AN INVESTIGATION INTO THE AESTHETIC CODES AND STRATEGIES USED WITHIN VISUAL ART TO REPRESENT AND CONSTRUCT SPACE, TIME AND MOVEMENT

by

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This thesis represents an investigation of the aesthetic codes and strategies used within visual art to represent and construct space, time and movement.

By examining the representation and construction of space and time through art and its intrinsic relationship with the structure of thought, this investigation reveals why an investigation of space and time is essentially an investigation of the subjective observer, and how this new perspective can help us to revise our understanding of art.

The study includes a number of surveys of strategies used by artists to represent and construct space and time and a typology of the possibilities of combining space and time in an artwork. The study also includes an exploration of modes of interactivity, the relationship between the new media score and the structure of the work, hue and markedness and the relationships between digital and tangible media.

The research leads to two new kinds of work, the Chronopan and the Chronocyclograph. Reflection upon this work offers new insights into space and dimensionality, oppositions, the instant and duration.

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G.	St George, P. (2005) Sequences: Contemporary Chronophotography and Experimental Digital Art. ISBN 0-905952-26-X [Exhibition Catalogue]

SECTION ONE

The research questions and their contexts

Chapter I. Introduction

In this first section I state why this investigation is worthwhile and important. I will look at the distinction between using aesthetic codes and strategies to *represent* space, time and movement and using aesthetic codes and strategies to *construct* space, time and movement. Thirdly, I will describe how I selected the codes and strategies that I intend to investigate.

This investigation is worthwhile because an understanding of space, time and their derivatives (movement, duration, the instant, speed and dimensionality) is important. This cluster of spatial and temporal issues has been at the heart of scientific, cultural and philosophical enquiry since Aristotle and Zeno. At the beginning of the twentieth century Einstein and Bergson refocused attention on space and time (Durie, 1999). This interest in understanding space and time has increased once again in response to the questions posed by Quantum mechanics (Feynman, 1985). These new questions shake our fundamental assumptions of space–time and we are forced to move back from some of the long–accepted answers to fundamental questions to re–examining the questions we ask about space and time. For illustration, we now question whether time is an invention or a discovery (Kern, 2003, pp. 10–64). We also have good reason to doubt that our physical world is three–dimensional and we ask whether it might be ten–dimensional or more (Greene, 2003) (see also **Chapter XIV**). Space and time were previously in the background and considered to be the dimensional axes used to measure events in the physical world. Now space and time are centre stage and are the medium of thought for the physical sciences and for many cultural practices.

In culture, questions about the nature of time are pointing to the role a human subject plays in what previously was thought of as an extrinsic objective independent reality. The investigation of an observer's role is much more than an investigation of the observer's perceptual apparatus. This new thinking is placing the observer at the heart of our understanding of space and time. This leads to a fresh examination of ontology, epistemology and aspects of subjectivity such as memory and consciousness. Cartesian dualist models (Campbell, 1970, pp. 41–58) had constructed a world of 'inside the observer' and 'outside the observer'. Different academic approaches and disciplines have been used to examine each of these two, supposedly distinct, domains. Now, in a wide range of academic fields (from reader–response theory (Tompkins, 1980) to quantum mechanics (Feynman, 1985)) the division between the purely mental interior of the observer and the purely physical exterior has been questioned. Time and space, once considered purely exterior and physical dimensions, are no longer considered to be independent of an observer.

The new thinking about space–time enmeshes time into space and space into time. This is so in poetry and verbal language, as well as in the physical sciences. For example, the temporal aspect of language such as one thought coming after another in a text also implicates the spatial dimension of contiguity. The spatial aspect of language such as the selection of available alternatives (and the combination of contiguous elements) implicates the temporal dimension of simultaneity. Thinking about time implies thought about space. Consideration of space implies thought of time. Later, I will see whether there is an analogous relationship between the structure of an artwork and the structure of thought. Perhaps, as in poetry and language, the visual representation and construction of space and time in artworks enmeshes time into space and space into time.

Lastly, thinking of space and dimensionality leads us to question assumed certainties such as 'cause' and 'effect'. This is an idea that is exemplified in Plato's *Allegory of the Cave* (Flew, 2002, p. 66), in Abbott's *Flatland* (Abbott, 1884), in Bohm's *Wholeness and the Implicate Order* (Bohm, 1980) and in Superstring theory (Greene, 2003). There is one idea that is included in all these diverse and far–ranging theories, that is relevant to this research. What appears to be a number of independent and related events (when viewed in two or three dimensions) might actually be one event when viewed in a greater number of dimensions. In a supposedly three–dimensional world we might think that we see two discrete events and we might then think that one event causes the other. This same relationship when seen in an eight, nine or ten dimensional world might be seen to be one event without any relationship of causality. To understand this idea, one has to imagine as Abbott did in *Flatland* that we exist in a two–dimensional world. We can then conduct thought–experiments with three–dimensional objects to see how these objects would be described by inhabitants of a two–dimensional world. For illustration, the inhabitants of a two–dimensional world might see the two circles (**Figure 1**). The inhabitants occupy the plane **P** and so see only what intersects their plane. When one circle moves the other circle will move as if to keep the same distance between the two circles. However the first circle moves, the second circle will precisely track its movements. Circle **A** and circle **B** would be seen as being in a causal relationship. The movement of circle **A** is the cause and the movement of circle **B** is the effect. Circle **A** affects circle **B**. A three–dimensional view of the same scene (**Figure 2**) tells us that the shape **C** is moving and that there is no causal relationship.

Figure 1. Two–dimensional world

Figure 2. Three–dimensional world

The distinction between using aesthetic codes and strategies to *represent* space and time and using aesthetic codes and strategies to *construct* pictures of space and time is fundamentally important. Space and time are not only independent realities 'out there' to be understood and represented by an objective observer. Rather, how we represent space and time can affect and possibly change our understanding of these dimensions. Thought and language are not only a medium for representing the world; they can construct and change the world we seek to represent.

Metaphor is a good example of how thought and language can shape meaning and construct aspects of our world. Lakoff and Johnson (1980) show that metaphor is a thought process and much more than a trope or figure of speech. In *Metaphors We Live By*, Lakoff and Johnson illustrate how the conceptual metaphor "argument is war" structures the way we engage in arguments:

ARGUMENT IS WAR

Your claims are *indefensible.*

He *attacked every weak point* in my arguments.

His criticisms were *right on target.*

I *demolished* his argument.

I've never *won* an argument with him.

You disagree? Okay, *shoot!*

If you use that *strategy*, he'll *wipe you out.*

He *shot down* all of my arguments.

"...ARGUMENT is partially structured, understood, performed, and talked about in terms of WAR [...] we act according to the way we conceive of things." (Lakoff & Johnson, 1980, p. 5) The strong inference is that if we thought about argument in a different way we would then argue in a different way. For example, instead of thinking of argument as war we could think of argument as dance. Then we would seek to enjoy the argument, perhaps show off our arguing skills, we could exchange positions sometimes taking the lead and sometimes following and then at the end of our argument we could gesture gratitude to each other and look forward to the next argument.

Metaphor and metonymy play a leading role in the language and thought about space and time. For example, when we struggle to think of consciousness and memory we refer to the present, memory of the past and we anticipate the future. In this model we often use a cinematic metaphor to describe an evenly spaced sequence of instants or 'nows'. Bergson was an early user of this cinematic metaphor, though in the language of the time he refers to "cinematographical apparatus" (Bergson, 1907, p. 332). Time is described as instants or planes of simultaneity and these are likened to images in a chronophotographic sequence or single frames in a cinematic film. Is this metaphor a representation of time or has it constructed our idea of time and consciousness? To use another spatial metaphor, the distinction between the two possibilities, representation or construction, must always be at the front of our mind.

To fully understand the distinction between representation and construction one needs to think of a series of interpretations. If we imagine a reality out there that is independent of any observer, a thing in itself, we can then imagine that this referent is translated into another form, such as a word, a sentence, a diagram or a picture, that can stand in for the referent. This second object can be said to represent the *Ding an Sich* (Oizerman, 1981, pp. 333–350). The direction of the transfer of meaning is from the referent to the reader of the text or the viewer of the picture. Alternatively, if we were to see, for example, a head in the clouds we have used a description of an object, the cloud, that will partly construct what we see. We see a head in the clouds, it is not an hallucination or an apparition, but what we see is partly what we have described and expect to see. If we had used a different description (such as *cumulus nimbus*), we would see a different object. Instead of being prepared to see a head in the clouds we might instead see imminent rain in clumps of water vapour.

I need to identify and then investigate a number of codes and strategies and then think about whether they represent or construct our ideas of space and time. First I will make two surveys of other artists' work and, secondly, I will build a typology of different ways of recording and presenting space and time. Recording is the first of the interpretations between an external reality and another form that stands in for that reality. A recording can be a representation, a construction or a mixture of the two. The typology will reveal how different methods of recording represent and construct meaning. Having made a recording, there is then a number of different ways that one can present the recording. The presentation is a new and subsequent interpretation and is further removed from a putative reality or an innocent representation of that reality. For example, I might first record the passage of a galloping horse using a ciné camera. I can then present the recorded footage as a projection on to a screen or I could print out each frame onto paper as a postproduction storyboard. Each method of presentation comes from the same recording, but each offers a very different picture of the galloping horse. The projection on a screen offers the illusion of a galloping horse, less the smell, the sound and other vibrations. The sequence of still images offers the possibility of analysing the gait of the horse.

These two exercises will enable me to identify, isolate and select codes and strategies that I can explore and analyse. The surveys will identify methods that have been used and the typology will identify methods that could be used.

Chapter *II. Survey one*

A large number of diverse aesthetic codes and strategies are used within visual art to represent and construct our experiences and understanding of space, time and movement. The ideas that inform the making and viewing of these works can be clustered under a number of key ideas. These ideas include simultaneity, duration, subjective time, objective time, the instant and pace. A small number of examples will illustrate the interrelationship between the works, the ideas that inform them and the use of particular technologies.

In works such as *Two Consciousness Projection(s)* (Graham, 1972) Dan Graham uses video and the time delay between a recording and viewing the recording to explore differences between different viewers' perceptions of an event and the lack of synchronicity between these different views.

Two Consciousness Projection(s) is a video recording of a performance in which Graham encouraged active participation by the audience. The first invited performer, a woman, is recorded whilst she is watching a monitor that shows her recorded performance. She is asked to express her feelings about viewing her own image. A second performer, a man, is behind the camera. He is asked to attempt to give an objective, distanced account of the woman's performance. The audience for these two volunteer performers is also participating. They observe the diverse psychological reactions of the two people who are trying to attune and project their consciousness onto, and to, each other. The audience observes both the live performance and the recording. There will be a difference and a delay between each audience member's observation and the converging, but different views of the two primary participants.

The woman is trying to give a subjective account of the performed experience. The man is trying to give an objective account of the woman's performance. They are asked to try to reach an agreement between their accounts and of course they fail. In spite of everyone's efforts to attune their consciousness to that of the other they can never coincide completely. There always is a time delay between the perceptions of the different performers involved in the event, as well as a difference in emotional experience. The same goes for the rest of the audience, for Graham himself and for the viewer looking at the subsequent video recording of the performance. Graham shows that complete control; a total fusion between the subject and object of the performed event is impossible.

In works such as *Opposing Mirrors and Video Monitors on Time Delay* (Graham, 1974) and *Two Monitors and two Mirrors at opposite sides of a room* (Graham, 1975) Graham uses two cameras, two mirrors and time delays between the two monitors to show different modes of perception simultaneously and to bring out the discontinuity between different realities. These works use closed–circuit video feeds to place viewers in room–scale installations where they occupy the double role of performer and viewer. Mirrored walls allow visitors to see the reflections of their surroundings, themselves and television monitor showing the 'recent past'. The video cameras are fixed on top of the monitors and the feeds are crossed so the viewer looking into monitor A sees the recording of the view from monitor B. This is another kind of reflection. So, in addition to the multiple and infinite reflections and reflections of reflections that one sees when standing between two mirrors that face each other, we also see the video 'reflections' and the temporal reflections between the current moment and the recent past.

Nam June Paik also uses video and technology that was new at the time, to exploit the phenomenon of the simultaneity of different events taking place at different times in different places. In his *Good Morning Mr Orwell* (Paik, 1984) Nam June Paik used a satellite link to present a programme of a number of artists who were performing in New York and Paris as if they were appearing live and together (on television) on 1 January 1984. Some of the segments were live and others were pre–recorded. John Cage, in New York, produced music by stroking the needles of dried cactus plants with a feather, accompanied by video images from Paris. Laurie Anderson and Peter Gabriel performed a new composition, *Excellent Birds*. The broadcast also featured the television premiere of *Act III*, with music by Philip Glass. The Thompson Twins performed their song *Hold Me Now*. Oingo Boingo played its song *Wake Up (It's 1984)* to an audience that presumably had recently woken up on the first day of 1984. Other contributions to the project included poets Allen Ginsberg and Peter Orlovsky, choreographer Merce Cunningham, and artist Joseph Beuys. The intercontinental exchange of highbrow culture and light entertainment was shown on WNET TV in New York, the Centre Pompidou in Paris and also parts were shown in Germany and South Korea.

The date of the performance was important. The work was seen as a rebuttal to Orwell's dystopian view of the future of television in the novel *Nineteen Eighty–Four* (Orwell, 1948). In the book, Orwell sees television as an instrument, in the hands of a Big Brother, that a totalitarian state would use to control its viewers. So, on the first day of this much–anticipated year, Paik was keen to demonstrate satellite television's ability to serve positive ends such as the intercontinental exchange of culture.

Artists have used different strategies to force the viewer to experience time passing slowly. In Michael Snow's film *Wavelength* (Snow, 1967) the camera takes a single intermittent 45–minute shot that slowly zooms in on a loft wall. The camera zooms from a wide view of the whole room to the narrow view of a new space recorded in the photograph on the apartment's wall of sea waves. The image of the wave acts partly as a visual pun to the aural 'sine' wave of the sound track. The zoom is not precisely continuous as the camera does change angle slightly and the focus is manually adjusted during the long zoom. The many textural changes that occur in the course of the film, subtle and radical colour changes, exposure changes, black and white shots, clear images, negative images, light flares, day to night changes, visible splices, and different film stocks present a heterogeneous collection of perceptions. This collection of perceptions is similar to the bundle of perceptions described by Hume in his analysis of our self, or personal identity (Hospers, 1988, pp. 268–269).

> "(E)very zoom makes an epistemological statement, contemplating man's relationship not with the world itself but with his idea or consciousness of it." (Belton, 1980, p. 21)

In a moving camera shot there is a physical movement of the camera through space. In the zoom shot there is no physical movement of the camera, except the slight movements of the lens itself. Here, the movement of the zoom shot in *Wavelength* is read by Belton as a metaphor for consciousness.

Wavelength consists of almost no deliberate action, and what action does occur is mostly elided. Conventional film language uses ellipsis to edit time. So, for example, we might see someone wake to the sound of an alarm clock. We then see the person, on the other side of a temporal edit, getting onto a commuter train. We do not think they have jumped in time and space from bed to train. Instead we accept that some time has elapsed between getting up and getting to work. In *Wavelength* the editing is performed in front of us and spatially. So, we see someone in shot who then walks out of shot to reappear some time later. Most of the action is out of frame so the room (and its doors and windows) act as cutting and editing devices. The viewer is required to complete the gap between what is seen and what they assume happens out of sight. There is thus an ellipsis of action, but not of time. We see the empty stage whilst the action continues (we assume) on another, out of sight, stage. There are four short scenes when characters are in view. In the first scene two people enter the room, and leave. Later, coming back, they chat briefly, and listen to

"Strawberry Fields Forever" (Lennon, 1967) on the radio. Still later, a man (played by filmmaker Hollis Frampton) enters inexplicably and dies on the floor. And lastly, the owner of the apartment is heard and seen on the phone, speaking, with strange calm (considering the event she is describing), about the dead man in her apartment whom she has never seen before.

> "[G]iven the film's durational strategy, we feel every minute of the time it takes to traverse the space of the loft to get to the infinite space of the photograph of waves—and the fade to white—at the film's end. The film inspires as much boredom and frustration as intrigue and epiphany..." (Zryd, 2007, p. 110)

The soundtrack is a pair of tones that shift in frequency (and so "wavelength"). This is an aural equivalent to the zoom lens shot, a sine wave that goes from its lowest note (50 Hz) to its highest note (12000 Hz). This minimalist sound combines with the ambient sound of the street outside the apartment. Towards the end of the work, the soundtrack and the ambient sounds combine as the two tones merge into the sound of a police siren. We do not have sufficient information to decide, but this siren could, perhaps, be a response to the events we have partly seen.

In 2003, Snow released *WVLNT* (or *Wavelength For Those Who Don't Have the Time*). The 45–minute film is divided into thirds and these are digitally superimposed to make a 15–minute composite version.

In Andy Warhol's film *Empire* (Warhol, 1964) a camera records 'nothing more' than the light changing on the side of the Empire State Building. It was filmed from 20:06 on 25 July to 02:42 on 26 July from the 41st floor of the Time–Life Building, from the offices of the Rockefeller Foundation. It was shot at 24 fps but is projected at 16 fps, so that, even though only about 6 hours and 36 minutes of film was recorded, the film when screened is about 9 hours and 54 minutes long. Warhol does not use temporal edits or ellipsis, but instead the duration of an event in the film is equal to the duration of the event being recorded (if projected at 24 fps).

As with Snow, the supposedly minimal contains a wealth of action. The film begins with a totally white screen of over–exposure and as the sun sets, the image of the Empire State Building emerges. The floodlights on its exterior come on, the building's lights flicker on and off for the next 6 1/2 hours, then the floodlights go off again in the penultimate reel so that the remainder of the film shows near total darkness. During three of the reel changes, filming started before the lights in the filming room were switched off, making the faces of

Warhol and Mekas (the cinematographer) visible in the reflection of the window.

In these works of both Snow and Warhol, the recording and unedited presentation of temporal processes causes the viewer to introject the passage of time.

In contrast, artists such as Goya and Monet have represented the experience of time moving rapidly in different ways. In Goya's *Saturn devouring one of his children* (Goya, 1823) the indexical movement of the brush and the application of paint is used to express speed or the rapidity of movement. Saturn is the Roman name for the Greek God 'Chronos' who is both the God and personification of Time. If we consider Monet's works in series, such as his many paintings of *Rouen Cathedral* (Monet, 1894), then we can see that he was attempting to paint a sequence of related instants of time. Particular codes had to be invented by Monet and other Impressionists because the act of painting a canvas clearly takes longer than the event that is being recorded.

There are many events and processes that happen too quickly for the eye to see. At the end of the nineteenth century artists and inventors started to develop strategies and to use new technological methods such as photography and chronophotography to help them see, understand and represent these events and processes. Philosophers, such as Bergson, conceptualised new descriptions of time. Bergson reacted against a purely mechanical description of time in which time was merely a parameter that allowed trajectories to be plotted. Mechanical time was considered to be isomorphic to a straight line and the present is reduced to a point on this line. Bergson described a kind of time that was more than a border between the past and the future. He called this time '*Durée*' (Bergson, 1889, p. 75–139). *Durée* is time as it is experienced and it enfolds both the memory of the past and the anticipation of the future. Bergson's ideas influenced Marey who captured time and movement by representing space–time as a continuum of overlapping images. Marey used technology that he invented to record successive moments. On some occasions he made sculptures that contain successive positions of an animal in movement. For example, in *Flight of a Seagull* (Marey, 1887) the flying bird is shown as a long stretched–out composite of overlapping birds. These new ways of thinking about time were assimilated and condensed by writers, such as Gertrude Stein and Apollinaire, who filtered the ideas through to artists such as Picasso and the other Cubists. Stein describes how many of these discussions took place whilst Picasso was painting her portrait (Stein, 1933). Two examples of the indirect use of Bergson's ideas are the *Portrait of Wilhelm Uhde* (Picasso, 1910) and *The Watch* (Gris, 1912).

The new visual codes were also directly used by Futurists such as Giacomo Balla in his

Flight of a Swallow (Balla, 1913). In turn, Bergson was himself influenced by Marey. In *Creative Evolution* (1907), he writes about Marey's instantaneous pictures of reality as it passes us by and he claims: "the mechanisms of normal visual knowledge are by their very nature cinematic" (Bergson, 1907). These ideas are later developed by Deleuze in his *Cinema 1, The Movement–Image* who refers to Bergson and then writes: "Not only is the instant a motionless section through movement; movement is a moving section through duration" (Deleuze, 1983, p. 15). At first reading this is confusing. A temporal 'instant' is described using the spatial metaphor 'section' and movement (usually measured in spatial distance in a given time) is being described as a part or section of a temporal duration. His use of terms is inconsistent with the old thinking about space and time, but entirely consistent with space and time being one surface upon which geometrical constructions produce derivatives such as the instant and movement. Deleuze's statement announces the conflation of space and time and brings this brief survey back to the starting point for my research.

Chapter III. Survey two

The first survey is in the form of a 'literature review'. This second survey is in the form of a curated exhibition called *Sequences: Contemporary Chronophotography and Experimental Digital Art.* In this exhibition I wanted to show work that was about sequences of images and that in some way continued one or more of the enquiries of the nineteenth–century chronophotographers.

Chronophotography is that collection of inventions that were designed and made at the end of nineteenth century to produce images and ways of viewing images that would increase our understanding of time and movement. Many of the later inventions from this period used photography to analyse and study motion over time and so are properly called chronophotography. This group of inventions includes devices that were developed by Ottomar Anschütz, Georges Demenÿ, Jules Janssen, Albert Londe, Étienne–Jules Marey, Eadweard Muybridge and Nadar (Gaspard–Félix Tournachon). The work of the many different chronophotographers is now often seen as no more than part of pre–cinema. This implies that chronophotography is only a form of primitive or proto–cinema and that these photographers of time were solely working towards the invention and development of cinema. This is clearly not the case. Marey and other chronophotographers wanted to achieve an analysis of motion, not its synthetic reproduction. They made cinema possible, but the invention of cinema was not their objective and, significantly, chronophotography is very different from cinema. A sequence of still images of an event seen side–by–side rather than one after another can help us to understand motion, time, duration, simultaneity and sequentiality. These same sequences viewed quickly one after another in the same place, as in a film, do not offer the same opportunities to understand a subject. A film re–presents the subject and shows successive views very quickly so that the individual frames are not seen. Instead, the series of views is seen as one continuously moving scene. By doing this, film simulates natural movement and hides its facture. A chronophotographic sequence of images can show us what we cannot see by direct observation, such as the true location of all four legs of a trotting horse. A film of the same horse will merely look like a horse trotting past us on the cinema screen.

Chronophotographers used sequences of images to study and understand a wide range of subjects including the motion of animals, the flight of birds and projectiles, wave patterns, blood flow and even visemes (visemes are the shapes that a speaker's mouth makes during speech). Chronophotographers had started to investigate many subjects and many possible forms of representation. One of these possibilities became cinema and this form was dominant for much of the twentieth century. Recently, cinema has retreated into the background of visual culture and, as we shall see, many contemporary artists are now making work that continues where the chronophotographers left off.

In very different ways, the fourteen artists in the exhibition continue where the nineteenth–century chronophotographers left off. These new chronophotographers are extending chronophotography into new areas such as entertainment, explorations of memory and subjectivity, kinetic sculpture and new experimental photography.

Having established the idea of showing work that represented space and time, I then used a number of networks (art, academic and expert) to gather suggestions for artworks that corresponded with my curatorial idea. This research produced a long list of work that was international, included both established and emerging artists and used a number of forms (from structural film to kinetic sculpture). During the harvesting of this work, I met a number of writers who either suggested work for the show or who wrote about contemporary visual culture. I invited these authors to each select one work from the exhibition and then to write an essay about that piece of work. (These essays are collected in St George, 2009. Both the book (St George, 2009) and the *Sequences* exhibition catalogue accompany this text)

Each of the essays is about one of the artworks in the show and its relationship to chronophotography. The authors were asked two questions: "Can we gain insights into the use of sequential images in contemporary art by re–examining chronophotography?" and "Do we gain a better understanding of chronophotography by re–assessing its history from the perspective of contemporary art?" Throughout this curatorial project my aim was to extend the dialogue between contemporary art and its antecedents.

Re–viewing nineteenth–century chronophotography from a contemporary standpoint can enrich our understanding. I am not suggesting that we should revise that history or recast physiologists and scientists as artists. I am suggesting that looking back through a number of different windows allows us to see what we saw before and also see other implications of the earlier work. Furthermore, the historical work can be appreciated in different and broader ways. When, erroneously, chronophotography is seen as one story (the story of proto– or pre–cinema) certain players are centre stage whilst others have bit parts or are mere stand–bys. When chronophotography is seen as a diverse set of enquiries and practices, with cinema being just one of the many possible stories, then the bystanders become the stars in new, previously unrecognised stories.

Many of these uncovered stories are unfinished. So, in turn, the contemporary work can be better understood by seeing many of the current practices and strategies as continuations of these unfinished stories.

This second survey was a useful research tool in a number of ways. The approach to selecting work (using a wide range of networks) provided a wider, more diverse and less predictable net. The essays on the work, in response to my research questions, provided new insights into the work and thirdly, the Curator talks that I held at each venue provided an opportunity for a focus group with elite, motivated viewers who could share with me their responses to the works.

