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Digital Filming and Special Effects

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ANALYTICAL AND SYNTHETIC

It is curious that digital photography should have spawned a respectable critical literature,[1] while digital cinematography has, as yet, generated very little theoretical work that deals specifically with film.[2] Two possible reasons come to mind. First, digital cinema approaches more closely the culture of animation than lens-based cinematography. And second, the darkroom has always been a key factor in photographic practice, whereas in cinema, post-production has traditionally been understood as the editing process, rather than the developing and printing of the film strip. I raise this curiosity, which in all likelihood will be a brief and passing phase, only because it raises another conundrum. Traditionally, studies of cinema history have always devoted a chapter to pre-cinematic devices (phenakistoscopes, thaumatropes and so on) and especially to the chronophotography of Eadweard Muybridge, Etienne-Jules Marey and their contemporaries (the most influential, although now controversial, account is Ceram, 1965).[3] Like other contemporary scholars, I rather distrust this continuity model of cinematic development. The quickest way to describe the difference between chronophotography and cinematography is to point out that the unit of chronophotography is the still frame, but that of cinema is three frames: the one just past, the current one and the one coming up. Crudely put, chronophotography was an analytical medium: cinema is synthetic. This is why chronophotography rather than cinema became the tool of choice for Taylorism and 'scientific management'.

A neat enough argument. My attention was caught, however, by a slide projected in a lecture by my colleague Anne Kennedy showing Marey's experiment with an assistant in a black bodysuit marked with white lines for the major limbs, allowing Marey to make a multiple exposure plate of the movement of the lines. An image of the assistant in the experimental regalia was captioned 'Marey's motion capture suit'. After arguing for some time the discontinuity between photographic and cinematic histories, I found myself having to agree: motion capture does hark back to Marey. The immediate thought that followed was: 'Isn't Muybridge's trip-wire operated array of cameras for capturing the motion of a horse the basis for John Gaeta's "bullet time" digital camera array as used in *Blade* (1998) and *The Matrix* (1999)?' Has digital cinema rewritten the history of the medium by assimilating chronophotography, in the same way that it has subsumed into its composite imaging the techniques of animation? And is my neat pedagogical antithesis between analytical and synthetic imaging thus promptly outdated and possibly quite wrong? To get to the heart of this puzzle we need two things: some history and some technology. First, though, we need to define what we mean by special effects and to single out those that are securely and indubitably digital.

THE POLITICAL ECONOMY OF SPECIAL EFFECTS

Special effects come in several varieties, and many are only marginally affected by the transition to digital technologies. Sound effects are still largely produced by the established analogue means of Foley editing, although there are specific examples in which the effect is dependent on digital equipment. Enhancing recordings – for example, to emphasise the lower register – merely expands on analogue techniques. However, Ben Burtt's design of the sound for the laser swords in *Star Wars* (1977) is dependent on the capabilities of digital mixing, even though many of the elements that make up the sword (for example, a Porsche backfiring) derive from real-world sources.[4] One telling example: the gloopy sound of the liquid metal enforcer in *Terminator 2: Judgment Day* (1991) is a faithful reproduction of the sound produced by turning an open can of dog food upside down. The digital production of music is becoming more significant, especially for lower budget productions such as Daniel Aronovsky's *Pi* (1999). The continuing difficulties that the music industry has with the MP3 sound compression format and its use in pirating recordings mean that the full impact of digital music has yet to be felt in the cinema, although virtually all recording now entails the use of digital machinery, if only at the mastering stage, as is notoriously the case with *Pulp Fiction* (1994). It is also the case that Hollywood's continuing love affair with the live orchestra is now backed up by the use of timecoded prints to facilitate synchronisation of score and image in the recording process. Meanwhile the digital control of theatre acoustics has become increasingly significant with the development of Dolby and THX systems. However, digital sound as a whole is still dependent on analogue and imitates it even more closely than visual effects. Thus there are no plans in hand for digitally synthesised voices, even though synthespians, virtual actors existing only in computers, are being developed as a commercial proposition.

