Modern handling techniques for transporting rolls of paper

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Automatic Guided Vehicle Systems, overhead cranes, and rail-mounted transfer cars can be used alone or in combination to move rolls more easily through plants.

The use of unit load Automatic Guided Vehicle Systems (AGVS) for the transportation of parent rolls of paper provides many benefits, both obvious and indirect. The AGVS is a derivative of other materials-handling techniques—in particular, overhead cranes and rail-mounted transfer cars—and complements them as well.

Paper mills have traditionally located primary and secondary processing operations in geographic proximity. A principal reason for this has been to make it easy to move the basic product, parent rolls, from one operation to the next.

Paper is made in rolls up to 10 ft in diameter, as wide as 24 ft, and weighing up to 50 or 55 tons. The parent roll is wound on a steel spool and transported by supporting the ends of the spool. After the product is initially made and processed, it is split into much smaller, more manageable rolls for shipment.

The methods of moving these parent rolls are the following:

1. Overhead crane with a spreader bar attached
2. Wagons or trailers pulled with a manual lift truck
3. Rail guided transfer cars, both manual and automatic
4. AGVS.

Cranes

The traditional overhead crane method of load movement is limited to movements within the crane bay itself. A "house" crane is generally not preferred as the primary method of moving paper rolls or "logs" from process to process because it is used for emergency purposes, construction, and paper machine repair. As an alternative to the house crane, gantry cranes, which cover a smaller area, are dedicated to production.

While the use of gantry type or house cranes is vital in an expanding paper mill, their use is self-limiting. It is common to supplement the material handling of jumbo or parent rolls through the use of wagons, trailers, or transfer cars.

Wagons

The use of wagons and trailers requires tow vehicles and trained operators, offsetting initial capital outlays with continuing operating costs.

Transfer cars

Transfer cars not only can be used to move paper between gantry cranes, but they can also be used to connect adjoining buildings. Typically, this rail-guided device is powered with an ac motor and has a cable reel trailing power behind. An operator, either riding on a platform or walking along beside it, controls the movements of the car.

As modern mills look for new ways to expand, the distance from old to new machinery increases. New buildings are being planned and constructed many hundreds of feet from existing machinery that must feed them.

Because of the need to travel greater distances, batteries are being added to transfer cars to provide dc power. This feature also permits the car to traverse the work area without the safety concerns caused by the "umbilical cord" trailing behind the vehicle. Typical safety problems are tripping hazards, severed power cables from crossing gantry rails, and trailing cables across the path of fire doors.

The next step in evolution of the modern paper mill transfer car is to automate its travel; that is, to permit it to travel without an operator. Because transfer cars can be equipped with multiple, redundant safety features found on AGVS, they can be permitted to travel without the walk-along operator. By using the logic in an on-board programmable logic controller (PLC), these cars can know where they are along the track, and they can detect "slow down" and "stop" markers. The PLC also manages safety features used to protect plant personnel. These safety features include:

