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A BACK STORY: REALISM, SIMULATION, INTERACTION

From a purely technological perspective the 1960s, a formative stage in the history of the modern computer, can be said to constitute the prehistorical era of the cultural forms and genres that I am concerned to explore here.[1] As functional performance improved and computation technologies became much more practicable (smaller, faster, more powerful *and* less expensive) it became possible to discern within the field a multiplication of possible lines of development, a focusing-in on areas for further research. This was coupled with a greatly increased alertness as to the nascent and future commercial opportunities that were opening up as work in the field progressed. The work undertaken in the research laboratories of the 1960s in areas such as information processing, modelling, remote control and manipulation, and graphic displays seems a far cry from today's computer animated cinema, arcade games and special venue attractions. Yet this is precisely where the technological link with these contemporary cultural forms resides.

Beginnings

One important example of the kind of focusing that commenced at this time is computer graphics. Highly sophisticated techniques of computer imaging are absolutely vital to the digital visual genres under investigation in these pages. At the beginning of their technological evolution, in the late 1950s, however, they consisted of little more than lines and dots on a cathode ray display screen. Efforts to improve and develop both the display screen itself and its graphics capabilities began at this time: both with respect to the visualisation of calculations under way in the computer, and in terms of its advantages as a user input mode. Similarly, the computer's ability – given the correct program and enough computing power – to model processes, events, states and so forth was another significant motive for pursuing visualisation technologies.

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Engineers and artists

Most of the early work put into developing such potential came from engineers and computer scientists working in corporate or academic research environments. A key example of such research was that into real-time interactive computer graphics. This came to practical fruition in 1963 in a system called *Sketchpad*, which allowed a user to draw directly on to a cathode display screen with a 'light-pen' and then to modify or 'tidy-up' the geometrical image possibilities so obtained with a keyboard. Though extremely primitive by today's standards, *Sketchpad* is viewed as a crucial breakthrough from which have sprung most of the later technical developments in the areas of so-called 'paint' and interactive graphics systems. By the mid-1960s, a similar system involving computer image modification was being used in the design of car bodies – a precursor of current CAD/CAM (Computer Aided Design/Computer Aided Manufacture) systems. And by 1963, computer generated wire-frame animation films – visual simulations of scientific and technical ideas – were being produced using the early vector display technique.

Many of the digital technologies and techniques underpinning current forms of visual digital culture were first developed in relation to research goals and technical problems that were construed in ways which had little to do with aesthetic applications. For the most part, the concern of those early computer scientists involved with computer graphics research was with perfecting and developing further what they saw as the computer's latent and extensive functional potential. Such work was undertaken in relation to ongoing research on commercial and military applications such as flight simulators and computer aided design. It would be incorrect, however, to claim that there was no aesthetic impulse operating in connection to these early centres of computer research. Some of the scientists and technicians involved in this nascent field of computer imaging began to look at their graphics in aesthetic as well as functional terms (see, for example, Franke 1971; Davis 1973: 97–105). In addition to concerted efforts aimed at various computer design processes and applications on the part of scientists, artists of the time began to see in the computer a new and potentially exciting means of aesthetic experimentation.

Those artists who began to explore this new means of image production did so as a way of augmenting their current aesthetic practices. For the most part the individuals concerned were mainstream modernists in aesthetic outlook and approach. Committed to modes of formalist image-making involving a sort of continual reworking of the self-same aesthetic axiom through experimentation with technique, they saw the computer as an instrument with great potential for the production of innovation in aesthetic form (see, for example, Vanderbeek 1970; Le Grice 1974).

Perhaps the best known of these early computer-artist experimenters is the late John Whitney.[2] Whitney's computer film work was guided by his attempts to draw a working analogy between abstract visual experimentation and music

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with its power to 'evoke the most explicit emotions directly by its simple patterned configurations of tones in time' (Whitney 1971: 26). His involvement in computer imaging began in the 1950s. Utilising outdated computing equipment junked by the military after the war Whitney began to construct computerised drawing machines. This led to the development of a fully automated system involving high precision integrated coordination and control of the entire production process (including drawing, motions, lighting and exposures) – a mechanical analogue computer, specifically designed to produce complex abstract film animations.

Like Whitney the majority of artists involved with computer image production in the 1960s worked in close collaboration with computer scientists and program researchers.[3] And many of the engineers and scientists who came into working contact with artists came to consider themselves – if they did not already do so – as producers of 'computer art' in their own right (see, for example, Noll 1967). To understand more fully the character of such collaborations and the shifting viewpoints they seem to represent, it is important to mention the broader context in which they were occurring.

Cybernetic serendipity

The 1960s is not only an era of intense practical development of new electronically and digitally based technologies, but also one of increased conjecture as to the nature of such technology and the promise it held for the future of society. Speculation was rife within the academic, political, cultural and business communities. The area was thought about in terms of the new cultural forms that would spring from it, the new aesthetics it would inaugurate, the new disciplines it would spawn, and the profound effects it would have on industry, work and leisure. The dominant tone of this thinking was of intense optimism: technology, particularly the new computer-based technology, was invoked as a panacea for the ills of the present.

Many within the artistic community shared this perspective towards the burgeoning new electronic technology and the cybernetic discourse surrounding it. Indeed, it is clear that the artist/technician collaboration already mentioned within the ambit of computer imaging, was an important aspect of a much broader 'investment' in new technology then being pursued by artists. Two exhibitions that now stand as emblematic of this tendency are the *9 Evenings: Theater and Engineering* performance events held in New York in 1966 and the 1968 London based exhibition *Cybernetic Serendipity* (see Whitman and Kluver 1967; Reichardt 1968).

The former involved works that issued from a collaboration between a group of American artists (associated with diverse fields that ranged from painting, theatre and choreography, to music) and a group of engineers. The latter was less parochial, drawing on work from the United States, Japan and Europe, it differed significantly from the former insofar as its focus was exclusively the

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computer and computer-related (or cybernetic) systems (see Reichardt 1968, 1971). It was an exhibition that attempted to demonstrate that the new computer technologies were soldering the unification of art and technology; producing a hybridisation of engineering and more properly artistic concerns. At the time, perhaps the most important theoretical advocate of this new technological optimism – at least as far as artists were concerned – was the media and cultural theorist Marshall McLuhan (see McLuhan 1968).

Another event, however, displays the more mundane and pragmatic dimensions of a maturing field. At the international symposium, Computer Graphics 70, there was a session on computer art – though a glance at the proceedings (Parslow and Green 1970) reveals it to be almost wholly overshadowed by the more utilitarian and commercial considerations that characterised the event. Here, clearly, we are already in a different world: back in the space of applied research and development where computer graphics were being viewed either as 'practical industrial tools' or 'research instruments'.

The proto-realists

It is within this functional/technical space of early computer imaging that we can locate the emergence of a problem that has preoccupied many of those working in the area to this day. It started out as a concern with the production of representational imagery by computer and, as the potential was realised, subsequently turned into a fixation with the perfection of simulated photo-realism. This preoccupation has considerable bearing on the development of the forms at the heart of this study. By and large, figurative representation was not a problem that troubled the first artists to become involved with computer graphics, it was, rather, the serendipitous possibilities for formal experimentation offered up by computer programming that they seized upon. On the other hand, representational concerns were present almost from the first in many of the uses to which computer scientists wanted to put computer images.

