Rail-Veyor®
A Revolution in Material Hauling

MOVING MATERIAL HAULING IN A WHOLE NEW DIRECTION
Summary

For decades, the mining industry has relied on trucks to transport material away from the mine face. Other material handling methods, such as conveyor systems and heavy rail lines, are widely used where conditions allow. Each technology has certain advantages, and each will likely see use for the foreseeable future. As environmental and economic pressures on the industry continue to mount, however, the shortcomings of existing hauling solutions have become painfully apparent.

Diesel truck hauling, while it involves relatively low capital expenditure and allows for flexibility in daily operations, also consumes tremendous amounts of energy, creates significant air quality issues and has the safety risk of loss of life accidents. Conveyors and heavy rail lines, while cleaner and more energy efficient, require extensive infrastructure investments and are unsuited for many mine sites due to their lack of flexibility.

Rail-Veyor®, an innovative technology that combines the flexibility of truck hauling with the energy efficiency of conveyors and rail lines, offers mine operators and other material handlers the opportunity to dramatically cut energy consumption without prohibitive upfront costs or reduced functionality.
The limitations of haul trucks, conveyors, and heavy rail lines are nothing new. Mine operators have always been aware that diesel trucks use vast amounts of fuel, and that conveyors and railways require capital expenditures that can hamper profitability for years. Yesterday’s hauling systems remain in use partly due to a lack of viable alternatives, and partly because (until recently) the benefits have always outweighed the costs.

Today, traditional hauling methods are under increased scrutiny, as the mining industry looks for solutions that will help mines remain viable under a host of new pressures:

**Ore quality:** Lower-grade ore deposits require mines to move larger quantities of material to obtain the same amount of product. Whether mines address this by using larger trucks, more trucks, or both, the inherent inefficiency of truck hauling is magnified as the amount of material increases.

**Remote locations:** Many undeveloped mine sites are located in remote areas, far from existing infrastructure and population centers. The costs of road improvement, conveyor construction, or railway construction can make an otherwise promising mine site unworkable.

**Environmental regulation:** The mining industry is a major source of greenhouse gases, owing largely to the emissions of diesel haul trucks. Governments around the world have implemented penalties for fossil fuel use and carbon emissions, and these penalties are likely to increase significantly in the years to come. Likewise, the requirement to move waste back to the original pit is increasingly showing up in new permitting and mine closure plan requirements.

**Workplace safety:** As haul trucks get larger and larger, workplace accidents become more dangerous and more costly. In addition, truck emissions contain high levels of hazardous particles that can adversely affect worker health. Liability claims (and insurance against them) can be a significant obstacle to mine operations.

In this business environment, mine operators need a solution that will allow them to take advantage of new opportunities and reduce expenses at existing locations.

**Rail-Veyor®: An Idea Whose Time Has Come**

Rail-Veyor, an innovative system that uses automated trains on scalable, easy-to-install light rail tracks, has emerged as the most promising hauling solution for the mine of tomorrow. Rail-Veyor systems can be installed in place of or in conjunction with traditional hauling systems and are suitable for use in a wide variety of applications:

- Open pit mining
- Hard-rock underground mining
- Aggregate handling
- Quarry operations

Offering a truly unique combination of flexibility, efficiency, and dependability, Rail-Veyor provides a solution that can bring jobs and profitable operations to otherwise unfeasible mining locations.
Unprecedented Efficiency and Effectiveness

Rail-Veyor® material hauling systems deliver an array of benefits, without the trade-offs associated with traditional hauling methods. While other solutions force operators to accept high energy consumption, high capital expenditures, or limited functionality, Rail-Veyor provides energy efficiency, flexible installation, and ease of use under virtually any operating conditions.

Energy Efficiency

Among the many benefits of Rail-Veyor technology, energy efficiency is perhaps the most significant. Rail-Veyor systems use a fraction of the energy consumed by haul trucks, and compare favorably to traditional conveyors as well. Rail-Veyor’s innovative design provides several advantages over other material hauling solutions:

• **High payload-to-weight ratios:** Rail-Veyor technology allows for payload-to-weight ratios similar or higher than those of traditional conveyors, meaning that most of the energy consumed (typically 75% or more) is being used to move material, rather than being used to move the transport mechanism itself.

