into each other and get pulled into a black hole. Players have two simultaneous views; the view from the particle as it speeds around the vortex, and the view of a 'distant observer'. Differences can be seen between the two views, which demonstrate how the relative frame of reference affects the perceived behavior of space and time. The temporal relativity is also visually communicated by two clocks, one showing 'particle time' and the other showing 'observer time'. By colliding particles off one another and into the black hole, players can observe spatial and temporal dilation effects and move through time into an increasingly uncertain future. This is enhanced by a ‘pop-science-pop-music’ soundtrack that becomes more ‘futuristic’ the further one gets. This serves as an acoustic reference point for movement through time - starting in the familiar musical world of the early 20th century when relativity was born, and potentially ending up in a sound environment aeons into the future. Each time a particle is annihilated in the black hole, a piece of the manifold is torn off and is sucked into the black hole's unknowable depths - this shows Einstein's refusal to accept the implications of his theories. When the entire manifold has been destroyed, the HyperCollider universe implodes in a 'big crunch' scenario hypothesized by Friedmann, and the game resets. See Appendix 1.5 for a description of the ideas and processes involved in this project, and ‘HyperCollider installation’ in the ‘HyperCollider’ section of the Documentation DVD.

As well as the interactive version of HyperCollider, I was asked by the National Gallery of Australia to produce a 6 metre by 2 metre image which was printed in large format and displayed in the gallery lifts.[84] This image, titled ‘Smolin Multiverse Vortex’ (see Figure 20), was inspired by the physicist Lee Smolin’s speculation that inside every black hole a new universe is born as the conditions in the unimaginably compressed core of a black hole could be the same as the conditions during the birth of our universe[85]. As nothing could survive a journey through a black hole and return, there is no way to prove or falsify this idea. Therefore within the science community, Smolin’s theory is merely speculative, but it is nevertheless poetically compelling.[86]

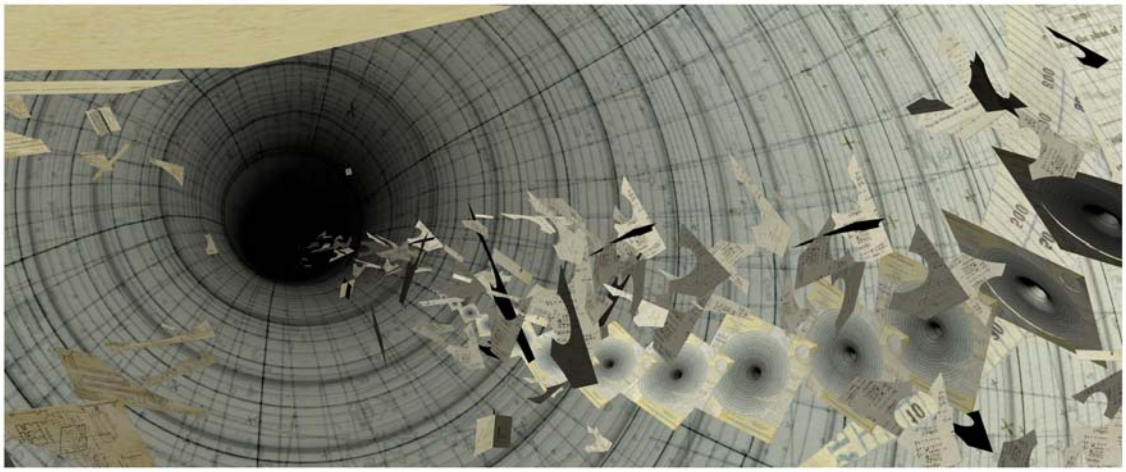


Fig. 20. 'Smolin Multiverse Vortex', 2004

4. Conclusions

4.1 Responses

I found that HyperCollider, which reveals some of the inexorable complexities and irrational aspects of science, brings out a wide spectrum of responses from the various communities that have experienced it. During its tour of regional Victoria, some people not so versed in the urban-centric language of media arts were at first apprehensive, but when told simply "It's a pinball machine – have fun with it", they didn't want to get off it! Many elderly people, also a bit cautious at first, methodically explored it, asked lots of questions and really took it all in - one woman described it as "kinetic art you can play with". Some people said "It's not art – is it a game? Is it science?" Children who have grown up with digital media and popularized physics seemed to understand it straight away. One boy played it for over 20 minutes (until I had to kick him off!), whereupon he explained to me how all the particles worked and what they "felt like" (I got the feeling that he might grow up to be a physicist!).

Reactions from members of the scientific community have been most interesting. For example, when I have demonstrated HyperCollider to scientists, some have been very enthusiastic about it, like the folks at the Australian Synchrotron particle accelerator, (where it was exhibited during their Open Day in 2005), yet others have reacted defensively. When Helen Quinn, the director of the particle accelerator at Stanford University saw it[87], she simply said "It's impossible to do that with fermions - the strong nuclear force is too strong". Perhaps she didn't subscribe to the tactics of humor and subversion inherent in it which are aimed to excite poetic 'leaps of logic' in the perceiver. Perhaps she was also unwilling to let go of her rigidly empirical stance, in case something illogical might crawl up through the cracks in the foundations of contemporary particle physics. Only occasionally do physicists speak of the 'pernicious infinities' that turn up all-too frequently in quantum mechanics that require 'renormalization'. Dirac lamented this process of renormalization as it "involve[s] neglecting infinities which appear in [quantum mechanical] equations…in an arbitrary way. This is just not sensible mathematics"[88]. This process is basically cooking the books to make the numbers fit the formulas so to avoid the perils of mathematical impossibility.

4.2 Collaborative futures

If scientists can embrace the non-logical, intuitive, subversive and poetic aspects of their traditions in more formal ways, and explore the 'irrational' forms of logic that artists use, perhaps science can evolve in unexpected ways with greater awareness of philosophical, cultural and historical factors and the myriad possibilities of finding and expressing knowledge. Scientists may then consider that art practice can be a powerful form of research that is complementary to the scientific pursuit of knowledge, and take inspiration from that. There is certainly a lot of inspiration artists can and do take from scientific theories past and present. Art that visualizes and explores scientific ideas, or works with elements of the scientists' language could help in developing scientific practices not dominated by logocentric thought and empirical dogmatism, creating previously unimagined areas of research. Feyerabend was an advocate of opening up scientific practice to non-scientific methods, summed up by his radical empirical principle of "anything goes"[89]. This is where collaboration can become a powerful tool that works for both sides of the art / science research spectrum and bring them closer together. Perhaps, in the style of the biologist and philosopher Francisco Varela, the trick may be:

> “not to repeat what the scientist has done let alone match the [scientists’] rigor or systemacity. To the scientist this smacks of the dabbler or dilletante. But in the 'interdisciplinary adventure' the practitioner is taking on a new vocabulary and lingo, other modes of thinking, other sets of procedure...to take bits and pieces from here and there to construct a new assemblage, another kind of aggregation - a collaging from which different, unscripted knowledge effects are squeezed out."[90]

The contemporary physicist Anton Zeilinger asks the question:

> "are alternative ways to do science thinkable, are they possible? Could science have gone in completely different ways from the roads which Galileo and Newton took three or four hundred years ago?"[91]

This is not merely a rhetorical question; this is an issue emerging at the heart of current scientific research. This question of ‘possible sciences’ is the kind of area in which informed artists and scientists alike can embrace the rational *and* the irrational, the formal *and* the intuitive, and collaboratively discover new ways of perceiving, understanding and communicating theories about the extraordinary universe we all inhabit. Whereas scientists attempt to link variegated phenomena with rigorous empiricism and make far-reaching conclusions about our perceived reality, artists embrace the vicissitudes of perception and our interpretations of it. Art can communicate those things about us and the universe around us in ways that fall outside the boundaries of formalised scientific rationalism. The artist closes the loop by feeding back into the larger culture at least a preparedness to contemplate new forms of knowledge, if not explicitly revealing such knowledge in the way scientists strive to do, using visual and sonorous languages not explicitly bound by the logocentric laws of empiricism and logic, but rather strategies that emphasise play, antithesis, drama, humour, musicality, ambiguity *indeed* as paths to insight or personal truth. There is encouraging evidence that scientific researchers are also attempting to open up dialogues and collaborate with artists in order to build upon and share knowledge, and cast a new light upon their own work; this became evident during the ‘New Constellations: Art, Science and Society’ conference at the Museum of Contemporary Art in Sydney (March 2006) in which I took part. Yet, as Barbara Maria Stafford states, “to produce a new world of perspicuous and informed observers (not just literate readers) will, I believe, require a paradigm shift of Copernican proportions”[92]. Perhaps the processes of convergence in contemporary media art and science will precipitate such a revolution.

Appendix 1: Project notes

1.1 'Corroded Grooves'

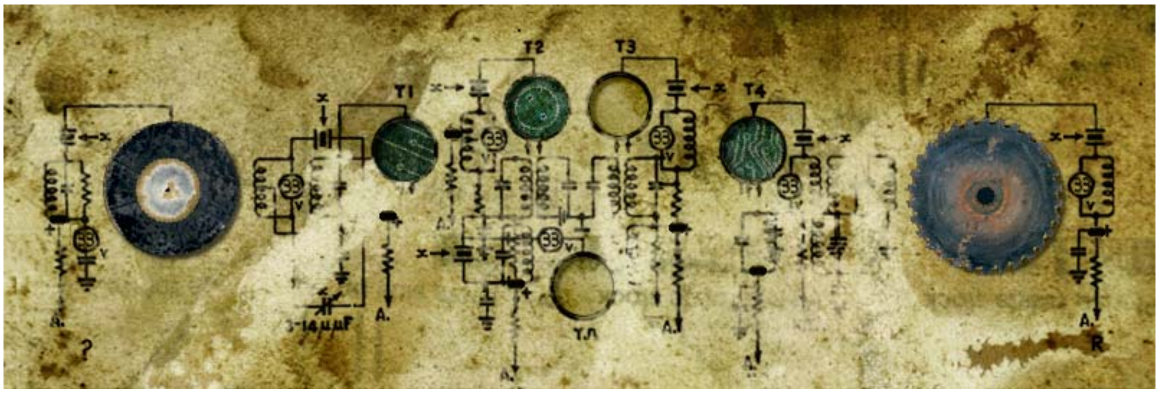


Fig. 21A 'Corrodrd Grooves' interface, 2000

Corroded Grooves was also shown at the 'D.Lux Media Arts D.Art 01' at the Sydney Exhibition Space in Sydney in 2001, and at the 'Scrape' exhibition at the RMIT 1st Site gallery in 2002. I did some live demonstrations of 'Corroded Grooves' that included a Hendrix-style setting fire to one of the turntables whilst it was playing a record, which the audience always loves, but which also had the added interesting effect of producing the sound of melting music as the vinyl heated up and liquefied. See Figures 21A & 21B and the 'Corroded Grooves' section on the Documentation DVD.

Fig. 21B 'Corrodrd Grooves' installation and performance, 2000

In place of their appropriate stylus, I fitted each of the Corroded Grooves turntables with surgical steel pins, which could move over all kinds of objects, amplifying the sounds of the surfaces. I used a variety of 'found objects' or, more accurately, 'found discs', including a rusty sawblade, sandpaper sheets, an old copper clock face, a burnt out clutch plate, and some 'hand pressed records', made by scratching patterns into a lead 'master disk' which was placed over old records and put in the oven so that the patterns melted into the vinyl and thus created acoustic patterns when the record was played (see Figure 22). The turntables played at a variety of standard speeds (16, 33.3, 45 and 78 rpm), and could be adjusted at will by the performer/audience. The seemingly chaotic noise of the needle upon the textural surfaces was transformed into acoustic patterns due to the repetitive looping motion of the turntable platters. This transmitted the 'information' on the surfaces (in an analogous way to the imprinting of sound into vinyl recordings which, in theory, could be decoded to play back the sounds made when they were created or inscribed!).

Fig. 22. Objects used in ‘Corroded Grooves’, 2000

The computer played a variety of samples taken from the turntables and other sources of a similar acoustic feel, which were digitally manipulated to create fragmentary rhythms, melodies, and bass tones. These sound loops were synchronized with animated images of the corresponding disks, and visual fragments of the actual computer processor used to manipulate them. The overall effect could be described as a bricolage-like "process which uses given material, given signifiers (a text, a chord sequence) but which creates from these new signifiers, a new reality which is not given”[93].

The sequence and tempo of the samples could be adjusted by the performer/audience through a virtual mixing interface. The computer itself also changed the musical sequences, randomising and deconstructing the loops, and inevitably breaking down the composition the user has created. Based upon circuit diagrams found in the record players, the ‘user-unfriendly’ interface was deliberately designed to be confusing and obscure, dispelling the projected notion that computers are easy to use. The interface was developed from a series of interactive digital sound experiments I did in early 2000, which also explored issues of noise vs music, randomness vs control, described below.

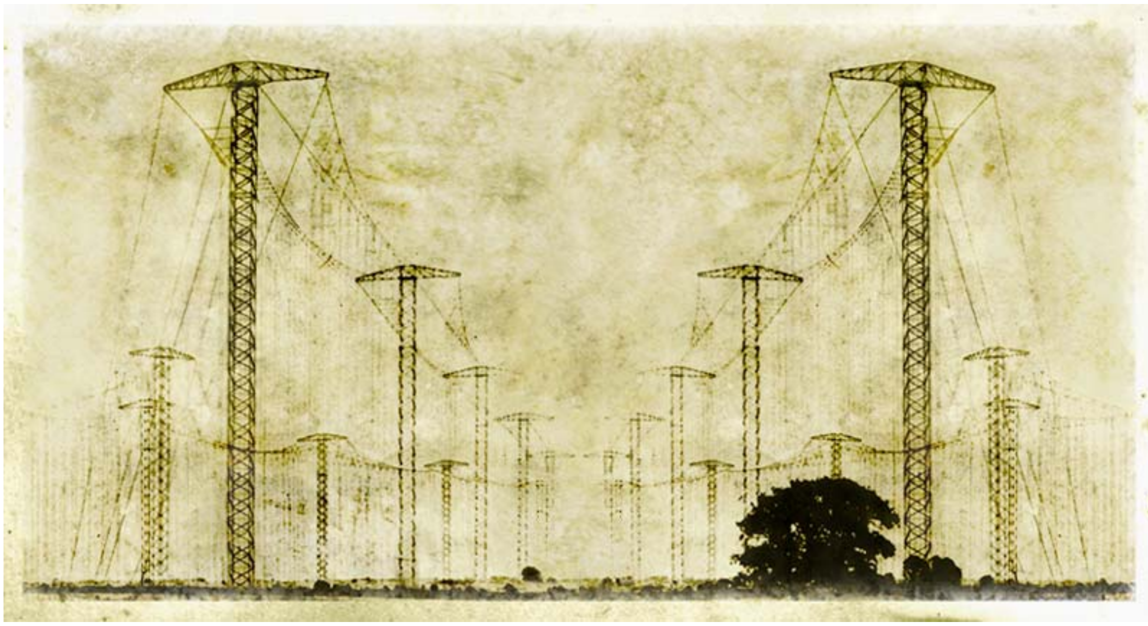


Fig. 23. Image from 'Radio Serenade', 2000

'Radio Serenade' (see Figure. 23) was made from recordings of late night AM and the Glen Miller song 'Moonlight Serenade' paired with gradually changing collages of a scratchy old photograph of a 1940s radio transmitter complex, which explored the nostalgic side of noise.

