



This document describes **Spatial Haptics** and its implementation in dark rides, themed entertainment, and interactive experiences. After some general descriptions, we detail methods to incorporate eaiHAPTICS actuators and associated hardware into typical seats and ride systems.

Key Features of Dark Rides and Themed Entertainment

Successful rides focus on the following elements:

- **Storytelling:** A compelling narrative forms the backbone of immersive entertainment
- **Technological Innovation:** Cutting-edge technology to create an environment that feels believable and lifelike (or fantasy-like)
- **Interactivity:** Allowing audiences to actively participate and make meaningful choices within the experience enhances immersion
- **Sensory Stimulation:** Engaging multiple senses, including sight, sound, touch, and sometimes even smell and taste, creates a more holistic and immersive experience
- **Physical Environment:** The physical space must complement the experience and transport audiences into the intended world

Technological innovation has progressed significantly in the past few years. Outstanding audio and video quality is readily attainable with innovation by Dolby and others. Ride vehicles, whether it be tracked, autonomous or robotic, offer almost endless opportunities for ride and motion profiles and multiple axes of movement, and the scenery designers can make magic in the physical environment.

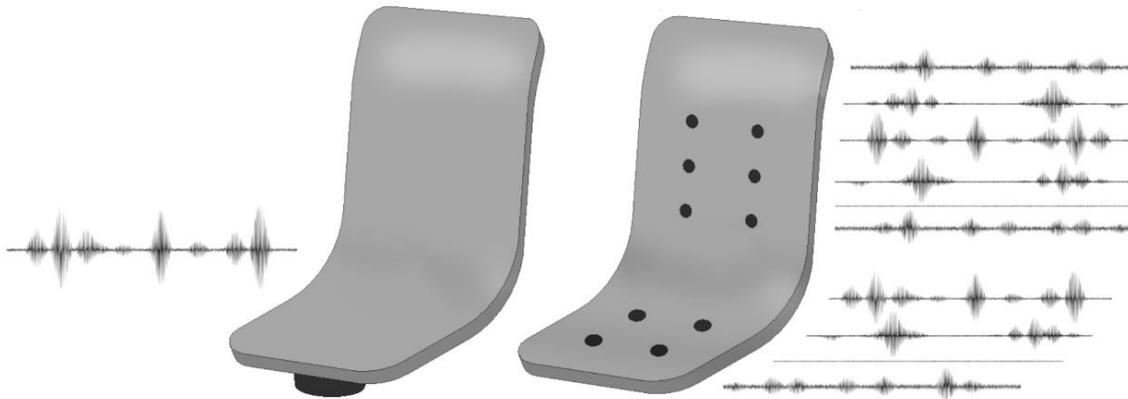
While these technologies certainly provide *Sensory Stimulation* to the visual and auditory senses, the sense of touch is mostly unused. While many themed rides and entertainment venues utilize bass shakers in the seat or floor, these are essentially audio enhancements for the low-frequency effects (LFE) from available audio sources, and reinforce effects such as explosions, gunfire, or deep bass in music.

By contrast, Spatial Haptics technology enables the creation of complex tactile sensations that can move across the user's body, mimicking textures, shapes, or motions. Haptics allow the creative team to extend beyond what you see and hear, into what you feel. Think about feeling the movement of wind or water across your body, the startling sensation of an insect crawling up your back or the surprising jolts from a light saber! Haptics is all about enriching our interactions by adding the sense of touch to the palette of creative tools. It's a medium that allows you to sculpt experiences, craft narratives, and connect with people in new and exciting ways.

Combining and synchronizing Spatial Haptics with audio, visual and environmental inputs opens a whole new realm of expression to create interactive and immersive experiences not previously possible.



Seat (Bass) Shakers vs Spatial Haptics



The figure on the left represents a seat with a single low frequency actuator. It is fed with a single channel signal, typically the same as, or derived from the low frequency effects (LFE) or subwoofer audio channel. Note that as typically implemented, it needs to have enough force to shake both the seat and occupant, so these devices are heavy and require significant power (a few 100 to 1,000 Watts).

The configuration on the right shows multiple haptic actuators in a seat, arranged as a spatial array to cover the area of the body in contact with the seat. Each actuator can be independently driven so, by controlling the content and timing, a wide range of sensations can be created. Because each actuator is in close proximity to the body it can, if properly designed, be small and require low power (5 to 20 W).

The enabling technology for these spatial haptics arrays is the eaiHAPTICS range of haptic actuators. Originally developed for the US military, eaiHAPTICS actuators utilize moving magnet linear motors that are optimized for high force and displacement against the human body. They operate in the frequency range that coincides with peak sensitivity of the skin's mechanoreceptors that sense vibration. They incorporate a moving contactor (or plunger) that is customized for mounting in a seat or against the body through multiple layers of padding and/or clothing. With similar impedance to a loudspeaker, these haptic actuators can be driven with low power audio amplifiers to create strong localized sensations on the body.