The Rise of Computer-Enabled Supply Chain Design

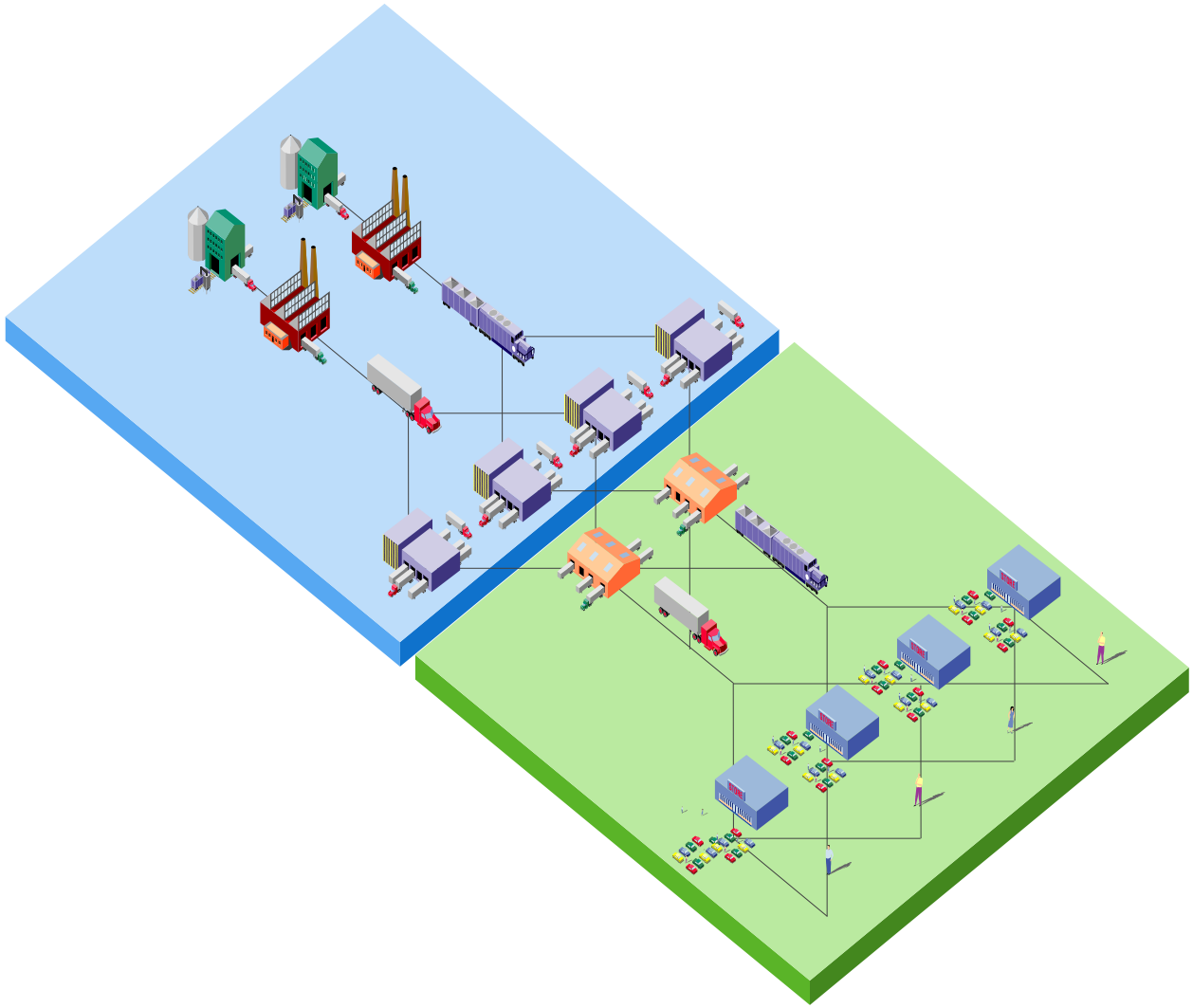
Steve Ellet | Vice President, Supply Chain Design

Overview

- What is Supply Chain Design?
- Where did it come from?
- Why does it matter?
- What are the key recent advancements?
- What's next?

CHAINalytics

What is supply chain design?



CHAINalytics

What is supply chain design?
Key Questions

What infrastructure is required for manufacturing and distribution?

