



SIMULATION MODELING FOR CONSULTING

WHITE PAPER



CONTENTS

01	Why use simulation modeling?	02
02	Simulation modeling for consultants	04
03	The only industrial-strength product	06
	Case Studies	10
04	A Customer-Centric Public Transport System	10
05	Microsoft End-to-End Supply Chain Solution	13
06	Walmart's Alphabot: Designing a Material Handling System with Simulation	16
07	Become a successful consultant in AnyLogic	19
	Conclusion	21
	Additional Resources	22

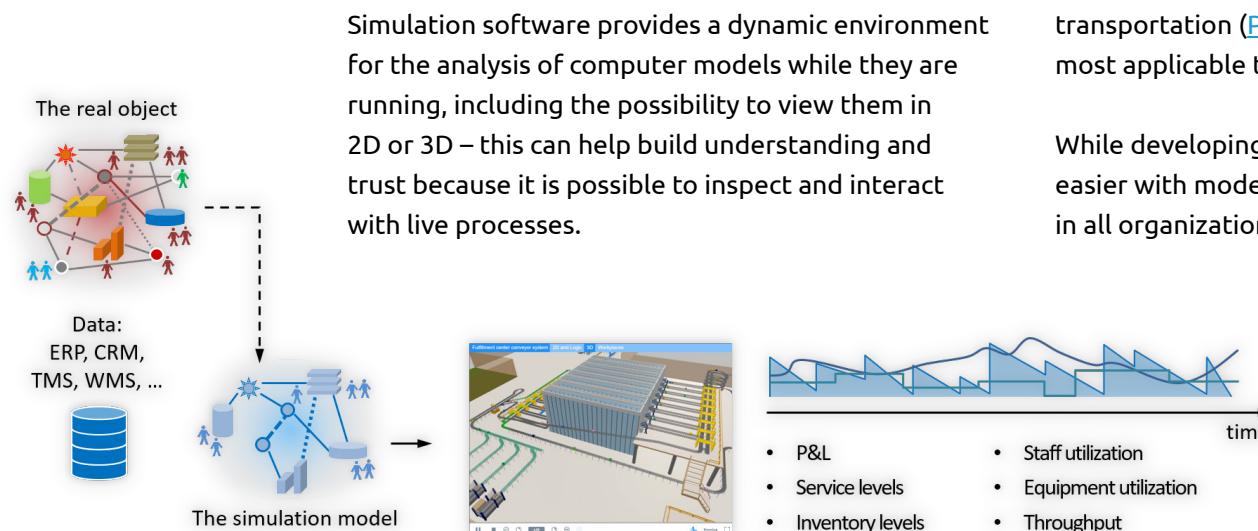
WHY USE SIMULATION MODELING?

01

WHY USE SIMULATION MODELING?

Simulation modeling solves real-world problems safely and efficiently. In a wide variety of business situations, simulation models provide insight and analysis that is easily verified, communicated, and understood. Across industries and disciplines, simulation modeling enables organizations to work easily with complex systems and to enhance the way they do business.

Bits, not atoms. With a valid digital representation of a system, you can conduct experiments without risk. Unlike physical modeling or experiments on a real-world system, simulation modeling is computer-based and provides a virtual place for experimentation.



It is now standard in business and engineering to use simulation modeling, and to meet the needs of different industries, a range of different tools exist.

Businesses use simulation when conducting experiments on a real system is impossible or impractical because of safety, cost, or time.

In the construction industry, architectural and engineering considerations will be modeled in a Building Information Modeling (BIM) tool such as Autodesk Revit. While for disciplines such as material science or signal processing, modelers might use Matlab. For many cases, such as for manufacturing ([Tata Steel](#)), transportation ([Port of Long Beach](#)), or business processes ([McDonald's](#)), the most applicable tool is the multimethod simulation modeling software AnyLogic.

While developing and maintaining cutting-edge simulation models has become easier with modern tools, they can still require skills and knowledge not retained in all organizations. In these situations, when there is a need to supplement in-house simulation expertise, consultancy allows organizations to efficiently realize the full potential of simulation modeling.

Read on and discover why consulting practices around the world use simulation, see examples of their work, and get started with AnyLogic – the only general-purpose simulation software for successful consultancy.

