Computer Graphics, Photorealism and the Media

Thesis

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Introduction

In the last few decades, and more recently in particular, the development and application of computers has had an increasing effect on the media, as well as the media's effect on the public, and their faith in what they see.

As a process, computer graphics is beginning to mature. For the first time ever in the world of filmmaking, directors are able to create exactly the sort of images they can conceive in their minds, without their vision being dulled by the limitations of technology.

There is, however, an enormous potential for misuse of the new technology. It is beginning to reach a stage where the public can no longer accept that "photography is truth", and if this is the case, what will it take to convince people, and what are the assumptions the public still make when viewing evidence of fact? What happens when computer graphics blur the line between fact and fiction? when dealing with photographic evidence, to what extent does the way in which images are coupled with words, and in what context they are used play a part in the efficient dissemination of ideas?

The use of computers in the media raises many important questions about truth and consequence - as well as the more down to earth practical elements of film production and information distribution. Computers are rapidly changing the way the media speaks to us and this is creating an entirely new set of problems in addition to solving many things that were previously problems before the advent of the "digital era"

In my Thesis I will attempt to describe the production processes involved in creating photorealistic imagery, as well as the application of these processes and their subsequent effect on the media and the public, in an attempt at understanding just how common perception is continuously being altered by technological change, and what problems this change could potentially solve or create in society over the coming years.

1) 3d Computer Graphics - an overview of techniques

The purpose of a chapter on computer graphics techniques is to give the reader an insight into the techniques professionals are using to create photorealistic imagery in the media today - what are the current limitations of the technology and what are the key areas requiring research and development. This section alone could easily span several theses so it cannot do any more than reference each area in the broadest terms. Used in combination 2d and 3d techniques can be used to fake imagery that looks indistinguishable from photographs.

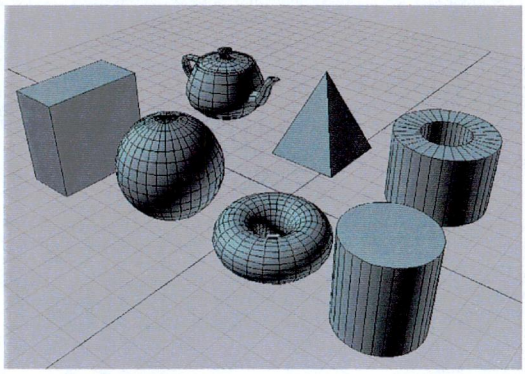
The standard process for creating 3d animation in film and other areas in the media is as follows; model/texture/light/animate/render and composite. Often, in larger visual effects companies such as Industrial Light and Magic and Digital Domain, a different person will handle each part of the process, so someone else will take over to texture your model as soon as you have completed building it. At the compositing stage (and to a certain extent at previous stages) both 3d and 2d techniques merge to form a final two-dimensional images for print or projection or other means of distribution.

Modelling

3d modelling is a difficult and time consuming task - depending, of course, on the complexity of the model (as of yet there is no "create dinosaur" button in commercial software). Usually this process begins with sketches of the model to be built that are then input into a computer by either 3d digitising or hand modelling on computer. Objects are built from "primitives" - boxes, spheres, cubes, pyramids, cones, tubes etc. Which can then be modified, joined or intersected to create more complex forms. These models are divided into polygons that form a sort of "skin" that envelopes objects - the more subdivisions, the smoother looking the resulting surface. The tools have developed to mimic the way artists are used to dealing with sculpture and practical modelmaking, so software developers use analogies like "sculpting with clay" to describe the way their software works, i.e. within that software you would be able to take a blobby shaped object and mold and deform it into shape like it was made of real clay. Other methods of modelling have spilled over from engineering techniques, such as extruding, lofting and lathing. NURBS (non-uniform rational b-splines) are a type of curve that can be used to model objects defined by control points, with the software defining a smooth surface between each control point. To create a human head, for example, one construction method is to create a series of profile curves around the apex of the head, then sweep a surface over these curves, then to manually refine and subdivide this surface point by point until it eventually resembles something close to an effigy. At this point most of the work takes place in wireframe mode, which shows only an objects edges and profile curves. Lately computers have become powerful enough to render objects in an interactive shaded mode, with rough lighting to give the modeller an approximation of what the final form will look like and aid in visualisation. The computer easily handles repetitive tasks such as object duplication - repeated struts on a bridge, for example. In general, it seems that things that are easy to model in real life (using clay or whatever) are hard to recreate using a computer, and vice versa.

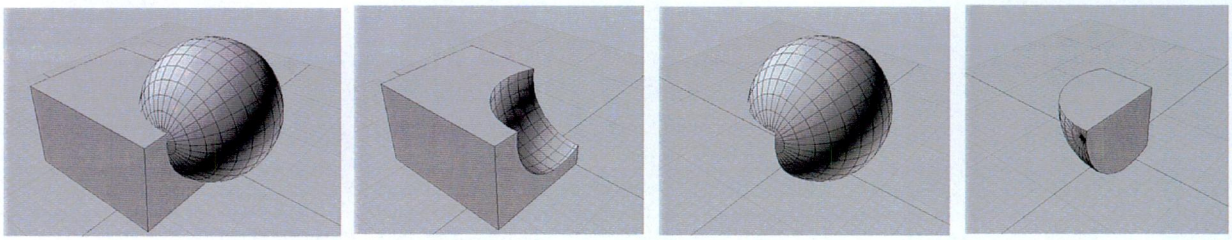
Texturing

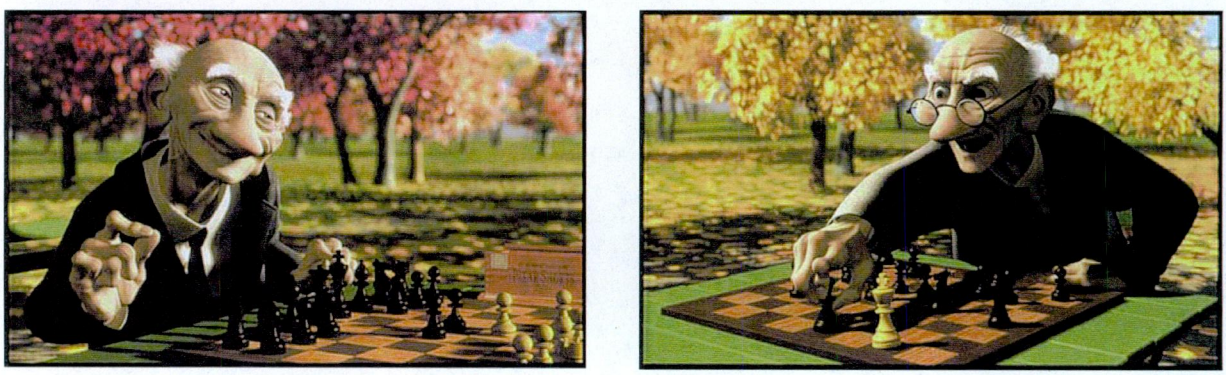
The most realistic textures come from real life - scanned bricks and mud and human skin really sell the illusion of reality when mimicking it on computer. Textures are a comparatively easy way to fake detail in an object - unless the camera is very close to, for example, a brick wall object, you will never notice that it is a flat surface with an image projection mapped onto the surface, if you go really close to the object, you will need to model the surface details. Textures can be mapped and layered onto 3d models using image projection techniques such as planar (projection) mapping, spherical (like an earth map distorted onto a globe) cylindrical (like a beer can) and UV mapping (UV mapping distorts the texture along the shape of the surface, so you get less "stretching" effects than the other mapping methods, for example - map a front photograph on a 3d model of a head and the texture will smear along the sides of the head. Procedural textures (textures defined by mathematical rules) can now create extremely realistic landscape or water surfaces, and software can now cope with object translucency and rim-lighting, bump mapping, specular highlights, diffused reflections, refraction and many other real world material effects. It's even possible to give 3d objects a 2d animated Cel look, to match it into cartoon animation rather than live action. Software now allows users to paint directly onto the surface of 3d objects in real time using simulated brushes, similar to holding a real model in your hand, turning it around and painting it. You can choose from a wide variety of brush types, from simulated airbushes to acrylics or charcoals to give objects a natural look.