Some fields of visual effects are likewise still very close to their analogue counterparts. Stunts, while often enhanced digitally, are pretty much analogue phenomena. The same is true for pyrotechnics and demolition, including miniature pyrotechnics and model work. Prosthetics and make-up, as for example the severed limbs, wounds and piercings with burning arrows in the opening battle sequence of *Gladiator* (2000), are done using time-honoured techniques. New technologies of latex and other modelling materials have changed the craft of make-up, but the fundamentals still apply, and the impact of digital technologies has been minimal. Modelling has, however, been deeply affected by the rise of digitally controlled animatronics. The difference between *The Muppet Movie* (1979) and *The Lost World: Jurassic Park II* (1997) is more than generic. The earlier film relied heavily on human operators working inside the life-size puppets, with only a modicum of wire- and hydraulically controlled mechanical movement. The animatronics for *The Lost World* involved the control of machines of up to nine tons with multiple axes of movement including such nuances as sniffing and flaring nostrils and apparent heartbeats. One significant advance in that film was the successful waterproofing of the circuitry, allowing the creatures to move through a waterfall, for example. To some extent, however, these dinosaurs are the direct heirs of the saurians in *King Kong* (1933), with the major differences that they can be filmed in real time rather than using stop-motion and that they are far easier to combine with the live action, especially in emotive scenes with actors.

Equally intriguing is the transition from painted backdrops, painted mattes and rear projection to chromakey and green-screen technologies, in which action is played out in front of a screen the colour of which acts as a reference tone, allowing all elements of the image which are that colour to be replaced with either a different piece of film footage (effectively rear-projection) or a digital still or moving panorama. Optical printing offered, from the 1930s onwards, a variety of complex and rich effects, such as the flamboyant wipes in *Flying Down to Rio* (1933) and the transformations of Tara in *Gone with the Wind* (1939), where the matte work was likewise outstanding. Rear projection was a major strength of the Ufa studios, where Hitchcock learnt his trade. It is a tricky effect to pull off, as the levels of illumination have to be very finely balanced and the focus adjusted to preserve the sense of depth in harmony with surrounding scenes. Moreover, synchronisation is a permanent problem: every film buff has noted the disparity between jauntily swung steering wheels and back-projected straight roads: there is a fine example of this in Hitchcock's own *Notorious* (1946). The replacement of these techniques with blue- and green-screen technologies was not without its hiccups. The log-line for the first *Superman* movie (1978), 'You will believe a man can fly', no longer convinces us. The wire work with Christopher Reeves is fine, but the compositing of foreground and background produced a strong line around the superhero that now appears unacceptable. Wire work in general has spread rapidly from its home in Hong Kong, where King Hu's *Touch of Zen* (1969) introduced the combination of wire and slow motion that would fuel the New Wave directors Ringo Lam, John Woo, Samo Hung and, most of all, Tsui Hark. With *The Matrix* (1999) and *Crouching Tiger, Hidden Dragon* (2000), Hollywood has appropriated the spectacular stunt choreography tradition in the interests of a cosmopolitan cinema that, despite the failure of *Crouching Tiger* to impress audiences in the Peoples' Republic, augurs a renewed effort to ensure that the American entertainment industry achieves a solid share of the rapidly expanding Asian market.

This family of effects is driven first by the need for spectacle and second by the need to deliver it at reasonable cost. Even the swollen budget of *Gone with the Wind* would not permit the building and burning of a Southern mansion. Using painted mattes and optical printing techniques, though intrinsically expensive, saved huge amounts of money. Rear projection, even if specially shot by a second unit, is far cheaper than taking the whole cast and crew on location. Miniature pyrotechnics, such as those used in the first *Star Wars* trilogy (*Star Wars* 1977, *The Empire Strikes Back* 1980, *Return of the Jedi* 1983), are clearly going to be far less costly than blowing up full-size sets. By the same token, the principle behind building sets as flats and leaving out sections that will not be seen by cameras leads directly to the building of virtual sets. There is no specific gain in spectacle: Ford's Monument Valley or Welles's Xanadu are no less impressive than Cameron's *Titanic*, and all three exist solely as pro-filmic, solely in order to be cinema. That one is digital, one constructed and one framed and composed does not alter the fact that all three are specifically cinematic. So there is no specifiable gain in awe or beauty. What is gained is the economy with which these sets can be manufactured and used.

