Overcoming the Curse of Precision

Exploring the ambiguous nature of visual
Perception using 3D animation software

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Declaration

I, Georgina Moore, hereby certify that except where due acknowledgement has been made, this work is mine alone.

The work has not been submitted previously, in whole or in part, to qualify for any other academic award.

Apart from the animations **Drive** and **The Story Continues**, the content of this thesis and project work is the result of work that has been carried out since the official commencement date of the approved research program.

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Name………………………………….

Date ……../………./2007

Abstract

3D animation software is extensively used to create graphics for special effects sequences in live-action films, in animated feature film production and for the generation of computer games and virtual reality content. It is a commonly held view within the computer graphics community that 3D animation software is "just another tool" for self-expression. This research questions that view by examining the inherent nature of the tool itself. In doing so, some of the philosophical assumptions embedded in the design of the new digital tool are revealed. 3D software assumes that vision is a mechanical process independent of any context, and thus reduces the world to mathematical principles. This research posits that no tool is neutral; all tools orient our behavior and contribute to the way we perceive the world.

The researcher has been trained in the use of traditional artistic methods, and like a growing number of other visual artists in recent years, has incorporated computer graphics into her artistic practice. This exegesis reflects upon the various ways in which traditional painting and drawing practice can inform the creation and manipulation of geometry in 3D animation software. The project work outcomes embedded in this investigation explore how a tool of such mathematical precision can be deliberately used to create work that communicates the subjective and ambiguous nature of everyday visual experience.

The researcher's previous experience as an observational drawer and painter is compared throughout this investigation with her more recent experience as a 3D animator. The research concludes that 3D is a powerful tool for creating animated graphics and, when used in conjunction with traditional drawing and painting techniques, can successfully be used to illustrate aspects of subjective visual perception. However, without reference to paintings and observational sketches, the 3D user is likely to approach the visual world in terms of the software's inherent Cartesian assumptions. 3D software, therefore, is too prescriptive to be used in isolation as a tool for the exploration of subjective perception. This finding has implications for the changing nature of visual arts practice and deserves further examination in order to encourage a more fruitful dialogue between traditional art practice and digital graphics software.

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INTRODUCTION

How do we see the world around us? It seems like a simple question, but the answer becomes more elusive the more the question is considered. In one sense, the way an object is seen depends entirely on the context in which it is encountered. Its shape and size vary according to the viewing angle and distance, and its colour changes across its form in accordance with the lighting context. At the same time, the object is considered to be of a constant size and shape, no matter what angle or distance it is viewed from, and it is claimed to have a constant colour under a variety of different lighting conditions.

I am from Perth, Western Australia, where the summer months are characterised by heat and glare and the harshness of the light seems to destroy the visual autonomy of forms, making it easier to see the world as a field of abstract shapes. As a visual artist, I have often scrutinised these shapes, and have always found them surprising, inconsistent, and elusive. But in everyday life we don't see areas of colour and tone, we see, and interact with a world of meaningful objects, chairs, cups, tables, people etc. How do we see, or make out, these stable objects when the visual field is in constant flux? Through the mediums of drawing and painting I have tried to explore the point at which we identify meaningful objects from an elusive and ambiguous visual field.

I began this research project with the aim of continuing my artistic concerns using 3D animation software, a medium that was then new to me. As I became more familiar with the software, questions arose concerning the nature of the tool itself. This thesis asks whether 3D animation software, which by default produces images of mathematical precision, can be used to create work exploring the subjective and

ambiguous nature of visual perception. By analysing the normal workflow, tools and techniques available to users of 3D software, I aim to expose some of the philosophical assumptions embedded in the design of the tool. I will argue that these assumptions are based on the philosophy of Descartes, and contrast these with Merleau-Ponty's description of "embodied perception", as well as with the perceptual ambiguity implicit in my paintings and those of other artists. The thesis, then, explores how, by drawing on experience with traditional artists' tools, the Cartesian bias inherent in 3D animation software can be overcome. Throughout this thesis I reflect on my experiences using 3D software, as well as my use of the tools and techniques of drawing and painting, in order to gain further understanding of the intrinsic differences between this relatively new digital tool and those of traditional artistic practice.

The specific questions addressed by this thesis are:

- What are some of the assumptions about visual perception that are implicit in 3D animation software?
- How can traditional painting and drawing practice inform the creation and deformation of geometry within 3D software?
- How can a tool based on metaphors of photography and the assumption of an objective reality be used to create imagery about the ambiguous nature of everyday visual experience?
- How does 3D software compare with painting and drawing as an image creation tool?

BACKGROUND

In this section I will reflect on my prior art practice and my introduction to 3D animation software. I then conclude with a description of the normal 3D workflow.

Reflection on Prior Practice

"For Merleau-Ponty, the painter offered, not a picture of the world 'as it is', but a picture of the world coming into being in the percipient's view of it, not before or after but as the attributes associated with use, significance, and value are applied." (Gilmore, 2005, p.294)

Like many visual artists I am in the habit of carrying a sketchbook and making small-scale observational sketches of my immediate environment. The sketches are sometimes extended studies and other times are quick attempts to capture initial impressions. Either way, making a sketch takes time and is always about capturing motion. Whether the subject matter is people and cars that are moving, or still forms such as buildings and trees, the light is always changing and my eyes continually move around the scene, finding and loosing detail and form. Although I may be aware of it on some level, I can never see or record all the detail before me. Therefore, what my pencil doesn't record seems somehow just as relevant as what it does. As visual records, these sketches often form the starting point for paintings (and for animated films as described below), but the activity of observing and sketching is as important as the finished drawings. It provides a way of scrutinizing the process of looking, of exploring "the stable things which we see and the shifting way in which they appear" (Merleau-Ponty, 1945, p.4).

"Lighting, shadows, reflection, colour … are not altogether real objects, like ghosts, they have only visual existence" (Merleau-Ponty, 1964, p.166). They are not seen by everyone because you have to see through them in order to see the object. In the words of Merleau-Ponty (1964, p.167), "To see the object it is necessary *not* to see the play of shadows and light around it." It is precisely these "not altogether real" objects that my sketches study and attempt to capture. Making a painting, I start with these carefully observed abstract shapes and, by a process of adding, subtracting,

enlarging and reducing, I shuffle them around until a complex picture evolves. During this process I try also to "listen to the materials" so that the finished painting is as much about the interaction between body, brushes, paint and canvas as it is about the two dimensional pictorial composition and the figurative (recognisable and nameable) elements of the picture. An example of this working method is **Chair Memory** (Fig.2), a painting created with reference to an observational pencil sketch (Fig.1).

Figure 1 Chair sketch, pencil on paper, 2002
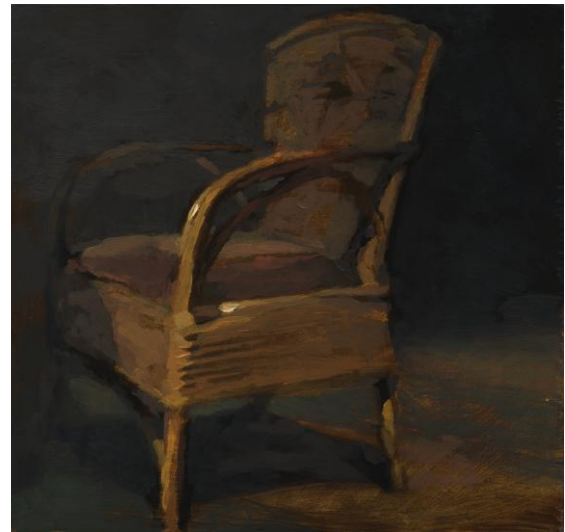
Figure 2 Chair Memory, oil on board, 2005

A viewer of this painting is firstly presented with the image of a chair and, on further inspection they can see how the image has been constructed. They can see the ground (the pigment stained board) beneath distinct brushstrokes, and the textures made by individual hairs of the brush. In one instant (or in one perceptual attitude) they see abstract paint daubs, which are a map of the movements of a body and its interaction with materials. In another attitude they see a chair, an object to be sat on.

My Introduction to 3D Animation Software

In 2001, I became interested in computer graphics. During a post-graduate course at RMIT I used 3D animation software to create a short animated film, **Drive**. Making this film was a process of discovery in which I learnt how to use 3D Studio Max. I had little knowledge of the correct workflow and procedures of the software so my focus was on getting visual results using the simplest method available. For example, in a scene where the traffic lights change from red to green, I animated the colour of the geometry from "reddish" to "greenish" (Fig.3).

Figure 3 Drive sequence, 3D animation, 2001

This allowed me to get the exact visual result I was after without tweaking the attributes of the lights. The "directness" of this process appealed to me and led me to think about the difference between using the software as a tool to create visual artefacts and using it to create a virtual world to be filmed by a virtual camera. I deliberately set **Drive** in a night time environment, where objects disappear into darkness. This meant that the imagery could lack detail and still be convincing. As research for a scene in the film I was sketching a floodlit building in the city one night, focusing on the distinct shapes created by the dramatic lighting, and I noticed how areas in deep shadow were perceptual voids.

Figure 4 Sketch of a building at night ink on paper, 2001

**Figure 5 Still from Drive (detail),
3D animation, 2001**

It struck me that I could build the virtual geometry based entirely on the sketch (Fig.4). So, rather than create the building as I knew (or assumed) it to be, and then lighting it to get the harsh shadows, I only modelled the lit areas, leaving the shapes that were in deep shadow as voids in the virtual geometry (Fig.5).

Likewise, in the same scene, the figures running down the street are not created in the usual way i.e. by modelling a NURBS or polygon mesh and then binding it to an internal skeleton. My desire was to give the impression of human movement, and this was achieved by animating the rotation and translation of simple geometric shapes (Fig.6).

Figure 6 Drive sequence, 3D animation, 2001

In another character animation experiment, the running dog in **Drive** (Fig.7) is created by animating three splines, then blurring and layering various versions of the rendered image sequence in After Effects. Making this film felt like a process of constant discovery and inspired me to undertake the current research project.

Figure 7 "Drive" sequence, 3D animation, 2001

While working as a full time animator in the advertising industry from 2002 to 2004, I was introduced to Maya 3D animation software. At the time this software was considered one of the most powerful digital image creation tools on the market. Then, as now, it was used in the creation of special effects for live-action films, and for creating animated feature films either with a cartoon-like style such as Shrek and Finding Nemo, or a photo realistic style in works like Final Fantasy. It is also used in the creation of graphics for computer games and virtual reality content. Creating animations for the advertising industry means working within the constraints and demands imposed by clients and deadlines. It also often means working as part of a team. On some projects Maya scene files are passed from one animator to another, so it is necessary to organise the scene in a conventional manner. In this production environment I soon learnt the workflow and techniques needed to get predictable results and became proficient in the correct use of Maya 3D animation software. The work in this research project has all been created using Maya, versions 4 to 7, and compositing has been done using After Effects.

As a user of 3D software the sense is that with enough knowledge of the tool any creative vision can be realised. Ironically, the more proficient I became with Maya, the harder I found it to move beyond its default aesthetic. I began to see the world in terms of the default 3D workflow and it was not as easy as I had assumed to explore my original artistic concerns with this new tool. I wondered about the intrinsic difference between 3D animation software and traditional drawing and painting

mediums, and the possibilities of a dialogue between the two. I began to feel that 3D was possibly not "just another tool" (Komorowski, 2002, p.1) for creating visual images, and I became as intrigued by what the program can do easily as by what it cannot.

Description of the Normal 3D Workflow

The following description is intended to give a brief overview of the common workflow used in Maya 3D animation software. Production can be broken down into five distinct stages; design, modelling, texturing, lighting, animation and rendering. The principals of these processes are the same for most 3D animation programs.

Design

When creating a scene in 3D it is usual to start by listing (in written or mental form) each of the objects in the scene. Information is then gathered from a variety of sources to help in the creation of an accurate virtual model of each object. For example, if the scene includes a table, a chair and a coffee cup, then we may do a Google image search for a table, measure and take photos of our favourite coffee cup and find a picture of a chair in a magazine. If it is a complex object then it may need to be photographed or sketched from three angles (e.g. front, side and top). If it is a model that will be animated, such as a character, it is necessary to design it in a "relaxed pose". In the case of a human figure, this means looking straight ahead with arms straight and out wide, legs apart. The pose must be symmetrical.

Modelling

In 3D software, a variety of modelling techniques are used to replicate the form of a real life or imagined object. Polygon and NURBS modelling are the most common. By panning, zooming and tumbling in the orthographic (side, front, and top) and perspective viewports, a model is considered and worked on from every angle. While working, a model can be viewed in "wireframe" display mode (which means that the mesh is see-through), or in a "smooth shaded" mode. Often at this stage little or no regard is given to the final context in which the object will be viewed and, generally, the more detailed a model the better it is considered to be.

Usually a model is created at the "centre of the world" (the origin of the x, y, and z axis). Often the transformations (movement, scale, rotation) of a model are performed on a separate "node" so that the model can be easily substituted, or can quickly be returned to the "origin" by "unparenting" it from the transformation node. The models may be created in separate scene files or on separate layers so that each model can be worked on and completed without visual interference from other models in the scene. A finished model is context independent. Models (often called assets) can be re-used in different scenes and in entirely different projects. They can also be bought and sold on the Internet.

Texturing

Typically it is not until a model is complete that colour and texture are applied. In the modelling stage the emphasis is on the form of the object and so it is usually viewed with a simple grey material (or "shader"). Once completed, specific materials are designed and applied to the object.

Lighting

While in creation, the model is usually seen under default lighting conditions (i.e. a gentle diffuse lighting set up with the main light source emanating from above and behind the camera). Specific lighting is generally applied to the scene once all the models are complete and in position.

Animation

Animation can be created "by hand", using keyframes; or automatically, by using dynamics, expressions, or alternative information input, such as motion capture.

Rendering

The camera icon represents a point in space from which the scene can be viewed or rendered. Camera attributes are based on those of a real life camera and include depth of field, focal length etc. By default the images rendered with a virtual camera are much like those taken with a real camera, in that they depict everything in the scene. Each pixel in the rendered image represents a point in virtual space.

Production environment

In many of the larger studios, employees are arranged into specialist groups who focus exclusively on one area of production; i.e. design, modelling, texturing, lighting, animation, or rendering. Often, each element of a scene is considered and worked on individually before being brought together at the end to form a whole. In these cases it is not uncommon for a creator of 3D content to see the full results of their work only after the entire production is finished.

THEMATIC SECTIONS

Organised under nine thematic headings, this section discusses the nature of the 3D toolset, as well as the methodologies used in the project work. The Cartesian assumptions embedded in the design of 3D software are discussed and contrasted with the ideas of phenomenologist Maurice Merleau-Ponty, and with the work of artists using traditional painting and drawing techniques.

The Eye is Like a Camera

"One encounters the world as a physical being not an abstract "point of view" for which the world is a picture or representation in the mind." (Gilmore, 2005, p.300)

"The camera obscura is congruent with [Descartes'] quest to found human knowledge on a purely objective view of the world." (Crary, 1992, p.48)

"Since the image in the camera obscura had been so readily equated with the retinal image, now the photographic image could be equated with the retinal image as well." (Wees, 1992, p.43)

"This has resulted in a very odd situation. An image deprived of the full possibilities of visual perception has become generally accepted as the only accurate visualisation of sight." (Wees, 1992, p.45)

As a visual artist I am interested in a model of human vision aligned with that of phenomenological thinkers such as Maurice Merleau-Ponty and artists such as contemporary landscape painter, Mary Tonkin. The work in this research project seeks to explore the nature of visual perception as subjective, incomplete, dynamic, and ambiguous. By default, the imagery rendered with Maya's virtual camera presents a scene in its entirety and with the exactitude of mathematical perspective. During this research project I continually asked myself "what might a person see?" as well as "what might a person *not* see?" I tried not to accept without question the default footage as rendered by Maya's virtual camera.

The camera obscura, precursor to the modern camera, consists of a darkened room with a single aperture in one wall through which light rays are projected from the outside world onto the opposite interior wall, where they form an inverted image of the exterior scene (Fig.8).
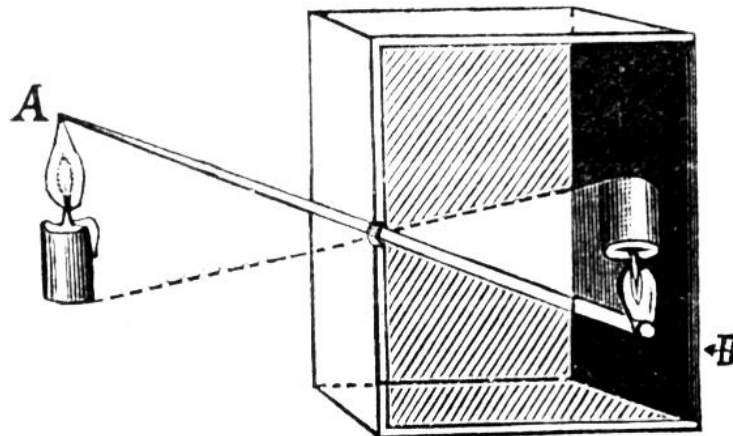
Figure 8 Camera Obscura diagram

In his book *La dioptrique* (1637), Descartes describes the camera obscura, making an analogy between it and the human eye. He was able to draw this comparison because of Kepler's discovery of the retinal image thirty years earlier. In the 17th and 18th centuries the camera obscura was used as an instrument of popular entertainment, of scientific enquiry and of artistic practice. Artists traced the projections inside the camera obscura as a way of starting a painting. This was apparently one method used in the development of pictorial perspective. Today it is a common view that what we see is the image on our retina formed by light rays projected from the external world: that "the eye works like a camera".

