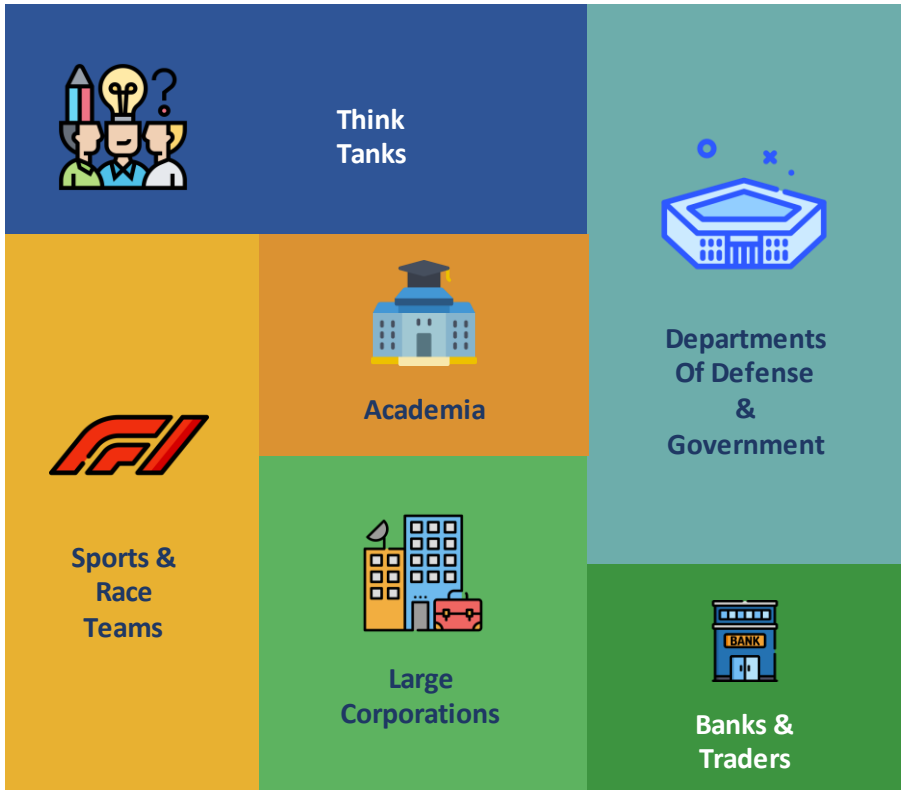
Introduction to Business Simulations

What We Will Discuss

1. What are the business simulations and what questions do they answer
2. Why use business simulations and what gaps do they fill in the scope of analytics
3. How simulations work and what scientific and practical methods they incorporate
4. Are the simulations right for your company, and how to get started with a project

Who Uses Business Simulations



Ordinal Science focuses on the industry

Who We Are

We are a team of business professionals, applied mathematicians, and physicists that brings academic advances to practical business use cases.

2000	Launched the company to develop transportation and logistics planning software
2005	Introduced early IoT technology development and implementation practice
2010	Expanded into Big Data Analytics and Streaming technologies.
2015	Expanded development of AI, robotics optimization, and applied mathematics for industry
2020	Focused on development of simulations for the industry and government

What are Business Simulations?

Business Simulations predict how various parts of the business evolve under a wide range of possible real-world conditions. With simulations, companies can test alternate scenarios before committing resources.

1. We build a software copy of the relevant parts of your business using key model components such as suppliers, transportation networks, labor pools, equipment pools, work modules, manufacturing lines, etc.

2. Each component is a mathematical model that behaves similarly to its real-world analog. Models are trained using data science when available, or calibrated using probability and game theory when data is lacking.

3. We ask the model a complex question by introducing a range of input parameters and tuning the rationality of behavior then run thousands of simulations. The model generates a range of answers that help companies make risky decisions.

Example: Questions a Supply Chain Simulation May Answer

Materials and Suppliers

If raw materials scarcity hits the market – how should we change production?

If suppliers are caught in disruptive geopolitical events – should we consider realignment and reshoring?

Shipping

If container shipping costs plummet should we move the large item assembly offshore?

During a supply crunch when and what could be moved to airfreight to satisfy demand and revenue needs.

Regulatory Regimes

A possible trade war threatens existing tariff regimes – does it make sense to consider new suppliers?

What would delays at customs mean for our optimal inventory levels?

Production and Labor

How would a labor dispute impact upstream and downstream processes?

What impact does doubling production have on inventory needs and distribution?

Distribution

Is our distribution center and warehouse network optimal and cost effective?

Would rerouting transportation to southerly routes during winter cause bottlenecks at hubs?

Demand Behavior

If product demand exceeds expectations – how long will it take to ramp up production?

If economic conditions depress demand when is the right time to decrease upstream purchasing?

Why Use Business Simulations

Traditional decision making strategies have blind spots, they do not handle the analysis of complex, evolving systems.

	Discretionary	Data Driven
Inputs	Intuition	Data Reports
	Industry Experience	Statistical Analysis
	Current Event Analysis	Data Science Models
Challenges	Industry knowledge is difficult to acquire	Timely gathering of data is difficult
	Analysis of multi-factor scenarios is unintuitive	Data Quality and Completeness are rare
	Human predilection to focus on outliers drives policy oscillations	Historical record predicts only a variant of the past
Risks	The interplay of complex factors that characterizes modern enterprises inhibits ability to analyze a required range of scenarios.	Predicting future outcomes in novel scenarios often fails if the historical conditions do not match the modern environment, business practices, and regulatory conditions.

Simulations de-risk decisions

1. Simulations model complex, sometimes irrational behavior of participants to explore risky "black swan" events difficult to detect with traditional analytics.

