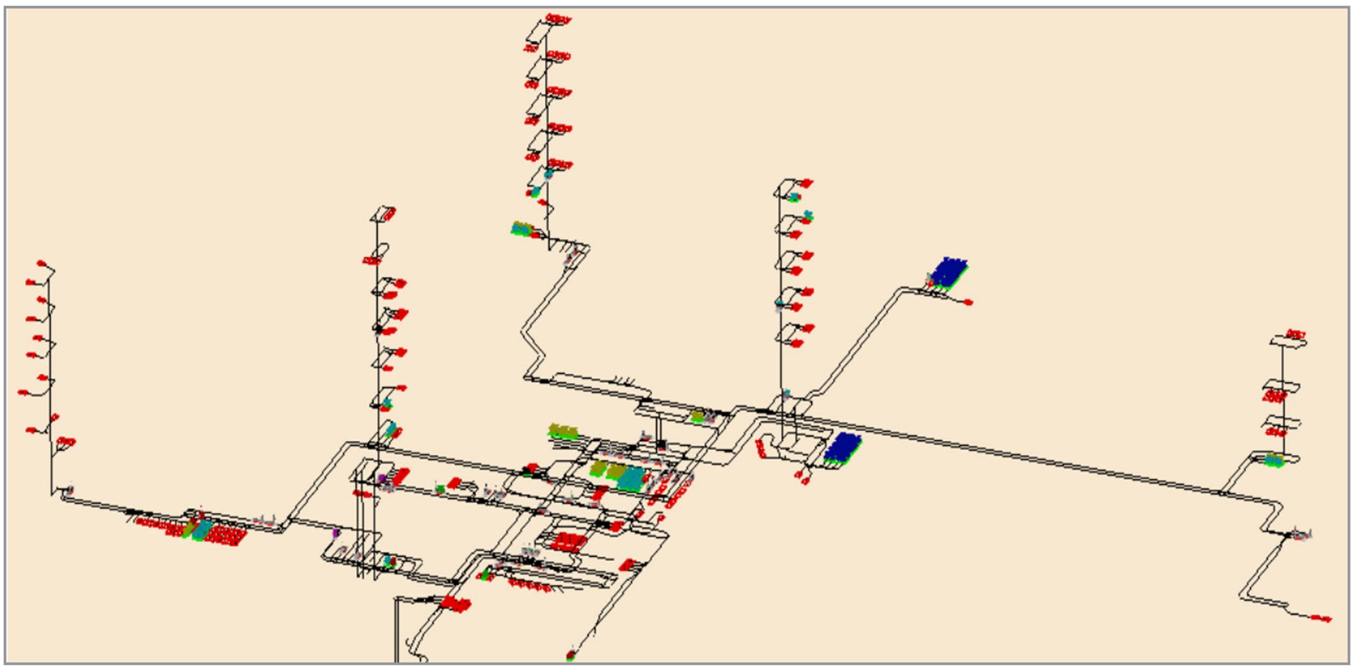
Design Simulation for TransCar® Automated Guided Vehicle System (AGVS)

Forecast the ability of an automated material transport system design to perform the defined workload within the available space and time.



Design Simulations Deliver Measurable Performance

Swisslog can provide system design simulations that provide architects, project planners, facilities managers and user departments the ability to view the operation of a proposed system in a three-dimensional, virtual-reality computer environment. Alternative simulation techniques provide data-based results without 3D visualization. Computerized AGV simulations are discrete event and time-based, enabling more accurate analysis than static calculations is for estimating vehicle quantities, bottlenecks and performance. They allow planners to evaluate system design and decision-making logic to ensure optimal performance of their automation. AGVS simulations should be developed as early in the design process as possible, to verify the expected cart movements can be achieved within the corridor space, elevator capacity and Pickup and Delivery (P&D) stations available in a preliminary plan. Adjustments to these facility design features have to be made very early in the design process or there may be operational limitations for the life of the facility. Please refer to the white paper "Twelve Important Considerations for Planning a Robot-Friendly Hospital" for facility requirements for AGVS.

Factors to Consider in Preparing Design Simulations

A key goal in simulating material transport systems is to model "real-world" behaviors. Therefore, Swisslog incorporates as many equipment operating parameters as possible into the simulation model.

CAD Layouts
An initial system layout is imported into Swisslog's simulation model to create an accurately scaled model of the desired layout. If bottlenecks are identified, adjustments will be recommended in space and/or timing of movements to alleviate them.

AGV Speeds
TransCar AGVs will travel at different speeds, depending on where they are located within the facility and what task they are performing. For example, AGVs may be able to travel at maximum speed when traveling down long, straight hallways; but will travel at slower speeds when traveling around corners, on ramps through areas with high levels of human traffic, or positioning for pick up, drop off, charging and travel on/off elevator cabins.