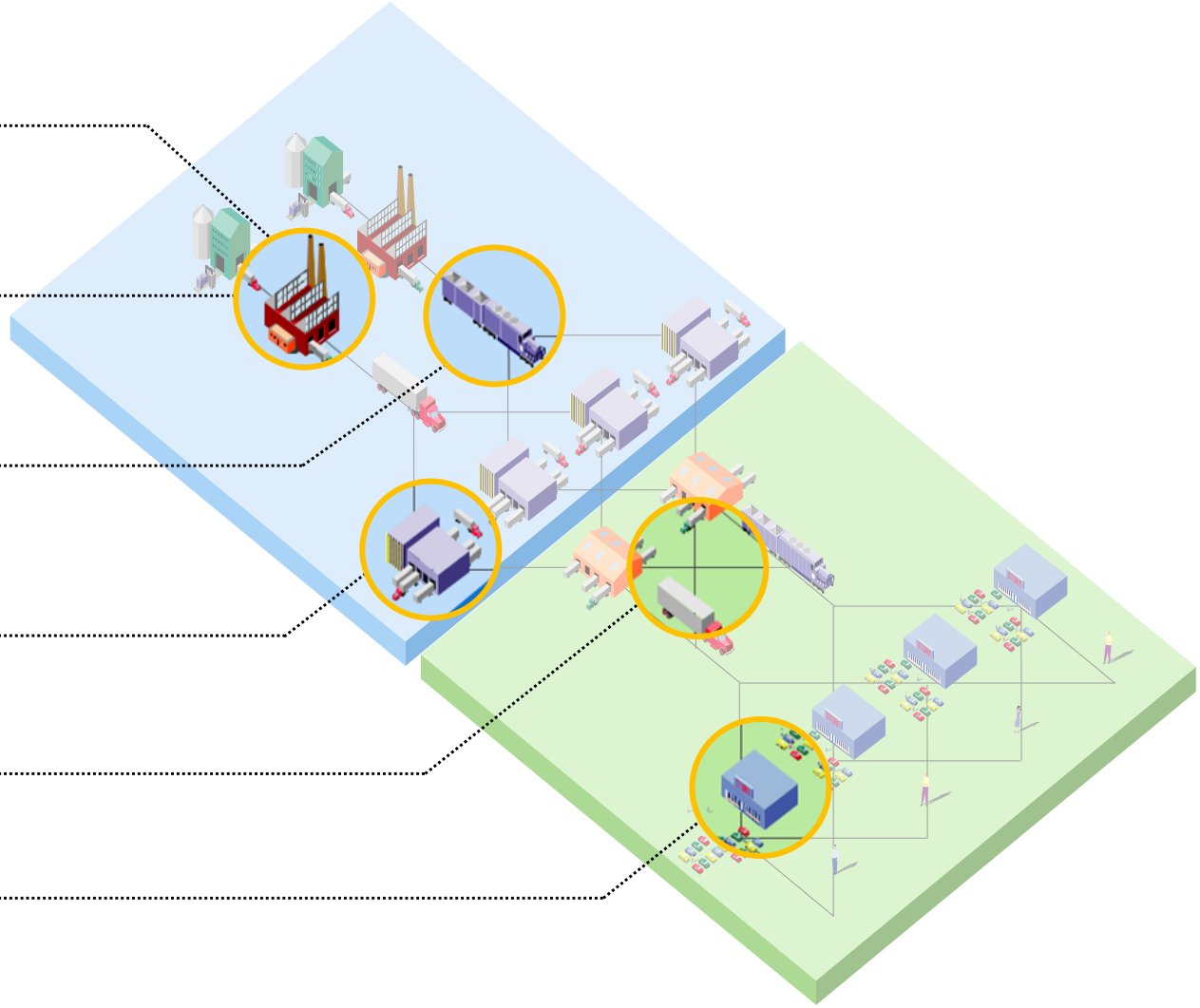
When should we buy or make product for the best use of capacity?

How should we transport product through the supply chain?

How much and where should inventory be positioned in the supply chain?

What is the best flowpath?

At what service level can we profitably satisfy demand?



CHAINalytics

What is supply chain design?
Key Data

Raw material costs
Supplier capacity and service
Inbound material lead time
Inbound lane costs