Left: computer graphics primitives, the basic building blocks of many objects in 3d

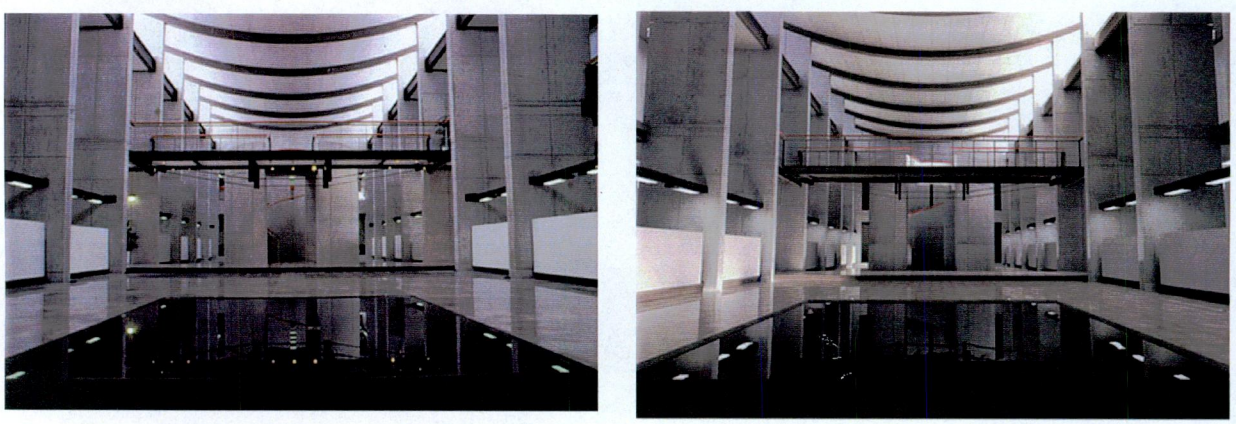
Below: Boolean operations between primitive objects;Union, subtraction (cube-sphere), subtraction (sphere-cube) and intersection

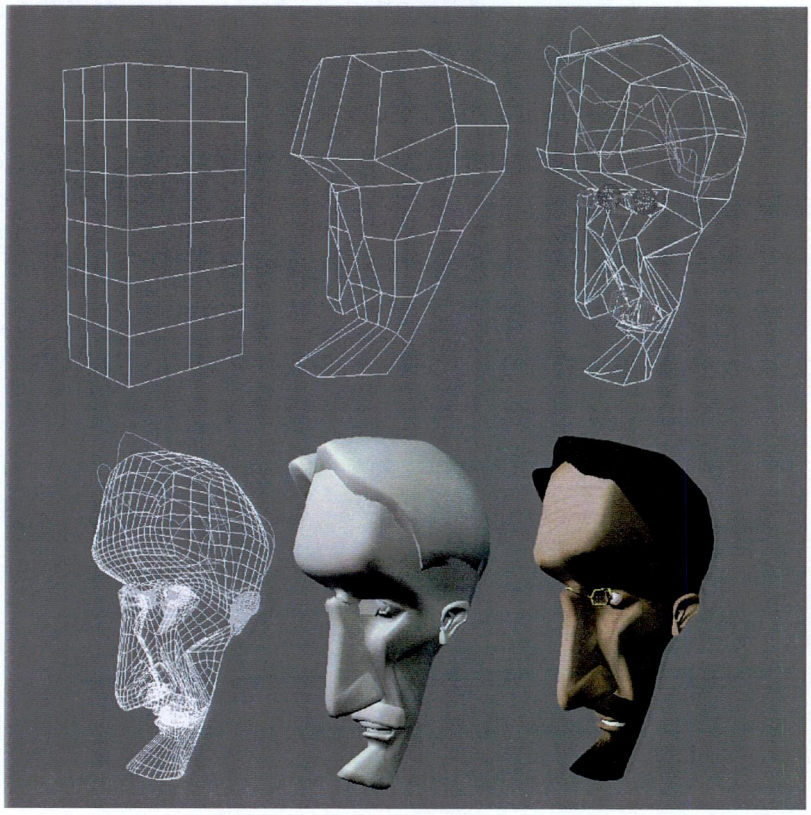




Above: Stills from Pixar's Oscar winning animated short film, Geri's Game. The film broke new ground in the development of cloth simulation and facial expressions.

Below: which is real and which is computer generated? The building was previsualised in a radiosity renderer Called Lightscape before being built. I actually can't remember which was the photograph!

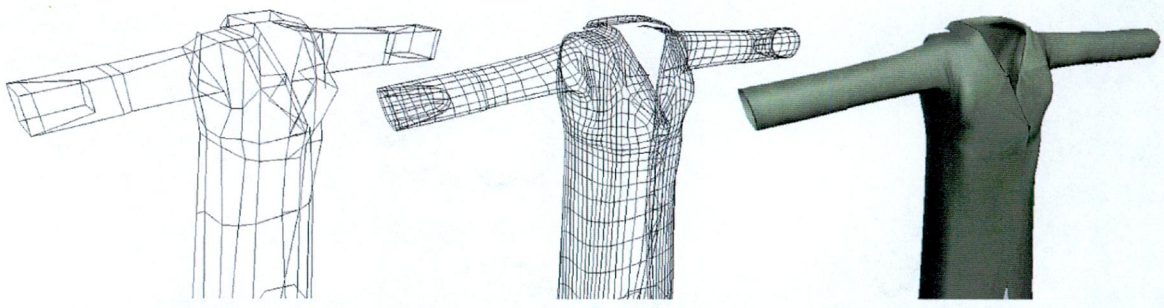




Building a computer generated character

Objects in 3d are usually built from generic primatives such as cubes, spheres etc. From these, more complicated objects can be created by moving and subdividing points and edges. A process called "meshsmoothing" can be applied to convert a low rezolution polygon mesh into a smooth, curved organic form. The images on this page show various stages of a model I created for my degree project.

After modelling, the charcter is given a skeleton that controls the surrounding mesh - move a hand on the skeleton and the mesh deforms to follow it - the character can breath automatically to a set timing and has bulging and contracting muscles set up. He has a range of facial expressions that were individually modelled from the original neutral master object, and can be animated using blended percentages, e.g. - you can give him 20% of an "ooo" sound mixed with 70% of an "eee" - and animate these parameters over time



Lighting

For the first time we are seeing synthetic images that are truly indestinguishable from photographs - and in certain cases have surpassed that level of photorealism (a term which has been much bandied about in relation to computer graphics) and reached the stage of photo-accuracy - where images are actually correct - something you would stake your hard earned reputation on. The term "photorealistic" is confusing as it implies that an image looks (reasonably) realistic, but not necessarily exactly what a given object would look exactly like under given circumstances and lighting arrangements. Lighting simulation techniques such as radiosity are based on physically correct illumination models, that is to say, the light bounces off walls and fills in shadows in exactly the way it would in real life rather than being a close approximation. All it needs is to be fed the correct information about surface properties and lightings arrays and the rest is semi automatic, requiring only a suitably fast computer and lots of RAM. Unfortunately one of the major problems at the moment is actually getting correct information into the computer to begin with, for example, if you have a red carpet, the colour you are seeing is only that hue and saturation because of the lighting you are seeing applied to it - change the lighting and the object colour appears different. Once this problem is out of the way though, people such as Achitects and Film-Makers will be able to produce images that are not only indestinguishable from photographs, but can also be quantatively analysed to determine predicted illumination levels, luminance gradients and visual performance criteria for scientific analysis.

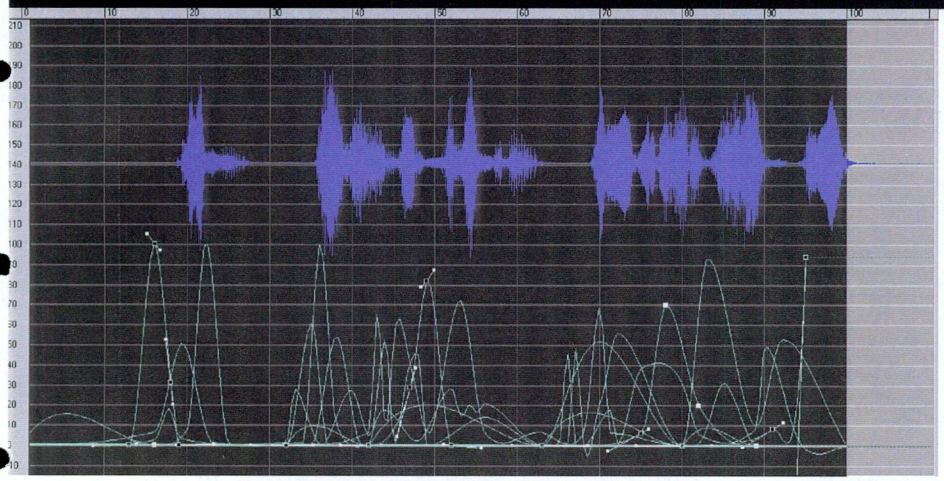
Computer graphic lighting schemes range from simple flat shaded models which provide rapid feedback for the user, to complex calculations of reflections and refractions and diffuse inter-object light bouncing and colour bleeding (the radiosity model). In between are a variety of techniques to provide quick and dirty (but often almost indistinguishable from the more complex systems) lighting techniques -casting soft shadows etc, that look identical to radiosity renders some or most of the time - with a bit of work, but can be rendered in a fraction of the time radiosity takes. For example, sometimes it is necessary to manually place bounce lights to simulate the look of radiosity, without actually commiting to a processor intensive radiosity renderer. Different software provides different solutions and it really depends on the users personal preference as to which solution they will use. In general - most of the same principles that apply to real world lighting apply also in the CGI realm also, except there are a few extra parameters required to get the same result.

