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## Important Considerations for Planning Your AGV Robot-Friendly Hospital

### What hospital architects and planners show know about AGV systems

Robotic delivery vehicles, also known as [automatic guided vehicles](#) (AGV's), are in high demand in today's hospital because of demographic and healthcare spending trends (see *Hospital Friendly Robots*). In the world of [healthcare logistics automation](#), these systems are designed specifically for [bulk material transport](#); transporting carts containing food/soiled dishes, clean/dirty linens, trash/biohazard waste and supplies weighing up to 1,000 lbs. Ongoing operational efficiencies are gained by automating the delivery of carts filled with various materials. Following are a dozen topics architects and planners need to consider when [designing a new hospital or major hospital expansion project](#) to be robot AGV friendly.



#### Environment

An indoor environment should be temperature controlled between 5 and 35 degrees Celsius (between 41 degrees and 95 Fahrenheit) with humidity controlled between 30 and 80 percent.

#### Corridor Space

Consult with the local Fire Marshall early in the project to determine how they will interpret building codes with regard to egress space. Some authorities (California OSHPD) believe the robotic/automatic guided vehicles represent a permanent obstruction and they want the required egress space for that corridor added to the travel space.

In round numbers each vehicle's travel envelope with a cart is 3-feet wide. Using one foot of space between the vehicle and the wall and between passing vehicles a 9-foot corridor is adequate for two lanes of straight travel. Vehicles require more space at corners, so ideally the corridor becomes wider at junctions where vehicles will turn, or the guide path will be designed to allow only one vehicle at a time through the intersection (at potentially reduced throughput capacity).

Others fire authorities will understand the vehicles can be commanded to stop (when there is a fire alarm) in alternating positions along the corridor, so they are not directly across from one another and will see only one vehicle as an obstruction. In this case if the egress space required is 5 feet, then a 9-foot corridor will also be adequate for two lanes of traffic. Again ideally a little more space is better and a 10-foot corridor will provide two feet of space adjacent to two lanes of traffic when vehicles are passing each other.

Various additional spaces along the corridor are required for vehicle charging and parking. The system requires one location for each vehicle, so that when there is no activity, they all have a place to either charge or park off the main travel paths. The service departments also require locations for sending and receiving carts.

### System Control Center Room

The control center PC is best located in a small lockable room with computer desk and work table somewhere central to the service departments. The room should have power and environment of 0 to 95 percent relative humidity and an ambient temperature of 10 degrees to 40 degrees Celsius (50 degrees to 104 degrees Fahrenheit).

The SCC room should also have a dedicated DID (direct inward dial) analog phone line and jack, a Local Area Network connection to broadband Internet access or high speed DSL Modem connection plus a phone-line with long distance service for voice communications.

### Robot Vehicle Maintenance Room

A lockable room should be provided for servicing the vehicles and storage of operations & service manuals tools and parts. This is best located in the same room as the system's control center. The space is somewhat dependent on the fleet size, with minimum being around 15 feet x 15 feet.

### Elevators

The [vertical transport](#) is via cart lift (may not have to be a full fledged elevator – depending on state codes). Since soiled laundry and trash are undesirable sights on personnel and public elevators, and the usage requirements probably demand full-time use of a dedicated vertical lift(s) for materials transport between the service levels of the hospital and the nursing units they serve. The number of lifts depends on the frequency of use required. It is entirely possible more than one lift will be required. Frequency can be determined from the throughput matrix (see below).

#### The ideal requirements of the lifts include:

- 2,500 lbs capacity per vehicle
- “C” rating
- 40 inch clear door opening and cabin width
- 79 inch cabin depth
- Maximum gap between lift and floor thresholds = 1 inch
- Leveling tolerance +/- .2 inches



Contact Jeff Barber at: [jeff.barber@swisslog.com](mailto:jeff.barber@swisslog.com) for a detailed control interface specification, which defines the signals and timing sequence between the robot and elevator systems.