2. Simulations provide a series of probable outcomes for highly complex, multi-factor scenarios that allow management to choose the best course.

3. Business simulations sidestep the challenges of data-driven decision making by generating high-fidelity future data in novel scenarios.

How simulations work – a few technical details.

Business Simulations incorporate probability theory, machine learning, process physics, labor psychology, and stochastic evolutionary behaviors into an ensemble of models that generates future data.

The simulation comprises interconnected nodes that represent business processes, human interactions, or physical systems. They impact each other in combination as the system evolves.

We run each simulation thousands of times, each evolving over a period of time steps. For some simulations a time step is a day, for others it could be an hour, a minute, or 100 milliseconds. In the end we generate a future state that describes a likely outcome under test conditions.

Time

Define Process Relationships. A mathematical graph determines the relationships between processes and degree to which they effect each other. For example, an output of a mine upstream determines available materials for production.

Calculate Component State. At each timestep, a Markov process or similar drives a probabilistic decision about what the component will do next; i.e. should a manufacturing plant increase production given the prior decisions, demand and supply signals, and labor availability?

Determine the Degree of Change. Once each component "decides" on its action, the simulation determines the degree of change the component undergoes. The decision is driven by stochastic processes influenced by probability, physical states, and influences of neighboring components.

Update the Simulation. The simulations calculates the new wholistic state of the system based on the component level decisions and the interactions between components, then it validates the consistency of the system state; i.e. can we actually produce what the simulation proposes?

Recompute Probabilities. Since the total state of the simulation changed during the time step so may the likelihoods of future events and choices. If the procurement model decreases the raw material purchasing for the following months, the probability of production increase drops.

Produce Results. When an individual simulation completes, the state of each component tells a story about how the decisions made during the simulation impact the outcome. As we run thousands of simulations, we aggregate the results from all to build the most likely picture of the future.

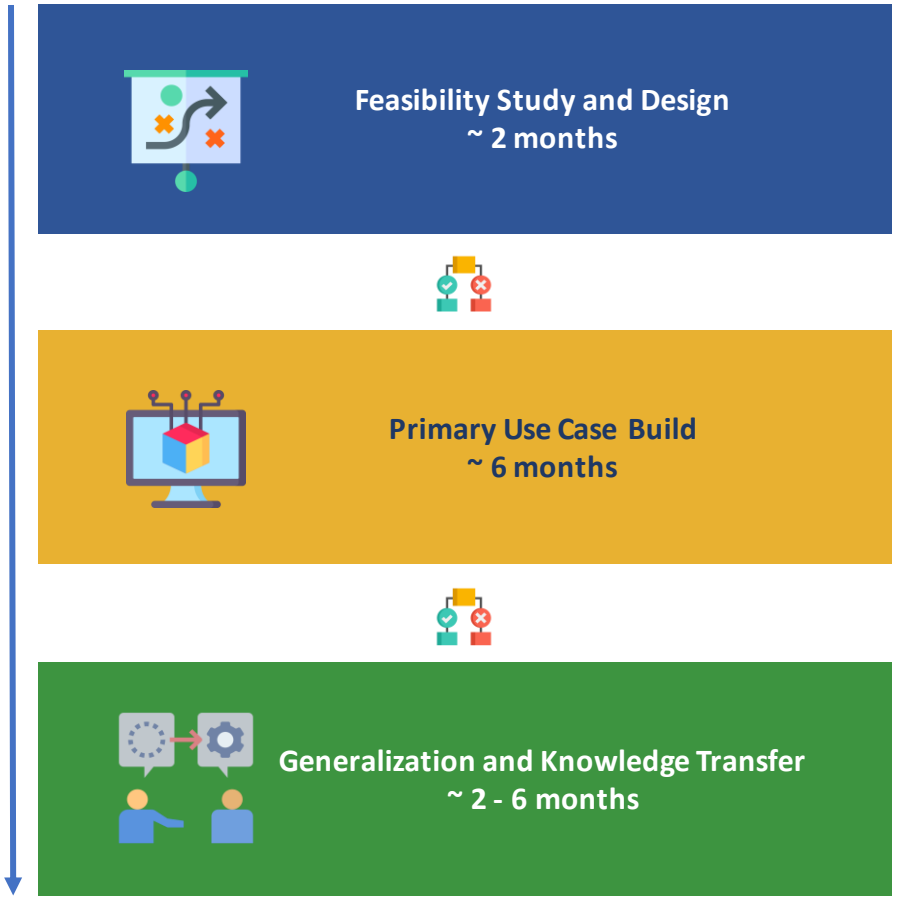
N – time steps

What is Next?

What organizations benefit from simulations?

1. Large companies with interconnected network of stakeholders
2. Companies operating in evolving markets with supply and demand shocks
3. Companies requiring extensive planning, scheduling and low fault tolerance in execution
4. Companies with extensive start-up costs and long change over times
5. Companies with long project timelines subject to external disturbances

Engagement Flow



During the Feasibility and Design phase we work with your team to determine the probability of technical success by analyzing the structure of the business relationships and the data. Then we solidify the maximum impact use case and design the simulation flow to support it.

If the probability of technical success meets the required threshold, we focus on the development of the simulation during this phase. The process involves integrating model components into a relationship graph, deriving key probabilities and distributions, and a fair amount of development as each company is quite unique.

The prior phase completes with a working model that answers the requirements of the primary use case. The next optional phase is to generalize the model to answer a wide range of strategic and operational questions. Additionally, many companies designate a team to support and further develop the simulation internally. In such cases we transfer the knowledge to the team.