Animation

There is a common misconception that when it comes to animating, the computer does all the work. Nothing could be further from the truth. It is the personality of the animator that shows through in his animation, and when left to its own devices, creating simulated walk cycles etc, the computer creates the flattest, most artificial motion. Creating realistic human motion is one of the hardest things to do in computer graphics - techniques such as motion capture help to a certain extent, but motion capture is limited by the performance of the actor doing the motions - get a bad actor and you have a bad animation, that is difficult to edit afterwards. Computers give controls for ease in/ease out of motion (real life objects never come to a halt instantly - and there is always a certain amount of anticipation before an object moves (e.g. punch someone, you draw your fist backwards first to gain momentum). These things are controlled by keyframing object rotation and position in the computer - set every important pose in a walk cycle and the computer will automatically generate the in between motion, albeit very roughly. It requires a great deal of hand tweaking to breathe the necessary life into a character. Characters are modelled in a neutral position, then given a control skeleton, similar to the armatures used in stop motion animation, which is used to pose the characters like a virtual puppet. Facial expressions can be controlled with 3d morphing techniques, the face is modified into the various phonomes, and the blending between these expressions can be controlled over time.

Rendering

Once the animated scene is set up and ready to render, its a simple series of mouse clicks to set the computer to output the final animated sequence. Select an output format (pal - tv resolution, widescreen film formats etc) and an output file name, and the computer will calculate all the cast shadows and object reflections and animation etc, that have been set up in the scene.

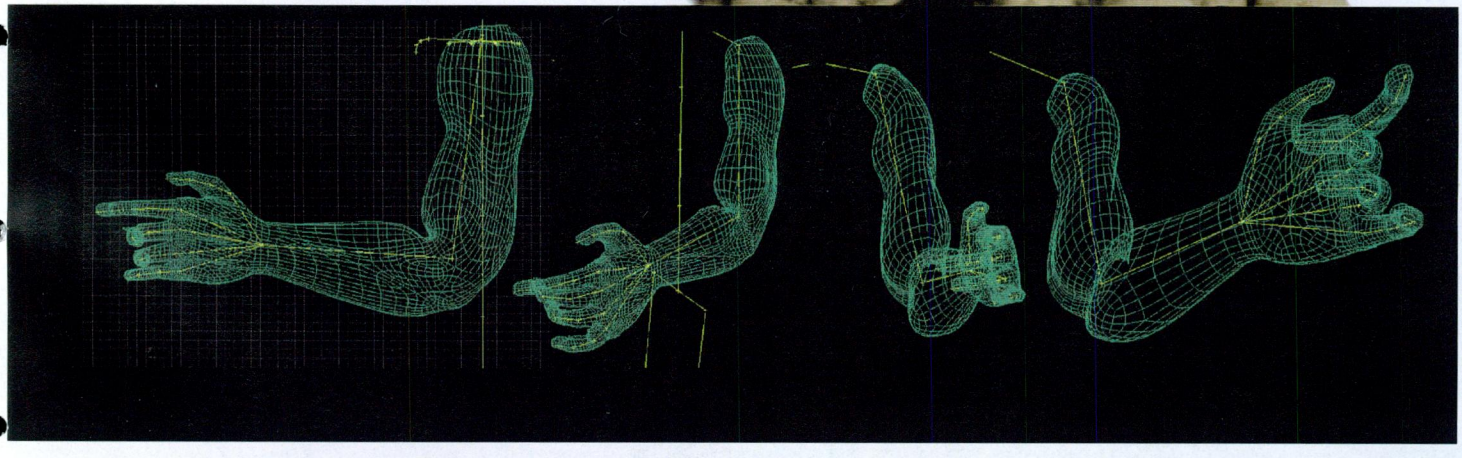


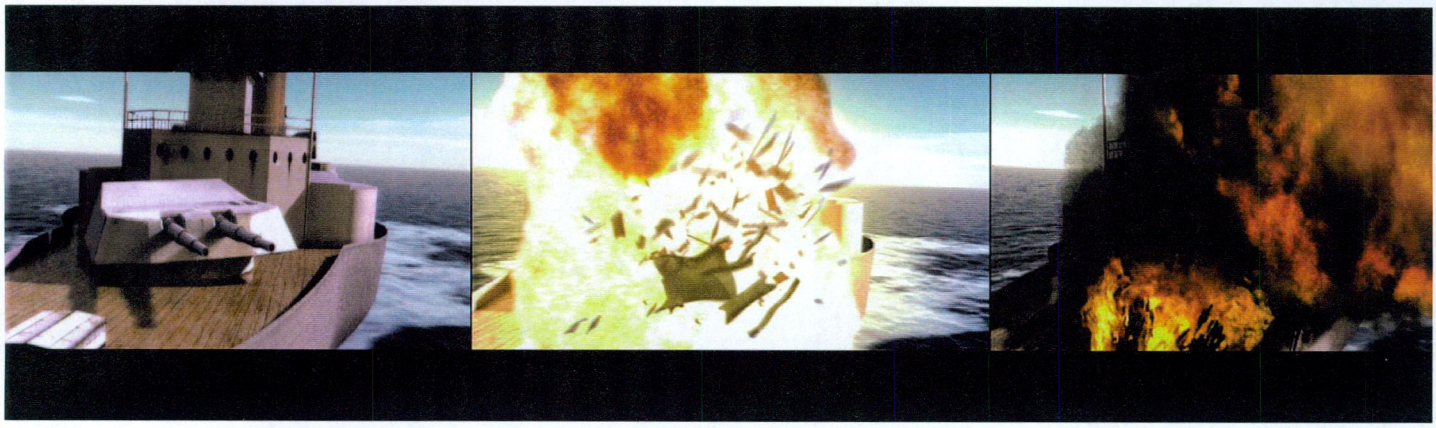
Above: Morphable Facial Expressions for a computer generated character

left: a function curve window for animated facial expressions, overlayed on the speech waveform. High points on the spline curves represents points in time where the appropriate expression is most prominant. The timeline goes from left to right, in this case 100 frames, or 4 seconds at pal (european) tv frame rate.

Right: A computer generated Volumetric Smoke cloud. Parameters that control density and motion can easily be altered to produce light fog or steam that looks completely realistic. It even casts shadows on itself.

Below: skeletal deformation of an arm - note the bulge of the bicep. Skeletons like this can be animated using Inverse Kinematics, this allows the animator to pick a finger and move it around and the arm will automatically follow it around, and the flexible skin will deform accordingly.





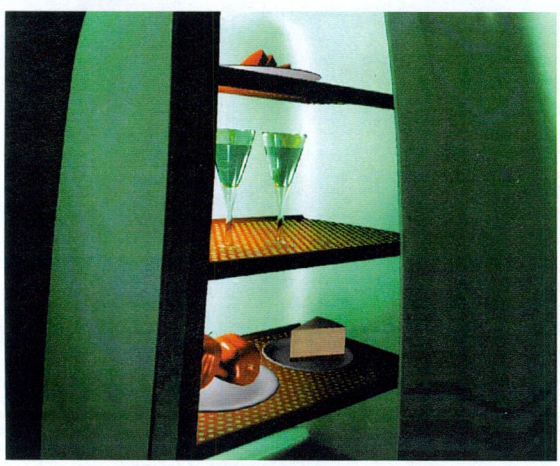
above: a sequence of images showing a computer generated boat being destroyed. it is made of approximately twenty layers altogether, including live action fire and smoke and computer generated wake and ocean elements. other layers include colour correction layers, to bring out contrast in the scene and brighten up the flare of the explosion

Compositing and Post Production

Post processing of images is extremely important in many areas of the media. It can turn a flat, artificial, plastic looking 3d render into something that matches perfectly into live action. Colour Correction can turn a flat, dull image into one full of life and interest. Animators are able to work on multiple simultanious overlapping layers, with soft edged masks, to blur or sharpen only one part of the image, or overlay type or other images in any way they want.