SIMULATION MODELING FOR CONSULTANTS



SIMULATION MODELING FOR CONSULTANTS

Consultants use simulation to resolve many different challenges for clients under a variety of circumstances. A single simulation tool that can be applied to each of these different challenges is essential because of time and cost – not having to learn a new tool or niche approach means more time can be spent on solving the problem at hand.

A good simulation consulting tool will permit multimethod modeling and avoid the constraints imposed by choosing a single method. Importantly, the tool should assist practitioners in the modeling process, such as with industry-specific libraries that ease and quicken modeling. The tool should also enable easy sharing and collaboration between client and consultant.

AnyLogic is the multimethod simulation platform for business. With it, you are never limited by a single modeling method. You can always choose the most efficient one, or combination, to best address your problem. Combined with industry-specific modeling libraries, AI integrations, and cloud platform capabilities, AnyLogic is considered without peers. Read on to find out more.

“I go back with AnyLogic to the very beginning: over ten years now. Ten years ago, AnyLogic was what I call the only industrial strength product that had a hope of doing both system dynamics, agent-based, and discrete-event in one package. As best as I can tell, it’s still the only package that has that capability. As we do more, especially in the realm of agent-based models, there are some open-source tools, but none of them has anything close to the functionality that AnyLogic does.”

– Dr. Mark Paich, Director, PwC



THE ONLY INDUSTRIAL- STRENGTH PRODUCT



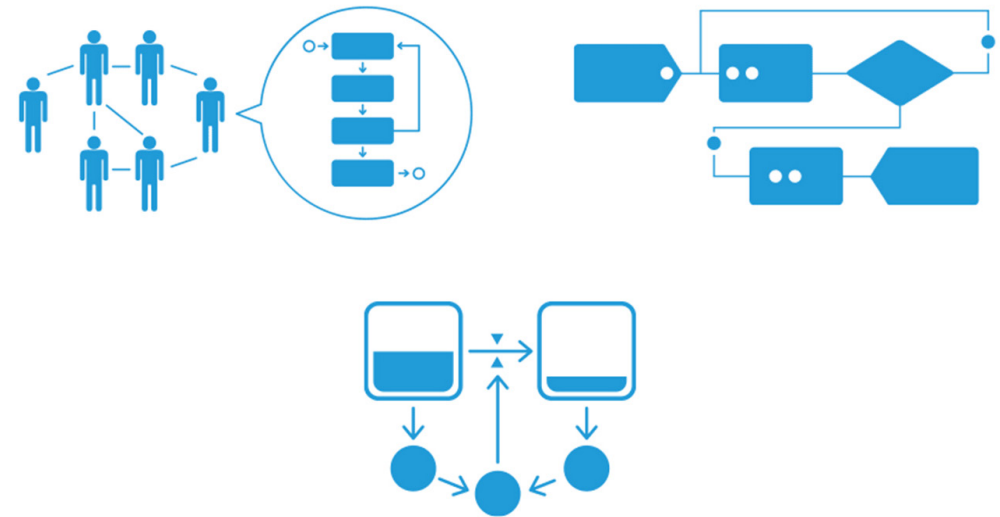
THE ONLY INDUSTRIAL-STRENGTH PRODUCT

AnyLogic is a powerful multimethod simulation modeling environment with extensive industry-specific libraries, advanced AI integrations, and built-in cloud computing capabilities.

There are three common simulation modeling methods:

- **Agent-based modeling** – for capturing the interactions of many independent objects such as in supply chain, social networking, and asset management.
- **Discrete event modeling** – for describing a sequence of events through time, and helping diagnose business or manufacturing process issues.
- **System dynamics** – for considering global dependencies without fine detail. They are used for modeling at a macro scale, such as for populations or economic systems.

For different situations each method will be more or less suitable and applying just one method will likely require unnecessary compromises. Unnecessary because with a multimethod approach each part of a system can be captured in the appropriate manner – no excluded elements or workarounds.



Agent-based, Discrete event, and System Dynamics modeling

Beyond combining the three main simulation modeling methods, AnyLogic offers built-in industry-specific libraries that let modelers work more quickly and easily:

- [Material Handling Library](#) for manufacturing and warehouse processes.
- [Rail Library](#) for rail transportation, terminals, and yards.