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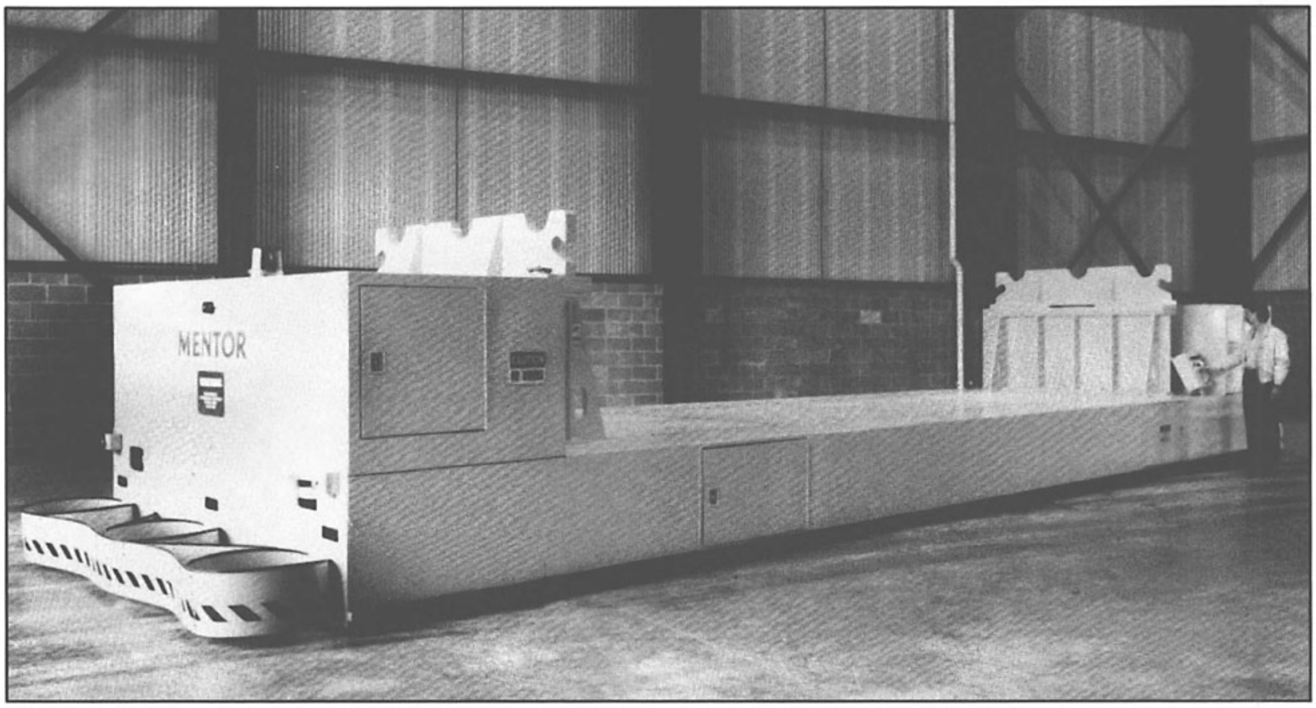
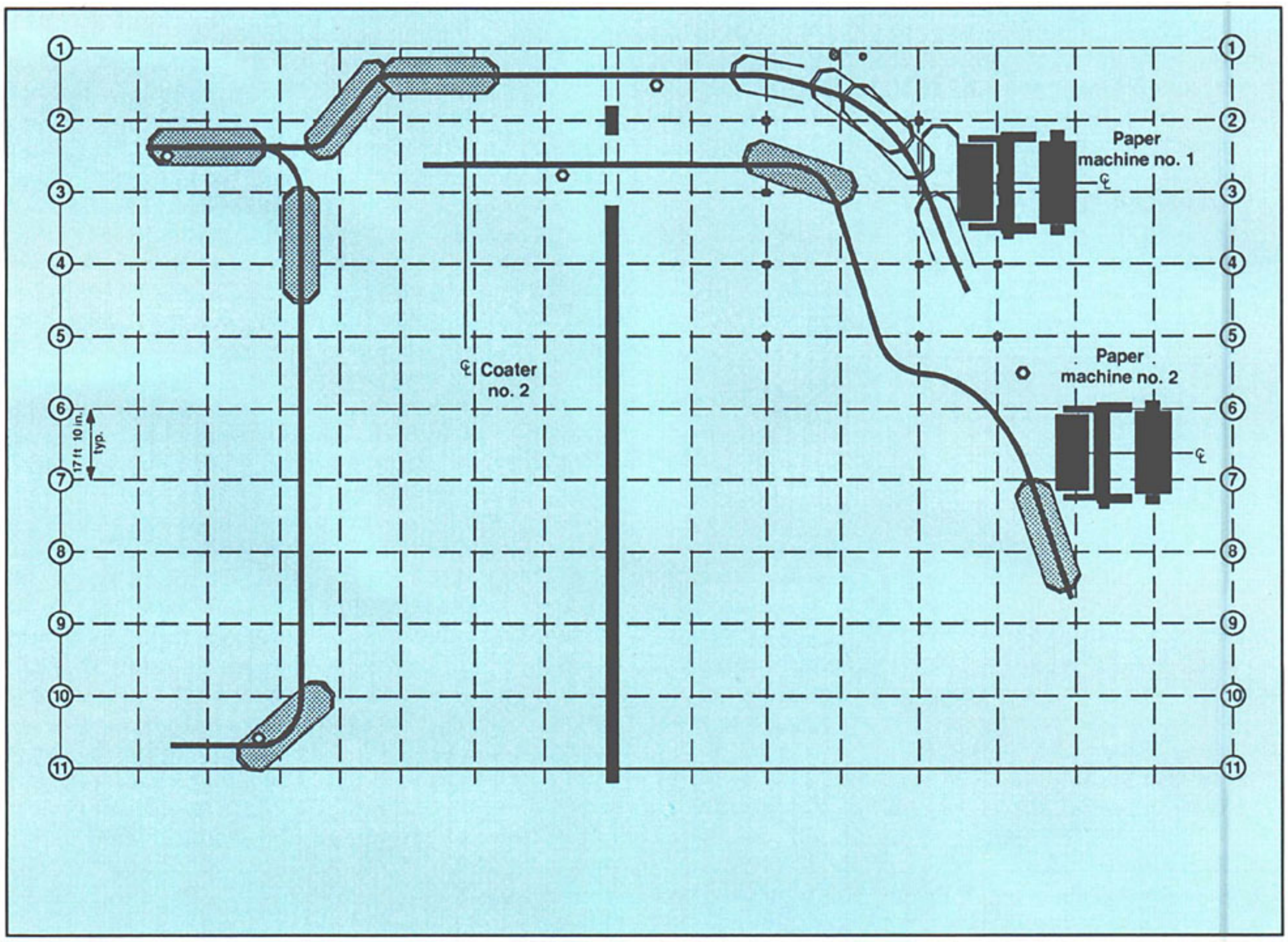
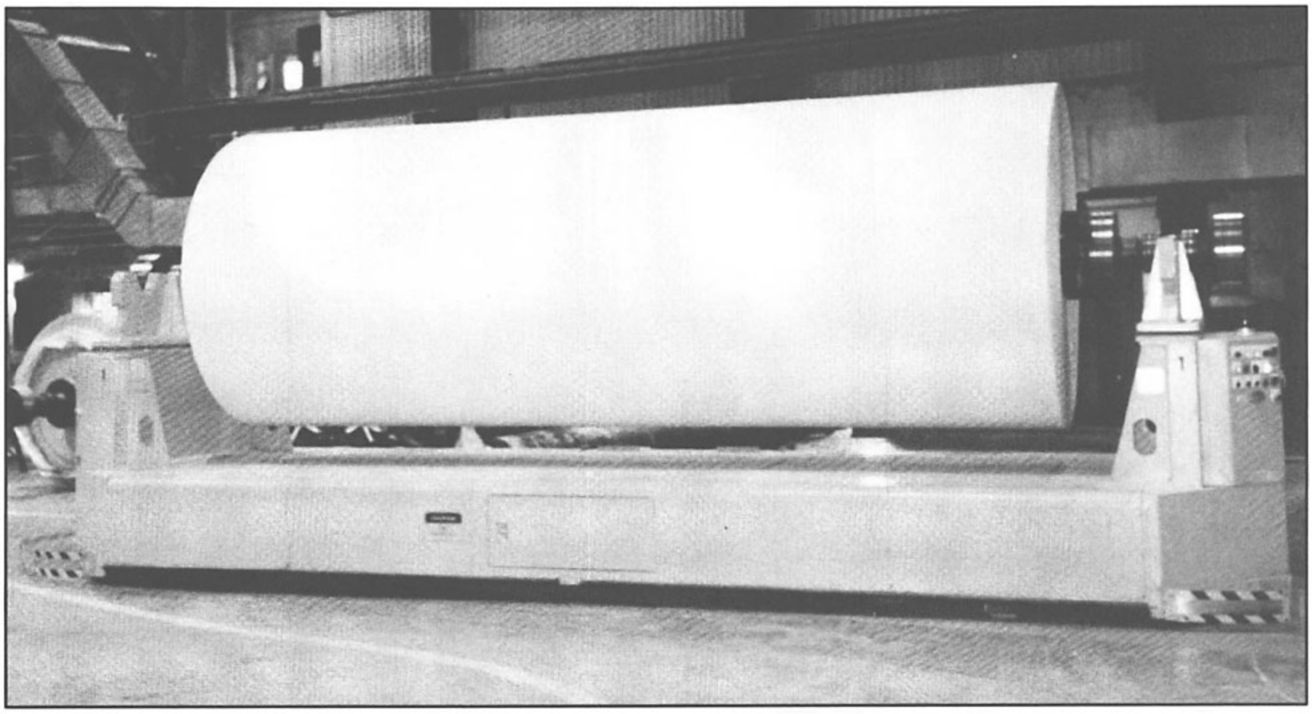
1. Paper roll AGVS with 55-ton capacity, used to transport reels between a primary paper machine and six additional stops in the system