Left, above: computer generated characters composited into a live action background

Left: an entirely computer generated scene



before

after colour correction and post processing

Compositing

This is the stage where 2d and 3d images merge to form a final rendered and colour corrected image or sequence of images. Sometimes it's easier to make the rendered image look more contrasty or softer, or add more blue or grain at the compositing stage, than it is in the 3d program to move and alter lots of individual lights to get the same effect. Colour correction can really make the difference between an artificial, plastic looking 3d render and something that matches seamlessly with live action. It is possible to exactly match the film grain of a specific film stock within a computer - if you shot live action using Kodak Eastman 5428 film stock, you can use a program such as DigiEffects Cinelook to give an identical grain to computer generated imagery. It even adds trapped dirt and hairs to the images - giving that realistic worn film look. Live action images shot against a blue screen can be composited into CGI environments or vice versa - shaky live action sequences can be stabilised, or 3d models can be tracked to the motion in a live action scene (for example - inserting a computer generated character into a live action scene shot with a shaky hand held camera). Crowds can be replicated from a small number of extras, shot several times from the same camera position, with the extras in different locations each time (as in Forrest Gump). Morphing can be used for things other than cheap effects - it can be used to subtly alter the shapes of objects (to ease the transition between a live actor and a digital stuntman, for example).

These techniques are not as easy as is often made out, often being quite technically demanding and time consuming, but the range of effects achievable (and the vast amounts of money generated by big budget films) are making it increasingly practical to produce high end effects for lower and lower budgets.

2) How digital Techniques are supplanting analogue, and how these techniques are being applied in the Media and in Film.

Chemical photographic processes have become highly standardised - how pictures are made, what can be represented with them and what uses they can be put to, but digital images, largely because they are comparatively new and constantly evolving, have much less standardised production processes. There are current standards but these are bound to continue to change over time based on the current rate of progress and change. Hardware and software continue to become cheaper and more sophisticated, and the range of problems they can handle becomes more and more diverse. The current life span of a new computer generally seems to be approximately six months, after which a new toy is released that supplants the current "state of the art" system.

Digital images offer greater scope for alteration than analogue because they are designed to be processed. Analogue systems degrade in quality when reproduced (video tape a video or photocopy a photocopy etc.), whereas digital images suffer no such problem - a copy is, bit for bit, identical to the original. Things which used to take weeks of painstaking work can now be done in hours or even minutes - not to mention the wealth of things that were previously impossible without the aid of computers. This enables them to be far more varied than any other means in their range of possible uses and contexts (can an analogue photo-enlarger be used to predict earthquakes or control a space shuttle? - I think not. If used for dubious purposes, computer generated imagery is also aided greatly by their ease of distribution and untraceability.

The use of computers in the media has become so prevailant in the media that even as far back as 1989, the Wall Street Journal estimated that 10% of all colour photographs published in the United States were being digitally retouched or altered - and this was well before the real explosion and democratisation of computer graphics tools in the media and public. Nowadays it is barely possible to switch on a tv or open a magazine without being confronted by computer aided design of some form or another, whether it is obvious and "in your face", or subtle, like removing slight wrinkles on a fashion models face, or changing the hue of their eyes. "In his prophetic novel 1984, George Orwell imagined a sinister records department containing 'elaborately equipped studios for the faking of photographs' What really happened in the 1980s was that elaborately equipped studios became unnecessary. It became possible for anybody with a personal computer to fake photographs." (From *The Reconfigured Eye* by William J. Mitchell, MIT Press 1992)

The 3d imaging breakthroughs of the late 80's and early 90's finally convinced a sceptical film industry that computer graphics had arrived as a cost and time effective production tool. The resulting technological revolution hit with a suddenness that had many traditional effects artists converting to computer graphics and digital-image processing. A key film in its acceptance was Cameron's 1989 film, The Abyss, with 20 shots and 75 seconds of 3d computer generated imagery, a then unprecedented quantity of work, requiring vast amounts of storage space and processing time. The Abyss not only accelerated the evolution of 3d computer graphics, but its animated water creature was visible proof to the film industry that computer graphics was a feaseable new tool for creating cinematic illusions. This success led Cameron to invent the liquid metal T-1000 for Terminator 2 - another landmark moment in CGI's early history... "Jim kept telling us that if the pseudopod didn't work out, he could always cut it from the movie. On Terminator 2, however, he commited himself to computer graphics by designing a main character, the T-1000, who was entirely dependant on computer graphics and who couldn't, under any circumstances, be cut from the movie". (Dennis Murren - Industrial Light and Magic - Into The Digital Realm, p200)

This and other minor successes led ILM to the production of what has been seen by many as the first major benchmark in the history of computer graphics and the film which caused the effects industry to become as huge as it is today - Jurassic Park. The film itself is thoroughly average - but - as everyone knows - the real reason everyone went to see the film was to see its real stars - computer generated dinosaurs that moved and acted in a more realistic manner than had ever before been seen (in the last 65 million years anyway) - something about this captured the public imagination and led to the film being at the time the most successful ever. It was the first film where living creatures (computer graphic elements) where indestinguishable from live action - that is to say, the CGI dinosaurs where indestinguishable from the anamatronic creations, and could be mixed and matched seamlessly.

"What can be created in the computer will in the near future be indistinguishable from what has been filmed by a camera. And the ramifications of that technological feat will be felt in every aspect of moviemaking; makeup, costumes, production design, casting, budgeting, and even the big screen itself"... "In the coming years, filmmakers will be able to ignore many of the current limitations of film

production. Multiple takes will be less necessary. Four hour long makeup applications will be unheard of. Crowds or massive explosions will be summoned in an instant. Actors filmed in separate locations will be able to perform scenes together"... "it may seem as if todays special effects wizards are simply retooling the dinosaurs, mummies, and aliens that inhabit the world of screen fantasy. But in fact, what they're retooling is Hollywood itself." (*The Outer Limits,* by John Horn, Premiere Magazine, Volume 12, No. 6, p.84)

It now seems inevitable that digital technology will pervade into almost every aspect of film production, and - as soon as it is practical, films will be shot on digital cameras and projected digitally. Such advancements will dramatically lower the costs of film production in time (as every new technology is initially very expensive, but gradually drops as it becomes more widespread). The Tools to do professional computer graphics work are now available to anyone with a spare £1500 to spend. The basic kit comprises of a PC or Mac computer with a scanner, printer and graphics tablet, plus the appropriate software. Usually Photoshop, illustrator and Quarkxpress for print work. For TV and film work it is a whole different league of software and hardware (and prices to match- though the price is finally coming down to an acceptable level) Adobe Photoshop is the worldwide standard software for photo-retouching and compositing work. Adobe are worthy of a mention not only for their superbly designed software, but also because they have recently been frantically advertising on London's Tubes - not for people to buy their software, but asking employees to turn in their workplace if they are using bootleg copies of Adobe software, in exchange for financial rewards (plus the benefit of clearing your conscience and knowing you did the right thing by destroying your business and losing your job).

Bootlegged copies of freelance software are freely available on cd ROM or on "warez" sites on the Internet, through IRC (internet relay chat) or on Hotline or FTP servers. People go on IRC to trade software - give out passwords to ftp sites where they can upload and download basically any program money can buy, in cracked versions with the security systems disabled. These programs are cracked by groups such as "X-Force" and "Siege", groups of hackers who freely distribute software in return for notoriety (as they are basically untraceable - they are pretty security conscious). If you have ever seen the film Hackers you will know exactly what real life hackers aren't like. For one thing, I've never met anyone who wears shades working at a computer. Real life hackers range from the ordinary looking to ultra nerdy. They are never, ever cool.

"In the 20th Century, Cinema was Celluloid; the cinema of the 21st century will be digital. Movie theaters will have better presentation, seating, and entertainment services. And the quality of the experience in terms of sound and images onscreen will increase - especially when theaters become all digital. You'll have a better, clearer, more realistic moviegoing experience.

Digital Technology will bring down the cost of making movies. More people will have access to rendering epic or fantasy stories. It used to be that literary genres such as science fiction and fantasy couldn't be portrayed adequately on film because they had to be shown as opposed to suggested in words, as they are in books. The gap between the two media is going to close up.