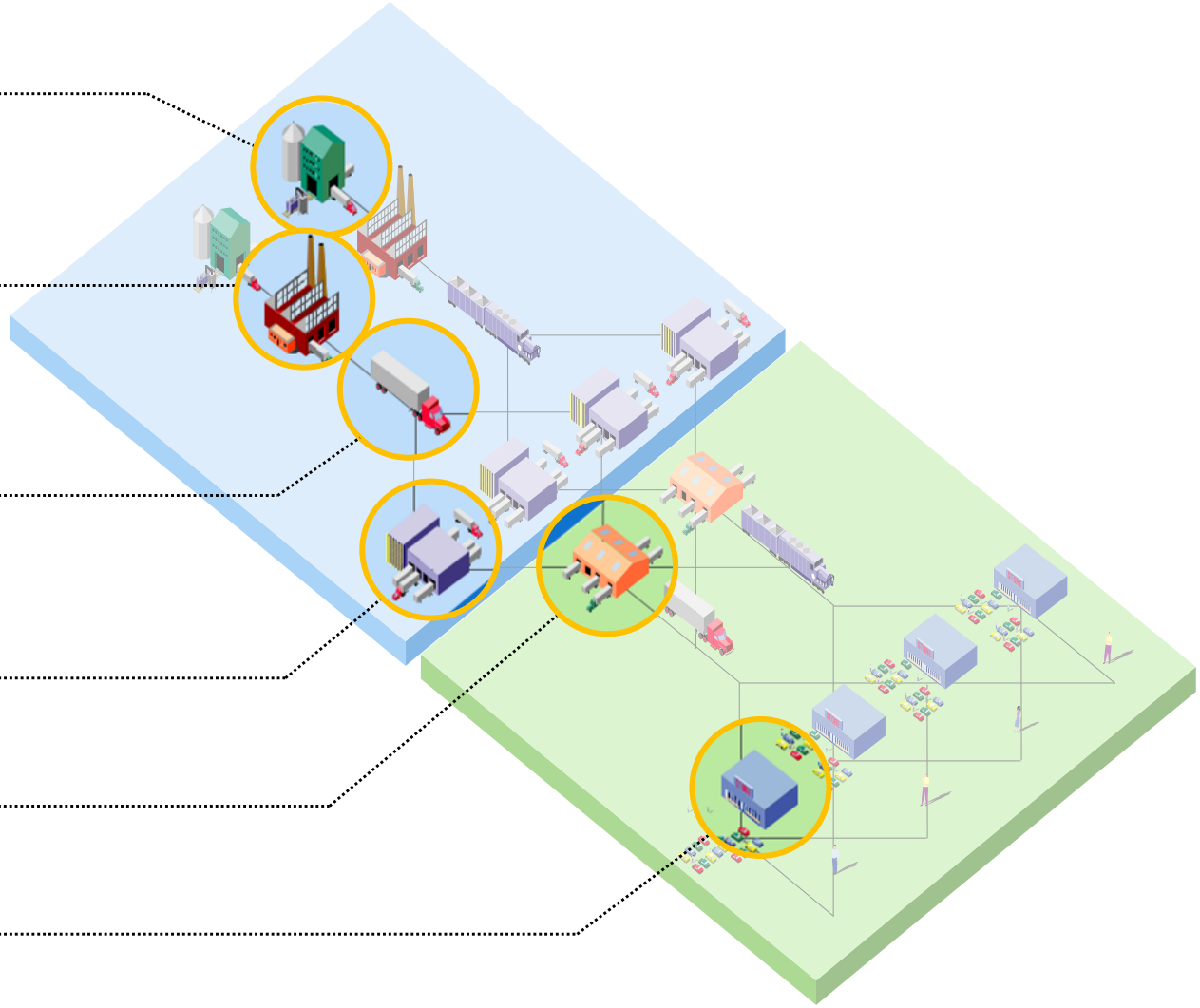
Labor, energy, land, facility cost
Production speed and capacity
Shift schedules
Lots, batching, yield, loss

Contract carrier rates
Private fleet sizing
Equipment and driver expense
Fuel surcharges
Load consolidation

Greenfield DC locations
Transfer lane costs
Outbound lane costs

Service level, fill rates
Forecast error and variability

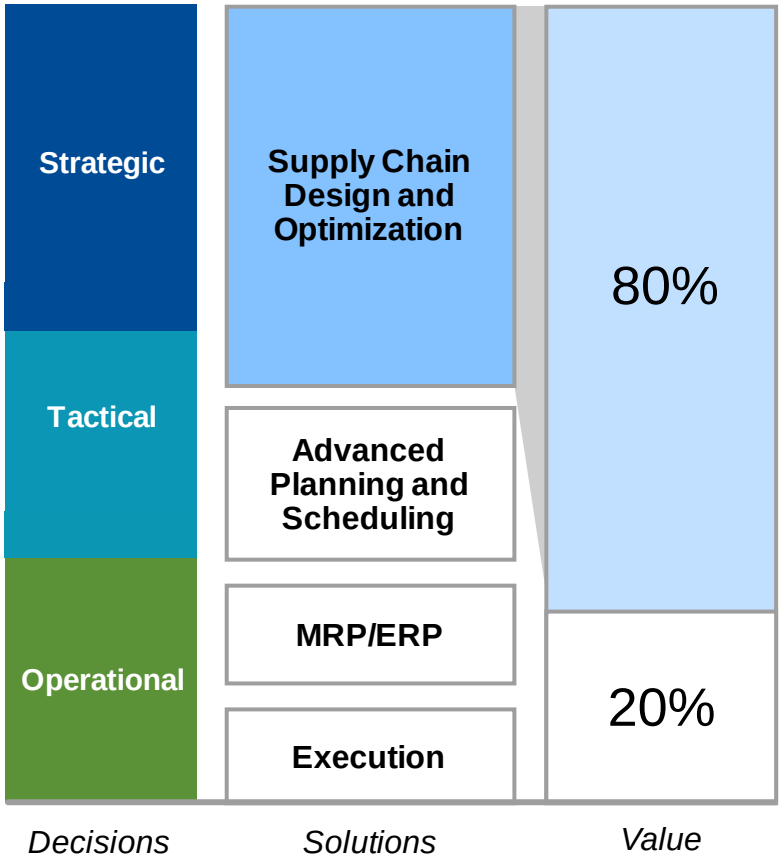
Customer demand
Product profitability
Price