The desire on the part of scientists to model or simulate physical processes and events in space (and time) was a central impulse in the production of the earliest computer graphics and films. Whilst concurrent with the initiation of applied forms, work was under way on computer produced figurative imagery as a research activity in its own right. Even the work conducted in collaboration with artists had a decided leaning towards more figurative kinds of imagery.[4] At the end of the 1960s experimentation began into the production of algorithms for the production and manipulation of still, line-based figurative images.

Thus, a picture begins to emerge of computer imaging in the 1960s, which involves a complex and somewhat tangled set of interests and pursuits. There was the growing applied research and development into the area on the part of scientists, engineers and corporate researchers. But there was also an early and significant aesthetic interest on the part of experimental artists. There are clearly moments when the aims and explorations of artists and engineers appear to

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coincide. Indeed, it would seem that these mainly corporate-funded collaborations were highly productive, even when what the artist was getting out of them diverged from what the technician was learning. The artistic impulse certainly contributed to establishing and advancing the field in the first instance and undoubtedly the commitment of most of these early computer artist pioneers to a non-functional exploration of a pure visual aesthetic continues to this day as a certain marginal tendency within computer imaging.

Simulation and interaction

In the early 1970s the enthusiasm of certain of the 'hard' computer engineers for the possibilities that had been awakened in the previous decade begins to coincide with those of art critics and some of the artists themselves. At least this is so with respect to what were viewed as being the most likely aspects of future development in the field. Thus, computer scientist Ivan Sutherland, having extended his initial research on real-time interactive computer graphics into the realm of the simulated experience of three-dimensional space, claimed that through his computer displays he had, 'landed an airplane on the deck of a moving carrier, observed a nuclear particle hit a potential wall and flown a rocket at the speed of light' (cited in Davis 1973: 103). One can already discern in this statement a fascination with two key concerns: *simulation* and *interaction*. In this respect it is illuminating to compare Sutherland with McLuhanite art and technology critic Gene Youngblood. Writing at the same time about trends in computer imaging – or as he calls it, 'cybernetic cinema' – Youngblood argues:

> If the visual subsystems exist today, it's folly to assume that the computing hardware won't exist tomorrow. The notion of 'reality' will be utterly and finally obscured when we reach that point … [of generating] totally convincing reality within the information processing system … We're entering a Mythic age of electronic realities that exist only on a metaphysical plane.
>
> (1970: 206)

Meanwhile, video artist Nam June Paik began, in the late 1960s, to talk of future art forms in which he anticipated completely new levels of interaction and interfacing between the artist and/or participant and the work itself, calling such work 'Direct-Contact Art' (see Davis 1973: 106).

Those engineers, artists and critics of the 1960s who, somewhat prophetically, saw a cultural future for the new computer-based technology in terms of interaction and simulation were quite right. More than anything else this formative or primitive era of computer graphics established a set of interests and research pursuits which form the basis for later developments in such areas as image manipulation, real-time interactive usage, three-dimensional image

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simulation, animation and realistic image synthesis. In their different ways these have become central to recent cultural forms such as computer games, special effects cinema and simulation experiences. Simulation, understood as the representational copying or modelling of phenomenal reality both on a two-dimensional screen and in terms of three-dimensional *virtual* space, has increasingly engaged the attention of computer image research since the turn of the 1980s.

However, the domains within which it has developed, the applications to which it has been put and the different cultural forms that have grown out of it, have diverged markedly from those anticipated by 1960s art. If anything, it is the enthusiastic remarks of the technician Sutherland which best capture what has subsequently taken place in the cultural domain: in terms both of content *and* form. As we shall see, it is in the mass cultural domain that the potential of interaction and simulation has been most extensively employed.

Digital cinema

The rise of mainstream digital cinema, computer animation and certain significant and related sub-genres of both music video and advertising are intimately tied to the development of computer imaging which I began to unfold above. Yet, how did we arrive at the current situation typified by the ultra-realistic animation and spectacular effects of films such as *Jurassic Park* (1993), *The Mask* (1994), *Toy Story* (1995), *Mission: Impossible* (1996) and *Armageddon* (1998)?

We left the story at the beginning of the 1970s having noted a growing interest in representational image production on the part of certain computer graphics researchers as the 1960s wore on. This interest was to turn into a fixation by the end of the 1970s. By then, however, certain technical developments, which had encouraged the attentions of the commercial cultural establishment, had conspired to shift this preoccupation with figurative imagery to another level.

Realism

The upshot of this became the dogged pursuit of a somewhat revised goal: the development of digital techniques for the production of so-called 'realism'. The notion of 'realism' has dominated computer image research and practice from the late 1970s and by and large it still prevails today. Until the 1970s image production had come to rely on the vector display technique for image generation: a process that limited the kinds and complexity of images produced. Eventually a different process of image manufacture and display emerged. Turning upon the calculation and display of 'pixel' values – so-called 'raster displays' and 'frame-store' techniques – these were much more conducive to the production of 'realistic' imagery. There are, of course, a host of differing and

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often contradictory conceptions of what constitutes representational realism. The one that came to discursive prominence within computer image research and practice is perhaps the one with which we are all most familiar. Quite simply it turns upon the notion of the proximate or accurate image: the 'realisticness' or resemblance of an image to the phenomenal everyday world that we perceive and experience (partially) through sight. For the majority of those involved with digital imaging at the time, the yardstick of such verisimilitude was photographic and cinematographic imagery.

Beyond the ultimate goal of producing 'photographic' imagery by other means, the motives for such a fixation with realism are diverse and appear to depend upon imperatives that are active within the particular domain in which they develop.[5] If the factors shaping the representational and 'realist' thrust in practical and scientific domains tended to have a functional basis, in the sphere of mass visual culture – the domain of entertainment cinema – the support for realism was part of a more general ideal, indeed, it comprised the predominant aesthetic regime. Clearly, computer imaging only really becomes interesting to the producers and distributors of Hollywood cinema when it can operate effectively within the parameters of its own established commercial aesthetic. By the middle of the 1980s the popular or journalistic criticism attached to Hollywood had, on the whole, embraced computer imaging and was enthusiastic in support of its potential. The pundits clearly believed they could see in this new imaging technology, intimations of novel extensions of the Hollywood aesthetic. They envisage the computer introducing a new degree of expressive 'freedom' to the established media of photography and cinema: one that would maintain the look of photography whilst cutting it loose from its referential ties (see, for example, Sutherland 1976; Sørenson 1984a and 1984b). Eventually, what began to fulfil such expectations was the computer's phenomenal rejuvenation of special visual effects, so intimately tied to the perfection of photo-realism. But we are jumping ahead of ourselves.