In the near future - it's going to happen very quickly - film is going to be photographed and projected digitally. The recorded image will go automatically into a computer, and most postproduction will take place in a computer. Many people in the film medium are going to have to learn new creative processes and techniques. But we made it through the silent era to the sound era, and from the black and white era to the colour era, and I'm sure we'll make it through to the digital era. Black and white silent movies will still be made, even in the digital era, because there are a million ways to tell a story. The creators palette has been continually widened. It was the same with painters during the renaissance, most of whom were technologists of sorts because of the huge emphasis on creating new colours and different ways of dealing with plaster and metal. Artists have always been coping with the limits of technology."
(*Movies are an Illusion*, by George Lucas, Premiere Magazine, Volume 12, No. 6, p.60)

The Media, in particular the news world - the same people that rank among the main users of computer graphics tools, have developed a strange attitude towards digital imagery, seeing image manipulation as a "transgressive practice", a deviation from the established regime of photographic truth. They fear that in the future, due to abuses in the profession, readers of newspapers and magazines would consider photographic "looking" images more as illustrations than as records of real events. On the other hand, the Entertainment industry has an entirely different attitude towards computer graphics - mainly positive, although in certain respects it is negative. Actors Guilds are presently worrying themselves silly over the future potential threat of being replaced with synthetic actors - "synthespians", who won't complain or demand huge amounts of money. Others see the advent of synthetic characters as something that will expand the horizons of creative moviemaking, "I was at Industrial Light and Magic looking at some early footage from the movie Dragonheart, although the person showing the

footage of Draco the Dragon was dismayed because the sound wasn't working, I found myself staring at the screen in fascination as Draco silently mouthed his lines. I was, remarkably, trying to read the lips of a computer generated character." (Barbara Robertson (CGW West Coast Senior Editor) *CGW* August 1997 p.26, Pennwell Publications)

Realistic synthetic human characters are still some way off, but looking all the more feasable with recent advances in the rendering of hair/fur, cloth simulations, fluid dynamics and muscle dynamics, giving fat that jiggles when characters move and hair that reacts realistically to inertia, wind and gravity. These are giving rise to ever more believable synthetic characters who are expressing a wider range of emotions than ever before. One film which helped advance the "synthetic replacements" debate was The Crow, which saw Brandon Lee digitally resurrected after an on set accident left him dead. This was a much more primitive form than whole character generation however, and the first attempts at this have tended towards more fantastical creatures that the audience doesn't see every day (and therefore have something to compare the characters realism with) such as the Dragon Draco in Dragonheart, and one of the humanoid, though not human, alien characters in the forthcoming Star Wars Prequel is entirely computer generated as well. Films such as Jurassic Park, Judge Dredd and Batman Forever have also used computer generated stunt doubles for scenes where it would have been too dangerous or expensive to risk using the stars (or with Jurassic park, where the character has to interact with, or in this case, be eaten by computer generated characters or creatures) The synthetic characters are seamlessly integrated with live action, assisted by 2d morphing techniques to ease the transition from real to computer generated and vice versa.

Apart from the more obvious showcases of CGI (computer graphic imagery) in films like Jurassic Park and Terminator 2, and a batch of more recent films, some have concentrated on using computers to produce invisible seamless effects to subtly enhance the story, which the audience (and even forgery experts) would never notice. Forrest Gump used computers to insert a frantically moving ping pong ball into a game of table tennis, 2d techniques to match actor Tom Hanks into file footage, and crowd replication compositing techniques to make a small group of extras into a huge crowd. Effects like these help the direct create the images they want on screen and extend the filmmakers craft without overpowering it.

Even films that are not obvious contenders for CGI treatment have benefitted from a digital makeover. In Casino, 3d digital matte paintings were created by Matte World Digital, to recreate the original look of Las Vegas which has since been altered substantially, and the original buildings knocked down. Such effects enhance the story rather than replace or overwhelm it. Films such as Spawn where over the top effects replace acting and a decent story have come into criticism not only from the media and public who hated it, but also from other computer graphics professionals who saw it as putting a stain on their craft - "My Opinion of American Cinema is that they have all the big effects, but the stories are getting less and less interesting"... "We went to L.A. and we saw Spawn. It was like, Jesus, if that's the way it's going, I should never have given up music" (From *Computer Arts Magazine*, Issue 13 (Winter 1997), p.60, Future Publishing)

Many critics have derided the modern "effects movie", stating that films use special effects as a means of disguising the fact that the film-makers are devoid of new ideas, and that any subtleties of plot and character are lost in a barrage of fantastical imagery. Zillionaire George Lucas disagrees: "The people who saw Star Wars and said 'spectacular special effects' just never understood it. The same thing with Indiana Jones: 'It's high adventure... just one cliffhanger after another.' Some people look at these movies and they don't see the intricacies of character and story because they are so overwhelmed by the whole thing. You can see so many movies released in the wake of those two movies, just loaded with special effects and stunts, but they don't make very interesting movies." (Industrial Light and Magic, Into The Digital Realm)

Rewriting the law

Computer technology is beginning to redefine laws, particularly in relation to copyright, as it is so easy to use, alter and re-use found or stolen images (or audio files, or any other digital file format). This could be as simple as scanning an image from a magazine without copyright consent or using images downloaded from someone else's webpage for your own. Differing laws in different countries make it very hard to prosecute anyone for breach of copyright. Even an action as simple as decreasing the brightness of an image actually changes every pixel value in the image, so really it is creating new image altogether even though the original could still be clearly visible, even if every piece of information in the rastor grid is altered - and pixel values are really just numbers, which cannot be copyrighted. Remember when the Intel Pentium first came out? - it wasn't called the "586" (the obvious

successor to the 286, 386. 486 etc...) because they realised they couldn't copyright the number and competitors could use the name as well.

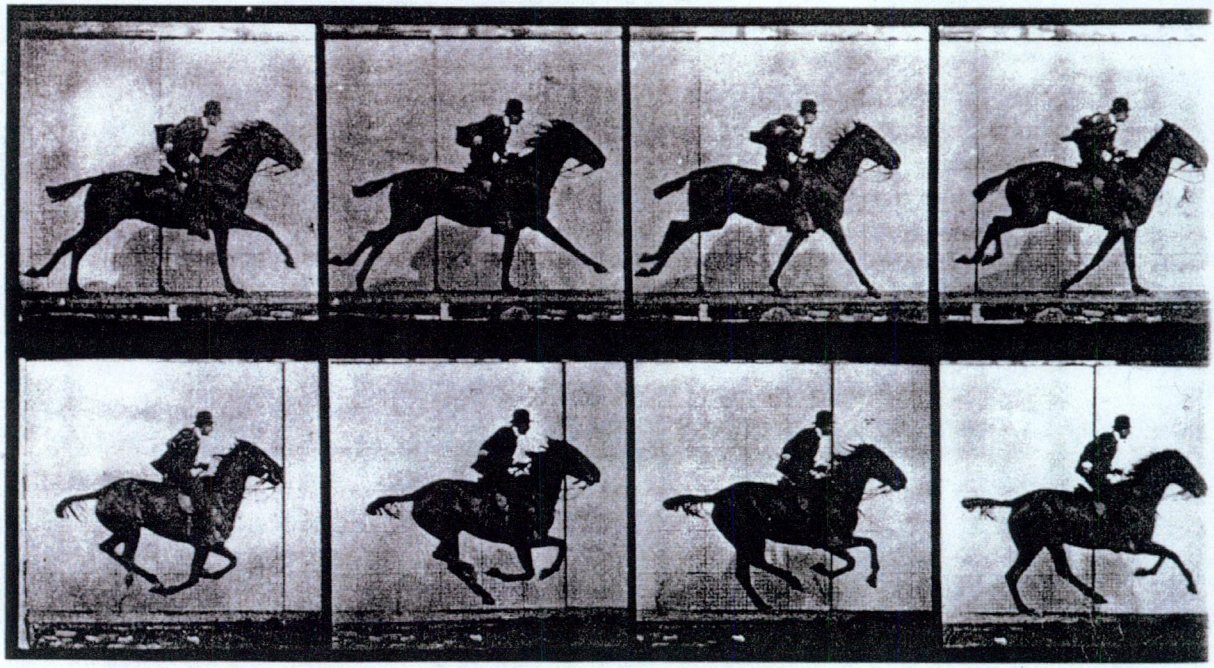
If part of an image is used for another purpose, when does this constitute breach of copyright? It seems ridiculous to suggest suing someone for taking a single pixel value, so exactly how much is the minimum? If digital images are far more susceptable to alteration than photographs, drawings, paintings or any other kinds of imagery, how can people be stopped from stealing imagery, or should they even be? These questions have created a not entirely successful demand for "digital watermarking" techniques. An image with a digital watermark contains embedded information about the creator and the image itself, as well as copyright information. This information will supposedly remain in the image even if printed and re-scanned, however such techniques are easy enough to bypass - blur the image and the copyright information is gone. It seems easier just to base copyright law on image recognition since it all depends on people and opinions anyway - These questions have not yet met with any definitive answer, and are well away from legal conclusions, since nobody seems to be able to decide on a single point of view of what is even right or wrong.

