# The Technological Art of Simulation

**By Graham Whitehead**

*Technology, principally through improved sound and visual systems, has played its part in the surge in popularity of cinema in the UK. This emphatic response to refining the "cinema experience" is also behind the worldwide growth of simulation theaters, essentially cinemas with the added dimension of a dynamic motion platform beneath the seats. Graham Whitehead of leading simulation attraction supplier, Thomson Entertainment, traces some of the more recent technological developments in this specialist area and their ultimate reliance on the human factor.*

Simulation theaters (or cinemas) have developed into some of the best-known and most popular attractions at entertainment venues around the world. "The Star Tours" and "Body Wars" rides at Disney theme parks, the "Back to the Future" ride, "Tour of the Universe" at the CN Tower in Toronto, "Cinaxe" in Paris, and parts of "Futuroscope" at Poitiers—all basically rely on the combination of visuals and movement for their appeal (Figs. 1 and 2).

Increasingly, however, such attractions are moving into the mainstream with simulation cinemas being included as add-ons to new multiplex developments as a sort of "ride the movie" preshow experience or a standalone revenue earner. Museums and visitors attractions, such as The Science Museum, London, and the Imperial War Museum at Duxford in Cambridgeshire, are also developing an increasing taste for this sort of technology as the cost reduces, thanks mainly to the massive leaps made in video and digital projection in recent years.

Although each project obviously varies, the essential components required to create a simulation cinema are broadly similar. A large screen, be it flat, curved, or domed; a high-quality sound system; a projector or projectors; a motion seating platform or platforms; and a means of controlling the various show elements form the basis of the attraction (Fig. 3 and Table 1). Of course, theming, automation of access, lighting and effects and various pre- and post-show activities all go into creating the "total" experience.

Most of the early simulation cinemas, developed in the early 80s, were based on large format film projection systems, which, for cost reasons, limited the market to very large venues, attracting millions of visitors annually. The onset of high-quality video projection systems and the diminishing cost differential to quality argument compared to film formats has opened the way for the new, broader market.

Another important development has been the introduction of smaller, more flexible seating platforms, enabling venues with limited ceiling height to contemplate a simulation cinema attraction. Last year, Thomson Entertainment introduced a four-seat unit which fits into a 3.5 m high room, and four such units formed the basis of a 16-seat cinema installed as part of a new entertainment complex in the waterfront district of Cape Town, South Africa.

The last, but far from the least important, driving factor in the market growth is the development in ride film content. The early simulation cinemas almost exclusively featured live action films, for example footage shot from the cockpit of a racing car or a fighter plane. While these still remain popular at venues where they are shown, it is the introduction and widespread adoption of computer graphics imagery which has really triggered the imagination of ride film makers and watchers alike.

Visitors to the cinema in Cape Town, for example, can be treated to a four-minute virtual journey through time, featuring encounters with dinosaurs and the first moon landing along the way. Futuristic car races, underwater rollercoasters, and space adventures are just some of the themes more commonly developed for audience enjoyment.

As content has moved forward, so

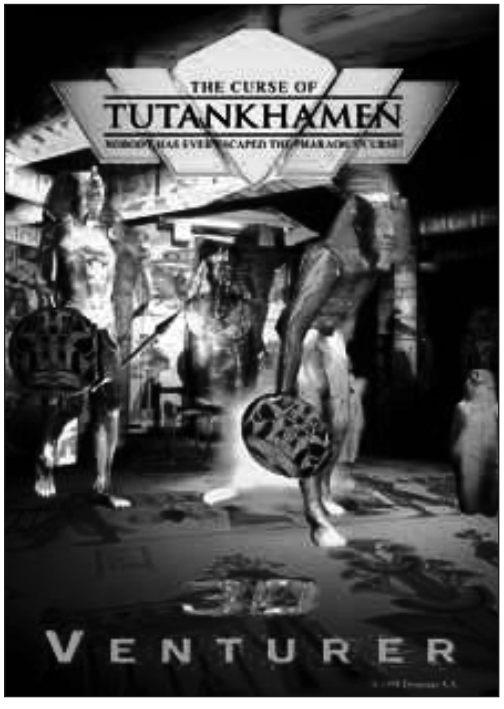


*Figure 1. Promotion poster for "Curse of Tutankhamen" 3-D ride.*

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*Figure 2. "Star Tours" attraction at Disney.*

has the hardware for delivering the picture to the screen. Alongside the more expensive large film formats, video delivery has moved progressively from u-matic tape, with its maximum 280-line resolution and relatively rapid degradation due to the physical contact between the tape and the video head, to component recorded video (CRV) with a noncontact medium and a resolution of up to 625 lines in PAL format. The problem with these analog methods of transmitting video signals is that they are susceptible to quality loss from one generation to another.