The earliest and most heavily computerised branch of the film industry, the Asian animation business based in Japan but with major studios throughout the Southeast Asian tiger economies and in India, follows the same logic. Few of the auteur animators in commercial cartoons are responsible for every frame. The lead animator sets the ground rules for characters, movements and environments, and supplies the artwork for key frames. The business of supplying the frames between key frames is 'in-betweening' and is laborious, repetitive, highly skilled, but at the same time not particularly creative. Mechanising this process was a natural place for economising on dull, repetitive work. Nonetheless, some aspects were slow to be fully mechanised. A human animator has no problem understanding how one part of a body moves in front of or behind another, but a computer needs to be instructed. This work on the z-axis (the depth axis of an image, at right angles to the picture plane) was for some time resistant to computerisation, and there are still several competing systems for sorting it out. A second problem was that of soft objects. A human animator knows that when a ball hits the floor, it compresses before rebounding. This observation became an absolute at the Disney studios in the 1930s, the law of constant volume: no matter how stretched, squeezed or battered, Mickey and Goofy were to keep the same apparent volume, unlike such competitors as Felix the Cat. Unfortunately, even in this quasi-mathematical form, a computer has difficulty understanding the problem, especially if it is instructed to work only in the two dimensions of cel animation. The result was balls that looked as if they were made of iron – hence the preponderance of billiard balls in early digital animations. The problem of making the objects soft and resilient was complex and took several years to resolve.

Once worked out, however, the results were highly successful. Katsuhiro Otomo's *Akira* (1987) became an international cult success, the subject of intensive use of computer animation for both in-betweening and for the creation of parallax effects, that is, the creation of an illusion of depth effected by making foregrounds move faster across the screen than backgrounds, as when nearby telegraph poles flash by, while distant trees and fields move more serenely past the window of a moving vehicle. *Akira* was not entirely original here: its parallax effect can be seen as a skilful computerised imitation of the rotoscope, a device based on multiple transparent layers of animation cells used to create foreground and background planes in the Disney studio from the late 1930s onwards. Animation studios also pioneered the use of digital extras. In *The Lion King* (1994), the wildebeest stampede was produced by supplying a small number of distinct behaviours and appearances for the wildebeest, replicating them digitally and controlling their stampede through the use of a flocking algorithm, one of the simple mathematical rules that gives a reasonable facsimile of natural behaviour (in this case the rule is 'always try to be surrounded by other wildebeest'). The carnival scene in *The Hunchback of Notre Dame* (1996) similarly employs a range of individual characters with specific appearances and behaviours, each of a slightly different duration, replicated in large numbers to give the sense of a turbulent and disordered crowd. Such digital extras become highly significant for both scale and cost-saving in Cameron's *Titanic* (1997).

Behind these technical and commercial successes lies again the importance of finance. Now that the global market for children's animation is largely supplied by the Tokyo-based studios, the demand far outstrips the number of skilled animators available. The availability of desktop computers with sufficient power and programs of sufficient sophistication for domestic level machines has driven the cost of computer animation rapidly downwards. In Thailand, even though wages have been kept very low, computerisation is now cheaper. This follows the proletarian model proposed in the 1970s by Harry Braverman.[5] The creative industries are imitating the retail and service industries by lowering the skills level of the workers by transferring those skills to machines. This process began in weaving in the eighteenth century, with the card-controlled Jacquard loom, one of the frequently cited ancestors of punch-card instruction storage systems. If the transfer of live skills to fixed capital began in one craft, it is not surprising that it should today return to assimilate another.

There remains a further area of digital cinema to consider: the use of computer programs such as Movie Magic to control budgets and schedules, and of scriptwriting software not only to format, but also to suggest plot structures and story twists. Even storyboarding has been altered by the arrival of packages capable of animating two-dimensional boards in rough but effective three-dimensional form. The pre-production arena has thus been carefully digitised, too. Inasmuch as the script has been, for almost 70 years, the central device for control of production expenditure in the North American film and television industries, its automation is a gain in efficiency through standardisation. Integrated script and production packages can be presumed to be in the pipeline. Pre-production is still then recognisably what it always has been, but with the additional control and economic efficiency given by digitisation.

