

MOTION and MULTIMEDIA

- the *PemRam*TM and the *Cyberseat*TM

Theme Park simulator motion systems transform visual software into an emotional experience. Now a new personal motion technology will make the Internet “body-interactive” and open huge new consumer markets for games and training software.

A British company, **Denne Developments Ltd**, has just launched a high-technology motion product that will replace hydraulics in the simulator business. It is important for the “arcade” and “simulation centre” markets but its real potential - as a multimedia system component - will emerge next year.

In 1996 the company plans to exhibit a personal seat motion system, interfacing to a home computer as part of a domestic simulator or a body-communication system. The development will allow the migration of digital primitives from big screen cinema chains, through simulation-centres, to private home use and out onto the Internet. To exploit this opportunity Denne Developments will cooperate with other companies in the USA and on the Pacific Rim, who will manufacture and distribute the motion system. DDL has also opened discussions with potential suppliers of supporting software.

THE COMPELLING POWER OF MOTION

Nobody drives, or flies, or moves in any way, by using visual information as the primary sensation for control. If you think about it, you will realise that you use your eyes to set targets for your actions but you control movement by feel. You feel the road through the steering wheel, you feel the seat acting on your body, the snow beneath your skis, the lift beneath the wings of your aircraft or the ground beneath your feet. You respond to these sensations instantly and instinctively; you respond subconsciously, without rational thought.

That is because human beings have been trying to stand upright for a million years or so; we have learned to program balancing skills as fast reactions to external forces. These forces are felt as pressures on the skin - and the skin is the largest and most primitive organ of the body.

It has the most deeply-rooted connections to the human brain. **Communicate with a human being through the skin and you trigger primal, powerful, emotional responses.**

The key element of simulation - which makes it very different from a cinema, TV or videogame experience - is the motion system. Motion has a powerful and gripping effect; it adds energy and excitement to the visual experience. This is because the sensations of movement go through the skin directly to the subconscious and instinctive parts of the brain. The provoked responses are irresistible and they force the person to concentrate intensively on the visuals of the experience. The participant is driven to act as though the visual scenes are real - whatever their visual quality - and as though life itself might depend upon the outcome. Full hormonal responses are triggered and the Virtual Experience becomes an emotional one. That is why entertainment simulators are so popular - and why personal, home-based simulators will be so attractive and so important as vehicles for creative software.

HYDRAULIC MOTION SYSTEMS.

Until now every good simulator has used a mechanism that relies on hydraulic rams to move the cabin (or “capsule”) about. Hydraulic rams are expensive, precisely-machined steel pistons driven by oil under high pressure. Until now only hydraulics technology, pushed to its limits, could provide the accuracy and fast response necessary to create the right sensations of movement. Only hydraulics was good enough to satisfy the exacting demands of the military and civil training business. The leisure industry also picked up hydraulics for its own motion simulators, such as those in the major theme parks. A strong demand now exists to bring small (one or two seat) motion simulators into entertainment arcades and to bring personal simulators into the home.

But hydraulic motion systems waste huge amounts of power and get hot. They need frequent careful maintenance and, inevitably, they leak oil, or spray it as a mist over their surroundings. There is sometimes a fire risk and possibly a toxic danger. Hydraulic technology is only acceptable if the mechanism is outdoors or is not close to the public and if it receives regular skilled maintenance. Something very different is needed for arcade machines and for use in the home environment.

Designers have tried without success to solve the problem using two obvious alternatives:-

- **Pneumatics.** This technology uses low-pressure air instead of high-pressure oil but it does not work because its response is slow (the ram has to be “blown-up” or “deflated” to the new pressure, which takes time) and because it is imprecise (the air is compressible; it bounces).
- **Electric jacks.** These use motors and speed-reduction gears to drive threaded shafts and nuts running on ball bearings. They are noisy and wear rapidly because they rely on hard metal surfaces under high contact pressures. Electric jacks are slow to respond or reverse direction because the motor and gears have to “spin-up” or “spin-down” to start and stop. This means that, like pneumatic systems, they cannot generate convincing, subconsciously-effective, motion cues.

LINEAR ELECTROMAGNETICS - THE HIGH TECHNOLOGY OF MOTION.

Twenty years ago “linear motors” were developed. They were, in effect, three-phase rotary electric motors, cut to the centre and rolled out flat. Such motors sprayed magnetic fields in all directions and were generally inefficient. They failed to find any really useful applications.