- [Pedestrian Library](#) for pedestrian flows in airports, stadiums, stations, or shopping malls.
- [Road Traffic Library](#) for car, truck, and bus movement on roads, parking lots, and factory sites.
- [Fluid Library](#) to simulate bulk cargo and liquid transfer in industries like mining or oil & gas.
- [Process Modeling Library](#) for generic business processes or workflows.

For the power user, AnyLogic features Java-level extensibility. This allows the creation of complex and reusable custom objects, experiments, and libraries. Model designers do not need to reinvent the wheel with every project. They can reuse components and even develop whole libraries that can be offered as add-on packs.

This extensibility combined with data interoperability provides flexibility for modelers. Models can be exported as stand-alone applications that integrate with external platforms, such as CRM or BI, and use data sources to self-configure. For example, a model that determines driver scheduling for a delivery company can be parameterized with data from the vehicle database. Any changes, such as for unplanned maintenance, can be accounted for and new scheduling assessed and tested. Outputs from the system can then inform the order management system to update delivery estimates.

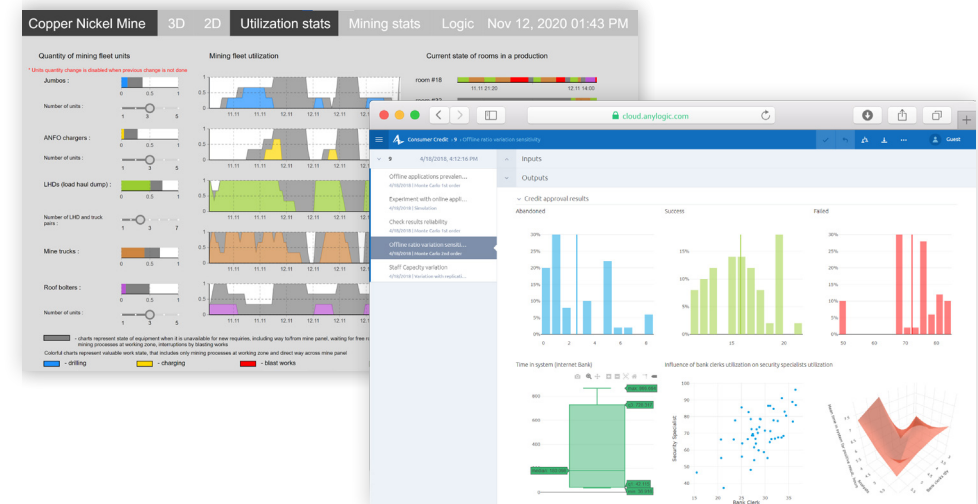
Integrated GIS mapping functionality lets models use routing and location-based data, both online and offline, as well as connect with other mapping services.

A powerful set of experiments lets you conduct analysis in different ways: Monte Carlo, Sensitivity Analysis, and Parameter Variation experiments help find how randomness and parameter changes affect model behavior. In addition, simulation optimization helps find better solutions for your business challenges based on your constraints and requirements.

AnyLogic Cloud

Collaboration is made easy when we can share common resources. AnyLogic simulation models can run in the cloud allowing them to be shared with clients and worked on with colleagues. Cloud models can have interactive dashboards and simply require a web browser to use. For easy bespoke integrations, inputs and outputs can be managed by RESTful API (JavaScript and Python).

Models run in the cloud while their animations render browser-side – the server-side manages the computation, easing the load on the client-side computer. If a



simulation is run without animation, it runs as fast as possible and can take full advantage of the cloud platform's computing capabilities.

Private Cloud

Privacy is important and that is why AnyLogic lets you take full control. AnyLogic Private Cloud installs and runs on a client's infrastructure. No need for an internet connection, clients have complete control over cloud data and internal network connections. Private installations can have custom branding or even fully customized interfaces, allowing consultants to maintain their own cloud and offer bespoke simulation models to clients. Custom interfaces let simulation models easily embed into other business workflows and tools. With an AnyLogic Private Cloud instance, you are free to use simulation however, wherever, and with whomever it is needed.