CHAINalytics

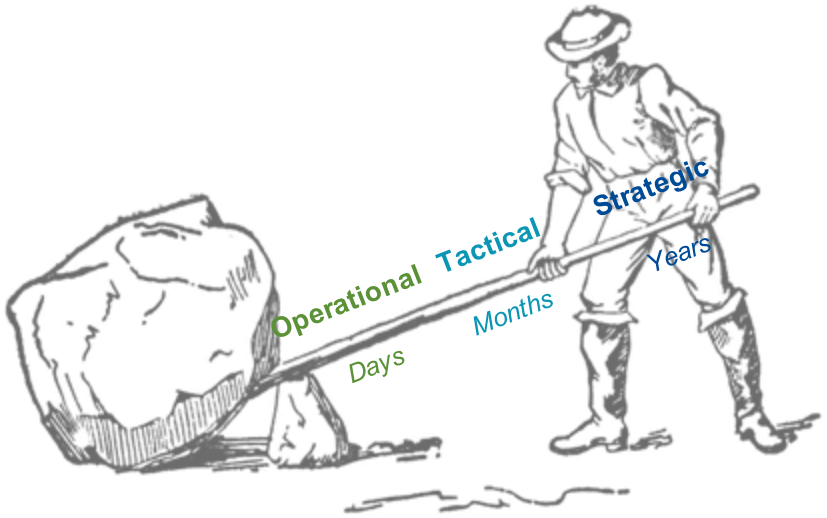
Why is supply chain design important?

The majority of a supply chain's lifecycle costs are locked-in at the start.



Source: Gartner / AMR Research

- Overall strategy first, then specific sites and incentives
- Just like investment decisions – pick asset allocation first, then specific stocks, mutual funds, etc.

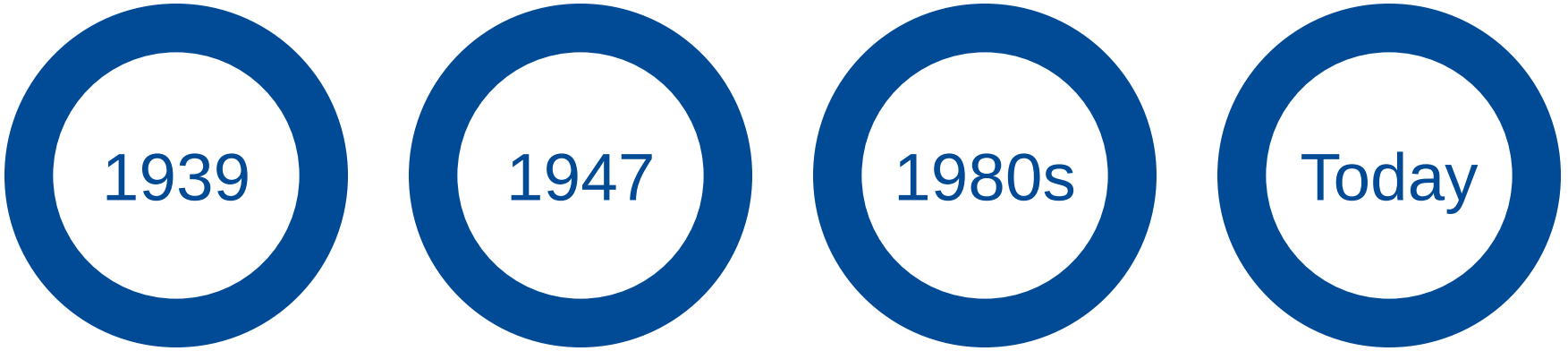


What do supply chain design engineers do?

- Sift through a vast quantity of data and options to arrive at the best design – one that meets the needs of the business and its customers with minimum **cost**, **risk**, and **environmental impact**
- Increasingly use large-scale mathematical programming models to evaluate trade-offs between cost and performance
- Supply chain design has become a respected area of Industrial Engineering, with dedicated academics, practitioners, software vendors, and consultants

Where did it come from?

The rise of optimization and supply chain design are inter-related.



Linear Programming	Simplex Method	Network Optimization	Mixed Integer Programming
Soviet economist, Leonid Kantorovich is credited with development	George Danzig's published method led to broader applications of LP	LP models replacing heuristics to answer network flow questions	MIP embraces advances in technology, making it better suited for Supply Chain Design

CHAINalytics

Why are MIP and computing power so critical?