DIGITAL TOOLS

Thus far we have suggested that digital cinema is a continuation of analogue media by cheaper means. However, it is in the nature of technological innovations to take on a life of their own. We all have desktop computers not because they increase our creativity, but because of a single software innovation: Lotus 1–2–3 and the spreadsheet. This permitted highly skilled accounting and arithmetical functions to be undertaken by unskilled office workers and made the devices needed to run the software economically viable. However, once the device was available in offices and swiftly afterwards in homes, the unused potential of the gadgets began to encourage the proliferation of new usages. Much the same can be said of the spread of digital film-making. At a certain point it becomes cheaper to buy the hardware to run Softimage than to hire animators. Just as the desktop computer became a cultural phenomenon, and in the same way that professional computer-mediated communication networks became the hacker paradise of the Internet, so the economically driven ubiquity of imaging software has opened up a new range of possibilities.

The first lesson for any student of computer graphics (CG) and computer-generated images (CGI) is the distinction between bitmap and vector graphics. The bitmap is the more familiar mode. In bitmap software, each pixel of the screen is ascribed a co-ordinate in a two-dimensional Cartesian grid known as a raster display the x and y axes of which cross at origin, which in most software programs is at the top left-hand side of the display. High-definition monitors approximate the density of 35mm frames (which contain about a million molecules of light-sensitive silver salts). Each pixel can now be given a specified set of qualities, notably colour. Areas of the screen can be selected and moved, copied and pasted, or given instructions ('filters', for example) to change in a specified way. These changes are governed by algorithms, mathematical formulae applied to the address and colour code of the pixels selected, and are familiar from Photoshop and AfterEffects, among many other programs. When a bitmapped image is magnified, the blocky, square shapes of the raster display are preserved, as is visible in some of the tornado effects in *Twister* (1996, a film rescued by stunning sound design). Bitmap images, however, do introduce layers to cinema. Analogue cinematography exposes a whole frame for a split second and stores the light coming in as a single, coherent image. Bitmap images permit operators to stack image elements over one another in layers and to perform various actions on each layer separately. Thus the digitally enhanced cracks in the glass window of the trailer dangling over the cliff in *The Lost World* could be laid into the image as a layer between live action and blue- or green-screen. The cracks themselves were rotated and stretched to fit the frame of the window, without altering any other component layers in the foreground or background. The effect of layering opens a new language for cinema, or perhaps reopens one of its least recognised: titling.[6] Peter Greenaway's *Prospero's Books* (1991) and *The Pillow Book* (1996) reveal how important these effects can be in reinvigorating the existing traditions.[7] Layers are not exclusive to bitmapped images and draw on the familiar technology of the rostrum camera used for laying graphics and text over cinematographic or video images. But layers are now intrinsic to digital cinema, unlocking new-found powers.[8]

Bitmap images are literally maps. Each point has a mathematical description which defines how it is displayed. Vector graphics, by contrast, instruct the computer to create virtual objects, which are only displayed at a later phase of their development. These vector objects may be very simple forms, such as a two-dimensional curve, or more complex three-dimensional objects. These shapes are not defined by the x and y co-ordinates of the raster display, but by algorithms that define their curvature and their volume. This means that a vector graphic can be expanded at will without becoming blocky. Vector effects have the added benefit of using less computer memory, as they describe curves, for example, according to algebraic principles, needing only the addresses of the end points, rather than storing the address and quality of each point along the way. For example, a circle might be described using formulae such as $2\pi r$, instead of a long list of addresses for every point on its circumference. This makes handling three-dimensional objects far simpler and allows for far more effects. In particular, vector 3D graphics can be viewed from any angle and at any magnification without losing detail. In addition, vector graphics tend to use polar co-ordinate systems (two quantities, angle from the pole and distance), rather than Cartesian (which requires three quantities, distance along x, y and z axes, to describe each point in three dimensions), allowing faster calculation of position in virtual space. The result is not digital 'painting', but digital 'sculpture', objects that have specific qualities in three virtual dimensions, rather than the two permitted by bitmapping. Three-dimensional vector programs usually come with a library of surface textures that can be applied to objects, which usually begin life as bare wire frames. Ray-tracing technology allows these surfaces to be applied in the same vector-based way – that is, as algorithms – so that objects can be viewed at great magnification and yet maintain meticulous detail, not only in pattern, but in texture as well. Three-dimensional, sculptural objects in the computer can also be lit and viewed from anywhere in that space and the behaviour of virtual light traced as a vector, reflecting off one surface, absorbed by another, casting shadows on a third. Not only does this complex of possibilities once again ease the burden of labour-intensive drawing by hand, but also, in the case of *Toy Story* (1995), the vector-based 3D toys can be transferred to computer-aided design and manufacture (CADCAM) programs so that the toys can be manufactured as immediate spin-offs, and new scenarios can be created – for example, for television – at little extra cost.