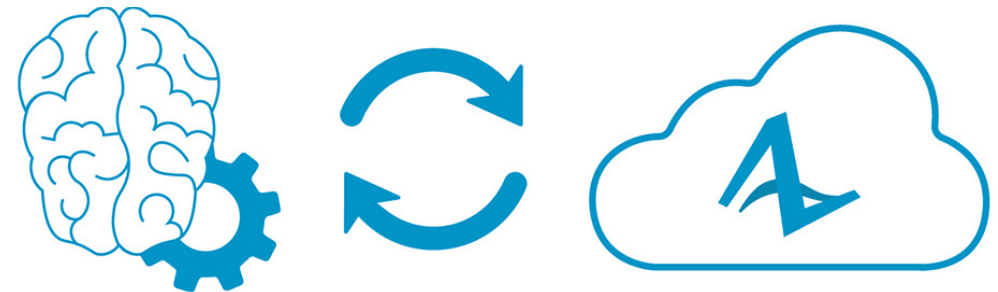
Cloud-based simulation modeling lets consultants collaborate on models as they are being developed and, with just a link, easily share them with clients for feedback throughout the design process or during troubleshooting.

The combined capabilities of AnyLogic simulation software form a powerful tool for resolving business challenges. The integration and general applicability of AnyLogic's capabilities help cut costs and save time because, once learned, no time is lost developing software knowledge and skills can be transferred easily between projects.

AI Integrations

Artificial intelligence technologies have risen in prominence over recent years, especially machine learning, and they naturally complement simulation.

AnyLogic's open API helps easily integrate with AI projects, while integrations with powerful machine learning platforms from [Microsoft](#), [Pathmind](#), and [H2O.ai](#) provide easy access to the possibilities they offer. To learn more about the synergies between AI and simulation, and how businesses are benefitting, download our [AI white paper](#).



Read on for case studies that demonstrate how consultants are leveraging AnyLogic simulations, cloud computing, and AI possibilities to give clients cutting-edge business insights.

AnyLogic is a powerful simulation platform with a long history of success across industries. Now, combined with cloud computation and connectivity, AnyLogic simulation models are powerful consulting tools for delivering more insights and easily visualizing them dynamically on computer or smartphone. Read more about [AnyLogic Cloud](#).



CASE STUDIES

A CUSTOMER-CENTRIC PUBLIC
TRANSPORT SYSTEM

A CUSTOMER-CENTRIC PUBLIC TRANSPORT SYSTEM

PROBLEM:

Public transportation services in Australia are undergoing a transformation. Changing demographics are driving the need for intermodal transport integration and major infrastructure investment from the federal government. To better address these challenges, smart cards are helping planners understand the public transport network from a customer point of view.

As part of the solution, PwC Australia developed a customer-centric view of railway infrastructure to help understand how incidents affect the current network and how to improve their handling. The project aimed to help:

- understand the number of customers potentially impacted by an incident such as a train derailment, engine breakdown, or medical emergency
- understand network behavior when incidents occur
- provide accurate predictions of incident-related delays
- support operational and maintenance decisions concerning incident responses
- identify incidents for root cause analysis, such as recurrent or location-specific incidents

To achieve these aims, PwC built a model of the transportation network that simulates train movements, and incidents, as well as customers at stations and in trains.

SOLUTION:

The model was built in AnyLogic and is multimethod – using discrete event modeling for train movements and agent-based modeling for customer behavior. In addition, plans to scale the model could easily be implemented thanks to AnyLogic’s extensibility.

Input data for the model was obtained from various sources, including the transportation company, government, and publicly available sources, and included:

- Network layout (signals, track geometry, stations, and platforms)
- Train data (train set types and capacity per carriage)
- Timetable (route, train type, number of carriages)
- Operating rules for recovering the network and in hot weather, including speed restrictions



Model Animation and Graphs

- Incident data (types of incidents)
- Passenger data (smart card data and existing usage statistics)

Train movement logic was modeled using the AnyLogic Rail Library while the platform's flexibility allowed the development of custom components to model specific aspects of the project.