2. Guidepath layout of AGVS connecting paper machine hall with coater hall



3. Bidirectional 48 V dc battery-powered AGVS designed to transport jumbo paper rolls. This vehicle has an overall length of 26 ft 11 in. and a maximum rated load capacity of 22 tons.



1. Mechanical bumpers, which on impact trip a limit switch and, as a result, produce an emergency stop
2. Fail-safe brakes, which spring on when activated but must be electrically released and held
3. Optical sensors, which "see" any object in the car's path and slow the car to "creep" speed or make it stop
4. Emergency stop pushbuttons located strategically on the four corners of the car
5. Audible alarm horn which sounds just before and during travel
6. Flashing safety beacon.

AGVS

Out of physical necessity, due to the ever-increasing size and complexity of facilities, a new, automated method of transporting jumbo rolls has evolved. Roll-handling Automatic Guided Vehicles are being specified, purchased, and installed in modern mills as the best possible way to meet the future demands for driverless, long-distance roll transportation.

Automatic Guided Vehicle Systems or AGVS are polyurethane-tired, self-propelled, driverless vehicles which follow a signal generated from a guide wire buried in the plant floor.

The buried wire (typically 16-gauge stranded with heavy jacket, buried in a slot 0.25 in. wide × 0.75 in. deep) broadcasts a weak FM signal. The AGV "follows" the signal by using antennas to sense its path.

AGVS have been used for many industrial material-handling tasks but, until recently, not for jumbo roll transportation. AGVS can be the most economical handling technique, if some of the following conditions exist:

1. Long moves over several hundred feet
2. Serpentine moves negotiating building columns or right angle centerlines of secondary processes
3. Remote call, dispatch requirements
4. Multiple vehicle management
5. Steady and continuous throughput—applications requiring repetitive load delivery, shift after shift.

Long moves over several hundred feet (**Fig. 1**) are practical with AGVS because large batteries can be provided which utilize on-line battery recharging (opportunity charging). In addition, guidepath installation is a fraction of the cost of installing fixed steel rails.

Serpentine moves are practical because vehicles can be equipped with steering and driving on both the front and rear, permitting turning radiuses of 20 ft and smaller on vehicles up to 30 ft and longer. **Figure 2** illustrates a plant layout where such turns are necessary.