Here I will describe the works that were included in the exhibition.

Figure 3. *Turnbaby* (Babel, 2002)

In 1911 Anton Bragaglia contrasted his notion of a futurist 'photodynamism' with the contemporary methods of cinematography and chronophotography: "We are not interested in the precise reconstruction of movement, which has already been broken up and analysed. We are involved only in the area of movement which produces sensation." (Bragaglia, 1911) Photodynamism records images in a distorted state "since images themselves are inevitably transformed in movement." (Bragaglia, 1911, pp. 38–45)

Turnbaby looks at first like a digital representation of a zoetrope. If left alone, the carousel of images turns, bringing one image into central view at a time. Unlike a zoetrope, the images (of *Turnbaby*) are presented on the outside of the spinning drum instead of the inside and the images are not seen through a narrow vertical slit so there is no illusion of movement only a blur of moving images. When a viewer moves a cursor over *Turnbaby*, things change. The speed of rotation can be increased and decreased and, at the correct speed, the sounds that accompany each image merge together to form a fragment of a sentence. Pressing down on any of the images both changes the size of the image and the sound associated with it, so then fragments of two sentences intersect with each other.

Babel sees *Turnbaby* (**Figure 3**) as a form of 'videodynamism'. His work is also unconcerned with perfect reproductions of the moment. As Bragaglia went on to say: "our aim is to make a determined move away from reality, since cinematography, photography and chronophotography already exist to deal with mechanically precise and cold reproduction." (Bragaglia, 1911). Babel intends the viewer to see the images dissolve into broken generalised forms. His work also depends on user interaction. The viewer must spin the digital version of the zoetrope, the viewer's intervention and action is necessary to keep the pictures in motion. Without this, the images eventually fade away.

Figure 4. *Stop Motion Studies* (Series 3) (Crawford, 2002)

The *Stop Motion Studies* (**Figure 4**) are a series of experimental documentaries that chronicle Crawford's interaction with subway passengers in cities around the world.

Much of human communication is non–verbal. In these photographs, the body language of the subjects becomes the basic syntax for a series of animations exploring movement, gesture, and algorithmic montage. Many sequences document a person's reaction to being photographed by a stranger. Some smile, others snarl, still others perform.

> "Crawford's microcosmic photographic studies of (mostly) people (mostly) riding on subways might initially seem like looping micro–films. But upon closer inspection, one realizes that the animations never actually loop. Imagine a slide projector tray filled with anywhere between three to eight slides. The projector displays these same slides infinitely, but always in random order. The projector also randomizes the duration each slide is displayed, anywhere from 0.03 seconds to 0.3 seconds. Finally, all the slides in the tray are of the same subject, all photographed within a limited time frame (less than two minutes). This roughly approximates the mechanics of what Crawford has termed "algorithmic montage". (Crawford, 2004, p. 27) The result is a kind of stochastic motion study more akin to chronophotography than film; but with the distinct, non–linear twist.
>
> The micro–scenes in *Stop Motion Studies* take place largely on subway trains, and this transitory 'stage' is the perfect locale for exploring the subjectivity of time. The fast speed of the trains provides a visual foil for the slow speed of the people on the trains. The people may move very little within their few allotted frames, while outside the world races past in a blur. Yet since the frames are displayed randomly, any sense of continual, linear motion is lost. The trains literally appear to be going nowhere fast. Like Zeno's paradoxical arrow, the trains are perpetually in motion, and yet they never arrive. This underscores the empathy we feel for the passengers who are trapped in a kind of modern purgatory — an in–between time/space they perfunctorily inhabit on their way from 'somewhere' to 'somewhere else'.
>
> Crawford's stochastic animations have a way of ephemerising even the people themselves. In one frame, a woman is a solid figure, and suddenly in the next she is a blur. The overall effect is reminiscent of Ezra Pound's *In a Station of the Metro* (Pound, 1913):
>
> > IN A STATION OF THE METRO
> > The apparition of these faces in the crowd;
> > Petals on a wet, black bough.
>
> Back and forth the woman mysteriously transitions. Neither frame is given chronological or hierarchical primacy. Is the woman there or gone? She is

perpetually both. In this sense, *Stop Motion Studies* becomes a formal tool for analyzing, unpacking, and coming to terms with the extreme compressions and expansions of 'standard' space/time that modern modes of transportation have thrust upon us." (Cloninger, 2009)

Figure 5. *Shotgun Muzzle Blast Photographs* (Dávidházy, 1995)

Andrew Dávidházy has developed photographic applications for strobe photography, high–speed photography, Schlieren and shadowgraph photography, ballistic photography, streak photography and many other kinds of photography. Most of his photographic studies reveal something about motion either through novel kinds of images or through novel sequences of images. The sequence shown here reveals the changes a cartridge of shot undergoes as it moves from the gun to its target. In an echo of Zeno's Arrow paradox (Flew, 2002, p. 432), at each instant Dávidházy's shot is still and at each instant his shot is moving.

"The work exhibited in Sequences, Shotgun Muzzle Blast Photographs, consists of a succession of photographs taken of the flight of a cartridge, as it is propelled from the barrel of a shotgun, towards its target. The photographs were taken in a lightproof laboratory approximately 25 feet by 12 feet in area. 35mm stills cameras were anchored on sturdy tripods and set at 90° to the trajectory of the discharge of a similarly secured shotgun. To catch the expelled shot a cast–iron tube 3/8 inch thick and filled with sand was fitted to the opposite wall. The Shotgun was fired remotely from outside the laboratory.

Each photograph was exposed with a 1/1,000,000 second "blast" of light from two Microflash units fired in unison by a homemade sound–activated synchronizer. This synchronizer picked up the sound of the shotgun blast and fired the flash units. The position of the synchronizer was adjusted back and forth along the path of the blast trajectory in order to alter the moment at which the flashes were triggered. The further the synchronizer was from the gun the later the flashguns blazed in relation to the moment at which the shotgun was fired. This provides, over a sequence of photographs, an examination of the opening action of the shotgun's projectile, its cup. As the cartridge's wadding–leaves peel back they expose the shot pellets, which are subsequently propelled from the cup on their independent, accelerating journey. The gas–cloud formed by the exploding cartridge is simultaneously revealed in perfect detail as it forms behind the wadding and pellets.

For the true appreciation of certain aspects of movement it is necessary to arrest motion and represent its passage as a series of still images. While it is impossible, with the naked eye, to distinguish intricate actions that are occurring fleetingly, chronophotography presents images to us, be they of a running horse, a falling cat or the flight of a bullet or shotgun pellets, that are strangely becalmed and awaiting our scrutiny." (Askham, 2009)

Figure 6. ***Timepiece*** **(Glanville, 2004)**

Timepiece is a site–specific and time–specific installation following the movement of light through a particular space. The patterns formed are marked with tape at 15–minute intervals. When complete, the installation records all the patterns simultaneously, with the relevant time marked on each one, and the compass orientation marked on the floor.

These patterns formed by light often go unnoticed. Here the taping of the light acts like chronophotography in that it allows the viewer to examine the flow of time as a series of packets. It presents a series of snapshots of the passage of time itself, but unlike a video any sense of narrative is interrupted as the viewer encounters the entire sequence simultaneously.

While the work captures the sequence of movement over time in much the same way as Marey and other chronophotographers used photography, it also goes further back, before even that technology was available. *Timepiece* and primitive sundials capture time in much the same way, and both raise questions about how the earth itself moves, about the nature of 'real' time and how more sophisticated, that is less direct, methods of documentation can modify our observations and experience. When time is presented on a digital clock using numbers, the timepiece refers only to other clocks. A sundial is connected indexically to its referent and needs no language to tell its story.

Figure 7. Trådar (Jönsson, 2004)

Trådar (threads) is inspired by the chronophotographers' technique of showing all the images from one sequence at one time in one place. The work is also inspired by dissatisfaction with the conventional cinematic technique of screening only one frame at a time.

> "In *Trådar,* Pia Jönsson uses chronophotography by presenting strips of film which are laid out horizontally or vertically across the screen at any one time. Each 'strip' or 'thread' presents a film sequence informed by narrative codes and conventions, which, combined with the processes of narration, results in a playful, multi–layered and ultimately tragic story. But it is this subtle and complex relationship between the surface formalist aesthetic and deeper narrative motivation of the overall film which invites the use of close textual and deeper structural film analysis.
>
> In chronophotography, the physical and technological constraints of capturing motion through the still photographic image, has resulted in the direction of 'action' presented either left to right or vice versa across the screen. By recording motion through a series of still photographic images, time and space are effectively frozen and expanded. In *Trådar,* Jönsson creates a visual matrix of film 'threads' sequencing action or spaces in simultaneous linear time. Each individual 'thread' is further fragmented by a series of up to four frames. Each individual frame presents a slightly different moment of time within the action of the 'thread'." (Cadwallader, 2009)

Pia Jönsson lays the frames of her film out in a continuously moving quilt or weave of images. The viewer can view the relationship between the past, the present and the future in one screen at any one time. The weave reveals the otherwise invisible dynamic relationships between the colours, movement and light of the frames. The rhythm of the movie becomes visible and the quilt becomes a storytelling device as well as one large continuously moving landscape of colours, geometry and shapes.

In the landscape that Jönsson weaves, the viewer can enjoy an extended voyeuristic pleasure. The viewer can see what is happening, what has just happened and what will happen. Her work is the visual correlate to Bergson's *durée* and to listening to a melody. We hear more than the current note, as we relate that sound to what has been heard before and to what we anticipate.

Figure 8. *Mutoscope No.3: McTaggart's Machine* (Lewandowski, 2003)

> "The steps a man takes, from the day of his birth until that of his death trace in time an inconceivable figure. The Divine Mind intuitively grasps that form immediately, as men do a triangle. This figure (perhaps) has its given function in the economy of the universe." (Borges, 1962, p. 212)

Simon Lewandowski's works are not reconstructions of pre–cinema or objects of nostalgia. His Mutoscope is a kind of laboratory apparatus for answering new questions.

A Mutoscope works on the same principle as a flipbook. The individual images are flexible opaque cards. Rather than being bound into a booklet, the cards are attached to a circular core, rather like a huge Rolodex. A reel typically holds about 850 cards, giving a viewing time of about a minute. The cards are viewed through a single lens enclosed by a hood. The reel is rotated by a hand crank. Each machine held only a single reel and was dedicated to the presentation of a single short subject.

Because a Mutoscope is turned by hand it is impossible to maintain the correct frame rate and so the images are sometimes seen as a movie (with a temporal dimension) and sometimes, when the frame rate drops, the images are seen as a sequence of still images (with a spatial dimension of exploration across the surface of the image). The illusion is never convincing.

Lewandowski's *Mutoscope* is extended to include a motor that rotates the reel and a video camera that replaces the viewing lens. The feed from the camera is shown on a crude monitor. Start the machine up and the pictures spin just about fast enough for us to assemble the passing images into a simple repetitive semblance of motion but slow enough for us to be able clearly to see the artifice that lies at the heart of all narrative.

The *Mutoscope* produces a repeating loop of recorded behaviour. The character seen through the *Mutoscope* performs the same action over and over again. As we see the repetitions we are better able to see geometric patterns in the behaviour that might otherwise, as Borges describes, remain invisible.

Figure 9. ***Bath Half Marathon*** **(Macmillan, 1989)**

Tim Macmillan's work is groundbreaking in two areas that are at the heart of modern and contemporary enquiries. For over 150 years, scientists, artists and philosophers have been seeking ways of understanding and representing space and time. These enquiries can broadly be divided into methods of representing space (e.g. the panorama and the cinéorama) and methods of represented time (e.g. chronophotography). Tim Macmillan's work in both these areas has been so advanced that many say our era has been partly defined by his work.

> "Macmillan's basic principle was to make "instantaneous exposures of a loop of film". A strip of 35mm film is held inside the grooved rim of the wheel. Over each frame is a pinhole or an optical lens, 300 in all, that yield twelve seconds of film–time when the strip is exposed, printed and joined end to end. The exposure is made all at once with an electronic flash. Anything that happens within the wheel – a jump or leap – is held in a single instant in time from all its available positions inside the circle. The pinhole or lens, which acts like a tiny camera obscura, also records the space around the circle, including the camera–wheel itself, which registers as a line bisecting the frame.
>
> The time–slice camera constructs new forms of vision, from points of view not available to the unaided eye. One such is the revelation of how a person leaps or a cat jumps, stopped in time but circled by the film. Another inexhaustible pleasure

of these time–slices is the passage between line, curve and plane, as the viewer's angle of sight rotates with its subject. Each cycle brings out new features of the visible in the twists and torques of the recorded space. To release the human eye from its single viewpoint was a main goal of the cubist painters and of such filmmakers as Dziga Vertov. Here it is achieved by exploiting the intrinsic properties of the medium of photography, in which (said the avant–garde filmmaker Maya Deren) "the object creates its own image". (Deren, 2004)

In the mid–1990s Macmillan came up with another entirely new concept for the spiral image of Bath Half Marathon (1995). Like the filmstrip system, it re–invents cinematic motion from a new perspective. For *Bath Half Marathon* he devised a spiral camera to create a time sequence on a single large plate, as Marey had, but in this case to represent a time–twist in space. Fitted with an old Kodak 'Disc' lens, it tracks across the rotating film plate to make the spiral image, much as a stylus tracks over a record. The camera has a turning handle at one end and a disc that holds a 10x8 negative at the other, opened at the front to make an exposure through a slit. The lens slides vertically in front of the film on an arm that reaches over the disc, which has a locating pin in a spiral groove on its back. Turning the handle rotates the disc, so that the spiral groove traces the lens over the film surface.

With practice, Macmillan was able to match the relative movements of the subject and the film plane so that the image did not stretch, blur or compress. Because the lens must track at a constant speed across the film to give an exact exposure, the handle must be wound quickly when the lens is near the centre of the axis and more slowly when it travels further away, since the relative speed becomes amplified. The relative speed of the subject, in this case the athletes, also affects the image, so that the shutter speed and aperture slit must be juggled to get the right exposure. When the subject is moving in the field of view, the camera is static, but to achieve a sense of coherent space around the camera requires the camera itself to rotate while the handle is turned.

The extraordinary sequence that results from this rebirth of chronophotography is printed straight onto a large plate, so that it is seen as a spiral from a distance but in sharp detail from close up. Inspired, says Macmillan, by Leonardo's machines as well as by cubism, it takes an arbitrary section of time but, through the spiral, evokes continuity in both directions across the represented moment, in a virtual image of Bergsonian flow. At the same time it evokes the new orientation of visual space explored by Duchamp and Lissitzky, also in the wake of photography and new technology." (Lees, 2009)

Figure 10. ***8 Hours*** **(Newth, 2001)**

This series of images was made on a road trip in the western United States in 2001, during the artist's honeymoon. The photographs show entire nights' sleep in budget motels in California, Arizona, Utah, Oregon, Nevada and Washington State. Using 8–hour exposures the night–long shots record the movement of the sleeping figures as if they were vapour trails over the bed. This movement is set against every detail, in sharp focus, of the sparsely decorated rooms. Recurring features: framed landscapes, lamps, tables and other hints of domestic comfort are consequently highlighted.

The photographs were made using a custom–built large format (10" x 8") camera, which was placed on top of the television set. The focal point of each of the motel rooms is a television. Instead of being watched, this television provides the ideal location for the camera that will watch and record life in the room for the duration of the exposure. The camera shutter was opened in the evening and kept open for eight hours. The following morning the negative was developed in the motel bathroom.

The earliest photographs made in the 1800s by Daguerre, Fox Talbot and others relied on bright light and very long exposure times. Subjects had to sit perfectly still for up to 40 minutes. To ensure the sitter did not move and the image did not blur, special metal braces were made to support the head. The technique used to make the *8 Hours* series of images, a large wooden camera and paper negative, differs little from that of the early pioneers of photography. However, instead of capturing the static likeness of the subjects, the very long exposure traces the movement of the sleeping figures. Modern photographic techniques enable movement to be frozen in a fraction of a second. The process used to make this series of images allows for a different, unfrozen, kind of relationship between the viewer and time, space and movement.

Figure 11. ***Fly's Eye*** **(Polli, 2002)**

The *Fly's Eye* describes a series of computer programmes designed to perform a real–time motion analysis and deconstruction of live or pre–recorded video. Each video frame is tracked and analysed according to the changing location of light, colour, or motion in the frame. A copy of each frame is placed in a position according to the results of the analysis. In the *Fly's Eye* installation, live video images are projected into a space and positioned based on the movement of viewers in the space. The *Fly's Eye* covertly 'watches' the viewer in the space while live feedback allows the viewer to simultaneously enjoy some control of their image.

> "Polli's fantasy is to be able to see through a fly's eye – to experience being able to interpret all of the information that is coming in at one time. Since 2000, Polli has

> been working with innovative eye tracking technologies and is the inventor of Intuitive Ocusonics which uses a computer to track images through the amount of light in an area. These eye–tracking interfaces bring together visual and aural information through high–end data transfer and tracking technology that can be manipulated in the display.
>
> In her creation of *The Fly's Eye,* Polli designed an interactive computer system that incorporates the movements of the viewers in the space as a camera eye figuratively "watches" them. Polli has found that as camera surveillance becomes more ubiquitous in society, people tend to be less intimidated by the medium. As the viewers move within the space and comfortably interact with the camera, the video feed tracks and analyzes the location of their motions. A live animation is created by the outcome of the motion on the video frames and is then placed onto a grid according to the defined programming principles." (Loring, 2009)

Polli's aesthetic strategy extends Marey's chronophotography by using contemporary interactive technology to not only portray objects and subjects in motion, but to portray the experience of the observer in motion.

Figure 12. ***Deception*** **(Schülke, 1996)**

Björn Schülke is interested in the history of moving images and in the relationship between cinematographic images and kinetic sculpture. In *Deception* a partial image is available on alternate sides of a thaumatrope. Movement of viewers in the gallery trigger the thaumatrope to rotate and the partial images are consequently integrated into an illusion of a message.

Over the last one hundred years cinema technology has been developed almost to the point of perfection. Viewers no longer recognise that the motion–sequence is merely a series of individual momentary images projected in rapid succession. Whether using film or video it is the slowness of the eye that generates a flowing movement for the viewer. It is the inability of the human eye to recognise motion–sequences projected in rapid succession as individual images that enables us to read the word 'deception' in this object.

Figure 13. *Border* (Almond, 1999)

In *Border* (**Figure 13**), two traffic signs for Oświęcim (synonymous with Auschwitz) are placed in the gallery with a few paces between them. The first sign would tell a traveller that they were entering Oświęcim. The second sign, with its diagonal red line, would tell the traveller that they were leaving Oświęcim or that Oświęcim no longer existed. The two traffic signs would thus serve as two moments in our history and as two frames in a movie. The interval between the two frames in this sequence and all other sequences of images is where the viewer imagines and creates meaning.

Figure 14. ***Supermoment*** **(St George, 2004)**

This work is based on observations of rooms after one think that the lights have been turned off. After their eyes have adjusted a viewer will see, all around a typical room, small light–emitting diodes (LEDs) and specular reflections from these small lights. These LEDs are in remote–controls, plugs, computers, printers, iPods, speakers, smoke alarms, battery chargers, everywhere. The reflections of the lights multiply the incidence of small coloured dots that inhabit rooms after we have left them.

When these lights are recorded and then viewed from a sequence of different angles a viewer can see that from particular viewpoints some constellations of LEDs reveal hidden and accidental drawings. The viewer can move around the work and discover the latent drawings. In this example, a viewer of the interactive work can find a circle and, from a different angle, a square. It is also curious that it is the same LEDs in the same location that have drawn both the circle and the square.

The lights have not moved; it is only our view of them that has changed. In the two–dimensional views of the lights there can appear to be contradictions between two found–drawings, one is a circle and the other is a square. These apparent contractions disappear when the different two–dimensional views are integrated into movement around a three–dimensional scene. Here, in a 'Supermoment' the different views are seen to be of the same object. This is analogous to looking at a friend talking. As our companion moves, turns and shifts their position we see very different views. Now two eyes, here an ear, now a laughing mouth. We are not shocked by these new views, we do not think our friend has been replaced by a strange usurper. We know, unlike computers, to integrate all these disparate views into an object of thought we call our friend in animated conversation.

Figure 15. *One Day in Japan, 15 September 2002* (Studiometis, 2002)

Studiometis are specialists in mixing media (Art, Design, Education, Theory), and cultures (France, Japan, Germany). They make interactive knowledge spaces using chronophotography and are looking for a smooth fusion of real and virtual spaces with a new language integrating chronophotography, video loops, animations and music.

One day in Japan is made using *vjying* software that has been developed by the Studiometis collective. The user navigates in an animation database. The loops are classified by theme or in a chronological order. The user can change parameters of the visual experience with the keyboard: rotation, zoom, speed are controlled by keys "O", "A", "up", "down", "right", "left" and so on. Animations consist of photographs taken in Japan on September 15, 2002. The user can mine the animation database to create different sequences.

Much of their work is intended to be shown with music as a performance so the mode of interaction is that of a video jockey (VJ). In *One Day in Japan,* the viewer can select, vary and interact with a great number of variables. Choices that the VJ can make include the expected variables such as speed and looping sequences but also include image manipulation such as luminosity, zooming, distortion and colour values. The convergence of chronophotography, music, performance and interactivity offers each viewer a unique and unpredictable experience.

Figure 16. *Planet Usher* (Tarrant, 2001)

Planet Usher is a new media project that tells the story of, and through, a twenty–year home video archive. Curiously, this audio–visual archive was produced by the artist's brother, Peter, who was born deaf, and has slowly gone blind due to the effects of Usher syndrome. Patrick Tarrant constructs an interactive home movie by using these videos in an interface that operates at the intersection between database and narrative. The sequences of repeating images that emerge from the interface survive in that ambiguous zone between the instability of memory and the necessity of memory for navigating a world where things forever appear on the brink of vanishing.

The story that emerges in *Planet Usher* is not simply a story about Peter, nor is it a pitiful story. The stories being told here are very much stories told by Peter, about the family and his world, as seen through the video camera, and refracted through a new media lens. Hence there is an ongoing sense of the video archive's productivity, rather than an absence or loss. The idea that the home video archive might persist as visual memory serves as a guiding principle for all the aesthetic choices made in *Planet Usher*. For instance, a

Chapter IV. Possibilities of Images

The two surveys have introduced a number of strategies and codes that other artists have used to represent and construct time. To see, not just what has been used but, what could be used I next created a typological survey of possible ways of recording and presenting images.

The strategies and codes that artists use intervene in some way between a putative reality and the meaning that the viewer gives. If the viewer simply points at the world out there, she has selected some part of the world and has directed our attention towards it. In most cases, an artist intervenes in a more significant and transforming way. In the works I have been interested in, works that come under the broad headings of photography, film or time–based art, the artist first records the event or scene and then presents the recording in some way. Recording is the first of the many interpretations between an external reality and another form that stands in for that reality. Presentation is a new and subsequent interpretation and is further removed from a putative reality. Recording and presentation are not, and cannot be innocent or indexical stages in the work's transformation. The typology will reveal how simple methods of recording represent and construct meaning.

In the chain of re–presentations between a putative reality and the meanings that a viewer gives to the work, the work is transformed into a number of new states. Some of these new states are created by new contexts that contain the work, some are created by the viewer and some are created by the artist. Recording and presentation are two simple stages that most time–based work must go through. This typology looks at these elemental processes and how they can be combined to make different kinds of work.

Typology is a heuristic strategy to find new ideas, methods and possibilities; a way of directing ones attention fruitfully. Typology is the systematic organization of artefacts into types, or categories, on the basis of shared attributes. A famous example of the heuristic use of typology is the Periodic Table. A period is a row of the table. The organisation of elements into a hierarchal table according to their atomic structure revealed spaces that directed explorers (structural chemists) to find new, previously existing but unknown elements. The Periodic Table also shows structural relationships between elements. This gives each element a position in the table. Groups of elements that share similar positions in the Periodic Table may share similar structures and similar properties. I created a typology of possibilities of images and this typology revealed a number of new methods of image making. These methods will be used to make the artwork that is the subject of this research. My periodic table of image–making methods shows the relationship between the spatial and temporal dimensions of an event, a recording of that event and the presentation of that recording. My aims are to reveal new possibilities for making images and to demonstrate the links and relationships between different image–making methods. Without this table, the methods I describe would not be seen as belonging together in one meta–category and new untried methods would not be revealed.

I have reduced the complexity of this table in a number of ways. The increased simplicity allows me to focus on a method's position in the table and its relationship to other methods and permits comparisons among methods to be seen more clearly. So, where I can, I have described the simplest version of any image–making method. For example, if a number of images can be shown on the same screen then I have described the instance when the images are in a row butting up to each other rather than scattered irregularly across the screen.

I have also reduced the complexity of the table by using images from one recorded event throughout the table. The event is a body rotating about its longitudinal axis. This event is selected because it quickly and easily demonstrates spatial and temporal changes. The length of the body is a simple ruler (from top to toe). The rotation of the body is a simple clock dial. Just as with a clock, the degree of rotation of the body is proportional to the time that has passed. Interestingly, as with most (if not all) analogue timepieces, time is indicated spatially. This 'clock–ruler' event can be viewed in Exhibit 1 on the accompanying DVD.