• **Low friction loss:** Haul trucks expend a tremendous amount of energy simply to overcome friction forces between their tires and the ground. Traditional conveyors, with rubber belts running over numerous steel rollers, also lose large amounts of energy to friction.

Rail-Veyor systems experience very little friction loss, as transport is conducted by unpowered steel wheels rolling on steel rails. Since Rail-Veyor trains are powered by external drive stations rather than car-mounted motors, the weight of the drive mechanism is eliminated from the train, and further, the rails can be greased, reducing friction between the train cars and the rail.

• **Energy regeneration:** Rail-Veyor systems can take advantage of gravity on downslopes to regenerate electricity, significantly reducing the energy inputs required to move material.

Together, these advantages combine to deliver remarkable energy savings. The table below compares typical energy consumption by haul trucks, traditional conveyors, and Rail-Veyor systems on flat ground and on a 10% grade. Rail-Veyor is the most energy-efficient solution in both cases, outperforming trucks by a factor of 20 on level ground.

<table>
<thead>
<tr>
<th>Material hauling solution</th>
<th>0% grade</th>
<th>10% grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haul trucks</td>
<td>.501</td>
<td>1.761</td>
</tr>
<tr>
<td>Traditional conveyor</td>
<td>.068</td>
<td>.353</td>
</tr>
<tr>
<td>Rail-Veyor</td>
<td>.025</td>
<td>.324</td>
</tr>
</tbody>
</table>

Flexibility

In addition to their unmatched energy efficiency, Rail-Veyor systems provide a high degree of flexibility, allowing mine operators and other material handlers to implement and reconfigure their transport systems to suit their business needs.
- **Easy installation:** Rail-Veyor® pt tracks are assembled using steel clips between rails and ties, allowing for rapid installation and relocation. Train assembly is easy as well, requiring only a simple clevis pin connection between one car and the next.

- **Incremental change:** Unlike conveyors or heavy rail lines, which are difficult (often impossible) to extend or re-route, Rail-Veyor lines can be modified quickly to accommodate changes to the mine plan.

- **Incline range:** While haul trucks are generally limited to operating on inclines of 10% or less, Rail-Veyor systems can accommodate inclines of 20% or more, allowing for more effective mine development.

**Simplicity**

Installing and operating a Rail-Veyor material handling system is fast and easy. Due to its simple design and small footprint, a Rail-Veyor installation can expand quickly to keep pace with mine development, often allowing for development rates that are two to three times faster than truck or conveyor-based systems.

- **Low underground drift:** Able to operate effectively in a 12x10 (4x3 m) tunnel, Rail-Veyor requires 50%-60% less drift space than haul trucks. Rail-Veyor tracks can often be installed in existing drifts and ramps with no need for additional excavation or ventilation.

- **Low ground support:** Above ground, Rail-Veyor requires far less aggregate than a heavy rail line and far less infrastructure than a traditional conveyor. A Rail-Veyor installation also requires less surface improvement than constructing a roadway suitable for haul trucks.

- **Fewer parts, less maintenance:** Haul truck maintenance is frequent, complex, with major overhauls and often requires expert technicians. Rail-Veyor components are highly durable and easy to replace when maintenance is needed.

- **Quick training:** While haul truck operators must be licensed and highly trained, operating a Rail-Veyor system requires no special training or certification. Controls are computer or tablet-based and can be handled remotely by a single operator.

**Environmental Benefits**

Rail-Veyor’s efficient operation can greatly reduce a mine’s impact on the environment (and the associated costs) while also creating a healthier and more effective workplace.

- **Smaller carbon footprint:** Rail-Veyor’s efficient design allows mines to move the same amount of material with less energy, reducing the mine’s fossil fuel use and carbon footprint. When electricity is generated using renewable energy sources, a Rail-Veyor system can be operated with minimal effect on the environment. Lower greenhouse gas emissions can also help mine operators avoid financial penalties, as governments continue to increase pressure on the mining industry while some jurisdictions may actually provide incentives.

- **No particulates:** Diesel trucks produce large amounts of emissions, reducing air quality at the site and exposing workers to a variety of hazardous particles. Rail-Veyor systems produce no emissions, helping customers meet PM-10 standards for air quality and avoid potential liability for workers’ health problems.
• **Less noise, less dust:** Rail-Veyor® trains are quiet and nearly dust-free, creating a safer and more comfortable work environment.