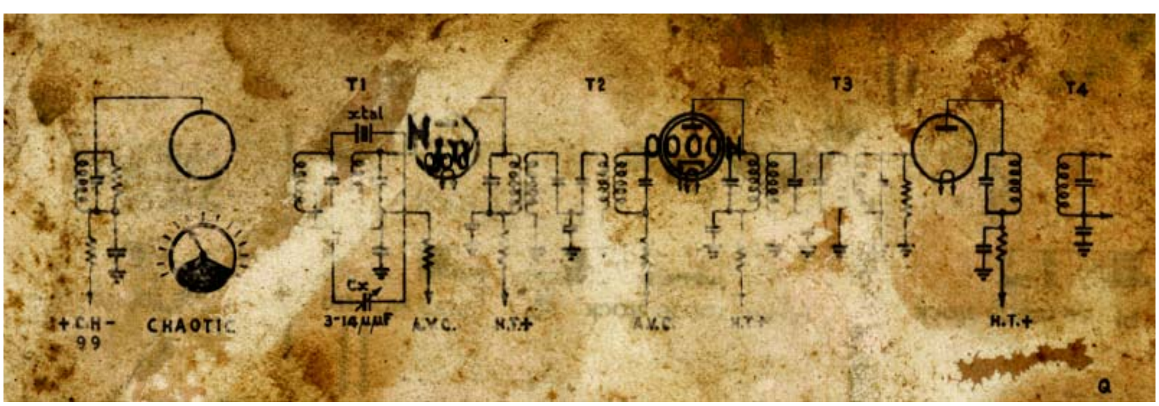


Fig. 24. 'Chaotor' interface, 2000

'Chaotor' (see Figure. 24) had an interface made from the circuit diagrams of the transmitters in 'Radio Serenade', with sound bytes of digital rock & roll, analogue feedback, and computer noise from corrupted and incorrectly encoded sound files. It played with the notion of user control – one had to 'fight' with the program to keep the musical structures working, but the computer would randomly take over with unpleasant and unstoppable sounds.

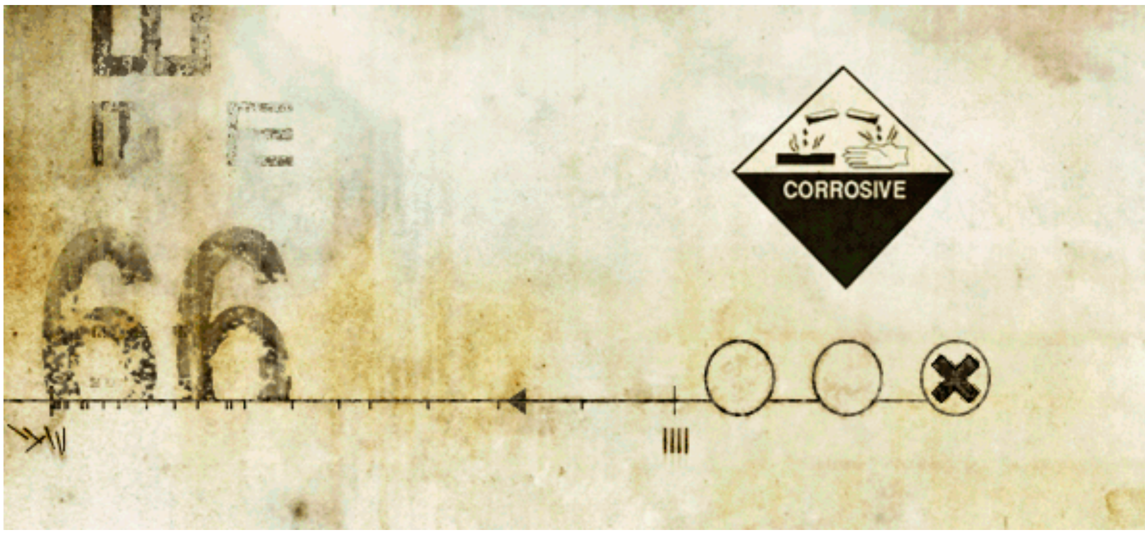


Fig. 25. 'Corrosive Rock', 2000

'Corrosive Rock' (see Figure. 25) also played with the fine line between rock & roll, electronic music and undesirable noises, encouraging the user to "make some noises with it and work out how it works"[94].

Fig. 26. ‘Demonor’, 2000

‘Demonor’ (see Figure. 26) gave the user no perceivable control over a barrage of explosive sound and visuals. All these works were able to ‘play’ themselves, due to the convoluted algorithms I had programmed into them, and could be seen as ‘automatic bands’. I performed these at an electronic music event, the ‘Nuit des Musiques Electroniques’ in Clermont Ferrand, France in March, 2000. See the ‘Early sound interactives’ folder on the Projects CD.

1.2 'Polyarticulate'

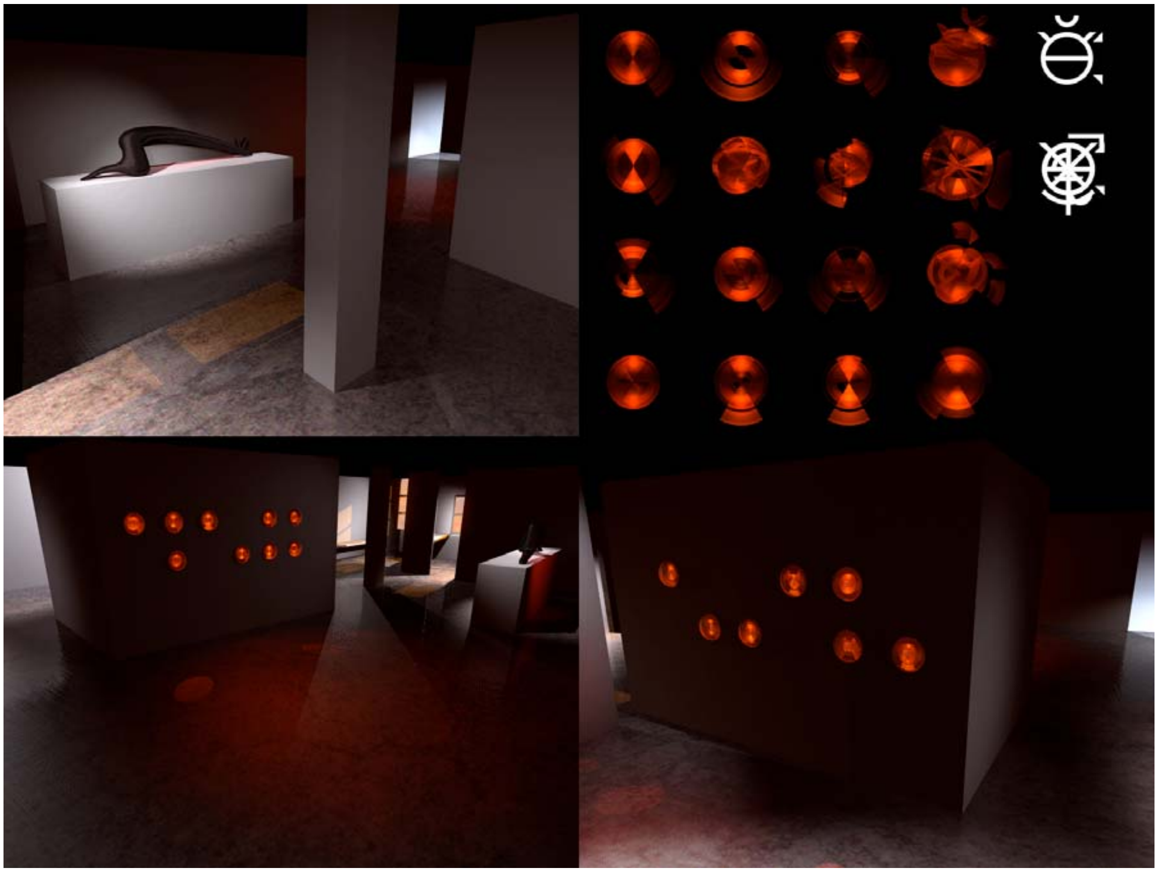


Fig. 27. Stills from 'Polyarticulate', 2002

'Polyarticulate', was a collaborative art project I worked on in 2002, which tried to give form to the frequent breakdown in communications across humanity by creating a lexical, aural and visual 'un-language'. The other three collaborators were graphic designer Andy Trevillian, writer Justin Clemens, and sculptor John Meade. The language was created from 16 arbitrarily chosen sounds (4 from each of us), which were given graphic form via the international phonetic alphabet with the assistance of a linguist known as 'Connell'. The sounds were developed through exhaustive recordings of a dozen people repeating each sound, which I edited together to create 16 syllables. The project existed as an installation in Westspace gallery, which contained a small closed room with 16 lens-like spherical windows in it, each displaying one of the graphic forms, a tongue-like sculptural object across from it, and a 36 channel sound system. Movement through the space triggered different syllables, spoken in a multiplicity of tongues and visually represented by animations of the graphic icons. Within the tongue-like object was a Theremin, which allowed gallery patrons to control the pitch and intonation of the syllables by gestural movement around the sculpture. A microphone allowed patrons to learn the language and speak to the installation in its language – the gallery audience could utter the syllables into the microphone, and the installation would reply in its own tongue. Ironically, this project was fraught with communication breakdowns between the collaborators, and almost failed to manifest if it had not been for an inhuman amount of labour over the last few sleepless days before the exhibition opened. A networking nightmare of linking 18 computers together to control the beast ensued, almost literally asphyxiating us in data cables and MDF dust. Even still, the installation was only completed an hour after the (packed) official opening, and it was activated untested. To our horror, the network overloaded and the installation began to make guttural howling sounds, and although we tried to reset the machines we were unable to stop it, not even when we turned it off – we had lost control of our own monstrous creation! That we created artworks that we could not even control pointed (rather too pointedly) to the difficulty of systems of knowledge that are so highly or specifically structured that the knowledge never makes its way out of those groups (and sometimes is not even attainable by those who created it). The process of establishing new knowledge can be self-defeating. Polyarticulate reminds us that art can *intervene* to reveal states, conditions, truths, contradictions in our apprehension of the world. To explore the digital version of the installation, see the ‘Polyarticulate’ folder on the Projects CD.

1.3 'The Magicians Den'

I originally wanted to build a real Tesla Coil for the room, of which plans are easily available on the internet. However, the cost may have been a bit too much, and the fact that I would have been dealing with high-voltage capacitors which would unleash into the space bolts of millions of volts put the gallery curator off for some reason! Thus I settled with three 10,000 volt Jacob's ladder kits from Jaycar, which only produced sparks of about a centimetre wide each of which arced up about 10 cm between two metal strips, but still carried the essence of the idea (as well as having small Tesla coils in them). The reengineering of the other devices was done with the assistance of Mike Marin, an electronics engineer and programmer, who built customized components which were hidden within the devices. Mike ended up custom designing circuit boards and microprocessors which controlled sequences of light-emitting-diodes (LEDs), which we had built for us as 'test samples' by a large computer hardware company, which we wired together ourselves a week before the exhibition! I added some digital sound sampler / playback kits to give added audio to the radio and x-ray box. I scanned in details of the original items, the internal components of the bakelite radio, old xrays and similar related material, which I digitally adjusted and printed out onto lightbox transparency film. These were mounted in the appropriate devices with the LED panels behind them, so that when they were activated, the LED lights illuminated to preprogrammed sequences and made the images look animated. The x-ray box had an added aural component, made from a recording of my own labored asthmatic breathing, the sound of the faulty minidisc player, and also abstract wet visceral noises of german potato-salad being stirred! The bakelite radio had as its tuning 'screen' an image collaged from its original frequency chart and circuitry on which was overlaid blue and red scientific diagrams (see Figure 28). The LED panel behind it was of blue and red lights - the idea was that only the blue diagram would be visible when the red light was on, and vice versa. This did not work as well as planned, but still provided an interesting effect. The visuals were accompanied by an 8 second 2 channel soundtrack constructed from real AM interference and late-night radio broadcasts, which could be 'tuned' from one track to the other by the tuning dial on the radio. The deployment of the old bakelite radio was particularly ironic, considering the overall costs involved ended up being over a thousand dollars just to 'simulate' its original function. (I guess the joke was ultimately on me!) To view the works, see the ‘Scrape’ section of the Documentation DVD.

Fig. 28. ‘Bakelite Radio’, 2001

1.4 ‘Virusspace’

The theory I examined for the ‘Virus’ images was that of 'mutationism', a form of accelerated biological evolution first proposed by the pioneer geneticist Hugo de Vries. According to mutationist theory (which I researched during my studies in science in 1994), the processes of evolution obey the laws of hydrodynamics. These processes can be mapped out in a theoretical topographical landscape known as 'genespace', where real or possible DNA that has a greater genetic 'fitness' (i.e. more likely to survive and evolve) would be mapped onto 'valleys' in genespace, and other forms of life with a lesser degree of genetic fitness would be placed on 'hills'. Thus there is an innate tendency for 'fitter' life to naturally evolve, just as there is a tendency for water to flow down into valleys. Questioning this model, I wondered what sort of genespace would contain teratagenes, genes which can be detrimental or lethal to the survival of the organism, and thus themselves.[95] I created a 'vectormap' of a seemingly limitless space containing entangled field-lines of undesirable possibilities, upon which sat virus spores and bacteria, waiting to be pulled through one of the 'manifestation' vortexes and into the physical world. When such teratagenes or viruses develop physically, spontaneously manifesting through some 'unlucky' dice-throw of evolution, they move from the space of possibilities into the world of the real. Hence the illustration 'Birth of a Virus', which is what lies on the other side of the 'Virusspace' image. The actual virus in 'Birth of a Virus' was created from digitally scanned squid tentacles and blue-vein cheese. As well as the explicit and textural links to life forms, there is also the analogy to artificial life, computer viruses and the idea of information as virus. This is hinted at in the variations of the 'Birth of a Virus' image, 'Untitled' collages (strains 2 & 3) (see Figure 29). Created from discarded scraps of paper, old scientific graphs, measurement charts, and obsolete computer punch cards, these particular variations on the image, or strains, were aesthetically successful enough to make it from the digital space of possibilities (Adobe Photoshop version 4) into the physical world (via 'Lambda Duratrans' light box prints). This playfully brings into light questions of aesthetic fitness and mutation, and the Dawkins-meets-Burroughs concept of beauty-as-virus.

