Simulating the movement of people

Cities around the world are growing at unprecedented rates putting governments, transport bodies and other infrastructure operators under pressure to provide safe, efficient public venues within budget constraints.

Legion has been a pioneer in developing scientific software to simulate the movement of pedestrians in buildings and city environments. We are trusted by infrastructure owners and operators and by major engineering and architectural consultants around the world to help design and validate a wide range of venues:

- Rail and metro stations
- Bus terminals
- Airports
- Sports and entertainment venues
- Major international events (e.g., Olympic Games)
- City streets (including interaction with vehicle traffic)
- Tall buildings (with emphasis on evacuation)

For such venues, designs and operating procedures need to be right first time. If not, large additional costs may be incurred and poor performance endured for years, even decades.

The key to optimal performance is: Test before you spend. Simulation based on correct scientific principles allows you to test plans before they are set in stone and before money is spent. It can also reveal how to optimise plans to deliver the required capacity in safety and comfort.

In this way everyone wins: pedestrians enjoy a better experience, while authorities keep their budgets under control.

Software

Legion SpaceWorks
Recognised worldwide as the ultimate software of its kind, simulates pedestrian movement quickly and accurately even in complex projects. It provides all the tools you need to create models, analyse them and share them with interested parties.

Legion Evac
Derived from SpaceWorks and intended for wide circulation, is dedicated to modelling emergency egress from all types of buildings and venues.
Science for Human Space

The Simulator at the heart of Legion software models the movement of pedestrians in a way that is true to real life, and it takes into account as far as possible their wishes, preferences and perceptions.

The movement of simulated pedestrians within Legion models is based on our extensive scientific studies of real people in real contexts. The rules of movement for individual pedestrians were found by Legion in an extensive study with hundreds of thousands of measurements of pedestrian movement taken around the world over many years.

The study discovered how people move and avoid each other and various kinds of obstacles based on their own (often unconscious) decisions. These behavioural rules were then used to build entities to represent a spectrum of pedestrians moving and reacting as subtly as real people do. A certain random element was also included to account for the fact that real people are not automata and that variations exist, even in the behavior of a single individual.

Legion pedestrians make their own decisions as in real life. They are not helpless objects directed by external forces; they are not subject to modeling metaphors which treat them as fluids or gasses; and they are not like chess pieces moving on a limited grid.

In the Legion Simulator crowd formation and patterns of movement emerge from the collective actions of all the individuals. That is how it happens in real life.

The Legion Simulator has been validated scientifically and by independent bodies. The underlying algorithms are the subject of patents issued in various countries.

Legion simulations are trusted by leading agencies around the world.
Legion simulations benefit everyone

Use Legion simulations at the outset of your project to achieve better performance lasting for decades. Save time and money too.

- **Manage Risk & Minimise Cost**
  Test the performance of designs and operational procedures before committing to spend money. Test different scenarios and layouts to optimise capacity, reduce costs and minimise risk.

- **Improve Operating Efficiency**
  Study the effectiveness of alternative operational strategies and detect the risks of missing key operational goals. Use simulations to help manage the performance of a facility, save costs and improve operational efficiency.

- **Ensure Safety & Comfort for Users**
  See how to improve the quality of pedestrian experience within your facility and maintain the highest safety standards.

- **Visualise & Communicate**
  Communicate project plans to stakeholders, understand the important issues and get project and financial approval. Legion's highly visual simulation outputs give stakeholders a powerful way to understand plans and risks and see how to manage them.

- **Be Green & Sustainable**
  Make public transport and public places more comfortable and efficient. With Legion you can contribute to achieving a greener, more sustainable world with satisfied users and improved economics.
Legion SpaceWorks simulates the step by step movement of pedestrians in public and private spaces, such as railway and metro stations, airports, stadia, tall buildings, and other public places. Designers, planners, and operators around the world use SpaceWorks to optimise the use of space; improve safety and operating performance; and reduce capital costs.

Legion SpaceWorks produces simulations and analyses of how pedestrians, or ‘entities’, move within a CAD-defined environment. Entities are intelligent individuals with personal preferences, a memory of environmental conditions and the ability to make their own decisions. These attributes determine their actions and paths throughout the simulation.