A considerable time was to elapse before digital imaging techniques became firmly established within mainstream cinema and related domains such as television, advertising and music video. Work in both software (or program) and hardware (machinery) development was angled towards techniques of animation, image manipulation and processing, image compositing, motion control and three-dimensional (still and moving) image generation. At various moments in the early years of this process such research fed into the production of particular films. Thus *Westworld* (1973), *Futureworld* (1976), *Tron* (1982), *Star Trek: The Wrath of Khan* (1982) and *The Last Starfighter* (1985) are now viewed as milestones in the history of digital cinema. The latter was hailed at the time of its release as a milestone of 'realist' computer graphics – the beginning of the gradual, yet eventual, takeover of Hollywood by computers (see Robley 1984; Sørenson 1984a).

By the mid-1980s many computer graphics companies had begun to make significant inroads in introducing digital imaging to television advertising,

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music video and animation (see, for example, Onosko 1984; Baker 1993). The work of developing systems and software for digital moving image production which had been undertaken in preceding years was now reaching fruition. Among the most celebrated work to appear in the commercial material shown at the annual ACM-SIGGRAPH (Association for Computer Machinery, Special Interest Group in Computer Graphics and Interactive Technology) Convention of 1986, was the music video for Mick Jagger's *Hard Woman*, the 'gold series' TV advertisements for Benson and Hedges, and the short entertainment animation *Luxo Junior*. Collectively these texts displayed the huge strides that had been taken with respect to the goal of 'realistic' digitally generated imagery and in terms of digitally assisted image compositing.

Significantly, by this time much of the research and development for commercial cultural applications had begun to leave the laboratories and was taking place within the computer graphics companies themselves. By 1985 some of these companies were also beginning to market their own proprietary hardware and software graphics systems to other producers.

Manipulation and synthesis

It is from the mid-1980s onwards that various modes of digital imaging finally establish a significant presence within the moving image forms of mass culture. Two somewhat distinctive strands of research and development underpin this advance and yet they are often closely related in terms of their deployment in the production of moving image texts. They are commonly referred to as 'image manipulation' and 'image synthesis'.

In *digital image manipulation* the computer is frequently employed to effect changes in images which it has not itself been involved in producing. There are basically two dimensions to this kind of work, though increasingly in productions associated with the moving image domain, these are combined or employed together. The first is connected to techniques of what is known as 'image processing', the second to techniques of image compositing. Image processing involves already existing imagery, for example, photographs, photographic reproductions, films and videos being digitally stored in the computer to be subsequently worked on or altered in a multitude of possible ways. These range from the addition and/or removal of blur, the undetectable removal of a particular part of the digitised image, the enhancement or changing of colour, to the 'crispening', 'warping' and merging of parts of the image. The compositing dimension, on the other hand, refers to the aspect of image combination. Here the already existing images may include 'found images', images deliberately produced for combination, or a mixture of both. If it is the former, then digital compositing may be employed along with some of the techniques of image processing to superimpose imagery from one source on to imagery of another. When this involves moving images, then techniques of digital motion control may be utilised together with techniques of image

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processing to ensure the seamless combination of the disparate source images within the frame or shot.

Such techniques are now widely used within television, advertising, publishing, video and cinema production. Indeed, these new and still evolving means have led to a new emphasis on the so-called 'post-production' aspect of moving image-making, and a host of new companies based on this increasingly important aspect of moving image production have sprung up since the mid-1980s.

Digital image synthesis is perhaps the area in which the 'realist' aesthetic goal has been most tenacious and influential. The key defining feature of image synthesis or image generation is that the images so produced are created *within* the computer. This involves the input of mathematical data to the computer's memory that effectively describes or models and then stores whatever is to be imaged. Once this is done the model can be manipulated, altered or refined in some way. Next, the model is converted into a picture: a particular view of the model is chosen and various techniques are then employed to complete or render the final image. A variety of techniques have been developed both for the initial introduction of the abstract model into the computer's memory and for the completion process – the viewing and rendering – of the final image. Especially after the adoption of the raster display system, researchers were much preoccupied with developing ways to produce 'convincing' lighting effects and surface textures to the objects and scenes imaged. Most of the concentration in recent years has been centred upon the generation of three-dimensional imagery, so-called because of the initial model described and stored in the computer. An underlying model which is three-dimensional, even though it will eventually be seen as a flat image, perhaps printed on paper or displayed on a video monitor or film screen, produces solid looking and hence more 'realistic' imagery. These basic procedures are more or less the same in both moving and still image generation, though the animation of scenes is obviously far more complex, requiring additional kinds of computation to produce and capture both the movement of figures and the virtual camera within the virtual three-dimensional set that contains the action.[6]

Pixar and 'ILM': flagships of manipulation and simulation

As early as the 1970s the general trajectory of developments in digital cinema to date had *already* been anticipated. In a popular review of the feature film *Futureworld* (1976), among the first Hollywood films to include computer generated images, areas of work are located and certain technical potentialities fixed upon that have been embraced and sustained as goals for research and development right up to the present (Sutherland 1976). Thus the aim of eventually being able to produce films without the present technical apparatus of sets, props, cameras, lights and the like is introduced. So also is the notion that soon there will exist synthetic actors playing scenes in such synthetic settings.

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The necessity is underlined, particularly in the entertainment sphere, of the urgent drive for near-photographic realism in digitally synthesised imagery, the suggestion being that the computer film will only really be a success when this is achieved. The reviewer's final speculation is that in the future there may well be forms which involve experiential interaction within a computer simulated world: what we now call 'virtual reality'.

In 1995 the first feature-length computer synthesised film *Toy Story* was released. This film realises, in part at least, the expectations raised in the 1970s of producing a film without the traditional apparatus. The film is a highly sophisticated and accomplished example of three-dimensional computer animation. It certainly adds a new quality or dimension of 'realistic-ness' to traditional Disney-style cartoon animation – one might even say a certain photo-realism is achieved relative to the rest of the genre. Ultimately though, one still has to say that the characters *are* clearly cartoon characters and that they all operate within generically familiar cartoon scenarios: the computer generated film that replaces live action has yet to appear. The technical possibilities mooted over twenty years ago have partly been met, certainly they are still being striven for, but, as usual, what is more interesting is what has been happening in the meantime (see, for example, Dixon 1995–6).

Two companies stand as emblematic of the two main trends of development within digital imaging since the 1980s: Pixar and Industrial Light and Magic (ILM). Pixar is primarily associated with computer image synthesis. It represents the important *animation* dimension of current digital cinema. Perhaps more purist in its approach to computer image production than companies operating within the live action sphere, it strives to produce *all* of its moving imagery with the computer itself. This imagery is, within its cartoon-influenced terms of reference, highly realistic. It involves refined techniques (programs), many of which were first developed by the company's own research team, for the various phases and procedures involved in three-dimensional modelling, animation and rendering. Work on perfecting software that further polishes the movement of figures, facial expression, lip-synch and so forth, as well as the refining of programs for rendering the scene all contribute to the underlying 'project' of seeking to produce synthetic photo-realistic imagery by other means. Although the content of the films produced over the years by Pixar is rather unexceptional, particularly to those who are familiar with Disney cartoons, the images themselves are not. *The Adventures of André and Wally Bee* (1985), *Luxo Junior* (1986), *Red's Dream* (1987), *Tin Toy* (1988), *Knick Knack* (1989), *Toy Story* (1995) and *A Bug's Life* (1998) are, above all else, films which have introduced striking novelty and effects at the level of the image to the domain of moving images.