Consider a warehouse rationalization model with “on-off” decisions for each site:

- Each facility has 2 states: “On” or “Off”
- For a simple network with 3 candidate warehouse location or size alternatives, the number of combinations is 2^3 or 8
- A modest network with 15 candidate warehouse location or size alternatives has 2^{15} or 32,768 combinations
- A network with 300 candidate warehouse location/size alternatives yields 2^{300} or $2x10^{90}$ combinations

By the way, the number of atoms in the universe is about 10^{80}.

Can your spreadsheet do this?

Enumeration breaks down in real-world situations.

Recent Advances in Supply Chain Design

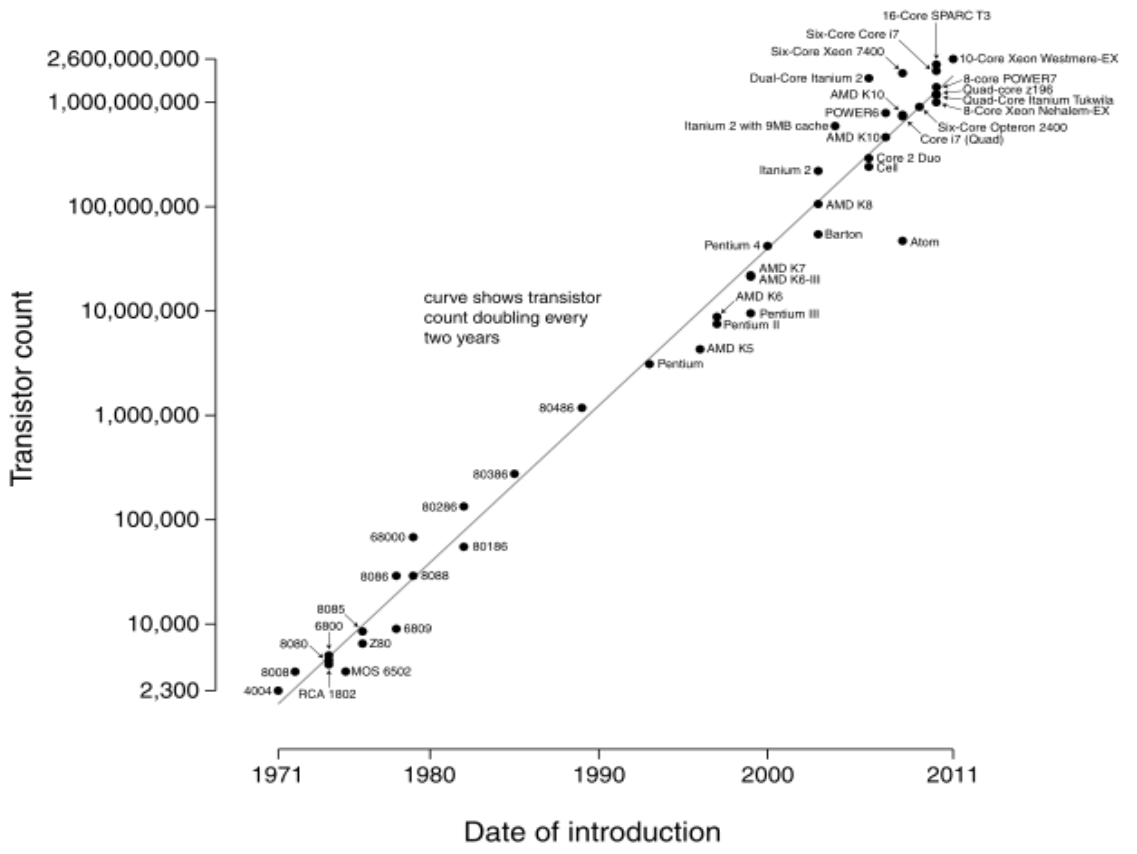
Computer hardware availability and cost (Moore's Law)

- 64-bit Windows removed prior limits on RAM
- Multi-Core & Multi-processor systems
- Cloud-based solving capability

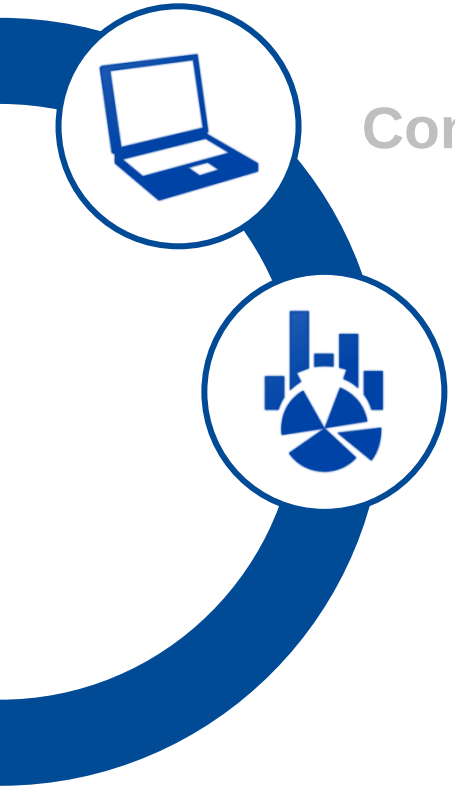
CHAINalytics

Impact of Moore's Law's on Supply Chain Design

The increasing availability of computing power, as described by Moore's Law, has significantly enhanced the complexity, accuracy, and adoption of computer-enabled supply chain design.