It is at this point that a further example of continuities between old and new media can be observed. During the preparation of *Snow White and the Seven Dwarfs* (1937), Walt Disney employed an actress to model the heroine. Her movements were both the subject of life drawing and recorded on film as a reference point for the princess's movement in the film. This pursuit of naturalism in animation that was the hallmark of Disney recurs 60 years later in the use of motion capture technology. Here an actor's face or body is dotted with emitters that can be recognised by a computer: light-reflecting discs, for example, or less visible infrared devices. The actor is scanned in motion, playing out emotional states or action sequences. The data recovered can then be applied to a wireframe object in virtual space, such as Buzz Lightyear, to provide the synthespian with a wider and richer emotional naturalism and a more credible set of anthropomorphic movements. As already pointed out, this takes us back to Marey's chronophotographic techniques, while leading forwards to the notion popularised in a number of technical and consumer journals of wholly lifelike synthetic performers, the 'idoru' of Gibson's recent cyberpunk fictions.

Of course, these three-dimensional objects have to be transferred to two dimensions in order to be transferred to film. In some projects, the result is subjected to bitmap modifications, such as the application of digital 'dirt' to add to the verisimilitude of the well-used toys on *Toy Story*. The opposite procedure is also an option. Bitmapped data of sufficiently high resolution can be imported into vector packages in order to be mapped onto virtual surfaces, for example, to support reflections of the live footage environment in the liquid metal body of *Terminator 2* or to supply the human features for Schwarzenegger's disguise as an overweight airline passenger in *Total Recall* (1990). This process is especially important to the field of morphing, where the ability to translate from live to virtual physiognomies is an important potentiality.[9] The four central tools – virtual objects, virtual surfaces, virtual lighting and virtual camera – can all be controlled with great precision, so that matching CGI and live-action footage can be achieved with the minimum disruption to cinematic illusion. Thus the virtual lighting can be rigged and calibrated to the same specification as the real lighting on the set with which the object is to be composited. Of particular significance is the fact that the virtual camera's movements around a virtual object or environment can be stored and applied to the digitally controlled movement of motion-control cameras capturing live footage, so that the two movements can be matched.

Motion control is, if anything can claim this distinction, the single most important aspect of the digital cinema. This is because, articulating layers with virtual vector space, it represents a hinge point between the analogue and the digital that is specific to the moving image. Motion control is a digital governor that recalls the movement made by a camera and repeats it. It is widely used in rostrum camerawork for titling and animation, and is now a key element of the new cinema. Critical to it is the treatment of the camera as if it were a virtual object on a par with the digital sculptures created in cyberspace. Because the single most delicate and precise task of the production process is compositing, the marrying of digital effects and live-action footage into a single frame, the ability to match camera movement in the two domains is critical. It has also led towards new conceptualisations of what a movie camera might look like, most impressively in John Gaeta's 'bullet-time' camera built for *The Matrix*. Here the traditional camera is replaced by an array of 70 still cameras and two motion cameras controlled digitally by a motion-control rig which itself is synched with an entirely digital mock-up of the whole scene. The entire array functions as a single device offering speeds of up to 500 frames per second in any shape including 360-degree circling of the image. This technique combines motion and still cameras. In addition, the post-production phase allows for the interpolation of new frames into the sequence. Interpolation works by the same process as in-betweening. Given two successive frames, the computer can be instructed to interpolate a third by averaging the differences between the initial two, thus extending the action and providing virtual slow-motion (see plate 01). Although this resembles step-printing, the traditional method for extending an action in the optical printer, the difference is that the new frame has never actually been exposed in a camera. It is instead a digital artefact.