All the image–making methods use samples from this one event. In all cases I have used the same arbitrary dimensions for my samples. My unit sample is a view that is 124 pixels wide and 155 pixels high and is shown for 1/3 of a second. This unit sample of an event (**Figure 17**) can be combined with other samples of the same event in a number of ways. For example, the sample view can be recorded and then, after a short interval, another sample view can be recorded. This can be repeated until a sequence of images has been recorded. This sequence can be quickly presented, one recorded image at a time, on a screen. This method is cinematic film and projection.

Figure 17. Unit sample of an event

The same sample view can be combined with other sample views of the same event in a number of ways. The views can be of the same space or of different spaces (**Figure 18**). The views can be recorded at the same time or at different times. Then the images can be presented in the same space or in different spaces and the images can be presented at different times or the same time. These four simple alternatives produce sixteen combinations and these are presented in the periodic table of the possibilities of images (below). A description of each image–making method follows the table (see **Table 1**). These descriptions include references to new image–making methods. Two new methods (Trackorama and Spheriscope) were the subjects of earlier projects and another two new methods (Chronopan and Chronocyclography) are the work that is made during this research project.

Figure 18. Unit samples of different spaces

(All the examples can be viewed in Exhibit 2 on the accompanying DVD.)

	00__	01__	10__	11__
__00	0000	0100	1000	1100
__01	0001	0101	1001	1101
__10	0010	0110	1010	1110
__11	0011	0111	1011	1111

Table 1. Periodic table of recording and presentation methods

The first two characters of an element's number refer to the recording method. The first of these two characters refers to the space of the recording and the second character refers to the time of the recording. Each character can be a "0" or a "1". "1" stands for different and "0" stands for not different (or the same). For example, 00 represents a recording of one view at one time.

The last two characters of an element's number refer to the presentation method. The first of these two characters refers to the space of the presentation. The second character refers to the time of the presentation. Each character can be a "0" or a "1". "1" stands for different and "0" stands for not different (or the same). For example, 00 represents a presentation in one space at one time.

The full list of possibilities is:

0000 Recording of one view at one time and presented in one place at one time

0100 Recording of the same view at different times and presented in one place at one time

1000 Recording of different views at the same time and presented in one place at one time

1100 Recording of different views at different times and presented in one place at one time

0001 Recording of one view at one time and presented in the same place at different times

0101 Recording of the same view at different times and presented in the same place at different times

1001 Recording of different views at the same time and presented in the same place at different times

1101 Recording of different views at different times and presented in the same place at different times

0010 Recording of one view at one time and presented in different places at the same time

0110 Recording of the same view at different times and presented in different places at the same time

1010 Recording of different views at the same time and presented in different places at the same time

1110 Recording of different views at different times and presented in different places at the same time

0011 Recording of one view at one time and presented in different places at different times

0111 Recording of the same view at different times and presented in different places at different times

1011 Recording of different views at the same time and presented in different places at different times

1111 Recording of different views at different times and presented in different places at different times

(Each of these possibilities is shown in Exhibit 2 on the accompanying DVD.)

I will now describe and illustrate each of the 16 possible ways of recording and presenting images.

Various kinds of recording are presented in one place at one time (00 row):

0000 Recording of one view at one time and presented in one place at one time

Recording of one view at one time and presented in one place at one time is, for example, a snapshot presented as a single image fixed on a screen.

(An illustration of this method of recording and presenting images is shown in Exhibit 3a on the accompanying DVD.)

0100 Recording of the same view at different times and presented in one place at one time

This is a temporal sequence of images taken with a stationary camera of one scene. The images are either recorded and presented on the same photograph (as in a multiple exposure) or a number of images are sandwiched together and projected together as one multiple image fixed on a screen.

Because a number of different images, recorded at different times, are shown in the space of one image there will be overlap and merging of the source images.

(An illustration of this method of recording and presenting images is shown in Exhibit 3b on the accompanying DVD.)

1000 Recording of different views at the same time and presented in one place at one time

This is a number of spatially separated images taken at the same time. The images are sandwiched together and projected together as one multiple image, or montage, fixed on a screen.

Because a number of different images, of different spaces, are shown in the space of one image there will be overlap and merging of the source images.

(An illustration of this method of recording and presenting images is shown in Exhibit 3c on the accompanying DVD.)

1100 Recording of different views at different times and presented in one place at one time

This is a number of spatially separated images recorded in a temporal sequence. The images are either recorded and presented on the same photograph (as in a chronophotograph) or are sandwiched together and projected together as one multiple image, or montage, fixed on a screen.

(An illustration of this method of recording and presenting images is shown in Exhibit 3d on the accompanying DVD.)

Various kinds of recording are presented in the same place at different times (01 row):

0001 Recording of one view at one time and presented in the same place at different times

Recording of one view at one time and presented in the same place at different times is, for example, a snapshot presented as a single image shown intermittently on a screen. If the pause between the periods during which the image is shown were indiscernible this would appear to be a continuous image. If the pause were discernable then the image would be alternately present and absent like the sound of Morse code.

(An illustration of this method of recording and presenting images is shown in Exhibit 3e on the accompanying DVD.)

0101 Recording of the same view at different times and presented in the same place at different times

Recording of the same view at different times and presented in the same place at different times is a conventional cinematic film with a stationary camera. If the presentation rate is the same as the recording rate then it is a normal ciné film. If the recording rate is much slower than the presentation rate and the presentation rate is one that would normally produce an illusion of continuous motion then this is a time–lapse movie. If the recording rate is faster than this presentation rate then we have a slow motion film (slow mo).

(An illustration of this method of recording and presenting images is shown in Exhibit 3f on the accompanying DVD.)

1001 Recording of different views at the same time and presented in the same place at different times

Recording of different views at the same time and presented in the same place at different times looks like a tracking shot in a conventional cinematic film but is different because all the views are recorded at the same event time. So, this is more like the rostrum camera technique of moving a ciné camera over a still photograph or animation drawing.

(An illustration of this method of recording and presenting images is shown in Exhibit 3g on the accompanying DVD.)

This recording of different views at the same time and presented in the same place at different times can also be a Timeslice. In a Timeslice a number of cameras are arranged around an event. The cameras are all exposed at the same time for the same duration. The images from the array of cameras are then presented sequentially in one place and so the view seems to move around the event in a frozen moment.

This apparently very novel technique has been seen before in the work of Muybridge and Nadar.

Figure 20. *Revolving self-portrait* (Nadar, 1865)

1101 Recording of different views at different times and presented in the same place at different times

Recording of different views at different times and presented in the same place at different times is a tracking shot in a conventional cinematic film.

(An illustration of this method of recording and presenting images is shown in Exhibit 3h on the accompanying DVD.)

Various kinds of recording are presented in different places at the same time (10 row):

0010 Recording of one view at one time and presented in different places at the same time

Because a recording of one view at one time is unique and because this one original is presented in different places at the same time, this method depends on duplicating or multiplicating technology such as mirrors, printing, beam–splitting, multicasting or a distributed network such as the Internet. Different places can be on the same screen, in different rooms like televisions in a motel, in different rooms or on different monitors over a distributed network.

(An illustration of this method of recording and presenting images is shown in Exhibit 3i on the accompanying DVD.)

0110 Recording of the same view at different times and presented in different places at the same time

Presenting recordings of the same view at different times in different places at the same time transposes time into space as Muybridge did in his chronophotographic sequences. This method is also used in the *predella* of a Renaissance altarpiece, in storyboards and in comic book art.

(An illustration of this method of recording and presenting images is shown in Exhibit 3j on the accompanying DVD.)

Figure 21. ***Bath Half Marathon*** **(Macmillan, 1989)**

This image–making method is fully described later as it is one of the new kinds of work that is made in this research project, but the essence of the technique is shown in this detail from a much larger and longer image. This shows the change in light during a 10–hour exposure. The change is distributed across the image so duration and space is then enfolded into one image. The left edge of the image shows dawn and the right edge of the image shows dusk, the transition from light to dark is revealed between these limits. I will refer to this new kind of image as a Chronopan.

Figure 22. Chronopan

1010 Recording of different views at the same time and presented in different places at the same time

This is an extended image and has many forms. The simplest form is a panorama. In a panorama the different views are recorded from the centre of a circle. In a Trackorama® (my earlier work), the different views are recorded from contiguous points along a line (or track). In a Spheriscopic image (my earlier work), the different views are recorded from the centre of a sphere. The scene can also be at the centre of the circle and the contiguous views can be on the circumference of the circle and this produces a peripheral image.

If the two similar images of the same scene are placed side–by–side, with the intention of creating an illusion of three–dimensional depth then this method is stereophotography.

(An illustration of this method of recording and presenting images is shown in Exhibit 3k on the accompanying DVD.)

Figure 23. Installation view of a Spheriscope

Figure 24. ***Peripheral image*** **(Dávidházy, 1985)**

1110 Recording of different views at different times and presented in different places at the same time

A recording of different views at different times that is presented in different places at the same time is a combination of the panorama (1010) where space is distributed along an extended image and the 'time as space' sequence (0110) where time is distributed along the image's surface.

(An illustration of this method of recording and presenting images is shown in Exhibit 31 on the accompanying DVD.)

Again, this image–making method is fully described later as it is another one of the new kinds of work that is made in this research project, but the essence of the technique is shown here. I will refer to this new kind of image as a Chronocyclograph.

Figure 25a. Chronocyclograph (one of a pair)

Figure 25b. Chronocyclograph (one of a pair)

Various kinds of recording are presented in different places at different times (11 row):

0011 Recording of one view at one time and presented in different places at different times

A recording of one view at one time that is presented in different places at different times is, for example, a single image (0000) that is intermittently shown on a screen and reappears in a different place each time it is shown.

(An illustration of this method of recording and presenting images is shown in Exhibit 3m on the accompanying DVD.)

0111 Recording of the same view at different times and presented in different places at different times

A recording of the same view at different times that is presented in different places at different times is, for example, a film (0101) that is projected in different places. The projection could move along a screen or it could move from one monitor screen to another. This is equivalent to taking a number of still images (0000) from a temporal sequence of images (0110) and showing these, one at a time, on different monitors. The viewer then assembles the spatial array of static images into a film.

(An illustration of this method of recording and presenting images is shown in Exhibit 3n on the accompanying DVD.)

1011 Recording of different views at the same time and presented in different places at different times

A recording of different views at the same time that is presented in different places at different times is, for example, a Timeslice film (1001) that is projected in different places. The projection could move along a screen or it could move from one monitor screen to another. This is equivalent to taking a number of still images (0000) from a spatial sequence of images (1010) and showing these, one at a time, on different monitors.

(An illustration of this method of recording and presenting images is shown in Exhibit 3o on the accompanying DVD.)

1111 Recording of different views at different times and presented in different places at different times

A recording of different views at different times that is presented in different places at different times is, for example, the combination of Timeslice film and conventional film that is projected in different places. The same effect can be achieved by taking a number of still images from an array of images. This array would include images that were taken of different views at different times. The still images would be shown, one at a time, on different monitors. The viewer then assembles the spatial array of static images into a film of a tracking shot.

(An illustration of this method of recording and presenting images is shown in Exhibit 3p on the accompanying DVD.)

SECTION TWO

Exploration and analysis of methods available to an artist

Chapter V. Introduction

The surveys of other artists' work and the analysis of the possible ways to record and present events have thrown up a number of aesthetic codes and strategies that have or could be used to represent and construct space, time and movement. In this section, I will explore and analyse these methods and in doing so I will attempt to determine their usefulness in representing and constructing space, time and their derivatives in visual art.

The methods fall into three groups. The first group of methods could be called interactivity and is the interrelationship between the observer and the work. Strategies for engaging with this relationship are explored, in some way, by most of the artists in my surveys. I will look at the relationship between the interior form of the work, in a digital work this is the new media score, and the structure of the work. Music is represented on paper in a score, this score represents both something of the composer's intentions and also instructions to the performer. So too in digital art, the score is the window in the software's graphical user interface where the author of the interactive presentation composes the work. When the work is compiled, the score is used to control how the work is seen and behaves. My investigation of the relationship between the internal and external structures of the work will enable me to see whether digital art offers a break with non–digital work and a breakthrough for artists in their continuing attempt to make a truly interactive work. The ways in which artists engage with the relationship between the observer and the work are very diverse and this subject is dealt with in **Chapter VII** below. I also explore the relationship between work made in a digital space, with digital bits, and the space that the observer inhabits, the world of tangible bits.

The first group of methods is based on the relationship between the observer and the work. The second group of methods enable an artist to engage with the relationship between the stuff of the work, the marks on the screen or surface of the work, and any depiction. This can be expressed as a relationship between how the work is made, its facture, and how the work is seen. For illustration, if the work is a painting this relationship is between the marks of paint on the canvas and the depiction. I will show that in an aesthetic work this relationship is intentionally ambiguous, indeed ambiguity can be said to define an aesthetic work. In the example overleaf (**Figure 26**), the eucalyptus leaves are the marks and the face is the depiction. It is possible to see both the eucalyptus leaves and the face. The two are in a two–folded relationship of ambiguity.

Figure 26. Eucalyptus leaves and a face (from Raetz, 1982)

Figure 27. Eucalyptus leaves

The third group of methods in this section is called 'markedness'. Markedness is a linguistic concept that developed out of the Prague School of literary critics and linguists during the years 1928–1939 (Chandler, 2004, pp. 110–112). A marked form is a non–basic or less natural form. An unmarked form is a basic, default form. For example, lion is the unmarked choice in English — it could refer to a male or female lion. But lioness is marked because it can refer only to females.

I wish, as an artist, to make work that is immersive and so, just as the page of a book is a transparent interface between the competent reader and the novel, the interface between the viewer and my work should be transparent. This allows a viewer to be fully engaged with the work (as they can be with other objects in their world) and because I want to avoid the work being bracketed–off or filtered through an institutional model of viewing and interpretation.

To do this, I need to find a way to mark off some part of the tangible, 'real' world as being capable of, or available for interpretation, as a depiction. By depiction, I mean that the marks are considered by an observer to be more than marks. They also stand in for something else. A painting, for example, is conceptually framed off from the rest of the world. We learn and know the border between the painting and the remainder of the world. A work of art is 'framed' and bracketed off by the gallery it is shown in and by the contexts and institutions that surround and maintain it. In contrast, I want to make work that is part of the world that the observer inhabits. I aim to direct a viewer's attention to some part of the world without creating a new separate object (such as painting or a sculpture) and without removing the artwork from the world and installing it in a place set aside for the showing of art (such as a gallery). The work will not be a representation of some scene or event, it will be part of that scene or event.

Consider, for example, some eucalyptus leaves hanging in a spider's web. From a certain viewpoint these leaves can be seen as resembling a human face (**Figure 26**). Do I now look at all eucalyptus leaves until I can discern a depiction? Is the depiction of the face an accident or is it intentional? To avoid these problems, there needs to be some cue that directs a viewer to see other parts of the world as both themselves and capable of representing or standing in for something other than themselves (eucalyptus leaves and a face) (**Figure 26**). An absence of that cue leaves the viewer seeing some parts of the world as being just themselves and nothing more (eucalyptus leaves) (**Figure 27**). So, in the closing chapter of this section I investigate the use of hue for marking off part of the world and so cueing the viewer to see the marked parts of the work as possibly standing in for some other thing.

Chapter VI. The relationship between the new media score and the structure of the work

During the eighteenth and nineteenth centuries there were many inventions that were designed to produce images and ways of viewing images that would increase our understanding of time and movement. This group of inventions is now called pre–cinema. Many of the later pre–cinematic inventions used photography to record and to reveal more about time and movement. This group of inventions is called chronophotography and includes devices that were developed by Le Prince, Marey, Baron, Grimoin–Sanson, Louis and Auguste Lumiere, Muybridge and Reynaud. Their devices attempt to show views that succeed each other in time. One or two photographers used devices that show successive spatial views. Examples of this kind of device developed from Robert Barker's Cyclorama (1787) and Panorama (1792) and include Tournachon's revolving self–portrait (1865) and Grimoin–Sanson's Cinéorama (1899).

The representation of space and the representation of time have evolved from separate traditions. Interactive devices have remained within the constraints of these two separate traditions. Interaction between the viewer and the temporal dimension of a recorded scene is now common and is made available by household devices such as video players. Interaction between the viewer and the spatial dimension of a recorded scene is also made possible (but less available) by software devices such as Panorama viewers and QuickTime Object Virtual Reality (Apple, 2007). In contrast to panoramas, which are captured from one location looking out at various angles, QuickTime Objects are captured from many locations pointing in toward the same central object.

Currently, there are no devices that enable the viewer to interact, using the same tools and interface, with both the spatial and temporal dimensions of a recorded scene.

In this chapter, I develop some methods and tools to provide interaction between the viewer and both the spatial and temporal views of a recorded scene. My aim in this series of experiments is to develop a technique that would bring together the two strands of visual enquiries and would treat both time and space as equal partners in dialogue.

I will describe three experimental models:

The first experimental model is an interactive *time–lapse* movie. A *time–lapse* movie is a sequence of successive views from one point of view. This device allows the viewer to interact with the temporal dimension of a recorded scene.

The second experimental model is an interactive *time–slice* movie. A *time–slice* movie is a number of views of one moment from contiguous viewpoints. This device allows the viewer to interact with the spatial dimension of a recorded scene.

The third experimental model is a device that combines and integrates the interactive *time–lapse* movie and the interactive *time–slice* movie into a new form. I make the third model by using digital media. The interior form of this digital work is the new media score. The inner structure of the work reflects how the work is made and put together. This internal structure is usually only known to the author of the work. The structure of the resultant work is the structure that is experienced by the observer. This third model will allow me to explore whether there is a useful relationship between the inner structure of the work and the structure of the resultant work. This exploration will enable me to see whether digital media offers a break with non–digital work and a breakthrough in my narrow attempt to make a work that enables the observer to interact with both the temporal and spatial dimensions of the work. The broader aim of the experiments is to explore whether it is possible to make a truly interactive or 'open work' (Eco, 1962, pp. 1–40).

Experimental model 1: The interactive time–lapse movie

A *time–lapse* movie is a sequence of successive views from one point of view. This interactive *time–lapse* movie allows the viewer to interact with the temporal dimension of a recorded scene.

In this preliminary research model (Exhibit 4 on the accompanying DVD), I provide some level of interactivity between the viewer and 132 images of a scene recorded at 30–minute intervals. These images are shown one after another at an arbitrary but consistent rate and in the order that they were recorded. By moving a cursor over the image, the viewer can change the rate at which the images are displayed and they can change the order in which they are displayed. This is equivalent to changing the view of the passage of time.

Figure 28. *22* hours

The duration of this recorded event was 66 hours. The event started at 17:00 and ended at 11:00 almost 3 days later. By changing the frame rate of the interactive movie (by moving a cursor over the image) this event can be viewed at different rates. The minimum and maximum frame rates for the movie are arbitrary. At the maximum frame rate of 4 fps the complete (66 hours) event can be viewed in one minute. At the minimum frame rate of 0.4 fps the complete event can be viewed in 5.5 minutes. A frame rate that would be consistent with the original, unaltered event would be about one frame every 30 minutes (0.0005 frames per second).

Events that have a temporal direction (such as the growth of a plant or the onset of dusk) can be viewed in the recorded direction or in reverse. These parameters can be changed during the viewing and the viewer is provided with information about where they are in the event.

Figure 29. ***34*** **hours**

The grey bar is an index of the rate of the interactive movie. When the rate of the movie is increased the dark grey button moves to the right. The light grey bar shows the range of available rates. The position of the dark button on the grey bar shows the relationship between the current rate and the range of available rates. The two numerical displays refer to times measured in the original, unaltered event. One display shows how much time has elapsed between the start of the event and the current view and the other shows the time of day.

Figure 30. *66* hours

Experiment 2: The interactive time–slice movie

A *time–slice* movie is a number of views of one moment from contiguous viewpoints. This interactive *time–slice* movie allows the viewer to interact with the spatial dimension of a recorded scene.

In this research model (Exhibit 5 on the accompanying DVD), I provide some level of interactivity between the viewer and a number of images recorded by cameras arranged around the circumference of a circle and pointing in towards the centre of the circle.

Figure 31. The arrangement of cameras

The cameras were equally spaced around the circumference of the circle. Images from this arrangement of contiguous cameras were assembled into a sequence. When this sequence is viewed, the point of view moves around the scene. The essential difference between this kind of movie and a tracking shot is that the spatial movement is not accompanied by a change in time. All the shots are recorded at the same time and so the effect is similar to a movement around the scene with time having been stopped or frozen.

This arrangement of cameras is not new. As can be seen in **Figure 32**, Muybridge used it as early as 1887.

Figure 32. ***Woman Spanking a Child*** **(Muybridge, 1887)**

More recently, practitioners in special–effects photography (an early example from this era is Tim Macmillan and his Time–slice films (Macmillan, 1994)) have animated sequences that they have obtained from cameras arranged in tracks. The novelty that I have introduced is to provide interactivity between the viewer and the animated sequence. By moving a cursor over the image in the interactive time–slice movie (Exhibit 5), the viewer can change the point of view.

Figure 33. A view of the screen of the interactive *time–slice* movie

Experiment 3: The combination of interactive time–lapse and interactive time–slice movie

The two preliminary research models are not original work. The purpose of making the models was to investigate their properties and then to investigate the relationship between the new–media *score* and an original kind of work that would combine the *time–lapse* (Experiment 1) and the *time–slice* (Experiment 2).

In Experiment 3, an event is recorded using a number of cameras and is recorded for a length of time. The frames from these cameras can be described as a database or an array of available images. Viewing a conventional film would be equivalent to viewing the available frames from one of the cameras and viewing one frame at a time with equal intervals between the frames until the sequence of images had been viewed. When viewing a conventional film, viewers typically sit immobile and passive and facing forwards as the frames are presented to them, in a fixed predetermined order, with a fixed interval between the frames. An interactive film might provide a method for viewing these individual frames in any order and at any pace. Because there are a number of cameras filming the one event from different angles and viewpoints it is also possible to provide a method for the viewer to change from seeing the recording from one camera to seeing the recording from a different camera. By interacting with recordings from any one camera and selecting one frame or another, the viewer is interacting with the temporal dimension of the film recording. By interacting with the recordings from the cameras and selecting one camera over the others, the viewer is interacting with the spatial dimension of the film recording. By interacting spatially, the viewer can move their view around the recorded scene. If these two modes of interactivity are put together, a viewer can interact with both the temporal and spatial qualities of the work.

Figure 34. The arrangement of cameras and frames in an array

Figure 35. 8 cameras and array of images

Firstly, I recorded an event using many cameras (**Figure 34**). Then, the frames from these recordings were imported into a digital application and arranged in a 'score' that is similar to that in **Figure 35**.

Figure 34 also shows the array of images. Each cell of the array represents an image in the score. Horizontal rows contain frames from the same camera. Vertical columns (also called channels) contain frames taken at the same time from different cameras. These images can be displayed on a monitor in different sequences. A number of images that are next to each other in the score can be thought of as a route through the sequences of images contained in the array. The heavy lines in **Figure 36** represent some of the possible routes that can be taken through the sequences of images.

Figure 36. The array of images and some of the possible routes through the sequences of images

The segments (a, b, c and d) of **Figure 36** are maps of some of the sequences of images. These maps represent both a route through the score and the sequence of images that is shown on the screen. Segment (a) of **Figure 36** shows successive frames from one camera. This is equivalent to the *time–lapse* movie when it is playing forwards. Segment (b) of **Figure 36** shows successive views from different points of view that have been taken at the same time. This is equivalent to the *time–slice* movie. Segment (c) of **Figure 36** shows successive frames in reverse order from one camera. This is equivalent to the *time–lapse* movie when it is playing backwards. Segment (d) of **Figure 36** shows successive frames from different points of view. This is a combination of the *time–lapse* movie when it is playing forwards and the *time–slice* movie. Segment (e) of **Figure 36** shows successive frames in reverse order from different points of view. This is a combination of the *time–lapse* movie when it is playing backwards and the *time–slice* movie. These routes and the relationship between the score and the sequence of images shown on the screen can be seen in Exhibit 6 on the accompanying DVD.

This new technique brings together the two, often separate, strands of visual enquiries (chronophotography and panorama) and treats both time and space as equal partners in dialogue. Typically, chronophotography is a series of recordings of a scene with each recording being different from each other by an interval of time. Equally, panoramas present a series of adjacent views of a scene each differing by an angle of view. The chronophotographic sequence is of the same scene or event. The panoramic sequence is recorded in the same sweep of time. The new technique allows the viewer to interact with both consecutive recordings and adjacent views of a scene and so with both the temporal and the spatial aspects of the scene.

Non–linearity

The combination of the spatial *time–slice* and the temporal *time–lapse* offers more than a choice between interaction with the spatial or the temporal dimensions of a work. The combination offers a non–linear relationship between the viewer and the spatiotemporal dimensions. For example, one can be moving within the array along a horizontal row of images, and so be navigating the temporal dimension of the event. One can then move vertically up or down one of the columns of images. The viewer is then navigating the spatial dimension of the event. Having done so, the viewer can rejoin the initial row of images at a different point in the sequence but without passing through the intermediary positions.