The main business of the company ILM lies with techniques of special effects in all their different aspects, and from the very beginning computer imaging

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was crucial to this work. Over the years the development and use of digital techniques has come to play an increasingly central role in ILM's work for the numerous live action-based film productions that the company has been involved in. The studio first used digital techniques for the special effects on *Star Wars*. The choreography of spectacular space battles and spaceship footage in this film was realised with a convincing verisimilitude that wholly overshadowed previous work of a similar kind. This impression was achieved in large part by the digital pre-programming of camera movement: a technique offering both an extraordinary degree of precision and the possibility of infinite repeatability. Now, not only could many layers of moving imagery be superimposed and married together seamlessly, but also the camera itself could appear to move freely (i.e. pan, tilt, zoom, track and so forth) within the space that was being represented.

What is important about the above from the point of view of this account is the recognition that digital techniques are associated from the beginning with *assisting* in the production of visual effects within already established forms such as live action feature film. Indeed, so-called 'special effects' have, since the production of *Star Wars*, been enjoying a remarkable renaissance. ILM (along with the numerous similar enterprises that have emerged subsequently) have played a significant part in the progress of this renaissance. The emergence of visual digital cultural genres themselves coincides with this regeneration of special effects. Broadly, it might be argued that much of the time these companies have developed and used digital techniques as a means both of improving the integration of established visual effects techniques and of enabling their further refinement.

Thus, it must be stressed that the computer has only *partially* replaced live action cinematography as an originator of images and scenes of apparent digital photo-realism. For, despite the increasing use of computer generated imagery in the 1990s, such scenes are still far more likely to have been contrived through a combination of computer assisted and manipulated traditional effects than through pure computer generated image production. Fuelling such development are recent improvements in techniques for converting original 35 mm film footage into a high-resolution format susceptible to digital manipulation and then back to film again with negligible loss of image quality.

Over the years ILM have worked on numerous films containing such effects.[7] Many of these are included in a distinctive corpus to have emerged within new Hollywood cinema as a predominant genre or type in the late 1980s and 1990s (see chapter 5). Cutting across traditional genres such as adventure, science fiction, fantasy and the like, these films should perhaps be more properly defined not by what kind of fiction they exemplify so much as by their sheer technological density, a characteristic that is evident in their display of outlandish and spectacular illusionism.[8]

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Television and video

Just as certain mainstream feature films now rely on the renovation brought to special effects by the computer, so too do advertising, music video and, latterly, television production draw heavily on the potential of the computer in this regard. Since the 1970s TV advertising and the music video have both acted as key sites for the development and exposure of techniques of digital image generation and animation, and of digital image manipulation. Like the cinema, both advertising and music video have since the late 1980s each produced a significant corpus or sub-genre that has formed around displaying the distinctive imaging capabilities of digital techniques (for examples, see chapters 4 and 5 below). In certain respects – though, crucially, not all – advertising and music video, have used the new technology in ways that deviate somewhat from the aesthetic predominating in the cinema. This, I believe, is attributable to their particular and distinctive overall aesthetic goals; or, more technically perhaps, to their differing institutional modes of representation (see, chapter 5).

The rapid advances in programming technologies coupled to the process of circuit miniaturisation that first began to take effect in the 1960s has meant that within a period of barely twenty years, digital imaging techniques have not only integrated with established means of production but in certain respects are now starting to replace them. In the domain of mass visual culture the technological shift from analogue to digital now appears to be irrevocable. With the emergence of the computer, entirely new ways of making images, together with distinctive ways of assisting and augmenting traditional methods and techniques of moving image production have become commonplace within contemporary forms of visual cultural production. Nowadays it is safe to assume – even when the work of the computer does not figure in a displayed manner in a music video or TV advertisement – that it has been involved nevertheless. So pervasive have digitally based techniques become in post-production processes, that even the music tape or advertisement that is being produced in a 'traditional' manner will have had some digital input, even if that input has had no tangible effect on the final outcome of the piece. Digital techniques have developed to the stage where they now appear to be on the brink of effectively replacing previous mechanical (analogue) technologies as the predominant means of producing moving images. A whole industry – increasingly multinational in character – of hardware and software producers together with a multitude of companies specialising in computer generated animation, digital special effects, digitally based post-production work and so forth, has grown up in relation to this development. Of course, new Hollywood and its immediate moving image family (advertising, music video and television) are not the only domains of contemporary visual culture to be affected by digital technologies. I must now introduce and sketch the rise of two further members of this extended family, starting with computer games.

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Computer games

By the early 1980s computer games (or video games as they are often called) had become firmly established as a new and significant mass cultural form.[9] As we begin the new century games have come to rank alongside cinema in terms of market size and cultural importance. Whether in the arcade or the home, the computer games of recent times are complex in their formal make-up, engaging players in various modes of real-time hands-on control of, and response to, technically sophisticated images, action and sound. Most current games' imagery is in colour, it is figurative, and – depending upon the genre – usually highly detailed and realistic; increasingly, it is likely to involve three-dimensional animation.

The story of the evolution of computer games as a visual cultural form since the 1960s is partially tied to the developments in digital imaging already sketched in relation to the emergence of digital cinema. Clearly, the headway made in the domain of computer imaging has fed into the growth of computer games since their commercial appearance at the beginning of the 1970s. Yet there is far more to the historical development of the form than this. Certainly, the computer game emerges as a historically discernible mass cultural industry a good decade earlier than its cousin digital cinema.

The hacker

The early or prehistory of games coincides roughly with the emergence of computer imaging (i.e. the 1960s). However, it was not from within the graphics milieu discussed earlier – not, at least, in any obvious or direct sense – that the first games emerged. There is something of an anecdotal element to the early history of the computer game. The first games are invoked as the diversions of a certain type of computer scientist who – in the early 1960s – was otherwise occupied in more 'serious' (if still somewhat idiosyncratic) pursuits (see, Brand 1972; Levy 1984; Haddon 1988). It is one type of programmer – the so-called 'hacker' – who has been most consistently associated with devising and playing the prototypes of commercial computer games.

Hackers are people who have developed extraordinary programming expertise. They have a monomaniacal relation to computers and what they can be made to do if the right instructions are fed into them. Hackers are to be distinguished from other programmers mainly by the way in which they make programming an end in itself. The hacker is often characterised as a perfectionist; involved in either attempting to right those parts of his program that are not functioning as smoothly as they might, or, alternatively, adding elements that are designed to improve what is already there. Levy refers to this phenomenon as 'making tools to make tools' (1984: 142). It is interesting to read, alongside Levy's enthusiastic and colloquial account of hackers, the

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somewhat different though highly informative accounts of hacking and hackers by Turkle (1984) and Weizenbaum (1984).