### Clean and Soiled Holding Rooms

The materials are transported between the service areas and the nursing units, so cart queuing near the patient areas is best provided in clean and soiled holding rooms that are actually vestibules connected to the lifts. The clean holding room may have a lockable access door, while the soiled may be open for nursing personnel to deposit materials in soiled carts.

It is best to have a passageway for vehicles to travel from the clean side to the soiled side, so they can release the elevator while they deliver a clean cart and drive around to pick up a soiled cart. The quantity of clean and soiled cart queuing positions are somewhat dependent on the [system throughput matrix](#) and cart delivery messaging system.

Two clean cart-receive positions and two soiled cart send positions should be provided with 3 each being user-friendlier. On the soiled side, there should be additional cart staging locations (one for each soiled material i.e. general waste, biohazard waste, laundry) for loading of soiled materials, because the carts in the send positions should be for sending fully loaded carts. You should consult with the manufacturer on the layout of this room, as adequate space is required for the robotic vehicles to maneuver under the carts in the send and receive positions.

### Floors

Floors should be adequate of supporting system vehicles (725 pounds per square inch) and level to the following tolerances: (4 mm/meter in travel areas, 3 mm/meter in charging locations). Sloped floor surfaces and the transition onto and off of ramps should be submitted to the manufacturer for review and approval.

Floors should be dry with anti-static properties ( $< 1 \text{ G Ohm} - 109 \text{ Ohm}$ ), measured on a  $20 \text{ cm}^2$  sample at an ambient temperature of 20 degrees Celsius (68 degrees Fahrenheit) and 50% relative humidity.

The floor covering should be a different color to define vehicle's travel envelope. Abrasion of the floor covering should not exceed  $110 \text{ mm}^3$  with a load of 5 N resistant.

The friction coefficient between the vehicles' wheels, made of Vulcolan, and any floor surface under any condition (dirt, moisture after cleaning, etc.) should be  $> 0,5$ .

Ceramic tile floors have to be installed even. Joints between tiles shall be maximum 5 mm wide and shall be filled flush to floor level.

### Power Circuits

Provide three phase power (480/3/60 – 6 amp service) to each battery charger and single-phase power (115/1/60 – 20 amp service) to each star distributor (network switch), Buss Controller, motorized door, and system control center. All circuits but the system control center (quad outlet) will be hard-wired.

### Send and Receive Stations

Besides the cart locations described on the patient floors, each of the main service-area send and receive locations require cart positions for the robotic vehicles to pick-up from and deliver to. The send positions will have a set of detents mounted to the floor for proper positioning of the cart for pick up and a dispatch terminal mounted on the wall. The send and receive positions will each have a sensor mounted in the ceiling to detect presence of a cart underneath. The quantity and positioning of the send and receive positions is dependent on the throughput matrix (see below) and the maneuvering space for the vehicle, so it is best to seek manufacture's input for proper layout.

### Automatic Doors and Fire Doors

Each doorway that will be traveled through by the vehicles shall either be held open by electromagnet, or be motorized. A control interface specification, available from [jeff.barber@swisslog.com](mailto:jeff.barber@swisslog.com), describes the signal interaction required so that once a vehicle starts through the doorway, the

operating mechanism will hold the doors open until the vehicle has passed completely through the door's swing radius. UPS power circuits should be supplied to the operating mechanism to insure it has power to hold the door open during vehicle passage. A signal is sent from the doors to tell the vehicle's control that the doors are completely open and ready for vehicle passage. All smoke, heat and fire detection is part of the door or fire control system.

### Throughput Matrix

The throughput matrix is a very important set of data that is required to properly size the system with respect to the number of vehicles, number of charging positions, quantity of send and receive stations and the vehicle's travel layout. The matrix is defined by the quantity of full and empty carts that will be moved to and from each pair of send and receive areas. The matrix should be broken down by the hour of the day. Contact [jeff.barber@swisslog.com](mailto:jeff.barber@swisslog.com) for a blank worksheet sample.