Structure

In this work, I have exploited the similarity between the structure of the *score* and the structure of the work. Images that were recorded successively are placed in the rows of the score in the order that they were recorded. Images that were recorded from contiguous cameras are placed in the columns of the score. The topological relationships are not changed. The relative positions of the cameras are used to determine the positions of the images the columns.

The interface of the application enables the viewer to navigate through this array of images. Just as navigating through a linear array of successive images is an interaction with a representation of time (Experiment 1), so this interaction with the spatiotemporal array is an interaction with a representation of both time and space.

This mapping from the structure of the score to the structure of the work is continued, I suggest, to the synchronic and diachronic structure of language and thought. Any one image in a sequence can be seen in relation to the images that precede and follow it just as words are syntagmatically related to sequences such as sentences, paragraphs and stories. Images in the work are also related to other alternative simultaneous views in the way that words are paradigmatically related to other words that could have been chosen and that exist in opposition to the selected word.

Chapter VII. Modes of interactivity

In the previous chapter I explored the use of the new media score to enable a physical interaction with a spatiotemporal representation. I found that it offers the possibility of an interaction between the viewer and the diachronic and synchronic structure of language and thought. I want to test this suggestion by making work and then learning how viewers respond to the work and to the way it is presented. I will use this feeback to make new work and then repeat the cycle. I will make five successive approximation of the work. Each version is intended to be an improvement on the previous version. The improvement is achieved by making a version of the work, showing it in a gallery, and then using feedback and critical response from visitors to the exhibitions to inform and guide the making of the work. In this way, each version of the work can be described as a successive approximation. The feedback and critical response was gathered in a number of ways. These include the comments book, informal conversations with viewers in front of the work and Artist's Talks. Artist's Talks are sessions where interested members of the gallery's Friends list or members of the public attend a meeting and engage in a critical seminar around the work. The gallery exhibitions provided another method for learning about the work and using that learning to improve the next version of the work. In the studio, an artist steps back from the work and looks at it as if he is a surrogate viewer. There are many established tactics for seeing the studio work through the eyes of someone else. The list of tactics includes looking at the studio work in a hand–held mirror and, alternatively, placing the studio work on a pedestal against a blank wall in order to model the gallery location. These methods of testing how the work will work in a gallery are insufficient for a work that requires the physical invention of a viewer. Viewing the work in a gallery, as an installation, with engaged viewers and interacting with the work as a surrogate viewer was very different from looking at the work in the studio. This gallery experience provided information that was not readily available in the studio. So, as well as being a study of the use of interactivity, these five studies were an opportunity for me to learn how different methods worked in a gallery and to learn how viewers responded to the work and to the way it was presented.

I will describe five versions of the work in the case study. Four versions of the work are in this chapter. The progression from one version to another in these four examples was one of increasing reliance on digital interactivity. At the end of making and reflecting upon the success and failure of the fourth version, I explore the interface between the observer and the work in **Chapter VIII**. This then leads the research into the fifth version of the work in **Chapter IX**.

The five successive approximations show a development in the interactive aspects of the work and a progressive move away from new media. Each version of the work is a rehearsal for the next instalment in the series.

Version 1

This was made for and exhibited in the Sequences exhibition at Peterborough Museum and Art Gallery, Peterborough (27 November 2004–23 January 2005).

The work was made in Adobe Director (Adobe, 2008). The fully working version can be seen in Exhibit 7 on the accompanying DVD. The screen shows a view of a constellation of small light–emitting diodes (LEDs). The work is based on observations of rooms after the lights have been turned off. After a person's eyes have adjusted, they will see that all over a typical room are small light–emitting diodes (LEDs) and specular reflections from these small lights (**Figure 37**). These LEDs are in remote controls, plugs, computers, printers, iPods, speakers, smoke alarms, battery chargers, everywhere. The reflections of the lights multiply the incidence of small coloured dots that inhabit rooms after we have left them.

Figure 37. View of a room showing small light–emitting diodes (LEDs) and specular reflections from these small lights

A typical view of a room showing the constellation of small light–emitting diodes (LEDs) shows a three–dimensional object that does not correspond to any idea cannot be seen as a representation of any other object. I will refer to this object as **Object A.** It can be seen in **Figure 37.**

When these lights are recorded and then viewed from a sequence of different angles one can see that from particular viewpoints the same constellation of LEDs, **Object A**, reveals hidden and accidental drawings. For example, one can find a circle (**Figure 38**) and, from a different angle of view, a square (**Figure 39**).

Figure 38. View of Object A from camera 1

Figure 39. View of Object A from camera 2

This early version of the work shows many of the features that were to persist and be developed throughout the research. These include the idea that such purportedly accidental drawings are there to be found and that the work merely documents and presents them. Also included is the use of hue to mark some of the lights as picture elements of a depiction (in this case a circle and a square). Further, already present in this early version is a set of contradictory two–dimensional drawings that are integrated at a higher dimensionality (three–dimensions). The diagram (**Figure 40**) illustrates how both **Figure 38** and **Figure 39** can be views of the same object.

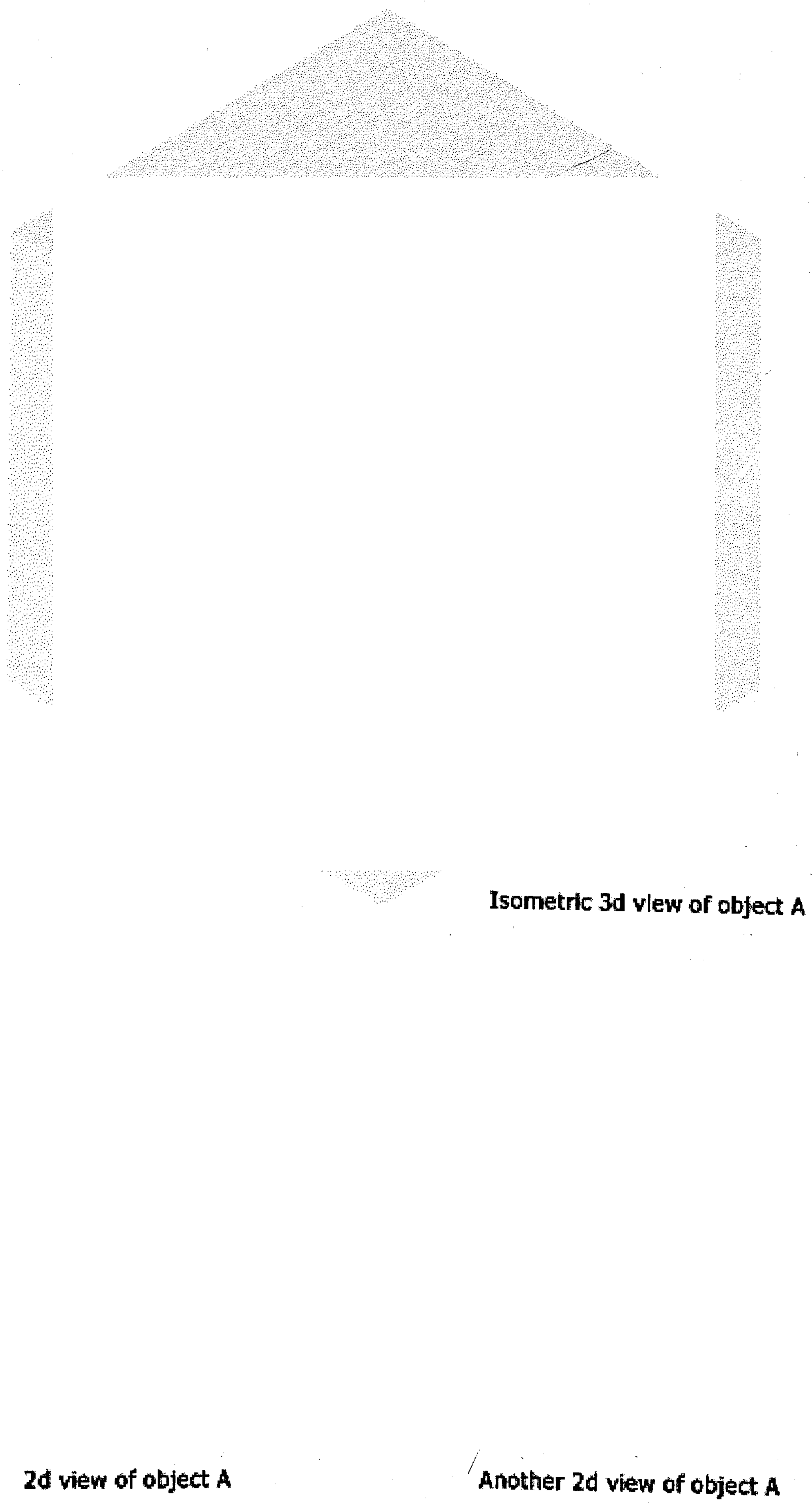

Figure 40. Two contradictory views are integrated when seen at a higher dimensionality

Here, I want to describe how the viewer could change their view of this work. The work was presented on a computer screen and the viewer moved the mouse so that the cursor (a small white cross–hair) moves across the screen. Vertical movements of the cursor are possible but do not affect the view of the work. When the cursor is equidistant from the vertical edges of the screen the constellation of blue lights depicts a circle. When the cursor is near either vertical edge the constellation of blue lights depicts a square. At any intermediary location of the cursor the lights are in some arrangement that is not clearly recognisable as any particular simple shape (**Figure 37**).

When the mouse has been left idle (or unmoved) for some predetermined time the view of the constellation will rotate autonomously according to a script. This automatic mode gives way as soon as a viewer moves the mouse. The purpose of this automatic mode is to cue viewers to interact with the work.

So, the interaction here is between the viewer and the work. The relationship is that the movement of the mouse stands in for the movement of a viewer around the room full of lights. There are also some transferences of scale. The scale of this work is clearly much smaller than a room of architectural scale. Such a room would be impossible to navigate in the way the viewer of this work can navigate, as walls would intervene.

An important, but easily overlooked, aspect of interactivity is from the work to the viewer. It is possible, and certainly intended, that the work will change the viewer and that after interaction between the work and the viewer he or she will notice these small lights more and that they might look for accidental drawings in constellations of these lights.

Version 2

This was made for and exhibited in the *Sequences* exhibition at Royal Pump Rooms, Leamington Spa (11 February–11 March 2005).

The work was, again, made in Adobe Director (Adobe, 2008). The fully working version can be seen in Exhibit 8 on the accompanying DVD. The major differences between this version and the earlier version are the size of the lights and the presentation of the image. An attempt was made to present this work in a more immersive way, that is to make the experience of viewing the work closer to viewing what the work stands in for. So, instead of presenting the work on a table–top computer, the work was presented on a flat–screen monitor. This monitor was set into the wall of the gallery as if it were a window. A mouse was provided on a plinth that was some distance away from the screen. This distance was equivalent to the desired viewing distance.

Figure 41. ***Supermoment*****: Version 2 (Modulated lights) (detail)**

Figure 42. ***Supermoment*****: Version 2 (Modulated lights) (detail)**

The lights in this version were more detailed (see **Figure 41** and **Figure 42**). This was achieved by surrounding the LEDs in materials that dispersed and reflected the light. The intention was to give the impression that the LED was contained in a larger object, some of which was illuminated by the LED. The interaction was between the work and the viewer. The viewer is given part of the story and they then provide the rest of the story.

The lights were also larger. The intention of larger and more detailed lights was to bring the work closer to the viewer and to provide changing views of each picture element as the angle of view rotated. In the first version, these views had changed but the size and level of detail of the picture elements made the rotating views very similar to each other. The changing views and various occlusions become apparent when three successive views are shown (see **Figure 43, Figure 44** and **Figure 45**).

Figure 43. View of Object A from camera 1

Figure 44. View of Object A from camera 2

Figure 45. View of Object A from camera 8

Version 3

This was made for and exhibited in the *Sequences* exhibition at Furniture Works, 41 Commercial Road, London (22 March–22 April 2005).

There are two significant differences between this version and previous versions. The fully working version can be seen in Exhibit 9 on the accompanying DVD. The most obvious difference is the introduction of a figure. This introduction was a strategy for introducing the second difference, changes over time and, importantly, introducing a narrative agent for that change. The changes in the image could have been made by simply moving objects around in the scene as in stop–frame or single–frame animation. This movements and changes would then be unexplained and difficult to understand. To avoid this distraction, the changes in the scene were seen to be made through the agency of the human figure that was also included in the scene. This gave the action coherence and focused attention on the changes in viewpoint and the changes over time.

If **Figure 46** is compared with **Figure 47** one will see a difference between viewpoints of the same scene. The differences are spatial as the images are from the same moment in time. Alternatively, if **Figure 47** is compared with **Figure 48** one will see a difference between views of the same scene from the same angle of view, but at different moments in time. Lastly, if **Figure 46** is compared with **Figure 48** one will see a difference between both spatial and temporal views of the same scene.

Horizontal movements of the mouse take the viewer through a sequence of spatial views of one moment, vertical movements of the mouse take the viewer through a temporal sequence from one viewpoint. Diagonal movements of the mouse take the view through the array of possibilities in varying combinations of both time and space. Changes in the scene due to changing viewpoint could have been confused with changes over time, this potential confusion was removed by introducing the human figure. The movements over time were then linked and associated with the movements of the figure and other movements or changes, not associated with the figure were interpreted as changes due to changing viewpoint.

Figure 46. Camera 2, Frame 1

Figure 47. Camera 6, Frame 1

Figure 48. Camera 6, Frame 2

Version 4

This was made for and exhibited in the *Sequences* exhibition at Lighthouse, Poole (28 May–23 July 2005). The fully working version can be seen in Exhibit 10 on the accompanying DVD.

A figure had been introduced to the previous version so that movement over time could be introduced and so that the viewer could interact with the work to select a different spatial viewpoint, a different point in time from a sequence or a combination of both dimensions. A human figure was introduced only because the movement could be closely controlled and because movement needed no external agency or explanation. In this version, the human figure becomes an actor in a dramatic narrative and so another layer of interpretation was added to the work. The title given to the work (*Annunciation*), the poses and the props all cued the viewer to interact not just with the spatiotemporal dimensions of the work but also with the story.

Figure 49. *Annunciation* (detail)

Figure 50. ***Annunciation*** **(detail)**

The navigation system was, again, horizontal movements of the mouse taking the viewer through the sequence of spatial views of one moment and vertical movements of the mouse taking the viewer through the temporal sequence from one viewpoint. Diagonal movements were interpreted as either horizontal or vertical and not a combination of both. The screen was again presented as if it were a window through to a scene in a darkened room.

Figure 51. ***Annunciation*** **(detail)**

The introduction of a strong narrative was accompanied by a new problem. Although there was no proscribed route though the database of views, it was now possible to become lost in the array of spatial and temporal views. A cursor was designed and implemented to give some very low–key feedback. As the viewer moved the cursor to the right of the centre of the screen the views would blend from one spatial view to the next (see **Figure 52**). As they did so, the vertical line of the cross–hair moves to the right. Equivalent movements of the cross–hair were supplied for the other three possible directions of movement. In this way, a viewer could tell where they were in the field of possibilities.

Figure 52. Changing views of the cursor for *Annunciation*

Chapter VIII. Digital bits and tangible bits

The first four models had provided an increasing amount of interactivity between the observer and the work. This was achieved by making the work increasingly complex. This was necessary if I wanted to show more than a constellation of simple lights. This increasing amount of interactivity between the observer and the internal structure of the work was provided using digital media. The combination of increasing complexity and a new medium provoked a crisis in the research.

The earlier forms of my gallery work used a computer to provide an interface between the viewer and an array of images. The viewer could move the mouse attached to the computer and so interact with the work. The interface between the viewer and the work is the monitor screen and this computer mouse.

The interface is a window into the work through which interaction could take place, but it is also a barrier and a dividing line. The interface, as it is usually constructed, divides the viewer's world into digital bits (the pixels and code of the application) and tangible bits (objects in their familiar world that can be touched in familiar ways). The opaqueness of the interface between an observer and my work (see Exhibit 10 on the accompanying DVD) was more of a barrier than a transparent interface between the observer and the work. For example, I had found it necessary to provide a new kind of cursor. The cursor tells the viewer where they are in the database of images. This cursor is unfamiliar and distracting. It is unlikely that anyone would learn to understand the cursor and so find the work accessible.

To resolve the crisis, I needed to investigate the interface between the user and the work and so the interface between the real, tangible world and the virtual, digital world.

The computer mouse provides a tool that the viewer can use to change what happens on the other side of the window. The computer mouse exists only in the computer world. It is not part of our world and our cumulative experience. In our world, we have learned to move and use graspable objects and we have learned to make associations between how these graspable, tangible objects look and feel and how they behave.

My aim in this chapter of the research was to take advantage of the skills and familiarity we have developed though a lifetime of experience and interaction with the physical world. Our experience with the physical world is multimodal. For example, as we move through the physical world we come closer or further away from noise or heat and our view of the world changes.

I designed and produced a device that would enable a viewer to move a physical object in a space so that their view of the digital work would change. I wanted there to be a strong relationship between the movements of the input device and the change in view. The movements of the viewer's body, as they reacted to and moved the surface of the input device, were intended to be an embodiment of the movements and changes in the digital information.

Figure 53. The Device

Figure 54. Relationship of the Device, the score and the screen.

The input device includes a moveable disc (**Figure 53**). **Figure 54** shows the relationship between the input device and the score and between the score and the images shown on the screen. Movements of the disc are tracked and these movements are input into the computers as mouse events. I wrote a computer programme that translated these inputs into movements of the playback head within the score of the digital movie. By arranging images in the score, a movement of the playback head (forwards or backwards along the timeline or vertically from channel to channel) is translated into changes in the screen image.

Each view of the input device in **Figure 55** shows this moveable disc in a different position. The computer programme links the movement of the disc to the score of images. Different movements of the disc will select different routes through the score and so different sequences of images will be displayed on the monitor.

Figure 55. A series of plan views of the input device.

When a viewer moves the disc to the right as shown in **Figure 55a** the route through the score of images is as shown in segment (a) of **Figure 56**. The sequence of images that will be shown on the monitor will be successive frames from one camera. This is equivalent to the *time–lapse* movie when it is playing forwards.

When a viewer moves the disc upwards as shown in **Figure 55b** the route through the score of images is as shown in segment (b) of **Figure 56**. The sequence of images that will be shown on the monitor will be successive views from different points of view that have been taken at the same time. This is equivalent to the *time–slice* movie.

When a viewer moves the disc to the left as shown in **Figure 55c** the route through the score of images is as shown in segment (c) of **Figure 56**. The sequence of images that will be shown on the monitor will be successive frames in reverse order from one camera. This is equivalent to the *time–lapse* movie when it is playing backwards.

When a viewer moves the disc upwards and to the right as shown in **Figure 55d** the route through the score of images is as shown in segment (d) of **Figure 56**. The sequence of images that will be shown on the monitor will be successive frames from different points of view. This is a combination of the *time–lapse* movie when it is playing forwards and the *time–slice* movie.

When a viewer moves the disc upwards and to the left as shown in **Figure 55e** the route through the score of images is as shown in segment (e) of **Figure 56**. The sequence of images that will be shown on the monitor will be successive frames in reverse order from different points of view. This is a combination of the *time–lapse* movie when it is playing backwards and the *time–slice* movie.

Figure 56. Routes through the score of images

Figure 57 (overleaf) shows a plan and an elevation of the turntable mat. The texture of the mat is shown. This texture enables the viewer to feel where their hand is on the mat and it provides some frictional grip.

Figure 57. Plan and an elevation of the turntable mat

Figure 58. The turntable being moved from position to position

Figure 59 shows an installation view of the work in a gallery and the relationship between the turntable and the screen.

I designed and produce a device that enabled a viewer to interact with a physical object that would change their view of a digital object, but at an unexpected cost. One of the aims was to dissolve the dividing line between the world of digital bits and the world of tangible objects. The new input device did provide a strong relationship between the movements of the input device and the change in view, but the novelty of the device was an obstacle to the transparent use of the device.

This loss of transparency would be reduced when the device became more familiar, but the device and its use would not become more familiar unless it was used widely and often. This is unlikely to happen as the disadvantages and the investment of effort far outweigh the advantages.

Figure 59. Relationship between the input device and the gallery work

Chapter IX. Supermoment

Version 5

This version was made for and exhibited in the *Sequences* exhibition at Q Arts, Derby (20 August–1 October 2005).

The crisis in the research and my failure to overcome the problems of providing a transparent interface between an observer and the internal structure work led me towards a new approach. In the next version of the work I attempt to take the array of images out of the new media work and display this as a work in itself. My aim is avoid the long chain of interactions, between the observer and an input device, between the input device and the computer, between the computer and the software and then between the software and the array of image. I can replace this chain of interactions by presenting the array of images directly to the viewer. The viewer can walk or look from cell to cell without the hindrance of the human computer interface or the manipulation of the mouse and the experience is no less interactive.

Figure 60. ***Supermoment***

Earlier, I set out to investigate whether there is a relationship between the spatial and temporal structure of a digital work and the spatial and temporal structure of verbal language. The internal structure of the digital work is the score. The score sets out the elements of the work, the images from cameras, in rows of consecutive moments and columns of simultaneous moments. The structure of thought and language is diachronic and synchronic (Saussure, 1916, p. 89). I recognised that these two structures, the digital work and verbal language, are isomorphic. Any one image in a sequence can be seen in relation to the images that precede and follow it just as words are syntagmatically related to sequences such as sentences, paragraphs and stories. Images in the work are also related to other alternative simultaneous views in the way that words are paradigmatically related to other words that could have been chosen and that exist in opposition to the selected word. I set out to exploit the isomorphism between these two structures by providing an interface between the observer and the digital work. This interface was intended to enable the observer to interact with and change the flow of the possible sequences of images. The interface in a digital work is the computer, the monitor or screen, the input device and any feedback on the screen such as a changing cursor. This interface was a barrier between the observer and the internal structure of the work rather than a window through which the observer could see and interact with the work. More so as greater content in the work led to an increased need for a complex interface and so the more there was to see, so it became less easy to see. At first, the input device was a mouse. I experimented with novel input devices, but these too became a barrier rather than a way of accessing the work. The interface, in the experiments that I have been describing, is said to be opaque. A transparent interface is where the observer can interact and change the work without being aware of the interface between them and the work. Examples, include reading a book and looking at a picture. The printed book is the interface between the reader and the text. There can, over time, be a transition from an opaque interface to a transparent interface, but this requires familiarity and sufficient time. The audience also needs sufficient motivation to invest time in becoming familiar with a new kind of interface. The opaque interface works against my aim to make work that is immersive and allows viewer to be fully engaged with the work.

I do not believe that viewers would invest time and effort in becoming familiar with the use of the computer and the interfaces that I had designed and yet I wanted to retain the relationship between the structure of the work and the structure of thought and language. To retain this relationship, I needed to have a transparent interface between the observer and the work. In other words, I needed to remove the opaque interface that was a barrier between the observer and the work. In *Supermoment* I did just that. In a digital work, the internal structure is not visible. It is accessed through the interface. As the author of the digital work, I can see that the internal structure of the work is an array of images. The rows of the array contain consecutive moments and the columns contain simultaneous moments. I decided to present that array of images stripped bare of its container. Excluding the middle meant that instead of scrolling a mouse in order to scroll from image to image, the viewer merely redirected her gaze.

This version (see **Figure 60**) is one picture that contains all the images that would have been in the array of images hidden in the new media application, but in this case they are presented adjacent to each other in rows and columns. In the new media versions the rows would be the rows of the score with each frame being filled by a different one of these images. As the viewer moved horizontally in the new media versions the screen would present one image at a time in a temporal order. In the new media version the columns represented different channels and moving vertically from channel to channel caused a change in the point of view. In this version, a viewer can still navigate from image to image but in a more transparent way and unfettered by the medium of the mouse, the computer programme and the monitor. They are also free from the restrictions of only seeing one image at a time.

Chapter X. Hue and markedness

Earlier, in **Chapter V**, I have described why I want to make work that is part of the real world and not bracketed off from that world. I have identified the use of 'markedness' as a strategy for marking off part of a work, or part of the world, as a depiction. One way to mark off part of a scene is to use hue. In this, the last chapter in this section, I develop a tool for investigating this use of hue.

Research method: I developed and built a computer programme that I could use as a research machine that would analyse the use of colour in an image. Using the machine, I could import a picture (**Figure 61**), select a hue and then determine where in the picture that hue was used (**Figure 62** and **Figure 63**). Lastly, I could use the machine to compute the ratio between the surface area, or amount of any selected colour, and then compare the result with the surface area of any other colour in the image and with the total area of the picture (**Figure 64**).

Figure 61. Picture before it is subjected to colour analysis

Figure 62. Picture during colour analysis

Figure 63. Picture after colour analysis, showing area of blue

The original (Raphael, 1514) is a *tondo*, but the illustrations in this chapter are a rectangular sample from the image.