The hacker's approach to computer programming has been characterised as 'playful' rather than utilitarian; in this way hackers are to be distinguished from other technicians (see, for example, Turkle 1984: 2–11; Haddon 1993: 126). Certainly, this rather curious conception of a compulsive yet 'playful' approach to programming *per se* is seen as predisposing the hacker towards the creation of games. *Space War* – the first game to emerge within MIT that got any exposure outside of its birthplace – is seen as typifying the hacker's predilection for highly formalist aesthetic modes (see Brand 1972; Turkle 1984).

Whereas divergent currents were involved in the first stages of computer image exploration, the same cannot be said of computer games: games it appears were created within a mileu that was highly uniform in terms of its affiliation and the practical and cultural interests of those affiliates. Indeed, in certain respects computer games were from their very beginnings grounded in preoccupations, notions and practices which to this day – despite other quite phenomenal developments (see pp. 28–30) – have remained remarkably constant. Certainly, descriptions of that 'first' game, *Space War*, seem extremely familiar. The game usually involved two players who each had real-time responsive control of manoeuvrable spaceships and the missiles that they fired at each other. The 'action was continuous, leaving little pause to stop and plan. It called on physical reflexes as much as on strategy' (Haddon 1993: 132). *Space War* is the archetypal battle or shooting game; the original of what has subsequently come to be known, in its myriad arcade and home computer variants, as the 'shoot-'em-up'.

It is important, however, to note that these early games involved primitive forms of real-time interactive graphics. *Space War* was created at the same time and in the same institution that computer graphics pioneer Ivan Sutherland was completing his doctoral dissertation ('Sketchpad: a man-machine graphical communication system' (MIT Lincoln Laboratory, 1962)). Were those hackers responsible for *Space War* aware of Sutherland's work in the area? Certainly – at the level of programming or 'hacking' a game – lie the very same problems of *interactivity* and *simulation* that were preoccupying those operating in the domain of computer animation and cinema at the end of the 1960s. Initially, it is the aspect of real-time response – what subsequently comes to be known within the form as 'gameplay' – that most interests these first computer games producers. However, it is not long before the visual dimension assumes a much greater prominence within the form – particularly as the computer game progresses through its commercial history and as graphics capabilities develop in sophistication.

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A new visual form

The computer game sprang 'almost fully formed' from the powerful minicomputers and mainframe machines that occupied the computer research centres in the 1960s. Driven by a certain technological obsession, technological in make up, and at the same time firmly rooted in form and content in popular genres – science fiction, Tolkienesque-fantasy and pinball – the first computer games also clearly locate themselves from the first within the space of commercial culture.

There are two facets to the rise of the computer game as a digital visual form: its development as a public form of entertainment via the arcade or coin-operated machine, and its development as a private form of entertainment through machines and software designed for use at home. The first commercial development took place in arcades at the beginning of the 1970s, though home development was to follow closely on its heels. Indeed, after 1972 the two strands evolve in parallel and relations between them are extremely close from the very beginning, not least because the dominant company of the early period – Atari – produced both hardware and software for both spheres. This link has continued unbroken right up to the present. Only the emergence of the personal computer introduces a certain discontinuity. Though, even here, links are quickly asserted at the level of software, for eventually games initially played in the arcade are converted for both home consoles and personal computers (PCs).

On one level the character of the connection between arcade games and home games is easy to describe: traditionally the arcade with its machines dedicated to the repeated delivery of one specific game, has always had the edge in terms of computer processing power. Thus in terms of the complexity and sophistication of 'game play' and audio-visual elements, the arcade machine has always held an advantage. The home computer game – continually hamstrung by price considerations – has until recently struggled to emulate the constant advance of its public and more technologically powerful relation. Things are not quite so simple however.

Arcades and consoles

The advances made in microprocessor technology led to the appearance of the first commercial games outside of the research laboratories. Dedicated games machines could now be built which combined both the TV screen and the player control of the image afforded by the computer. And, if the first stage of computer games history is that of the hackers and the 1960s, then the second commences with *Pong* and the beginning of the commercial exploitation of the form in the 1970s. During this period computer games slowly develop and grow in the arcades until, at the end of the 1970s, there is an explosive growth in interest in the form. The game that initiated this period of intense popularity was the prototype 'shoot-'em-up' *Space Invaders*. When this game was first

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released in Japan – which is where it was developed – its rapid rise in popularity had been quite phenomenal. And the release of the game in the US and Europe had a similar impact, prompting a sharp escalation in arcade game development and manufacture. During this period of video game fever, a host of new games were released into the arcades. Many of them were variations of the *Space Invaders* combat theme, indeed, the majority of them were 'shooting' or 'battle' games – 'twitch' games as they came to be known. Such games required high degrees of concentration, hand–eye coordination and rapid reflexes.

Visually, these early games tended to be highly schematic, with flat geometrical figures composed of dots or vector lines, action which took place against a flat two-dimensional background, and an increasing, though variable, use of colour. Sound effects were beginning to play more of a part in the experience, and a range of monaural noises were attached to the various on-screen opponents and to actions. The shooting game – and among the many to emerge at this time were *Galaxian*, *Asteroids*, *Defender*, *Battlezone* and *Pleiads* – was consolidated as the staple of the arcade, a position which it holds to this day; in fact it is one of the main kinds of the whole computer game form.

From the first there had been attempts to build games around flight and driving simulation technology, and these continued to appear during the first video arcades boom, as did some of the first games based upon attempts to produce a simulated experience of sports such as soccer and golf. At the same time, other kinds of game such as *Pacman*, *Lunar Lander* and *Donkey Kong* moved away from the shooting theme in various ways, thereby prefiguring subsequent genre developments. The arcade game *Donkey Kong* is significant as an early example of an enormously successful type of game that has subsequently come to be known as the 'platform' game. In this kind of game the player usually controls a character whose ultimate objective involves progression through a particular location filled with a variety of obstacles.

Alongside these developments there was a parallel process under way with respect to home computer games, or 'video games' as they are called. Throughout the period under discussion this took the form of TV games which were played via consoles attached to the domestic TV set. Initially, these consoles were limited to playing only those games that were encoded on its fixed chips. However, since the semiconductor manufacturer Intel had already announced in 1971 that it had developed a 'micro-programmable computer on a chip', it was not long before such technology was installed in home games consoles. Once it was – from the mid-1970s on – games machines became 'potentially "software players" like hi-fis and other home based delivery systems' (Haddon 1988: 66). Most of the successful games first produced for the coin-ops were copied for home consoles, though for those familiar with the original versions the home games were only a pale reflection of their more sophisticated because more powerful relatives.

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Games on the first PCs

One important upshot of the transition to microprocessors in the middle of the decade was that it encouraged a greater separation between software and hardware development and manufacture. By the end of the 1970s it was not just the huge companies like Atari who were designing games software. Independent companies had begun to emerge and, through licensing agreements, were developing game software for the machine manufacturers. As the decade drew to a close these client manufacturers were not just producing software for dedicated games machines but increasingly for personal computer manufacturers such as Apple, Commodore, Tandy and even Atari itself.