The digital systems being widely introduced and used today do not suffer from this problem, taking the audio and visual information and translating it into a series of binary digits, or bits.

The most widely adopted digital system is MPEG-2. This offers full 720 x 480 resolution as well as full 60 field/sec video. Essentially an

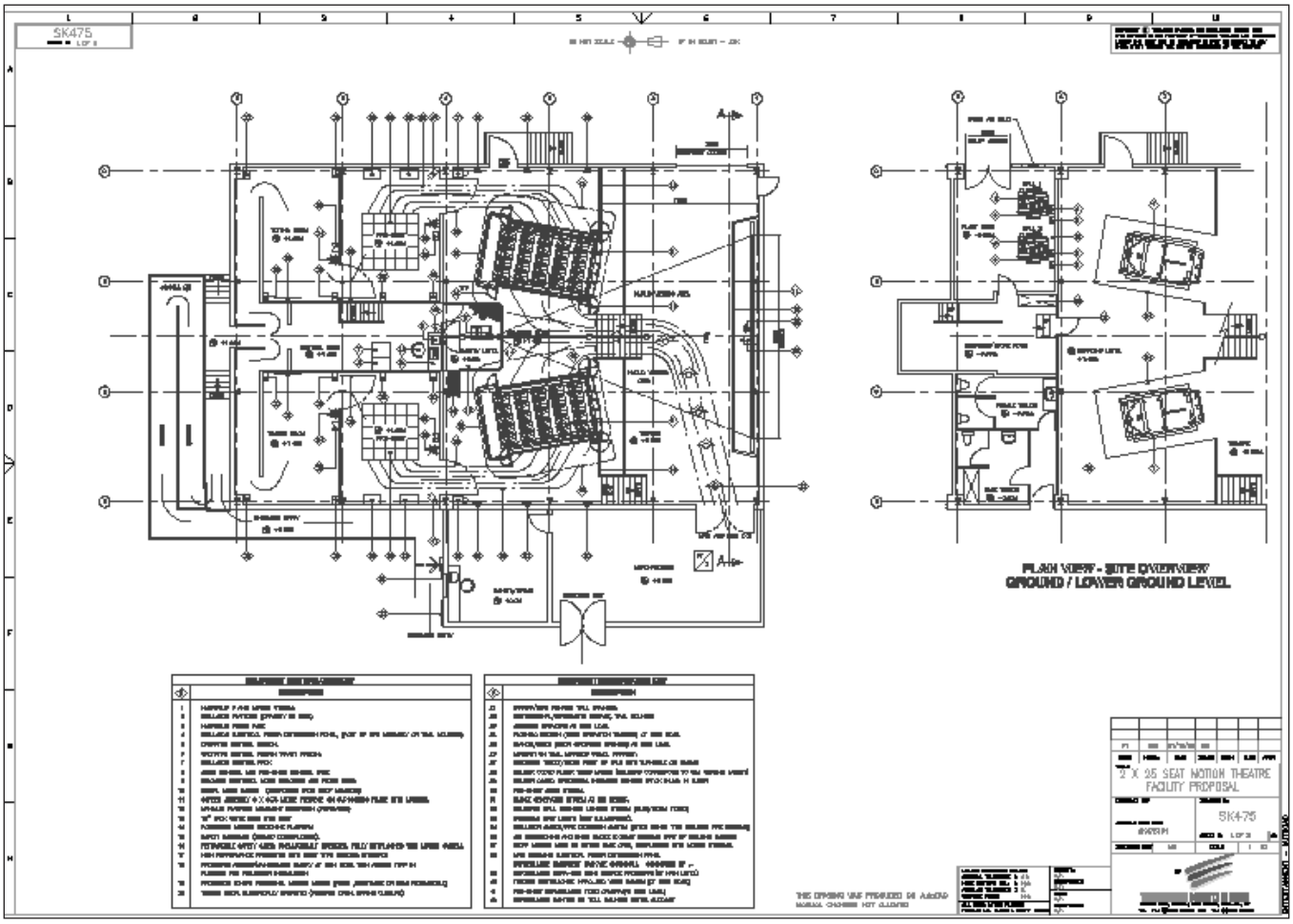


*Figure 3. Typical layout for 50-seat simulation theater. (You are not meant to read the fine detail!)*

**Table 1—Typical Equipment Specification for a 20 to 25-Seat Simulation Cinema (Video-Based).**

- Screen (up to 12 m wide)
- Motion platform/s and passenger capsule/s (permanently fixed on concrete slab or mounted on portable base/s)
- Air cooled hydraulic power unit (for hydraulic systems only)
- Electrical distribution board
- Simulator control system, incorporating visual delivery system, amplifier, system computer,seat restraint interface and 4.5-in. rack mount mini color touch screen
- Optional additional show control system for special effects
- Digital high-resolution video projector with line scan doubler or high-definition video projector. Two projectors required for 3-D.
- Optional 2-D/3-D visual switcher system
- Audio system (mid-range example), consisting of:

| | |
|---|---|
| Graphic equalizer | Two full-range speakers |
| Limiter/gate | One sub woofer |
| 2-way crossover stereo | 2 x 3.0 K amplifiers |

- Ride film software—delivered on securitized CD-Rom with motion control program stored on floppy disk.

effective means of compressing video, the MPEG-2 system enables full screen video pictures to be stored on the computer hard disk and transmitted onto large screens with no loss of quality. Alongside the technical benefits, the digital system also provides a number of practical and security benefits for the venue operator, ride film maker and equipment supplier.

What will be apparent about everything described to date is that the technology used to create simulation cinema attractions is well proven in other spheres and is nothing remarkable.