First, the model provided a network-level view of customers at stations: it shows the number of customers currently waiting at each station on the network, including their direction of travel, and the number of passengers on each train.

The model shows the behavior of the network as it recovers from an incident and the time required to return to normal. If an incident occurs, it can have a long-lasting impact on the timetable, especially during rush hours. Recovery from

an incident can take several hours and a Network Incident Graph helps analysts by clearly showing the length of time each incident affects the whole network – a capability that enables the testing and comparison of different incident mitigation policies.

The model's key metric is Lost Customer Minutes (LCM), calculated as the sum of delay minutes for all individual journeys within a particular train or network segment. LCM can also be reviewed in the context of when minutes are lost, such as at rush hour or during the weekend.

The model's interface also includes a conventional train graph and an animated model with a GIS map to visually present processes in the system. The train graph and network animation show where trains are on the network, how close they are running to their schedule, and if they will be available for return journeys.

RESULT:

From the model's precise insights, PwC developed better mitigation policies that helped the government lessen the impact of incidents and quicken recovery. The model allows policy analysis according to the number of passengers affected by an incident – helping provide a qualitative assessment from the point of view of passengers. With the help of the simulation model, it is now possible to evaluate investment decisions according to their estimated impact on Lost Customer Minutes and related KPI.

The project is continuing and will include other forms of transport as well as future network extensions. Additionally, there are plans to simulate passenger flows within and around stations to investigate overcrowding.



MICROSOFT

MICROSOFT END-TO-END SUPPLY
CHAIN SOLUTION



MICROSOFT END-TO-END SUPPLY CHAIN SOLUTION

PROBLEM:

Microsoft contracted Goldratt Research Labs to design, validate, pilot, and implement an end-to-end supply chain management solution based on Theory of Constraints (TOC) best practices.

A critical part of the project was for Goldratt Research Labs to develop a self-configurable supply chain simulation model. The model was to validate the operational and financial improvements of a TOC-based solution.

SOLUTION:

A Strategy-and-Tactic tree (S&T Tree) was developed to show exactly which rules were needed to achieve the desired performance improvement and objectives.

An AnyLogic simulation model was developed to test and verify the operational and financial performance of the new rules.



Supply chain and product data are extracted from the SAP system and used to configure and fully model the Microsoft global supply chain. Additionally, historical customer demand data and daily on-hand-stock data were used to compare simulated (using the new TOC-based rules) vs. actual past performance.

A simple custom user interface allows stakeholders to manage scenarios and select which TOC rules to use, which product channels to include, and the period to simulate without knowledge of the simulation modeling platform. The output of the simulation is visible directly from the AnyLogic model and can also be exported to Excel.

The model can be run in three different ways:

- Single run experiment
- Sensitivity analysis to test parameters against outcomes
- Scenario comparison