For the 1970s are also the period in which the microcomputer (or PC) begins to take shape in the US. It was mainly computer hardware enthusiasts and program 'hackers' who initially pursued the idea of converting the new microprocessing technology into programmable general-purpose *personal* machines (see Freiberger and Swaine 1984). As these prototype home computers began to emerge in the second half of the 1970s – to be bought for the most part by computer 'hobbyists' – a preoccupation with software applications designed to display what such novel machines could do, took hold. Programmes centred on games were a central component of this process of demonstration and exposition. However, hobbyists apart, the new companies were already beginning to capitalise on a distinctive and fast growing kind of consumer, one who merely wanted to use the home computer as a delivery system for pre-programmed software.

Whereas the arcade and home console's reputation was built mainly around action genres – shoot-'em-ups and simulations – home computer game playing enabled the pursuit of the more cerebral puzzle-solving and map-making adventure genre. Ultimately, it would seem that the reasons for this have to do with time. For these games do not rely on rapid physical reflex, on the contrary, they often require long periods of reflection and information assessment before options are acted upon via the key board – indeed, they are designed that way. Clearly, both practical and financial (profit) considerations militate against these kinds of game appearing on arcade machines. Of course, the new independent games software companies also converted many of the arcade games of the time for the personal computer. However, one of the main contributions of these companies was the development of the fantasy/adventure as a distinctive game type.

The emergent independent games industry based around the microcomputer and founded largely on the interest of hackers and hobbyists operated largely along artisanal lines. Throughout the boom period of the early 1980s and beyond, both in the US and Europe, this hobbyist element of the young independent games industry encouraged a production process based around individual programmers working on a commission basis. Game writers worked in relative isolation on the conversion of an existing game or the development and perfecting of a new one.[10]

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All of this was to change during the 1980s. If the 1970s and early 1980s had been the time of the 'coin-op' and the home games console, the rest of the 1980s was the decade of the home computer as far as game playing was concerned. During this period home computer hardware advanced from cassette to floppy disc, thus speeding up the time it took to load games on to the machine. At the same time the power of the machines themselves increased, which meant faster response times when playing, increased sound and image capabilities, and/or more elaborate or complex games.

Gradually, the dedicated player or user superseded the hobbyist who had been concerned to build machines (from kits) and to program as well as play. As the software companies began to cater for this kind of consumer, as the capacities and capabilities of the machines advanced, and as the market form itself matured, then so, inversely, did the maverick or independent programmer begin to recede. For, as the computer games industry grew and began to show a potential for stable profit making, so, slowly but surely, did the giant multimedia corporations become more centrally involved, investing in both hardware and software development and in lucrative licensing agreements with Hollywood and TV. Marketing (management of research, promotion and advertising) became more closely tied to production schedules. By the end of the 1980s, regulated teams of programmers, sound engineers, graphic artists, animators and so forth had largely superseded the freelance programmer.

This eventual regulation of the industry is also of course centrally related to the development of the form itself. In ways that closely resemble the industrial development of Hollywood and pop music as cultural forms and institutions, computer games have settled quickly (much quicker than either of the former) into a stable form with a limited number of 'genres' or game types. Like the mainstream cinema before it, computer games production appears to involve a process of refining, improving and 'innovating' within a set of formal parameters which remain stable from the outset, only changing, if at all, extremely slowly and over a relatively long period. Increasingly, as we shall see, the element of producing a novelty-effect within the repetition of a well worn game format, has rested upon the production of a greater sense or impression of realism within the game experience.

The return of the console

Having – to an extent at least – effectively seen off consoles dedicated solely to computer games playing in the 1980s, the personal computer sees them return with a vengeance in the 1990s. Perhaps one reason for this largely successful challenge to the growing supremacy of the home computer rests with the fact that it was becoming a general purpose machine – more and more people were using the personal computer for practical pursuits such as word-processing, accounting, publishing and so forth.

Yet, what also appears to have helped to re-establish the dedicated home

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games console, was the cartridge-based character of its software and the relatively low cost of the consoles themselves. Cartridges meant virtually instant playability, plus they could hold more information, which meant that a player did not have to wait for the game to be loaded, nor did s/he have to swap disks during play as was often the case on the microcomputers of the day. Certainly, the console – tenaciously promoted as a superior delivery system in terms of response and playability – triumphed in the long run. For, with the development of more powerful systems (which entailed smoother interfacing, improved response, more realistic characters, smoother motion and so forth), consumption of such machines and the games they play has grown enormously (see Hayes and Dinsey with Parker 1995).

The first years of the 1990s is a period of near-monopolistic manoeuvring between two companies – Nintendo and Sega – for leadership of the home console computer game market. In conjunction with carefully managed and hard fought publicity and advertising campaigns both sides systematically refined, restyled and increased the capabilities of their hardware. Of course, the games themselves had been 'upgraded' and 'reinvented' and a host of new ones had been released to display these improvements in delivery capabilities. Central to each were their particular versions of the popular platform genre based upon the numerous *Mario Brothers* games for Nintendo and *Sonic the Hedgehog* games for Sega. However, the other major action genres are all strongly represented on their consoles, and the two companies have been at the forefront of the 'innovation' which has taken place in the form of these games (see pp. 30–1). Though others have entered the market to challenge their monopoly (see Hayes and Dinsey with Parker 1995).

However, the 1990s are only partly the story of the rise to supremacy of the console – important though this undoubtedly is. The playing of games in arcades has continued to evolve. One of the functions of the arcade is to premier new games before their release on home platforms, which are now beginning to deliver comparable experiences in terms of graphics and interactive response. In addition, the dedicated 'one game only' machines of the 'coin-op' have concentrated upon enhancing even further the experience of *as ifness* that is central to the game-playing experience. Which is to say, they refine the elements of a single game experience along the lines of increasing the illusion of participative engagement. Thus we see arcade games where the interface no longer involves mock-ups of racing car interiors, but rather the cars themselves with a response to the screen to match. In addition, many games now include elements of so-called 'virtual reality' technologies; that is to say, machines which incorporate head-mounted display helmets, and/or synchronised movement. Similarly, the home computer has continued to grow, evolving in its latest manifestation into a powerful multimedia system. PCs now operate CD-ROM, have the capacity to link up to the Internet (for multi-player games) and – with greatly improved sound and image reproduction – are just as capable as the dedicated console of playing the most sophisticated games.

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The ascendancy of the personal computer in the 1980s brought with it a certain re-balancing of games genres, such that the 'slower' games of exploration, fantasy and puzzle solving achieved something approaching parity with action genres in terms of popularity.[11] Yet, it is the 'twitch' games – the 'shoot-'em-ups', 'beat-'em-ups', 'platforms' and 'racing' games – that continue to be the most popular. And the rise of the dedicated home console in the 1990s has further underlined this dominance. The majority of the games made for and played on the 1990s home consoles have been action games, latter-day examples of *Space War* and *Space Invaders*.

Yet, though the recent action games share the fundamental characteristics of real-time control, fast hand–eye coordination, strategy and shooting, as their early predecessors in other respects they could not be more different. Thus in extremely popular mid-1990s examples of the shoot-'em-up game, such as *Doom*, *Hexen* and *Quake*, the player's viewpoint is first person, with the screen representing a direct view of the scene as if seen through the player's own eyes. If the player turns, runs, leaps, stops, then these actions are synchronised and matched accordingly with changes and movements on the screen, producing the sensation of being there. The environments of these games are rendered in extraordinarily realistic detail, with naturalistic surface texture, dramatic lighting effects and subtle use of colour. Nowadays the majority of adversaries – monsters, zombies, aliens and so forth – are rendered and animated with the same high levels of surface accuracy and increasingly this is combined with a persuasive anthropomorphism.