In contrast to Descartes, for phenomenological philosopher Maurice Merleau-Ponty the sensory (or perceptual) apparatus is not just a transmitter and the same stimulus will not necessarily produce the same sensation. In other words, the eye is not like a camera and we don't all see the same thing; as individuals we don't even see the same thing each time we are presented with the same stimulus. Many artists who have scrutinised their own visual perception have also come to the conclusion that we don't see what a camera sees.

Contemporary landscape painter Mary Tonkin produces work that "celebrates visual perception as something dynamic, binocular, elastic and intelligent, not automatic or mechanical as you might assume from photographic processes" (Nelson, 2003, p.1) (Fig.9).

Figure 9 "Summer, Kalorama", Mary Tonkin, oil on canvas, 2003

Merleau-Ponty gives an account of perception based on our intuitive bodily understanding of the world. While for Descartes we are primarily thinking beings, for Merleau-Ponty we are primarily "coping" beings, which means that we instinctively negotiate the world in terms of our skills and desires. In the words of Zaner (1964, p.246), "Perception is not in the service of *knowledge* ... rather, *it is in the service of action*. That is to say, perceived objects *are what the body does or can do to them*" [my emphasis].

In accordance with Descartes' idea that "objective knowledge of the pre existing world 'out there' can be gained despite the fallibility of the senses" (Crary, 1992, p.43), the design of 3D animation software is based on metaphors of photography and algorithms intended to simulate real world phenomena. For creators and consumers of 3D animation, the terms "photo-realistic" and "realistic" are used interchangeably, and an authentic visual experience is often assumed to be one that emulates the codes, conventions and artefacts of cinematography (camera moves and cuts, lens flare, depth of field, etc). The design of 3D animation software and the acceptance of the photo-realistic imagery it can produce as "realistic" seems to reflect the idea that human vision is like the mechanical process of photography and that what a camera sees is a "true" representation of the world.

Intrinsic Vs Extrinsic Qualities

Descartes famously declared that there are two types of "substance" in the world: mind and matter. The essence of mind is reason or thought, and the essence of matter is its spatial extension. The body and its sense organs are part of the latter category along with everyday objects. Descartes was only interested in things we could know for certain. For him, reliable knowledge of the world comes through rational reflection. Knowledge that comes through our bodily senses is unreliable and sometimes deceptive. Descartes was therefore among many philosophers who felt it necessary to make a distinction between the so-called "primary" and "secondary" properties of objects. For Descartes what is certain about an object (and all matter) is its mathematical structure; its length, height, and width. He assumed that these qualities don't change so our knowledge of objects should be based on these "primary" qualities. The "secondary" qualities of an object are subjective in nature, they are harder to quantify and are always changing, we cannot have absolute knowledge of them and so they don't tell us anything about the true nature of an object. "It can be shown that weight, colour, and all other such qualities which are sensed in bodily matter, can be taken away from it, while leaving the matter itself intact. From which it follows that its nature depends on none of these" (Descartes, 1901/1641, "Principles" 2:4).

According to Merleau-Ponty, Descartes liked copper engravings because they retain what for him is the essence of objects, their spatial dimensions. These engravings play down "secondary", merely subjective or accidental qualities and focus on the shape or spatial properties of an object: "they present the object by its outside, or its envelope" (Merleau-Ponty, 1964, p.172) (Fig.10).

Figure 10 17th century copper engraving

In his paper, "An Invitation to Discuss computer Depiction", Durand (2002) makes a distinction between "intrinsic" and "extrinsic" properties of scenes or objects. "Intrinsic" properties are constant, invariant, quantifiable, measurable, and transferable, while "extrinsic" properties are "merely accidental", context dependent and subjective. This distinction between "intrinsic" and "extrinsic" properties is similar to that made by Descartes between "primary" and "secondary" properties. According to Durand, "invariants [or primary qualities] are by nature a 'better' or at least more immutable representation", though he concedes that "most pictures are a hybrid [of both] and managing the balance between extrinsic and intrinsic properties is one of the keys to good depiction" (Durand, 2002, p.113).

The popular feature length animated film *Shrek* (Fig.11) was created using the normal 3D workflow as it is described above. Looking at a still from the film, it is interesting to see how the "balance between extrinsic and intrinsic properties" has

been managed. It is also interesting to consider the aesthetic similarities between this image and a copper engraving similar to those of which Descartes approved. In both the engraving and the still from the 3D animation, each object depicted is bathed in a diffuse light, which accentuates its autonomy and its 3 dimensional form.

Figure 11 *Shrek* 3D animation, Dreamworks, 2001

The result is something rather like Renaissance chiaroscuro shading, which, as described by Durand, "renders shapes using light and dark, but emphasises the intrinsic colour rather than some accidental lighting" (Durand, 2002, p.113). In these images, the colour, tone and shadows are present primarily as indicators of the three dimensional nature of objects, and are subtle so as not to interfere with the illusion of depth. In other words, the "secondary" or "extrinsic" properties are used as design elements aimed at giving visual clues about the "primary" or "intrinsic" properties of objects in the scene.

It is possible to see a correspondence between this popular 3D aesthetic and the typical 3D workflow, the first stage of which is to empirically analyse the scene and the objects within it. During the modelling and rigging stages an object is considered in terms of "primary" qualities, such as its dimensions and form, and, (if it is a character) its bone structure. During the texturing phase its "intrinsic" colour, specular roll off, surface reflectivity, etc, are all assessed. It is only later, during the lighting and rendering phase that the accidental "extrinsic" properties emerge. To build a detailed model in Maya is a long and tedious task, so whatever the required lighting context, it is usually designed to display all the hard-earned detail of objects within the scene.

By contrast, when sketching or painting a scene the qualities that primarily interest me are the particular, the context dependent, and the ephemeral: the so-called "secondary" or "extrinsic" qualities. These qualities provide the context in which objects and spaces are experienced. As Merleau-Ponty points out, it is only through the so-called "secondary" subjective qualities that we can arrive at an idea of objective "primary" qualities. In contrast to Descartes' (and Durand's) suspicion or dismissal of qualities considered as "merely subjective", for Merleau-Ponty the body is not a barrier between us and the world, but the means by which we are a part of it, and have access to it. According to Merleau-Ponty, if Descartes "had examined that other, deeper opening upon things given us by their secondary qualities, especially colour", he would have puzzled over "a conceptless universality and a conceptless opening upon things. He would have been obliged to find out how the indecisive murmur of colour can present us with things … in short the world" (Merleau-Ponty, 1964, p.172).

When working in 3D the emphasis tends to be on the general idea of an object rather than on specific instances or occurrences of it as encountered in everyday life. The following animation projects aim to reverse this tendency by taking the accidental or "extrinsic" properties of objects as the starting point and allowing them to dictate the tools and techniques used within Maya. As with the floodlit building created for "Drive", I did this by referring to my drawings and paintings for ideas on how to create a 3D scene.

My first experiment for this research project, **Cane Chair** (Fig.12), takes the context dependant information gathered in an observational sketch and arranges it in virtual 3D space. Incidentally, the painting **Chair Memory** (see Fig.2) is based on the same sketch.

Figure 12 Cane Chair sequence, 3D animation, 2002

I started by scanning the pencil drawing and then used Adobe Streamline to convert the tonal digital image into crisp vector line work. When imported into Maya this line work was automatically translated into a number of "CV" (Control Vertices) curves. I then created a virtual camera and aimed it directly at the flat plane of curves. While referring to the camera view to make sure that the 2D image in this view remained unchanged, I worked in the perspective viewport to move the curves' individual CVs along the Z-axis. I moved the CVs forward or backward in space depending on a rough estimation of the spatial position of each point that the original pencil line work was meant to describe. Eventually I had a network of three-dimensional lines roughly describing the shape of a chair. I then attached a Paint Effects brush to the curves, to give them thickness and simulate pencil line work when rendered. Animation of the camera is such that, at a certain point the depiction of a chair breaks down and becomes abstract line work. Having lost the original scene file, I recently replicated this experiment using Maya's new Toon Outline tools and introduced movement to the line work by animating Modifiers.

Figure 13 Cane Chair 2 sequence, 3D animation, 2006

Red Chair (Fig.15) also began with an image from my sketchbook, this time of a small-scale gouache painting (Fig.14). I scanned the image and used the Magic Wand tool in Adobe Photoshop to select contiguous regions of colour in the digital image. These selections roughly corresponded to the paint strokes evident in the original painting. I made ten layers in the Photoshop file and on each layer I filled a selected area with white and its inverse with black. I saved each of the layers out as black and white Tiff images to be used as Transparency Maps. In Maya I created ten NURBS planes spaced evenly apart, one behind the other. and assigned a Lambert Shader to each plane.

Figure 14 Red Chair sketch, gouache on paper, 2002

The full colour image of the painting was mapped to the colour and Ambient Colour attributes of each shader, and one of the ten different transparency maps to the corresponding shader attribute. Hence each plane showed different parts of the painting, and the ten planes together formed the complete picture. A camera was then animated moving through the planes. In order to counteract perspective and ensure that the fragmented image resolved into the complete picture, I also animated the position of the planes, making them move towards each other on the z-axis. An alternative to animating the position of the planes would have been to alter the size of each plane according to its distance from the camera (i.e. to make each plane larger than the one in front of it).

Figure 15 Red Chair sequence, 3D animation, 2002

Each of the two original chair experiments was completed in a day and both were successful in discovering ways of translating an observational pencil or paint sketch into three dimensions. Both animations contain a certain "a-ha" factor, as the moving vantage point reveals the scene's logic to the viewer. **Cane Chair** (Fig.12) begins with the depiction of a recognisable object that is broken down into textured abstract line work as the camera moves "too close". **Red Chair** begins with abstract coloured shapes, which resolve into a recognisable object as the camera moves backwards and the planes move together.

Poly Dog (Fig.16) explores another way of translating brush strokes into virtual 3D geometry. In this piece I created a number of three dimensional polygon shapes and positioned them in space to indicate the figure of a dog.
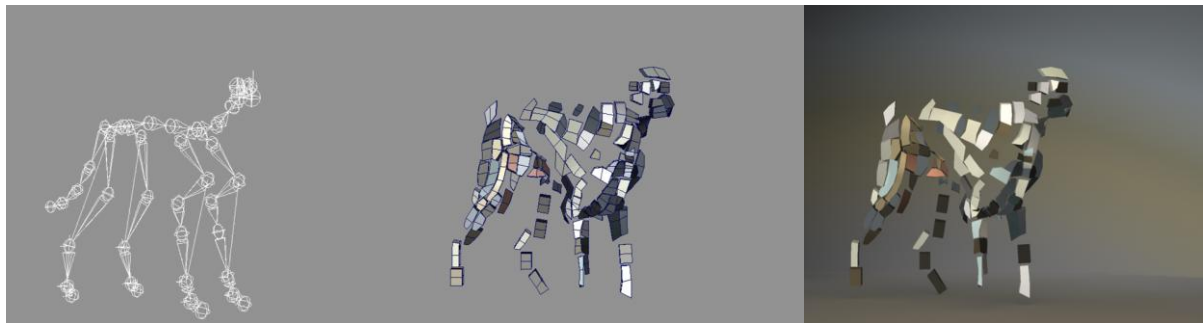
Figure 16 Poly Dog sequence, 3D animation, 2005

I used a reproduction of a painting I did several years ago in the Maya viewport

as reference (Fig.17). In **Poly Dog**, the polygon shapes are positioned across the X-Y plane and coloured to correspond with the daubs of paint visible in the original painting. They are positioned on the Z-axis to correspond with a low-resolution polygon dog model I also used as reference. The dog skeleton was built and rigged in the normal way, and bound to the polygon shapes so that movement occurs when the skeleton is animated.
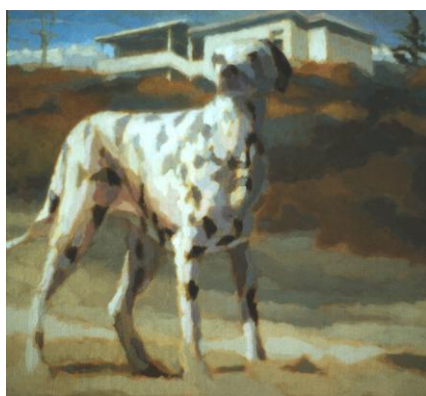
Figure 17 Beach Dalmation, oil on board, 2000

This experiment took a long time in comparison with the previous two, and I feel is not as successful in creating an engaging image. It seems too bound up in the default 3D aesthetic of "solid objects in empty space". To me, the painting on which the animation is based is more interesting (see Fig.17). In this image the shapes of colour depicting the dog interact with the shapes depicting the background elements (sand, sand dune, building). The dog is embedded in the background but also seems precariously poised, as if he might be about to move. In order to explore this interaction of figure and ground in the **Poly Dog** animation I would have to add polygon shapes to indicate background elements in the scene.

Chinese New Year is an animation I created as a television commercial. The client wanted a stylistic finish that isn't relevant to my discussion here, so for the purpose of this project I have reduced the coloured footage to black and white (Fig.18).

In making this piece my focus was on creating simple and suggestive line work, and then finding the simplest way to achieve movement of this line work. I began by creating a series of illustrations depicting objects in a calligraphic ink style using a graphics tablet and Adobe Illustrator. When I was happy with the simplicity of the designs, I used them as reference images within the Maya viewport. While animating, I discovered that the simplest way to achieve the required movement was often to manually keyframe the deformation of the line work across the picture plane. So **Chinese New Year** was created by animating 3D geometry and groups of curves in 3D space, as well as by animating flat line work across the 2D picture plane.

In the opening scene a viewer is presented with swinging lanterns, which eventually change shape to depict chopsticks and a fish platter (Fig.18).

Figure 18 Chinese New Year sequence, 3D animation, 2003

This transition is achieved by animating the line work across the picture plane. Likewise the transition from fortune cookie to fire crackers occurs in the 2D space of the picture plane (Fig.19).
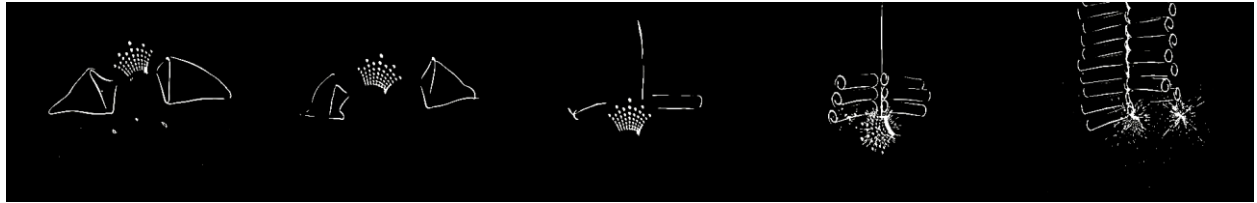
Figure 89 Chinese New Year sequence, 3D animation, 2003

In order to achieve these transitions I keyframed the X and Y-axis positions of the CVs controlling the shape of each curve. At the time of creating this piece Maya didn't have the same toon outline tools it currently has so the firecrackers' line work was created by making a number of cylindrical surfaces. Two surfaces were created for each cracker. Positioned one inside the other, the surfaces differ slightly in size, according to the desired thickness of the line work. The inner, smaller surface has a matte opacity of 0 and occludes the outer surface which has its Normals reversed (i.e. facing inside the model).

The fortune cookie was also created by animating the position and rotation of lofted curves across the X-Y axis (the picture plane) (Fig.20).

Figure 90 Chinese New Year sequence, 3D animation, 2003

First I created and animated basic fortune cookie geometry and used it as a reference for the location of the line work (i.e. the position of the lofted curves). To create the Chinese dragon I experimented with ways of depicting a dragon in sparse, suggestive line work. When I was happy with the design of the dragon in Illustrator, I created similar curves in Maya. I grouped the curves of the mouth, moving the pivot point to the base of the jaw, and put this group within the group of head curves. The CVs of the tail curves are each Clustered. A Lattice Deformer controlling these clusters

is bound to a skeleton running the length of the tail like a backbone. This skeleton is controlled by a Spline IK and each of the CVs of this spline IK is a Soft Body. This set-up allowed me to animate the position of the head and have the tail follow with a flowing movement (Fig.21). **Chinese New Year** uses Maya's Particles to achieve the sparks and smoke effects.

Figure 21 Chinese New Year sequence, 3D animation, 2003

Like the previous three experiments, **Chinese New Year** explores the area between abstraction and figuration. In most instances we see *through* the line work to the objects depicted. In the transition sequences the calligraphy momentarily loose its illusory quality and becomes moving abstract shapes. Once these shapes have sufficiently indicated another form they become "transparent" again. In **Chinese New Year** there is an ongoing interplay between abstraction and figuration, between the fact of the 2D picture plane and the illusion of depth.

Figure and Ground

"*Every object that is perceived belongs to a field of other objects which are not perceived.*" (Scott, 2002, p.1)

In the early 20th century Gestalt psychologists developed the concept of "figure and ground". They noticed that, when presented with a visual image, we tend to separate a dominant shape (a figure) from what our current concerns relegate to background (or ground). The figure/ground distinction is one of several laws of perceptual organisation outlined by the Gestalt psychologists. Each of their principles reinforces the idea that the world is not simply and objectively "out there" but is constructed in the process of perception (Gordon, 1997, pp.64-66).

As soon as you create a piece of geometry in 3D it is a figure (an object of focus) against a ground (the viewport background, which is typically a flat grey colour). When working on a complex scene, Maya provides various ways to "hide" or "template" objects so that the one being worked on is the centre of focus. Each object is therefore worked on as a figure out of context of its (back)ground. In everyday perception, figure/ground distinctions are ambiguous. A background element (even a negative space) may become a figure before being lost into the ground as another figure is found. **Cube Threshold**, **Cube Threshold Line** and **Man Threshold** are short animations that explore the point at which figure/ground distinctions are made and lost.

