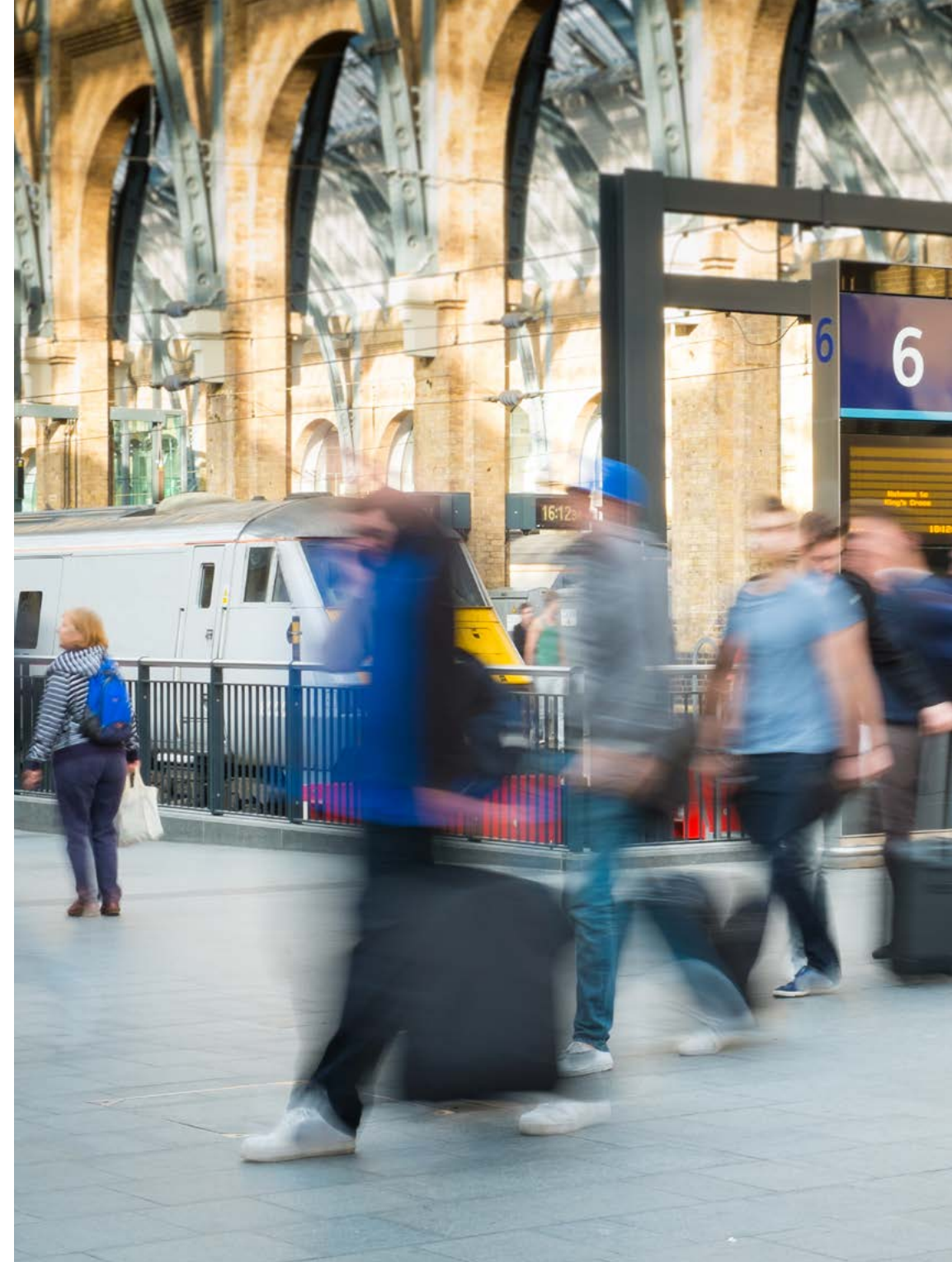# Planning Resilient and Reliable Rail Infrastructure

Using Pedestrian Simulation

Bentley®

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Solve Your Biggest Rail Infrastructure Challenges

Planning for Optimal Performance

Unexpected events can cause delays, higher costs, and, ultimately, unhappy customers. Often, these events are associated with station designs and operational plans that do not meet requirements and need to be fixed or improved to accommodate modern day challenges, such as increasing demand and emergency evacuation scenarios. Although industry codes and standards provide guidance for how individual elements of stations should be designed, they do not subsequently show how those elements work together. It is key to find immediate solutions to problems that may already exist.