The institution of computer games

Less than a decade after it was originated the computer game became a new culture industry. Barely twenty years later is has become one of the major institutions of contemporary visual culture. The rise of this industry has produced new kinds of manufacturer, dedicated to the production of machines for game playing and to the production of games themselves. New companies have grown up around these different, though interconnected areas of production, and as the industry has grown so has interest in it from producers and distributors in older and well established areas of popular visual entertainment. Many of the original games companies have either disappeared or been incorporated in larger conglomerate concerns with their own computer games divisions.[12]

In the field of software production – the life-blood of the industry – similar developments have taken place. There is now both in-house software design by the hardware manufacturers who control distribution and numerous third party software houses that operate through licence agreements. In addition, most of the Hollywood studios now have computer game production subsidiaries, as do many of the established computer animation companies.

In the case of Hollywood, licensing film titles to computer game manufacturers for tie-in productions has long been commonplace. However, it is at the

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level of game design and development that a confluence is occurring in terms of underlying aesthetic ideals. Unsurprisingly, the dominant visual aesthetic of verisimilitude is now viewed as the main sign of success and progress within the form. This shares much in common with the prevailing aesthetic of digital cinema, especially in terms of the illusionist goals fuelling the endeavours of those involved. In this respect, the main difference between the two lies with the fact that, unlike cinema, games involve the element of so-called 'interaction'. This means that the player has an element of control and – within certain limits – is able to act upon that which appears within the audio-visual field of the screen. In the case of the computer game, this defining element of the form has become an additional and vital factor in a constant striving for greater and greater levels of illusion. Only now, the illusion is not just the impossible photography of digital cinema (*just as though* it had been photographically recorded), but rather of producing an experience that is *as if* one were actually taking part.

Given the above, then perhaps it is not surprising that the current character of games production is one of increasing cooperation and integration between other sectors both of the traditional and the digital imaging domains. Nowadays, the research, development and production of games can take up to two years or more and cost as much as several million dollars. Both digital and traditional forms of animation play a central role in games imagery: and the techniques of classical animation are being married with those attached to the digital cinema, such as, 3-D modelling, ray-tracing and motion-capture. Indeed, as data storage technologies become more powerful, traditional live action imagery is being incorporated into interactive programs. Although this has happened in the domain of CD-ROMs oriented towards reference and educational uses, software companies are already producing so-called 'interactive movies': hybrids of movies and computer games where the spectator selects options to determine the way the plot unfolds.

Special venue attractions

Terms such as 'special venue', 'special attraction', 'ride film' and 'simulation ride' have become common currency in the past decade, particularly in the context of mainstream cinema and the popular criticism surrounding it. The terms are used to refer to a range of phenomena which collectively make up a distinctive dimension of contemporary audiovisual entertainment, one which has grown rapidly since the 1980s – a fact that is related to many of the developments in the digital cinema described above. Special venues are exhibition spaces that are dedicated to showing a variety of non-traditional forms of cinematically related spectacle entertainments. These range from purpose-built theatres to specially adapted exhibition sites in locations such as theme parks, shopping malls, urban centres, hotels, amusement arcades and the like.

The term 'special attraction' is used to refer to what is exhibited at such

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venues. Currently, the two main categories of special attraction are Imax films and the 'simulation ride'. Significantly, however, there are variations and hybrid forms of both of these emerging all the time (see pp. 33–5). Motion simulation-based attractions employ a hydraulically moveable platform (which supports the, usually seated, audience); the pre-programmed movements of the platform are synchronised with projected moving images and sound to fabricate the sensation of travelling. Imax (and Omnimax) films are shot and projected via specially designed film recording and projection systems. The original cinematography uses 65 mm film stock and this then gets printed on 70 mm for projection, the resulting image is ten times larger than conventional 35 mm film. Imax films are projected on to giant rectangular screens and Omnimax films on to giant spherical screens. The sheer size of the screen causes the spectator to lose sight of its edges and this produces a sensation of proximity and 'engulfment'.

Imax and motion simulation

Fundamentally, Imax cinema is a variant of traditional analogue cinematography. It does not depend upon digital techniques – though there are several reasons why it is important to the background history being sketched here (see T. Wollen, 1993). In the first place, Imax is a pioneer of the special venue attraction. Second, it has evolved in its own manner under the same aesthetic rubric of 'realism' that is central to the two broad areas of digital culture already introduced. Finally, in the same way as mainstream cinema, Imax systems are themselves succumbing to the lure of the digital, and simulation rides are now being produced in the Imax and Omnimax formats. Imax films operate within a perspective of both perfecting and augmenting the dominant ideal of visual realism already encountered with regard to digital cinema and computer games. They do this through their own technical modification of the existing apparatus of the cinema: attempting to improve upon prior registers of surface accuracy by combining magnification with high fidelity, thereby intensifying the spectator's illusion of 'being there' by engulfing him or her in the image. This project has an affinity not just with the modes of visual digital culture already alluded to, but, more importantly for present purposes, with those slightly more recent digitally based attractions which revolve around the simulation ride. The character of this kinship is both aesthetic and technical: technical development and innovation provides the basis for the production of novel image-centred forms based upon illusion and special effects.

Undoubtedly the immediate technical predecessor of the simulation ride as an entertainment form is the simulator used for professional training. Specifically, it is the oft-cited flight simulator, introduced to train pilots during the Second World War and intensively developed in both military and civil contexts ever since, which lies at the technological heart of today's simulation ride attractions. The flight simulator has three fundamental components: image,

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motion and interaction (hands-on control). Most flight simulators consist of a detailed mock-up of the cabin of a specific aircraft replete with instruments and seats but without the rest of the plane. This is:

> enclosed by a visual surface on which the visual scene is shown. To simulate the motion of the plane the cockpit is mounted on a platform that can be moved up and down and from side to side as well as tilted. As the pilot operates the controls of the aircraft both the visual scene content and the sensation of aircraft motion change.
>
> (Haber 1987: 90)

Of course, the digital computer is central to such a sophisticated technical apparatus. The computer enables the simulator to produce real-time synchronised changes both in the visual field and on the motion rig in response to the trainee operating the controls.

As we have seen two of the elements of the flight simulator – graphics and joystick control – are central to the computer game. With simulation rides however, whilst the visual aspect and the motion component remain central to their basic formal make-up, the element of being able to directly control or affect what one sees disappears. Simulation rides have developed around the impression of propulsive motion that the flight simulator is able to convey to passengers. Meticulously choreographed to repeatedly unfold in an unvarying manner, in this sense, the form has more in common with the sub-genres of digital cinema than with computer games.