See the 'Imaging Examples' folder on the Projects CD.

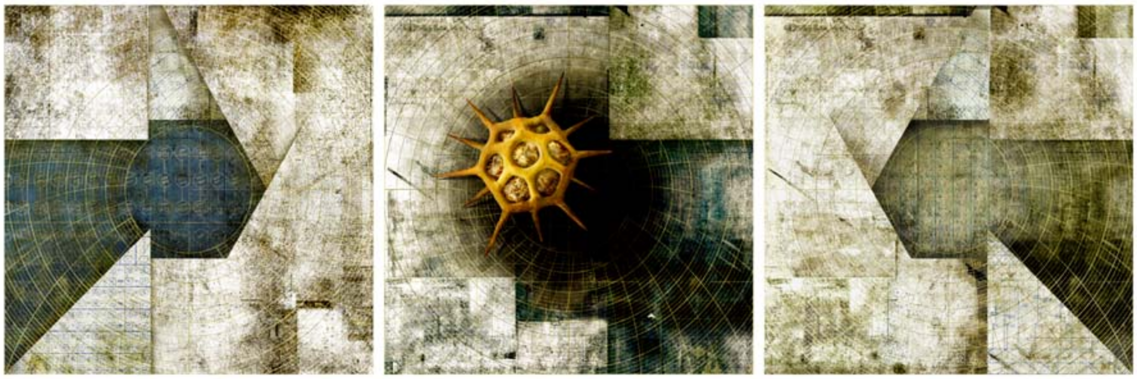


Fig. 29. 'Birth of a Virus' and 'Untitled Collages (strains 2 & 3)', 2000

1.5 'Feynman Field & Tesla Coil'

As well as using the Feynman diagrams, I researched three-dimensional visualizations of a variety of phenomena in physics, and found that the toroid was a recurring form. I then created images and animations of toroidal versions of Feynman diagrams and electromagnetic fields, but it wasn't quite right (see Figures 5, and 31A and 31B, and 'Early field visualization' in the 'Feynman Field & Tesla Coil' section of the Documentation DVD).

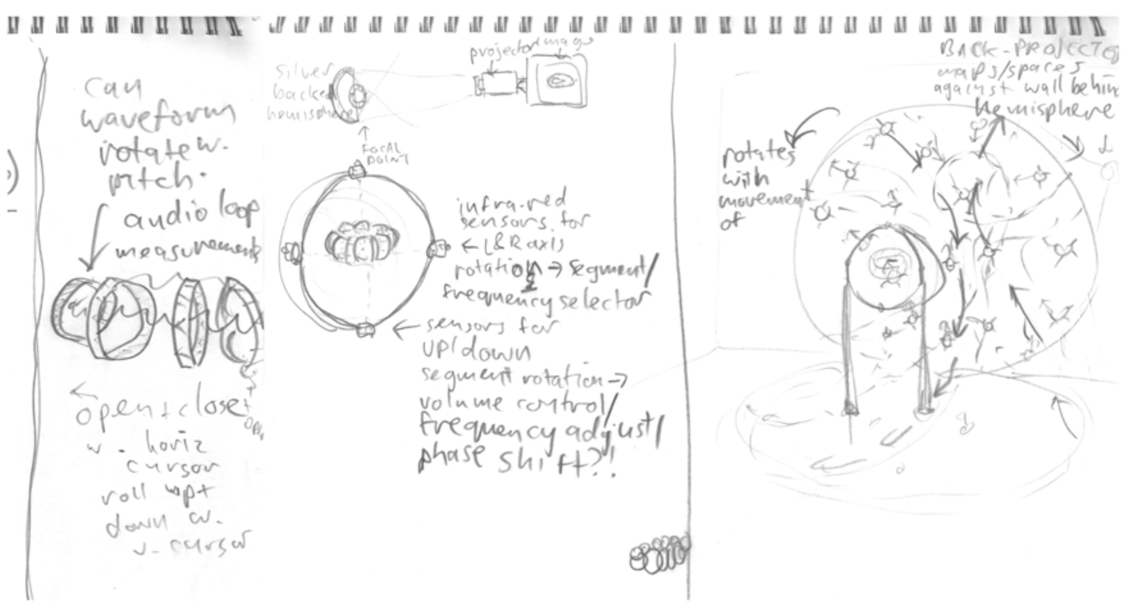
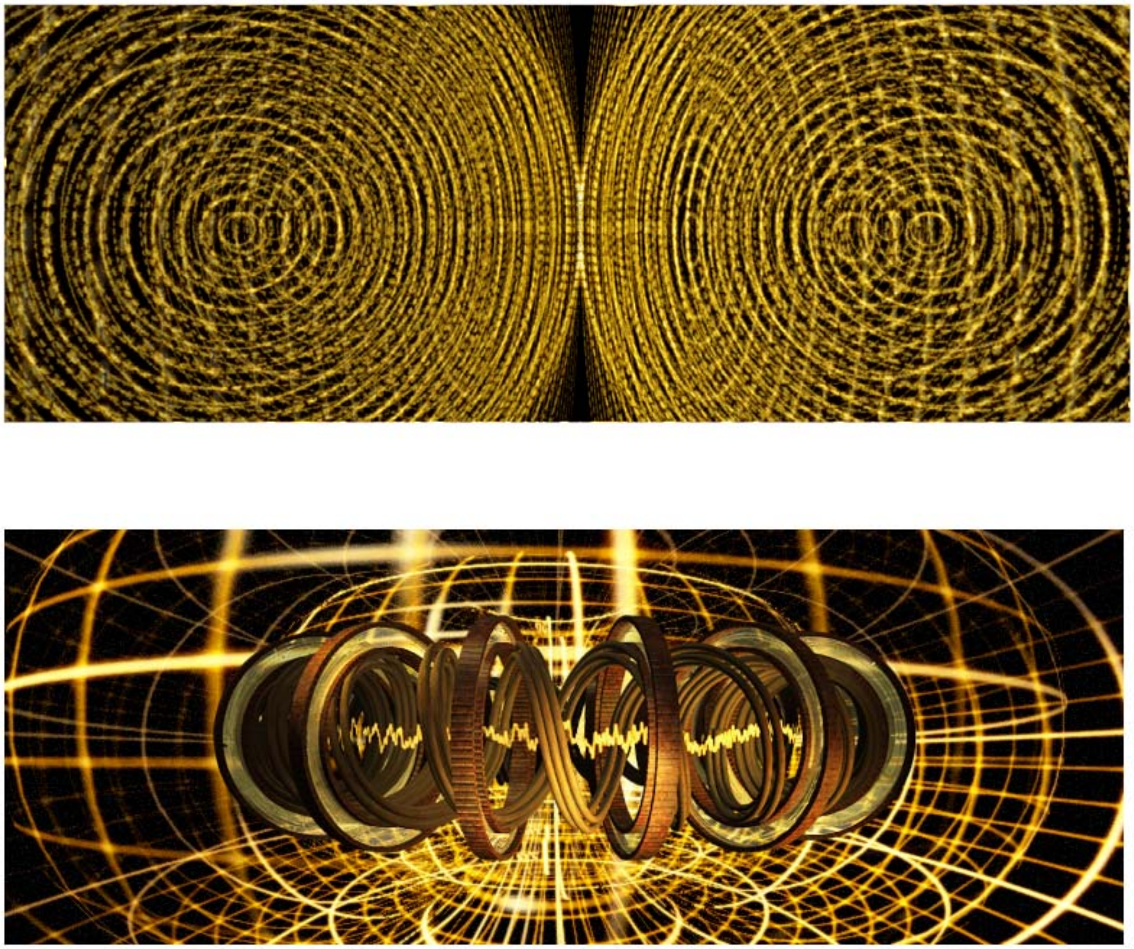


Fig. 30. Initial sketches for 'Feynman Field & Tesla Coil', 2002



Figs. 31A & 31B. ‘Electromagnetic field visualizations’, 2002

For a while I was unable to find the right ‘combination’. Then one night, during a ferocious lightning storm, I came up with a visualization that suddenly seemed to be right. This was comprised of three interlocking toroidal fields, each containing the symbols of the subatomic particles which creates such fields but whose movement is dictated by the fields (see ‘3 Phase Field test animation’ in the ‘Feynman Field & Tesla Coil’ section of the Documentation DVD). This 'three phase field' was then imported into the Macromedia 'Director' authoring program (version 8.5) as a 'Shockwave 3D' model which could be controlled and animated in realtime.

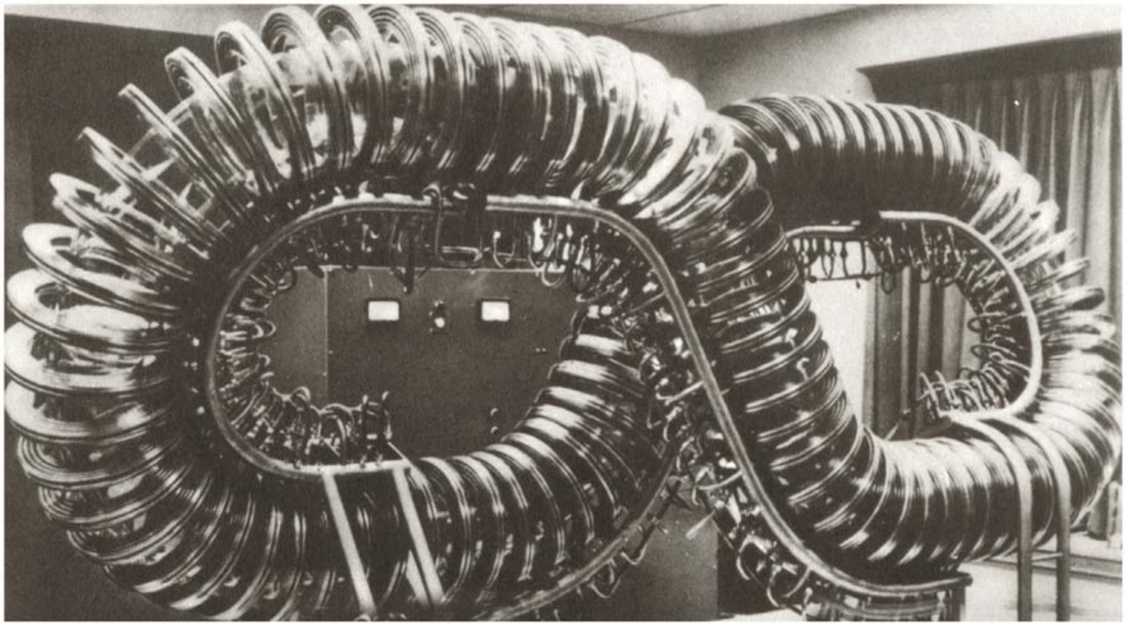


Fig. 32. ‘Stellarator’, reproduced in C. Hatcher, *Horizon Book of Science*, Hamlyn, 1961, p.34

The navigation interface itself took inspiration from toroid shaped scientific devices used to create and analyse such energies; a cross between a stellarator, a particle accelerator used to smash together subatomic particles and create quantum events (see Figure 32), and a Tesla coil, a device which releases vast amounts of electromagnetic energy, created in the late 18th century by Nikola Tesla (see ‘Tesla Coil animation’ in the ‘Feynman Field & Tesla Coil’ section of the Documentation DVD). This navigation object was initially going to be reflected into a silvered glass hemisphere so it would be focussed in the space in front of the viewer, and would appear to float like a hologram. I did some small-scale optical experiments with fellow media artist and electronics expert Olaf Meyer, and glazier Ian Mowbry, which seemed promising, but when we made a large scale silvered piece of glass, it did not work sufficiently well to exhibit it. Thus I used a 80cm x 80cm sheet of glass mounted at 45 degrees over a concealed computer monitor (in the style of 1980's arcade games), which made the image seem to sit in the space behind the glass. Behind the 'Tesla Coil' the 'Feynman Field' was projected onto a large screen.

To navigate through and interact with this simulated quantum space I used two computers to control the two images, and used a Sharp GP2D02 infrared distance measuring beam to detect hand movements which dictated horizontal movement in the space. Olaf Meyer assisted in networking the two computers using a MIDI (Musical Instrument Digital Interface) converter attached to the output of the infrared sensor. This allowed one to control the rotation of, or 'steer' the Tesla Coil, which in turn controlled movement through the Feynman Field. This also thematically linked the invisibility of the navigation sensor with the invisibility of the quantum world.

The sound component also took inspiration from quantum physics. When two sound frequencies are played together, the difference in frequencies and phase creates peaks and troughs of energy and creates pulses or beats. This is basically a sonic implementation of Heisenberg's Uncertainty Principle: to measure the position or energy of a subatomic particle / wave, scientists' instruments emit an energy beam of adjustable frequency and measure the diffracted vibration pulses. If the two frequencies are quite different, the diffracted pulses will be high and the position can be accurately calculated, but if the two frequencies are similar, less pulses will be diffracted and thus the frequency or energy can be accurately worked out, but it is impossible to know both. Thus it is impossible to say whether any subatomic entity is a particle or wave, from which Heisenberg's uncertainty principle is based, and also Bohr's wave-particle duality theory.

From this principle I created a sound-based navigation and interaction system. The speed of rotation of the Tesla Coil increased the frequency of a midrange pitch pulse it regularly emitted, which was also visually represented by a sine wave traveling through the middle of the coil. Movement through each of the three fields activated one of three bass tones of slightly different frequency. By listening to the beats created by the two tones, one could work out the relative frequencies. When the pulse emitted by the Tesla Coil matched the key of the bass tone (being one octave higher), the relative field would rotate and photons of energy would be emitted. When all three fields became activated, the energized state of the whole system would lead to a 'quantum leap', communicated by increasingly high frequencies and visual warping of the energy fields. This would reset the system and everything would return to a state of stillness and equilibrium.

It is interesting to note that the entire conception and production process was done over a highly active 8 week period, propelled by a near-impossible deadline, as well as working on the 'Polyarticulate' collaborative installation and two other exhibitions. My mind was in such an energized state I often worked around the clock, and the night of the storm and breakthrough I began to actually hallucinate energy fields eminating from metal objects around me and such things as the tram lines on the street! To view and play the work, see the ‘Field & Coil Project’ folder on the Projects CD, and the ‘Feynman Field & Tesla Coil’ section of the Documentation DVD.

1.6 'HyperCollider'

Fig. 33. Initial sketches for 'HyperCollider', 2004

'HyperCollider' originated during the inaugural online artist-in-residence with the National Gallery of Australia which I took in March / April 2004. The residency was in association with the 'Metis' art / science program and the CSIRO on the theme of 'time', so my brief was to come up with an online project about time. Thus Einstein's theory of relativity seemed the perfect idea to explore, which I had been fortuitously reading about when I was informed I had been given the residency (with an 8 week deadline - an ironic lack of time!). A few days later I awoke early in the morning with the vision of an almost complete HyperCollider in my head. I scribbled it down on paper and then spent 7 sleep-deprived weeks manifesting it (see Figures 33 and 34). I enlisted the assistance of Ken Mok who did the kinematics programming using 'Shockwave 3D', and created a self-contained digital 'universe' with its own unique physics properties which allowed the interactive to work in 'realtime'. Thus one cannot precisely predict in advance what interaction events will occur within HyperCollider (just as in the physical universe).