In contrast to those described above, these three experiments use the normal 3D workflow; i.e. objects are created in their entirety, they are then animated, lights are added to the scene, and finally it is rendered through a virtual camera. **Cube Threshold Line** and **Man Threshold** use After Effects compositing software to apply filters to standard 3D generated footage.

The simplest thing to do in 3D is to create a NURBS or Polygon "primitive". **Cube Threshold** (Fig.22) began with the creation of a polygon cube: "Create > polygon primitives > cube". The rotation of the cube was then animated 360 degrees around each axis, and a spotlight positioned to illuminate it from the upper right hand side. The scene's background colour was set to mid grey. At a point halfway through the cube's rotation, I tweaked the tone of its default grey shader until each of the cube's visible faces (as seen through the camera) was the same tone as the background colour. For this frame of the animated sequence, the figure (cube) disappears into the (back) ground.

Figure 22 Cube Threshold sequence, 3D animation, 2003

Cube Threshold Line (Fig.23) was created by importing the rendered **Cube Threshold** image sequence into After Effects and applying a Find Edges filter. In this way the tonal information was converted into line work. **Cube Threshold Line** is more abstract than **Cube Threshold**, making the 3D cube slightly more difficult to discern.
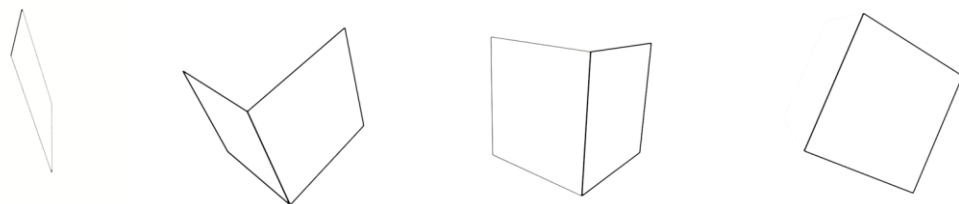
Figure 23 Cube Threshold Line sequence,

3D render with After Effects Fine Edges applied
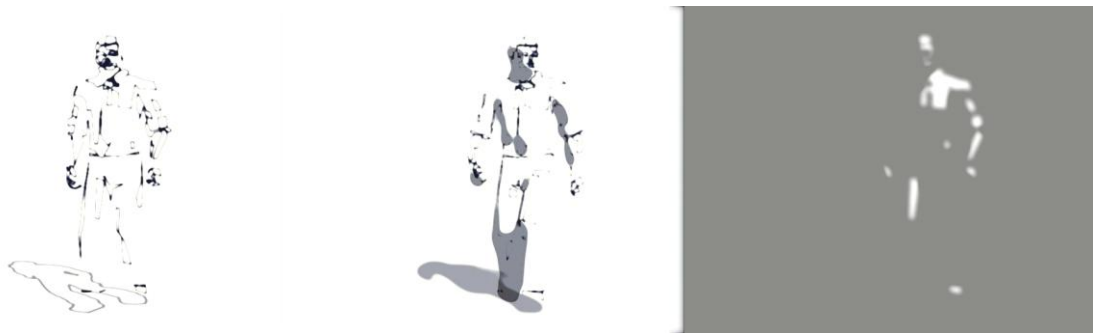
Figure 24 Man Threshold sequence, 3D renders, various After Effects applied

Man Threshold (Fig.24) is basically a repeat of **Cube Threshold** using more elaborate modelling and animation techniques in Maya and further exploring compositing techniques in After Effects.

A surprising outcome of these experiments is the discovery that once the figure has emerged it remains present in our perceptual experience even when it has visually subsided. This is best illustrated when the movie is shown as a loop. It would be interesting to repeat this experiment with a series of slightly different animations, each one presenting a reduced amount of visual information and an extended duration of the figure's disappearance.

Maximum Grip

"I never experience the light as a determinate amount, according to Merleau-Ponty. Instead, I see, in a direct bodily manner, how the light would have to change for me to see the colour better." (Kelly, 2005, p.85)

"… it is part of my visual experience that my body is drawn to move, or, at any rate, that the context should change in a certain way …" (Kelly, 2005, p.87)

Often imagery as it is rendered straight out of Maya is visually constant with no sense of the eye having to work to gain information. In this sense it seems to present the viewer with an "optimal body-environment relationship" (Dreyfus, 2005, p.138). **Photoshop Ball** applies various Photoshop filters to standard 3D generated footage in order to explore the account of perception which says that part of our experience of seeing objects is *how well* we see them (Fig.25 & Fig.26).

Figure 25 Photoshop Ball sequence, 3D renders with various Photoshop filters applied
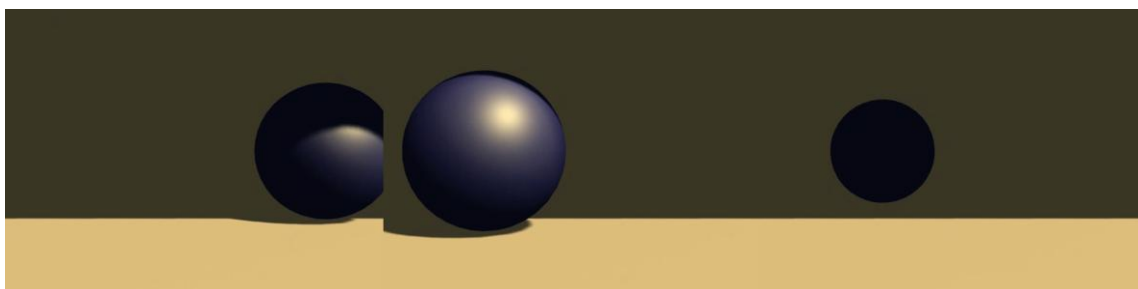
Figure 26 3D renders before the application of Photoshop filters

This experiment uses a very simple Maya scene, comprising a sphere, a plane, and a couple of cubes. I added a few keyframes on the sphere's rotation and translation, and simple lighting and no texturing. This took only a few minutes. After rendering a sequence of image files I opened one of them in Photoshop and used various tools and filters to "mess the image up" and introduce a random element. I applied several Blur, Adjust Levels, and Spatter Brush Stroke filters while recording the image editing process as an Action. Using Photoshop's Batch Processing function, the effects were then applied to each frame of the sequence. Because of the random nature of some of the filters used, as well as the fact that each frame is processed separately, the final footage seems to "jump around". This effect is similar to film grain, which is considered by experimental filmmakers, such as Stan Brakhage, to approximate the visual "noise" perceptible in a dark room or when we have our eyes closed.

In **Photoshop Ball**, as the ball rolls towards the camera and out of shadow it becomes overexposed, and when it moves away from us and into shadow it is underexposed. This less-than-perfect exposure and the flickering noise effect combine to ensure that the "intrinsic" properties of the ball are not the most visually apparent aspects of the scene. For example, it would be hard for a viewer to distinguish the "intrinsic" colour of the ball. Even its exact size is difficult to grasp because the crescent of shadow moving across the ball is a more distinct shape than its circular contour. This experiment took about half an hour in total and I am intrigued by the results. It seems to me that the Photoshop batch process added a degree of visual interest to the untreated Maya renders which could be explained by the account of perception that says part of our experience of seeing objects is *how well* we see them.

In Merleau-Ponty's account of embodied perception we are always tending toward "maximum grip" (Dreyfus, 1996, p.1), which means that we are compelled to get the best possible view of the thing perceived. Our perception of objects is experienced as a deviation from this "maximum grip" or desired norm. "When we perceive things … we are constantly sensitive not only to what we perceive, but also, and essentially, to *how well* our experience measures up to our needs and desires" (Kelly, 2005, p.97). In the roughed up, harshly lit **Photoshop Ball** footage the sense of how the scene, or our bodies in relation to the scene, would have to change in order for us to get a better "grip", forms a significant part of our perceptual experience.

Perhaps we experience some kind of bodily involvement and are compelled to seek change. If we want to assess the colour of the ball then our eye automatically tries to find an area of its surface seen under optimum lighting conditions. That area is difficult to pin down and possibly doesn't exist, making it hard to distinguish the "intrinsic", constant colour of the ball. So our experience of this scene includes a sense of how the lighting would need to change for us to see the colour of the ball better. In contrast, the visual experience of the untreated footage, in which the colour and shape of the ball are clearly defined, involves a minimum of deviation from the desired norm and therefore little tension or compulsion to act.

Presence as Access

"Phenomenologically, the world is given to perception as available, or as accessible." (Noe, 2006, p.14)

We can shift our attention from one aspect of a scene to another, or move around objects in order to see features relevant to our current needs and desires. The extent of our physical ability to do these things informs our perceptual experience. This means that there may be aspects of a scene that are not currently part of our visual field, but which are still perceptually present because we feel we could see them if we tried.

In **Saltram** my aim was to create a minimalist style that presents the viewer with a visually rich experience, exploring the premise that there can be more detail perceptually present than is actually given. In this animation there are no outlines and an object's colour is often not discernable from the adjacent background. Despite this, each object's contours are perceptually present to the viewer because the sense is that they are available. In another example, there is a large wall of foliage presented as one large dark shape. If a viewer senses that they could adjust their vision to discern detail within this silhouette then they may experience it as a number of smaller trees instead of one large shape.

The first stage in the creation of **Saltram** involved producing a number of pencil sketches, then arranging them to form a detailed storyboard (Fig.27).
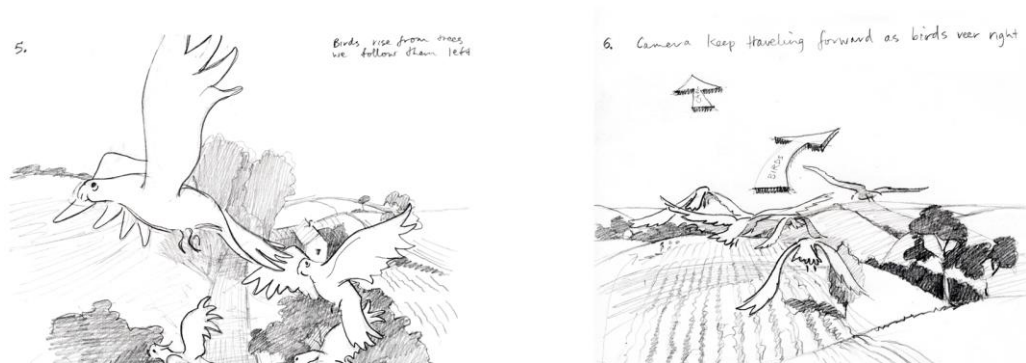
Figure 27 Saltram storyboard images, pencil on paper, 2003

To eliminate the graphite texture and extraneous tonal information in the sketches, I then used Adobe Illustrator to translate them into three-tone vector graphics (Fig.28).

gure 28 Saltram vector graphics created in Illustrator, 2003

This stage also allowed me to experiment with the exact level of information to be presented to the viewer. During this process I broke the picture down into shapes and asked myself which category a particular shape fell into; which of the three tones it should be. The aim was to create a matrix of interesting 2D shapes through which three-dimensional objects can be recognised.

Figure 29 Saltram visual style images,
created in Photoshop using a variety of image editing techniques, 2003

At the same time as working on the tonal artwork, I used Photoshop to develop a number of possible visual styles for the piece (Fig.29). This process involved using Photoshop Layer Styles, with a variety of Photoshop filters. The tonal images where applied to various layers as a Layer Mask. In the final style, as chosen by the client, coarse paper was used as a base texture, and in addition to three ink tones (off-white, brown, and dark sepia), the clouds and rays in the sky were given an embossed paper look.

Once all the design work was complete I began building the scene in Maya. My first animation tests involved flying a camera over a flat plane on which were placed low-resolution stand-in objects to give a sense of scale. I soon realised that I couldn't achieve the intimacy of the initial storyboard vignettes by laying out the landscape along the X-Z axis "as it actually is". Better results were achieved by radically accentuating the curve of the earth and making the landscape spherical in shape. This meant that objects arrived and left our field of vision in a more abrupt fashion. As with the development of the tonal images, my aim was to keep the Maya scene as simple as possible (Fig.30).
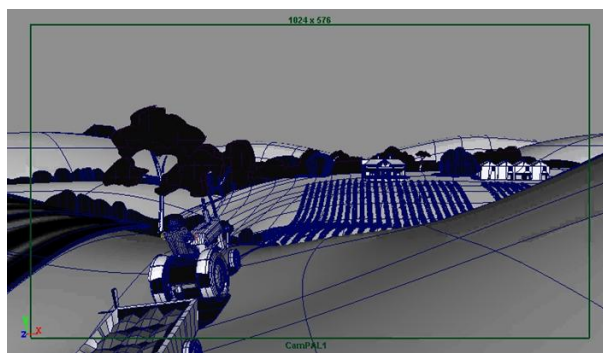
Image 1 All shadows and highlights created using black, white or grey geometry
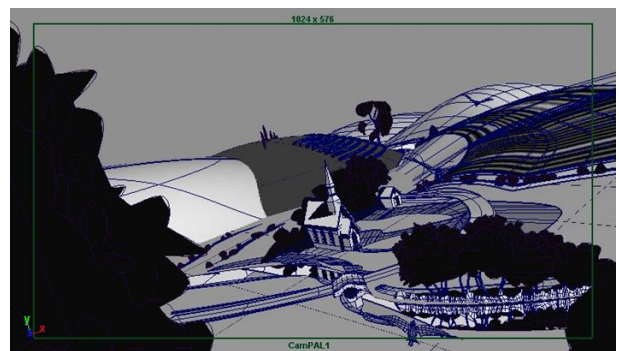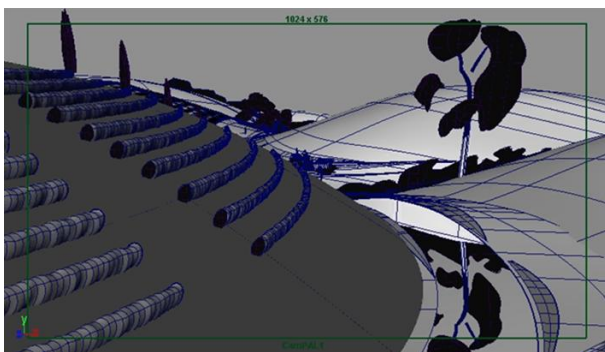
Image 2 & 3 Reflections created by duplicating and inverting models

Figure 30 Saltram stills

I made the decision to exclude lights from the scene and to describe an object's shadows and highlights using black, white, or grey geometry (Image 1). There were no "true reflections", so those seen in Saltram were built forms (Image 2). The reflected church, bushes and trees are geometry that has been duplicated and inverted (Image 3).

As the camera moves toward the tractor climbing the final incline, the colour of the hillside on the right changes from a solid tone to thin lines describing the furrows of a ploughed field (Fig.31).

Figure 310 Saltram, rendered sequence showing animated hillside texture

This was achieved by animating the texture map applied to the hill geometry, and is intended to replicate the way our vision might pick out the detailed shadow lines only as we draw nearer to the field. It also eliminates the common 3D animation problem of a finely detailed texture map that "buzzes" when seen from a distance. The birds were created in the manner of most conventional 3D characters. They were built symmetrically and in a "relaxed pose" and the flock was created by duplicating the original.
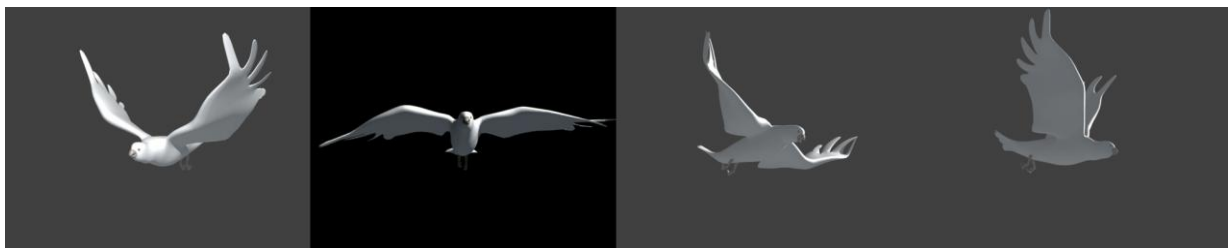
Figure 311 Like most 3D characters, the Saltram bird was built symmetrically and in a relaxed pose.

In order to achieve the chosen visual style on the full 750 frames of footage, it was necessary to create a Photoshop action so that the image editing process could be automated using Photoshop's batch processing capability. On completion of modelling and animation, I rendered out two sequences of images: one sequence containing the grey and black areas, and the other with the embossed sky elements. I wanted to use each of these images as a separate layer mask in Photoshop. In order for each of the

images to be accessible to the batch process, I found it necessary to combine them into one file. Using After Effects' Set Channels effect, I created Tiff images with one rendered sequence in their red channel (Fig.33), and another in their blue channel (Fig.34 & 35).
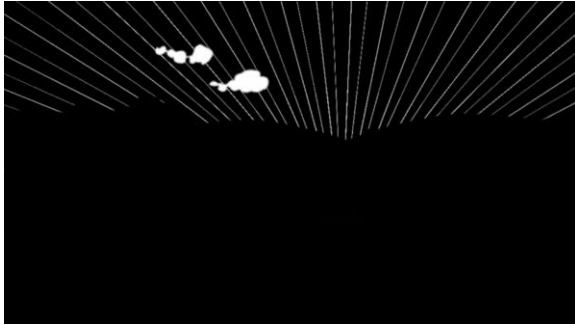
Figure 123 Saltram, render of embossed sky elements

Figure 34 Saltram, render of grey and black areas
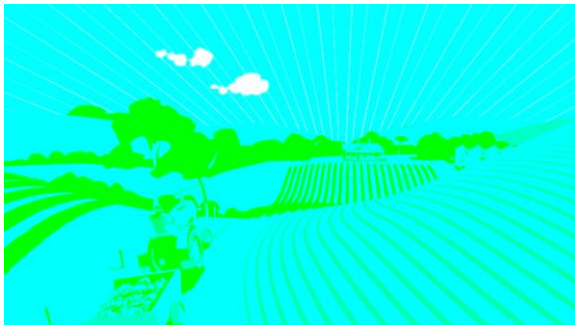
Figure 35 The above two renders combined inin one Tiff image file.