The whole can now be assembled. Increasingly, after some awkward experiences, films are being edited on digital nonlinear suites. The term 'nonlinear' is a video expression. Analogue video editing demanded a linear style. Once the opening shot had been laid down and followed by a second shot, the only way to recut was to start again from the beginning, as each shot followed the next in linear progression on the tape. Random-access memory (RAM) storage means that any shot can be shortened or lengthened, or moved at any time during the edit. This was always true of film editing, which is why most programs draw on the language of the film editor's suite (using terms such as 'bins', for example). The major advantage of digital editing is that it allows compositing of live-action and digital components, and the mixing, in layers, of cinematographic, bitmapped and vector graphics.

The sand demon of *The Mummy* (1999) uses such vector effects when it disperses into flies or grains of silicate. Flocking behaviours guide the film's scarabs. This is a medium-budget film. Effects have emerged from the action and science-fiction genre to become central to films such as *What Dreams May Come* (1998) and *Magnolia* (1999). But now not only Hollywood and not only blockbusters benefit from CGI: the medium-budget *Space Truckers* (1997) had its effects largely completed in Ireland. Peter Jackson cut his effects teeth with *Heavenly Creatures* (1994), relying on the emerging effects industry of Wellington, New Zealand ('Wellywood'), and bringing back as a prize *The Lord of the Rings* (2001). Jeunet and Caro moved from festival animations to *Alien Resurrection* (1997) via their *Delicatessen* (1990) and *The City of Lost Children* (1995). Pioneering titles such as Tsui Hark's *Zu: Warriors of the Magic Mountain* (1983) give a sense of the power of Hong Kong cinema. Today Atom Films and other microcinema sites show large numbers of digital showreels and calling-card shorts. The sales drives of both Sony's Vaio and Apple's iMac depend on the attraction of running nonlinear editing and effects packages on home movie systems. The effects of 1982's *Tron* can already be performed on entry-level computers using freeware, partly because it is entirely bitmapped, partly because effects are only 'special' when they are also 'cutting edge'. There remains the stranglehold on distribution addressed elsewhere in this collection. However, the creative tools of the industry are being internationalised and democratised, as well as shifting into new creative directions.

TEMPORAL AND SPATIAL

Blue-screen technology refers to the layers of the image as plates: background plate, matte plate, and so on. Matching the various plates requires one more technical device. When a camera moves through space, objects close up appear to move more quickly than more distant objects. When compositing, the editor has to take account of this parallax effect, ensuring that the planes or layers move in relation to one another in such a way as to convince the spectator that they share a common spatial orientation to the camera. This final adjustment to composite images suggests a solution to the problem with which I started: is digital cinema analytic or synthetic? Frequently, when the answer to a classificatory or categorical question seems difficult to find, it is because the categories employed are wrong. Parallax describes relations in space through a relation in time, the relation of relative velocity. Perhaps our categories of space and time, analytic and synthetic, are what is really at issue.

Why was chronophotography considered 'analytic'? Because it fragmented time into discrete steps and used those steps to analyse movement. Historically, its major function would be in the design of workstations in industry. In other words, and despite its name, chronophotography was a spatial art, rather than a temporal one. However, the return of chronophotography in forms such as bullet time suggests the opposite: that chronophotography has at last become an art or craft for the microscopic investigation of time. Cinematography, by contrast, first appeared as a purely temporal form, demanding the unit of three frames, rather than one. But the parallax effect gives away the true nature of cinema as it has developed over the intervening decades. Movement in cinema is not purely temporal, but is responsible for producing the illusion of depth. Deep-focus photography, for example, so widespread in contemporary Hollywood as to have become clichéd, used to depend on fast film stocks and extra lighting for more distant objects. Today, however, it rests on the audience presumption that large, fast-moving objects are closer than small, slower ones. In the neo-Hollywood of the 1990s and 2000s, space has usurped the privilege of time. Narrative is diminishing in importance (hence the ubiquity of the 'mythic quest'), while diegesis, the imaginary worlds created by films, becomes more significant. Gotham City is more important than the forgettable narratives of the Burton and Schumacher *Batman* films: *Batman* (1989), *Batman Returns* (1992), *Batman Forever* (1995), *Batman and Robin* (1997). This is why the most cited manual of Hollywood script writing today is Christopher Vogler's *The Hero's Journey* (1996), a spatial metaphor of travel which also introduced Hollywood to 'mythic structure', a second spatial metaphor, in place of the linear, temporal models of the past.