Reveal the Unknown

Forecasting technologies help you discover problems before they happen and help improve the operation of the station. Modeling and simulation software reveals unknown and unexpected consequences, which would not otherwise have been accounted for. If initial investment plans do not work as expected, they result in expensive rework costs later. With simulation software, you can be confident that you are making the right decisions at the right time, so you do not waste money on projects that will not work.

The Role of Pedestrian Simulation

Simulate Real Life

Pedestrian simulation virtually shows how people will move through stations in different circumstances. It can be done broadly, to show overall flows, or in detail, to show how crowd patterns emerge from interactions between individuals fulfilling personal objectives. By providing visibility of performance, pedestrian simulation software lets users change "problem" designs until they work better, as part of a performance-based design process. It gives stakeholders greater certainty that real stations will perform for the duration of their intended life.

What Questions Can It Answer?

Pedestrian simulation software can answer a range of questions that arise when planning, designing, operating, and maintaining stations:

PROJECT MANAGEMENT

- How well would the proposed designs work?
- Would the station be able to serve peak demand?
- If not, what could be changed to improve it?
- Would that alleviate congestion?
- How much would that improve capacity?
- If rail service was disrupted, could it handle the excess demand?
- Would people be able to evacuate from the station safely in the event of an emergency?

BUSINESS CASE

- What would happen if no improvements were made to my station?
- How much better would my potential project make my station, than if nothing were done?
- What are the costs and benefits of my potential project?
- How do my potential project's costs and benefits compare to alternative potential solutions?
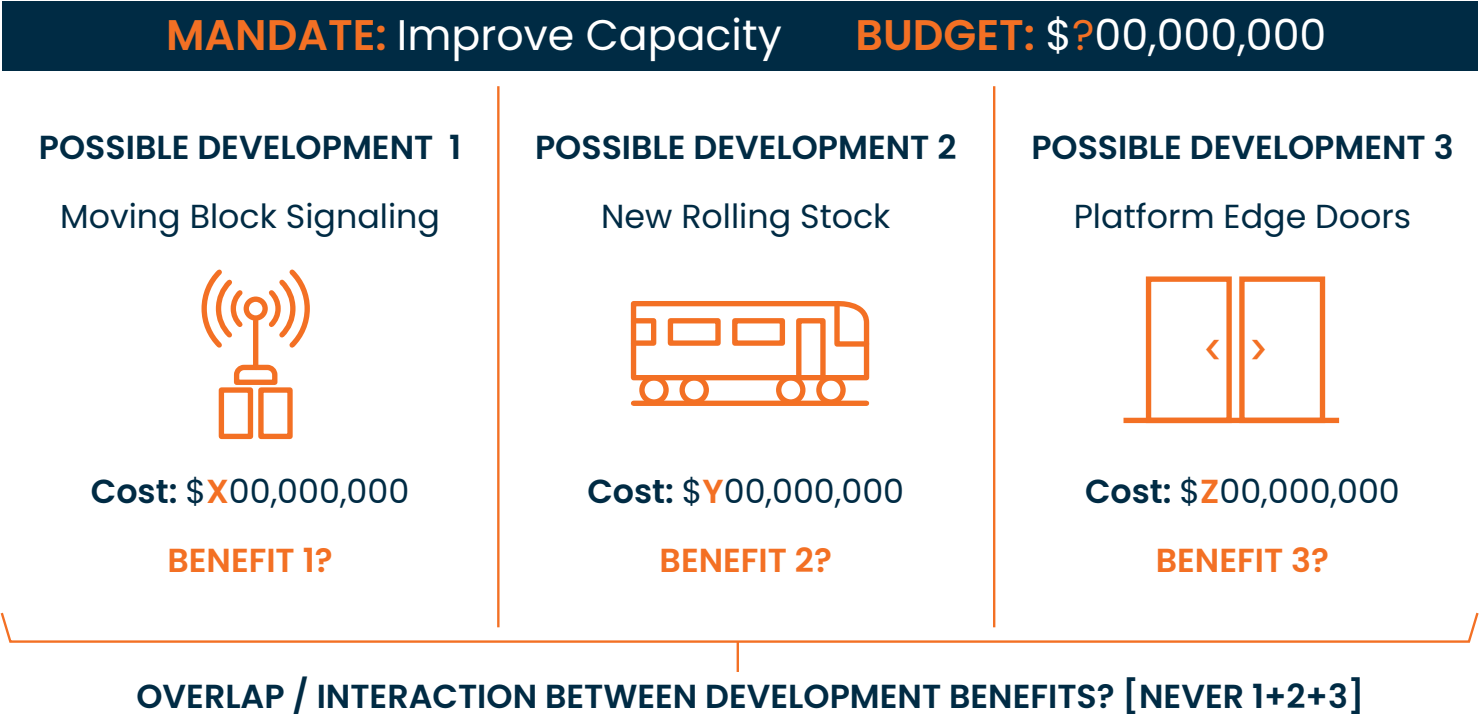
- How could I reduce my potential project's risk?
- How could I increase the feasibility of my potential project?
- What would the return on investment of my potential project be?