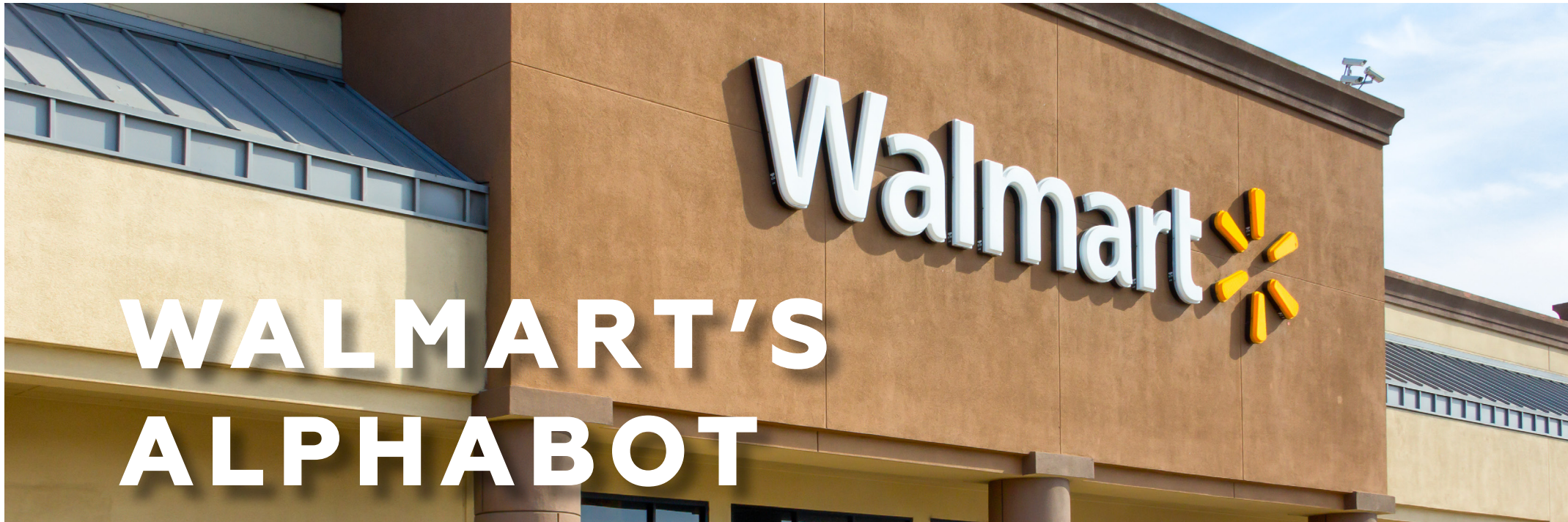
The interface includes network flow and mapping visuals to show the supply chain configuration. Users can view cumulative plots of actual and forecast demand versus production capacity to understand potential problems. And, while the model is running, it is possible to view operational and financial statistics to monitor performance.

OUTCOME

Microsoft's CTO of Global Supply Chain, Robert Meshew, [confirmed the results](#) they have achieved since integrating the new TOC-based end-to-end supply chain solution into their SAP system.

"The outcome has been nothing short of remarkable. In that time, we've seen our service levels rise to our customers by over 5%. At the same time, we've seen our inventory levels drop by quarter billion dollars across the board which has led to reduced markdowns and reduced excess and obsolescence of over a hundred million dollars."

Microsoft's CTO of Global Supply Chain, Robert Meshew



WALMART'S ALPHABOT

DESIGNING A MATERIAL HANDLING
SYSTEM WITH SIMULATION



WALMART'S ALPHABOT: DESIGNING A MATERIAL HANDLING SYSTEM WITH SIMULATION

PROBLEM

Walmart wanted to evaluate the suitability of the Alphabot® concept before making a financial commitment to its development. Alert Innovation had already made static spreadsheet calculations for the project but agreed with Walmart that the spreadsheets could not be relied upon due to system complexity and the variability of order demand and execution. They tasked MOSIMTEC, a simulation consulting firm, with designing a material handling simulation model for an independent technology feasibility assessment. The goal was to:

- Understand the throughput and turnaround time capabilities of the Alphabot® system during peak customer demand periods and assess service levels.
- Understand any potential performance weaknesses of the Alphabot® system with realistic demand data and variability.
- Identify the best configuration of the racking structure, automated bots, and each-picking workstations required for a variety of store profiles.
- Compare the capital expenditure requirements predicted by the model vs. the business case spreadsheets.

- Use model throughput and turn-around-time results to compare the proposed performance of Alert Innovation's Alphabot® with other industry-leading Automated Storage and Retrieval Systems (ASRS) and Goods-to-Person (GTP) technologies.

Simulating the material handling system would help understand the true cost of rolling out the system in the real world and identify store-specific deployment requirements.

SOLUTION

Walmart's initial goal was to make a go/no-go decision on the Alphabot® project launch. Within seven weeks, MOSITMEC was able to learn the system, design initial control algorithms for bot decision making, build the material handling simulation model, analyze results, and present findings to Walmart leadership.

In the final delivered model, Walmart managers could specify different inputs, like the number of bots and their length, width, acceleration, and speed in different areas. Physical racking configurations, like the number of aisles and levels, the space between levels, and the number of workstation tiers, and

other physical components of the system were all configurable. Control logic parameters were also made available to allow Walmart to run further analysis.

After completing the independent analysis of system capabilities, MOSIMTEC transitioned the AnyLogic material handling design model to Alert Innovation for long-term use in fine-tuning software control algorithms for eventual production deployment.