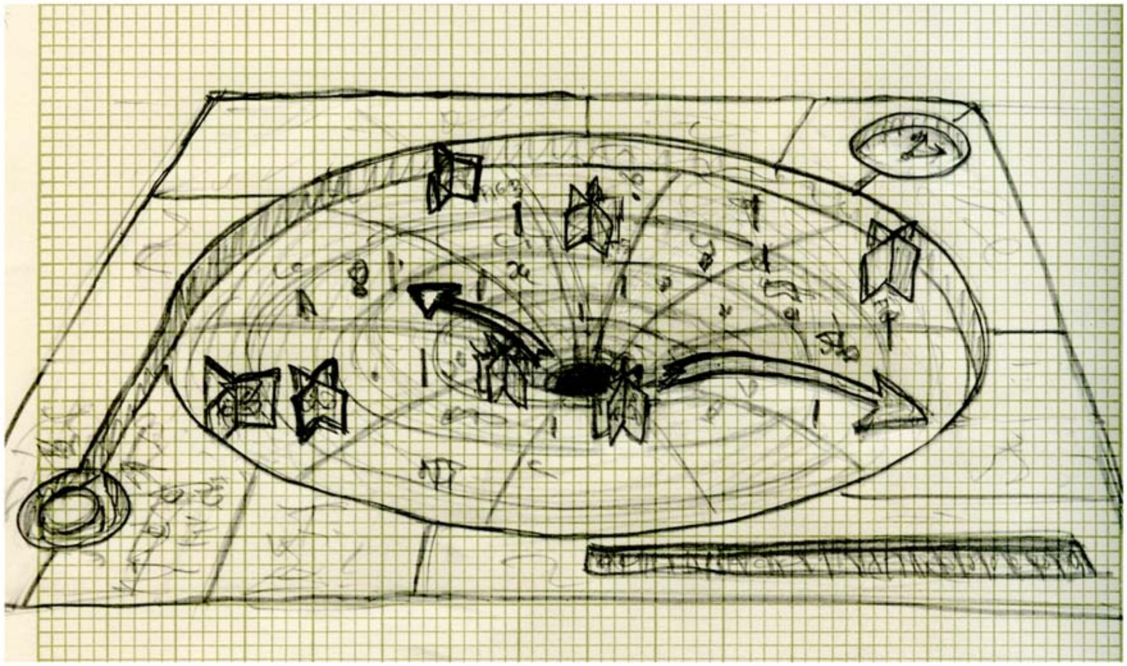


Fig. 34. Subsequent sketch for ‘HyperCollider’, 2004

As this exploration into physics stemmed from a pop-science perspective, it followed that its sound component had to be constructed from pop-music. The soundtrack was itself inspired by Heisenberg’s uncertainty principle –fragments of sounds were put together using the granular sound manipulation program ‘Supercollider’. The name ‘HyperCollider’ relates to the ‘Supercollider’ program, and is also an ironic reference to the massive ‘Superconducting Supercollider’ particle accelerator which was partially built in the USA, but which was abandoned due to its estimated cost of over 8 billion dollars, after they had already spent several billion on it. Supercollider treats sounds as being composed from grains or particles, as well as waves, and is thus analogous to Heisenberg’s and Bohm’s quantum theories. Using Supercollider and a ‘Kaoss Pad’ dynamic effects processor, I constructed an acoustic-historical timeline soundtrack (which I also released on CD). This was chronologically comprised of the following: relatively long samples recorded from dusty 1920’s gramophone records; scratched 1940’s big-band ‘long-player’ records; 60’s style guitar-pop-funk (remixed from my band ‘Crank’) mixed with AM radio static; 80’s disco mixed ‘live’ with snippets of dance music taken from the radio; 90’s rock (remixed from the vinyl 7’’ ‘Songs of Science’ release by Crank in 1995) which was mixed live with bits of Barry White put through the Kaoss Pad and an Igor Stravinsky concert that happened to be playing on the radio at the time; fragments of pop music and techno playing on commercial FM radio; successively tiny fragments of dub and hiphop and other unidentifiable sound bites sampled from the radio; these were all then fed back into themselves to create a cacophonous sound of 'pop eating itself'; then finally a 'post-music' mix of tones from a Tibetan singing bowl and suras (verses) from the Holy Qu'ran 'sung' from an electronic mosque-clock. This created an overall soundtrack that becomes increasingly unpredictable the further it moves into the future, until it finally resolves into fluid waveforms which themselves move into tonal areas beyond the range of the perception of contemporary humans. It also eludes the issue of copyright infringement, as the live sources and increasingly short durations of the samples make their origins uncertain and ultimately impossible to define.

HyperCollider was further developed with assistance from the Film Victoria Digital Media Fund. A cabinet was custom built by Lindon Davey-Milne to house the digital media, which I designed in the style of a 1920s German style pinball machine called 'Imo Weltflug' (Flying around the World), perhaps what Einstein himself might have played. This was then fitted with antique buttons, a period coin slot and spring-loaded launcher, which were wired via a mouse to a computer. A data projector and mirror were used to project the 'observer view' onto a horizontal silk screen in the top of the cabinet, and an LCD screen was mounted to the backboard upon which the 'particle view' was shown.

Fig. 35A. ‘HyperCollider’, *Topologies,* Convent Gallery, Daylesford, November 2004

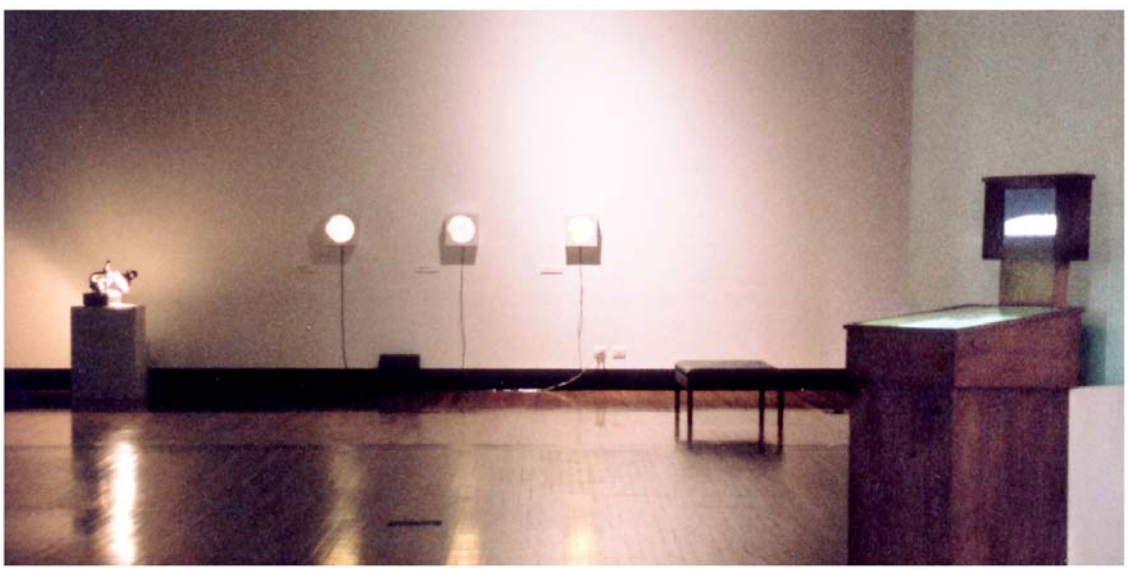


Fig. 35B. ‘HyperCollider’, *Topologies,* Latrobe Regional Arts Gallery, Morwell, December 2004

Fig. 35C. ‘HyperCollider’, Australian Synchrotron Open Day, February 2005

HyperCollider toured around Victoria as part of the ‘Topologies’ tour with Donna Kendrigan. This included the ‘Infirmary Room’ of the Daylesford Convent Gallery in November 2004 (see Figure 35A), the Latrobe Regional Art Gallery in Morwell from December 2004 to February 2005 (see Figure 35B), and at the Exhibitions Gallery in Wangaratta in April and May 2005. It was also shown at the Australian Synchrotron Open Day in February 2005 (see Figure 35C), the RMIT Gallery in November 2005 as part of the ‘Davidian’ exhibition, and at the Macquarie University Gallery in December 2005 – January 2006 as part of the ‘World Year of Physics Art Prize’ (which it won) and was acquired by Macquarie University.

Endnotes

[1] R. Boyd, "On the Current state of Scientific Realism", in R. Boyd, P. Gasper, & J. Trout (eds.), *The Philosophy of Science*, MIT Press, 1993, p.195

[2] ibid, p.197

[3] K. Popper, "Selections from *The Logic of Discovery*", in Boyd et al, p.106

[4] ibid.

[5] ibid.

[6] ibid, pp.107-108

[7] ibid, p.110

[8] ibid, p. 100

[9] ibid.

[10] ibid.

[11] ibid, p.101

[12] ibid.

[13] D. Bohm & D. Peat, *Science, Order & Creativity*, Routledge, 1987, p. 33

[14] T. Kuhn, 'Scientific Revolutions', in R. Boyd et al, p.140

[15] ibid, p.142

[16] A. Einstein, *The World As I See It,* Princeton, 1935, p. 125

[17] A. Einstein, in P.A. Schilpp (ed). *Albert Einstein: Philosopher and Scientist*, New York, 1951, p.683

[18] P. Feyerabend, *Against Method*, Humanities, 1975, pp.19 – 20

[19] Bohm, et.al, p. 2

[20] ibid, p. 59

[21] ibid, p.59 - 61

[22] ibid, p.9

[23] W. Kandinsky, *Point and line to Plain*, Dover, 1979

[24] ibid, pp. 38 - 39

[25] L. Shalin, *Art & Physics - Parallel Visions in Space, Time and Light*, Perennial, 1991, p. 210

[26] "Empiricism", *Wikipedia,* 10 May 2006 <http://en.wikipedia.org/wiki/Empiricism>

[27] E.H. Gombrich, *Art & Illusion: a Study in the Psychology of Pictorial Representation,* Phaidon, 6th edition, 2002, p.271

[28] ibid, p.272

[29] Bohm et.al, pp. 39 – 44

[30] ibid, p. 85

[31] A. Miller, 'Visualization Lost and Regained', in J. Wechsler (ed.), *On Aesthetics in Science*, Birkhauser, 1988, p75

[32] ibid, pp. 75 - 76

[33] Bohm et.al. p. 20

[34] T. Kuhn, *The Structure of Scieintific Revolutions*, University of Chicago Press, 2nd edition, 1970, p. 175

[35] ibid, p. 149

[36] Often such thoughts or 'visions' can preoccupy my mind so that they appear all around me - for example I may be walking down the street and I suddenly see details associated with my idea throughout the environment (that I had previously never noticed) which appear magnified, sharper, brighter, almost whispering out the solution to my yet-unformed hypothesis! These ideas often form into an overall object, image or form, but the details will still be unclear. I may use traditional drawing tools and/or a computer with visualization software to try and create a generally concrete model of whatever it is in my mind, then fine-tuning it. This can be like playing a game with my unconscious, I won't know exactly what it should be like until I get it 'right', then at some point of adjustment I suddenly know it is correct, as though that was actually what my unconscious mind had been trying to tell me the whole time! This makes the production process quite fuzzy in terms of delineating the stages of formation, development and construction. Usually the state of my mind at these times of emerging ideas is highly energetic, sometimes allowing me to work on several different projects at once (for example the work leading up to 'Scrape' exhibition - although occasionally it can become too much to bear!

[37] N.K. Hayles, 'The Condition of Virtuality', in P. Lunefeld (ed.), *The Digital Dialectic: New Essays on New Media,* MIT Press, 1999, p.76

[38] Bohm, et.al, p. 130

[39] M. & I. Goldstein, *The Refrigerator and the Universe: Understanding the Laws of Energy"*, Harvard University Press, 1993, back cover.

[40] ibid, p.186

[41] W. Stephenson, "Electric Light of the Future, " in M. Seifer, *Wizard: the Life and Times of Nikola Tesla,* Citadel Press, 1999, p. 124

[42] The images showed regional 'styles' of textural form and a recurring universal constant. Each work consisted of two photographs (each 40 x 25 cm), most of which were photographs of walls with textual and textural markings on them - showing the tensions between visual information and noise. The pairing and overall arrangement of the works created a dialogue between each of the two, (in particular 'Auvergne wall meets Varanasi wall') and the series as a whole.

[43] I tried to make these forms look like a cross between an organism and a machine, but ended up looking a bit like a bone! One friend said it reminded him of the famous bone / spaceship cut in Stanley Kubrik's '2001', whilst another friend (a psychoanalyst) said it looked like a phallus, buttocks and breasts all in one (although I don't have the space here to get into that type of analysis)!

[44] Most of this was achieved in a highly energized mental state the week before the exhibition opening, and with intuition and luck, it worked!

[45] This was also meant to be projected on the opposing wall to the 4 dimensional animation sequences, and really enhance the 'other-worldliness' of the gallery space, but due to a lack of equipment, it was shown on a computer monitor.

[46] S. Walls, 'Fringe Art reviews', in *Beat* magazine, 01 October, 2001

[47] Kuhn, pp. 182 - 183

[48] B.M. Stafford, *Good Looking: Essays on the Virtue of Images*, MIT Press, 1996, pp. 22-23

[49] ibid, p. 23

[50] C.P. Snow, The Two Cultures and the Scientific Revolution, Cambridge, 1959, p. 13

[51] "The Sokal Affair", *Wikipedia,* 30 May 2006 <http://en.wikipedia.org/wiki/Sokal_Affair>

[52] C. Paul, *Digital Art*, Thanes & Hudson, 2003, p. 8

[53] D. Tofts' *Interzone: Media Arts in Australia*, Craftsman House, 2005

[54] Paul, p. 16

[55] R. P. Feynman, QED : The Strange Theory of Light and Matter, Princeton, 1985, p.118

[56] ibid, pp. 118 - 119

[57] ibid.

[58] H. R. Pagels, 'Uncertainty and Complementarity' in T. Ferris (ed). *The World Treasury of Physics, Astronomy and Mathematics*, Back Bay, 1991, pp. 98 - 103

[59] Stafford, p. 25

[60] Bohm et.al, p.181

[61] A particularly strange example I read about physicists' arrogance towards human reality is in relation to the 'symmetry breaking' event shortly after the creation of the universe according to the 'inflationary theory' of cosmic evolution. Shortly after the 'big bang', the universe existed in what is known among physicists as a 'symmetry paradise', where there was one 'grand unified force', and all matter had the same fundamental properties. Then, at 10^{-36} seconds, there was the 'Symmetry Breaking' event and the creation of different particles and forces that make up the universe as we know it. The effects of this event made the mathematics of particle physics very complicated, and has brought much woe upon the physicists. Ironically, according to these physicists, if the symmetry breaking event did not occur, they would not be here today, along with the rest of us and everything else!