Figure 36 The final frame after the renders have been combined and edited in Photoshop

I then recorded an action in Photoshop that opened each Tiff file in turn, along with the paper texture file. Through a series of filters, lighting and embossing effects, layer masks, and general image editing techniques, each frame of the final footage was created (Fig.36).

The fact that the scene has no lights means that the landscape is spherical instead of flat, and I used a number of unconventional modelling and texturing techniques, meaning that the individual vignettes within the animation don't have to obey an overarching logic (e.g. precise mathematical perspective or algorithms replicating the physics of light and shadow). This allowed me to focus on presenting aspects of objects as they might be visually encountered: inconsistent and incomplete.

33

Perception of Detail

"Perception does not arrive all at once … as of the sixtieth of a second in photography." (Nelson, 2003, p.1)

When we experience a detailed scene we never see all the detail at one time as a camera does. According to the idea of presence as access, even if we never perceive all the detail in a scene, we may still experience the scene as densely detailed. The unseen detail is somehow present because we feel that, if we chose to, we could shift our focus, move our eyes, turn our head, and we would see more detail.

Suitcase is part of a larger animation project in which I collaborated with five others to create a music video clip that combines 3D animation and live action footage. Since creating the clip I have worked further on the footage to explore the nature of the perception of detail. Creation of the music video involved camera tracking and image editing techniques that aren't relevant to the current research project.

In everyday vision our eyes shift over a scene, bringing various details into consciousness according to our needs and desires. **Suitcase** represents the way human vision might scrutinize aspects of an object. The movie presents the detailed texture of the suitcase rising and falling, flowing across the form in the manner of underwater caustics. Detail of the whole case seems to be perceptually present even though only limited aspects are given at any one time.

To create this piece I began by photographing a suitcase from a three quarter angle. Using this image as a 2D reference in Maya I created some very simple polygon models representing the body and handle of the case, and created a simple texture for the case based on a perspective projection of the photograph. I animated the position and rotation of the case and rendered a sequence of full colour images (Fig.37).

Figure 37 Suitcase, render of full colour image, 2004

I then assigned the case a new shader with an animated Fractal Noise texture assigned to its colour and ambient colour attributes as a projection, and rendered the sequence again (Fig.38). This sequence simulates the look of caustics on an object as seen underwater.
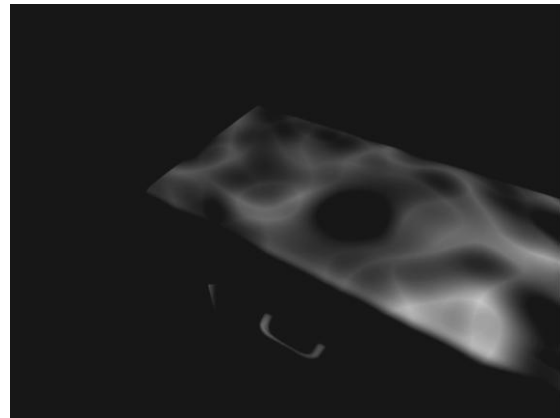
Figure 38 Suitcase, render of fractal noise texture, 2004

Assigning a Z-depth shader to the case, I rendered the sequence for a third time (Fig.39). I imported all three sets of images into After Effects along with the background footage. Using the black and white caustics and Z-depth renders as track mattes, I duplicated and edited the full colour rendered sequence several times. I animated a number of After Effects affects, including Tint, Blur, and Adjust Levels to create the rising and falling of detail seen in the final movie (Fig.40).
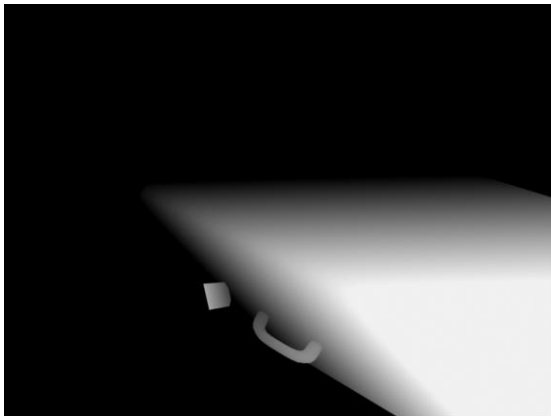
Figure 39 Suitcase, render of Z-depth image, 2004
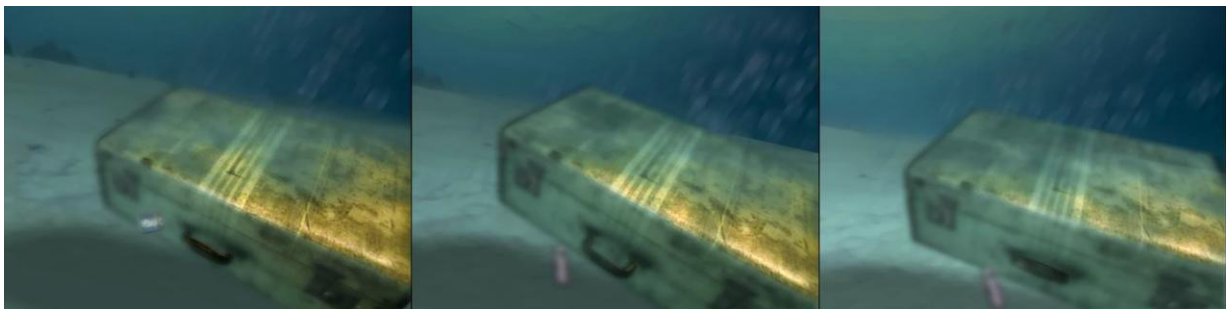
Figure 40 Suitcase sequence, 3D animation and live action footage, 2004

Oil Rig is another animation in which I experimented with the possibility of detail being perceptually present yet visually absent. In contrast to **Suitcase**, where I textured and rendered the case in detail and then lost information via the compositing process, in **Oil Rig** I wanted to create a model in Maya that represents "an object rich in detail as seen from a great distance".

Oil Rig is one of the first sequences I created for the **Plant to Plant** animation that is described in more detail below. Among my source material for this project were hundreds of high-resolution photographs of the Woodside LNG plant and surroundings. As I studied photos of various oil rigs I felt overwhelmed with the task at hand. The last thing I wanted to do was reproduce the topology of this elaborate piece of equipment. Even in the reference photos, which were taken from a helicopter and therefore dwarf the architecture and reduce it to two dimensions, I could not visually comprehend its complexity. I wanted my final piece to show this fact, that the eye cannot fully capture, but is aware of, the richly detailed topology. I wanted the rendered image to allude to complexity and yet to be derived from a simple form.

Based on the photographs, I drew a basic floorplan of an oil rig and used it as a reference image in Maya to create a simple polygon object (Fig.41). This model was

created as a three-dimensional canvas on which to paint, rather than as a virtual replica of an oil rig. After organising the model's UVs using Maya's Automatic Mapping, I used the 3D paint tool to paint light and dark shapes on the low-resolution polygon model.
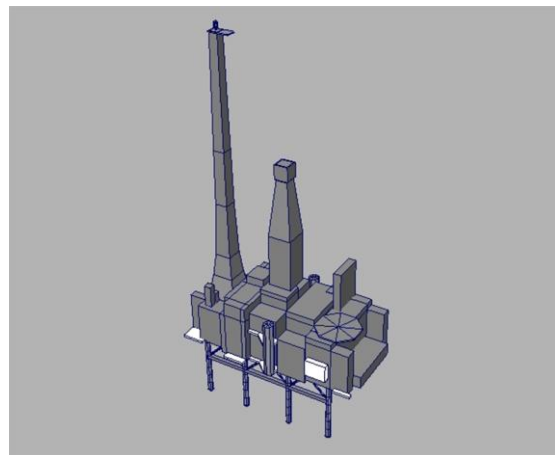
Contemplating how to paint the model, I took into account the scale of the oil rig and the fact that it would be perceived from a great distance, and decided that a viewer would notice only areas of high contrast. I studied the photographs and noted which bits of the rig "jumped out at the eye". Some areas of the map I created were

low-resolution, causing the image to "stretch". To remedy this I opened the 3D paint texture in Photoshop and applied a Paint Daubs filter (Fig.42). I also created a transparency map so that any areas I hadn't painted would allow the background to show through (Fig.43). This created a degree of visual confusion that replicates the way contrasting shapes might flicker against each other in harsh sunlight.
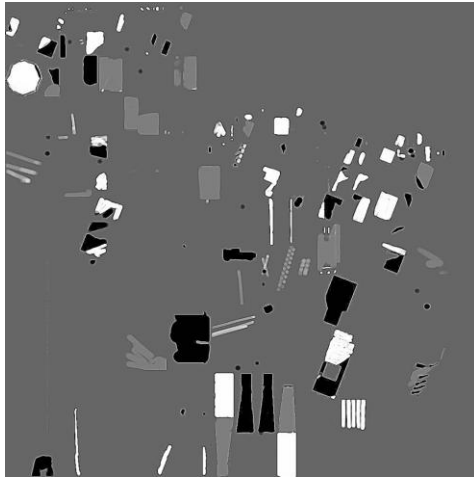
Figure 42 Oil Rig, colour map with Photoshop Paint Daubs filter applied, **2006**

Figure 43 Oil Rig, transparency map, 2006

After some experimentation, I applied an animated paint effects brush to the geometry to pick out some outlines of the form. To create the oil rig's reflection I duplicated the rig geometry, scaled it -1 about the y-axis and applied a different paint effects brush. In both cases I rendered the animated brush with the visibility of the geometry turned off. The rig's shadow on the ocean surface is a dark shape painted onto an otherwise transparent grey NURBS plane (Fig.44).

Figure 44 Oil Rig, ocean transparency map, 2006

As in later seascape scenes of **Plant to Plant** (see Fig.50), the vast ocean and sky are suggested rather than created as built forms within Maya (Fig.45).
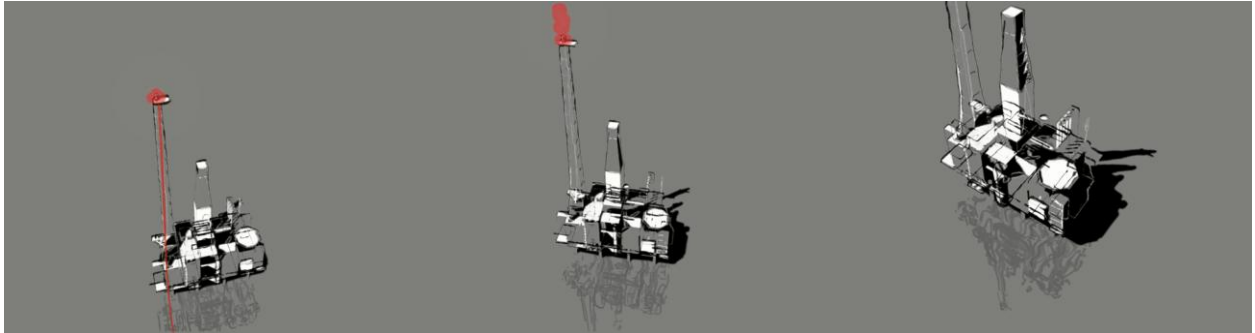
Figure 45 Oil Rig sequence (excerpt from Plant to Plant), 3D animation, 2006

Perception of Space

Produced in collaboration with Pia Ednie-Brown and Jeremy Yuille, **Bio-See** is designed to be an advertisement from the future. It was commissioned by Experimenta, who called for 25-second advertisements for their show, "The House of Tomorrow". The advertised product is a face powder that induces synesthetic modes of perception in the wearer. The idea is that diverse information from both intimate and distant sources (such as economic data, temperature, pulse rate, air flow, weather etc) affects the way the world is seen by the wearer of "Bio-See" powder.

Bio-See opens with a face emerging from a neutral grey ground with a puff of powder, followed by camera moves replicating the character's visual interrogation of a domestic breakfast scene (Fig.46).
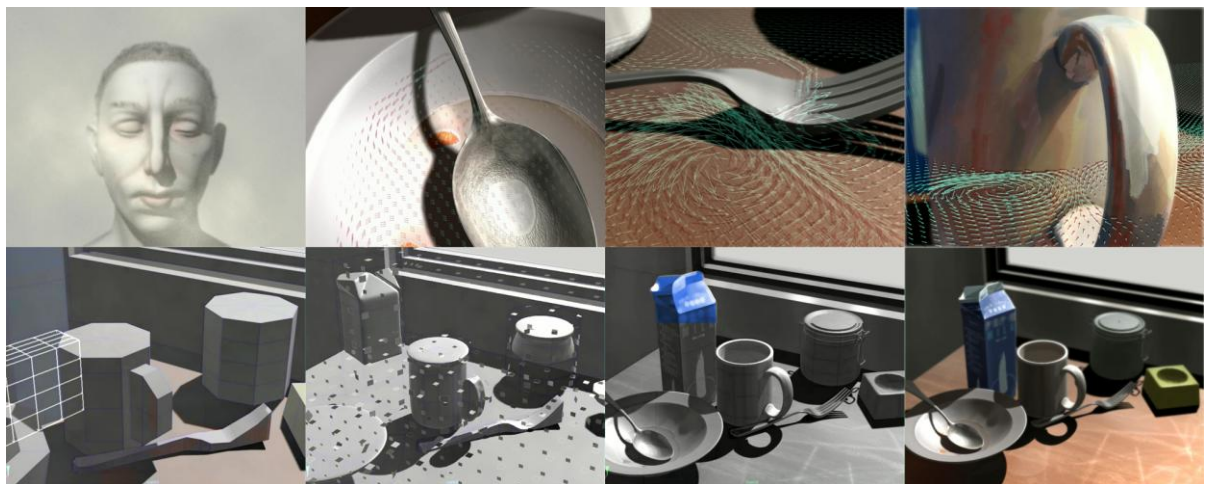
Figure 46 Bio-See sequence, 3D animation, 2003

Hundreds of tiny arrows fill the cereal bowl, swirl across the tabletop and around the coffee mug, indicating her awareness of the flow of air around these forms. Part of her perception of the cup is the fact that she could reach out and grasp its handle or feel the warm contours of its sides. Representing the layers of knowledge that she is implicitly aware of, the table scene is depicted in a variety of different

styles. First, the size and position of a wireframe primitive is animated to indicate her appraisal of the items as architectural forms occupying space. Presented as larger, low-resolution models, the presence of each object extends beyond the borders of its (high resolution) form. Each facet of these objects then shrinks to reveal models of the negative spaces inside them. This indicates that the character's perception of the milk carton includes the fact that she knows it is half empty, and she knows how much more coffee she could fit in her mug. Next, a tonal image of the high-resolution models is introduced and is quickly tinted by blocks of flat colour. Blue sweeps over the milk carton, brown over the tabletop etc. These colours represent each object's constant colour that she is aware of beyond the accidental lighting context. Over this image slides the variant or "extrinsic" colour, at which point the image approaches a photo-realistic style.

Descartes developed the Cartesian coordinate system that forms the basis of 3D animation software. The Cartesian grid has three axis — x, y and z — representing height, width and depth. In this mathematical model, space is an empty container within which any point can be described as a set of x, y, z coordinates. This spatial paradigm is so embedded in western thought that it just seems like a practical and accurate way of describing the way the world is. But there are other ways of thinking about space. For Merleau-Ponty the Cartesian coordinate system and mathematical perspective don't describe the way we experience space in our everyday lives. He says that distance is perceived, not as a mathematically measurable amount that increases or decreases, but as a tension which fluctuates round a norm. For him, space is not homogenous, and the way we perceive the dimensions of an object, or our distance from it, depend what we perceive that object to be.

Despite its futuristic theme, **Bio-See** could be interpreted as an attempt to visually represent space as it is felt. Generally it explores the interaction between vision and knowledge; the way that our perception of an object includes our knowledge of what it would take to reach out and touch or hold it, as well as the spatial relationship between it and other objects.

Making this piece was a laborious process. The bulk of the film was created using the default 3D workflow, which means that I spent many hours modelling and texturing each object in isolation. The face, tabletop, and cereal bowl are polygon models with relatively complex materials assigned (i.e. each material has a colour map,

bump map, specularity map, etc). When I was happy with the level of detail in each model, I brought them together in one scene, arranged them in space and added a number of lights to simulate sunlight through the window. The most successful part of the animation is the arrows swirling across the tabletop and around the coffee mug. To create these, I used Maya's Fluid Effects tools, which were designed to create visual effects such as smoke, fire, or swirling liquids. Within the Maya interface a fluid container's dynamic properties can be represented visually in several different ways, one of which is as directional arrows. These arrows are designed as visual information for the animator and are not intended to be used in the final footage. Positioning the fluid container around low-resolution versions of the bowl, fork and cup geometry, I animated an Emitter so that the arrows seem to interact with these objects. The Maya Hardware Renderer was used to render a sequence of Tiff files that were then composited over the software rendered image in After Effects. These interface artefacts, which were designed as a way for the 3D user to visualize dynamic information, seem to fit the theme of the animation.

