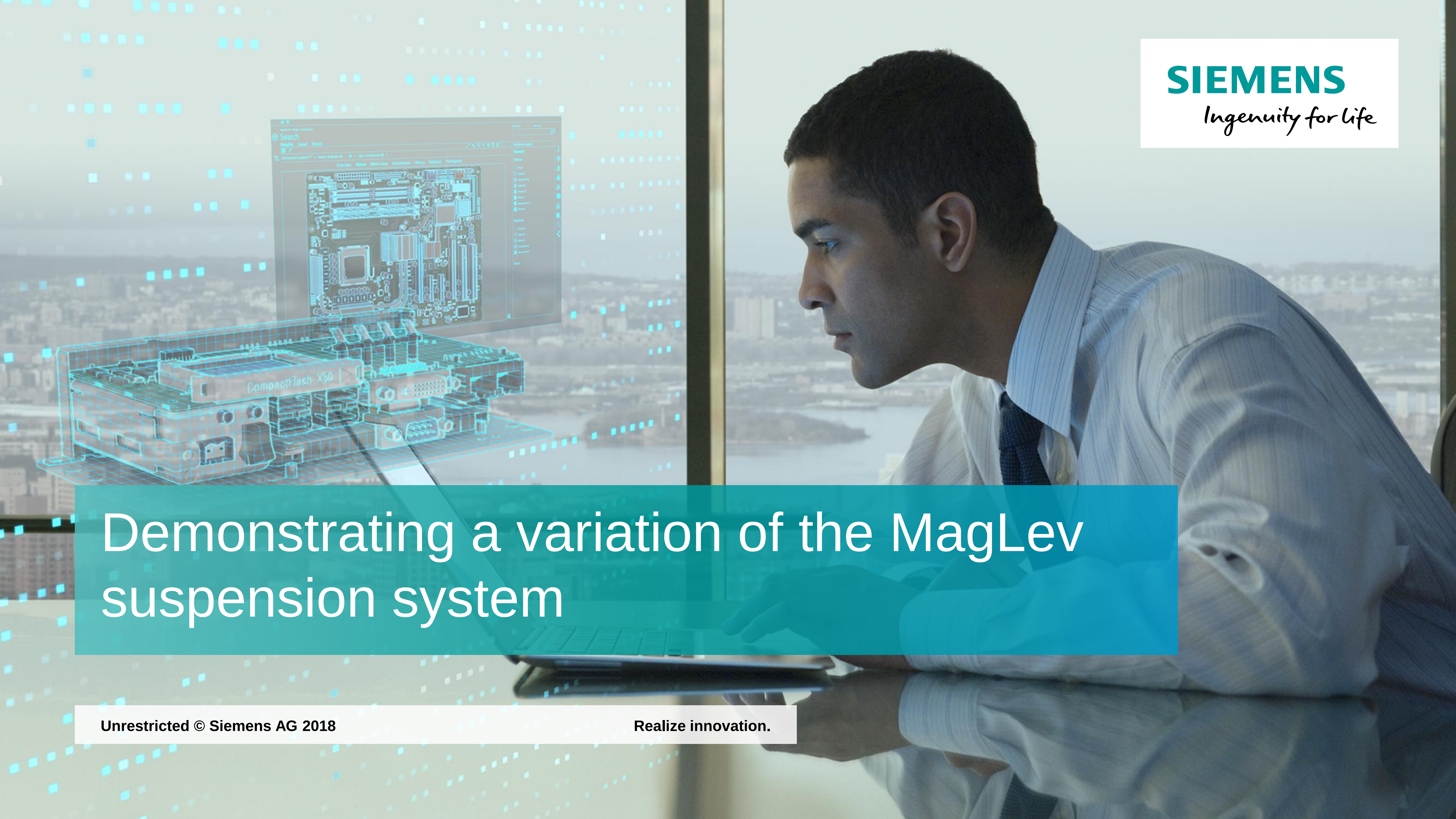

Demonstrating a variation of the MagLev suspension system

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Demonstrating a variation of the MagLev suspension system