[62] ibid, p. 24

[63] I was told this anecdote a physics student after a talk I gave about parallels in the history of modern art and science, in October 2005 at RMIT University.

[64] L. Shalin, p. 189

[65] ibid, p. 195

[66] Interestingly, this book reinforced the ideas in my own works, such as HyperCollider, (although I only read it after finishing the projects, perhaps another example of scientifically undetectable prescience?)

[67] A. Miller, p.76

[68] ibid, p. 77

[69] L. Shalin, p. 214

[70] ibid, p. 215

[71] I did some visualization and sonification experiments of Lorenz's discoveries of the strange behavior of data in hydrodynamics equations under certain conditions, known as 'strange attractors'. These proved to be interesting but a bit of a cliché (which demonstrates the ironic fate of a scientific paradigm that has been over-exposed in popular culture).

[72] B.B. Mandlebrot, 'How Long Is the Coast of Britain?' in T. Ferris pp. 447 - 455

[73] Stafford, p. 23

[74] ibid.

[75] Examples include the information visualization methods developed at MIT University by Ben Fry, and the research currently undertaken at the Spatial Information and Architecture Laboratory at RMIT University.

[76] "Famous Dreams and Dreamers", *The Dream Tree*, 5 December 2005 <http://www.dreamtree.com/Culture/Famous.htm>

[77] G. Chaitin, in M. Akiko & H. U. Obrist (eds.), *Bridge the Gap?*, Verlag der Buchhandlung, 2001 p.47

[78] ibid.

[79] ibid, p.219

[80] "Richard Feynamn", *Wikipedia,* 1 December 2005 <http://en.wikipedia.org/wiki/Feynman>

[81] B. Greene, *The Elegant Universe*, W.W. Norton & Company, 1999, p. 169

[82] R.W. Clark, *Einstein: The Life and Times*, Avon, 1971, p.270

[83] ibid, p. 414

[84] Due to the usual impossible deadlines, the image was made in one long night (perhaps an example of a human-scale time dilation!) It is interesting to note that as it was exhibited in the NGA elevators, the 'Smolin Multiverse Vortex' image was usually moving through space and time, which enhanced the vertiginous feeling of the vortex image. Sometimes one would literally fall towards the image (part of which was on the ceiling), and was thus it became a literal example of the equivalence of gravity and acceleration according to the theory of general relativity. Funnily enough, sometimes the image was opposite Jackson Pollocks' beautiful 'Blue Poles', and at other times it was across from the toilets!

[85] B. Greene, pp. 369 - 370

[86] Interestingly, the difference in scales between the 2 gigabyte (2,600,000,000 information units) file size of the image and the 5 megabyte (5,400,000 information units) file size of the web-based interactive provide a nice analogy for the difference between the cosmic and subatomic scales probed by relativity and quantum physics respectively (although the actual scale difference is an impossible to comprehend order of 10 to the power of 61, or 10,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000.)

[87] This was during a talk and demonstration I gave to the members of the Australian Physicists Association in February 2005.

[88] J. Gribbin, *In Search of Schrodinger's Cat*, Black Swan, 1984, p.259

[89] Feyerabend, p.28

[90] S. Maharaj in Akiko et.al, p.112

[91] A. Zeilinger in Akiko et.al, p.221

[92] Stafford, p. 23

[93] A. Tobin, *Bricolage*, Ninja Tune, 1997, back cover.

[94] 'Corrosive Rock', *Topologies*, 20 May 2006 <http://www.topologies.com.au/corrosive.htm>

[95] A particularly unpleasant example is chromosone 17p11.2, which is the location of Smith-Magenis syndrome, or SMS, a debilitating and often terminal disease.

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Appendix 2: Support material

Public presentations of projects and associated ephemera

Conferences:

'Wandering with Spinoza', Victorian College of the Arts, Melbourne September 2006

'New Constellations: Art, Science & Society', Museum of Contemporary Art, Sydney, March 2006

'Metis:time', National Museum of Australia, Canberra, May 2004

Exhibitions:

2005

'HyperCollider' exhibited at Macquarie University 'World Year of Physics Art Prize', Sydney, 'Davidian', RMIT Gallery, Melbourne, and Australian Synchrotron Open Day, Melbourne, and Exhibitions Gallery, Wangaratta

2004

'HyperCollider', exhibited at National Gallery of Australia & online at the National Gallery of Australia website and 'Symmetry' journal website

'Topologies' duo touring exhibition with Donna Kendrigan, Daylesford Convent Gallery, & Latrobe Regional Art Gallery

2002

'Feynman Field & Tesla Coil' exhibited at 'Prototype', Experimenta Media Arts program at Victorian Arts Centre Blackbox, Interact Festival

'Poly-Articulate', collaboration with Justin Clemens, John Meade and Andy Trevillian at Westspace Gallery, Melbourne

'Static', solo show at Linden Gallery, St.Kilda

2001

'Scrape', solo show at RMIT Union First Site gallery, Melbourne Fringe Festival

'Corroded Grooves' exhibited and performed at 'D.Art 01', D Lux Media Arts program, Sydney Exhibition Space

2000

'Corroded Grooves' exhibited & performed at 'Sonic Residues 02', Electroacoustic music program, Australian Centre for Contemporary Art, Melbourne

'Videoformes' media exhibition and music festival, Clermont-Ferrand, France

Young-hae Chang, *DAKOTA*

tile) 50Hz buzz, which is inflected and modulated as the image flickers and shifts. Hearing and vision get wired directly together through a single signal-abstraction.

Myriam Bessette's *Nutation* (Canada) approaches the same fusion, though less directly; a vertical band jumps and bends with the audio, twisting, braiding out into multiples and burning to white as noise bursts in the soundtrack. Here the sound/image relationship seems constructed rather than automatic, though the results look a lot like what Finnish minimal noise/techno outfit Pansonic did at the *What is Music?* festival earlier this year, running their chainsaw-tone generators through a video projector. Ian Andrews, the Sydney-based artists whose work featured in a retrospective this year, is on a related track. Some of his recent *Microsound* web works are also essentially synaesthetic data; flickers of ASCII and pixels oscillating in sync with jittering clicks and sound spasms (*transmission, k-88, channel-11, channel-66*). These are simple phase/permutation textures, layers of loops, but they accumulate into frantic, jumpy, surprising masses, with the loops' internal rhythms full of holes and changes. These works also show, incidentally, that Flash doesn't need to be dull and overdesigned—it's a great platform for ultra-compressed online audiovisuals.

So this is audio/visual synaesthesia, one of the touchstones of the electronic arts, a creative aim as old as the hills. More particularly though, it's a form of synaesthesia imagined or realised through the technical underside of electronic media: it routes signal and data from one sense-channel to another. Earlier versions of the synaesthetic ideal have imagined a kind of sublime sensory fusion or a perfect aesthetic whole—a *gesamptkunstwerk*. This is grittier, more concrete; a technical transcoding operation. In fact, this emergent digital synaesthesia isn't so much about sensory fusion, or sound/image, as the common structure underneath both sensory channels—the signal/data itself. Hearing and vision are channels for apprehending that basic, raw material.

Back to data, which is all through d>art. Kawai Masayuki's video *a not = a or For Devatas who Keep on Dancing* (Japan) is constantly breaking down into spastic—and artfully degraded—visual signal. Aphorisms damning the mass media are drolly intoned over scrolling, flickering noise: "only the moment when video completely denies itself…is the Art in the virtual image of the Revolution." I'm not sure that this data.art is self-denial, though, more a symptom of a broader engagement with media substrata, a process where the floods of data underpinning our culture seep into sensory and aesthetic experience. Meanwhile [mez] writes *Data[h!][bleeding T.ex][e]ts* (Australia), densely encrypted realisations of language-becoming-information. Chris Henschke frames his sound interactive *Corroded Grooves* (Australia) citing Katherine Hayles, and calling for the breakdown of "culturally-imposed structuralist dichotomies such as information/materiality, pattern/randomness, information/noise." *Corroded Grooves* goes about this in the same way as a lot of post-techno experimental audio; noisy, gritty beats and loops, tone and melody submerging under layers of detritus. Digital sound, but soaked in the sounds of material and media-decay. This is a solid addition to the growing genre of mix-and-loop audio interactives, with an intricate interface and a tastefully grubby sound; pity that, when I visited, the amplification was turned down too low for it to be really enjoyable.

Of course these 2 threads don't account for the whole collection, by any means. Among the highlights on other tracks were Young-hae Chang's *DAKOTA* (South Korea)—a stunning piece of online performance poetry; screen-high text (Flash again) stepping past to a fierce soundtrack of looped jazz-drum licks. Beautiful for its simplicity, and sheer impact, this is a wild ride—it's so rare to feel 'glued' to a computer screen. Also notable for visual and interactive suppleness was the Glaser/Hutchison/Xavier project *Juvenate* (Australia), a textless web of mobile imagery and video on memory, illness and childhood. Still in memory-space, Richard Grant's videoclip for Japanese dark ambient outfit Maju is superb. *Pale Blood Coloured Recollections* (Australia) feels like an audiovisual stream of remembrance—8mm film worked into dense, permeable, labile textures, flashes of free association and perceptual noise. It's digital synaesthesia again, but intricately wrought rather than elemental; this was the most visually luscious work in the collection. Alongside pieces like Stanza's *Central City*, it suggests a ratcheting-up of the aesthetic density, sophistication and fluidity of digital media practice.

While *d>art* was a rewarding collection, it could certainly stand to be smaller and more consistent in quality. There are also serious problems with the exhibition format; the Customs House space is too small to accommodate 30-odd CD-ROM, web and sound works. Packing them onto machines, screens and listening booths got them in, but the result is oppressively dense (the busted air conditioning didn't help). I haven't reviewed the sound works here because I didn't hear them—2 CD players with headphones, in a room already full of people, machines and sound, is just not a conducive way to present audio work. Maybe dLux should consider pressing a CD compilation (cheap, these days) or better yet, put the audio online? It's a very valuable undertaking, sifting and presenting this mass of work, but the results need to be more easily digestible.

d>art 01, *Sydney Film Festival & dLux media arts, exhibition: sound/CD-ROM/internet, City Exhibition Space, June 10 - July 1; screenings: film/video/animation, Dendy Opera Quays, Sydney, June 15 & 19*, www.dLux.org.au

'Realtime' review of 'Corroded Grooves', August / September 2001

'Scrape' exhibition invite, 2001

SCRAPE

Until Oct 12 at RMIT First Site Gallery

After seeing *Scrape*, my definition of art now involves the word "interactivity". RMIT digital imaging and sound design lecturer, Chris Henschke, presents this interactive exhibition at the RMIT First Site Gallery, in which he uses modern technology to explore the relationships between aural, visual and tactile media, so rather than just viewing art the audience becomes involved in a complete sensory experience.

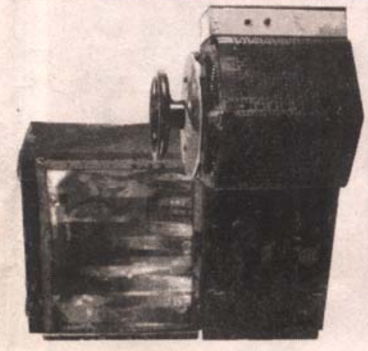
The first thing that I noticed when entering the exhibition is the Electrical Room; a pseudo-historical laboratory that contains artefacts of obsolete electrical information equipment. Loaded with a mouse and observing the images on the computer screen, the user is given the opportunity to manipulate their surroundings, which soon develop from just "a room" into an innovative environment containing the static sounds of 'Corroded Grooves' – "collisions of obsolete and future technologies".

These sounds seem at first a little "user-unfriendly", but the visitor soon becomes accustomed to the environment as their senses are further stimulated. One feature that works particularly well is the large plasma screen, occupied by a three-dimensional reel of stunning cascading images that can be accompanied by your own personal soundtrack, as you chose to add various musical elements.

Although these interactive elements are the more exciting features of the exhibition, it is the combination of sensory and non-sensory (digital prints) mediums that help to achieve the overall effect, which is inspirational both to the graphic artist and the artist in general.

STEPHANIE WALLIS

Scrape beyond the screen



In these times where Internet dating is more popular than the real thing, you receive more mail to your inbox than your letterbox and SMS messaging is a valid form of dumping someone, one multimedia exhibition begs you to come out from behind you username and really interact. *Scrape*, a collision of obsolete and future technologies, invites you to get physical.

In describing his exhibition, artist Chris Henschke says: "Instead of always using a keyboard and mouse, *Scrape* encourages people to play around, struggle with computers, you actually have to turn knobs and twist things. I am trying to breakdown the publicly projected image that computers are so friendly."

Scrape is the result of a "backlog of years of stuff in my head. I try and understand myself and then illustrate these ideas."

So just what's in Chris's head?

Scrape is a collection of multi-sensory reactive spaces where it is up to the audience to create the mood through interaction with tactile, aural and visual cues. In the main gallery, you can play record-like objects such as rusty clock faces, burned-out clutch plates, sander sheets and hand-pressed vinyl on antique turntables. These textures are translated by a user-hostile computer interface into fragmented rhythmic and melodic loops or 'Corroded Grooves'. Henschke explains he is "trying to find meaning or language that is embedded in these surfaces."

Do you want people to interact with your work at 33, 45, or 78 rpm? "Depends on their mood," says Henschke.

The most enigmatic of the rooms is the non-cartesian animated space: portrayed as many dimensions inhabited by many entities where the audience can create their soundtrack using musical elements supplied by Henschke, Dave Brown and Darrin Verhagen.

A veritable mad professor's historical laboratory awaits you in the 'Electrical Room', where outdated devices such as a bakelite radio and old-fashioned electric meters are imbued with some surprising high-tech enhancements. It allows you to "reflect back on where we've come from...we were doing just fine until computers came along" and to "look at different ways of interacting with technology without having to use a computer," says Henschke.

Who does Henschke hope will participate in this feast for the cochlear and retina? It's not just for tech-heads, in fact it's for people who feel disempowered by computers - "anyone from the street can walk in and interact with the exhibition without having to login."

REBECCA COOK

Don't miss the opening night extravaganza with Lazy playing @ 6:30pm (exhibiton opens at 5.30pm), Tuesday, October 2.

Scrape runs from Oct 2 – 12, First Site RMIT Union Gallery Basement, 344 Swanston St, Tuesday – Friday 11am – 5pm, Saturday & Sunday 1pm – 5pm.