The research tool can be seen in Exhibit 11 on the accompanying DVD. The tool is used in the following manner. First an image is imported. Then a reference colour is selected and its RGB values and a degree of tolerance are entered into the programme.

When the programme is running, each pixel is tested. The examination starts in the top left corner and then moves along each row (from left to right). The colour value of each pixel is read. Each pixel is then counted as being the same as the reference colour if its colour value is within the margin of tolerance set. When the complete image has been scanned, the result of the examination is presented as a ratio of the area of that colour and the total area of the picture. Also, the pixels that are counted as being the same as the reference colour are marked so that I can see the location of that hue. The result is both a map of the location a selected colour and a graph of the area of that colour compared to the total area.

Note: colour rgb (105,101,115) = 5% of total picture area

Figure 64. Picture after colour analysis, showing area and proportion of blue

The use of this machine in an exploratory rather than exhaustive way led to a number of findings and three ideas that were used in my work.

I compared the use of hue in a number of Renaissance paintings and compared this with the use of hue in other paintings and in continuous tone images such as colour photographs. I am not claiming to further our knowledge of Renaissance techniques nor I am I claiming to have uncovered an intentional technique from the Renaissance period. The limited number of available pigments might have determined the techniques used during that period.

I did not analyse a large number of paintings and make a comparative study. My approach was motivated by an interest in a question about the use of colour in a small number of paintings. The use of my machine helped me to pin down some of the ideas that motivated these explorations.

I found that the use of colour in the Renaissance paintings was special in a number of ways. I found that the Renaissance paintings I analysed (for example see **Figure 61**) appeared bright overall, but an objective analysis revealed that a very limited range of hues was used. Typically, these hues were a particular red, a blue and a yellow. There was often an olive green. The rest of the picture was painted using four tertiary browns (see **Figure 65**).

Figure 65. Renaissance colour palette

The hues that are used are discrete rather than continuous. If the hue were to be represented by wavelengths of coloured light then a histogram of the quantities of wavelengths used would show all the wavelengths clustered around a small number of adjacent columns rather than spread throughout the gamut.

When a hue was used, it was used in one island or one area of the painting and only in that area. A particular hue could have been, but was not, used in a number of places within the picture or even dispersed throughout the picture. So, we have an orange sleeve (see **Figure**

63 and the detail in **Figure 66** below). This sleeve is only this orange hue (with shadows and highlights) and this orange hue is only used in this sleeve area.

There is a one–to–one mapping between the area of the picture where one colour occurs and the area of the picture where an object is depicted.

Figure 66. Detail of Figure 63

The amount of high colour was very low. The ratio between the total area of colour (red, blue, olive green and yellow) and the total area of a painting was usually less than 40%. It is surprising to realise that a painting that is 60% brown, and other tertiary colours, appears bright and colourful.

The results reveal that the use of colour in a Renaissance painting was very different from the use of colour in many other paintings and photographs, prints and natural scenes. In these other kinds of image, there would be a large, probably uncountable number of hues, there would be a continuous distribution of colour throughout the gamut, any one hue would be distributed throughout the picture or scene and lastly, it is uncommon outside Renaissance paintings to find small islands of bright colour in a sea of tertiary brown.

These findings led to three ideas:

Idea 1

Using the colour analysis tool I found that the ratio of a colour to the total area of a tertiary brown (or dark) image raised the attention paid to that area of colour. This made the colours in a Renaissance painting 'sing'.

I used this idea in the work to direct attention to those parts of the image that I wanted to be interpreted as depictions. I did this by setting my scene so that it was near black and using small areas of coloured light to mark the areas of significance. I used lights that emitted colour from a discrete range of wavelengths and shaded the lights to avoid illuminating other surfaces.

Using this technique I was able, as Renaissance painters did, to bring attention to parts of an image without those parts being dissociated from the rest of the picture area.

Idea 2

Colour and phonemes

This idea is derived and developed from Eco's 1985 essay *How Culture Conditions the Colours We See* (Blonsky, 1985 p. 166–167). When I compared the use of colours in an image with the use of phonemes in a verbal language I found that competent viewers and competent listeners interpret colours and phonemes in very different ways.

Competent viewers (of colours) and competent listeners (to phonemes) both use the skills of categorisation and discrimination, but in different ways. We can see the difference between competent viewers and competent listeners by comparing viewing colours with listening to phonemes (see **Table 2**). We learn first to discriminate between a hue that is, say, red or yellow, then we learn to discriminate an increasing number of hues between red and yellow. These colours do not necessarily have names. It is important to notice that as a viewer becomes more competent they increase their skill in discrimination. To hear, or to give meanings to sounds in an aural language a competent listener needs to increase their skills in categorisation. The smallest categories of meaning in a sound language are called phonemes. The categories are discrete and we must ignore the continuous range of differences between any two categories. A phoneme, say for illustration, 'pa' (the sound that we make with our lips at the beginning of speaking the word pin) should not be confused with 'ta' (the sound that we make at the beginning of the word tin). There is no meaning given to sounds in–between pin, kin, bin and fin. If we did not inhibit our powers of discrimination between any two phonemes we could not understand anyone speaking to us. We would be confused every time we heard a person whose accent and voice we had not heard before. We would be in the position of learning a new language.

So, as shown in **Table 2**, competent viewers (of colours) and competent listeners (to phonemes) both use the skills of categorisation and discrimination, but competence in viewing depends on increasing discrimination while competence in listening depends on increasing categorisation.

There are exceptions. Individuals (such as actors, impersonators, impressionists and speech therapists) are competent in listening to tonemes (the subtle variations in–between phonemes). This competence depends on increasing discrimination (rather than increased categorisation) and is independent from the acquisition of language.

	
Viewing colours	Listening to phonemes
Competent viewers increase discrimination.	Competent listeners increase categorisation.
The circles represent colours. Competent viewers pay attention to differences between new colours and existing colours and they ignore similarities.	The circles represent phonemes. Competent listeners pay attention to similarities between new sounds and existing phonemes and they ignore differences.

Table 2. Competence of viewers and listeners

Using the colour analysis tool I found that there is a one–to–one mapping between the area of the picture where one colour occurs and the area of the picture where an object is depicted and so, intentionally or unintentionally, Renaissance paintings are using colour as discrete 'verbal' categories. In a Renaissance painting, there is no analogue range of colours for the competent viewer to discern between one hue and another. Instead, uniquely, viewers of a Renaissance painting do not use increasing discrimination to pay attention to differences between new colours and existing colours and so ignore similarities between colours. Instead, competent viewers of a Renaissance painting pay attention to similarities between new colours and existing colours and tend to ignore differences. So they read the painting as a text with a number of colour–coded areas of meaning. Examples of such areas would include 'the blue sleeve' and 'the red sleeve'.

I adopted a similar technique in my work. Having brought attention to certain areas of an image, I then categorised some areas for interpretation as a depiction by using one colour, and only one colour in that area.

Figure 67. *Supermoment*: Version 1 (Light–emitting diodes) (detail)

<u>Idea 3</u>

My analysis and reflection upon the use of colour in Renaissance paintings led to a third idea. In the paintings that I examined, colour was used in 'islands', or discrete areas, and the shape and the position of these marked–off areas indicated their meaning. If the same shape and the same colour were in a different location it could suggest a very different meaning.

This links to a more general observation that a blob of colour obtains its semantic use from its context in the image. The same blob of yellow (in every way except context) could be a field in one painting, a haystack in a field in another, a highlight on a car in another and a pat of butter in a fourth painting.

These ideas were used in my work. The same picture elements were placed in different configurations and contexts to make different depictions. The examples below are of the same three–dimensional configuration of lights seen from two different viewpoints.

Figure 68. *Supermoment*: Version 1 (Light–emitting diodes) (detail)

Figure 69. *Supermoment*: Version 1 (Light–emitting diodes) (detail)

SECTION THREE

Introduction to the making of the work

Chapter XI. The making of new kinds of work

Having identified and analysed some of the aesthetic codes and strategies used within visual art to represent and construct space, time and movement, my research progressed to using this new learning to make new kinds of work.

This work is a continuation of the research. My initial thinking about time and its derivatives (movement, pace and duration) and space and dimensionality had led me into a survey of work that has been made to represent and construct time and space. This survey was in the form of a survey of other artists' work and a series of exhibitions of curated work.

The new work that I will now make comes from two sources. One source of the new work was my failed attempt to use digital technology to make interactive work. Earlier I had made four models of work using a computer and an input device. This work was shown in gallery exhibitions. My analysis of the work and the response to the work led to the insight that the computer doe not provide access to an open work. Instead the opaqueness of the interface is a barrier between the observer and the work. The problems associated with providing a transparent interface between an observer and the internal structure of the work are too numerous for this research and this leads me towards a new approach. My aim is avoid the long chain of interactions, between the observer and an input device, between the input device and the computer, between the computer and the software and then between the software and the array of image. As far as I can, I will replace this chain of interactions by presenting the array of images and the structure of the work directly to the viewer. Where I can, I will present images rather than computer applications and assume that the viewer can better interact with the work without the hindrance of the human computer interface and the manipulation of an input device. My finding and one of the foundations of the new work is that excluding the mediation of the computer and its input device will make the work more, rather than less, interactive.

The other source is the heuristic typology of possible ways of recording and presenting images. This Periodic Table of image–making techniques revealed two gaps in the lexicon.

These two are:

"0110 Recording of the same view at different times and presented in different places at the same time" and **"1110 Recording of different views at different times and presented in different places at the same time".**

For ease of reference I use the neologism 'Chronopan' for "0110 Recording of the same view at different times and presented in different places at the same time" and 'Chronocyclograph' for "1110 Recording of different views at different times and presented in different places at the same time".

To make the Chronopan, I will *record the same view at different times* by using a controller for the camera shutter that will record an image at timed intervals. The controller is an intervalometer and is software that sits on the computer. The computer then both controls the remote camera and is a storage device for the images that are recorded by the camera. These images will be *presented in different places at the same time* by taking a thin strip from each of the resultant images and then using a computer programme (see **Appendix A**) to assemble these thin strips into one image. The intention is to enfold duration into one image. The short exposure times of photographic images support the idea that the images are instantaneous and that a photographic image records a moment or an instant. The short exposure time of a single photographic image arrests movement and so leads to the illusion that time has also been frozen. The Chronopan will focus on the contradiction between the idea of the instant and the complementary idea of *durée* or duration. The completed Chronopan will reveal many hours of duration, but little or no movement. If successful, when a viewer looks at the left–hand edge of an image they will see the scene at one time, when the viewer looks at the right–hand edge of an image they will see the scene at a much later time, and as they scan or pan over the image they will see the transition and the duration recorded in between these two limits.

To make the Chronocyclograph, I will *record different views at different times* by extending, combining and using a number of techniques. The first two of these techniques are derived from chronophotography. Chronophotography can be divided into methods that record a moving subject from a number of cameras and then show these images in a sequence and methods that record different positions of a moving subject from one camera and so, in the same image. Muybridge was an early exponent of the first approach and Marey developed the second approach. The recording of different positions of a moving subject in the same image can be achieved using two techniques. The first of these two techniques is *flashing lamp stroboscopy*. The shutter is left open for the duration of the event and a flashing light intermittently lights the scene. This light is outside the scene.

The ambient lighting and dressing of the scene is dark and so nothing is recorded when the external light is off. When the pulses of the external light illuminate the scene an exposure is recorded. A sequence of exposures is made each time the external light flashes on and these exposures are recorded on top of each other in the same image. The second technique is *motography.* Again the scene is mostly dark and the shutter is left open. A small light is attached to the moving subject. As the small light moves in the scene it is recorded as a line in the photographic image. The light needs to be small enough to appear as a point when it is stationary and it should not illuminate the rest of the scene. The Chronocyclographic method uses both *flashing lamp stroboscopy* and *motography* in the same image. The third technique that is used in Chronocyclography is *stereophotography.*

The event being recorded includes a subject dressed in black in a black set. The subject performs a choreographed (see **Appendix B**) or planned action with some white objects. A small light is attached to the wrist (or other relevant part) of the subject. If this scene were recorded using 'instantaneous' photography the result would be a single dot of light whereas the result using motography records the trace of the light as a line. The length of this line is proportional to the duration of the event. This small light is a different hue and luminosity from the rest of the scene and so the line it produces is marked off from the rest of the image (see **Chapter X**). *Flashing lamp stroboscopy* produces an image of successive positions of the subject performing the action. The information that the chronophotographic methods make available is not available in instantaneous photographs or in moving images (such as film and cinema). This method is further extended by stereophotography. I will record the same event from two orthogonally positioned cameras (see **Appendix C**). Recording the same event from two mutually perpendicular views and presenting these two views next to each other (*in different places*), to be viewed *at the same time*, enables comparisons to be made between the two views.

Seeing a three–dimensional event from two different two–dimensional views is analogous to seeing any *n*–dimensional event through a number of *n*–1 dimensional pictures. This is not exceptional when this is done with static objects, but using this method with traces of a subject's movement should produce very interesting results. The line that is drawn over time by the light that is attached to the moving subject can produce a recognisable shape in one view. The same performance recorded at the same time from the other camera can produce a very different drawing. The results of using stereophotography in this way are analogous to the problem of dimensionality. What might appear to be two events linked in a causal relationship might, when viewed at a higher dimensionality, be one event. Stereophotography also extends chronophotography by adding information about simultaneity. The information and the insights that the stereophotographic method makes available would not be found or seen using other known methods.

In the Chronopan work I will reduce movement and spatial change and focus on the change of light over time. If I include spatial movement and change I introduce many other distractions such as distorted shapes and broken shapes. In the Chronopan work I focus attention on the passage of time and on duration. In the Chronocyclography work I attempt to focus attention on movement through space and I reduce the temporal dimension or the representation of duration by having one exposure record more than can be seen at one time. I further reduce the temporal dimension and increase the opportunity for exploration of the spatial by taking simultaneous recordings from more than one point of view and showing them contiguously. This will introduce the possibility of exploring picture–space and dimensionality.

I needed to develop some new tools to make the Chronopan and the Chronocyclograph. The development and a description of these new tools are described in a number of appendices. The new tools are the slit–scan application (**Appendix A**), the tool for drawing a Supermoment (**Appendix B**), a method of aligning a number of cameras (**Appendix C**) and a method of simultaneously opening a number of shutters (**Appendix D**).

SECTION FOUR

The Chronopan and the Chronocyclograph

In this section I will introduce and show the work that was made during this research.

Chapter XII. The Chronopan

The Chronopan work can be seen in Exhibit 12 on the accompanying DVD. A Chronopan is a single image that shows duration of several hours. The right hand side of the image is recorded several hours later than the left hand side of the image. The image space in–between the two sides of the image shows the duration between these two limits. This duration is spread evenly across the image. The time of the image can be measured spatially as with a ruler (see **Figure 70**). So, for example, if the left hand side of the image shows 20:00 on 7 June 2007 and the right hand side of the image shows 06:00 on 8 June 2007 there are 10 hours shown in the whole image. These 10 hours can be read spatially, so the centre of the image (half–way across) is a record of the scene five hours after the start time. A record of the scene that was made two hours after the start time can be found 2/10 of the way across the image.

Figure 70. Measuring duration across a Chronopan image

Each Chronpan in Exhibit 12 is accompanyed by information about the location of the recordings. The caption under each Chronopan includes the time of the earliest recording, the time of the latest recording and the duration of the Chronopan image. The caption also includes the time of the 'cusp', this is the time around which the samples were selected. The sample that corresponded to the cusp time is selected first and then an equal number of samples before and after the cusp sample are used. The cusp time is chosen for maximum impact and change in the Chronopan image. If a Chronopan includes only nighttime hours then the image is consistently dark. If a Chronopan includes only daytime hours then the image is light with only minor variations as the sun's light is temporarily occluded by clouds. The greatest changes in ambient light occur during and around twilight and so I selected cusp times that fall within morning twilight or evening twilight.

On some occasions the samples are presented in rows instead of columns. The resultant image is then read vertically, with the start time at the top of the image and the end time at the bottom of the image. This is interesting in at least two ways. When the scene is a landscape or an interior we tend to turn our head (from left to right and right to left) to survey the panorama. In this way we read the image horizontally (*and parallel to the horizon*). Having surveyed the scene we can choose to tilt our heads up to view the sky (or ceiling) and down to view the ground (or floor). Each column in the columnar image has sky, landscape and ground distributed throughout and a reading from left to right shows changes in these parts of the scene over time. When the samples are presented as rows instead of columns the changes over time are first seen in the sky, then the landscape and then the ground rather than in all zones at once. This might seem a disadvantage, but presenting the samples as rows does offer the possibility of presenting temporal changes in the vertical axis and spatial changes in the horizontal axis (see *roomtime* in Exhibit 12 on the accompanying DVD).

Chapter XIII. The Chronocyclograph

Note: The Chronocyclograph work can be seen in Exhibit 13 on the accompanying DVD.

A Chronocyclograph is a recording of a subject performing a task. The task is a mundane household chore and the performance is recorded in a set that is dark and without ambient illumination.

The actor performs the mundane task in a carefully researched way. This research included watching an actor perform household tasks. I watched several repetitions on two adjacent monitors. Each monitor was from a different camera and the two cameras are positioned so that their points of view are perpendicular to each other. The actor had a small patch of white material attached to their wrist. As the actor moves I watched this white mark move on the screen and I followed the line it drew. I watched the repetitions of the same task until I found some hint of a recognisable drawing on both monitors. Then this rough drawing was taken into the drawing tool that I developed earlier in the research (see **Appendix B**). I used the drawing tool to develop and improve the drawing and, most importantly, to identify and record the points through which the actor should move in order to repeat the drawing.

Two types of recording are then made. Both are present in the same image.

All the actor's movements are carefully planned and rehearsed, but the movement of the wrist deserves particular attention. The wrist is selected because it is close to the hand. The hand is closest to the action. By attaching a small white light to the wrist I can be close to the action without hindering the performance. The actor's wrist follows a choreographed path. This path is the Supermoment drawing. As the small light moves in the scene it is recorded as a continuous line in the photographic image. This continuous line is a trace of the route through which the hand and wrist have moved in order to perform the household task.

A short pulse of bright light is intermittently fired at the scene. An exposure of the actor's movement is recorded each time the light flashes. The shutter is left open and so these poses are recorded on top of each other in a multiple exposure. This *Flashing lamp stroboscopy* produces an image of successive positions of the actor performing the task. Each image of the subject in the multiple exposure is separated by a space in the picture that is proportional to the speed of movement of the subject during the interval between flashes of light. Each image of the subject is blurred according to the speed of the subject's movement relative to the duration of each flash of light. Further, the duration of the event, the distances moved by the subject during known intervals, the average speed of the subject at stages during the performance and the path that the whole performance traces are all represented in the same image. So the relationships between poses, motion, speed, and duration are made available in a visual equation. These visual correlates for speed, movement and duration can be seen in **Figure 71 and Figure 72**. The two perpendicular views of the same scene are presented as a pair of images.

Figure 71. Woman tossing and turning pancakes in order to cook them evenly (a)

Figure 72. Woman tossing and turning pancakes in order to cook them evenly (b)

Details of these two perpendicular views show the two depictions. These depictions are to be found in the line that is traced by the recording of the small light that was attached to the actor's wrist. In this example, a wine glass can be seen in one view of the scene (see **Figure 73**) and a different view of the same line is revealed to be a wine bottle (see **Figure 74**). The drawings that are made by the trace of the actor's movement are similar to constellations, cloud shapes and other anamorphoses. From most points of view this kind of three–dimensional drawing would look like a meaningless shape, but a depiction can be seen in the shape when it is viewed from a particular angle. The change of angle will often require more than a turn of the head. In fact, the change of angle for viewing a constellation can be several degrees of longitude. The bodily movement is an important part of anamorphosis as it immerses the viewer in finding the hidden image. The collaboration with the viewer also adds doubt to the ambiguity that exists around the depiction. Is the depiction there to be discerned by a competent viewer or is the depiction seen in meaningless shape?

Figure 73. Detail of Woman tossing and turning pancakes in order to cook them evenly (a)

Figure 74. Detail of Woman tossing and turning pancakes in order to cook them evenly (b)

SECTION FIVE

Evaluation and Reflection upon the work

In this section I will reflect upon the research (the work and the making of the work) and see what light this sheds upon the aesthetic codes and strategies used within visual art to represent and construct space, time and movement.

Chapter XIV. Space and Dimensionality in the Chronocyclography work

Throughout the research with the Chronocyclography work I have assumed that a viewer will engage with the work at a number of levels and that there is some relationship between their engagement at one level and their engagement at another level.

To analyse these relationships I will start by describing the Chronocyclography work at a number of levels. At one level, the pictorial level, these drawings are marks within an image. Nothing more. At a higher level, these marks are configured into a depiction. We see the marks as a square, a circle, a bottle, a glass or some other object. It is assumed that, at this level, the representation is denotative and that the relationship between the marks and the depiction is iconic. In other words, the signifying relationship between the marks and the depiction operates because there is some resemblance between the configured marks and the referent depiction. At a higher level, a viewer makes associations between these depictions and ideas. For example, a viewer might make an association between a depiction of a wine glass and ideas such as domesticity, still life, rhopography, *xenia* and even sacramental ritual. These ideas are culturally, psychologically and historically dependent. The association between the depiction and the idea is often arbitrary and learned. It is assumed that, at this level, the representation is connotative and that the relationship between the depictions and the associated ideas is symbolic. In other words, the signifying relationship between the depictions and the culturally associated ideas is arbitrary, conventional and learned.

So, the work can be described as existing in at least three levels. The levels we have so far identified are the pictorial level, the depictive level and the connotative level.

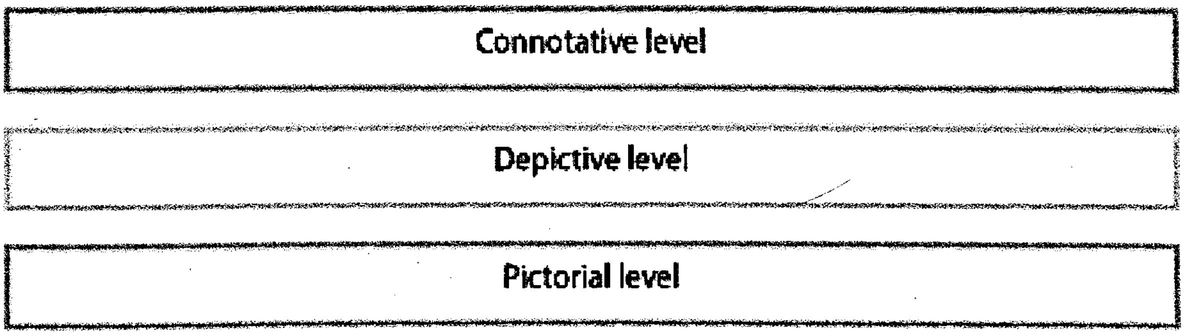

Figure 75. The three simple levels in the Chronocyclography work

These levels are complex and ambiguities in one level are disambiguated or integrated at, or by, a higher level. This is best understood by looking at the structure of the work.