The real trick with a simulation experience is in being able to manipulate the technology to "fool" the consumer into thinking he or she is really experiencing the film that they are watching. Hence, the motion program devised by the system programmer is the defining technology for the quality of the attraction.

Working within the confines of the simulator's motion capabilities, the programmer has to translate the visual cues into a realistic experience. The margins for error are slim. Marginal misprogramming results in a sloppy ride; more serious errors can have rather more unpleasant consequences, such as motion sickness. Research has shown that this can occur with a 0.6-sec delay between picture and motion.

The majority of modern entertainment simulation platforms utilize a 3-axis motion system (Fig. 4). The three types of movement that this permits are:

• Pitch—the raising or lowering of the nose of the capsule to simulate acceleration and deceleration.

• Roll—which inclines the machine from side to side.

• Heave—the vertical up and down movement of the simulator.

While this is sufficient for most entertainment applications, 6-axis systems are also available which add the dimensions of:

• Surge—forwards and backwards movements through a horizontal plane.

• Sway—side to side movements through a horizontal plane.

• Yaw—sideways rotational movement.

Nearly all simulation platforms are either hydraulically or electrically controlled, with a very small portion using pneumatics. The hydraulic systems work by controlling the flow of oil under pressure to the hydraulic rams in the legs of the platform, while electric systems use signals to electric motors on the motion framework to generate the movement.

Numerous off-the-shelf and bespoke solutions exist for the programming itself, but in nearly all cases they program in terms of axis information. This involves giving a command to each axis of the motion system as to its required position in relation to a specific frame in the film.