'Beat' reviews of 'Scrape' exhibition, September / October 2001

Chris Henschke

Chris Henschke is a masters student and lecturer in digital imaging and sound design at RMIT (Royal Melbourne Institute of Technology). His S C R A P E exhibition was recently part of the Melbourne Fringe Festival combining digital artworks with interactive audiovisual displays.

Workflow

Henschke usually starts by composing an image in his head, then scans in bits and pieces of raw material and experiments with them in Photoshop.

'I also try to contrast that', he explains, 'by re-working the ideas on paper, but terrifyingly, I find that I now seem to be able to draw better with a mouse than a real pencil!'. Henschke will spend weeks or sometimes even months working on several images simultaneously:

'I can return to an image a thousand times, trying a million combinations and variations. This can be a danger of the digital world: you can get lost in the microscopic details and spend hours working on something, and then when you zoom out, you realise you have been working on one inch of the overall image. I find it important to always go back to the macroscopic level and get an overview of the piece before diving back down.'

Untitled Collage (strain 1)
A 'remix' or 'mutation' of the space taken from the 'Birth of a Virus' image. The fragments taken from an old computer punchcard is a reference to the birth of the computer era.
(above left)

Untitled Collage (strain 2)
Another variation on the 'Birth of a Virus' space featuring an old pipe size conversion chart embedded in it.
(above)

Digital tools

Depending on the nature of the project, Henschke may use any number of different digital tools. 'One day I may be creating animations and use After Effects or possibly a 3D package. I sometimes use 3D modelling software to create objects or even to lay out a 2D image. For interactive works I always work with Director—it can be a monster to work with, but it does bring things to life.' Henschke also works with sound and enjoys the layering and sequencing involved working with audio compositions.

'Then there's the Photoshop', says Henschke, 'which is something I can always depend on—it's the most traditional and stable of these digital tools!'.

Inspiration

A lot of Henschke's recent works have been inspired by Nikola Tesla and Wilhelm Reich—artists of a scientific nature. Tesla would demonstrate his electrical apparatuses by charging himself up with them until he was surrounded by a glowing aura and would then shoot lightning bolts out of his hands and across the spellbound audience!

'Such things have inspired me', explains Henschke. 'When I demonstrate my interactive turntable installation, which allows the audience to digitally extract and mix sounds taken from rusty metal discs and sandpaper sheets, I like to set fire to the record players. It gives a form of energy and life to the sound being created—you can actually hear the record melting!'.

Birth of a Virus
Inspired by the work of a colleague (also the bass player in his old band 'Crank') who investigates the way viruses mutate at the CSIRO Biomolecular Research Institute. Descriptions of the viral universe ('Gene Space'), led Henschke to visualise the moment when viruses spontaneously mutate into new strains.
(above)

Contact details
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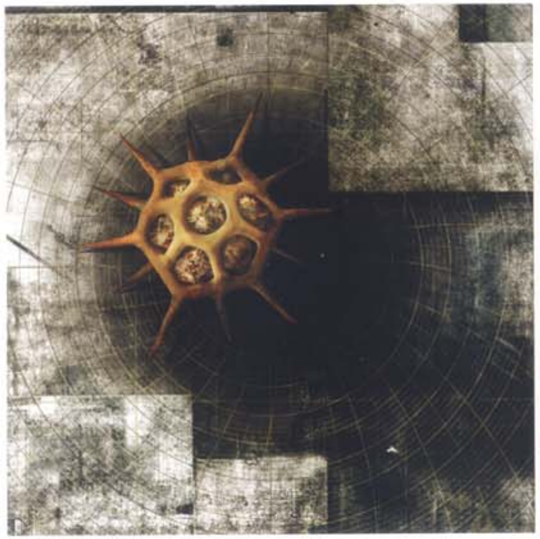
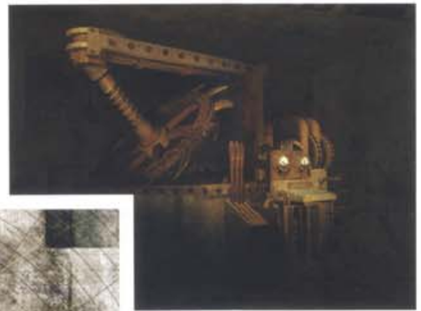
Web: www.chaoscillator.com/scrape/

'Design Graphics' review of 'Scrape' exhibition, issue 76

SCRAPE

Digital media artist and RMIT lecturer Chris Henschke talks to Gillian Bartlett about putting his love/hate relationship with technology on show at the Melbourne Fringe Festival in his multimedia exhibition, SCRAPE.





By "acoustically recycling record-like found objects", such as rusty clock faces and sandersheets, then feeding the sounds into "a user un-friendly computer interface", Henschke intends to create "unstable musical hybrids", forming "a sonic spectrum between information and noise, order and chaos, loosely titled Corroded Grooves.

→ Aural stimulation is just part of this multi-sensory mystery tour through collisions of obsolete and future technologies. Hoping that it will challenge "the nature of art and the traditionally passive role of the audience," Henschke sees the exhibition as an exploration of "correspondences between aural, visual and tactile media in a way that rejects the current trends of hyperslick design and technophiliac elitism."

→ Hmm, some of my best friends are hyperslick technophiles...

What's the set up? The gallery is divided into three rooms, loosely grouped into the themes of past, present and future.

→ In the 'past room' the audience will have to manually engage with various antique mechanical devices, such as resistometers, electrical demand meters, pressure gauges, x-ray light boxes, Morse code relays and AM/SW radiograms. These artefacts of "obsolete electrical information technologies" require audience interaction for the visual and audio content to be revealed.

→ Digital image transparencies are placed in the viewing areas of these devices. When a button is pressed, a custom-made microchip circuit plays various soundtracks and sets off animated sequences of light, causing the images to become dynamically illuminated.

→ In the 'present area' are 10 large photographic works and an interactive turntable installation.

→ In the 'future zone', a series of digitally created images are displayed on the walls in hand-made light boxes. On the two walls at either end of the gallery are digital video projections incorporating components of the light box images.

→ Across the floor of this space is a grid of lasers, positioned such that when the audience approaches certain light box images, corresponding sound and digital video sequences are triggered. The audience interacts with these projected scenes, and creates their own soundtracks, moving through the digital spaces taken from the images.

In words that won't send our readers running for the dictionary, what is SCRAPE actually about? Not wanting to be too academic or reductionist, the exhibition can be described as a series of 'postcards' of my attempts to understand and illustrate certain connections or relationships that I keep noticing. These connections may be between various seemingly unrelated objects or bits of information, and also between the senses (sight, sound, smell, touch etc).

Is the exhibition just a good excuse to clean out the garage, or does it have something relevant to communicate? What's wrong with cleaning out the garage? Pablo Picasso and Marcel Duchamp (to name-drop a couple of rock stars) did some great things with stuff they found in their garages! Seriously though, the things in our garages can tell us a great deal about ourselves.

→ The half-forgotten and semi-discarded objects from our lives are like a set of specimens of our personal and collective histories, they allow unique insights into where we have been, and point to where we are going.

No self-respecting exhibition would be caught dead without a soundscape or soundtrack these days: Why is that? Sound communicates emotion. Sound is also BIG. Images are always a finite size and are usually quite small (especially if you're on a budget!), but sound can be infinitely large! (real value for money!)

Titles like "birth of a virus" and "evil machine" point to a rather dark obsession with technology. Lie down on the couch and tell us about it. Living in an era where we have technologically pushed ourselves close to extinction, the promises that technology will give us all freedom and happiness have a hollow ring to them.

→ A recent global survey found that people living in technologically advanced societies are actually less happy and more stressed than people living in more 'traditional' societies!

→ Ironically, technology is largely driven by inhuman, greedy and boring corporate or military powers.

→ People who have access to current technology find themselves quickly becoming miserably dependent on it and end up spending their lives in front of a screen, whereas those who do not have access to technology become further marginalised and socio-economically disadvantaged! Trying to extract some meaning or sense from such ironic environments tends to lead to the creation of unsettling hybrids of positive and negative.

Would you rather live in a world without machines? This is one of those questions that belong in the 'fantasy' genre! I would rather have two worlds, one which is a garden-of-eden style paradise, free from human made devices, and a hellish world entirely constructed out of endless screaming machines, just to make a nice contrast!

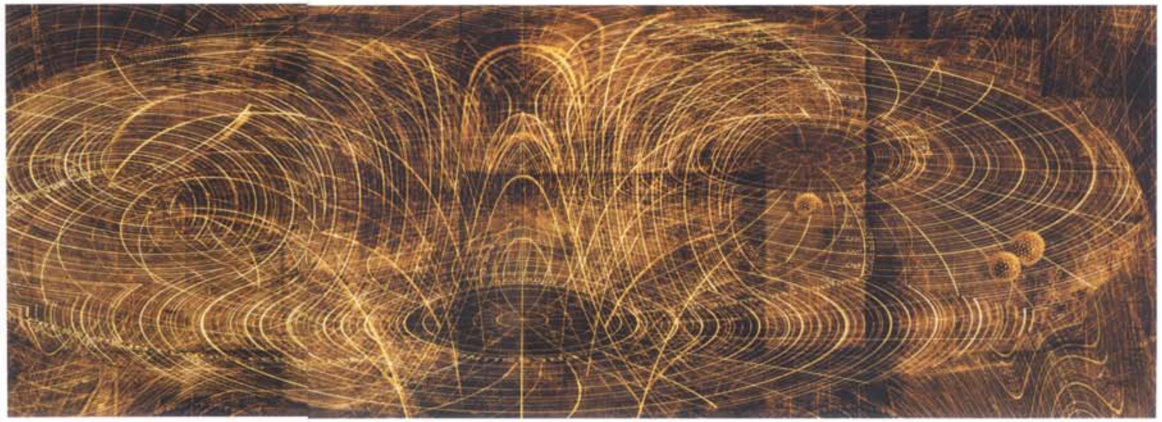
How will the exhibition challenge the nature of art? 'Art' is traditionally something hung out of reach in big silent halls, but increasingly it requires people to touch it and make loud noises come out of it!

In launching such a multi-sensory attack are you attempting to control your audience's experience? An increasingly culturally sophisticated public demands a more immersive exhibition environment. Allowing the audience to interact with art, and to create their own, breaks down the hierarchy of artist over audience, and the subjective nature of experience (whether in a gallery or down the street) means that everyone will have a different and unique experience. If I wanted to control the audience, I would have to be them to a chair and submit them to a series of intense 'Skinnerian' mental and physical stimuli!

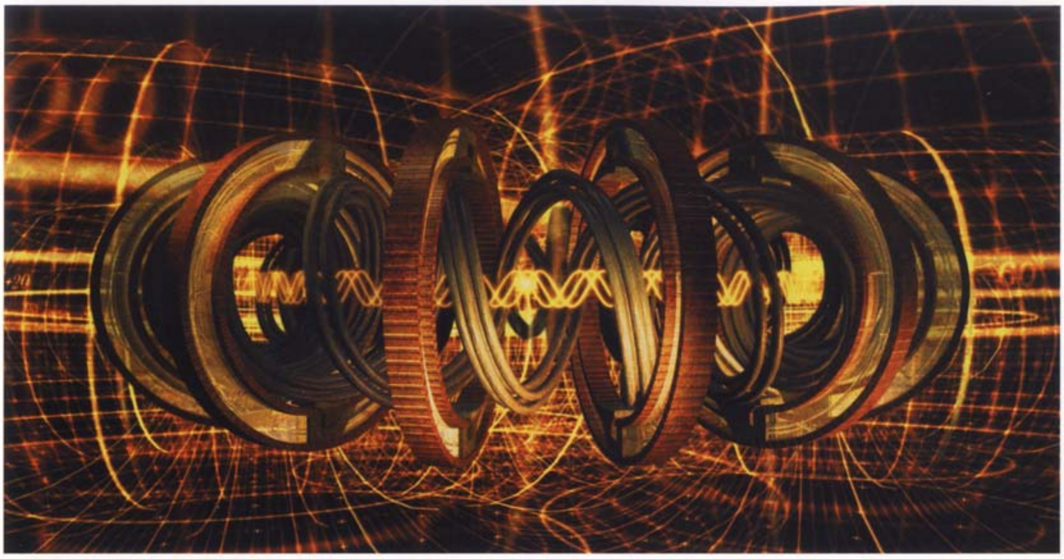
What is your vision of the future in terms of technology and design? The future of technology and design will be faster and slicker, yet more complicated and have less content, thus both sides will end up cancelling each other out. Overall, it will be the same old shit in fancy new packaging! ●

SCRAPE runs from October 2 – 12 at RMIT Union Arts and First Site Gallery, as part of the Melbourne Fringe Festival. Chris Henschke is also presenting Orchestra of Rust in the Experimenta Interactive Media Lounge from October 18 – November 3 at Black Box in the Victorian Arts Centre.

"'Art' is traditionally something hung out of reach in big silent halls, but increasingly it requires people to touch it and make loud noises come out of it!" Chris Henschke.