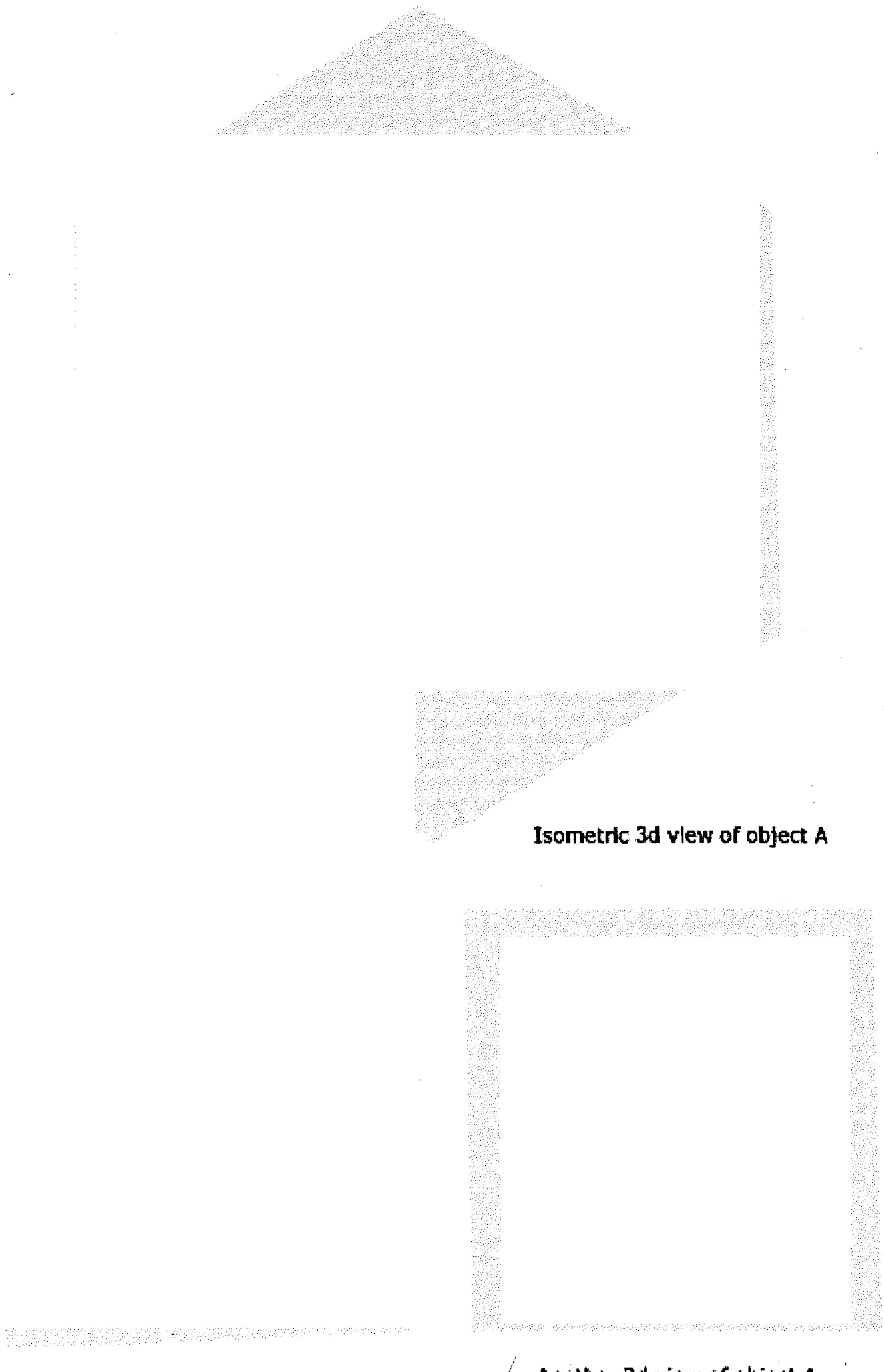

Figure 76. The integration of oppositions in the Chronocyclography work

The Chronocyclography work has been constructed so that doubt is introduced into the pictorial level. The certainty of the two views (the square and circle in **Figure 76**) is questioned by understanding that one person is simultaneously drawing both pictures. The person is actually drawing the more complex three–dimensional shape (**Object A** in **Figure 76**) and this complex shape looks like a circle from one view and it looks like a square from another view. The idea that the person is drawing the more complex three–dimensional shape is supported by the other information in the pair of images. For example, in **Figure 77** and **Figure 78** one can see the performance of the household task and the consequential drawing of the complex shape. It is important that the drawings are both part of the image (at the pictorial level) and are marked, by their different luminosity and hue, as part of a different level of interpretation (the depictive level). The technique of marking off part of an image for interpretation of a different kind was explored in **Chapter X**, here I want to point to the relationships between levels and the transfer of meaning and interpretation between levels. If the contrary drawings were only available as part of and at the depictive level, inscribed on to the pictures, there would be no ambiguity. The ambiguity is revealed, at the pictorial level, by seeing that one action caused the two drawings. Also, this transfer from one level to another, in a chain of associations, leads to the disambiguation at the connotative level. The two images appear to be two views of the same scene and of the same performance. Within each image there is a drawing. These two drawings are different and yet each is drawn simultaneously and by the trace of one action. The drawing in **Figure 77** contains a wine glass. The drawing in **Figure 78** contains a wine bottle.

Figure 77. Detail of Woman tossing and turning pancakes in order to cook them evenly (a)

Figure 78. Detail of Woman tossing and turning pancakes in order to cook them evenly (b)

The doubt that is introduced into the work at the pictorial level is resolved by integrating the two contradictory drawings into two views of one object at a higher level of dimensionality.

The two pictures are seen, one in each image, but the three–dimensional view has to be understood by seeing the two–dimensional views as projections from a three–dimensional scene (**Figure 79**).

Figure 79. Projections from a three–dimensional scene

The Chronocyclography work has also been constructed so that the ideas that are associated with the depictions, at the connotative level, are in opposition.

The idea that I am exploring in this chapter is that the relationship between the two drawings at the pictorial level is isomorphic with the relationship between the pair of oppositions at the connotative level and that a viewer's engagement with the drawings leads to a similar engagement with the pair of oppositions.

The relationship between the two drawings is one of ambiguity. Ambiguity is not the same as doubt, vagueness, confusion or ambivalence. Doubt, confusion and ambivalence can be psychological responses to ambiguity. Vagueness is insufficient information whereas ambiguity might be too much information. Ambiguity can be very clear. One of the tests for verbal ambiguity is to look for two unrelated antonyms. So, the English word 'hard' is ambiguous as it has the two unrelated antonyms soft and easy (**Figure 80**).

Figure 80. Two antonyms of an ambiguous word

Ambiguity occurs when two interpretations (**Picture 1** and **Picture 2** in **Figure 79** and **Value 1** and **Value 2** in **Figure 80**) are available, but both cannot be accepted simultaneously without doubt, nor can one interpretation be rejected without doubt. The two alternative interpretations are accepted at the same time and a relationship of mutual contradiction between the two interpretations is also seen. The relationship between the two interpretations is such that each casts doubt on the other. The more one tries to be certain about one interpretation the more the alternative interpretation casts a peripheral doubt.

When a scene is ambiguous, it is incomplete. To complete the scene the viewer must resolve the ambiguity.

The viewer's attempt to resolve the ambiguity at the pictorial level might lead them to *doubt* the opposition at the higher, connotative level. This doubt might also migrate from the particular to the general as having doubted an opposition; a viewer might bring this healthy scepticism to all apparent oppositions.

The viewer's attempt to resolve the ambiguity at the pictorial level might lead them to attempt to *resolve* the opposition at the higher, connotative level. In doing so, the viewer, like the reader of a text, brings a range of cultural, aesthetic, emotional and psychological histories to the dialogue. So, the result of unifying the opposition is unpredictable and will be different for each viewer that has a different history.

"A text is made of multiple writings, drawn from many cultures and entering into mutual relations of dialogue, parody, contestation, but there is one place where this multiplicity is focused and that place is the reader, not, as was hitherto said, the author. The reader is the space on which all the quotations that make up a writing are inscribed without any of them being lost; a text's unity lies not in its origin but in its destination." (Barthes. 1968, p. 148)

If the isomorphism between the pair of drawings and the pair of oppositions leads the viewer to both doubt and try to resolve the connotative opposition the opposition becomes an ambiguity. This has an aesthetic implication because it makes the work unfamiliar.

When images and ideas are presented in an unfamiliar way, the viewer is required to pay particular attention to the work. The attention awakens the viewer to the images and ideas. Usually we simply recognise or overlook the objects that surround us. Just as something that sends us to sleep is called anaesthetic, an object, image or idea that awakens us is called aesthetic.

Ambiguity forces the viewer to do some work to turn the unfamiliar into something familiar. The scene is incomplete until the viewer has done this work. So making work that is unfamiliar can be an aesthetic technique or a strategy for making ambiguous and hence aesthetic work. This technique can be called defamiliarisation or making strange. This technique was first explored in literary theory and was used to distinguish poetry from practical language. Defamiliarisation (*остранение*) was identified as a technique for forcing the reader to see common things in an unfamiliar or strange way. Shklovsky writes about the relationship between the unfamiliar and the aesthetic process in a 1917 essay called *Art as Technique* (Lodge, 1988, p. 15–30) This technique has also been explored in psychoanalytic criticism (Wright, 1984, p. 145). In psychoanalytic criticism the unfamiliar or incomplete would correspond to the uncanny or to the *unheimlich.*

The viewer's attempt to resolve the ambiguity at the pictorial level might lead them to *integrate* the opposition at the higher, connotative level.

The activity of disambiguation (resolving the ambiguity) becomes much more than looking at a scene or thinking about ideas. The ambiguities can take the viewer into many different areas of her life, her physical and mental relationships to the world and her societal relationships with others in that world.

The unification or integration of an opposition implies the creation of a new higher–level idea. Here one is reminded of the start of this research and the diagrams (repeated here in **Figure 81** and **Figure 82**). Two ideas might, to the inhabitants of a two–dimensional world **P** see the circles in **Figure 81** as in some causal relationship. So as circle **A** moves it causes the other circle **B** to move. Inhabitants of a three–dimensional, higher–level, world see the one continuous shape in **Figure 82**. This higher–level idea is equivalent to the sculptural object in the pictorial ambiguity. Cause and effect are usually recognised as separate and related events. Through the process being described here, seemingly discrete events might be seen to be part of one continuity.

Figure 81. Two–dimensional world

Figure 82. Three–dimensional world

This same structural relationship exists between the two oppositions at the connotative level (**Figure 83**).

Figure 83. Integration of oppositions at the connotative level

There is historical support for the idea that there is some relationship between a viewer's engagement with an ambiguous image and their engagement with ideas that are represented by the image. One of the many examples of artists making images that require some perceptual disambiguation is **Figure 84**.

Figure 84. ***The Ambassadors*** **(Holbein, 1533)**

The Ambassadors is understood by a number of authoritative authors (Collins 1992, Leeman, 1975, & North, 2004) to be working at both the pictorial and the interpretative, or connotative, level. Art historians see a strong relationship between the pictorial level and the connotative level of this work. Conversely, art historians do not, and would not, suggest that there is no relationship between the different levels of the work.

The Ambassadors are shown as showing off their worldly knowledge and travels, but cast across the picture like a shadow from an object outside the scene is an anamorphic distortion of a skull. This gives the work the properties of a *vanitas* and is perhaps intended to remind contemporary viewers that worldly knowledge, experience and wealth are temporary and valueless when judged in an eternal, spiritual or religious world. This proposition is made in two ways. There is an opposition between the subject matter associated with the objects being displayed on the table (between the two ambassadors) and the subject matter associated with the skull (death). More importantly, there is an opposition between the viewing schema necessary to view the two parts of the opposition. The same subject matter of the ambassadors and the skull could have been presented within the same pictorial schema. There is a conflict between two views and this is represented by the conflict between the three–point perspectival representation of the ambassadors, and their worldly goods, and the skull anamorphosis.

An anamorphic image appears normal only when viewed from some particular, usually unconventional, perspective or when viewed through some transforming optical device such as a mirror. Strictly, the Chronocyclography work is not anamorphosis because these drawings do not work by being distorted from some undistorted version; the undistorted version does not exist. The two depictions only exist as projections of a sculptural object in two picture planes.

There is a two–folded relationship between two pictorial schema in both the Chronocyclography work and The Ambassadors. Both interpretations are available, but both cannot be accepted simultaneously without doubt. A relationship of mutual contradiction between the two interpretations is also seen. The relationship between the two interpretations is such that each casts doubt on the other. The more one tries to be certain about one interpretation the more the alternative interpretation casts a peripheral doubt.

I have used the neologism 'Supermoment' in the Chronocyclography work to introduce an association with Superstring theory (Greene, 2003). The 'super' in Superstring theory refers to the extra dimensions, over and above, the three or four dimensions that we perceive and that we move in. Superstring is a unified theory that provides a single mathematical framework in which all the fundamental forces and units of matter can be described together in a manner that is internally consistent and consistent with observation.

Superstring theory requires space–time to have 10, 11 or 26 dimensions. Our observations are in a four–dimensional world and our vision is in 2+1 dimensions (vision in 3 dimensions would allow one to see all sides of an object simultaneously) and so we have difficulty visualising higher dimensions because we try to understand using our four–dimensional perceptual system. The solution, in Superstring theory, is to assume that there are 10 or more space–time dimensions but that the observable activity is propagated in a four–dimensional subspace called a 4–brane world (Greene, 2003). The other dimensions are *compactified* (Greene, 2003). The word 'brane' is derived from the word 'membrane'. A membrane has three dimensions whereas an n–brane has n dimensions and these are a selection or subset of the total number of available dimensions. This offers consistency between the theory and what we can observe.

So, Superstring theory copes with the potential incompatibility between the theoretical world and the observable world by suggesting a subspace of four of the 10 or more dimensions in which the observable activity takes place. This is analogous to a three–dimensional model being presented in the 2–brane space of a computer screen. It is also analogous to the projection into the 2–brane shadows of Plato's cave and the projection of three–dimensional characters into the 2–brane world of *Flatland.* Using the vocabulary of Superstring theory, the Supermoment drawings that I have used in the Chronocyclography work can be described as a three–dimensional sculpture projected into two different 2–brane worlds. A 2–brane world is a two–dimensional picture. The two two–dimensional worlds might be considered contradictory, but they are unified when observed in the three–dimensional world.

Chapter XV. Oppositions

Resolving oppositions is much more than making a choice between Option **P** and Option **Q**. To resolve an opposition, we have to question and possibly redefine our understanding of the options. This means questioning the assumptions and the rules that generated the two options. The resolution of oppositions also takes us into a complex of other possibilities.

The relationships between oppositions are typically shown in a Semiotic Square (Greimas, 1983). But, I do not want to explore oppositions in a technical way to explore logic, linguistics or semiotics. So I have adapted the Semiotic Square to construct my own version of a Square of Oppositions. My Square of Oppositions can, instead, be used to highlight 'hidden' underlying themes in a text (the Chronocyclography works) or practice (my research and the making of the works). Oppositions and oppositional relationships are at the root of language, thought, ambiguity and aesthetic function (Mukařovský, 1936). In language many ideas, and the terms that express them, can only be understood by reference to an opposing term (e.g. male/female, hot/cold, hard/soft). Thought, logic and language are structured by relationships between terms. Language structures thought and thought structures language. The anatomy of this structure is held together by oppositional relationships. These dualistic structures are used throughout the project both as a heuristic strategy and as subject matter for the work.

One of the hidden strengths of the Square of Oppositions as a heuristic strategy is that it produces a finite number of possibilities. Without this containing quality the references from the original terms to related terms and then to culture would become lost in a hell of infinite connotations. The finite structure produces interesting information but not an excessive and overloading amount of information.

I use the Square of Oppositions in two general ways. Firstly, the Square of Oppositions can be used to open out and reveal overlooked possibilities and implications from the initial opposition. Secondly, the Square of Oppositions is used to explore all the types of relationship between these uncovered terms.

The Square of Oppositions can reveal overlooked possibilities by following its rules of construction (see **Figure 85**). These rules, and the anatomy of a Square of Oppositions, are described in detail below. By way of introduction, two contrary terms **p** and **q** (e.g. white and black) are selected. These two terms are placed along the top edge of a square. Then, the diagonals of the square are used to determine the two terms that lie on the bottom of the edge of the square. The diagonals represent contradictory relationships and so the terms at each end of the diagonals are contradictory terms **p** and **not–p** (e.g. white and not–white). The relationships between terms are known and are a consistent and defining part of each Square of Opposition. They come first and are used to generate and position the other terms.

If the first four terms that are at the corners of the schema (**Figure 85**) are taken to be midpoints on a larger square we can extend the lines and produce four new terms these correspond to **p** and **q** (white and black), **q** and **not–p** (black and not–white), **not–p** and **not–q** (not–white and not–black) and **p** and **not–q** (white and not–black). In this way terms and propositions that might have been overlooked are noticed and recognised. The Square of Oppositions is thus used to direct ones attention fruitfully.

Figure 85. Square of Oppositions

Because the construction of the Square is based on oppositional relationships the construction of the Square of Oppositions does more than reveal some otherwise overlooked terms. The completed Square is a table of the relationships between the terms. Looking at a completed Square (**Figure 86**) we can see the first term, then the contrary term, then the terms that are contradictory to each of the contrary pair, then the terms that are related by implication and so on. The Square reveals a number of linked terms and it reveals the nature of those links.

For example, in the Christian West at a certain time in history, it makes some sense to recognise and speak of an opposition between Virgin and Mother. These terms will be articulated along the top axis of our Square of Oppositions (**Figure 86**). The first term, '**virgin**' is placed in the top left corner of the Square of Oppositions. Then the opposing term ('**mother**') can be placed opposite in the top right corner of the chart. The term is selected from many terms according to the kind of relationship of opposition between the two terms. The relationship should be contrary. Putting any two terms at the upper corners of a Square of Oppositions does not produce this relationship. Instead, the rule is used as a filter to select propositions that are suitable for inclusion in a Square of Oppositions.

Simple rules generate the rest of the schema. The third and fourth terms are the contradictory terms. So the bottom right corner contains '**not–virgin**' and the bottom left corner contains '**not–mother**'. These are connected to the other terms by lines that show the contradictory relations.

Then lines of implication are drawn (between '**virgin**' and '**not–mother**') and between '**mother**' and '**not–virgin**') and all the terms and relationships are shown in **Figure 86**.

Figure 86. Square of Oppositions: Virgin and Mother

The upper horizontal axis of the Square of Oppositions represents contrary oppositions (see **Figure 87** overleaf). "All S are P" and "All S are Q" are at the poles of its upper axis.

This opposition is the driving force of the machine. The relationship between the two propositions is contrary and analogue. The more the one of these two propositions is true the less the other is true. An example of a contrary relationship is white and black. The whiter a wall is the less black it is. This is clearly context specific; on a chessboard these two terms would be contradictory and not contrary. The two terms in a contrary relationship are in opposition but there is an analogue range of possibilities (greys) that lie between them. Using our Virgin/Mother example the contrary opposition that lies on the upper ('complex') axis does not denote that the more '**virgin**' you are, the less '**mother**' you are. It denotes that of a group the more are **virgin** the fewer are **mothers**.

Figure 87. Contrary opposition

The lower horizontal axis of the Square of Oppositions also represents contrary oppositions but whereas the propositions on the upper axis represent 'presences' and the propositions on the lower axis represent 'absences'. With one notable exception ('**Virgin Mother**'), both assertive propositions, on the upper axis, in the relationship cannot be (fully) true, but both can be false. The contrary relationship between negative propositions (e.g. '**not–mother**' and '**not–virgin**') is represented on the lower axis of the Square of Oppositions.

The diagonals represent contradictory oppositions (**Figure 88**). "All S are P" is diagonally opposite "No S are P" and "All S are Q" is diagonally opposite "No S are Q". The relationship between the two propositions is contradictory and digital. If either proposition is true then the other is false.

The lower corners of the Square of Oppositions represent positions that are not accounted for in simple binary oppositions. If our contrary opposition is white and black and our contradictory opposition is 'white' and 'Not white' then 'not white' does not necessarily equal 'black'.

"All S are P" and "No S are P"

Figure 88. Contradictory opposition

The vertical axes represent implication (**Figure 89**). **q** implies **not–p** (All S are P implies No S are Q). Continuing with our earlier example, "All S are virgins" implies that "No S are mothers" and "all S are mothers" implies that "No S are virgins".

The direction of implication is from the upper proposition (superaltern) to the lower proposition (subaltern), but not conversely. In the Square of Oppositions, "No S are virgins" does not imply that "All S are mothers".

Figure 89. Implication

In language, thought and cultural practice one term in an opposition is often *marked (Chandler, 2004)*. The unmarked term is primary, being given precedence and priority, whilst the marked term is treated as secondary or even suppressed and excluded as an 'absent signifier'. When morphological cues (such as *un–* or *–in*) are lacking, the 'preferred sequence' or most common order of paired terms usually distinguishes the first as a semantically positive term and the second as a negative one. Male and fe–male. Man and wo–man.

The vertical axes of implication have an assertion at one pole and a negation at the other pole. This is a third kind of opposition and the Square of Oppositions generates new possibilities by synthesising these assertions and negations along an axis of implication. For example, virgins with non–mothers, white with not–black and mothers with not–virgins.

Three further examples of the Square of Oppositions in use and three further examples that resolving oppositions is much more than making a choice between Option **P** and Option **Q** are shown below in **Figure 90, Figure 91** and **Figure 92.**

Figure 90. Square of Oppositions: Being and Appearing

Figure 91. Square of Oppositions: Inside and Public

Figure 92. Square of Oppositions: Landscape and Architecture

Chapter XVI. Aesthetic and cultural context

Late in the nineteenth century, researchers (Londe, Brissaud, Dessoudeix, *et al*) used chronophotography to help doctors analyse the distorted movements of psychiatric patients (see **Figure 93**). The interval between the images was set according to the illness. It was assumed that the patient was possessed. If the doctors could find a correlation between the pathological movements of the patient and the pattern of movement of some other creature they would then uncover what had possessed the patient. If, the theory went, the involuntary movements of the hysterical patient were those of a jaguar then, explaining *ignotum per ignotius,* a jaguar had possessed the poor madman. What the doctor did next is lost to history.

Figure 93. ***Attack of hysteria in a man*** **(Londe, A., 1885)**

Later, in the twentieth century, researchers (Gilbreth (Mundel, 1960, p. 27), Shaw (Mundel, 1960, p. 318), *et al*) used Chronocyclography to determine the most efficient way to perform an act such as typing, making an apple pie, filing record cards, performing surgery or assembling a manufactured item. Their findings were used to design kitchens, keyboards, workplaces, operating theatres and assembly lines. Their nascent method was time and motion study and their technique was to attach a small light to the wrist of the subject and then to record the trace of the subject's movement whilst performing a task. The trace of an efficient person's movements would be recorded and this unique and ideal line of movement could then be used as a template. Less efficient apprentice workers would be trained to follow the track of the efficient worker and workplaces could be laid out in the most effective pattern. The aim was mechanical efficiency; more work done in less time. Clearly this training method sacrificed physiological and motivational differences between individuals on the altar of uniformity and measurability.

My work uses a mixture of these two chronophotographic approaches but for quite a different purpose. My aim is not to discover what has possessed a person or to find the best way to exploit their labour, but to visualise what they might imagine when in a state of ennui. The performer traces a line in three–dimensional space. This line is shown from two different viewpoints. When the three–dimensional trace of the performer's movement is reduced to two–dimensional views we see apparent contradictions. For example, we see the line as drawing a wine bottle from one viewpoint. Then, when the same line is seen from a different viewpoint it is seen as drawing a glass of wine. In this way, these drawings are similar to constellations, cloud shapes and other anamorphoses. These images, when seen in pairs as stereo–chronocyclographs reveal something significant about the discreteness of events, causality, binary relations and dimensionality. By distilling the three–dimensional shape into two of its derivatives one can understand that these two anamorphic depictions are integrated by the one three–dimensional form. Understanding the pairs of stereo–chronocyclographs, and discerning the relationship between the three–dimensional drawing and the two depictions that are its derivatives, gives us insight into the relationship between apparently discrete events. What appears to be a number of independent and related events (when viewed in n dimensions) might actually be one event when viewed at a higher number of dimensions.

In this example of a Chronopan (**Figure 94**), a decaying bouquet of flowers is photographically recorded over a two–week period. This images that have been recorded during this period are then enfolded into one image. The fresh flower can be seen at the base of the image, the spent flower at the top of the image and the transition is revealed between these two limits.

Figure 94. Chronopan: Lily

The process can be understood by comparing a Chronopan with Cinema. In Cinema we have a sequence of images that are viewed one at a time. These are shown below (**Figure 95**) as a stack of consecutive images. The first image is at the base of the stack and the most recent image is on top of the stack.

Figure 95. Cinema as a stack of consecutive images

If we label the axes of this stack, the spatial dimensions of the image are measured along the x and y axes and the vertical axis of the stack is time (t). If we view the same stack of consecutive images from the edge (**Figure 96**), we see that the x and y coordinates of the Chronopan image are replaced by the x and t coordinates (where t is time). So, in a Chronopan image, the temporal dimension has been converted and compactified into a spatial dimension.

Figure 96. Chronopan as a still image with a temporal dimension

This leads to an interesting contradiction or apparent paradox, the solving of which will answer many questions about the instant and duration. A photograph is often called instantaneous or a snapshot. A Chronopan is a still image that, like a film, contains duration. The opposition between an instant in a photograph and duration in a movie is shown in **Figure 97**. Our expectation is that a photographic image is instantaneous and is the recording of an event that lasts for less than 1/60 of a second. With contemporary light–sensitive emulsions or digital sensors any photographic exposure of more than a fraction of a second would be over–exposed and any movement would be extremely blurred.

> "Objects moving are not impressed. The Boulevard, so constantly filled with a moving throng of pedestrians and carriages, was perfectly solitary, except for an

> individual who was having his boots brushed. His feet were compelled, of course, to be stationary for some time, one being on the box of the boot–black, and the other on the ground. Consequently, his boots and legs are well defined, but he is without body or head, because these were in motion." (Morse, 1839)

Since Morse's observation of an early daguerreotype we have expected exposures to approach the instant and to be either so short as to freeze motion and duration or to be long and so fail to capture anything that is moving.The Chronopan images are recordings of events that have durations of hours or weeks and yet the scene is not blurred or overexposed.

Figure 97. Square of Oppositions: Instant and Duration

We expect to see photographic images as *stills* or as frames in the *movies*. The Chronopan, apparently, represents both the instant and duration. This paradox is played out in many fields. The frames of a movie are used as a metaphor for time as it is experienced. The starting point for this metaphor is Bergson's notion of *Durée* (Bergson, 1889). Bergson proposed *Durée* in the late nineteenth century when cinema was newly invented and the Chronophotography of Marey provided a ready metaphor. *Durée* is Bergson's description of the illusion that connects the past and the future with the present. Without an observer, who has consciousness and memory, no thing in the present moment can know anything about the past (it no longer exists) and no thing in that plane of simultaneity we call 'now' knows anything about the future (it is yet to exist). This illusion, of duration, is in the mind of the observer who can compare the present with their memory of the past and their anticipation of the future. This metaphor is cinematographic, each moment or a 'now' is a frame in a movie and each frame of a movie is a plane of simultaneity. Here sequences of images have been used to construct, rather than represent, meaning. Bergson's Durée employs consciousness and memory to connect 'nows' into a continuum just as the still frames of a movie are connected into continuous motion.