Bio-See manages to visually represent the positive presence of "empty" space, but it is still bound by the strict laws of mathematical perspective and represents form in a conventional manner. **Saltram,** with its large areas of flat colour, is more successful in escaping the confines of precise pictorial perspective.

Parts Make Up a Whole

"[Tonkin's paintings] translate the organic experience of seeing, which is not satisfied with the accumulation of isolated perceptions (detail) but rather lives in their connexions." (Nelson, 2003, p.1)

"For the phenomenologist, the objects of ordinary, naïve experience are the things themselves, given as meaningful wholes rather than as isolated qualities." (Moonie, 2005, p.10)

"Once again we see that the whole is different from the parts studied in isolation." (Gordon, 1997, p.69)

The empiricist or scientific worldview breaks everything down into measurable parts. Empiricists think that our perceptual experience is composed of sense data; that our experience of the world is as science describes it, piece by piece. According to this view, it is our judgments that put the pieces back together to form a whole. Empiricists would say that when we see an apple we see its size, we see its roundness, and we see its green colour, then we piece this information together to experience the whole green apple. According to phenomenologists, on the other hand, although we can adopt an attitude where we visually focus on its shape, its size, or its colour, this is not normally how we experience an object. We generally don't perceive an object's shape or height separately from what we perceive it to be. Normally we encounter an apple as a whole green apple not a collection of attributes or sense data (Moonie, 2005; McClamrock, 1990).

The working procedure of 3D encourages the content creator to think of a visual whole in terms of its component parts. In order to create a 3D scene it is first broken down into objects, then each object is analysed as a collection of attributes, and each of these attributes is composed of a sub-set of attributes. The idea of "realism" in 3D seems to be all about adding more and more parts; more objects with more detail. In the words of Jean Detheux, an artist who has moved from traditional to digital tools, "I am constantly amazed at the vast amount of work that goes into trying to (re)create a whole by adding parts!" (Nagel, 2001, p.1).

In contrast to the atomism of empiricism, in my project work I tried to work from the general to the particular (as I do when making paintings). My focus was on keeping the overall impression of the scene at the forefront of my mind and not obsessing about isolated parts. In the larger projects — **Chinese New Year**, **Saltram**, **Plant to Plant —** I tried to do as much work as possible on paper before using the software. I found that I got the best results by developing a storyboard and visual style for images before creating a Maya scene file. Once inside Maya, I referred to these images constantly in an effort to avoid the temptation to approach the scene as a simulated reality. In **Bio-See** I fell into the trap of obsessing over the parts. In the other projects my desire was always to keep the scene simple and create only the visual information necessary for the desired impression.

Drawing in 3D

"Science looks at things from above, painting immerses the viewer in the world on view. The painter does not depict representations in his mind but paints with his body which is mingled with the perceived world." (Jay, 1993, p.143)

"Aside from the arms, hands, eyes and brain, it is almost a nuisance to have a body when one is working with a computer." (Pryor, 1990, p.1)

As these two quotes imply, there is a difference in the way an artist interacts with the world through the medium of painting, and through the use of the computer. When painting or drawing it is easy to conceive of the making process as a conversation between the materials, the artwork, and my whole body (my arms, eyes, mind, etc). I make marks on a surface and the movements of my body are directed, in part, by the emerging image.

The Story Continues is a charcoal animation that I created in 1996 using a method similar to that developed by South African animator William Kentridge. An A3 piece of paper was pinned to the wall in front of a super 8 camera, which was set on a tripod about 1.5 metres away. The process of animation involved creating and changing a charcoal drawing (using various erasers, rags, and sometimes smudging with my hands), then exposing a couple of frames of the super 8 film. To achieve the correct exposure, I worked under hot spotlights, and in order to achieve convincing movement in the final footage I had to work quickly. The process involved rubbing out and redrawing parts of the image then spinning round and squeezing the camera's trigger release, then turning back to the image to change it a little more. Working like this for hours was physically demanding. I soon fell into a rhythm and worked up a sweat.

The animated forms on the page came directly out of this working method. For example, the bird seemed to emerge out of the page (Fig.47). I made no conscious decision to create a bird, have it fly toward the camera and then turn around. It seemed to arrive of its own accord, somewhere between thinking and making.

In contrast to this example of a hand drawn animation technique, when working on the computer the physical involvement is limited to small movements of the hands and arms. A variety of new input devices have been developed but currently most people drive 3D software with a mouse, a keyboard, and or a stylus. Whether moving vertices around on a polygon model with movements of the mouse, painting "skin weights" with a stylus, or using the keyboard to enter location coordinates or write an expression, working in 3D feels like a very rational process. I am yet to have experienced "losing myself" in a "conversation" between body, tools and materials, as I have when working with the tools and techniques of drawing and painting.

While animating with charcoal and paper I immediately saw the results of each mark I made. In contrast, as a user of 3D animation software, what I see is not what I get. The image I work with in the viewport is only an indication of what the final rendered image will look like. Each frame of a 3D animation must eventually be rendered, which takes seconds, minutes, or days, depending on the complexity of the scene. The extent to which the final render differs from the viewport image depends on the tools and techniques used to create the scene. Generally speaking, the more the 3D scene uses simulations (such as Maya's dynamics), or automation (such as expressions, Plugins, etc) the more visually removed the viewport image will be from the final render. Also, although computer processors and graphics cards are becoming more powerful, there is still a point in every project where the scene becomes "heavy", making the program's response to user input sluggish, and making computer crashes more common. This can be overcome by using stand-in low-resolution geometry while developing a scene, (substituting it for high-resolution objects in the final render), or by hiding objects until the final render. Both methods obviously increase the visual distance between the viewport image and the final render.

Figure 47 The Story Continues sequence, charcoal animation, 1996

For these reasons, when creating a scene, it is necessary to project forward to an idea of what it will look like. To again use the analogy of a conversation, this is equivalent to saying something and then continuing to talk based on assumptions regarding the nature of the response. Perhaps this is why it seems hard to surprise yourself with 3D animation. For it to be usable, computer software has to produce predictable results.

Many of my experiments explore ways of using hand painted or drawn imagery within a 3D scene. **Red Chair** and **Bio-See** use paintings as texture maps; **Cane Chair** translates a pencil sketch into a number of Maya CV curves; **Saltram** uses a scan of coarse paper to add background texture. These techniques were successful in their attempts to emulate the appearance of a hand-drawn look, but they don't address the issue of bodily interaction and a conversation with the tools and materials. This is an issue I attempted to address in the animation **Plant to Plant.** In this animation I tried to find ways of interacting with the software that were equivalent to using a pencil and paper: ways that were immediate and easy. In addition to the techniques used in prior projects, I aimed to approach the 3D scene as I would approach a drawing.

Plant to Plant (Figs 48-53) was commissioned by David Lancashire Design to be displayed in the visitor's centre located at Woodside Petroleum's North West Shelf gas plant in the north of Western Australia. The finished animation is projected onto a wall as a two metre high image. The soundtrack for **Plant to Plant** was created by West Australian sound artist Cathie Travers. The purpose of the animation is to tell the story of the formation of petroleum, and the extraction, treatment and export of LNG. I spent several weeks researching the subject matter with the help of a chemistry teacher and a geologist.
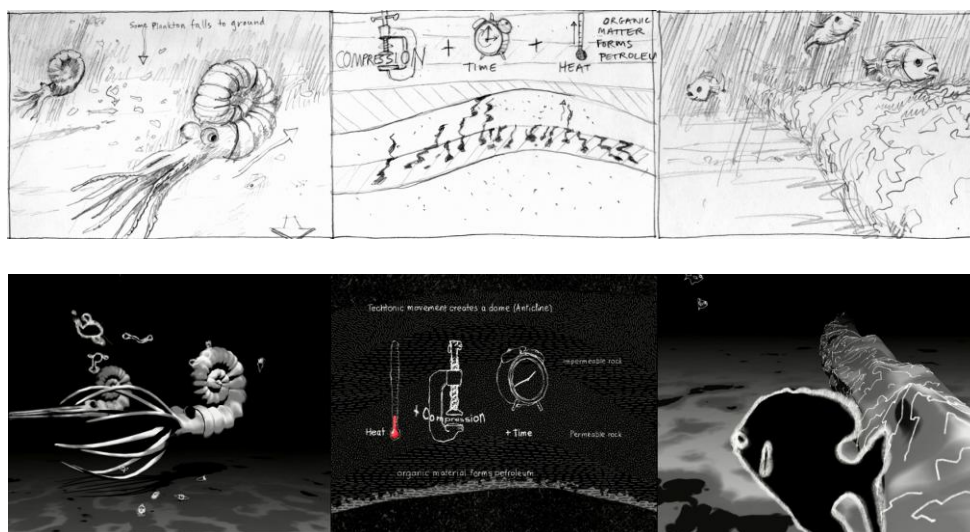
Figure 48   (top) Plant to Plant storyboard images, pencil on paper, 2006
(bottom) Plant to Plant sequence, 3D animation, 2006

The medium I find easiest to work with, and most direct, is pencil and paper, so I used these tools to create a storyboard. My focus was on getting a large amount of information across quickly and simply, while also creating aesthetically pleasing pictures by following traditional rules of composition (i.e. the rule of thirds, etc). After a series of changes, the storyboard was given the client's approval. It took four months to complete **Plant to Plant**, during which time I continually returned to the storyboard imagery for guidance on how to approach the 3D scene. I wanted to avoid using the default 3D workflow, which is time consuming and which I felt could result in the addition of superfluous detail to the animation. Drawing is commonly used as a preparatory medium by artists, but I approached **Plant to Plant** as a three dimensional temporal drawing and I wanted the final animation to retain an incomplete, provisional feeling.
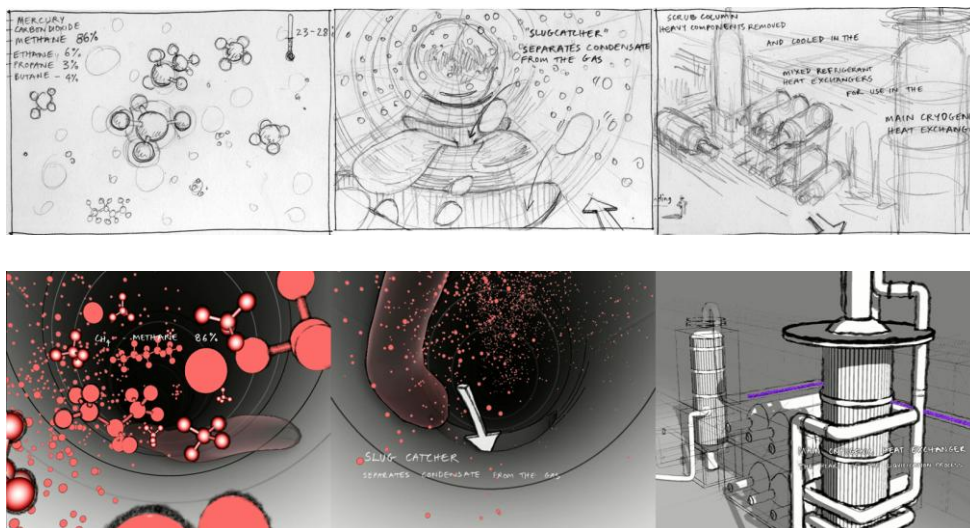
Figure 49   (top) Plant to Plant storyboard images, pencil on paper, 2006
(bottom) Plant to Plant sequence, 3D animation, 2006

A common way of beginning a drawing or painting is to start with a mid-tone ground and coax out forms by adding darker and lighter areas. Approaching **Plant to Plant** in the same way, I used a three-tone palette of black, grey and white, with the mid-tone (grey) as the background colour for most of the scenes. I made a decision on which areas should be white and which should be black according to the abstract properties of the shapes, as well as their power to conjure the illusion of form (much as I did with **Saltram**). Thinking of the animation as a moving sketch meant that I didn't try to "fill in" the frame, I only thought about how and where to make black shapes and white shapes to indicate forms.
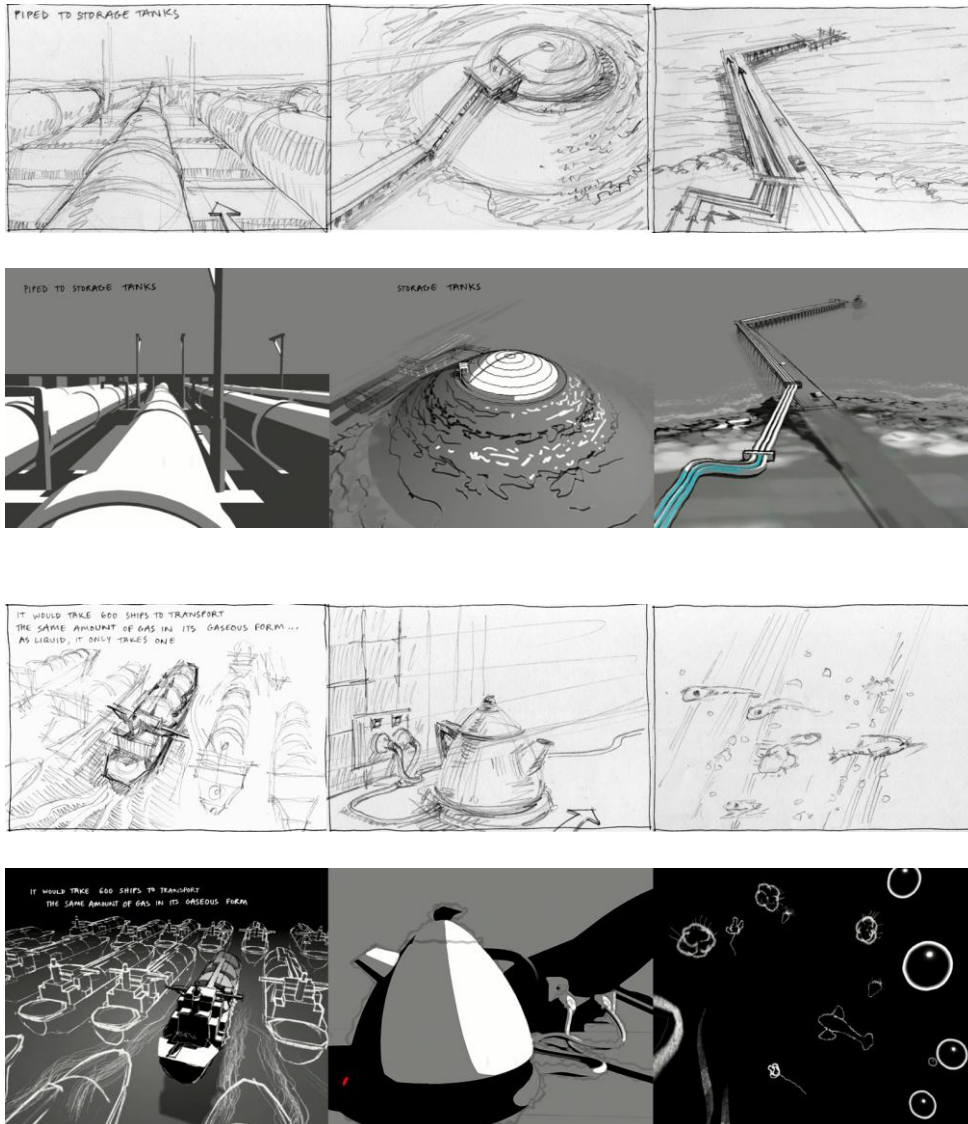
Figure 50 (above) & 51 (top) Plant to Plant storyboard images, pencil on paper, 2006
(bottom) Plant to Plant sequence, 3D animation, 2006

As mentioned in the earlier discussion of **Cube Threshold**, the easiest thing to do in Maya is to create a primitive object. Each primitive has a number of Creation Parameters that can be altered in the Channel Box after creation, either by numerical input or by depressing the middle mouse button and dragging the mouse from left to right in the viewport. For example, a NURBS sphere's creation parameters include Start Sweep and End Sweep. By highlighting the start sweep parameter in the channel box, and middle mouse button dragging the mouse from left to right in the viewport, a NURBS sphere can be seen to "draw itself on" in three dimensions. Much of the animation in **Plant to Plant** was done by keyframing similar creation parameters of primitive objects. This method of working was so direct and simple that it felt like the

3D software equivalent to dragging the point of a pencil across a piece of paper. I also used simple NURBS Lofted, Revolved, or Extruded surfaces and animated their construction history or creation parameters. These two animation methods were used in the depiction of all the LNG plant processes (Fig.52 & 53)

Figure 52 (top) Mercury Removal Unit and (bottom) Propane Heat Exchanger "drawn on" by animating their construction histories, 2006
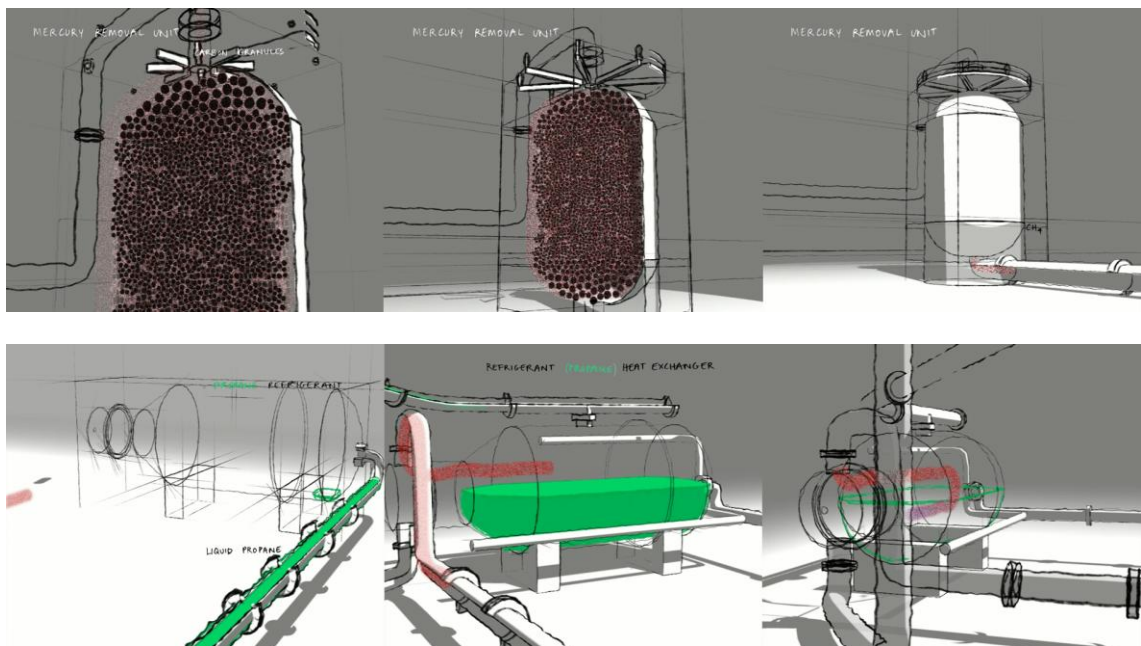
Figure 53 (top) Final Mercury Removal Unit and
(bottom) Final Propane Heat Exchanger, 2006

The addition of moving line work allowed me to introduce detail and offset the "hard-edged" nature of Maya's Primitive geometry. Since the creation of the first **Cane Chair** experiment, Maya has introduced a number of toon line tools that can be used to add a profile outline to any piece of geometry. Adding movement which replicates the "boiling" effect seen in hand drawn animation, can be achieved by creating a modifier and animating its, rotation, noise, and "dropoff" parameters. **Plant to Plant** depicts organic processes and scientific processes. The combination of boiling line work and simple geometry seems to adequately illustrate these two themes.