OUTCOME

By estimating equipment requirements needed to meet various turn-around-time thresholds, the outputs from the initial material handling design model informed the business case for deploying Alphabot® more widely. The model showed that Alphabot® would pick 95% of online grocery orders in less than eight minutes, with an average pick time under five minutes. The model also determined which system designs would produce the largest ROI.

Walmart and Alert Innovation launched a proof-of-concept pilot of Alphabot® at a Walmart supercenter in Salem, New Hampshire in March 2019.



BECOME A SUCCESSFUL CONSULTANT IN ANYLOGIC



BECOME A SUCCESSFUL CONSULTANT IN ANYLOGIC

Simulation modeling is a powerful tool for analyzing and developing complex business systems that can provide unique strategic and operational insight and decision support. But how do you get started?

If your organization has not used simulation modeling before, it can be difficult to know where to begin. AnyLogic has many resources to help ease development and understand the important factors that need to be considered. To get started quickly, it will be an advantage to have a background in areas related to systems analysis and integration, industrial engineering, or manufacturing process engineering. For advanced features, it will also help to have some knowledge of programming.

To read further into how simulation modeling is being used by companies to solve complex challenges, download our [Multimethod Simulation Modeling for Business Applications white paper](#).

For those who wish to start by trying the software, AnyLogic PLE offers a free way to begin. You will find tutorials with accompanying models included in the application. There are also [how-to videos](#), [how-to blogs](#), [webinars](#), and, for inspiration, [case studies](#) from sixteen industry verticals.

Of course, when needed, you can call on the AnyLogic support team. They are experienced in working with commercial simulation models and in working with application partners. Do not hesitate to [contact us directly](#) for help with implementing an AnyLogic simulation modeling solution.



CONCLUSION

Consultancies use simulation when working on client projects, helping clients tackle unforeseen challenges, creating new tools for clients, and conducting specialist research. In all cases, simulation modeling complements the specialist knowledge of the consultants with data analysis possibilities not available with simple spreadsheet-based or linear programming methods. Simulation modeling allows its practitioners to tackle complex challenges and provide clear insights.

Consultants reduce the need for organizations to develop specialist in-house knowledge, they speed up solution development, and they help fully realize the benefits of simulation modeling. Consultancies often find organizations are looking for external help with simulation modeling and, for many organizations, consultants are the primary way to access the full benefits of advanced simulation modeling.

Applied well, simulation modeling offers consultancies and organizations an alternative to the traditional methods of spreadsheet-based analysis or linear programming and is superior when developing solutions for complex systems and processes.

AnyLogic [multimethod simulation](#) software combines the three main modeling paradigms: discrete event, system dynamics, and agent-based. Combining these methods allows systems to be modeled in detail and without compromise.

Specific AnyLogic libraries also assist modeling. The [Material Handling Library](#), [Process Modeling Library](#), [Rail Library](#), [Road Library](#), and [Fluid Library](#) combine to help capture the details of a system.

“In my opinion, AnyLogic is one of the most flexible and efficient simulation tools on the market, that can be applied for solving operational and strategic tasks in a wide range of industries, including retail and logistics.”

– Andrey Semenov, Sr. Manager, Supply Chain Management, Deloitte

Using AnyLogic, consultants apply simulation modeling to many different challenges, helping businesses in all kinds of industries. Challenges involving business and social processes, industrial facilities, supply chain, transport, and more. Increasingly, client solutions demand cloud-based implementations and machine learning integrations. With AnyLogic, consultants are meeting these demands and empowering their clients with tools for doing better business.

The field of simulation modeling continues to develop, and it is necessary to stay up to date with the current trends of multimethod modeling, cloud-based simulations, and new AI integrations. If simulation modeling is not yet a core competency, there has never been a better time to get started.

AnyLogic leads the field of general-purpose simulation and, when facing a broad range of challenges, AnyLogic is the only choice.

ADDITIONAL RESOURCES

| [White Papers](#)

| [Case Studies](#)

| [Videos](#)

| [Books](#)

| [Download AnyLogic Simulation Software](#)

| [Seminars and Training](#)



CONTACTS

THE ANYLOGIC COMPANY

info@anylogic.com

[Contact your local office >>](#)