'Desktop' review of 'Scrape' exhibition, issue 174



Tonal Field Navigator Chris Henschke 2002

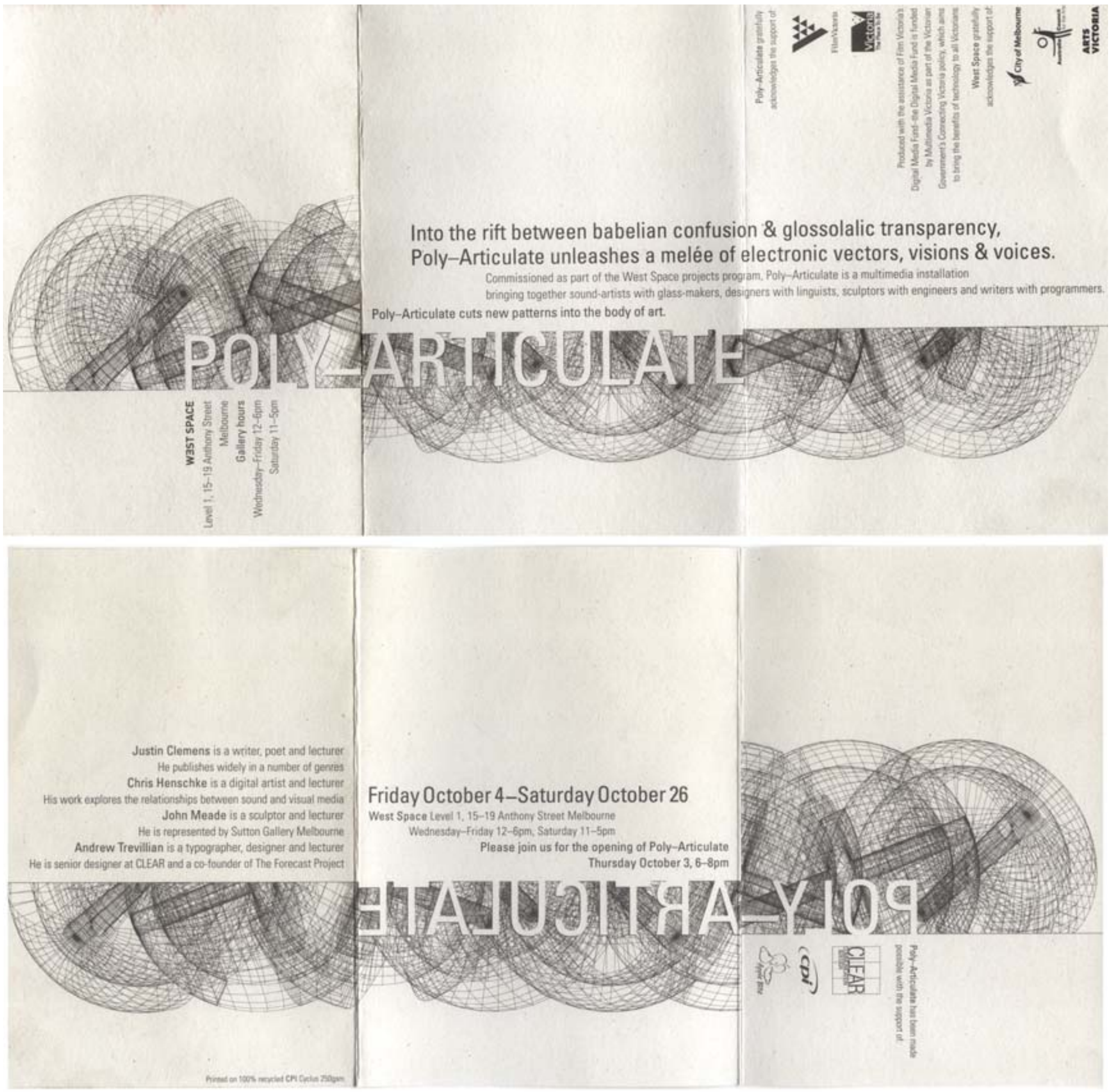
The *Tonal Field Navigator* is an obscure scientific device and musical instrument, projected into a silvered glass hemisphere so that it appears to float like a hologram. When the audience place their hands into the projected hologram, infra-red sensors are triggered, the hologram starts to spin and a three-dimensional projection on a rear screen moves through a rich and imagined landscape. Waves of sound sweep over the audience as they explore these environments, immersing them deeply within endless acoustic spaces.

Taking inspiration from Nikolai Tesla's 'electrical sorcery', quantum field theory and Heisenberg's uncertainty principle, the *Tonal Field Navigator* explores the view that everything can be visualised as energy waves and fields differentiated by frequency. The electromagnetic, gravitational, nuclear and quark forces of the quantum universe are interpreted and remapped in a way that gives them a compelling aural and visual form and invites exploration.

Sound by Darrin Verhagen, David Brown and Chris Henschke; Programming by Ken Mok and Chris Henschke.

Chris Henschke is a Melbourne based artist who has been working with digital media since 1993. His main areas of research are in experimental virtual environments and interactive sound installations. His works have been shown in various Australian and international exhibitions including the Australian Centre for Contemporary Art, Videoformes 2000 (France) and MILIA 99 (Cannes, France). He is currently a lecturer in interactive sound design and digital imaging at RMIT, where he is also undertaking a Masters by Research in Animation and Interactive Media.

Experimenta 'Prototype' catalogue, August 2002



‘Polyarticulate’ exhibition invite, 2002

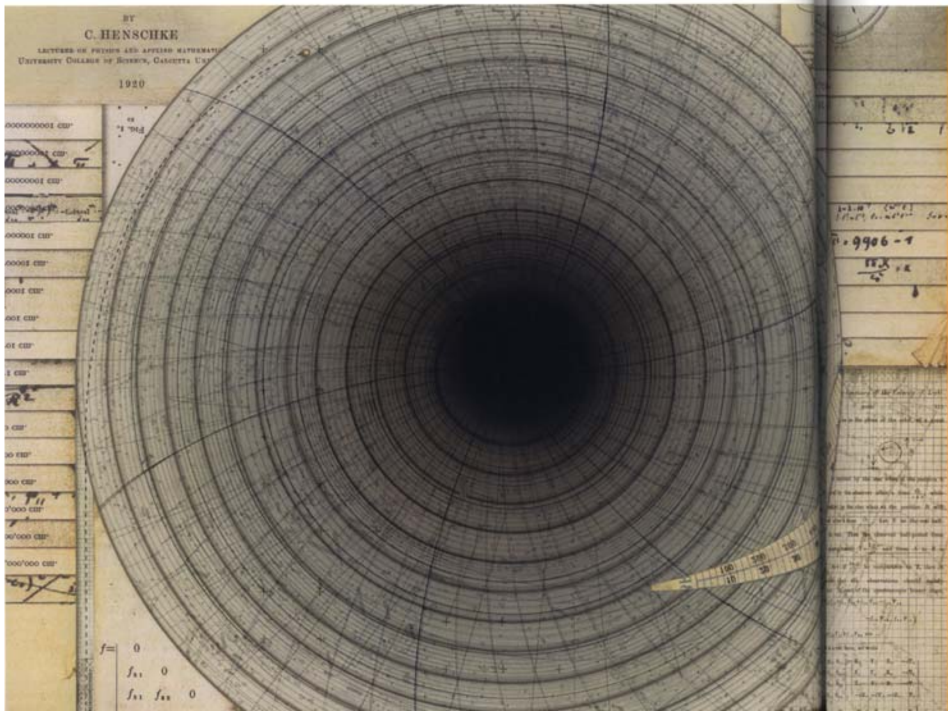
'Metis' publication, May 2004

CHRIS HENSCHKE

HYPERCOLLIDER

HYPERCOLLIDER :: CHRIS HENSCHKE :: IN 1907, THE YOUNG ALBERT EINSTEIN PUBLISHED A PAPER WHICH SHOWED THAT TIME AND SPACE ARE FUNDAMENTALLY INTEGRATED, AND THAT MOVEMENT THROUGH ONE AFFECTS MOVEMENT THROUGH THE OTHER. THIS DESTROYED THE CLASSICAL NOTION THAT THE PROGRESSION OF TIME IS CONSTANT AND UNCHANGEABLE. EINSTEIN PROCLAIMED THAT ALL OBJECTS IN THE UNIVERSE ARE ALWAYS TRAVELLING THROUGH SPACETIME AT ONE FIXED SPEED: THAT OF LIGHT. ACCORDING TO EINSTEIN, IF SOMEONE WAS ABLE TO TRAVEL AT 99.999% THE SPEED OF LIGHT FOR THE DURATION OF SEVERAL DAYS, MILLIONS OF YEARS COULD PASS FOR SOMEONE ELSE TRAVELLING AT A RELATIVELY SLOWER VELOCITY.

CHRIS HENSCHKE
HYPERCOLLIDER (TONEARM) 2004
STILL IMAGE FROM ONLINE INTERACTIVE
COURTESY THE ARTIST



A few years later, Max Planck, the father of quantum physics, determined that the smallest possible unit of time is about 0.0000000000000000000000000000000000000000001 of a second. Albert Michelson measured the speed of light to be 299792458 metres per second, evidently the fastest possible speed in the universe. Midway between these poles of spacetime exists the universe we know, but what happens when one approaches such extreme limits?

HyperCollider is an online project that probes such limits through the use of sound, image, motion and interactivity. It playfully investigates Einstein's theory of general relativity and its extreme cosmological conclusions which Einstein himself initially refused to believe, dubbed the 'three gates of time'—the big bang, the big crunch, and black holes. It explores the concept of spacetime geometry and creatively visualizes what may happen when velocities approach the speed of light and how spacetime warps around a black hole.

This virtual instrument is a hybrid of an old fashioned pinball machine, gramophone player and a contemporary particle accelerator, using elements taken from early 1900s scientific texts on relativity. The device utilizes the universal constant of the speed of light, much as physicists do when probing the limits of temporal and spatial scales. As in a particle accelerator, the audience, or users, are able to shoot photons of light and other particles into the device at different velocities and observe what happens to them.

Visitors to *HyperCollider* are given a multi-perspective, non-linear, interactive experience. Each participant is given the option of different viewpoints—outside the device, in the space within the device, and from the particles flying through the space. From such different points of reference, the relative changes in time become clearly evident to the observer. A fluid sense of time is enhanced by action replays at 99.999% the speed of light, while clocks and counters measure the different flows of time for stationary, slow and ultra-fast moving objects. The clocks age and corrode to emphasize these extremes. Also lurking within the depths of the device are the actual equations and formulas devised and handwritten by Einstein; interesting but generally incomprehensible to the layperson.

The work is digitally constructed using 3D modelling software to create a virtual environment in which observers can move about and interact. It allows online users to log in from varying time zones in different geographic locations.

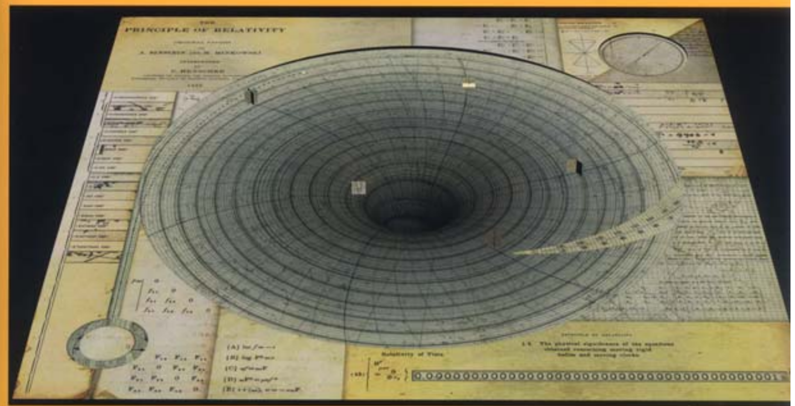
'Metis' publication, May 2004

CHRIS HENSCHKE
HYPERCOLLIDER 2004
STILL IMAGE FROM ONLINE INTERACTIVE
COURTESY THE ARTIST

00:33 → As this exploration into physics stems from a pop-science perspective, its sound component also refers to popular music relating to the eras the user moves through when interacting with *HyperCollider*. This serves as an acoustic reference point for movement through time, i.e. starting in the early 20th century when Einstein published his theories of relativity, and potentially ending up in an acoustic environment a million years into the future.

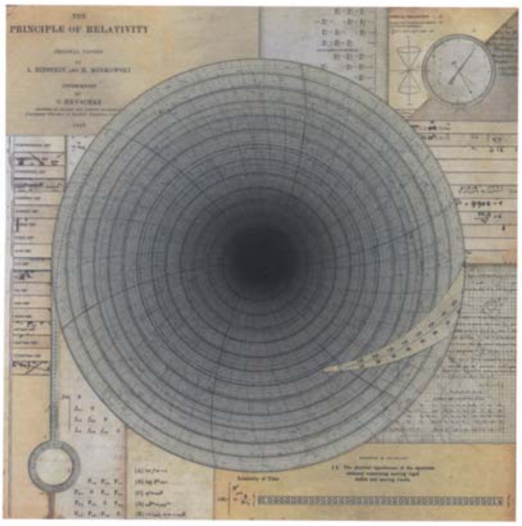
HyperCollider is exhibited at nga.gov.au/spatial. This domain is a new initiative at the National Gallery of Australia providing an online environment for the exhibition of electronic works of art. Concurrent to the virtual manifestation, *HyperCollider* also exists temporarily in material form as large scale, panoramic prints of the device and the space within it. These visual moments in spacetime are displayed as part of the Gallery's Lift Art project where the elevators' traffic and trajectory heighten for passengers the sense of movement through time and space.

There is an irony expressed in *HyperCollider* about how science attempts to understand and explain the world around us, but can in fact further mystify it to the uninitiated. As multi-billion dollar particle accelerators are built to explore the fundamental elements of our universe and ourselves, increasingly exotic theories are being spawned to explain it all. Superstrings, ten-dimensional space and multiple universes make Einstein's theories seem old-fashioned in comparison, and they are. Relativity is nearing its 100th birthday, and the worlds of science have become a lot stranger since then.



CHRIS HENSCHKE
HYPERCOLLIDER (OVERVIEW) 2004
STILL IMAGE FROM ONLINE INTERACTIVE
COURTESY THE ARTIST

Metis' publication, May 2004

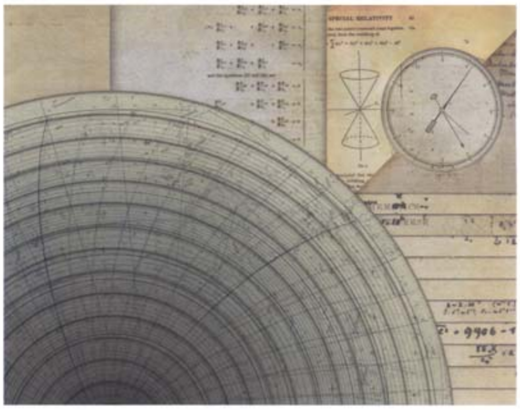


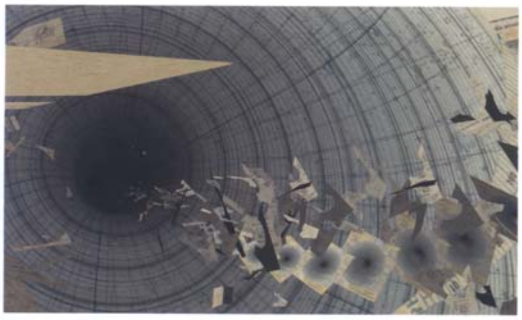
HyperCollider by Chris Henschke Commissioned by the National Gallery of Australia for the Metis 2004 exhibition.

→ When a young Albert Einstein published the theory of general relativity in 1908, he proclaimed that, "All objects in the universe are always travelling through space-time at one fixed speed – that of light. The speed of an object through space is... merely a reflection of how much of its motion through time is diverted." (Brian Greene, The Elegant Universe, p.50) A few years later, Max Planck, the father of quantum physics, determined that the smallest possible unit of time is about 0.0000000000000000000000000000000000000001 of a second (called 'Planck time'). Albert Michelson measured the speed of light to be 299,792,458 metres per second – evidently the fastest speed attainable. Midway between these poles of space-time exists the universe we know, but what happens when one approaches such extreme limits?

→ *HyperCollider* probes such limits through the use of sound, image, motion and interactivity. It playfully investigates Einstein's theory of general relativity and its extreme cosmological conclusions, which Einstein himself initially refused to believe, dubbed the 'three gates of time' – the big bang, the big crunch and black holes. This virtual instrument is a hybrid of an old-fashioned pinball machine and a contemporary particle accelerator, using elements of early 1900s scientific texts.