The animation starts with a written statement of the first law of thermodynamics (Fig.54). The text is formed by Maya CV curves, which are positioned at various points along the Z axis (i.e. at various distances from the camera). Some letters are larger than others but, due to the effects of perspective, they are all the same size on the picture plane. I turned each of the curves into a soft body, using Maya dynamics so that the movement of the plankton disturbs the formation of the letters, eventually making them illegible. As the plankton advances, the curves change from meaningful words to abstract lines. As in most of the project work, I continued this theme of abstraction and figuration throughout the animation. By limiting the palette to black white and grey I could ensure that the visible shapes don't correspond to the contours of objects and all of the geometry at least partially disappears into the ground. The line work clarifies the contours of objects and is a necessary addition because of the unfamiliarity of the subject matter and the need to convey precise information.

Figure 54 Plant to Plant opening sequence, 3D animation, 2006

In order to keep the scene files light so that the software response was immediate, and also to ensure that the image in the viewport was not far removed from my final render, I avoided using Dynamics, automated animation techniques, and complex geometry wherever possible. Hence the blue gas flame is a simple piece of NURBS geometry animated with keyframes to make it dance (Fig.55).
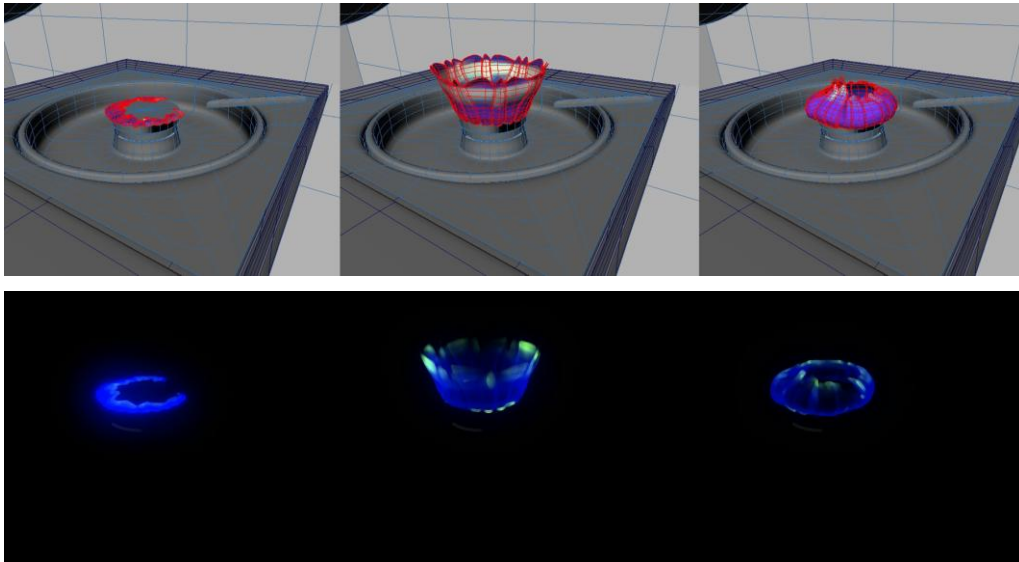
Figure 55 (top) Gas Flame, created with animated NURBS geometry
(bottom) Final Gas Flame sequence

As in **Saltram,** to achieve shadows and reflections I often used geometry rather than a light source. In the **Air Fin Coolers** scene (Fig.56) the shadows are created with lofted geometry so that they can "slide" on in a style similar to the movement in the rest of the scene.
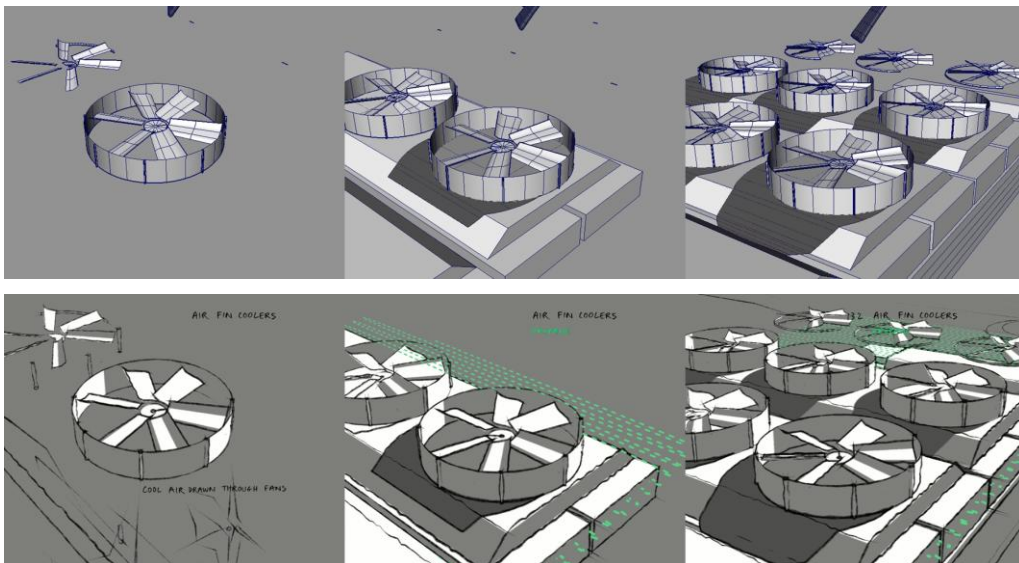
Figure 56 (top) Air Fin Coolers. Shadows in the scene are animated "lofted" surfaces.
(bottom) Final Air Fin Coolers sequence

As in the **Oil Rig** scene, the large expanse of ocean and sky in the jetty scene is a void. The reflections of the jetty are models duplicated and inverted with a ramp texture mapped to their opacity (Fig.57).
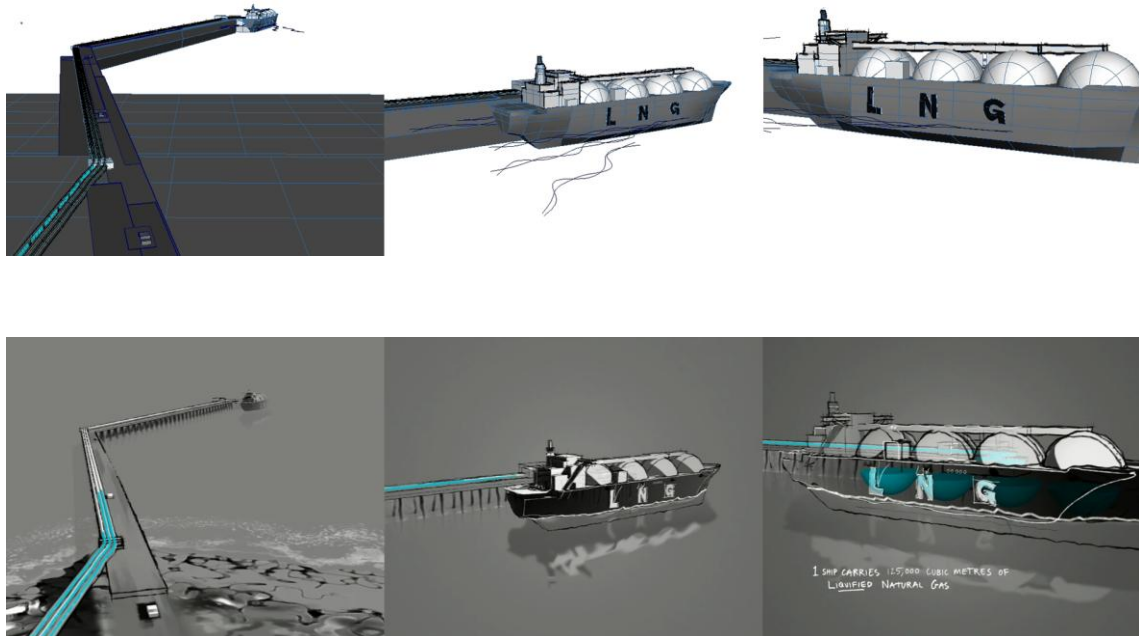
Figure 57 (top) Jetty geometry sequence. Reflections and shadows are geometry rather than lighting effects. (bottom) Final Jetty sequence

Plant to Plant is the longest animation I have completed and, despite the "dry" subject matter, the process of creating it remained relatively fresh. Throughout production I explored various techniques and was pleased to find simple and surprising ways of achieving appropriate visual results without spending hours modelling, texturing and lighting. I would like to experiment further with the idea of 3D temporal drawings, particularly with using movement (of points, lines or shapes) to create the illusion of form; like writing your name at night with the end of a stick glowing red hot from the fire.

DIRECTIONS IN 3D

"Either one believes 'the real' is a known, quantifiable and finite entity and it then is common to render it according to societal models ('photo-realism), or, as is more often the case with 'artists', to 'improve upon its assumed-to-be-known appearance by manufacturing a style'." (Detheux, 2002, p.6)

Referring to art and animation in general, the above quote by Detheux seems to describe two current trends in 3D animation: the pursuit of photo-realism, and the development of a variety of non photo-realistic rendering techniques based on established artistic styles. In this section I will outline these two main trends and then present a selection of artists who use 3D software to produce work that doesn't fit these categories.

Realism

"Despite the fact that our primary connection with 'the real' is first and foremost subjective, we surrender that to the false gods of objectivity and marvel at the "success" of anal-retentive renderings of monkeys 'one hair at a time'." (Detheux, 2002, p.6) (See Fig.58)

Before Kepler's discovery of the retinal image, which allowed comparisons between the camera obscura and the human eye, theories of vision contained no intervening "picture" between us and the world (Wees, 1992). A consequence of the camera-eye analogy is that paintings using mathematical perspective, as well as photographs, film, and photo-realistic 3D animations are commonly thought of as equivalents to human

Figure 58 Polar Bear, 3D image, artist unknown. Sourced from the Internet.

vision. To describe these images, Wees uses the term "visualisations of sight". These images usually present an unambiguous world and are often considered as depictions of reality that are "even more accurate" than what we see.

"However, it appears that natural phenomena will require more research into the fundamental way things occur in nature, and in terms of computer graphics, their representation will build on previous work, but will still require new modelling techniques." (Csuri et al., 1983, p.1)

This quote, from a software developer, illustrates the idea that gaining objective knowledge about the world, understanding "what is" and how "it" works, is the key to creating convincing "visualisations of sight". Since commencing this research project there have been many developments in 3D software design, such as Image Based Lighting (Fig.59) and Global Illumination (Fig.60), which contribute to the pursuit of photo-realism. A lot of computer-generated imagery is used in the film industry to create special effects that couldn't be filmed using real actors and props, or that would be too expensive or dangerous to film. This imagery is designed to fit seamlessly with live action footage and so must be photo-realistic.
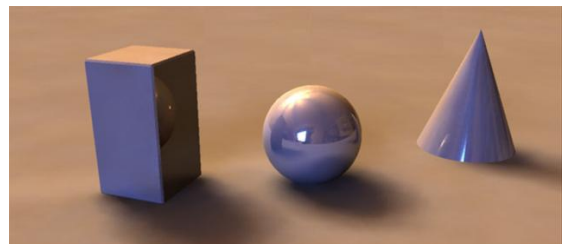
Figure 59 3D render using Image Based Lighting. Sourced from the Internet.
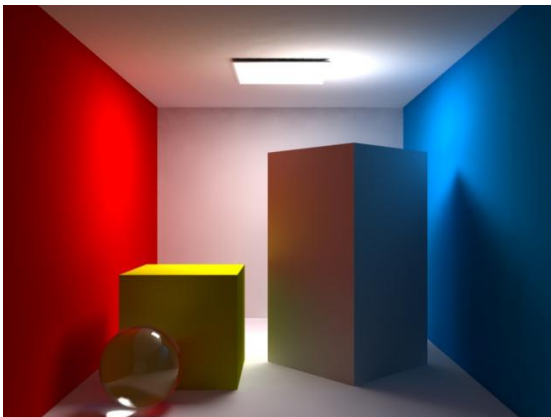
Figure 60 3D render using Global Illumination. Sourced from the Internet.

However, the pursuit of photo-realism in 3D animation extends beyond the special effects industry into movies, games, and virtual reality content. Even the 3D comic style of *Shrek* (which I have referred to as the default 3D style) is considered to have a degree of "realism" that is lacking in traditional 2D cartoons: "Its creators take pride in *Shrek* bringing the first realistic computer-generated human characters to the big screen" (Wachs, 2001, p.1).

Non Photo-Realistic Rendering

"As technology improves and the visuals created by CG tend towards seamless reality, the more lifeless seem these pictures." (Yoshinori, 1999, p.1)

"3D animation production … tends to negate what is possibly our "better" part (as humans), the ambiguous, the undefined, the "still in the making'." (Nagel, 2001, p. 1)

Many think that, by focusing on the visual simulation of reality, computer graphics ignore "the act of interpretation as an important component of our enjoyment of visual art" (Yoshinori, 1999, p.2). This sentiment, along with recognition of the wealth of visual knowledge generated by centuries of artistic practice, has led to the proliferation of a variety of "non-photo realistic rendering" techniques. Commonly referred to in the computer graphics community as NPR, this term refers to any technique that produces images using 3D animation software that are not designed to mimic physical reality. Generally NPR rendering methods take 3D geometry as input and use a filtering method (like that found in image editing programs such as Photoshop) to create images based on an established artistic style. An example is the Toon Shader, available with most 3D programs, which allows the user to render their geometry in a style that resembles the appearance of a traditional 2D cel-painted cartoon.

Images produced in the 19th century by the Impressionist painters are still very popular amongst the general public. It is not surprising then that there have been many attempts to emulate this painterly style using 3D animation software. This image is from a paper by Barbara Meier called "Painterly Rendering for Animation" (Meier, 1996) (Fig.61). The method Meier describes uses particle generation to represent geometry, organises the particles in screen space and sorts them in order of their distance from the camera. An algorithm (i.e. a mathematical procedure) is then used to render the particles as 2D brushstrokes. A user creating painterly imagery with

Figure 61 3D render using the "Painterly Rendering" described by Barbara Meier, 1996

Meier's software uses the default 3D workflow as described above, and then the software automatically performs this complex process of conversion.

The subject of her painterly rendering tests is a haystack, a favourite subject of Impressionist painter Claude Monet, who spent years painting haystacks under different lighting conditions (Fig.62).
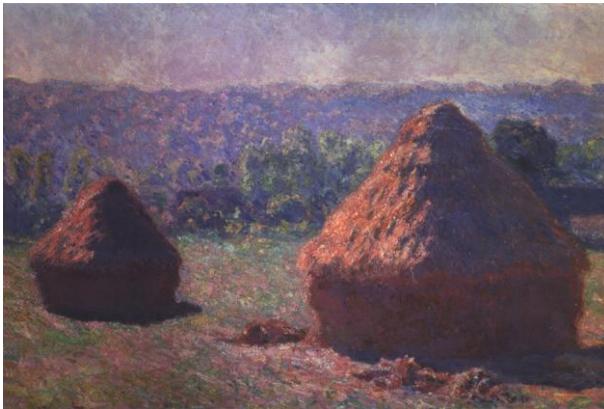
Figure 62 "Haystacks, End of Summer, Morning Effect", Claude Monet, oil on canvas, 1890-1891

Like his fellow Impressionists, Monet was interested in capturing sensations. He tried to avoid, as far as possible, seeing the world through established theories and structures, attempting to "see" before understanding what it was he was looking at. Meier's (and most other) painterly renderings, by contrast, are created using the default 3D workflow, which means that everything in the scene has to be "understood" (named and analysed) before it is "seen" (rendered). The working process of a painter and that of a 3D artist producing a painterly render are totally different. Therefore, any similarities between 3D generated "painterly" renderings and the work of the artists whose styles they emulate are merely superficial.