Analysis of pedestrian movement can include measures of density, space utilisation, journey times, flow rates, and pedestrian experience.

Legion SpaceWorks is standard Windows based software, available with workstation or network licences. The three main applications within SpaceWorks are the Model Builder, Simulator, and Analyser:

- **Model Builder**
  Defines the physical and operational characteristics of the space, including pedestrian demand and operational data. Activity objects are overlaid on CAD.

- **Simulator**
  Calculates and visualises how entities interact and move through an environment. Sophisticated movement decisions are made by each entity, based on personal preferences, objectives and recent experience.

- **Analyser**
  Displays and analyses simulations using a range of customisable maps and metrics based on quantity, speed, flow, time and density measurements. Videos, spreadsheets and graphs can be easily produced for reports and presentations.
Legion Evac is a specialised pedestrian micro-simulation tool for modelling evacuations. Evac combines the fully validated simulator of Legion SpaceWorks with flexible modelling and analysis tools. This enables the user to simulate the evacuation of different environments including transport hubs, metro stations, shopping malls, airports, stadia, offices and public buildings.

Evac imports results from simulations run in NIST’s Fire Dynamics Simulator (FDS) and works with metrics such as levels of toxicity, visibility, and temperature. FDS data can be overlaid on a pedestrian simulation for analysis and visualisation. Conditional behaviour can also be built into a model, so that entities will react to the different ‘products’ of fire.

Evac is standard Windows based software. It includes a Model Builder to define the physical and operational characteristics of a space; and an Analyser to simulate and analyse an evacuation. The analysis capabilities are as advanced and flexible as those available in Legion SpaceWorks.

Also, all files generated in Evac can be opened in SpaceWorks. This ensures an easy upgrade from Evac to SpaceWorks when required.
Other Legion software

Legion 3D is a companion to Legion SpaceWorks. It displays and records rich three-dimensional visualisations of Legion models, incorporating 3D CAD, Spatial Objects and a wide range of realistic pedestrian characters.

It can provide very intuitive and persuasive visual outputs for presentations and design projects. It does this by taking accurate, scientifically validated, SpaceWorks or Evac simulations and presenting them in a fully rendered 3D environment.

Legion 3D visualisations are populated using a pre-defined collection of 3D characters who display a variety of characteristics: age, gender, skin tone, and style of dress. These 3D pedestrians follow the movements of an underlying simulation and thus communicate pedestrian behaviour via a ‘real-world’ view of a proposed space or venue.

To achieve this, Legion 3D combines three types of file:
- Simulation data file produced within Legion
- SpaceWorks or Legion Evac
- 3D scene modelled using third-party design software
- Optional ‘Aimsun results file’ (XML) for adding road vehicle movements to the visualisation

The 3D environment can be viewed from multiple viewpoints using built-in views; zooming, panning and tilting tools; and cameras. Special features include:
- Dynamic cameras that can track a journey from a pedestrian’s point of view.
- Automatic creation of staircase and escalator connections between floor levels
- Adjustable rendering quality to improve presentations and playback speed.

Legion 3D is standard Windows software and is available with workstation or network licences.

Legion for Aimsun is a pedestrian simulation plug-in, for use with the traffic modelling software, Aimsun, developed by Transport Simulation Systems (TSS).

Legion for Aimsun combines Legion pedestrian simulation with Aimsun traffic micro-simulation into a product that transport planners and traffic engineers can use to model the different and often competing requirements of pedestrians and vehicles.

Legion for Aimsun enables realistic modelling of public transport interchanges, including vehicle boarding and alighting, and pedestrian crossings. The concurrent simulation of pedestrians and vehicles ensures that each is aware of the other within the simulated space.

Three editions of Legion for Aimsun are available: Base, Lite and Extra. The Lite and Extra editions allow an increased number of pedestrians per hour and a wider range of pedestrian activities to be modelled.

For large or complex studies, where the activities and behaviour of pedestrians require detailed analysis, a pedestrian model can be built in Legion SpaceWorks and then imported into Legion for Aimsun.