Safety also can be factor in determining operating speeds at each location. Facilities should consider what maximum speed is considered safe for each corridor.

Battery Charge States
Each AGV contains a rechargeable battery to power the vehicle motors and onboard computerized navigation and safety systems. Within a simulation model, various "battery drain rates" are assigned to each vehicle depending on what task the vehicle is currently performing. Battery type and charge level information is used to determine when a vehicle needs to dock at a charging station and how long it needs to stay on the charger. Different battery technologies can be evaluated to determine which one is best suited for the scheduled cart movements. Multiple matrix scenarios can be run to determine the effect of having additional vehicles and battery chargers in the system.

Elevator Times
Elevator performance data is incorporated into the simulation model. Time required for opening doors, closing doors, elevator acceleration and travel speed are all used to simulate the "flight" times from one floor to another.

Cart Priority
Within the simulation model, certain carts may be given priority of movement over other types of carts when multiple cart types are waiting for pickup at the same time. This ensures timely delivery of critical payloads, for example, hot patient food carts destined to patient floors during each of the meal times. Zoning techniques can be employed to stage empty, charged vehicles in locations adjacent to priority pick up locations just prior to the scheduled need.

Human Response Time
The number of drop off positions available and the amount of time required for a user to remove the cart from the delivery position are closely related. Efficient system operation is dependent on having space available to deliver the carts upon arrival at the destination. Recommendations might be made to lower the Human Response Time (HRT) to remove carts from a delivery location. Within the simulation model, values are assigned using various distributions to determine optimum HRT values.

Simulation Recommendations

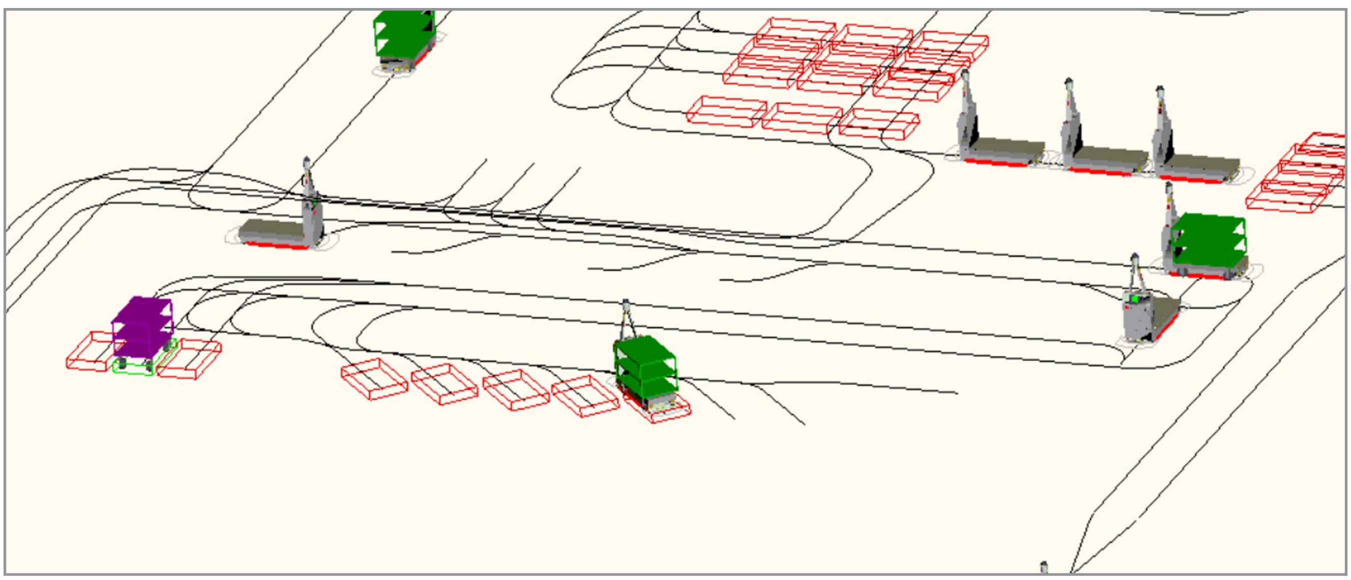
During a system simulation, certain process factors are identified that can improve system efficiency. Initial requirements are defined by a cart move matrix which includes 24 one-hour time slots into which all expected cart movements during one day are placed. If the initial matrix produces peaks in activity that cause additional vehicles, or layout bottlenecks (including elevators), adjustments to the timing of the cart movements, vehicle quantity, charger quantity or physical layout may maximize the overall system efficiency and provide the lowest overall system cost.