3) "Photography is truth", or was anyway...

The notion that "photography is truth", a transparent window on the real world, is essentially flawed anyway. Photography is a filtered and controlled window on the world. The photographic process has nowhere near the tonal range of the human eye (the brightest white available is that of the background page) or the colour depth (certain florescent colours are unreproduceable using the standard 4 colour CMYK print process). They are limited in their resolution, in their depth of field and by artifacts of the process, such as lens flares when bright lights are within the cameras field of view and film grain, which varies with the type of film used and is recogniseable by experts. These artifacts give away the process, but since we have become so used to seeing images presented in this manner we accept them as real, or at least a standard by which reality can be judged under certain circumstances, the "photography is truth syndrome". Open a magazine and look at any photograph, you can hopefully assume it was a direct translation from reality to the printed page. When You see a photograph containing a bright light (such as the sun or a spotlight) within the camera's field of view, you often see the effect of the light reflecting and refracting in the lens, creating rainbow patterns of light and spherical or hexagonal shapes on the resulting image. The effect differs with the type of lens used and the focus of the camera. This is different to the way light interacts with the human eye - we see a light flare with our own eyes when we look at a bright light but it looks slightly different to the way it would look from a camera in the same position looking at the same light. - yet we take for granted that the way the camera sees it is correct because of familiarity. Computer simulations of artifacts such as lens flares and depth of field mimic the way light interacts with the camera lens rather than the human eye (such simulations can widely be seen in photoshop's vastly overused lens flare filter - just about any badly designed billboard, album cover or webpage will feature at least one of these monstrosities - They are everywhere.

The introduction of digital filtering techniques shows us that there are many more possible windows onto the world than can be achieved through photographic processes alone. The medium can effectively be used to challenge established certainties. This makes it important to find out not only how photographs or synthesised images are made, but also why they are made, how they are used, how their potential uses are established, how they are distributed, how they are arranged and titled with words, how they can be made play roles in stories and how they can construct or alter beliefs and desires.

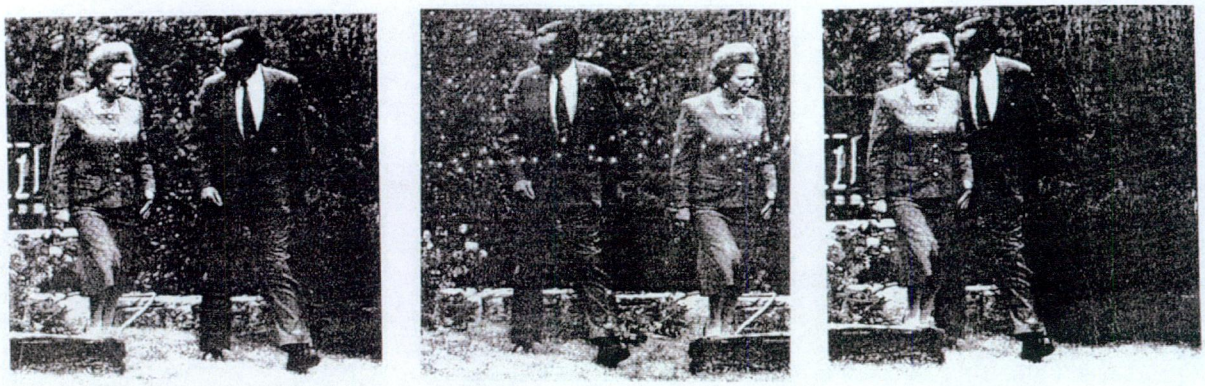
People will accept not entirely accurate images as photorealistic under certain circumstances, and conversely refuse to accept "real" photographs as convicing evidence if the subject contains information they do not expect to see in "real" images, or if it contains information they only expect to find in forgeries - when something is real, but doesn't conform to our expectations of what real things look or behave like, we can be as suspicious of these as we are of established forgeries. If there really are UFO's above us all the time, the fact that some or most photographs are fake will lead most people of a sceptical persuasion to assume that the rest are fake also unless proved conclusively otherwise. When the Platypus was first brought to Europe, it was widely suspected of being an assembled fake - nobody though any living creature would look like that! In part it resembled the kind of old mythical creatures - invariably mix and match body parts from several creature - a wolf's head, a snake's tail etc etc. If we can be fooled into thinking that a forgery is real, then our presumption that photos can only show real things will do the rest. This presumption is under increasing jeapardy from digital editing techniques. As the tools available get better and faster (The major Film FX studios write their own proprietry software as commercially available software isn't always up to the job - for Antz, Paciic Data Image (PDI) used extensive and powerful proprietry facial animation software to complete the job - and their own fluid dynamics simulator to create the films water effects, and Industrial Light and Magic (ILM) use 80% proprietry, 20% commercial software) it becomes harder and harder to distinguish an unedited image from one that has been altered. Forgeries of photos have been occurring since the inception of photography, but has only recently taken a dangerous (depending on how you look at it of course) leap forward, in the last 15-20 year, and shows no sign of slowing down.



Above: Photograph as proof, made to show up the incorrect paintings of horses in motion, by Eadweard Muybridge

Left: Obviously faked, and revelling in the fact - The Weekly World News prides itself on it's ridiculous headlines.

Below: a chat, a quarrel, and an intimate whisper. Rearranging the figures of George Bush and Margaret Thatcher within the frame of a photograph changes our interpretation of the action.



4) The importance of Context and intent in the presentation of realistic imagery

Context and intent are very important in the portrayal of "realistic" imagery. In Jurassic Park, the dinosaurs are treated in a realistic manner (i.e. they cast shadows and physically interact with people and scenery etc.), but they are obviously not "real" - the film is not trying to make people believe that there actually are dinosaurs alive today. Similarly, Independence Day is not meant to be interpreted as a documentary detailing the actual real life invasion of Earth by evil aliens from another planet.

Press photographs are never entirely isolated - they are always surrounded by and placed within other structures, the text from an article, titles, captions and its layout on the page. These define its purpose and imprint themselves on our memories - we feel cheated if and when they deviate from these standard procedures. A picture of a tropical beach labelled "Bray Seafront" is misleading, because obviously Bray doesn't have a sunny tropical beach, but the image or the caption alone would not be misleading - only when they are used in combination does it become something of a lie. The label is analagous to a name and the picture analagous to a predicate, and in combination give something that is either true or false, a kind of statement. It can easily be equivolent to the malicious use of quotations and soundbites to confer a false meaning on certain events. In the same way, a film reviewer who states "the following statement is untrue; I loved this film" could be misquoted as saying "I love this film" if taken out of context.

In the same way, Nazi Minister for Popular Enlightenment and Propaganda Josef Goebbels was always careful to obscure lies behind a veil of truth - the sole aim of propaganda was success - rather than lie he would always tend to distort the truth, so if questioned about the truth of any statement he always had a channel of escape. Many of his distortions of truth had a lot to do with interpretation of words in relation to images - "Kaiser of America - speaks - in Berlin" was the text from one of their posters - only on closer inspection did it become apparent that the "Kaiser" was American Millionaire Henry Kaiser, and that the poster was really just advertising a rally to be held in Berlin, where Goebbels would be speaking out against the evils of this and other dollar capitalists who were holding Germany in thrall. Basically it was just a Jew bashing session.

Walt Whitman's studio portrait 1883 shows a butterfly perched on his finger, claiming "I've always had the knack of attracting birds, butterflies and other wild critters." The butterfly was actually made of cardboard and was attached to his finger with a wire loop. The image told the truth about certain things - what clothes he was wearing on that date, the length of his beard etc., but used in the context of convincing people it was a real butterfly it again became a lie. It could have been a simulation of "if a butterfly had landed on my finger, this is how it would have looked". Changing the context in which it is presented can totally alter the meaning of the image to it's intended audience. Photos, within their own limitations can only present the actual world, but staged, contructed or altered images can present a possible world as if it were the real world.