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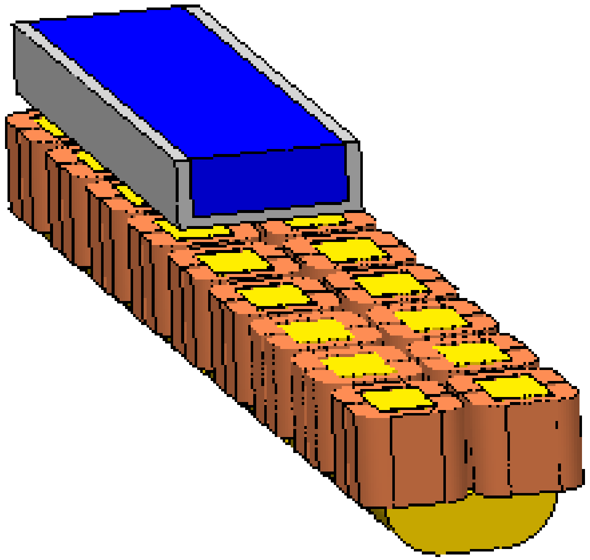
The concept of the magnetically levitated train or "MagLev" dates back many decades. There are two basic types of MagLev suspension systems: one based on static forces of attraction, the other based on repulsion forces from dynamically induced eddy currents. This gallery page demonstrates a variation of this second type, which implements the "Magnetic River" concept. The idea is to use the same set of coils for both levitation and propulsion. In the motor shown here, the coil structure is in a transverse flux configuration similar to that used in the prototype NASA MagLev for a shuttle launch system. However, instead of a single-phase source, the coils in this motor are connected to a three-phase supply in sequence to produce a traveling magnetic wave along the track. This is a scale model in which the vehicle is only 36 cm long (about 1 foot).



The performance of this machine is simulated using Simcenter MagNet's Transient 3d with Motion solver. The vehicle, consisting of the aluminum channel with payload, is given six degrees of freedom so that it is free to rotate about the roll, pitch and yaw axes and also free to move in all three dimensions (up-down, left-right, forward-backward). The vehicle is initially resting on supports 1 cm above the track, which is 0.5 cm below its equilibrium position when the track is energized.

MAGLEV CURRENT DENSITY

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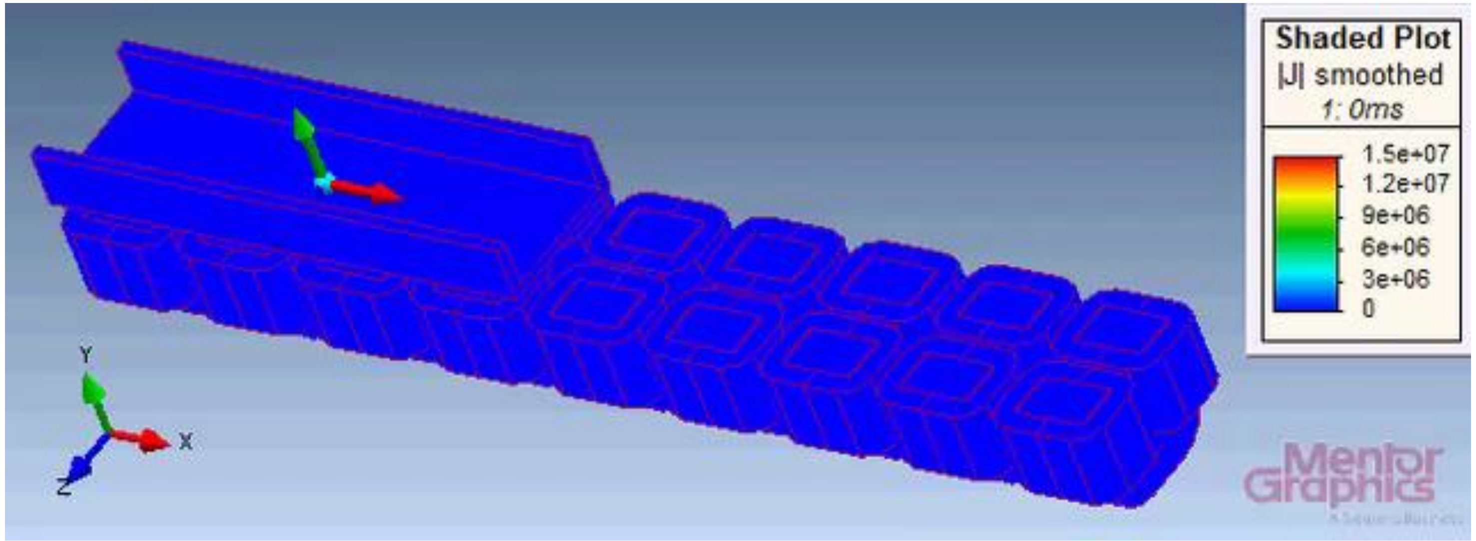