Excerpt from 24 hour cart move matrix

TO: South Tower						
	Hour					Floor
Floor	12 AM	1 AM	2 AM	3 AM	4 AM	Total
Ground		1				1
1			1			1
2				1		1
3		1				1
4			1			1
5				1		1
6	1				1	2
Total	1	2	2	2	1	8

FROM: South Tower						
	Hour					Floor
Floor	12 AM	1 AM	2 AM	3 AM	4 AM	Total
Ground		1				1
1			1			1
2				1		1
3		1				1
4			1			1
5				1		1
6	1				1	2
Total	1	2	2	2	1	8

Simulation Results



The simulation results summarize the number of cart movements achieved along with vehicle and elevator utilization, on an hour by hour basis. Results may also include responses to any of the specific objectives mentioned below.

What to Expect: Step-by-Step Simulation Overview

1. Confirm the 24 hour Cart Movement Matrix

Document a weekday for total full and empty cart movements expected (with future anticipated growth). The full and empty moves normally balance with each other since carts have to move in both directions in the system. The origin and destination for each cart has to be clearly matched to locations on the layout.

Typical moves include:

> Patient food trays to patient floors
> Clean linen to patient floors
> Medical surgical and housekeeping supplies to patient floors
> Biomed equipment between patient floors and equipment cleaning / PM location
> Medicine from pharmacy to patient areas
> Incoming bulk food and medicine from dock to hospital cafeteria / pharmacy
> Soiled dishes from patient floors to kitchen
> Soiled linen from patient floors to laundry or dock
> Trash from patient floors to waste processing / disposal areas

2. Define Simulation Objectives, which may include one or more of the following:

a. Create the TransCar travel route, including all send and receive stations, elevators, parking and charging locations for the project.
b. Model the TransCar vehicles, including their technical specifications such as load- and path-specific speed, acceleration, deceleration, turning speed, positioning time, Pick up and Drop off time, travel orientation, battery discharge and recharge time, etc.
c. Process jobs according to cart move matrix (schedules) to determine the number of vehicles. Verify the quantity and location of battery chargers required to accomplish the required throughput identified in the 24-hour cart move matrix.
d. Determine routing, zoning, dual cycle, job stealing and reservation strategies in order to maximize the system performance capability.
e. Determine what the human response time needs to be for the required and maximum throughput levels. Verify that the number of P&D positions in the layout is adequate to provide the required throughput and desired HRT.
f. Create a run-time tool for future use in testing variations of the matrix (with purchase of a run-time license).
g. Provide a video for senior management/decision makers.

3. Define Simulation Project Deliverables, which may include one or more variations of the following:

1. Simulation delay analysis for the throughput scenario including vehicle congestion and delays caused by insufficient pick/drop locations or the specified operator response times.
2. The following statistics will be collected and presented in tables or graphed in the simulation report:
   i. Vehicle utilization-hourly AGV fleet utilization
   ii. Elevator utilization-hourly elevator utilization per elevator
   iii. Cart washer utilization-hourly cat washer utilization per cart washer
   iv. Average and maximum cart pickup times as compare to the system requirements
   v. Comparison of using NiCad, versus Lithium Ion and Lead Acid batteries
   vi. The simulation captures the order creation time, AGV assigned to order time, cart pickup time and cart drop off time for each mission created.
3. Simulation report, which includes the assumptions, a description of operation, results, and recommendations.

Benefits of Automated Guided Vehicle Implementations

> Significantly lower labor costs than manual delivery methods
> Improved delivery speed and reliability
> Reduced injuries and compensation claims
> Level workloads and building traffic / congestion / elevator usage through the entire 24 hour period
> Increased payload delivery potential over manual lifting and transporting—from approximately 500 to 1,000 lbs. or more
> Eliminates incidental damage from manually pushed carts hitting doors, walls and elevator doors and interiors

Contact Swisslog for more detail on how a design simulation can help your facility renovation or new construction project.

TransCar® is a registered trademark of Swisslog Healthcare Solutions.

About the Author:

Jeff Barber has been involved in designing, estimating, sales, project management and installation of automated material handling systems for 35 years, including pneumatic tube systems, track vehicles and AGVs, primarily in hospitals. He holds a BS in business administration from Mt. Scenario College in Ladysmith, Wisconsin. Additionally, Jeff completed a management training program with emphasis on electrical and mechanical engineering.

About Swisslog Healthcare Solutions

Swisslog Healthcare Solutions (HCS) is the leading supplier of automation and software solutions for materials transport and medication management in healthcare facilities. Swisslog has installed facility-wide and pharmacy automation systems in more than 3,000 hospitals worldwide, including more than 2,000 in North America. Denver-based Swisslog Healthcare Solutions offers total system design, manufacturing, installation and customer support—providing an integrated solution for lean workflow and operations that enhances information access, patient safety and cost efficiency.

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