Case study; a landscape photograph

If you were to take an image of a natural landscape that happens to show, for example, telephone wires cutting across the scene ungracefully, what would happen if the intruding objects were digitally removed from the image? - If the context is just to show an arbitrary image of a natural environment, not relating to any particular place, then such alteration is harmless, or if it is showing how to remove the intruding parts of such an image digitally (such as a photoshop computer graphics tutorial in a magazine such as Computer Arts or MacFormat etc) then such alteration is harmless. Similarly, if it is expected that such intruding objects (or whatever is the focus of our attention) would be in such an image, for example if the image with removed telephone wires was shown to the man who lives next door to the scene portrayed in the image, and by removing it and therefore drawing attention to it's ommission and saying that it's not meant to be taken seriously, or if the alteration is so badly done as to make it obvious that it has been tinkered with, then again it is harmless.

If, on the other hand, it is saying that *this* particular landscape is not disturbed by mankind (if the land was being sold as unspoilt for example) then it is being dishonest - and that is where the media's worries lie. If governments and those with alternate or dangerous agendas can cheat in the same way then there is good reason to worry as the techniques are becoming so seamless that even the best forgery experts would be hard put to recognise a fake. They used to be able to tell fakes from things like incorrectly distorted reflections, and computers can now easily simulate physically correct reflections

fig1)

fig2)

fig3)

These images give a visual demonstration of the importance of context in relation to imagery.

fig1) shows an unaltered natural landscape photograph, which is unfortunately obscured by an unsightly telephone pole.

fig2) shows the same image with the telephone pole and wires digitally removed.

fig3) shows the landscape with the pole removed, albeit very badly.

The meaning of the images depends entirely on how they are presented to the viewer - presented merely as a demonstration of computer graphics the images are harmless, however, if fig)2 was used, for example, to sell this particular piece of property, with a claim that it is unspoilt, the image becomes a lie.

The fact that this sort of retouching is so easy has become a potential concern for many media analysts (and of course the Tabloid Press)

and refractions and caustic light distribution and radiosity and any other technique it's hard to fake by hand.

The 1930's production code, although severely dated, sounding almost jingoistic today, still retains a certain significance and several interesting points relating to intent. It refers specifically to films, but the same points hold true when related to any means of mass information distribution. It clearly states the importance of cinema in society's development (or regression). At this point in time, the cinema was heavily regulated by the Catholic Church, who saw early on the medium's potential as a way of disseminating positive or negative information to the public and influence what they think, thus evil was never to be presented alluringly as it was thought, and often still is, that the public are directly influenced by what they see on film. The production code is now almost embarassing to read, as it assumes a universal Christian ethic code which many people do not adhere to, especially in recent years.

"by natural law is understood the law which is written into the hearts of mankind, the great underlying principles of right and justice dictated by conscience..." etc etc. (Belton, John, Movies and Mass Culture, Athlone, London, 1996, p146)

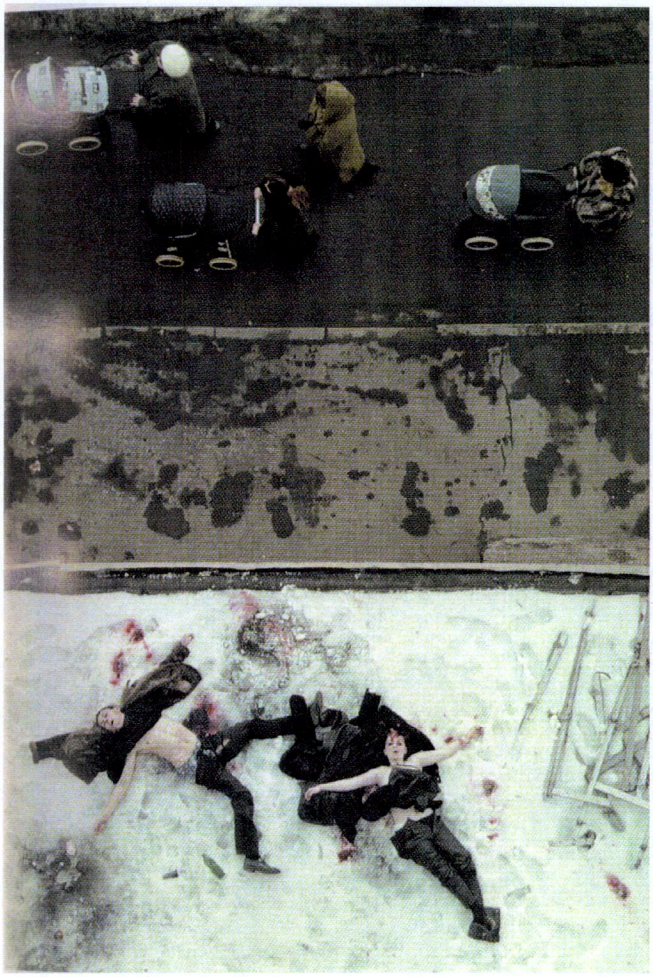
The production code is, in parts, interesting, particularly when it doesn't assume the audience to be completely lacking in free will; "it has often been argued that art itself is unmoral, neither good or bad. This is perhaps true of the THING which is music, painting, poetry etc. But the thing is a PRODUCT of some person's mind, and the intention of that mind was either good or bad morally when it produced the thing. Besides, the thing has its EFFECT upon those who come into contact with it. In both these ways, that is, as a product of a mind and as a cause of definite effects, it has a deep moral significance and unmistakeable moral quality." (Belton, John, *Movies and Mass Culture*, Athlone, London, 1996, p142).

Truth and Expectation

The way an image *should* be presented can be built up in our memories so that we can expect them to represent certain things if placed in a certain context, for example, we expect a truthful undoctored image on the cover of a respected newspaper such as *The Irish Times*, but we would not be in the least surprised to discover that an image on the cover of a fashion magazine was retouched. We expect films to construct realities from photographed , if perhaps staged realities, but a news program should show us what actually happened unless otherwise specified (e.g. a simulation of a plane crash or anything that is difficult or impossible to film - chemical reactions in the centre of the sun etc.) If images are used out of context we rightly feel cheated, assuming of course, we discover the deceit. It came as something of a shock to discover that *National Geographic* would use digital techniques to move two of Egypt's Pyramids closer together to create a more aesthetically pleasing composition for the cover of the magazine, since it is so well respected internationally. (they later apologised.)

Sir Arthur Conan Doyle (creator of Sherlock Holmes - masterly interpreter of physical evidence) believed in the existence of fairies. He also believed he knew what they looked like. Two girls, Elsie Wright and Frances Griffiths created a forgery of fairies dancing about a young girl, using cardboard cutouts. Even though it was comparatively crude, and laughable by todays standards, it was enough to convince Conan Doyle, because his desire to believe was so strong anyway - the photograph became the icing on the cake.

Sometimes we accept photographs as "real" because they represent something we have never seen, or could not have seen, but they conform to our expectations of what a given thing *would* look like, such as the digitally recontructed images of venus sent by the Magellan Probe, which most casual newspaper readers probably thought were photographs. These sorts of images - Landsat images, Magnetic Resonance Scans, Radar Scans, Scanning Tunneling Microscope images and Cycloramic Camera images, although often appearing photographic, are created by entirely non-photographic means, and whose equivolent "exposures", that is, their process of creation, are often far from instantanious. They don't even necessarily record light. They are not a "real" view in the photographic sense, but a mathematical prediction (often using a certain amount of guesswork) - a simulation of what the object, scene or event being viewed would look like under certain idealised conditions, such as simplified lighting schemes, where no shadows are cast or radiosity is not calculated etc. Scanning tunneling microscope images, for example, cannot record light, because the wavelength of light is too great to be visible at that scale, so the lighting is applied afterwards on computers to make it acceptable for viewing, because we expect it to look a certain way. These processes all take information directly from real world object or scenes, but this information is different to the light recorded by a camera, but



Left: At first sight this photograph appears posed and artificial, like a fashion shoot; it becomes far more remarkable when you realise that it records a real event. Like the duck billed Platypus when it first arrived in Europe, nobody expects real things to look this artificial. Taken in Moscow by Dmitri Khrupov, the image shows the dead bodies of a young Russian couple who jumped from the roof of a 16 storey building under the influence of drugs. The mothers pushing prams are on a level beneath the couple, yet the composition makes it appear as if they are only feet away, causing an eerie balance of life and death.