PROGRAM CONTROL

- Am I making the right planning decisions?
- Which system upgrades should be capitalized?
- What are the cost-benefit ratios of my competing potential upgrades?
- How would different combinations of my potential upgrades work together?
- How would capital best be allocated across those upgrades that should be funded?
- When and in what order should I implement upgrades to meet approaching challenges?
- How will my system improve going forward with this approach?

FIGURE 1: Comparing the benefits of possible developments to improve capacity

MANDATE: Improve Capacity   **BUDGET:** $**?**00,000,000

POSSIBLE DEVELOPMENT 1

Moving Block Signaling

Cost: $X00,000,000

BENEFIT 1?

POSSIBLE DEVELOPMENT 2

New Rolling Stock

Cost: $Y00,000,000

BENEFIT 2?

POSSIBLE DEVELOPMENT 3

Platform Edge Doors

Cost: $Z00,000,000

BENEFIT 3?

**OVERLAP / INTERACTION BETWEEN DEVELOPMENT BENEFITS? [NEVER 1+2+3]**

FIGURE 1 shows how the benefits of different possible developments can be compared. For example, new moving block signalling may safely let trains run closer together, resulting in more being sent down a track in a given period and increasing the peak potential carrying capacity of that line. Another example is that new rolling stock may increase train capacity, even if train length is unchanged, by using different or reduced seating layouts. Yet, this may be in vain if too few doors extend boarding and alighting, holding up trains behind and reducing the overall carrying capacity of a line. Rolling stock is designed to reduce the time that trains dwell in stations. Platform edge doors may actually increase average dwell times slightly. However, because they also stop passengers holding train doors, they prevent longer dwells, making service capacity more reliable. Each development has its own costs and benefits, some of which may overlap. Pedestrian simulation software shows the effects of potential developments, including what their effects would be in combinations.