The current density is shown in this video, and there are several interesting features to note. First of all, it can be seen that there is a large transient induced in the first time step, due to the sudden turn-on of the three-phase current waveform. This transient quickly dies out but it imparts a strong upward acceleration to the vehicle. Next, it can be seen that as the vehicle rises up and the separation from the track increases, the magnitude of the induced currents decreases. This also affects the thrust along the track, which is highest when the vehicle-track separation is small.

MAGLEV VEHICLE LAUNCH

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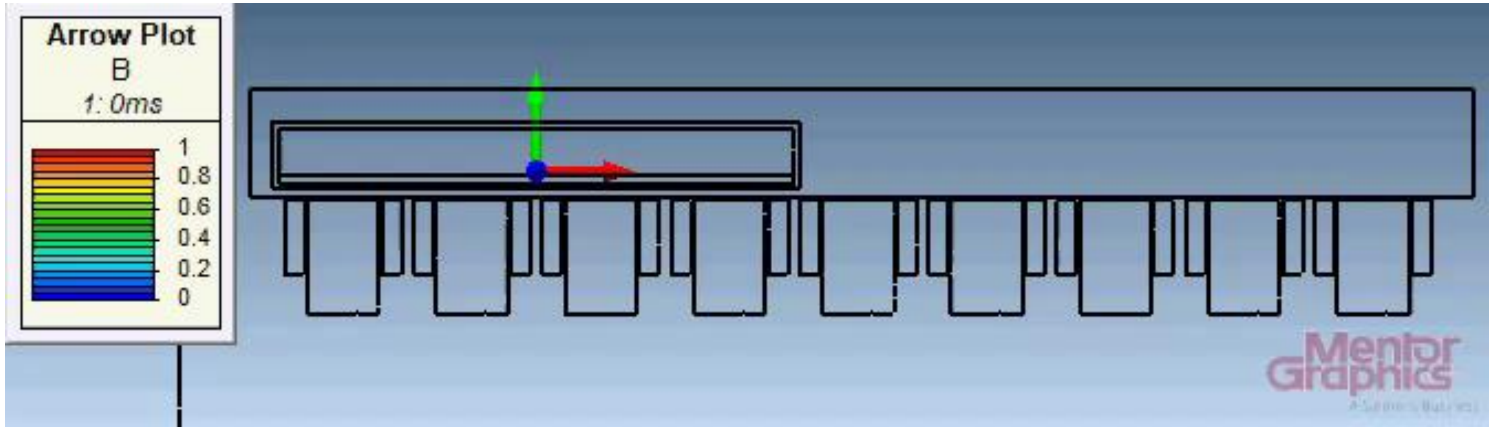

This video shows the vehicle launch from a different viewpoint. The simulation covers the first few tenths of a second after the power is switched on. The oscillating behavior is typical of this type of MagLev, and is one of the reasons why this type has not seen widespread use. In fact, the vehicle in this example is too short to be very stable around the pitch axis and it can be seen that the lower rear edge strikes the track. The arrow plot shows the magnetic field around the vehicle.