Recent Advances in Supply Chain Design

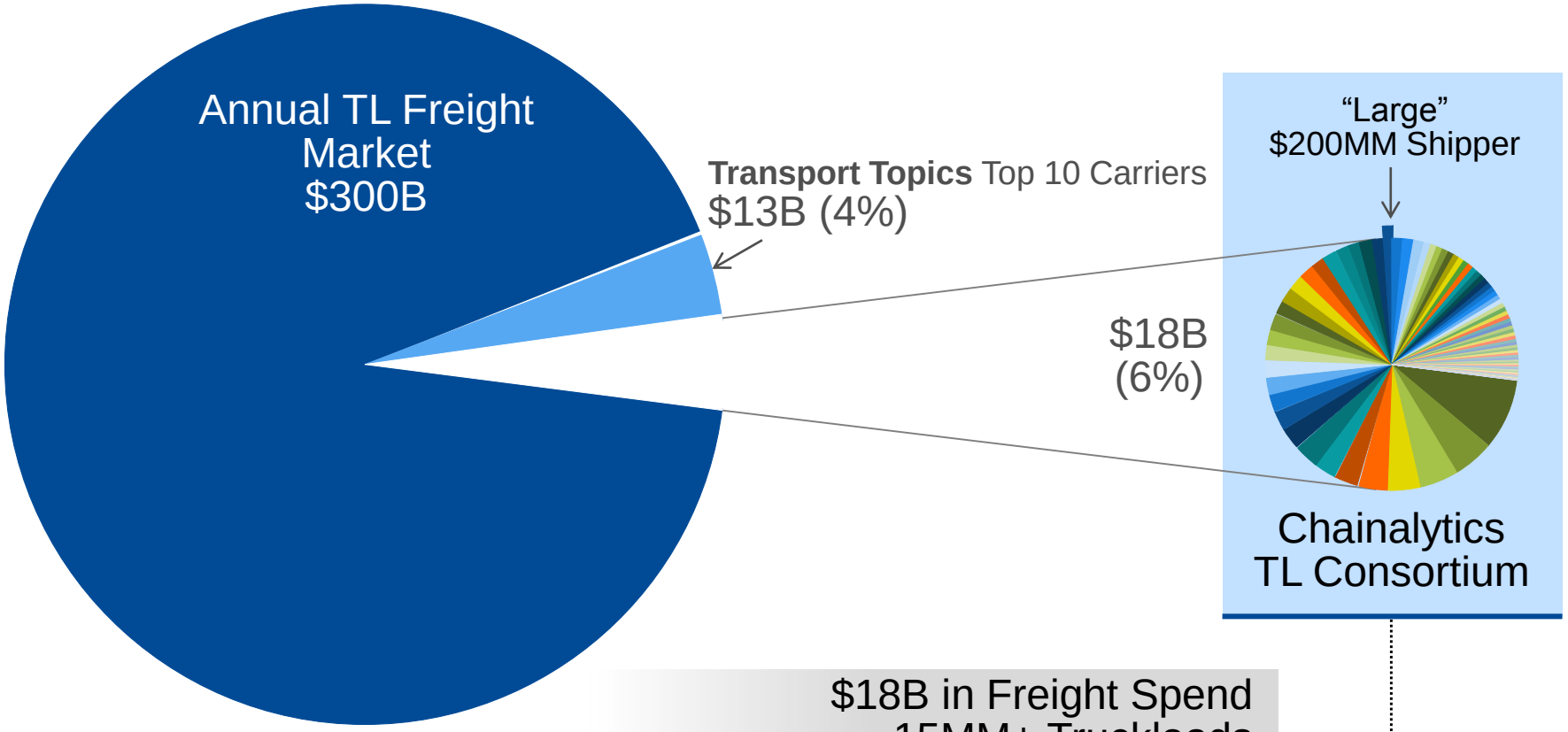


Computer hardware availability and cost (Moore's Law)

Big data systems make it possible to access and manipulate the large datasets which underlie supply chain design models

- Access to historical data like shipment history and POS data
- Predictive, unbiased "design data" for new options to test