There is a fourth term in the Square of Oppositions (**Figure 97**) that charts the opposition between the instant and duration. This is, for example, Zeno's arrow, the object in motion that is at any moment stationary. So, paradoxically, the arrow is neither moving nor is it still.

Thinking about the Chronopan leads to an apparent contradiction between the instant and duration. This one contradiction is embedded into our ideas of time, simultaneity, the workings of cinema and Zeno's paradox. A disentangling of the paradox will resolve the contradiction and so tell us more about time and its derivatives and the power of images to represent and construct meaning.

Is time, consciousness, movement and cinema a continuum that can be sampled discretely or is time and consciousness a sequence of discrete instants, like the still frames in a movie, that are connected together by an illusion.

Chapter XVIII. Time stops everything happening at once

The Paradoxes (Flew, 2002, p. 432) were written by Zeno in about 470 BC. In the Arrow paradox, objects at rest occupy a space equal to their own dimensions. An arrow in flight at any instant occupies a space equal to its own dimensions. Therefore an arrow in flight is at rest.

In the *Stadium paradox*, it is impossible to complete the course. Before you reach the far end, you must reach the halfway point. Before you reach that, you must reach the halfway point to it. And so on, indefinitely. If space is infinitely divisible any finite distance must, allegedly, consist in an infinite number of points; and it is, it is also said, impossible to reach the end of an infinite series of operations in a finite time.

In the *Achilles and the tortoise paradox*, if Achilles gives a tortoise a handicap he can never overtake. For when Achilles reaches where the tortoise starts, then the tortoise will have moved on. When Achilles gets there, then the tortoise will have got a little further. And so on, indefinitely.

A paradox is an apparently unacceptable conclusion derived from seemingly reasonable arguments that are based on seemingly reasonable premises. To resolve a paradox we must accept the unacceptable conclusion or we must question the arguments and the premises and, in doing so, see which of the arguments and premises are unreasonable. Zeno's paradoxes were written so that we would question the premises that were contained in contemporary theories of motion. These theories of motion contradicted theories that Zeno, and his teacher Parmenides, held to be true. Zeno designed and wrote his paradoxes so that the conclusions would be clearly contradictory and so demonstrate that the premises were absurd.

Zeno is trying to prove, *reductio ad absurdum,* the theory that he supports by disproving the alternative theory. This is a very weak form of proof as it is dependent on the latent premise that only two theories are possible and that they are mutually exclusive. For illustration, in the arrow paradox we are implicitly asked to accept that the arrow is stationary or it is moving, that it cannot be both stationary and moving, that the arrow cannot be sometimes stationary and sometimes moving and that, apart from stationary and moving, there is no other way of describing the arrow's state.

Accepting the paradoxes as they are, we must resolve them by looking again at the premises and arguments they parody. Zeno and Parmenides thought that motion was an illusion. Some opponents of this theory thought that space and time were infinitely divisible and that motion is continuous and smooth flowing. Zeno attacks this idea of motion in the Stadium and Achilles paradoxes. Other opponents thought that space consisted of indivisible units separated by a void and so motion was discontinuous and would proceed in tiny jerks from one unit of space to the next. Zeno attacks this idea of motion in the Arrow paradox.

We can picture the idea of indivisible units separated by a void by looking at a digital clock. The time is 10:56 and then it is 10:57. Apparently, on a digital clock, there is no time in between 10:56 and 10:57. Some of Zeno's opponents confused space with the representation of space just as one could confuse time with the digital representation of time.

So, the purpose of Zeno's paradoxes is to show that motion is an illusion. His method is to take the premises of the theories of motion, that were available to him at the time, and by well–contrived arguments show that they lead to absurd conclusions.

A meaningful solution of these paradoxes must account for motion and decide whether it is real or an illusion and if real, whether it is continuous or intermittent.

The belief that motion is an illusion is not an antique, obsolete view. Bergson comes to much the same conclusion when he writes about Zeno, continuity and duration in *Time and Free Will* (Bergson, 1922, Chapter 3). In summary of both Bergson's and Zeno's views on motion, at any one moment everything is or it is not. We have, what is now called, a plane of simultaneity. Without an observer, who has consciousness and memory, no thing in that plane knows anything about the past (it no longer exists) and no thing in that plane of simultaneity knows anything about the future (how could they?). We cannot even think of successive planes of simultaneity because this implies some meta–plane into which the planes of simultaneity are slotted in order. Motion is an illusion in the mind of the observer who can compare the present with their memory of the past and their anticipation of the future. Everything that is, is static.

Before we use the new understanding that the Chronopan gives us to simply solve these paradoxes, I will review the approaches that others have taken. A popular approach to solving Zeno's Arrow paradox is to use ideas from mathematics, such as Calculus, to find successively accurate approximations of its speed at an instant.

> "If the arrow is moving at a given instant there must surely be some speed at which it is moving." If you know the time the arrow left the bow and the time it hits its target and you know the length of the arrow's trajectory between these two times then it is simple to calculate the average speed of the arrow's flight. If you want to discriminate among speeds along the way then you can take smaller and smaller samples of distance and time and so approach increasingly accurate measurements of the arrow's speed. "Speed at an instant *i* is identified with the limit of average speeds during intervals converging to 0 and containing *i*." (Clark, 2002, p. 7)

This approach does not solve the paradox as it leaves the scenario untouched and merely copes with it.

The standard approach to solving the *Stadium* and *Achilles* paradoxes is to accept that the problem is how to complete an infinite series of acts in a finite period of time (Clark 2002, p. 1). The mathematical solution to this problem, so presented, is to define the sum of an infinite geometric series as the limit to which the sequence of its successive partial sums converges. If the intervals that Achilles crosses are 0.5000 m, 0.2500 m, 0.1250, 0.0625 m, 0.0313 m, 0.156 m and so on, then the partial sums are 0.5000 m, 0.7500 m, 0.8750 m, 0.9375 m, 0.9688 m, 0.9844 m and so on, getting closer and closer to 1 m. At which point, Achilles reaches the end of the course or catches up with the tortoise.

In my solution, I will show that the infinite series is a red herring. The issue has been shifted from the true problem to the issue of infinite series.

The essence of the Arrow paradox is that at any instant the arrow is where it is. It is in its own space. If we looked very closely at the arrow it would be stationary. So the paradoxical conclusion is that the arrow is both stationary and in motion? How can this be? The solution is found when we question the premise that an instant exists.

Whenever a photographer is trying to use a sequence of photographs to record a moving subject, however slowly moving, they know that there is no such thing as an instant. There may have been cameras called 'Instamatic', there may be settings called 'instantaneous' but these terms are at best figurative. 'Instant' is a relative, rather than an absolute, term. Any photograph of any object, even an arrow, moving past the camera will show the subject moving for some time. The duration of this movement may be very short, but it will never be an instant. This is not a comment about the technical limitations of cameras, shutters or lighting; it is an insight into time and motion.

An instant is a time interval of no length. It is a paradoxical and self–refuting term. The arrow is stationary at any instant because the distance travelled by a moving object in no time is zero. Knowing this, the paradox evaporates.

The Stadium and Achilles paradoxes are solved by examining them from imaginary cameras at the side of the track. The set–up of these cameras would be similar to the arrangements used by early chronophotographers such as Muybridge to record and understand the motion of horse, dogs and other animals. We can easily repeat the results that Zeno describes if we select the appropriate time intervals between the photographs taken by our imaginary cameras. Let us say that Achilles, or any other runner, is running past us and we take photographs at intervals of 0.5 s, 0.25 s, 0.125 s and so on. If we then put these photographs together as in a primitive form of cinema and then play this back at a constant frame rate we would see that the runner appears to progressively slow down. Zeno refers to distances travelled but by omitting to refer to the time taken to travel these distances he is able to mislead us. Zeno's Stadium and Achilles paradoxes can only be convincing if references to time are omitted.

The infinite series of distance intervals only occurs if we take an infinite series of time intervals to record the motion of the runner. We only need to solve the infinite series problem if we accept being misled or distracted from the argument of motion to an irrelevant argument about infinite series.

Without altering the events that Zeno describes in any way, if we take our series of views, or snapshots, at regular time intervals we will see the faster runner catch up with and overtake the slower runner and we will see the runner reach the end of the stadium.

Chapter XIX. Conclusions

At the beginning of this research, I set out to investigate aesthetic codes and strategies that can be used within visual art to represent and construct space, time and movement.

The new work I have made during this research is intended to be art but my practice falls in the overlap between art and science. This dichotomy between art and science is best understood by looking at chronophotography's heritage. Chronophotography's antecedents are in both art and science. I will provide a detailed example.

In 1891, four years before the Lumière brothers made and projected the first film (Mannoni, 2000, p. 450) 'La Sortie des Usines Lumière' (Workers Leaving the Lumière Factory) (Lumière, 1895), Marey recorded a film of waves hitting rocks in the bay of Naples. (Marey, 1891a) This film can be seen in Exhibit 14 on the accompanying DVD. Instead of showing the film to the public, Marey published twelve still images from the film in a science journal (Marey, 1891b) and again in his 1894 'Le Mouvement'. (Marey, 1894)

Figure 98. ***La Vague*** **(detail) (Marey, 1891)**

Marey's motivation is scientific; the sequence of still images (see figure 98) reveals information about the waves as they hit the rocks "...on peut suivre les phases du mouvement d'une vague qui vient frapper des rochers : la vague monte d'abord et couvre ces rochers d'écume, puis se retire et l'agitation de la mer se calme peu à peu. " (...one can follow the phases of the movement of a wave that has hit the rocks: the wave first rises and covers the rocks with foam, then it retreats and then sea becomes calm again) (Font–Réaulx, 2006, p. 53), but this new information is as hidden in the film as it is in an unmediated view of the waves. Marey publishes the still images instead of projecting the film because his approach is that of a scientist. Marey was not immune to the aesthetic properties of the images. "Ces images étaient d'une pureté parfait et pourraient même supporter un agrandissement de leurs dimensions sans perdre sensiblement leur beauté." (These images were of perfect purity and could withstand enlargement without appreciably losing their beauty.) (Font–Réaulx, 2006, p. 52) Marey's decision to show the still images instead of the projected film demonstrates his motivation to understand more about waves and the decision shows that he considered the use of the chronophotographic images to further the scientific investigation of waves more important than their aesthetic value.

Marey recognised both art and science in his chronophotography, but science was the driver and overrides any latent interest in art. My position is exactly the reverse. My motivation is primarily aesthetic, but I am not immune to the scientific part of my work.

My practice has roots in chronophotography and so inherits chronophotography's heritage in both art and science. Scientific methods were used to improve each Chronopan. Data was extracted from each result and analysis of the variables led to the setting of new variables for the next Chronopan. So, science was used to improve the results, but any improvement is judged using aesthetic standards. My overriding motivation was to find the variables that would produce a beautiful image and an image that would best exemplify the underlying ideas of subjective time and duration.

Similarly, science is present in the pairs of Chronocyclograph images but as I describe in **Chapter XVI. Aesthetic and cultural context** I repurpose science not to better understand mechanical efficiency but to create a beautiful image and to create an image that best exemplifies the underlying ideas of oppositions and dimensionality.

My practice also lies in the overlap between computer technology and art (in the overlap between the digital and material domains) but again, although some technology is used and technological practices are employed, the driving force is art. This can best be understood in my explorations of interactivity. I started with some assumptions about interactivity. I assumed that if the viewer could engage with the spatial and temporal dimensions of a work then they could, by analogy, engage with space and time. Further, I assumed that interactivity could best be provided through a computer programme and a screen. This assumption was based on seeing a similarity between the structure of the computer programme that I intended to use and the structure of the language we use to think with. Our language can be said to be spatially and temporally structured. I assumed that I could use a computer programme to structure visual art so that any one image in a sequence of images could be seen in relation to the images that precede and follow it just as words are syntagmatically related to sequences such as sentences, paragraphs and stories. I also assumed I could use the same computer programme to structure my visual art so that images in the work are related to other alternative simultaneous views in the way that words are paradigmatically related to other words that could have been chosen and that exist in opposition to the selected word. I intended to make a visual art work that had a structure inherited from the structure of the computer programme used to make the work. I thought that this structure could then correspond with the synchronic and diachronic structure of language and thought. These assumptions might still be valid, but my attempts to make visual art in this way failed. Through reflection on the failure, I gained new insights. These insights enabled me to make work of a new kind that did allow the viewer to engage with space and time.

The plan to use a computer programme to structure visual art failed for two reasons. First, my understanding of interactivity was underdeveloped. I increased my understanding of interactivity by making a series of experimental works and then reflecting on viewers' responses to these works. Each experiment led to new insights and these insights were used to make the next experimental art work in the series. The series of works and my growing understanding of interactivity is more fully described in **Chapter VII Modes of interactivity.** Second, I had underestimated how much the paraphernalia of computer programmes, the screen, the mouse, the navigation through the programme and the user interface worked against interactivity. Instead of being a transparent interface in–between the viewer and the text of the work, the paraphernalia became the locus of attention. My attempts to overcome this problem are more fully described in **Chapter VIII Digital bits and tangible bits.**

The solution to both these problems (modes of interactivity and opaqueness of interface) was to recognise that a viewer can engage with the spatial and temporal content of a work by laying out the work in a new way that is simpler in construction. For example, instead of making an editing tool for scrubbing through a movie, then providing widgets for slowing and speeding the pace of the movie and then providing further enhancements that enable the viewer to jump from one place in the movie to another place in the movie I can lay out the frames of the movie side by side and let the viewer direct their attention to one image and then to another. The viewer readily, easily and transparently performs the interpolation and integration of the frames. Further, laying out images in new, unfamiliar ways has another desirable advantage. When images and ideas are presented in an unfamiliar way, the viewer is required to pay particular attention to the work. The attention awakens the viewer to the images and ideas. Usually we simply recognise or overlook the objects that surround us. Just as something that sends us to sleep is called anaesthetic, an object, image or idea that awakens us is called aesthetic. This aesthetic function (Mukařovský, 1936), together with defamiliarisation and ambiguity are more fully explored in **Chapter XIV Space and Dimensionality in the Chronocyclography work.**

In **Chapter II Survey one** and **Chapter III Survey two**, I explored techniques that other artists have used to make work that engages with space and time. In **Chapter IV Possibilities of Images** I investigated different ways to present one image next to another. This investigation was in the form of a typology. I made something similar to a Periodic Table of image–making techniques. My aim was to see, not just what has been used but, what techniques and strategies could be used. This typological survey of possible ways of recording and presenting images revealed two gaps in the array of possibilities and these are my new ways of laying out images so that a viewer can engage with space and time in visual art. I called the two new forms 'Chronopan' and 'Chronocyclograph'.

The Chronopan image (more fully described in **Chapter XII The Chronopan** and **Appendix A The Slit–scan application**) is made up from a number of strips. Each strip has been recorded at a different time of day. The strips are kept in the order in which they were recorded and the strips are thin enough to give the illusion that the assembled strips are one image. I chose to record scenes with very little movement. If there had been movement then one strip would not align with the next strip, as part of the image would have moved.

By making the Chronopan image in this way the only change from strip to strip, and so across the image, is a change in light. So, for example, if the recording is from 05:00 to 10:00 the light will change from night–time at the left–hand side of the image through twilight and dawn in the body of the image to full daylight at the right–hand edge of the image.

The Chronopan shows us what has not been seen before. If we were to sit and watch the scene without the aid of any optical or photographic device we would only see one light condition at a time. We would notice that the lighting had changed and we could remember something of the previous light levels, but we would only see one light level at a time. We would not see night, dawn, twilight and morning at the same time. If we recorded the scene with a still camera the light from the scene during the many hours of exposure would be cumulatively recorded and so the image would be over–exposed and the whole image would be lit by this one long exposure. If we recorded the scene with a movie camera we could see the transition from night to day at different speeds, but we would still only see one time and one light level at any one time. If we presented the frames of a time–lapse movie side by side we would approach the view offered by the Chronopan, but the visual system would adjust from image to image to minimise and negate differences between consecutive images. Our visual system adjusts what we think we see to minimise differences in lighting conditions and also to negate differences in colour cast to ensure that the perceived colour of objects remains relatively constant under varying illumination conditions. The changes in colour temperature are greatest during twilight.

With the Chronopan we see the transition from night to day in one image. We can also see changes of colour temperature within the image. In this way the Chronopan shows us something of duration, one of time's derivatives. Duration (*Durée)* has been investigated by Bergson (Bergson, 1889), Deleuze (Deleuze, 1983), Marey (Marey, 1887), Zeno and many others. The word *Durée* is used by Bergson and subsequent writers when referring to the idea of duration that seems to connect memory of the past, experience of the present and anticipation of the future. Duration is important because of its contrast and opposition to the idea of an instant. The idea of Durée is important because it most clearly contrasts the ideas of subjective and objective time. My intention is to enfold duration into one image. The short exposure times of photographic images support the idea that the images are instantaneous and that a photographic image records a moment or an instant. The short exposure time of a single photographic image arrests movement and so leads to the illusion that time has also been frozen. The Chronopan focuses attention on the contradiction between the idea of the instant and the complementary idea of *durée* or duration. The completed Chronopan reveals many hours of duration, but little or no movement. When a viewer looks at the left–hand edge of an image they will see the scene at one time, when the viewer looks at the right–hand edge of an image they will see the scene at a much later time, and as they scan or pan over the image they will see the transition and the duration recorded in between these two limits.

One of the objectives of this research was to find aesthetic codes and strategies that can be used within visual art to represent and construct duration. I have done this with the Chronopan. My other objectives were to find aesthetic codes and strategies that can be used within visual art to represent and construct space, time and movement. I have done this with the Chronocyclograph.

To make the Chronocyclograph (more fully described in **Chapter XIII The Chronocyclograph** and **Appendix B The tool for drawing a Supermoment**), I extended and combined a number of extant techniques (these were uncovered in **Chapter II Survey one** and **Chapter III Survey two** and revealed in **Chapter IV Possibilities of Images**) to make a new kind of image. One of these techniques is *flashing lamp stroboscopy.* The shutter is left open for the duration of the event and a flashing light intermittently lights the scene. The only source of light is the controlled light from the flash. A sequence of exposures is made each time the external light flashes on and these exposures are recorded on top of each other in the same image. Another technique is *motography*. Again the scene is mostly dark and the shutter is left open. A small light is attached to the wrist of a moving subject. As the small light moves in the scene it is recorded as a line in the photographic image. The light needs to be small enough to appear as a point when it is stationary and it should not illuminate the rest of the scene. A Chronocyclograph is made using a combination of these two techniques. Both techniques are used in the same image so the resultant image shows the movement that the subject makes as a sequence of overlapping, intermittent and partly transparent snapshots and overlaid on this multiple exposure, and tying these glimpses together, is a line that traces, continuously rather than intermittently, the path that the subject's wrist has followed.

Each image of the subject in the multiple exposure is separated by a space in the picture that is proportional to the speed of movement of the subject during the interval between flashes of light. Each image of the subject is blurred according to the speed of the subject's movement relative to the duration of each flash of light. Further, the duration of the event, the distances moved by the subject during known intervals, the average speed of the subject at stages during the performance and the path that the whole performance traces are all represented in the same image. So the relationships between poses, motion, speed, and duration are made available in a visual equation. These visual correlates for speed, movement and duration can be seen in **Figure 71 and Figure 72.**

In the Chronocyclography work I attempt to focus attention on movement through space and I reduce the temporal dimension or the representation of duration by having one exposure record more than can be seen at one time. I further reduce the temporal dimension and increase the opportunity for exploration of the spatial by taking simultaneous recordings from more than one point of view and showing them contiguously. Using a third technique that is derived from *stereophotography*, the Chronocyclographs are shown as a pair of images. Two perpendicular views of the same scene are presented. This offers the viewer different pictures of time and movement. Each of the pair of images is a two–dimensional reduction from a three–dimensional scene. Each of the two pictures shows a different trace line of the small light that has been attached to the performer's wrist. If this were all we would assume we had seen recordings of two different performances. But, also in the same images are the multiple exposures of the performer's movement. This shows the two images to be pictures of the same performance. The contradictions and ambiguity that are embedded into the Chronocyclograph leads us to a deeper understanding of dimensionality, causal relations and oppositions. This is more fully described in **Chapter XIV Space and Dimensionality in the Chronocyclography work.**

The contradictions and ambiguity that are embedded into the Chronopan leads us to understand old and new questions about time and its derivatives. Photography, Cinema and other aesthetic codes and strategies used within visual art can be used to represent and construct space, time and movement. The new understanding that these visual practices offer can be flawed. The cinematic metaphor offered the false picture of time and consciousness as a sequence of 'nows' separated by a void. Extending visual practice into Chronocyclographs and Chronopans and so avoiding the false dichotomy between still and moving images offers new pictures of time and consciousness. Paying attention to the contradiction between the instant and duration rather than overlooking it leads to an understanding of time, consciousness and movement as continuous rather than intermittent. Time can be discretely sampled and we can refer, metaphorically, to instants and moments, but unlike this research, it never stops.

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Appendix A. The Slit–scan application

To make the Chronopan I want to present images of the same scene, but taken at different times, so that they can be seen together at one time. I do this by taking a thin strip from each of the recorded images and then using a computer programme to assemble these thin strips into one image. Here I will describe the computer programme I designed and made to achieve this.

I used the object–orientated language called Lingo to write the programme. A programming language such as Lingo is closer to machine language than it is to higher–level languages such as English. For this reason, discussion of its use is usually not part of an art and humanities research document and is usually restricted to programming forums where implementation is the subject and its higher–level use is ignored. I have decided to include a short appendix on the use of Lingo because I believe it is important, because I think programming will increasingly become part of art practice and because programming was a significant part of the research and the findings are worth sharing.

The Chronopan images are single images that contain samples from a large number of source photographs. These samples are either horizontal rows or vertical columns. These rows or columns can vary in size, but can be as small as 1 pixel wide. The samples should be taken from the source photographs in the correct order. This order is determined by the order in which the photographs were recorded. By taking a thin sample from successive photographs and compositing them side–by–side in a destination image the resultant image is a record of the scene over a long duration.

I used Lingo to make an application that would build these images. The application is designed to take samples from the photographic images in one folder, to process them according to user–defined variables (thickness of sample and so on) and then to save the resultant image in another folder.

Lingo was also used to produce a report that contained a list of the values of the variables used to produce the resultant image. This report converted a hit or miss process into research. With the combination of new images and the report I am able to repeat successful combination with different source images, I am able to make small incremental changes to the variables during a process of successively improving an image and the reports provide a way of describing the images. The reports can be used to learn about and improve the work.

I used Adobe Director (Adobe, 2008), the DirectImage Xtra (DirectXtras, 2004), for reading from and writing to images that have not been imported into the Director application, and the FileIO Xtra (Macromedia, 1997) for writing to an external text file.

The application is designed to process a folder of photographic images. The name of this folder is 'images' and the images are named 'image0001.tif', 'image0002.tif' and so on. These images need to be recorded sequentially. This was achieved by using the intervalometer to control the camera.

The first step is to measure the image (**Figure A-1**). Custom variables are given values. These values are obtained using the system variables sprite(1).width and sprite(1).height. These custom variables are declared global and so can then be used throughout the application. For example, these variables are used in the image processing. Using the 'rect' values, or left, top, right and bottom of the image, defines the area of an image to be used. The same values can be used to calculate how many samples are needed. This is calculated by dividing the width of the image by the width of the sample.

```
Global imageLeft,imageRight,imageTop,imageBottom

on startMovie

  imageLeft = 0
  imageTop = 0
  imageRight = sprite(1).width
  imageBottom = sprite(1).height

  userSettings--custom command

end startMovie
```

Figure A-1. Code sample: measuring the image

I then need to assign values to a number of user–defined variables (**Figure A-2**). The value of var1 is the thickness of the samples.

The value of var2 is used as a switch to determine whether the samples are columns (var2 = 1) or rows (var2 = 2). If the samples are columns then the values for top and bottom will be constant, but the values for left and right will change. If the samples are rows then the values for left and right will be constant, but the values for top and bottom will change.

The value of var3 is used as a switch to determine whether the samples are taken in the order they were recorded or in reverse order. This order is dependent on the value of var2 and whether the samples are columns or rows. So, if the samples are columns then right–reading (var3 = 1) is taken to be earlier samples to the left and later samples to the right. The Chronopan is then 'read' from left to right. If the samples are rows then earlier samples are at the top of the composite image and later samples are lower and so the Chronopan image is read from top to bottom. Assigning a value of zero to the variable (var3 = 0) reverses the order of the samples.

The value of var4 is used to determine which is the first image to be used. If the value of var4 is 0 then a sample from the first image in the folder is used at the beginning of the Chronopan image. If I want to ignore the first 600 images I would use var4 = 600.

The variable var5 is used when the samples are not right–reading (this is determined by var3 = 0). Because the images are being sampled in reverse order I need to use var5 to determine the last image.