Introducing LEGION

LEGION is passenger modeling, simulation, and analysis software. It lets users build working digital models of stations and see how they will be used before they are built. Design and operating alternatives can be tried and compared.
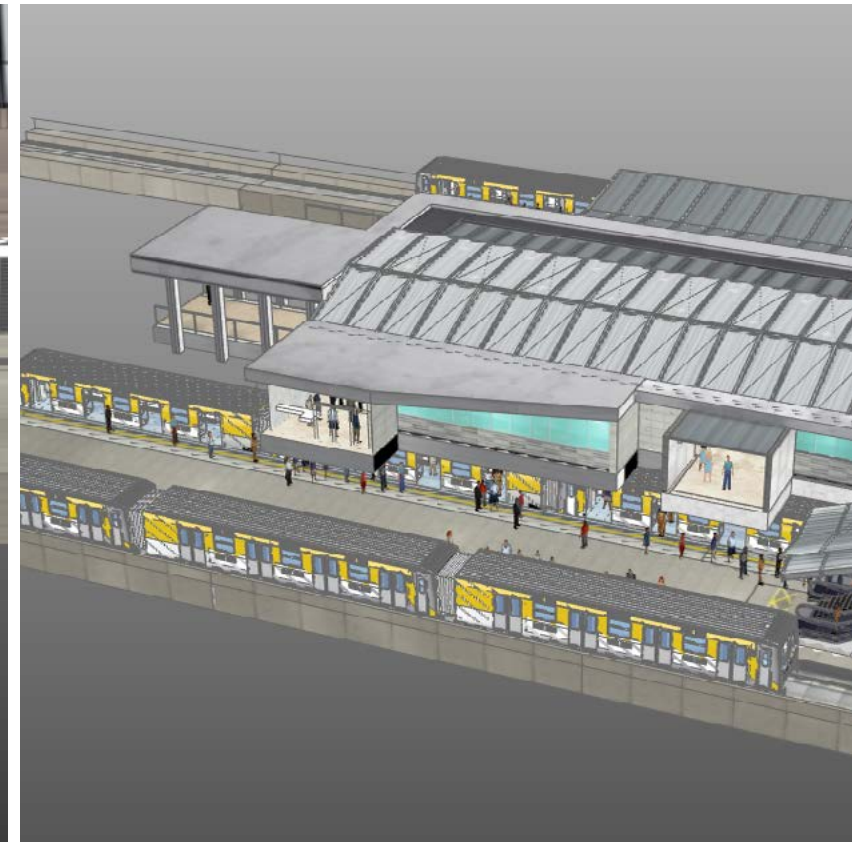
How LEGION Can Help You

Make Smarter, More Informed Planning Decisions

CAPABILITIES:

- Test any number of scenarios using real-world data to compare operational performance and determine the right solution for your project
- Discover unexpected insights based on LEGION's extensive empirical scientific research
- Identify bottlenecks, areas of congestion, and under-used areas of space and implement strategies to enhance pedestrian flow
- Find extra capacity within existing space where possible to avoid large expansion costs
- Test evacuation strategies to mitigate risk associated with emergencies
- Enter input data quickly and easily using a logical and structured data template
- Define, re-use, and share objects across projects and teams to increase productivity

Remove the Uncertainty of Station Design

BENEFITS:

- Reduce expensive rework costs
- Extend the life of the station
- Reduce investment risk
- Prioritize projects that have the most impact
- Support investment decisions
- Streamline processes
- Improve health and safety responses

Get the Design Right, First Time

Testing a variety of scenarios allows you to fully understand how your station will perform under different circumstances, as well as enables you to identify the scenario that best meets your needs. This increased insight into operational performance reduces the risk associated with the project, and, in turn, reduces the cost of capital needed to complete the work, lowering your costs.

Increased Insight = Less Risk = Lower Cost

Optimize Station Performance

Once you have chosen your preferred scenario using LEGION, you can refine your design even further. Test evacuation strategies and identify potential problems before they happen. Discover what works, what doesn't, and make changes accordingly to improve the safety and efficiency of your station.

Don't Stop Operations When You Don't Have To

We understand that sometimes, it is not feasible to completely shut down station operations. When problems occur, use LEGION to isolate a specific area and fix the problem while keeping the rest of the station running, so you don't miss out on valuable revenue.

Stories from Users Like You

Bloor-Yonge

Bloor-Yonge station in Toronto, Canada, was the busiest station in Toronto Transit Commission's (TTC) network. It had become a bottleneck on the Yonge line, where its T-shaped interchange design and high boarding and alighting demand caused extended dwell times. Also, the high level of transfers between the Yonge and Bloor-Danforth lines had caused deteriorating pedestrian levels of service (LoSs) on the interchange vertical circulation and platforms.