But if the linear motor concept is taken a stage further there is a dramatic improvement. Imagine that the “rolled out motor” has its long sides curled up again to form a piston sliding in a cylinder. This wraps up and contains all the magnetic fields and greatly improves the efficiency. Then add the power of modern permanent magnets, switching transistors and microprocessors. What you get is a **silent, compact DC electromagnetic ram** that can produce powerful thrusts with an almost-instantaneous response. We call it a **PemRAM™**, meaning Precision ElectroMagnetic Ram. The piston of the **PemRAM™** can be sealed to the cylinder so that it prevents gas flow and acts as part of a gas spring supporting the deadload of a simulator capsule. The motion base does not then consume any power unless the capsule is moving. A block of patent applications is in place that protects the DDL **PemRAM™** motion technology in twenty-two countries.

BODY-MOTION FEEDBACK.

One of the extraordinary characteristics of the **PemRAM™** is that it is a force-generator, not a movement-generator like the hydraulic ram. That is to say, the piston only generates just the right amount of force to hold the simulator in any required position - and this force is measured continuously. Suppose that the simulation is of a surf-rider, for example. When the surfer moves, the weight distribution on the simulator changes and the forces produced by the rams automatically adjust to compensate. The new force measurements can be fed into the computer running the Experience, so that the surfer’s motion is altered just as it would be in reality.

For the first time, therefore, it is possible to simulate travel that is controlled by the natural and instinctive movements of the human body. This is an important and exciting development for serious training and for entertainment simulations that have a sports theme.

BEATING THE LIMITATIONS OF RAM SIMULATORS.

There are strong limits to the amount of force - of “g” - which a simulator of convenient size can usefully produce. If a strong force is applied for too long the simulator gets up too much speed and the capsule cannot be stopped gently before the rams hit their end stops. If that happens the illusion is destroyed and the simulation fails. A good working limit is half a g for a tenth of a second. In a military aircraft a six-g turn often lasts for more than twenty seconds, so that it is impractical to use a ram-driven motion base to simulate it. To overcome the problem, simulator designers developed another device, called the “g seat”.

In this simulator, skin sensations are varied by controlling in a complex way the pressures in a matrix of pads forming a harnessed flying seat, thigh restraint and back rest. The pilot feels the sensations that he would do if the seat were moving against him - but in fact the seat hardly moves at all. Unfortunately the “g-seat” technology is difficult and expensive. However, by adapting the **PemRAM™** technology it is possible to make a low-noise, low-cost “g seat” which is simple enough for use in the home. It is safe, so that it can be used by an occupant wearing a VR helmet and absorbed in a networked competitive game, even when there is a baby crawling nearby. DDL has lodged patent protection for the technology in twenty-two countries and is in discussion with some of the major Japanese distributors of consumer entertainment products.

LUXURY AIRCRAFT SEATING.

With a zero input signal a **PemRAM™** simulator seat has the uncanny ability to isolate the occupant from surrounding vibration and to produce a “floating” sensation. It has a market as a luxury aircraft seat; also being available to act as a motion simulator if the passenger wants to play a videogame en route.

The seat has a wide bandwidth - it can communicate force and vibration to the skin at frequencies well into the audible range. Clearly, seats of this type can create powerful skin sensations to assist relaxation and stress-removal - or to promote extreme excitement. An extraordinary range of multimedia visual, sound and motion-generating software can be marketed for use with the **PemRAM™** seat.

A UBIQUITOUS TECHNOLOGY.

This article has focused on the effects of the **PemRAM™** on those markets that have strong connections with multimedia. DDL is also developing large markets in other industries.

For example:-

- Car suspensions.
A compact and efficient **PemRAM™** allows a luxury car to be fitted with an active suspension unit for a perfect, gliding ride and safe cornering performance. When acting as a damper, the device feeds power back into the electrical system instead of throwing it away as heat: the damping coefficient is variable over a wide range in milliseconds if necessary. The gas-spring, developed for use in simulators, replaces heavier mechanical components.
- Passenger lifts.
We expect silent and reliable **PemRAMS™**, generating thrusts of several tons, consuming little power and counterbalanced on gas springs, to supersede hydraulic mechanisms in low-rise passenger lifts. Smaller devices have other uses in improving the performance of high-rise cable lifts.
- Manufacturing industry.
Hydraulic rams have disadvantages in many industrial roles, especially where oil leakage produces a contamination problem. **PemRAMS™** are in demand for sorting and packaging equipment in the food industry, for example. Another version will be used in huge quantities as a simple positioning device.
- Security products.

One of the attractive features of the ***PemRAM™*** is its exceptional speed of response. It is possible, for example, to get a bullet-proof screen up faster than a robber can get the bullet from the gun.