Establishing a new spectacle form

Among the first people involved in the development of the simulation ride was Douglas Trumbull who, seeking the kind of 'liquid realism' he had only been able to glimpse looking at *2001: Space Odyssey* embarked on a project to produce a commercial film system with a similar visual quality. Trumbull is credited with the creation of the celebrated 'Star Gate' sequence on *2001*. This was produced utilising techniques pioneered by John Whitney Snr in the 1960s (see Whitney 1981). In the 1970s he and his associates developed a large format (70 mm) high definition (60 frames per second) film process called Showscan that was similar in many respects to the Imax system which had been introduced a few years earlier. In the early 1980s the Showscan system was used in the production of *Tour of the Universe* one of the first simulation rides. Other specialist production companies have emerged around the form, particularly in the United States. In addition to producing large-scale rides several of these companies are also involved in exhibition (for further details of this history, see Pourroy 1991; Huhatamo 1996).

The form has developed and expanded greatly since the 1980s. Such attractions are no longer confined to the large theme park and similar locations,

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smaller versions of the simulation ride can be found in amusement arcades, funfairs and shopping malls. It is, however, the theme park and the specially designed 'ciné city' type of exhibition site which houses the most technically sophisticated and spectacular rides.[13] These tend to be large-scale productions, realised through some kind of large-format film system such as Showscan, Vista Vision or Imax. Such rides are installed in large theatres, which have either been specially built or specifically adapted for the purpose. Usually, they are located in a limited number of sites.

Traditionally it has been at the theme park locations of large corporations such as Disney and Universal – where attractions are designed both with expectations of longevity and in terms of being at the leading edge of the genre – that the most effort has gone into formal development and innovation. One of the clearest examples of this was the production of *Back to the Future: The Ride* (1991) by Universal Studios for its Florida and Hollywood theme parks. Whereas, the majority of simulation rides involve a platform situated in front of a flat screen which acts as the 'windscreen' for the ride one is experiencing, *Back to the Future: The Ride* departed from this convention and utilised a hemispherical screen. The attraction was shot for exhibition in a specially constructed building that contained a giant Omnimax surround screen. In this instance the motion platform – which carries eight passengers – is an open-topped DeLorean car. As those familiar with the film *Back to the Future* on which the ride is based will know, the car doubles as a time machine (for more detail on the technical problems encountered in the production of this ride see Pourroy 1991).

Digital technology is a vital component of *Back to the Future: The Ride*. It is crucial both to its kinetic aspect and to its audiovisual dimension, though it is not deployed in the direct rendering of the visual imagery. Increasingly however, computer animation and image synthesis are finding their way into special venue attractions. For example, in a ride entitled, *In Search of the Obelisk* (1993) located at the Luxor Casino in Las Vegas, computer graphics and computer animation begin to figure more prominently. Here computer images augment scenes involving miniature backgrounds by adding computer generated flying vehicles, smoke and so forth; and at least one sequence was entirely computer generated (see Abrams 1995). Even the traditional Imax medium has succumbed to digital image effects and computer generated imagery. In *The Journey Inside* (1994), an Imax film about the production, use and workings of microchips, the film climaxes with a computer generated 'ride-like' journey into a computer chip.

At the more technically sophisticated end of the special venue form there have also emerged hybrids such as Universal Studio's theme park attraction, *Terminator 2: 3-D* (1996) and Walt Disney World's, *Honey, I Shrunk the Audience* (1995). Costing as much as blockbuster special effects films to produce and install, these special attractions, based – as so many are – on tie-ins or sequels to successful feature films, are an amalgam of formats and techniques. Thus large format 3-D cinema, special effects, computer manipulated, compos-

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ited and generated 3-D moving images, live theatrical performance and 'elaborate in-theatre effects' are all present – though neither involves a motion platform. Both use large, high definition film formats in an attempt to match the clarity of normal vision and, at the outset at least, to produce the impression of actually being present at a live event. Innovative 3-D processes are used, partly to intensify this high definition illusionism, partly to exploit the impression that people and things can leave the screen and enter the personal theatrical space of the audience – usually to exhilarating effect. In the case of *Terminator 2: 3-D*, one way in which this is achieved is by the use of live actors who are seamlessly integrated into the cinematic action and space. In *Honey, I Shrunk the Audience* in-theatre special effects carry over the action taking place on the stage/screen to the space occupied by the audience. For example, the sneeze of a giant dog is not just seen and heard, it is also *felt*. In a manner that parallels the attempt to produce the illusion of propulsion in the simulation ride, these attractions are attempting to produce the illusion that the distinction between screen space and the space of the audience itself has dissolved.

One thing which remains unchanged whatever the size of the attraction is the relatively short duration of the ride experience itself. Indeed, this is a definitive characteristic of the special venue form. Even Imax films are far shorter than the 90 minutes plus running time of the average feature film and average out at about 40 minutes apiece. Simulation rides and related special venue attractions are shorter still. A major ride such as *Back to the Future: The Ride*, is a mere 4 minutes long, whilst *Terminator 2: 3-D* – with a running time of a full 12 minutes – becomes an epic of the genre. Moreover, the majority of the smaller arcade simulations and medium-sized rides last no longer than 5 minutes. Of course these attractions are technologically dense and require a great deal of painstaking development and laborious production time before their release. What is more, such high concentrations of technological prowess do not come cheap. This applies particularly to the larger-scale instances of the genre but is also a factor that is present in the smallest examples. Undoubtedly, this goes some way towards explaining the brevity that characterises the form, but it does not totally account for it. For it also seems that there is something in the aesthetic character of the genre itself which dictates the short duration of its particular attractions. Douglas Trumbull says his rule of thumb is, 'as you increase the power of the medium, the audience wants to shorten the experience. The more immersive the experience, the more compressed it should be in time' (quoted in *In Camera* Autumn 1994: 10). He may well have a point, yet one wonders if there is not more involved in understanding what is occurring here than this. However, these are questions we shall explore in subsequent pages.

As this overview of the recent emergence of the forms at the centre of this book shows, the development of the computer is having a significant effect on mass visual culture. New technology centred upon digital microprocessing and computer programming is transforming the ways in which visual culture is

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produced and received. It is doing this, as we have seen, both at the level of technical modernisation and at the level of formal developments. In a period of barely twenty years, digital techniques have left the research laboratories and integrated with established means of production and exhibition. With the emergence of the computer, entirely new ways of making images, together with ways of assisting and augmenting established methods and techniques have become commonplace within contemporary forms of visual cultural production. Moreover, this process has also given rise to the emergence of distinctive genres and forms within the sphere of mass visual culture. Among these, two in particular – computer games and simulation rides – appear to be unprecedented. New-sprung concepts such as 'simulation', 'interactivity' and 'immersion' have emerged to describe what is seen as unique and different within these new forms, whilst older-sounding terms like 'realism', 'illusionism' and 'spectacle' still appear to play a crucial part in the discursive practices which constitute them.

Clearly a new aesthetic space has opened up within contemporary culture, one which owes its existence to digital technology. It is important to stress, however, that this debt is by no means absolute. The computer is vital to understanding the make-up of the forms whose development we have just sketched, yet it is not the only agency explaining what they are and how they have come to be that way. The computer has not shaped the aesthetic character of these forms all by itself, as – taken on its own – an account such as the one above might be mistaken for suggesting.

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