To some postmodern commentators, this shift towards spatialisation represents a triumph over linearity and is considered subversive of narrative form and therefore good. What such commentaries ignore is that the digital domain is governed not by the forms which dominate cinema, depiction and narrative, but by data arrays: databases, spreadsheets, catalogues, search engines, info-bots, geographic information systems, mapping and other fundamentally spatial organisations of knowledge. Whether digitisation is cause or effect of this cultural drift is beyond the scope of this chapter. What is clear, however, is that the most intensively digitised films offer us entry to fictional worlds which become zones in which, in fantasy, we can play out not only the narrative on offer, but also a hundred more. In this sense, the effect, and especially the imaginary world of a film or film cycle (Federation Space in the *Star Trek* series, for example), has taken over from the star, not just as a box-office draw, but also as the prime site of fantasy for audiences. The recycling of vector graphical objects in film-associated games and their applicability to CADCAM manufacture means that this fantasy can be played out directly with toys and other products that are direct descendants of the objects caught on-screen. And diegetic worlds can benefit not only from spin-off markets, but also from the fan-base built up by audiences who continue the narratives of *Star Trek*: *Star Trek: The Motion Picture* (1979), *Star Trek II: The Wrath of Khan* (1982), *Star Trek III: The Search for Spock* (1984), *The Voyage Home: Star Trek IV* (1986), *Star Trek V: The Final Frontier* (1989), *Star Trek VI: The Undiscovered Country* (1991), *Star Trek Generations* (1994), *Star Trek: First Contact* (1996), *Star Trek: Insurrection* (1999) and of course three television series; *Star Wars*: including *Star Wars: Episode I – The Phantom Menace* (1999), *Star Wars: Episode II – Attack of the Clones* (2001), and a series of television spin-offs; *Alien* (1979), *Aliens* (1986), *Alien 3* (1992) and *Alien Resurrection* (1997);

and other cult series, giving individual films, and more importantly the formats of fictional worlds, immense value, greater even than that of the biggest stars. Far from subverting the dominant media, such post-narrative spatialisation works hand-in-glove with it.

Rather than time-based narrative, we have entered the era of the cinema of effects. Such is the case with *Gladiator*, where battle after battle becomes more and more spectacular. The film's time is marked as an experience of a sequence of visual and auditory shocks, rather than as an unfolding plot. Certainly the protagonist is on a journey: his desire to return home. But that journey becomes a desire to die, and his death travels with him from the moment of his wife's death, a static and unchanging point around which the quest narrative is structured. The doomed love of *Titanic* serves a similar function. These and many such narratives ('Neo, you are the One') of recent years devolve upon the recognition and acceptance of fate, a fate that is entirely against the concept of history as open-ended evolution and change. Sophisticated crane and Steadicam work operates in the same direction: to remove the temporalities of classical editing, replacing it with a view of spaces within which audiences orient themselves without reference to the rules of continuity cutting. Instead, temporal units become elements of a spatial structure in films such as *Pulp Fiction* and *Magnolia*, as much as in more obviously effects-driven films. Thus in *Independence Day* (1996), we know from the narration that the big explosions occur simultaneously. However, we do not only see them one after another: each is shown a number of times, and the moment itself is announced visually by a laptop computer's clock, aurally by 'It's time', and musically through a crescendo in the rhythm, prior to the actual explosions. Time, therefore, is not merely distended: it is spatialised.

A great deal of time has been spent talking about the shift from cinematic depiction to digital fantasy, no longer burdened or defined by the task of representation. But media, and especially digital media, are not only representational, a task undertaken only in specific circumstances and within film only truly attempted in the documentary. Media mediate. They stand between people, as the material forms of our relationships. The more those relationships appear to us as the ineluctable relation between objects in space, the less we can feel at home in an historical sphere of action. Spatialisation of the effect may appear to save us from the linearity of narrative, but the two are, to paraphrase Adorno, the torn halves of an integral tyranny to which, however, they do not add up. Immanuel Kant is largely responsible for the division of space from time when, in the *Critique of Pure Reason*, he argued that these two dimensions exist a priori, that is, before human thought. This binarism haunts the aesthetics of representation, and it is at this level that digital cinema works, altering and reconstructing the relations between temporality and space. The true task of digital cinema is not simply to free itself of representation. There is too much at stake in the development of digital documentary for that to be an option. Nor is it to become entirely spatialised, the ideal of a user-navigable immersive virtual reality. Nor yet is it to return to the linear temporality of narrative cinema. It is rather to create a new temporal art, capable of mediating relationships between people as historical and therefore as evolving and open. This new art of time will also of necessity be a new spatial art, as it will have to address as a given that relationships between people are now global. Network technologies give us an inkling of where such a vast art form might come from and the lack of access to it a sense of why it is so important to develop: only those who cannot speak for themselves are condemned to be represented.