The value of var6 is used to determine the period or the intervals between sampled images. If the source images had been recorded at 10 minute intervals and I want to sample at that rate I would use var6 = 1. If I choose a value of var6 = 3 then every third image is selected and so the time interval between images would be 30 minutes. In this way, the duration of the composite image can be increased without increasing the width of the samples (and hence the coarseness of the image).

The value of var7 is used as a switch to determine whether the report containing the local values of all the variables is written into the message window (var7 = 1) or saved into an external file (var7 = 2).

The value of var8 is set to be equal to the number of external images. This is used to check that scripts do not call for or refer to images that do not exist.

```
Global root,suffix,var1,var2,var3,var4,var5,var6,var7,var8

on userSettings
  var1 = 1
  var2 = 1
  var3 = 1
  var4 = 600
  var5 = 0
  var6 = 1--period
  var7 = 2
  var8 = 5500
  root = "image"
  suffix = ".tif"
end
```

Figure A-2. Code sample: assigning values to variables

The local variables, root and suffix, are used to refer to image names. Each image has a root, an index and a suffix (e.g. 'image0003.tif'). The index is a local variable that is the result of a function. The three variables are then concatenated to produce the name of the referent image. In the example of concatenation (**Figure A-3**), the fragment of script refers to an image in a folder called 'images'. The name of the image is imageN.tif where N = (var8 – var5) – (myIndex*var6).

```
root = "image"
  suffix = ".tif"
"images:"&root&"000"&(var8 - var5) - (myIndex*var6)&suffix
```

Figure A-3. Code sample: concatenation of variables to produce file name

I then need to take the user–defined samples from each of selected images. The fragment of script in **Figure A-4** loads an external file from the folder 'images' into the virtual image (myImage).

```
imageLoadFromFile (myImage, the pathName&"images:\
"&root&"000"&(myIndex*var6)+var4&suffix)

member("source").image = imageSaveToImage(myImage)
```

Figure A-4. Code sample: Loading an external image into a virtual image

The script in **Figure A-5** takes a sample from the cast member 'source' and places it into the cast member 'destination'. The first set of four values defines a rectangular area of the destination image. The second set of four values defines a rectangular area of the source image. The values are the left, top, right, and bottom coordinates of the rectangle. In this example, a column is being copied from the source to a column of the destination image so that the coordinates of the top and the bottom remain constant. The width and position of each columnar sample is calculated according to the user–defined local variables (such as column width) and are represented by myIndex. This function is contained within a repeating handler. Each time the handler is repeated, the value of myIndex will increase so that the samples are taken from different parts of the image, in the correct place and in the correct order, and so that the repeating handler ends when the destination image is complete.

```
member("destination").image.copyPixels(member("source").\
image,rect(var1*(myIndex-1), imageTop, var1*myIndex, imageBottom),\
 rect(var1*(myIndex-1), imageTop, var1*myIndex, imageBottom))
```

Figure A-5. Code sample: Taking a sample from the source image and inserting into the destination image

The complete composite image is saved to an external image (**Figure A-6**). The completed composite image is virtual and is held in myImage. This image is then saved into an external file named textfilename&."tiff". Textfilename is a local variable that is produced from the date and the time and so helps to identify the image. The text report is given the same name with a txt suffix.

```
on exportImage
  imageSaveToFile(myImage,the pathName&"results:\
  "&textfilename&".tiff",100,1,1)
end
```

Figure A-6. Code sample: exporting and naming the composite image

An example of an image name is chro24111639.tiff. This was made at 16:39 on 24 November and is made from the images that had the root name chro.

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Appendix B. The tool for drawing a Supermoment

To make the Chronocyclograph I needed to design and make a tool to draw the shapes that would be a guide for the choreographed action. A Supermoment (in this project) is a three–dimensional drawing or shape that depicts something recognisable when projected in one picture plane and something different in another picture plane. When making the work, the subject will have a small light attached to their body and will move so that they trace the path of this three–dimensional drawing. The path of the small light will be photographically recorded during a long exposure so a line in the photographs will be produced that maps to the Supermoment drawing. Here I will describe the use of the drawing tool I devised to find and make these drawings.

The drawing tool opens with a 'Chooser' (**Figure B-1**). Selecting the upper button (1) increases the number of elements that will be in the Supermoment drawing. An element in a Supermoment drawing is a reference point in three–dimensional space. These 'dots' are joined to make the drawing. The maximum number of elements here is 24, but could be any number.

Selecting the lower button (2) in the 'Chooser' (**Figure B-1**) decreases the number of elements that will be in the drawing. The minimum number of elements here is 2, but as in any drawing there is a clear relationship between number of marks used to make the drawing and the resolution of the drawing. Two elements could be used to draw a line, but nothing else.

The upper text (3) presents a message that confirms whether I am increasing or decreasing the number of elements. The lower text (4) presents a message that tells me how many elements will be used in the drawing.

Selecting the green button (5) takes me to the 'Drawing Window' (see **Figure B-2**) and selecting the mauve button (6) closes the 'Chooser'.

Figure B-1. Chooser

The right–hand pane of the Drawing Window (see **Figure B-2**) shows a view of the Supermoment in a two–dimensional picture plane. The left–hand pane shows another view of the identical Supermoment in another two–dimensional picture plane.

We can use the Cartesian coordinate system that is used to locate objects in a three–dimensional world, to identify these picture planes and the relationship between them. In this system, the three axes are mutually orthogonal to each other (each at a right angle to the other). In both panes the vertical axis is labelled Y. This means that distances from the bottom edge of each picture can be measured along the y axis. In the right–hand pane distances from the left hand edge of the picture are taken to be measured along the x axis. The left–hand pane shows the identical Supermoment with the world system rotated by 90° so in this picture distances from the left hand edge of the picture are taken to be measured along the z axis. If the right–hand pane is thought of as side–to–side (x) and up (y) then the left–hand pane can be thought of as front–to–back (z) and up (y). The point of intersection, where the axes meet, is called the origin and is labelled (0,0).

Selecting the upper blue button (1) in the Drawing Window (**Figure B-2**) increases the size of the elements that are in the Supermoment drawing. This choice is here rather than in the chooser because this choice has to be made visually and interactively. Selecting one of the lower blue buttons (2) decreases the size of the elements that are in the drawing.

Selecting the other lower blue button (3) toggles the visibility of the lines that join the elements. If the lines are visible and the button is selected then the lines are hidden. If the lines are hidden and this button is pressed then the lines become visible. This is used to predict whether a certain constellation of elements could be discerned as a shape and to determine where extra or fewer elements are needed to improve the drawing. This text (4) presents a message that tells me the number of elements and their size.

The square blobs (5) within the panes represent elements. These can be dragged to make new drawings. Any movement of an element in one picture is reflected by a movement of a different view of the same element in the corresponding picture. The two panes are two pictures of the same object. Each blob is shown twice, once in the xy picture plane and again in the yz picture plane.

Figure B-2: Drawing Window

The drawing tool is used to simultaneously draw from two views. Without this machine, it is extremely difficult to predict which pair of two–dimensional drawings could be combined into one object. With this machine, I can explore what is possible and whilst doing so I will often find other unpredicted possibilities. It is a machine of discovery that is used for finding Supermoment drawings rather than a machine for drawing what one knows.

Moving an element along a line parallel to the horizontal axis has no impact in the corresponding picture. When the upper button (1) in the drawing window (**Figure B-3**) is selected, the coordinates of each element in the drawing are printed out to a message window (see **Figure B-5**).

Selecting the blue button (2) in the Drawing Window takes me to stage 2 (see **Figure B-4**) of the drawing. Selecting the mauve button (3) takes me back to the 'Chooser' (see **Figure B-1**) and selecting the mauve button (4) closes the Drawing Machine.

Figure B-3. Drawing Window (detail)

The second stage of the drawing is an animation of the Supermoment. The animation shows how the view of the Supermoment will change according to the angle of view. Moving around a static object and rotating an object in front of a static viewer both equally change the angle of view. This change is, in one sense, spatial because it is the view of the one object that is changing. The change has temporal implications because it takes time to move from one view to another just as it takes time to move from one word to another in this sentence. The temporality of the changing view is also apparent when one considers that one view is seen after another and a series of views are seen in a linked sequence.

Selecting the blue button (1) in the drawing window (**Figure B-4**) toggles the visibility of the lines that join the elements. If the lines are visible and the button is selected then the lines are hidden. If the lines are hidden and this button is pressed then the lines become visible. As before in the first stage of the drawing (**Figure B-3**), this is used to predict whether a certain constellation of elements could be discerned as a shape and to determine where extra or fewer elements are needed to improve the drawing.

Selecting the blue button (2) starts and stops the animation. Selecting the blue button (3) causes the animation to proceed without my intervention whereas pressing the other blue button (4) puts the animation into manual mode. The rotation of the Supermoment drawing is then dependent on the location of the mouse. The mouse can be moved over the index lines (5) and the view of the

Supermoment will be rotated accordingly. The current angle of view is shown in the text readout (6).

Pressing the blue button (7) hides the plan view in automatic mode and pressing the blue button (8) hides the plan view in manual mode. The plan view is a view from above the Supermoment. The same elements are shown using yellow blobs. This plan view helps me to disambiguate the drawing and to understand its configuration in three–dimensional space. It is also useful to be able to hide it and see an uncluttered view of the Supermoment.

Figure B-4. Drawing stage 2

When the upper button in the drawing window (**Figure B-3**) is selected, the coordinates of each element in the drawing are printed out to a message window (see **Figure B-5**). The message window reports the x, y and z coordinates of each of the elements in three–dimensional space. This information converts the two two–dimensional images into one three dimensional object. The coordinates can be used to rebuild the Supermoment in the studio or in an installation.

When making the Chronocyclographs, these coordinates are used to choreograph the movement of the actor. The actor in the Chronocyclograph uses the coordinates to accurately move a small light from point to point and so trace the Supermoment drawing as a line in space. This single line is recorded from two orthogonally positioned cameras as two different drawings.

Figure B-5. Message window

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Appendix C. A method of aligning a number of cameras

To make the Stereo–chronocyclographs I needed to record the same event from two orthogonally positioned cameras. To do this I designed a method of positioning and aligning a number of cameras. This is not a process that involves critical, aesthetic or philosophical thought, but it is at the heart of research by practice.

[

Figure C-1. Showing the position of seven cameras

The problem can be described in one annotated diagram, but the solution took a year to find. The problem I was trying to solve was how to position a number of cameras so that the cameras are the same distance from one point and the distance between adjacent cameras is constant. I also needed to align the cameras so they were level, the same height and viewing angle. The solution is shown in **Figure C-1** where the cameras are positioned on the circumference of a circle. The subject would be positioned at the centre of this circle. At first this technique was used for seven cameras. The seven–camera set up was used for the five early versions of the interactive work. When I moved to a two–camera set–up for the stereo–chronocyclography I used the same technique with cameras at position 2 and position 5 (**Figure C-2**).

Figure C-2. Showing the position of two cameras

I needed to position and align the cameras in this way because I would be photographing and comparing images recorded by these cameras. These images are of the same object or event. For example, if I recorded a small cube with all seven cameras I would not want the size of the cube to appear to change from view to view. To achieve this constancy of scale I needed all the cameras to have lenses of the same focal length and to be the same distance from the subject.

Figure C-3. The effect of cameras being at different distances from the subject

Secondly, I wanted the amount of change from view to view to be constant. As the viewing angle of an object changes we see a new aspect of the object and we compare our current view with previous views in any sequence. We perceive the difference or change in view between our current view and the previous view as if the object had rotated or we had moved around the object. To achieve a constant change in this angle of rotation I needed the distances between adjacent cameras to be constant.

Figure C-4. Showing a constant change of angle between successive views

Lastly, I wanted the alignment of the object and position relative to the edges of the image to be constant from image to image. If the tilt of the cameras is not consistent, the following undesirable effect will be seen.

Figure C-5. The effects of inconsistent tilt

If the subject is not consistently positioned in the centre of the image, the following undesirable effect will be seen.

Figure C-6. The effects of inconsistent position

If the cameras are not consistently level, the following undesirable effect will be seen.

Figure C-7. The effects of inconsistent level

In a studio setting all three errors will probably occur at the same time.

Figure C-8. The effect of combined alignment errors

To achieve a constant alignment of the cameras I needed to be able to control the pitch, yaw and roll of the cameras and to point the aligned cameras at the same subject.

During the research period there were many unsuccessful attempts to position and align the cameras. These failures reveal many of the differences between theory and studio practice. These failures were useful because they prompted thought and reflection, whereas successes tend to be unnoticed and ignored.

I will describe just one systematic problem here. I call this problem systematic because it lay behind all the failed attempts to position and align the cameras. It is very easy to draw two lines crossing (**Figure C-9**) but real materials have three dimensions and cannot occupy the same volume of space (**Figure C-10**).

Figure C-9. A two–dimensional drawing of two crossed lines

Figure C-10. A three–dimensional drawing of two crossed lines

The failed attempts to position and align the cameras included hanging the cameras on steel rods that were drilled into the ceiling. This method was designed to overcome the evenness of the floor and the problems of aligning tripods. This attempt failed because the rods vibrated too much and attempts to dampen the vibrations also failed.

Another failed attempt to position and align the cameras used a large–scale railway track with the cameras mounted on carriages that could be moved along the track. The track was laid on a horizontal surface made from foam–board mounted on tripods. This method is elegant and entertaining, but the track is not manufactured accurately and there is no simple method of joining two segments of track so that they continue the same curve.

An interesting, but unsuccessful attempt to position the cameras used a rotating target. In this approach I assumed that it was not necessary to use accurate measurement and geometry to position and align the cameras. Instead, the important consideration was, I thought, the functional result of any change. Alignment is achieved using the camera as a sighting device and a target. The purpose of positioning and aligning the cameras is to take consistent images of a number of views of a subject. The essence of this approach was to attach a transparent drawing to the viewfinder screen of the camera and then look through each camera at a large target (**Figure C-11**). The target is positioned at the centre of the stage. I could then move the camera until the target aligned with the drawing on the viewfinder screen. Having aligned one camera, I would rotate the target by the appropriate amount and then align the next camera. I used a large ruler to determine the distance between the target and the cameras.

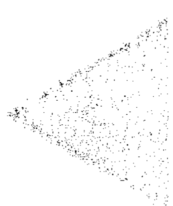

Figure C-11. The target

Pitch is rotation about the x–axis. This is checked by ensuring that the horizontal line of the target coincides with the horizontal line on the viewing screen. Yaw is rotation about the z–axis. This is checked by ensuring that the vertical line of the target coincides with the vertical line on the viewing screen. Roll is rotation about the y–axis. This is checked by ensuring that the horizontal and vertical lines of the target and the viewing screen coincide along their length.

The approach failed because thin lines of say 1 mm thickness (**Figure C-12 A**) drawn on the camera's viewing screen (100 mm from eye) and lines of 20 mm (**Figure C-12 B**) on a target that is 2 metres away subtend the same angle at the eye. The result is that an apparent accurate alignment of two lines on the viewing screen can conceal a large error.

Figure C-12. Plan view of one line at 100 mm from the eye (A) and another line at 2 m from the eye (B) showing how both lines subtend the same angle at the eye

For the successful solution, the position of the camera was achieved by using trilateration. Trilateration is the technique of calculating a point given its distances from other known points and is closely related to triangulation (the technique of calculating a point given its angles from other known points).

The cameras were mounted on tripods and these tripods were mounted on dollies (**Figure C-13**). These dollies allowed the cameras to be quickly and easily moved. The dollies could be locked into position using a lever that supported the dolly on a pole instead of a wheel.

Figure C-13. A dolly

The first dolly was positioned at the location where the subject would be recorded (**Figure C-14**). A bar, which had been cut to the correct size, was then used to position the second dolly (**Figure C-15**). The bar had locating holes at each end that fitted over the central lug of the dolly. The distance between these two locating holes is the radius of the circle and is equal to the distance between a camera and the subject. This bar is called the radial bar.

Figure C-14. Stage 1 of trilateration

Figure C-15. Stage 2 of trilateration

Once two dollies were in the correct location, each subsequent dolly was positioned using the radial bar and a chord bar (**Figure C-16**). A chord of a curve is a geometric line segment whose endpoints both lie on the curve. The distance between the two locating holes on the chord bar is equal to the distance between two adjacent cameras. This process was then repeated for each camera (**Figure C-17**). When, using this process, all seven cameras were in their correct locations the triangulation bars were removed (**Figure C-18**).

Figure C-16. Stage 3 of trilateration

Figure C-17. Stage 4 of trilateration

Figure C-18. Stage 5 of trilateration

Alignment was then achieved using a laser line, a mirror and a target (**Figure C-19**). A coherent and narrow beam of light was sent from an emitter mounted on the dolly in the centre of the circle. A laser light has a very tight un–diffused beam and is very strong and concentrated.

Figure C-19. Alignment using a laser line, a mirror and a target

A small mirror was mounted on the front of the lens of one of the cameras. If the camera is correctly aligned the beam of light from the centre of the circle is reflected from the mirror mounted on the camera back along the same path. If there is any misalignment, the beam is reflected at some angle and so a second spot of light is seen on the target that surrounds the emitter (**Figure C-20**).

Figure C-20. Evidence of misalignment using a laser line, a mirror and a target

Alignment is achieved by changing the pitch, yaw and roll of the tripod head until the second spot of light is merged with the source of the laser (**Figure C-21**).

Figure C-21. Realignment of camera and target by moving the reflected spot of light closer to the source of the light

LIST OF TABLES AND FIGURES

Appendix D. A method of simultaneously opening a number of shutters

Stereo–photography also extends chronophotography by adding information about simultaneity. To take two or more photographs at the same time and for the same duration I needed to develop a method of simultaneously opening a number of shutters.

This appendix looks at my attempts to synchronise camera shutters. Research in this area led to the development of a pneumatic multiple–shutter and an electronic 'Time machine'. At a higher level, this research led to deeper understanding of the 'instant', duration and synchronicity. This appendix also shines light on the relationship between low–level practical research and the higher–level implications of this research. This relationship is embedded into research by practice.

I was attempting to synchronise the shutters from a number of cameras because I wanted to be able to record the same moment from a number of spatially differentiated, but contiguous viewpoints. The organisation of the different, but related viewpoints can be simple, for example a circle, or it can be complex. The camera positions are points along a motion path. It is important that the distances between these points along a motion path are equal and it is important that the distance between the points and the subject is constant or constantly changing. These issues of alignment and position of cameras are covered in **Appendix C**. These recorded images are then shown sequentially in the same place (on the same screen) or next to each other in a stereo–photograph. This inversion from spatially differentiated images to temporally differentiated images produces a movie of transport about a scene (along the motion path) at one moment (without any change in the temporal dimension). Two frames of such a movie are shown next to each other in the stereo–chronocyclographs.

The idea of a moment is, of course, contentious. Terms such as 'instant' and 'instantaneous' suggest that it is possible to open the shutter for no time. An exposure of zero duration can be approached, but it is never possible. For our purposes here, this problem can be avoided by seeking instead to synchronise the camera shutters so that they are all open for the same duration. The opening and shutting of any one shutter should be in phase with the other shutters.

My first attempts to synchronise a number of camera shutters started with trying to synchronise cine cameras. This introduced a new problem. Cine cameras have a frame rate. So the problem of synchronisation of cameras is much more than pressing the shutter releases at the same time. Each camera has to go through the following list of events: ***1.*** The shutter release is pressed. ***2.*** There is some period of latency. This is the mechanical delay between the shutter release being pressed and the motor of the cine camera starting to turn at operating speed. ***3.*** There is a period during which the film is moving and the shutter is closed. *4.* There is a period during which the film is stationary and the shutter is open. Even this event could be re–categorised as a number of events. No shutter is immediately open and then, at the end of the exposure time, immediately shut. So this event (shutter is open) could be, more accurately described as three events. These events are: shutter takes time to open, shutter is open and then shutter takes time to shut. The shutter is then intermittently closed and open (events *3* and *4* are repeated) according to the frame rate of camera.

Synchronisation is lost if, for one camera, the duration of any of these events is out of phase with the other cameras. The frames recorded when synchronisation has been lost are useless in one of three ways. If the shutter from one camera is shut when the others are open then only unexposed film or a black screen is available from that viewpoint. If the shutter from one camera opens for the same duration as the other shutters, but the start and close time are ahead or behind the others then there will be some apparent movement when the image from this viewpoint is seen. Thirdly, if the shutters on two cameras are open for different durations the exposure will be different and the amount of movement, or any other change that is captured in the exposure, will be different.

As the synchronisation of cine cameras demanded the solution of so many interrelated problems, I decided to first synchronise a number of still cameras. Then, if successful, I could move from the simpler problem to the more complex problem. Typically, still cameras are divided into two types: cameras that record on a photosensitive emulsion that is transported on a film, and cameras that record images via an electronic image sensor. For this research, the most important attribute of a camera was the type of shutter release. The two types of shutter release are mechanical and electronic.

I first tried to synchronise mechanical shutters. To start the exposures from a number of cameras at the same time, I would need to press a number of shutters at the same time. My approach was to use long cable releases to bring all the pistons to the same place and then to make a simple device, rather like a trumpet, that would enable me to press the ends of the cable releases at the same time (**Figure D-1**). When the plate is depressed it will press all the cable releases at the same time. These will then press the shutter releases of a number of cameras at the same time.

Figure D-1. Construction drawing of multiple cable release.

I needed the cameras to be equally spaced around a circle with a radius of about 2 metres. Further, the best place to bring the ends of the cable releases together in my trumpet device was in the centre of the circle. This was not desirable as it would be in view. More importantly, this technique did not work well whether I had the ends of the cable releases collected in the centre of the circle and so 2 metres away from the cameras or collected out of shot and so all at different distances from the cameras. The piston has to overcome the friction of one tube inside another and this friction will vary from one cable release to another and so even if the cable releases are pressed at the same time this does not translate into camera shutters being pressed at the same time.

The mechanical cable releases did not work at longer distances so I next tried to use pneumatic shutter releases. Squeezing a balloon at one end of the pneumatic remote release transmits pressure to the other end of the remote release. This pressure triggers the mechanical shutter of the camera. Pneumatic remote releases work well at distances greater than the 2 metres I needed.

My problem then became how to squeeze eight balloons at the same time. I solved this problem by using an air compressor. The output of the compressor was connected to a distributor that supplied eight tubes. These tubes were connected to the pneumatic cable remote releases in the place of the balloons. A valve was used to control the output of the compressor. This system is operated by closing the valve and then compressing the air to a pre–determined pressure. All the shutters could then be pressed simultaneously by switching the valve and so releasing the high–pressure air into the tubes.

This approach appeared to work well with cameras with mechanical shutters. To be sufficiently confident that I had synchronised the camera shutters I needed to view the resultant photographic images. The quickest and easiest way to this is to use digital cameras, as the results are quickly viewable. This led to a new problem, but the solution to this problem led to the solution of the more general problem.

Manufacturers of mechanical cameras provide a threaded socket to take the threaded plunger of the cable release or the pneumatic remote release. Typically, this threaded socket is not available on digital cameras. The junction between a pneumatic remote release and a digital camera are not made to a high quality and do not work well (see **Figure D-2**).

Figure D-2. Cable Release Adapter Bracket

I next tried to synchronise electronic shutters. Digital cameras do not have a threaded socket for mechanical or pneumatic remote releases because they are fitted with a port that accepts an electronic, and superior, shutter release. A remote release for a digital camera sends its signal electronically through the shutter jack. This signal is transmitted quickly and consistently.

I determined the signal that was sent by the shutter to the camera and then made a relay that would send the same signal when switched. I then used a simple configurable timer (Mumford, 2001) that would switch on and off at pre–determined times (**Figure D-3**). I can set the duration of the period when the switch is off (pause) and I can set the duration of the period when the switch is on. The duration of the 'on' signal has to be sufficient to trip the shutter. This was determined empirically by trial and error. An adaptor was then inserted in the setup to convert one trigger to a number of triggers in parallel (see **Figure D-4**). This could be used to trigger multiple cameras.

Figure D-3. The Time Machine

Figure D-4. Multi–channel hubs

This solution solved the problem of synchronisation and it solved the more general problem of recording a sequence of images at consistent intervals. If the switch is used once it can trigger a number of cameras at the same time. If the intervalometer function of the device is also used, this switch can be used at regular intervals. With this combination of electronic trigger and timer a number of still cameras are converted into a number of synchronised movie cameras. The period between frames is limited by the latency of the recording device. Any consistent delay or advance can be corrected by using an electronic delay in that camera's circuit.

In the end, the journey described in this appendix did not lead to a technical solution that I used, because the difficulties of latency and synchronisation led me to an approach that avoided opening and closing the shutters. Keeping the shutters open in a dark studio does not expose the film. I can then illuminate the subject for controlled periods and it is this that will be recorded in each camera. This intermittent exposure of the subject (*flashing lamp stroboscopy*) was used to make the chronocyclographs. The research was not wasted as I used the Time Machine to control the intermittent flashes of light and although the journey led nowhere, I continue to carry the learning (about the instant, duration and synchronicity) that I picked up on the way.

REFERENCES AND BIBLIOGRAPHY

Mumford. (2001) *The Time Machine* was developed with and obtained from Mumford Micro Systems, Santa Barbara, California

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