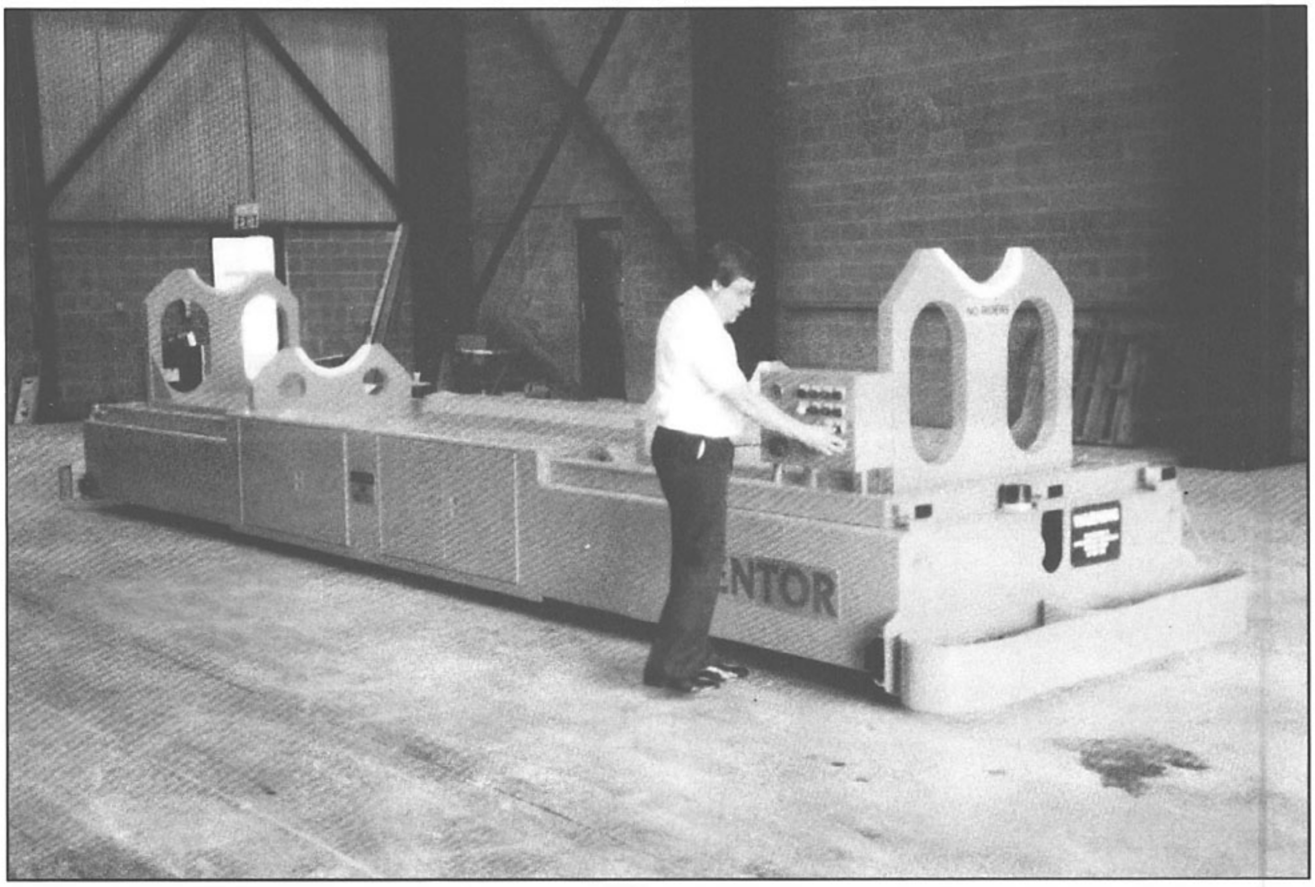
Pushbuttons may be installed for operators to request the next available vehicle to "go" to a requested position.

Off-board microprocessors can send vehicles, provide communication over embedded floor wire, and block intersections from potential vehicle collisions, enabling multiple vehicle operation on common paths.

The Automated Guided Vehicle

Automatic Guided Vehicles for jumbo roll handling (**Fig. 3**) are typically at least as wide and slightly longer than the roll to be transported. Safety features, as previously described, are mandatory and standard. Supports are mounted on the vehicle's chassis, such that the reel spool

4. Bidirectional 48 V dc battery-powered AGVS designed to transport polyester film rolls. This vehicle has an overall length of 27 ft.



is loaded by crane into cradles attached to the vehicle's chassis. These supports can also be used to return empty spools. Low-voltage dc motors (typically 48–72 V) are used to provide tractive effort. Steering is also accomplished by dc motors turning the drive assemblies down the buried wire guidepath.

AGVS opportunity charging

To facilitate three-shift operation, there is a process identified as opportunity charging. Typically, in the course of every hour, the vehicles are stopped while being loaded, unloaded, or waiting for the next request to move. During this waiting period, batteries can be recharged without removing them from the vehicle. This technique is called opportunity charging.

At "home" position or other strategic vehicle parking locations, plates are located on the floor and wired to battery chargers located nearby. When the vehicle arrives at one of these opportunity charging locations, on-board collector shoes mate or make physical contact with the on-floor charging plate. When this contact occurs, the charger senses the presence of the vehicle's battery and switches on. Correctly designed, opportunity charging can provide a continuous availability of energy to the AGV, virtually permitting perpetual motion of the system.

AGVS system layout

The layout for AGVS in a paper mill can look like that shown in Fig. 2, which provides a pathway from the paper machine hall to the coater hall.

Long distances, heavy parent rolls, and serpentine or right-angle turns are present in both of these applications.

The two-vehicle system shown requires an off-board or ground controller to accept operator orders, to prioritize orders, to select best available vehicle and best available route, and to provide zone blocking so that vehicles are inhibited from traveling to zones occupied or about to be occupied by an oncoming vehicle.

This type of AGV can be used not only in paper mills but also in facilities that make pulp, plastic film (**Fig. 4**), or aluminum. Likewise, heavy-load AGVS can also be used in metalworking facilities for handling steel coils, ingots, or pallets of sheet metal blanks.□