Right: A staged incident: Walt Whitman and the cardboard butterfly. He claimed always to have a knack of attracting birds and insects and other wild critters

is no more or less "real" than photography - just less commonly used, therefore lacking the familiarity factor of photography.

Any photo can obviously show the absence of a near infinite amount of things, however this only becomes important or interesting when it conflicts with our presuppositions of what a particular image *should* contain. When this absence can be made appear plausable, it can change our beliefs. The kind of image that is easiest to refute as a forgery is the kind that presents something spectacular or unlikely to the viewer - such as the alien spaceships hovering over the cities of the Earth in *Independence Day*. The way they are depicted is important as films are such carefully controlled creations. Theoretically, a good director should know exactly how and why every tiny part of every scene is put there, to create a particular mood and sway the emotions of the audience according to their will. There is no chance that *Twister* could be a documentary, even if some shots in the film are shot in shaky handheld documentary style, as all the cameras just "happen" to be in exactly the right place at the right time to make each shot look visually spectacular, and the acting is pretty dire also. The is a certain messy, uncoordinated feel to documentary filming and photography that is intrinsic to its production process (and the realities of filming people's spontanious reactions and events that are beyond the filmmakers direct control) that is hard to simulate (though by no means impossible), but this style generally doesn't suit a Hollywood motion picture narrative unless the aim of the narrative is to be as realistic as possible, which isn't always the case, however, Newsreel type images are often used to relate film images to reality, and because, even in the imaginary world of film, if there is an accident or newsworthy incident the press will come to record it.

One film that uses this type of documentary footage in abundance is Oliver Stone's *JFK*. To treat these sequences as fiction you must understand that what you are seeing is just a picture, that it is not being used to report an actual scene or event even though it might look like it could be - the rules governing valid reporting are suspended for works of fiction. *JFK* was contraversial because it intercut simulated footage with real life newsreels - misleading the public as it blurred the line between fact and fiction. When we don't know if the rules of reporting are in effect, we don't know what to believe. That's why the audience apparently ran out of the theatre during that old silent test shot of a train coming towards the camera - because the audience had never seen anything like it before and didn't know what rules to conform to as they were not set in the publics' collective minds as they are today.

Are people really just lemmings?

This leads on to the question of public intelligence - how easily are they fooled, and how will they react to deception. This has become a matter of media debate that has never quite got out of "personal bias and opinion" status. Thus in such an argument I can only add my own personal bias and opinions - largely because objective evidence is not really available on the subject even though millions have been spent (wasted?) on research. Films in Hollywood tend to aim at the lowest common denomonator - stupid people. Films are made this way because film making is a business - and that is where the money is. It's slightly harder to view in Ireland, as cinema audiences tend to be reasonably restrained, but in America it's amazing to see how openly emotionally involved the audience becomes when watching films en masse. They roar and scream at the screen, cheer and clap and generally act in a rather jingoistic manner. Their (yes another sweeping generalisation) emotions appear totally swayed this way and that based on the directors intention. If the director wants the audience to hate a character, they will most definately hate that character, and maybe even the actor playing that character, and that actors family, and all his friends - well maybe.

This is one reason why censors and Tabloid journalists are so worried by cinema violence, because, fueled by certain isolated examples, they have come to believe that if the audience can be made to empathise with a character of ill repute, why golly they might just go out and duplicate the character's actions - because they are completely stupid you see - utter morons. While I do believe it is very possible to sway an audiences' emotions, I think the gap between seeing something bad (and even empathising with it) and doing something bad yourself is, well, big. (not to mention the fact the not everyone can even agree on what is good or bad anyway). To do this you would have to already be cerebrally unhinged, and if it's not a film that triggers it off, in all probability, something else eventually will. I don't see how the wider audience should be restricted to cater for a small number of potential lunatics, then again I might if I had been personally affected by such a lunatic, but the fact that I have not can hopefully at least allow me to be reasonably objective about the subject, in as much as anyone can be objective about something so intrinsically subjective - all of which is making me talk in circles and avoid the point of this chapter, which is - people in general are dumb, but not *that* dumb.

The most important aspect of public susceptability to persuasion relating to computer graphics and photorealism is - what would happen if someone produced a fake - something everything thought was real - something that could stir up public emotions as strongly as the Rodney King video footage did. What if the media are already doing this? - it's far from impossible, however improbable. It's really just a matter of degree - the altered *National Geographic* cover is nothing compared to what could be done to fool people. Such a tool could prove extremely powerful in unscrupulous hands. If the Nazis had access to such easy and powerful forgery equipment - think how much stronger a hold on the population they could have had considering the astonishing use they put propaganda to using such comparatively primitive photographic montage techniques as were available at the time.

Conclusion: the impact of computers on the media

Computer technology has pervaded almost every aspect of human life, and the media is no exception. In their short history, computers have managed to revolutionise the print process (and soon enough will make a similar impact on the motion picture film-making process when digital film cameras are fast, powerful and cheap enough to make images of comparable quality to standard 35 mm Film as used in cinemas today) and made it's resources available to almost anyone and democratised the desktop publishing world. They have altered our perception of photographs as definitive evidence of fact, they have made possible more varied, spectacular or subtle imagery to be produced and (by largely digital means also) disseminated through the media. They have made forgery far easier (colour photocopiers are the tip of the iceberg), more widespread and more difficult to track down, as well as creating important issues relating to copyright and ownership of information, imagery and audio, and they have made the public become more visually aware - the public demand ever higher standards from the media as yesterday's special effects don't seem quite so special any more.

In essence, Computers have made it easier for the media to lie. The media often exploits the public ignorance of computers. In Jurassic Park, we see what is supposedly a live video transmission displayed on a computer screen with someone talking to the person on the screen via the computer, but at the bottom of the "live" video window is a timeline indicator - moving slowly to the right, i.e. it is a pre-recorded video clip being played back, and the person in front of the computer is acting in synch with this, pretending to be talking directly to the person on screen. This minor detail would most likely escape the notice of anyone not familiar with computers. Another glaring innacuracy relating to computer hardware is the "I know this, this is a Unix sytem" scene. Unix machines don't have 3d interfaces, being a text based system. Unix systems only have 3d interfaces and 13 year old girls are only computer geniuses (it's both sexist and true) in Hollywood. Even if the public did know it was a cheat, they have already paid the entrance fee into the cinema to see it (assuming anyone would be pedantic enough to leave on such a minor issue) so there is nothing they can do about it, thus film makers can get away with cheating the audience as much as they like in this manner because the audience will still flock to see films like this in droves, that is, the film is not dependant on scientific accuracy, if it was then it would have been a failure at the box office in the same way films that promise to be funny but aren't fail. *Godzilla* promised to be entertaining, but ended up being a financial failure.

The increasing sophistication of these techniques has forced people to become more aware of the tricks of the trade, as old fashioned 1940s Science Fiction FX now appear dated and unconvincing, so might today's "photorealistic" effects appear clumsy and unrealistic in the future, due to the increasing visual literacy of the public. The media can control the public to a great extent, but the hypodermic model does not hold true. People are not going to like a terrible film because they are told they should like by the film's makers so the media depends as much on the public to fuel their industry as the public depend on the media to keep them informed and entertained. The power of the belief in photographic truth was demonstrated in 1991 when a videotape showed white Los Angeles Police officers beating Rodney King brutally - it provided such irrefutable evidence that when a jury of no blacks failed to convict the officers, Los Angeles exploded into days of rioting and looting. Most people believed their eyes - not what the legal system tried to tell them. Imagine what would be possible if such footage were faked and presented as real?

Until relatively recently the use of photographic processes in the media, film, tv and print had become standardised - altering a photo was a difficult, specialised and expensive process. In the media, and the public, it was generally considered that when you saw a photo, it was basically a visual record of reality. It was always *possible* to alter images or place them out of context to mislead, but what has changed now is the ease with which this deceit can be accomplished and the regularity with which it *is* being accomplished, in addition to the sophistication of the effects possible which have now become commonplace due to the introduction of computer based image editing and creation environment.

The uses of digital imaging technology are becoming widely institutionalised, and the technology is restructuring institutions, social practices and the formation of belief. No longer are we blindly accepting photographic evidence as objective truth. In subtle and none too subtle ways it is altering the way we see and perceive reality.

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Note on Colour plates

Most of the computer generated images in this thesis are my own work, except for the stills from Pixar's *Geri's Game* and the Lightscape Architectural rendering. Most are purely personal work, created for my degree project and examples created specifically for this thesis with the exception of the images on the *Compositing and Colour Correction* plate, which were joint projects I created with Nick Ryan of Image Now Films, so thank you Nick.