3D as Art

If NPR merely involves the application of filters aimed at giving 3D generated imagery the look of an established artistic style, how can 3D animation software be used in a truly creative way? It is a commonly held view that art is about the exploration of media and processes to produce work that prompts a viewer to move beyond habitual perception. Wentworth, in his book "Phenomenology of Painting" (Wentworth, 2004) says that, when using traditional painting media, the potentiality of the paint can bring forth different aspects of the world depending how it is used. Likewise, an awareness of the creative possibilities unique to 3D software is perhaps necessary for true artistic use of the medium. The examples below present a small

selection of the various ways that artists have found to incorporate the use of 3D software into their work.

German artist Gero Gries creates large-scale computer-generated prints that achieve a clarity beyond photo-realism. His work is inspired by a number of artists who have focused on the depiction of interior scenes, particularly the early 20th century Danish painter, Vilhelm Hammershoi (Kaufhold, 2006) (Fig.63). Unlike the painters before him, Gries uses 3D software to construct and virtually photograph his interiors scenes and his finished pictures embody the nature of this new media. Whether a deliberate artistic decision or an accidental consequence of his chosen medium, on close inspection it is possible in some images to see the repetition of Gries' hand painted texture maps.

Figure 63 "Dust Motes Dancing in the Sunlight, Interior of the Artist's Home", Vilhelm Hammershoi, oil on canvas, 1900

Looking closely at his image of an underground carpark (Fig.64), it is possible to see that the asphalt's texture forms a repetitive pattern. All his images have a sense of unsettling familiarity. Devoid of people, the everyday scenes have an eerie quality of objectivity, stark precision and solitude. Gries uses the normal 3D workflow and it seems that the particular qualities of the software (when used in this way) combine to create a series of images charged with a sense of alienation.

Figure 64 "Deepo", 3D render, Gero Gries, Lambarda print, 2007

By contrast, Char Davies aims to use 3D software in an unconventional manner in order to overcome its inherent biases and expand the boundaries of its ubiquitous aesthetic, which she describes as "hard-edged-objects-in-empty-space" (Davies, 2004, p.2). William Wees could be referring to Davies when he describes how avant-garde filmmakers call attention to the camera/eye metaphor by using unorthodox film making techniques to defamiliarise the viewer and explore conventional assumptions about human visual perception (Wees, 1992). Davies is a former painter who now works with Virtual Reality installations. Her work is created with the 3D animation program SoftImage. She was involved in developing this software and says that the experience led her "to understand the potency of this technology in reinforcing traditional Western scientific values." Before her introduction to digital tools, Davies painted still-lives of glass jars and mirrors, which explore the visual dissolution of form. In these paintings she developed a visual aesthetic of semi-transparency and semi-abstraction. She continues to explore this aesthetic using 3D software. In her Virtual Reality installations she is seeking the "ambiguous intermingling of various luminosities and hues", and creates layers of transparent 3D models arranged so that "all semblance of solidity, surface, edges and distinctions between things … [are] dissolved" (Davies, 2003, p.1) (see Fig.65).

Figure 65 "Winter Swamp", Char Davies,
still from "Ephemere" virtual reality installation, 1996-1998

Christian Hogue is another 3D artist who uses digital software in an unconventional way. Hogue works with 3D laser scanning technology, and "explores the shapes and contours of the human body captured with lasers and examined via the dispassionate eye of the computer" (Hogue, 2007, p.1). The digital image shown here was used on the cover of ColdPlay's album *A Rush Of Blood To The Head* (Fig.66). It shows the model of a human figure from the chest up that has been deformed by an apparent digital glitch. Artists practicing in any medium are often on the lookout for "happy accidents". This is one of the few examples I have found of an evocative image that seems to have resulted from a 3D computer graphics "accident".
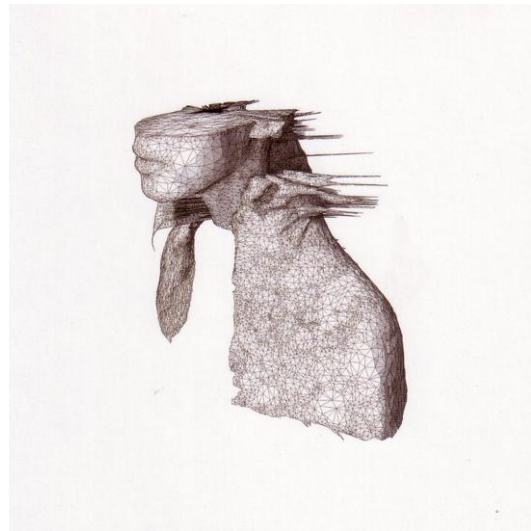
Figure 66 Coldplay, *A Rush of Blood to the Head* Album cover, Christian Hogue, 2002

Figure 67 *Happy Feet* (2006) uses motion capture technology for all its character animation.

Just like previous technologies such as the microscope, digital graphics tools allow us to see things previously invisible to our eye. They allow us to visualize aspects of the world around us in new ways. An example of this is "Motion Capture", a technique that translates motions into 3D files. Motion capture is most often used for animating characters in movies and computer games (Fig.67). Recently, it has also been explored by artists and designers such as furniture design team, FRONT, who have developed a method for turning freehand pen strokes made in the air into real pieces of furniture (Fig.68). Their method incorporates motion capture technology, 3D animation software, and a 3D printing technique called "Rapid Prototyping" (Front Design, 2007).
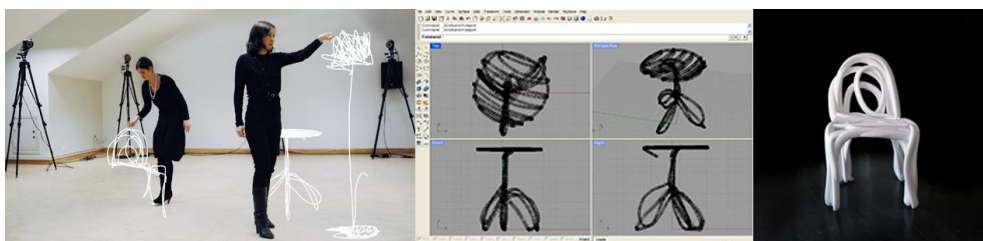
Figure 68 FRONT, using motion capture technology to turn pen strokes into real furniture.

Vita Berezina-Blackburn is another artist whose work focuses on the creative use of motion capture and 3D animation (Fig.69). Berezina-Blackburn often creates pieces in collaboration with dancers and choreographers, and her work is generally for film, performance or installation. She uses Maya to create virtual characters and animates them via motion capture data (Berezina-Blackburn, 2003-2006).
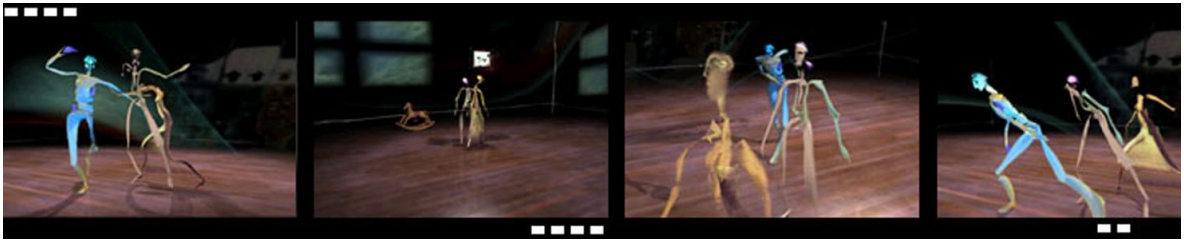
Figure 69 "When I am Little Again" sequence, Vita Berezina-Blackman, 3D animation, 2004

OUTCOMES

What are some of the assumptions about visual perception that are implicit in 3D animation software?

Even more than photography, 3D animations tend to present objects to the viewer in a clear, constant, and unambiguous manner. This is because a 3D user firstly describes objects in terms of context independent data, and then the software renders images according to a set of mathematical rules. New rendering algorithms are being developed all the time (either with the aim of greater realism or more variety of NPR techniques), but they all tend to provide a constant and linear relation between a perception (rendered image) and its stimulus (object/s). By default, the software treats all objects and their attributes uniformly, regardless of their relationship to each other or their meaning to the viewer. Therefore, to consider 3D animations as visualisations of sight assumes that vision is a mechanical process like photography.

There is an assumption within some sectors of the computer graphics community that the addition of more and more objects and detail to a 3D scene will ensure the creation of a "realistic" or convincing image. The design of 3D software ensures that a user approaches a scene in terms of its component parts, and continues to work on these parts independent of their context. Often the scene in its entirety is not experienced as a whole until the final stages of production. This emphasis, on the parts over the whole, seems to accord with the empiricist assumption that the world can be accurately described by breaking everything down into measurable parts, and that our visual experience consists of a collection of sense data.

Creating with 3D animation software is a very rational process. Whether entering data via the mouse, a stylus, or the keyboard, the tacit knowledge of the user's body is largely ignored. Many of the procedures required to create a 3D scene are laborious, and visual feedback is limited, so it is usually necessary to know what you want to achieve before you start. The software is commonly considered as a tool,

a means to an end, to be used by an artist seeking "self-expression". In general, 3D is based on the scientific worldview, which "treats objects and beings in the world as essentially susceptible to manipulation and control" (Gilmore, 2005, pp.299-300).

How can traditional painting and drawing practice inform the creation and deformation of geometry within 3D software?

In **Cane Chair** (Fig.12) I translated an observational pencil sketch into virtual three-dimensional line work. Similarly, **Red Chair** (Fig.15) uses the scanned image of an observational gouache sketch mapped onto a series of NURBS planes, and **Poly Dog** (Fig.16) translates brushstrokes into 3D as a cluster of multicoloured polygons. **Chinese New Year** (Figs 18-21) also uses sketches, which focus on the particular and the context dependant, as its starting point. Each of these projects successfully explores ways of creating 3D models based primarily on how they are subjectively perceived, rather than how they are "known" to be.

When painting and drawing it is easy to make a minimum of marks that imply more than is explicitly depicted. Working in 3D, on the other hand, it's hard to get results without starting from an accurate model built in its entirety. The level of detail can easily be reduced in the rendering or compositing phase (as it was in **Suitcase** [Figs 37-41]), but the challenge for me in this project was to discover ways to build incomplete 3D models that allude to more information than is actually present in the 3D scene file. The most successful piece in this sense is **Oil Rig** (Figs 41-44) in which I painted areas of colour on a low-resolution model so that it represents "a large object rich in detail seen from a great distance". **Cube Threshold**, **Cube Threshold Line**, and **Man Threshold** (Fig.22, 23 & 24), also use a minimum of visual information. These three animations explore the point at which a viewer makes out a figure against a (back)ground. **Cube Threshold** depicts a grey cube rotating against a grey background, while **Cube Threshold Line** and **Man Threshold** use post processing techniques to derive line work from similar grey-scale renders. Likewise, **Saltram** (Figs 27-36) and **Plant to Plant** (Figs 48-57) use a variety of unorthodox modelling and shading techniques to create minimalist imagery that alludes to more visual information than is explicitly presented.

One of the features of my paintings and drawings is that a viewer can sense the bodily involvement of the artist. By incorporating a digitised "hand made" sketch, the

3D animations **Red Chair** and **Cane Chair** both achieve a hand drawn quality. Likewise, the scanned paper texture used in **Saltram** and **Plant to Plant** give those animations a tactile feel often lacking in computer animation. The black and white line work used in **Plant to Plant** was created using Maya's relatively new toon outline tools. The wiggly quality of the line successfully emulates the provisional, searching quality of a pencil sketch. It is interesting to note, however, that this "wiggle" is in fact derived from computer generated "noise" and created via numerical input rather than the bodily involvement of the user.

When working with traditional drawing and painting tools I can immediately see the effects of my actions on the materials and respond instinctively. A concern of this research project was to find ways of working with 3D software that afford direct visual feedback and allow me to get lost in the "conversation" between artist and materials. I found the best way to do this was to avoid simulations, plugins, and automated animation techniques. By keeping the models and scenes simple, the viewport display provides a closer indication of what the final render will look like. The computer is also less likely to provide a sluggish (delayed) graphics display, and less likely to crash. Animating the creation parameters of polygon and NURBS primitives in **Plant to Plant** was a straightforward process, which I felt approached the simplicity and "directness" of sketching with a pencil.

This tendency toward simple scenes and manual keyframe animation also makes it easier to avoid the overarching logic of the computer. It allowed me to "bend" the rules of physically correct lighting and mathematically precise perspective (something so easy to do using pencils and paint). Some examples of this are the use of coloured geometry as shadows and inverted models as reflections in **Saltram** and **Plant to Plant**.

Many paintings and drawings allow the viewer an awareness of illusory three-dimensional objects, as well as the paint daubs or line work that constitute the artwork. This interplay between abstraction and figuration is achieved throughout much of the project work presented here. **Chinese New Year**, **Cane Chair**, **Red Chair**, and **Saltram** all present the viewer with both the illusion of depth and the fact of the two dimensional image. In another way, **Bio-See** (Fig.46) also tries to find a 3D equivalent to painted brushstrokes. This animation shows hundreds of tiny arrows flowing around the bowl and across the tabletop. These arrows are elements of the 3D

software interface and were included in the finished animation with the intention of providing a visual signature of the medium, similar to the brushstrokes in a painting. Designed to be used as a visual feedback, these arrows are usually seen by the 3D user while working and are not normally included in the final work.

What these projects demonstrate, therefore, is that specific painting and drawing practices can be used to inform the creation and deformation of geometry in 3D software. The key insight that I have discovered in this regard is that reference to these practices can help the 3D user to avoid the temptation to build a complex simulated world; an approach encouraged by the normal 3D workflow. By keeping the scenes simple the user gets more immediate visual feedback and can also avoid the overarching logic of the software.

How can a tool based on metaphors of photography and the assumption of an objective reality be used to create imagery about the subjective nature of everyday visual experience?

3D uses a multitude of algorithms based on the physics of light and the laws of mathematical perspective. However, in subjective vision there is not a linear relationship between a perceptual field and its physiological cause. Therefore, to successfully create imagery about the subjective perceptual experience using 3D software, it is necessary to move away from the notion of building a simulated world and recording it with a virtual camera. In this project I referred constantly to my painting and drawing practice in order to develop creative ways of using 3D software. I digitised paintings and drawings and used them directly within the 3D environment, or referred to them for hints on how to build particular objects. I also reflected on my experience of creating imagery using traditional tools in order to find alternatives to the default 3D workflow. I found that by using traditional artistic mediums as reference and inspiration, it is possible to escape the overarching pictorial laws resulting from the software's algorithms and to create imagery about the subjective nature of everyday visual experience.

How does 3D software compare with painting and drawing as an image creation tool?

Many artists use traditional tools and materials in an attempt to make work that explores alternatives to Cartesian mind/body and subject/object dualities. They aim for an open approach to their subject matter and engage in a bodily interaction with their chosen medium. In the creation process they are not always making conscious decisions about how to proceed, and are often being led by the intelligence of the materials. For this reason they regard their work as a conversation, or a "collaboration between artist and materials" (Bolt, 2007, p.30). It could be said that the intention of these artists is to "look, do, in order to maybe understand" (Detheux, 2003, p.1). By contrast, it is necessary for users of 3D software to "understand" before they "do" or "look". The sequence is reversed, because to create an object using 3D software means analysing and understanding it in a very particular way before it can be built or rendered.

Getting predictable results when using 3D software means following specific working procedures. Because you don't "see what you get" while you're working, and because much 3D work is time-consuming and laborious, successful use typically means knowing what outcome you are after before you start. In my experience, this leaves little room for the surprises and "happy accidents" so familiar to a painter (although I have seen others achieve this: see Hogue's work as discussed above). By contrast, painting and drawing tools and techniques seem less prescriptive; they engage with the embodied knowing of the artist and seem to present greater potential for exploring subjective perception, or our "primordial contact with the world prior to the impact of conventional scientific knowledge" (Paterson, 2005, p.1).

On the basis of my research, I conclude that 3D software is a particularly restrictive image creation tool when compared to traditional painting and drawing tools. Of course, all image creation tools have their limitations and orient artistic expression in some way. My concern with 3D software is that it encourages the illusion of unlimited possibility when this is not the case. The sense of unlimited creative potential felt by the user of a "high end" 3D program reflects the concerns expressed by Heidegger about the danger of modern technology (Heidegger, 1977).

CONCLUSION

As a visual artist I have explored, through traditional painting and drawing media, the way an object makes itself visible before my eyes and throughout this research project these explorations have informed my use of 3D software. I have found that 3D is a powerful tool for creating animated graphics and, when used in conjunction with traditional drawing and painting techniques, it can successfully illustrate aspects of subjective perception. However, without reference to paintings and observational sketches, the 3D user is likely to approach the visual world in terms of the software's inherent Cartesian assumptions. Therefore, this thesis concludes that 3D software is too prescriptive to be used in isolation as a tool for the exploration of subjective perception.