“Big Data” Drives Freight Cost Prediction

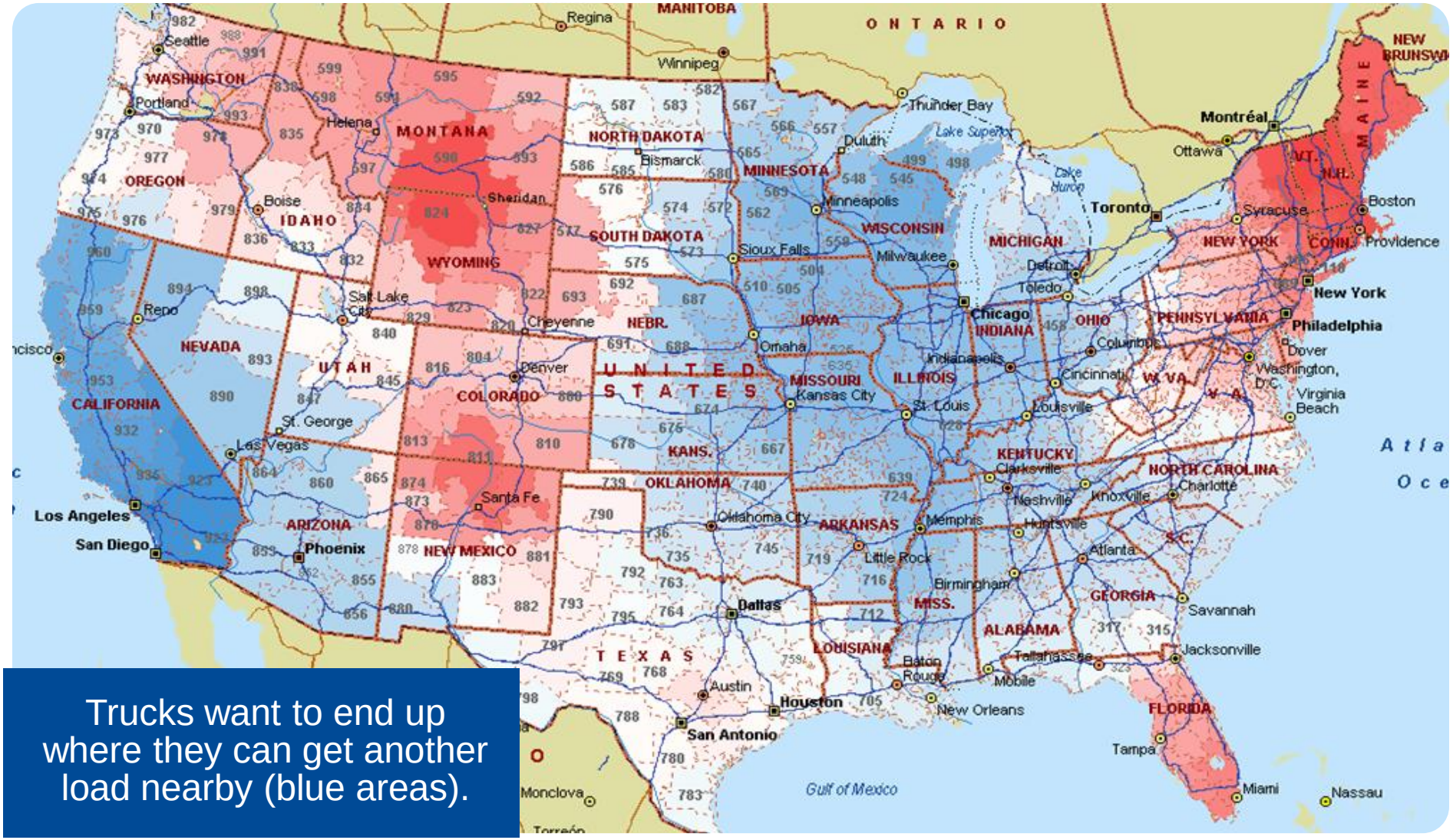


$18B in Freight Spend
15MM+ Truckloads
108 Member Companies
Refreshed multiple times per year

CHAINalytics

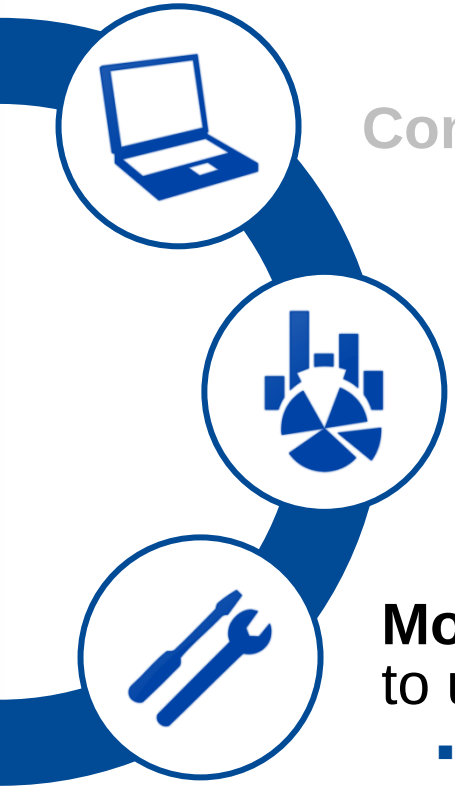
Predicting Freight Costs

Where do trucks want to go (and not want to go)?