The more the transport requirements are leveled out throughout the day (24 hour period), the higher the return on investment will be, and fewer vehicles (less congestion), and fewer chargers will be required to meet the cart transport requirements for the peak period. It is best to start the matrix with the patient-food delivery/soiled dish returns cycles and then fill-in the open spaces with equal quantities (assuming equal distances) of other material transports. Usually waste collection and linen distribution are easier to accommodate in the evenings.

The matrix may serve as the data input for an animated computer simulation if the design is complex enough that manual calculations do not provide a high degree of comfort in determining the number of vehicles required or travel network designed.

### Carts

To derive the number of cart movements, it is useful to know the volume and capacity of the carts. The footprint of the cart is 32 inches wide by 54 inches long. The cart height can vary by whatever is user friendly with the facility openings. The capacity of the robot is a maximum of 1,000 lbs., however most carts weigh less, since manual movement of 1,000 lb. carts is difficult. The cart's tare weight should be subtracted from the robot capacity to get net capacity. The size, space and features underneath the cart have to be specific for the robot to interface properly and thus it is best to obtain specifications from the manufacture. For example, self-centering swivel-castors and magnets on the cart improve the handling during automatic pick-up and delivery operations.



### Optional Systems

There are a few systems that are optional, but very nice for smoother operation and observation of the robotic delivery system.

**Paging System** - The System Control Center is capable of sending a page announcing the pending delivery of a cart to its destination. Pages are sent from the System Control Center over a hospital network to their paging system. Paging system compatibility should be verified with the manufacturer. Additional power and equipment are required for this sub-system.

**Closed Circuit TV** - Closed circuit TV monitors in the control center room are ideal with cameras mounted in clean/soiled holding rooms, as well as in all main corridors and the entry/exit of all lifts. Additional power and equipment are required for this sub-system.

**Warning Signs** - "Caution, Automatic Vehicle Approaching" signs are recommended where personnel might be entering vehicles travel areas. Signs are mounted to walls or ceilings in adjacent corridors or rooms and flash when vehicles are in the vicinity. Audible tones are available as well. The buss controller provides power to these signs.

**Room in Use / Arrival lights** - We recommend each clean receive room have a three-color light outside. Flashing yellow normally indicates that at least one cart is ready for removal from the delivery detents. Flashing red normally indicates that all delivery positions are full and the system can back-up since there is no location to deliver more carts. Flashing blue indicates that an automatic vehicle is inside the room delivering or picking up carts. The buss controller provides power.

**Rotating Beacons** - Audible/visual warning devices can be supplied to meet special warning requirements where vehicles may travel in public areas.

**Mechanical Trash Dumper** - Assist in dumping heavy carts into compactors or sanitizers. Additional power and equipment is required.

**Automatic Cart Washers** - Desirable for adequate cleaning and sanitizing of carts. Substantial savings are achievable in the delivery system if carts are cycled between clean and soiled functions in each cycle they are used. Clean meal/linen carts can be used to return soiled dishes/laundry. Clean waste carts can be used to deliver general supplies. Using carts for both clean and soiled transport reduces the number of carts and the number of deliveries required. Automatic washers can be manually loaded or loaded directly by the robotic vehicles if they are equipped with powered conveyors. Additional power and equipment are required for this subsystem.

**Preventive Maintenance Agreement (PMA)** - Normally the manufacturer provides a PMA for the AGV to include preventive service at some level of response for one to three years past the system acceptance date. The requirements are found in the specification for the AGV system purchase.

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#### A note about the author:

Jeff Barber has been designing automated material handling systems for 20+ years and manual material handling systems for 25+ years. He began his material handling career in an 18-month management-training program including half of it in the engineering disciplines of mechanical and electrical engineering. His experience includes application engineering, system design, system layout, field surveys, simulation, estimating, project management, product management and sales support. He has worked within Swisslog holding positions of product manager, sales engineer, applications engineer and system design analyst. He is experienced with several automated transport and storage systems for healthcare environments.

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