Meanwhile those who are audiences for increasingly breathtaking spectacles find themselves in a curious double bind. The protagonist of *The Matrix* has to learn to want escape from its illusions, but as audiences, we want to remain in them. *Gladiator* offers a moral judgment on the Roman games, but we go to see it in order to witness them, even though our identifications (and possibly those of the Romans, too) are at least as much, if not more, with the victims as with the perpetrators. Such diegetic worlds are self-contained and exclusive: only those who participate are inside the world. Spatial fiction depends upon spatial exclusion, much as free trade depends on the immobilisation of would-be migrants. The new spatialisation of special effects cinema is as illusory and as damaging as the linear temporality of the narrative cinema it replaces. Reconceptualising media history, we leave behind the analytic/synthetic distinction, and even the space/time distinction, in order to envisage a cinema that is inclusive and for the first time recognises its destiny not as representation or storytelling, but as mediation, and its destiny not as a binarism, but as a dialectic.

Notes

1. See Fred Ritchin, *In Our Own Image: The Coming Revolution in Photography* (New York: Aperture Foundation, 1990); Derek Bishton, Andy Cameron and Tim Druckery (eds), *Digital Dialogues: Photography in the Age of Cyberspace*, *Ten: 8 Photo Paperback*, vol. 2 no. 2, Autumn 1991; Paul Wombell (ed.), *Photovideo: Photography in the Age of the Computer* (London: Rivers Oram Press, 1991); William J. Mitchell, *The Reconfigured Eye: Visual Truth in the Post-Photographic Era* (Cambridge, MA: MIT Press, 1992); Martin Lister (ed.), *The Photographic Image in Digital Culture* (London: Routledge, 1995); Kevin Robins, *Into the Image: Culture and Politics in the Field of Vision* (London: Routledge, 1996).
2. But see Graham Weinbren (ed.), 'The Digital', special issue of *Millennium Film Journal*, no. 34, Autumn 1999; John Caughie and Sean Cubitt (eds), 'FX, CGI and the Question of Spectacle', special issue of *Screen*, vol. 44 no. 2, Summer 2000; Tim Murray (ed.), 'Digitality and the Memory of Cinema', special issue of *WideAngle*, vol. 21 no. 3, 2001; Vivian Sobchack (ed.), *Meta-morphing: Visual Transformation and the Culture of Quick-Change* (Minneapolis: University of Minnesota Press, 2000). See also, Andrew Darley, *Visual Digital Culture: Surface Play and Spectacle in New Media Genres* (London: Routledge, 2000).
3. C. W. Ceram, *Archeology of the Cinema*, trans. Richard Winston (London: Thames and Hudson, 1965).
4. Vincent LoBrutto, *Sound-on-Film: Interviews with Creators of Film Sound* (New York: Praeger, 1994), pp. 13–49.
5. Harry Braverman, *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century* (New York: Monthly Review Press, 1974).
6. See Margaret Morse, *Virtualities: Television, Media Art, And Cyberculture* (Bloomington: Indiana University Press, 1998), pp. 71–98.

7. See Yvonne Spielmann, *Intermedialität. Das System Peter Greenaway* (München: Wilhelm Fink Verlag, 1997); Alan Woods, *Being Naked Playing Dead: The Art of Peter Greenaway* (Manchester: Manchester University Press, 1996).
8. Yvonne Spielmann, ‘Expanding Film into Digital Media’, *Screen*, vol. 40, no. 2, Summer 1999, pp. 131–45.
9. See Vivian Sobchack (ed.), *Meta-morphing*.