→ Visitors to *HyperCollider* are given a multi-perspective, non-linear, interactive experience. Each participant is given the option of different viewpoints – outside the device, in the space within the device and from the particles flying through the space. From such different points of reference, the relative changes in time become evident





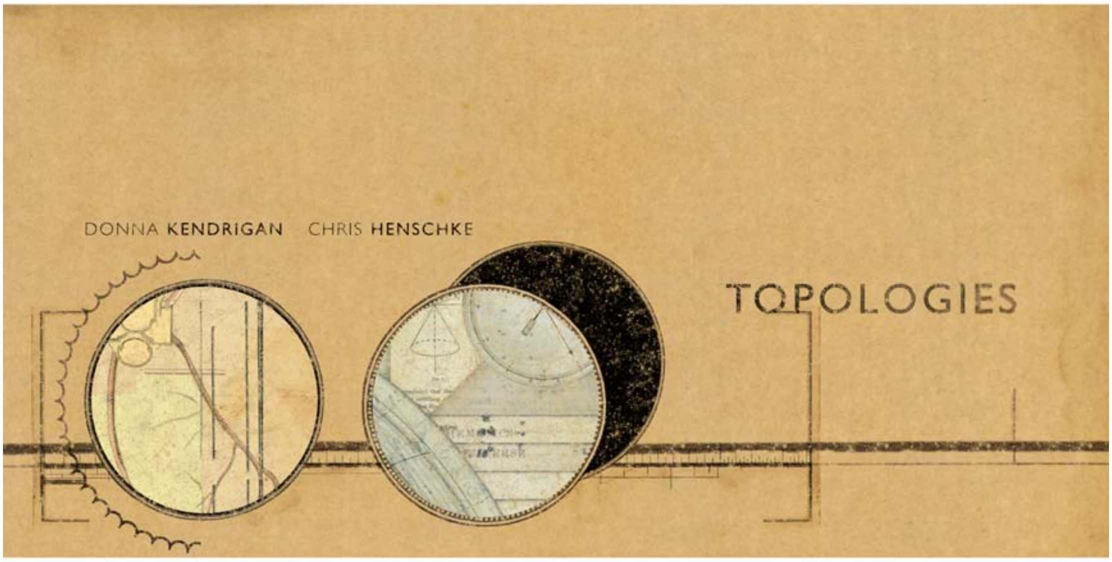
to the observer. A fluid sense of time is enhanced by action replays at 99.999 percent of the speed of light, while clocks and counters measure the different flows of time for stationary, slow and ultra-fast moving objects. The clocks age and corrode to emphasise these extremes. Also lurking within the depths of the space are the mathematical formulas and equations devised and handwritten by Einstein – interesting, but generally incomprehensible to the layperson.

→ As this exploration into physics stems from a pop-science perspective, its sound component also refers to popular music, relating to the time period that the user moves through when interacting with *HyperCollider*. This serves as an acoustic reference point for movement through time, i.e. starting in the early 20th century when Einstein published his theories of relativity, and ending up in a sound environment a million years into the future.

→ *HyperCollider* manifests in the form of a standing pinball machine. To launch the work, one pulls back on a spring-loaded trigger, as one would with a pinball game in order to shoot off the steel ball. The main interface of the work is projected from below onto a custom-made screen on top of the machine. A smaller LCD screen is embedded within the machine. ●

For more information about the tour visit <www.topologies.com.au>.

'Desktop' review of 'HyperCollider', issue 200

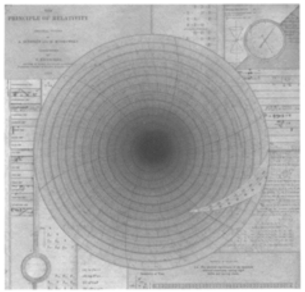


'Topologies' exhibition invite, 2004

Chris Henschke & Donna Kendrigan

TOPOLOGIES *Interactive Exhibition*

Toured Victorian Regional centres 2004-2005
Daylesford Convent Gallery, Daylesford, 5 November – 9 December 2004
La Trobe Regional Gallery, Morwell, 18 December 2004 – 13 February 2005
Exhibitions Gallery, Wangaratta, 22 April – 8 May 2005
by Julie Turner



Left: *Chris Henschke*
Image from HyperCollider interactive (top view)
Lambda Duratrans print in lightbox
22 (W) x 22(H) x 12(D) cm
Image courtesy the artist

Topologies featured two interactive works, *HyperCollider* by Chris Henschke and *Transplants* by Donna Kendrigan.[1] Both played with science fiction and scientific theory, sharing a fascination with the aesthetics and technologies of 19th and early-20th century science. *Topologies* toured Victoria's Daylesford Convent Gallery, La Trobe Regional Gallery and the Exhibitions Gallery, Wangaratta, from November 2004 through to May 2005.

The works located the exploration of scientific theories in a playful post-modern era. *Transplants* took the form of a botanical catalogue found in a fantastical, genetically modified garden of the far future (portions of the catalogue were revealed when specific plants within the virtual garden are investigated). Similarly, *HyperCollider* explored Einstein's theories of special and general relativity within the confines of an impossible machine; one that posed as contemporary yet was an absurd hybrid – part 1930s pinball-machine, part 1950s particle-accelerator.

Transplants – experienced on a touch-screen built into an old-fashioned, eccentric botanical cabinet – initially revealed via screen and voice-over the flowery, loquacious text of Adam Browne's short story (its inspiration). The user then explored a beautifully designed, map-like aerial view of a garden. On closer inspection, the map represented human bodily activity – breathing, twitching, pulsing. Upon selecting certain images, one discovered meticulously textured and animated flesh-botanical creations: grapey bunches of eyes, oozing kidney plants, hearty hearts pumping and murmuring sweet nothings. Unnerving organic sounds and witty, mock-scientific plant studies accompanied them, parodically nostalgic for dusty botanical catalogues and fading diagrammatic medical studies.

HyperCollider was encased in a wooden, exact-replica, German pinball-machine of the 1930s, complete with spring-loaded trigger, playfully investigating Einstein's theory of general relativity and its extreme cosmological conclusions. A hybrid of pinball game, gramophone player and particle accelerator, *HyperCollider* was created from a collage of Einstein's relativity papers and handwritten notes, pressure graphs and star charts. *HyperCollider* allowed 'players' to launch various particles into its theoretical universe, to collide into each other and get pulled into a black hole, where spatial and temporal dilation effects were observed. By bouncing particles into the black hole, players could move through time into an increasingly uncertain future. This was set to a 'pop-science-pop-music' soundtrack that oscillated between sounds recorded in the early 20th century and those seemingly made a million years in the future.

Audiences responded enthusiastically to the works. At Daylesford, the works stood at either end of a long, narrow and darkened space under the convent eaves, linked by glowing light-boxes featuring details from the works. La Trobe Regional Gallery was huge in contrast and yet the works and light-boxes, together with illuminated microscope slides and related ephemera, drew users invitingly through the space. In both instances, people clustered together, experiencing the works in groups of twos and threes, laughing, commenting and taking turns. Curators of both galleries commented on how 'active' the works were, firmly drawing observers into hands-on interaction via the works' compelling soundtracks, elegantly wrought images and clever wit.

It is worth noting the keenness of many less computer-literate viewers of the exhibition. While younger viewers spent a short time with each interactive before moving on, some of the most engaged and enthusiastic feedback came from older or less 'contemporary art savvy' people who took pains to explore every facet of the works and the ideas on which they were based.

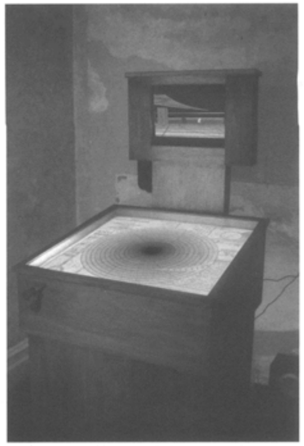
Further information can be found on the website
www.topologies.com

Julie Turner is a Melbourne based writer and editor with interests in film, comedy and interactive art.

<note>

[1] Chris Henschke was commissioned by the National Gallery of Australia and Donna Kendrigan's work was funded by the Australian Film Commission.

Below: *Chris Henschke*
HyperCollider pinball machine, 2004
Interactive housed within a custom-made 1930's German-style pinball machine cabinet
66(W) x 163(H) x 63(D) cm
Image courtesy the artist



Bottom: *Donna Kendrigan*
Image from Transplants interactive
Lambda Duratrans print in lightbox
27.5(W) x 27.5(H) x 9(D) cm
Image courtesy the artist

'Unmag' review of 'Topologies' exhibition, issue 4

RMIT Gallery

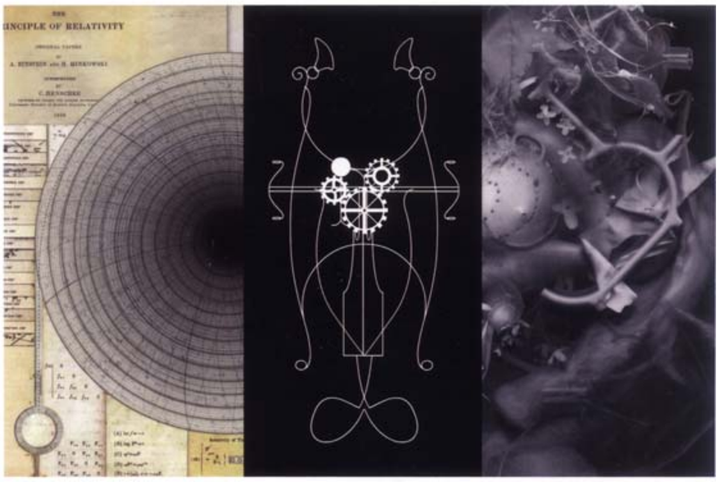
The RMIT Gallery Board and the
RMIT Gallery Director, Suzanne Davies
have great pleasure in inviting you
to the opening of

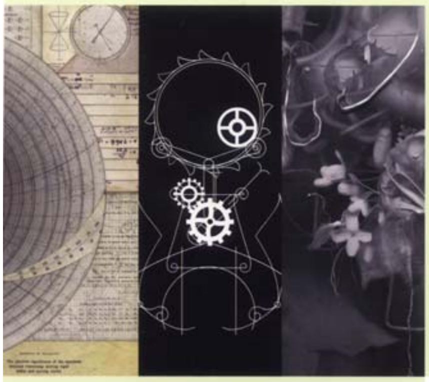
CHRIS HENSCHKE
LYCETTE Bros
MURRAY McKEICH

DAVIDIAN

To be opened by
Senator The Hon. Rod Kemp
Minister for the Arts and Sport

Opening Tuesday 15 November 6 – 8 pm
RSVP 03 9925 1717 / rmit.gallery@rmit.edu.au
Exhibition dates 10 – 19 November 2005





CHRIS HENSCHKE
LYCETTE Bros
MURRAY McKEICH

DAVIDIAN

10 – 19 November 2005

Images (l–r)
Chris Henschke, *HyperCollider* (detail), 2004, digital collage
Lycette Bros, *The Modern Compendium of Miniature Automata*, (detail) 2003 screen images of digital interactive
Murray McKeich, *A0013100* (detail), 2005, digital photomedia

RMIT University

RMIT Gallery

RMIT Gallery RMIT Storey Hall
344 Swanston Street, Melbourne 3000
Tel: +61 3 9925 1717 Fax: +61 3 9925 1738
Email: rmit.gallery@rmit.edu.au
Website: www.rmit.edu.au/rmitgallery
Monday–Friday 11–5 Saturday 2–5
Closed Sundays and Public Holidays
Lift access. Free admission

Public transport RMIT Gallery is situated on Swanston Street near the La Trobe Street intersection. The building is located diagonally opposite Melbourne Central and can be reached by trams travelling on Swanston and La Trobe Streets, and the City Circle. **Parking** Four commercial parking stations are located within a two minute walk of the gallery and metered parking is available in Swanston, La Trobe and Franklin Streets.

'Davidian' exhibition invite, 2005

The Sydney Morning Herald

art

m To contact the art page editor, email metroart@access.fairfax.com.au

COLLISION THEORY

ART MEETS PHYSICS IN A QUIRKY SHOW. **TRACEY CLEMENT** REPORTS.

Last year was the world year of physics, but who knew? A quick dive into a handy copy of *Physics for Dummies* reveals that physics is about the fundamental forces of nature. These things never go away, they just seem more complicated as big-brained boffins try to figure it all out.

Why 2005? It marked the 100th anniversary of Albert Einstein's theory of relativity. Despite his work being used in the creation of the atom bomb, Einstein became a pop-culture icon, the poster boy for scientific genius. He even left some nifty sound bites about art, such as: "The most beautiful thing we can experience is the mysterious. It is the source of all true art and science."

Macquarie University's physics department decided to celebrate with an art competition, the World Year of Physics Art Prize. Melbourne artist Chris Henschke won the competition with his interactive sculpture *Hyper Collider* (left).

Henschke sexes up physics using Einstein's theories, cutting-edge technology and old-school cool. *Hyper Collider* resembles an antique wooden pinball machine on steroids. Flashing lights and spring-loaded levers crash into the high-velocity graphics of computer games.

Instead of a ball, a theoretical particle whizzes around a digital vortex and gets sucked into a black hole.

Other exhibition highlights include Sean O'Connell's kinetic sculpture *Permeant Permutations*, which captures the random beauty of chaos theory in a spinning ballet of stainless steel balls, and David Stephenson's nocturnal photographs, which trace the graceful arc of stars across the sky.

Once again science and art make terrific bedfellows. As Einstein said, "Creativity is contagious. Pass it on."

WORLD YEAR OF PHYSICS ART PRIZE
Macquarie University Gallery, Building E11A, North Ryde, 9850 7437. Monday-Friday, **until January 23.**

METROPICKS

VINCE FROST

*Frost*bite: Graphic Ideas by Vince Frost* is a bold immersive environment, with massive graphics on the floor and walls. It's like walking into one of Frost's magazine layouts, blown up larger than life and expanded into three dimensions. **Sydney Opera House** Exhibition Hall, 9250 7645. Tuesday-Sunday, until **March 12.**

HOT

Group show *Hot* perfectly captures the mood of a Sydney summer. Murray Hilton seems to have been scuba diving with X-ray specs. Fish bones form a graphic pattern in his giant photomontage. Matthew Johnson's blurry dot paintings shimmer in a permanent heatwave. **Tim Olsen Gallery**, 76 Paddington Street, Paddington, 9360 9854. Tuesday-Friday, **until January 28.**

VIKINGS

All that plundering and pillaging gave the Vikings a bad rap. Examine their arty side in this show of Viking jewellery, armour, swords and even board games. Highlights include a genuine horde of buried silver treasure. **Australian National Maritime Museum**, Darling Harbour, 9298 3777. Daily, **until June 18.**

Vikings

Tracey Clement

'Sydney Morning Herald' review of 'World Year of Physics Art Prize', January 13-19, 2006