In response to these issues, TTC undertook a study and used LEGION to test potential operational strategies and capital construction improvements intended to alleviate current and future (2031) capacity issues. They also used LEGION in a second study to assess the Eglinton Crosstown Light Rail Transit (LRT) and GO Train demand forecasts and potential improvements. These improvements include a six-platform station design, a potential Downtown Relief Line, Automatic Train Operations, and station operations strategies designed to separate opposing passenger flows.
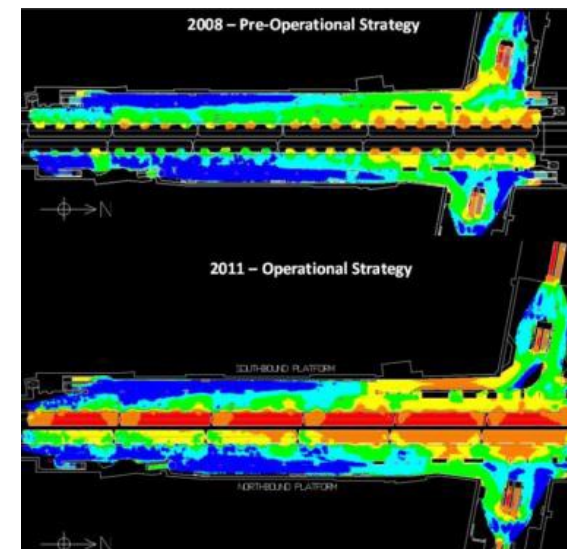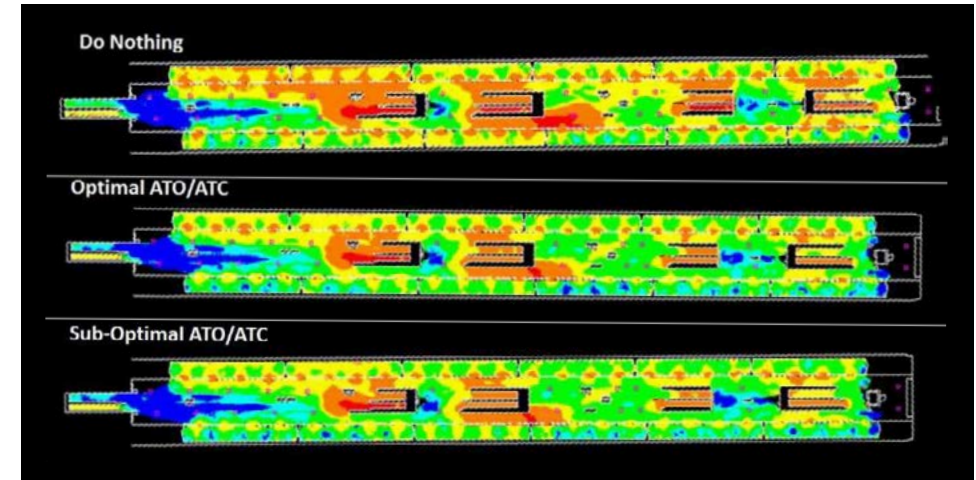
" LEGION was fundamental and decisive for the successful performance of Corinthians-Itaquera station during the opening game of the 2014 FIFA World Cup. It provided the fluidity required to safely serve the public.

— Fernando Galego Boselli, Architect, Companhia Paulista de Trens Metropolitanos

" This tool, which we know well after hundreds of projects realized with this software, is the ideal solution for this sizing study at the Gare du Nord. Highly visual, LEGION makes it easy to validate and adjust, if necessary, the design and relevance of the redevelopment project.

— Gonzalo Tavares, Mobility and Pedestrian Flow Analyst, SYSTRA

Get Started Today

Discover how to improve your station design with LEGION and turn your investment into a success.

Buy LEGION

ABOUT BENTLEY MOBILITY SIMULATION

Thousands of professionals around the world rely on Bentley's mobility simulation software to understand the urban, metropolitan, regional, and national movement of people.

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Improving infrastructure for people

EMME®
Multimodal transport planning

CUBE®
Predictive modeling and simulation of transportation

DYNAMEQ®
Traffic simulation and dynamic traffic assignment

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