All tools orient the user's behaviour in a particular way. 3D software wants you to start from the intrinsic, to think about the context independent, stable properties of objects, and to analyse the visible world in terms of quantifiable attributes and component parts. It treats all objects uniformly regardless of their context, or their meaning to the viewer. Used in the conventional manner, 3D software doesn't allow the user to take the complexities of subjective visual experience as the starting point for creative exploration. According to Merleau-Ponty, "A wooden wheel, placed on the ground is not, *for sight,* the same thing as a wheel bearing a load … [likewise] the light of a candle changes its appearance for a child when, after a burn, it stops attracting the child's hand and becomes literally repulsive" (Merleau-Ponty, 1945/1962, p.60). But in 3D software, a wheel is modelled in the same way regardless of its context. The model is used multiple times in a scene, and even in entirely different projects. With specific texturing and lighting, the rendered scene will achieve a particular mood and atmosphere and may even approximate the look of a subjective visual experience, but the process of creating the animation will always be reflected in the final work. According to the theory of processual aesthetics, "a things final form … reflects the process of its making, which in turn effects the message of its content" (Albers, 2007, p.1). Today, 3D software can simulate the "hand made" look of traditional media but

an artist with brush in hand brings forth different aspects of the world than does the same artist using digital tools.

Some people feel that computer generated imagery lacks "expression" or "soul". Their suspicion is that the computer "does all the work" and input from the artist or user is minimal. By contrast, people within the 3D community most often regard the software as a powerful tool for "communication" and "self-expression". They consider that modelling with polygons is like using clay but without the restrictions of gravity, or the size of your fingers. 3D allows you to apply colour to objects without the limitations of mixing pigments (digital colours can even have a luminance or saturation value of greater than 1 or less than 0), and to use camera and lighting equipment cinematographers can only dream of. The implication is that with enough knowledge and pre-planning a user can manipulate the software to achieve any desired result, including the look of traditional artistic media (thanks to the development of non photo-realistic rendering techniques). "What creates computer animation is the artist" (Lasseter, 2007). "If we've done our job you never sense the technology behind it. You just get the art out of it." (Brown, 2007). These statements, by 3D content creators, emphasise the role of the artist in the creation process and express a sentiment common in the computer graphics community. So, on the one hand, 3D software is assumed to be a totally prescriptive tool that determines its use and, on the other hand, it is considered to be a neutral tool that can be used to materialise an artist's vision. In fact, both these opposing views oversimplify the complex interplay between user and tool.

By contrast, in traditional artistic practice, the particular qualities of a chosen material (and its associated tools and techniques) are often embraced as part of the making process. Whether sculpting clay with your fingers, mixing paint with a palette knife, or applying colours with a brush, it is obvious that "the qualities, features and limitations of materials effect what we can do with them" (Barnacle, 2007, p.6). Seeking a "collaboration" between artist and materials, the artist recognises that "the materials are not just passive objects to be used instrumentally by the artist, but rather the materials and processes of production have their own intelligence that come into play in interaction with the artist's creative intelligence" (Bolt, 2007, pp.29-30).

The relationship between traditional artistic tools and digital graphics software is dynamic and complex. Within the computer graphics community, abilities in

traditional drawing, design, and sculptural techniques are highly regarded. These skills are generally assumed to translate into 3D as abilities in character design, lighting, composition, texturing, and modelling. In a reciprocal manner, digital graphics tools are being embraced by artists and absorbed into traditional arts practice. Digital painting and drawing is becoming commonplace. In both 2D and 3D software, the computer is increasingly being used to emulate the look of traditional painting and drawing media. The product description of Maya 3D animation software states, "to visual artists, the computer is simply another in a long line of creative tools" (Autodesk, 2007). Typical of the computer graphics community, this statement foregrounds the agency of the artist and downplays the role of the tools and processes of creation in the finished artwork. My research has demonstrated that no tool is neutral; all tools orient our behaviour and contribute to the way we perceive the world. This has implications for the changing nature of visual arts practice and deserves further examination in order to encourage a more fruitful dialogue between traditional art media and digital graphics software.

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Glossary

3D Animation and Computer Graphics Terminology

action

A Photoshop action is a series of image editing steps that have been recorded so that the computer can run through the steps automatically when asked to perform a particular action.

adjust levels

A Photoshop filter, or After Effects effect, which adjusts the tonal range of an image.

Adobe Illustrator

A vector based drawing program developed by Adobe Systems.

Adobe Streamline

Adobe Streamline is software that converts bitmap images to vector graphics. It is no longer available as programs such as illustrator now have more powerful capabilities for tracing bitmap graphics.

After Effects

After Effects is a digital motion graphics and compositing software published by Adobe.

ambient colour

A material (shader) attribute that controls the overall colour of an object.

automatic mapping

In Maya a models UVs can be arranged automatically (by the software) or manually (by the user). With automatic mapping they are arranged automatically.

batch processing

In Photoshop the batch processing command runs an action on a folder or series of image files.

binding

In animation, the process of attaching deformable objects (*skin*) to a skeleton.

Bitmap graphics

In computer graphics a bitmap image is composed of a pattern of dots. The other method for representing graphical images is vector graphics, which uses mathematical equations or geometrical formulas to represent images.

boiling

A description used in animation referring to the agitated, or wiggly line work created when frames are drawn by hand.

blur

A filter found in most digital image editing programs (including After Effects and Photoshop) which blurs the image, making it out of focus.

bump map

A bump map is an image file used to add the look of texture to a model's surface. The darker areas of the image file look like depressions in the model's surface while the lighter areas look like protrusions. The model's geometry is not actually altered by the bump map as it is with a displacement map.

channel box

An editing window where you can view and edit an object's keyable attributes.

cluster

In Maya creating a cluster from a single point or a group of points (eg. CV's or vertexes) allows you to perform transformations on them that you otherwise couldn't.

CMYK

Refers to a colour model used in printing. CMYK is short for **c**yan, **m**agenta, **y**ellow, and Blac**k.**

compositing

The combining of visual elements from separate sources into single images, often to create the illusion that all those elements are parts of the same scene.

creation parameters

In Maya a creation parameter is an attribute that dictates the form of the model which is created.

CV or Control Vertex

Maya terminology. In modelling, a point that controls the shape of a NURBS curve or surface.

CV curve

Maya terminology. A type of NURBS curves

depth of field

In photography, the range of distances within which objects will be sharply focused. (Objects outside of this range appear blurred or out of focus.) In Maya, all objects are sharply focused by default, no matter how near or far they are from the camera. However, Maya does selectively focus on objects to simulate depth of field.

displacement map

In 3D software a displacement map causes the actual geometric position of points over the surface of a 3D model to be displaced.

dropoff

The dropoff of many Maya attributes can be adjusted to change the way the values fall away.

dynamics

Using dynamics in Maya means setting up the conditions and constraints that you want to occur, and then allowing the software to automatically solve how to animate the objects in the scene based on rules which simulate natural forces.

effect

In After Effects an effect is applied to an image sequence to alter its look in some way. It is the equivalent of a Photoshop filter.

emitter

In Maya's dynamics or fluid effects, an emitter generates moving or stationary particles while an animation plays. Emitters are useful for producing smoke, fire, fireworks, rain, and similar effects.

end sweep

An attribute listed in the channel box which dictates the completeness of a NURBS model such as a sphere or cylinder. It is one of the models creation parameters.

expression

An instruction that controls keyable attributes over time. Expressions can be comprised of mathematical equations, conditional statements, or user programmed commands.

extrude

Modelling in Maya, extruding is the process of creating a 3D surface or shape by sweeping a cross-section or profile along a curve. In other software packages it is known as *loft*.

filter

In Photoshop a filter is applied to an image to alter its look in some way.

find edges

Find edges is an effect available in After Effects. It identifies the areas of an image that have significant transitions and emphasizes these edges. Edges can appear as dark lines against a white background or coloured lines against a black background.

focal length

In photography, the distance from the camera lens to the film plane that determines the angle of view. In Maya, a focal length constraint is useful for controlling the angle of view in a scene.

fluid effects

Part of Maya dynamics, fluid effects simulate realistic fluid motion, such as water, clouds or fog.

fractal noise

A type of noise effect available in After Effects.

global illumination

In 3D graphics global illumination refers to the technique used to capture indirect illumination, the natural phenomenon where light bounces off anything in its path until it is completely absorbed.

Google

An online search engine

Graphics tablet

A graphics tablet is a computer input device that allows the user to hand-draw images and graphics, similar to the way one draws images with a pencil and paper.

Hardware renderer

Some elements in Maya are only visible when rendered using the hardware renderer (rather than the software renderers).

hide

In Maya objects that are not being worked on can be hidden to reduce visual clutter. A hidden object is temporarily removed from view; it is not deleted or moved.

high-resolution

In computer graphics high-resolution refers to a highly detailed model or digital image.

construction history

Modelling in Maya, construction history is saved information about how an object was created. For example, the original curves or surfaces used to create a surface.

Image-based lighting

Image based lighting is a 3D rendering technique which involves applying an environment image onto a dome or sphere in a 3D scene to simulate the way objects are affected by their surroundings.

keyframe animation

The manual assignment of a particular set of values to an object's attributes (for example, translate, rotate, scale, colour, etc.) at a specific time (or *frame*).

Lambert shader

A material (shader) with no specular highlights. An object created in Maya is assigned a grey coloured Lambert shader by default.

lattice deformer

A lattice deformer surrounds a deformable object with a lattice that you can manipulate to change the object's shape.

layers

In Maya you can assign objects to a number of overlapping layers. Using layers, you can organize elements of a scene and selectively make them visible or invisible in the 3D view. You can also template or reference all objects associated with a given layer.

layer style

In Photoshop a layer style is a style generated via any number of filters and image adjustments that is applied to a layer.

layer mask

In Photoshop a layer mask is a black and white image which is connected to a layer to control its transparency. The image can be coloured but only the tonal information is relevant. The darker the layer mask image the more transparent the layer and the lighter the layer mask image the more opaque the layer.

lens flare

In rendering, a simulation of several bright disks of light, of various sizes, extending in one direction from the light source designed to replicate a camera lens effect.

loft (or lofted surface)

In modelling, a series of curves (or splines) can be lofted together to form a surface. The lofted output can be a polygon or NURBS model but is most often NURBS because of the smoothness of NURBS models.

low-resolution

In computer graphics low-resolution refers to a model or digital image which isn't very detailed. To speed up computer processes, low-resolution models or images are often used as placeholders.

magic wand

In Photoshop the magic wand tool selects contiguous areas of an image.

map (or texture, or texture map)

A map is an image applied to a model to provide surface detail. To map is to apply one or a number of images to one or a number of attributes of a model's shader.

material (or shader)

A description of what an object looks like when it is rendered.

matte opacity

If a shader's matte opacity attribute is set to 0 then it is not visible in a rendered image **and neither are any models occluded by it.**

Maya

A high-end 3D computer animation software package originally developed by Alias Systems Corporation but now owned byAutodesk.

modifier

In Maya a modifier is something that deforms a model or curve.

node

A construct that holds specific information, along with the actions associated with that information.

noise

In 2D computer graphics the addition of noise adds a random distribution of colour levels. In 3D computer animation noise can be added to an animation to introduce random movement.

normal 3D workflow

In this paper I refer to the typical, default, or normal 3D workflow by which I mean the way the software is most commonly used.

normals

The direction of a polygon face. If a model is single sided it is only visible from the direction in which its normals are facing.

NURBS

Maya terminology. NURBS is an acronym for non-uniform, rational B-Spline. It is a mathematical model commonly used in computer graphics for generating and representing curves and surfaces. A NURBS model differs from a polygon in that its shape is generated from a mathematical equation (rather than by defining a definate number of points in space).

origin

the point on the XYZ axes at which coordinate values are all zero (that is, 0, 0, 0).

paint daubs

A filter in Photoshop which replicates the look of daubs of paint.

paint effects

A component of Maya used to paint brush strokes and particle effects on a 2D canvas or on or between 3D geometry. Paint Effects can be used as a traditional paint program to paint images on a canvas, to paint repeatable textures applied to 3D geometry in scenes, or to paint in 3D space

parent

In Maya a parent object controls the attributes of one or more child objects.

particles

In Maya particles (or particle objects) are dynamic objects. They are typically animated by manipulating fields, collisions, springs, emission, goals, or particle expressions.

Photoshop

Photoshop, is an image editing program developed and published by Adobe Systems.

plugins

is a computer program that interacts with a host application (a 3D program for example) to provide a certain, usually very specific, function "on demand".

polygon

A type of model with defined vertices (points) and edges.

Often known in other software packages, as "*mesh*".

primitive

In Maya, a simple shape that can be moulded or expanded to add more detail. Primitives include spheres, cubes, cylinders, cones, planes, and toruses.

projection

Maya has several projection types that turn any 2D texture into a 3D texture (like a real life projector).

reflectivity

In Maya, a material attribute that gives a surface the ability to reflect its surroundings or the Reflected Colour.

rendering

The process of creating an image or sequence of images from a scene. During rendering, Maya generates a two-dimensional image, or series of images, from a specific view of a three-dimensional scene, and saves it as an image file.

revolve

In Maya, a curve can be revolved around an axis to create a revolved surface (in the path of the revolved curve).

RGB

Refers to a colour model commonly used in computer graphics. RBG is short for red, green, blue. A 32 bit Tiff imabe has 4 channels, red, green, blue, and alpha.

scene or scene file

A Maya file is often called a scene file or simply referred to as a scene.

set channels

An effect available in After Effects that allows you to copy channels from other layers to the red, green, blue, and alpha channels (or, in the case of CMYK images to the cyan, magenta, yellow, and black channels) of the current layer.

shader (or material)

In 3D software, a description of what an object looks like when it is rendered.

skeleton

In animation, a structure that consists of joints and their bones, used to create hierarchical, articulated deformation effects on deformable objects such as NURBS surfaces.

skin weights

In Maya when a surface is bound to a skeleton skin weights can be adjusted across the surface of the model by painting tonal values directly onto a 3D model. These skin weights determine exactly how the model is deformed by the skeleton.

smooth shading

A geometry object display technique that can quickly shade the surfaces of objects. Smooth shading is more realistic but slower than wireframe display.

soft body

In Maya, when converted to a soft body, a polygonal surface, NURBS surface, NURBS curve, or lattice deformer will automatically bend and deform when influenced by a field or struck by a collision object. This deformation occurs as part of Maya dynamics (which uses simulation algorithms).

SoftImage

A 3D modelling and animation program.

spatter brush stroke

In Photoshop the spatter brush stroke filter replicates the look of a spatter airbrush.

specularity

Specularity is the quality used in many 3D programs to set the size and the brightness of a texture's reflection to light.

specularity map

Is an image file created specifically to control the specularity value across a model's surface.

specular roll off

One of the attributes of a material controlling a surface's highlights

spline IK

In Maya, a spline IK handle lets you control a joint chain with a NURBS curve.

spline

Splines were originally developed for shipbuilding. A way to draw a smooth curve through a set of points was needed. The solution was to place metal weights at points and pass a thin wooden beam between the weights. In 3D graphics a spline is a curved line, made up of segments and defined by control points.

start sweep

In Maya, an attribute listed in the channel box which dictates the completeness of a NURBS model such as a sphere or cylinder. It is one of the models creation parameters.

stretch

In 3D a texture map is said to stretch when it results in a blurred render because it lacks the required image resolution.

Stylus

The pen-like utensil used with a graphics tablet is referred to as a stylus.

3D (or 3D software)

In this thesis the terms "3D" or "3D software" refer to 3D computer animation software packages such as Maya or 3D Studio Max.

3D paint tool

In Maya a technique of painting directly on models in 3D space.

3D Studio Max or 3ds Max

A 3D computer animation software package originally developed by Autodesk.

template

In Maya, the action of making an object unselectable. The object is still visible, but changes to a grey colour to indicate that it cannot be selected or changed

texture (or map, or texture map)

A texture is an image applied to a model to provide surface detail. To texture is usually to apply a number of images to different attributes of a models shader.

texture mapping

Texture mapping is a method for adding detail, surface texture, or colour to a computer-generated graphic or 3D model.

Tiff

A Tiff (Tagged Image File Format) is a digital file format.

tint

An effect available in After Effects alters an image's colour information, giving it a tendency toward a chosen hue.

toon shading

In Maya, a method of creating the look of 2D cel or cartoon animation using 3D modelling and animation software. Elements of the "toon" look include profile lines (toon outlines), border lines, crease lines, intersection lines, and solid colour shading.

toon outline

One of Maya's toon shading tools, adding toon outlines to an object creates profile lines whose attributes can be modified and animated.

toon shader

In 3D graphics, a shader designed to replicate the look of 2D cel painted animations.

track matte

In After Effects a track matte is used to show one layer through a hole in another layer. It involves two layers; a fill layer and a matte layer. Either the track matte layer or the fill layer can be animated.

transparency

In 3D software, transparency is a material (or shader) attribute that controls a surfaces opacity.

transparency map

A transparency map is an image attached to a material's transparency attribute. Normally a transparency map is a tonal black and white image. White gives a surface full transparency, grey gives half transparency, and black gives full opacity.

true reflections

Maya refers to reflection simulated using raytraced rendering as true reflections.

2D

Two-dimensional

unparent

In Maya, a parent object controls the attributes of one or more child objects. To unparent an object is to sever the connection between it and the control object.

UV

In Maya, UVs are points that correspond to polygon vertices, but live in the 2D world of the texture. They control which points (pixels) on the texture correspond to which points (vertices) on the mesh

vertices or vertexes

In Maya vertices or vertexes are points on a polygon that can be moved to reshape the model.

vector line work (or vector graphics)

In computer graphics, vector graphics use mathematical equations or geometrical formulas to represent images. The other method for representing graphical images is through bit maps, in which the image is composed of a pattern of dots.

viewport

The window or graphic display of 3D software. The perspective viewport shows the objects in perspective, while the side, front and top viewports show the models using orthographic projection.

wireframe

A display technique that shows a geometric object as a collection of lines.