In the case of Thomson Entertainment, the interface to the programming tool is a graphic editor with an oscilloscope-style display. The whole system operates on a PC, generating a final motion program on floppy disk for insertion and downloading into the simulation cinema's main com-

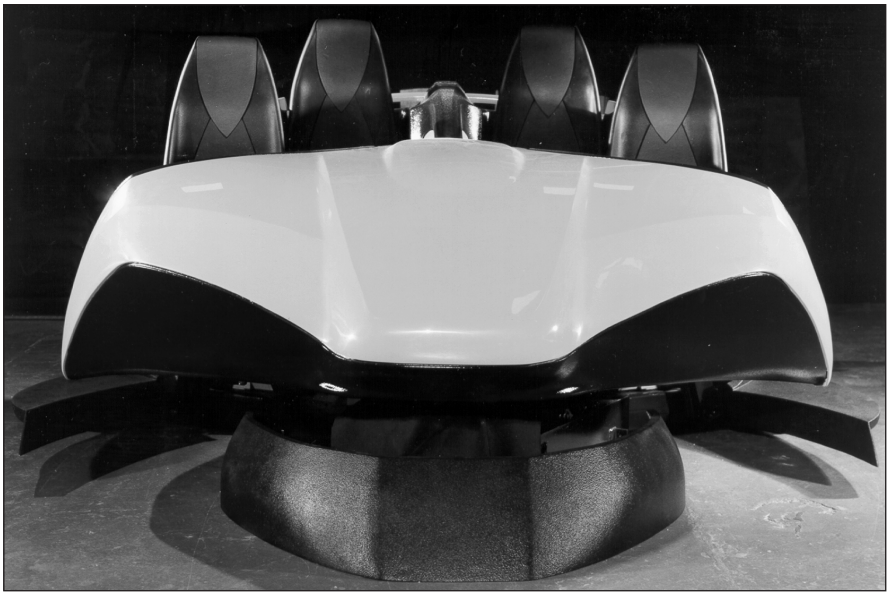

*Figure 4. Venturer T4 3-axis motion theater seating platform.*

*Figure 5. Factory demonstration of 20-seat motion cinema.*

puter. However, the quality of the motion program is more a matter of experience and art than a true science.

For a start the programmer has to decide whether he wants to achieve a true simulation of the visual material or to create a program that exaggerates reality. For example, experience would tell us that the body is pushed away from the corner when taking a curve in a car, while in an aeroplane it banks into it. It might be a conscious decision to do the opposite where true simulation isn't the desired effect.

While it is a totally subjective area, Andy Smith, chief motion programmer for Thomson Entertainment, says that a good motion program, much like a good visual, must have contrast. "In some cases, motion can clutter a good image and motion will never recover a bad image—in my view it can only exaggerate what's already there."

"Quite often, in order to achieve the desired contrast, less can be more, serving to highlight the dramatic moments," he adds.

Nowhere is this probably more true than in the emerging trend towards more 3-D film content in simulation cinemas where objects can suddenly appear to leap out of the screen at the viewer. The motion program needs to be written to amplify those particularly dramatic moments such as massive rocks rolling out of the screen and threatening to pulverize the audience or a large spike appearing to lodge between the viewer's eyes.

The total installed base for simulation cinemas is still relatively small with less than 1,000 around the world (Fig. 5). With costs falling and an emerging group of potential new non-theme park venues, it is an area with considerable growth opportunities, not the least for film producers looking for new outlets for their work.

New technologies have a definitive role to play in turning the potential into reality. For example, the MPEG-2 technology has enabled Thomson Entertainment to introduce a system of flexible ride film licensing that allows users to rent films for periods of as little as one month if they wish. This is tackling one of the entertainment business' greatest bugbears in recent years; the cost and, in some cases, redundancy of having to license film material for five years.

The new system means that the venue operator receives his ride film on a CD-ROM. When, and only when, it is downloaded onto the main computer, then the clock starts ticking on whatever duration of license has been agreed, giving the user a warning in advance of when the ride will "bomb" from the hard disk. A PIN number, exclusive to the CD on which the ride film is supplied, protects both the property of the venue operator and also the copyright of the ride film producer in a market where illegal copying of ride films has been prevalent.

The ability to switch between 2-D and 3-D is also proving of interest, and the installation in Cape Town was the first to incorporate a switcher filter. This works by switching the audiovisual source and moving the polarizing filter required for 3-D back and forth using a motor driven actuator. The whole process is controlled from one touch of the operator's control system touchscreen.

Other technological advances, in particular relating to electronic distribution of ride films and motion programs are, without doubt, not far round the corner. But, just as with high street cinemas and multiplexes, it's worth remembering that there has to be a high degree of "art" in taking the viewer out of his everyday world, especially when it's only for three to four minutes.