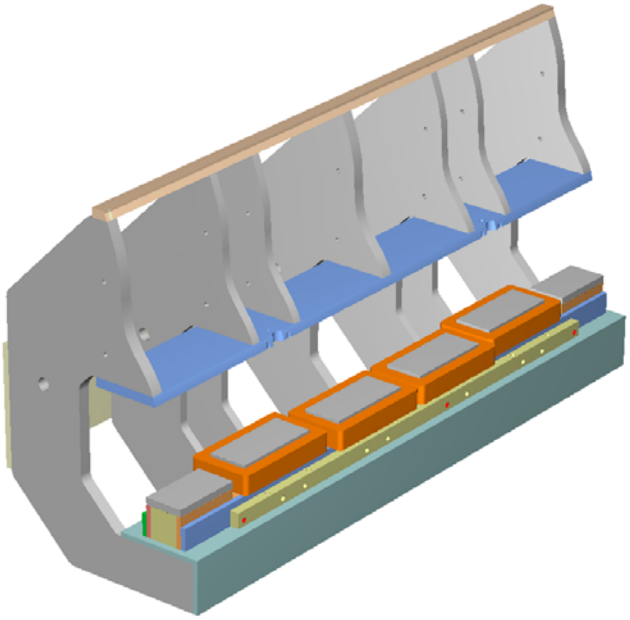
The MagneMotion Maglev System M^3

The MagneMotion Maglev System "M^3" is designed as an alternative to all conventional guided transportation systems. An important part of the design effort was Minimizing 3 parameters: cost, travel time and environmental impact. The architectural rendition shows important features: the use of small vehicles operating on a guideway that has relatively little visual impact compared to many elevated transit systems. Small vehicles lead to lighter guideways, higher vehicle frequency, lower power requirements for wayside inverters, more efficient regenerative braking and reduced station size. The result is a system that can be built for about $20M per mile of dual guideway exclusive of land acquisition and station costs.

M^3 was designed with the following objectives for improving on conventional transit systems and strategies for realizing the objectives.

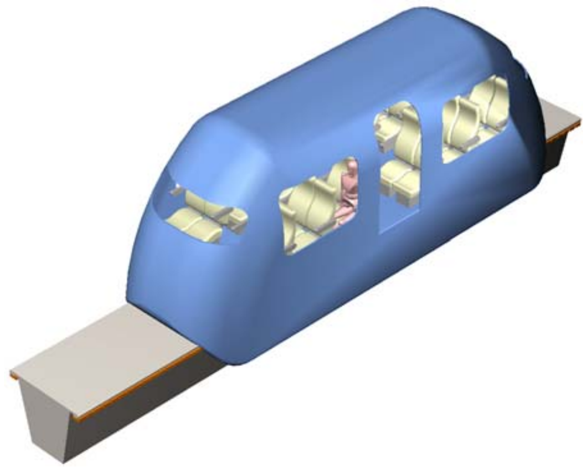
- Decrease travel time by at least a factor of 2: Allow speeds up to 45 m/s (101 mph), acceleration and braking up to 2 m/s^2, short average waiting time and reduced dwell time.
- Decrease operating cost by at least a factor of 2: Use less energy and reduce labor and life cycle costs.
- Reduce guideway cost by at least a factor of 2: Reduce guideway weight by reducing vehicle weight and matching the guideway to the vehicle.
- Reduce environmental impact: Reduce noise, guideway visual impact and energy consumption.
- Create an improved ElectroMagnetic Suspension (EMS): Use permanent magnets with a 20 mm magnetic gap (15 mm physical gap) and make each magnet contribute to lift, guidance and Linear Synchronous Motor (LSM) propulsion.
- Provide excellent ride quality: Pay careful attention to guideway design and take advantage of the distributed and non-contacting nature of maglev forces.
- Create a very safe and secure transportation system: Use a dedicated guideway, vehicles that cannot derail, redundant linear motor propulsion that does not depend on friction and totally automated operation.

The drawing of a short suspension pod for a demonstration prototype shows how magnets support the vehicle in an ElectroMagnetic Suspension (EMS). Arrays of permanent magnets on the vehicle are attracted upwards to suspension rails on the guideway and provide suspension and guidance forces as well as the field for the LSM propulsion system. Feedback-controlled currents in control coils wound around the magnets stabilize the suspension. The LSM windings are integrated with the suspension rails and excited by inverters located along the guideway.



The design objectives were achieved by taking advantage of existing technology including improved microprocessor-based power electronics, high-energy permanent magnets, precise position sensing, lightweight vehicles, a guideway matched to the vehicles and the ability to use sophisticated computer-aided design tools for analysis, simulation and optimization.

For urban applications a baseline vehicle is designed to carry 24 passengers seated with room for 12 standees at times of peak load. The LSM is designed to provide speeds up to 45 m/s (101 mph) and acceleration and braking up to 2 m/s^2 without onboard propulsion equipment. It can negotiate an 18.3 m (60') radius turn. When operated in platoons it is possible to achieve capacities of 12,000 passengers per hour per direction.



For some applications it is desirable to use smaller vehicles with lower top speeds or larger vehicles with higher top speeds. Both of these options are possible with the same guideway and suspension system. The only changes necessary are in the size of the power system used for propulsion. A 12 passenger vehicle with room for 6 standees and with a top speed of 30 m/s (67 mph) is an option when the application requires shorter trips with lower capacity and the reduced cost is an important advantage. A longer vehicle with 36 seats is a possible option for speeds up to at least 60 m/s (134 mph). The important fact is that, with proper attention to design, it will be possible to upgrade M^3 systems to larger vehicles and higher speeds and capacities if such demands are important in the future. The evolution of railroads has shown the desirability of the ability to evolve as times and needs change.

Capital cost estimates are based on discussion with vendors of the major components with the addition of contingencies of 50% for guideways and 25% for other components. Summarizing the results, in M$/mile: power and propulsion control ¬ 9.61; dual guideway: 6.4; LSM stator ¬ 4.1; and vehicles (4 per mile) ¬ 1.3 for a total of $21.1M per mile of dual guideway. This is less than half the capital cost of any new rail-based transit system.

Operating cost is lower partly because of reduced energy consumption. Estimated consumption is 100 W-h/pas-mi or 1170 BTU/pas-mi. This is less than half the energy intensity of any rail-based transportation system, based on data in the U.S. Department of Energy publication *Transportation Energy Data Book, Edition 22*, 2002. Other operating cost savings are due to automated operation and an almost total lack of wear items that require regular maintenance.

M^3 suspension concepts have been tested by constructing a demonstration prototype. This prototype uses full-scale magnets but the vehicle is shorter and narrower than the full-scale system. The prototype is fully functional, and has met its design objectives. The computer models used to design the demonstration system correctly predict the system behavior with good accuracy so it is reasonable to expect similar validity for the models of the full-size system. The guideway is 6 m long and allows a vehicle move of 3.9 m. With a nominal load of 981 kg the maximum test speed was 1.74 m/s (3.8 mph) with an acceleration of 2 m/s^2. The photograph shows the guideway in the foreground with propulsion windings wound around teeth on laminated suspension rails that are mounted below the top guideway plate.

The M3 development has been funded as a cost-sharing partnership between MagneMotion and the Federal Transit Administration. The project is continuing with the objective of constructing a full-scale test track that can demonstrate all aspects of the designed performance.

The web site www.magnemotion.com contains a more detailed report and a short video of the operation of the demonstration prototype. Contact: Joe Meagher, MagneMotion Inc., 20 Sudbury Road, Acton, MA 01742, 978-461-5090 x223, jmeagher@magnemotion.com.