POSITION OF VEHICLE IN SIX DEGREES OF FREEDOM

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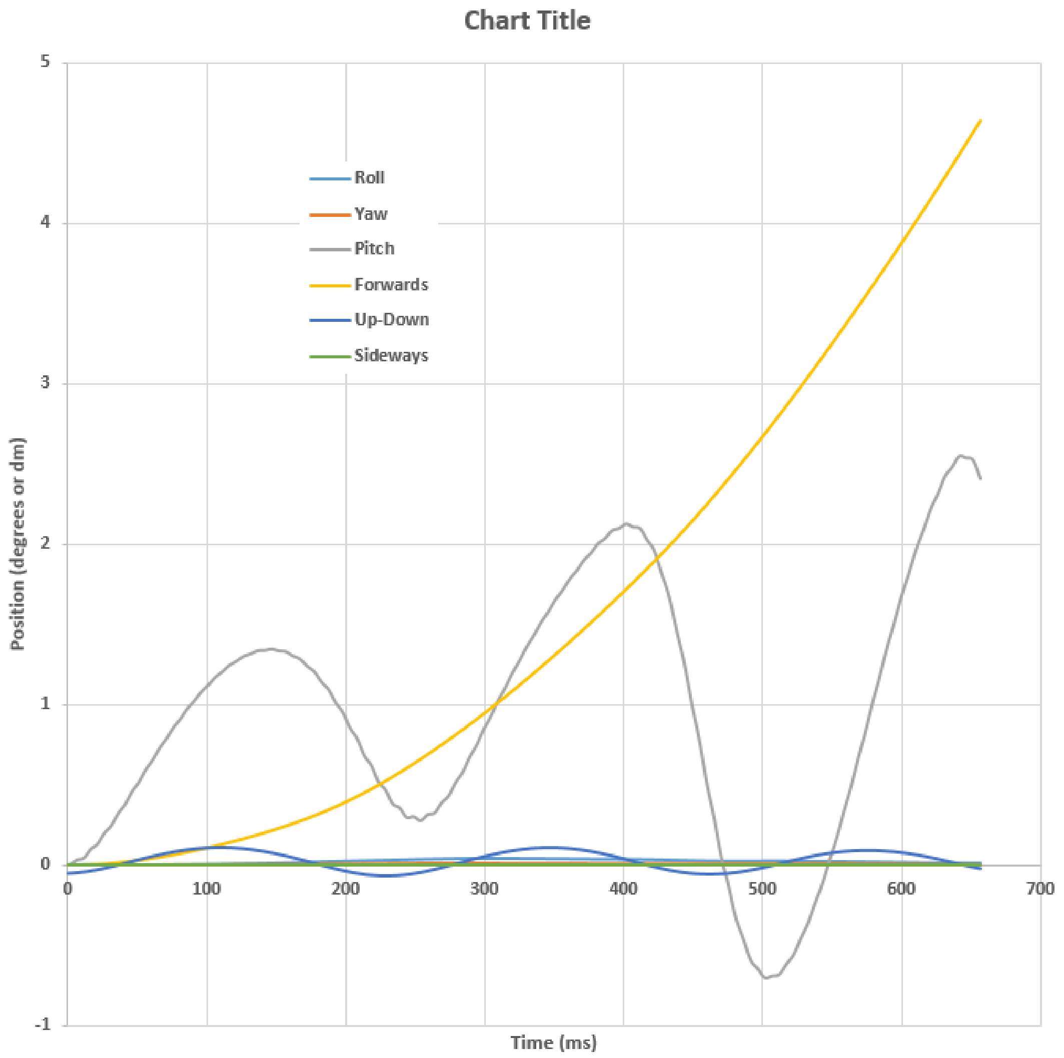
This graph shows the position of the vehicle in all six degrees of freedom as a function of time. The vehicle undergoes a steady acceleration along the track, and the pitch and up-down motion of the vehicle are also seen to be significant. This is due to the initial turn-on transient but also to a known phenomenon with levitation MagLev systems, commonly referred to as the "dolphin effect". In fact, even after the oscillations die out, the vehicle will not always fly level along the track; it may be pitched up or down depending upon the speed.



ACCELERATION OF THE VEHICLE

This graph shows the acceleration of the vehicle over the course of the simulation. The orange trace is the instantaneous acceleration, whilst the blue trace is a moving average over one period of 12 milliseconds. The variations are caused by several factors: the height above the track, the position of the vehicle relative to the poles, and the phase of the excitation. At the end of the simulation, the MagLev has achieved a speed of 1.4 m/s which is 5% of the synchronous speed of 27 m/s.