• **Reduced fire hazard:** Rail-Veyor has a significantly lower fire hazard than either diesel trucks or conveyors, a factor that can be critical in an enclosed or underground environment.

## Simple, Fast, and Flexible

A Rail-Veyor system consists of a light rail track with drive stations located at regular intervals. Trains of open-trough cars run from the loading zone to the offloading zone, and then reverse back to the loading zone again.

Rail-Veyor installations are highly customizable and can be modified to suit the topography and material to be handled at each site. Rail-Veyor technology can be used over various operating distances, including tracks less than 1km to over 50km.

### Track

A typical Rail-Veyor installation features a 37.875 inch / 962 mm gauge track installed on stamped steel rail ties. Rails are easy to install and can be moved as needed. Due to the system’s low car weight and low ground pressure, very little crushed aggregate ballast stone is required under normal conditions.

Like other Rail-Veyor components, the tracks can be designed to suit each operator’s specific needs. The gauge, rail type, and other characteristics can be modified as appropriate.
Cars

A Rail-Veyor® car is an open steel trough set on a single set of 16-inch (41 cm) steel wheels with heavy duty automotive bearings. Cars are connected to each other with steel clevis assemblies and flexible flaps that prevent material leakage. Steel plates mounted on the outside of the wheels provide a contact surface for the drive stations to propel the cars along the track.

Trains

Multiple Rail-Veyor cars are connected together to form trains, each of which operates as a single open trough. A lead car, with four wheels instead of two, is placed at the head of each train.

Any number of cars can be combined to form a train, allowing operators to customize the system to meet the specific needs of the site. Rail-Veyor trains are easily able to operate on slopes up to 22% (Even higher depending on material rollback properties) and can negotiate turns with a radius of as tight as 100 feet (30 m). 100 feet (30 m) with standard cars. Special shorter cars can turn even tighter.
Drive Stations

Propulsion for a Rail-Veyor® train is provided by drive stations located at intervals along the track. Drive stations consist of motors mounted to foam-filled tires that press against the rail car side plates and propel them either forward or reverse. Drive stations use tensioning systems to ensure proper drive pressure and electrical control cabinets utilizing variable frequency drives to control the speed for each train.

Drive stations do not run continuously, but rather use proximity sensors to detect approaching trains before engaging the motors. This design allows the system to reduce energy use and motor wear without compromising effectiveness.

Return Loops

A Rail-Veyor car is an open steel trough set on a single set of 16-inch (41 cm) steel wheels with heavy duty automotive bearings. Cars are connected to each other with steel clevis assemblies and flexible flaps that prevent material leakage. Steel plates mounted on the outside of the wheels provide a contact surface for the drive stations to propel the cars along the track.
Depending on the specific installation, the train then either re-inverts as it continues along the track or reverses along the same vertical loop.

Controls

Rail-Veyor® is an automated system, requiring no manual intervention from loading to unloading. Once up and running system control usually requires only one operator to monitor the system, either at a central control center or using a tablet computer.

Operators are able to monitor train locations, drive station functionality, and other key system information in real time. The user interface is designed to meet the needs of the mine site and can be upgraded and modified over time as needed.
The Time is Now

Rail-Veyor® technology has existed for more than 15 years and is experiencing rapid adoption as mine operators recognize the benefits it can bring through energy savings, faster mine development, enhanced workplace safety, and environmental improvements.

Implementing a Rail-Veyor system can help mine operators address long-term concerns such as decreasing ore quality and stricter environmental regulation, as well as shorter-term considerations such as commodity prices and fuel prices. When prices drop, mines equipped with Rail-Veyor systems can continue to operate profitably, because their operations are more efficient and require a smaller workforce. When prices rise, those same mines are able to ramp up production without incurring a corresponding rise in costs due to excessive fuel consumption.

Capital vs operating Costs

With its unmatched combination of low capital costs and low operating costs, Rail-Veyor also allows for mining operations in locations that would otherwise be unprofitable due to challenging terrain, ore quality, or inaccessibility.

The mining industry is changing, and material hauling strategies need to change with it. The flexible, efficient Rail-Veyor system is the key to effective material hauling in the next generation of mines.