Trucks want to end up where they can get another load nearby (blue areas).

Recent Advances in Supply Chain Design



Computer hardware availability and cost (Moore's Law)

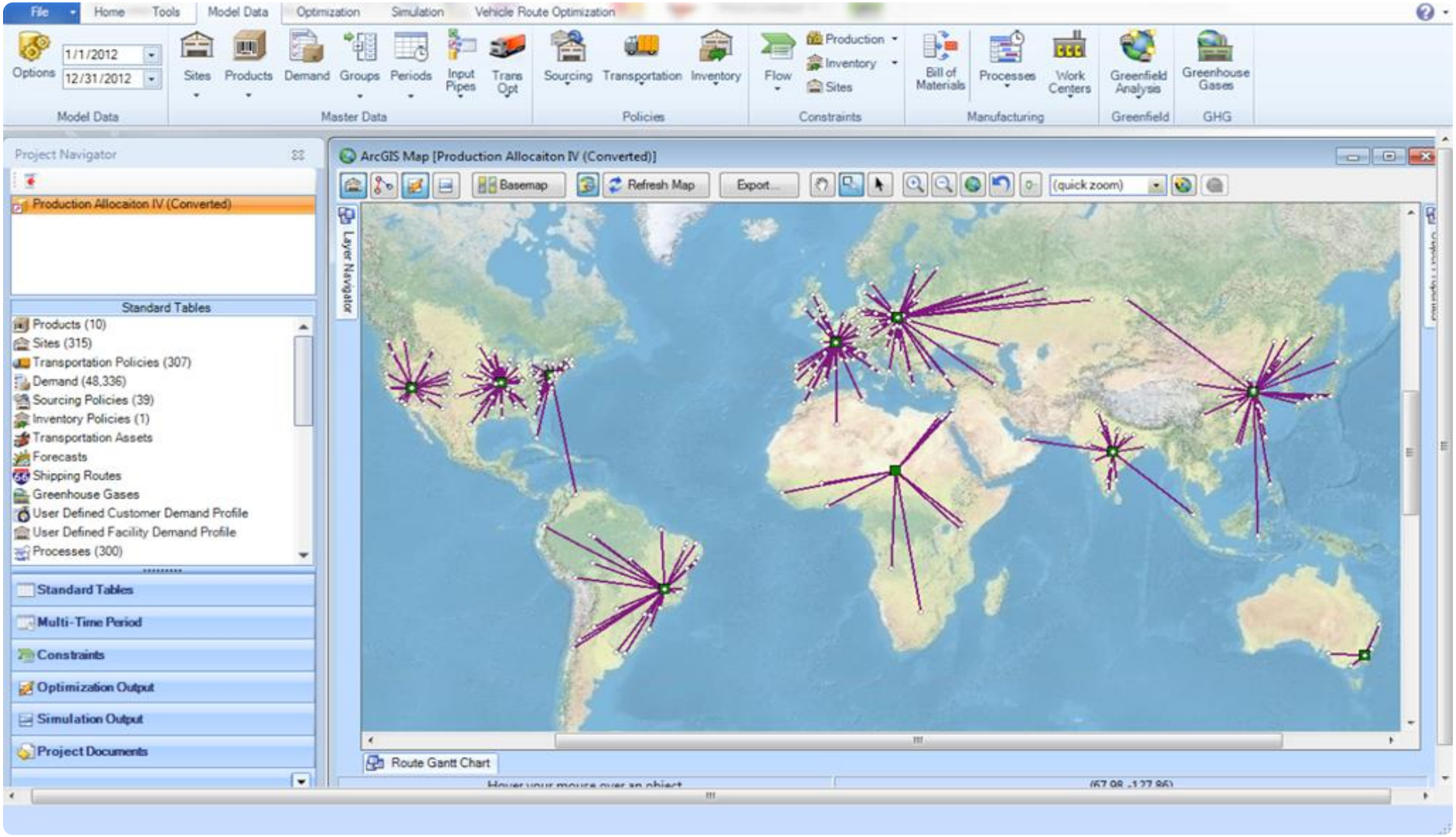
Big data systems make it possible to access and manipulate the large datasets which underlie supply chain design models

Modeling tools have become sophisticated and easier to use

- Multi-objective functions
- Coupling of optimization and simulation
- Automated sensitivity analysis
- Math formulation and solver improvements
- Usability to engage business leaders

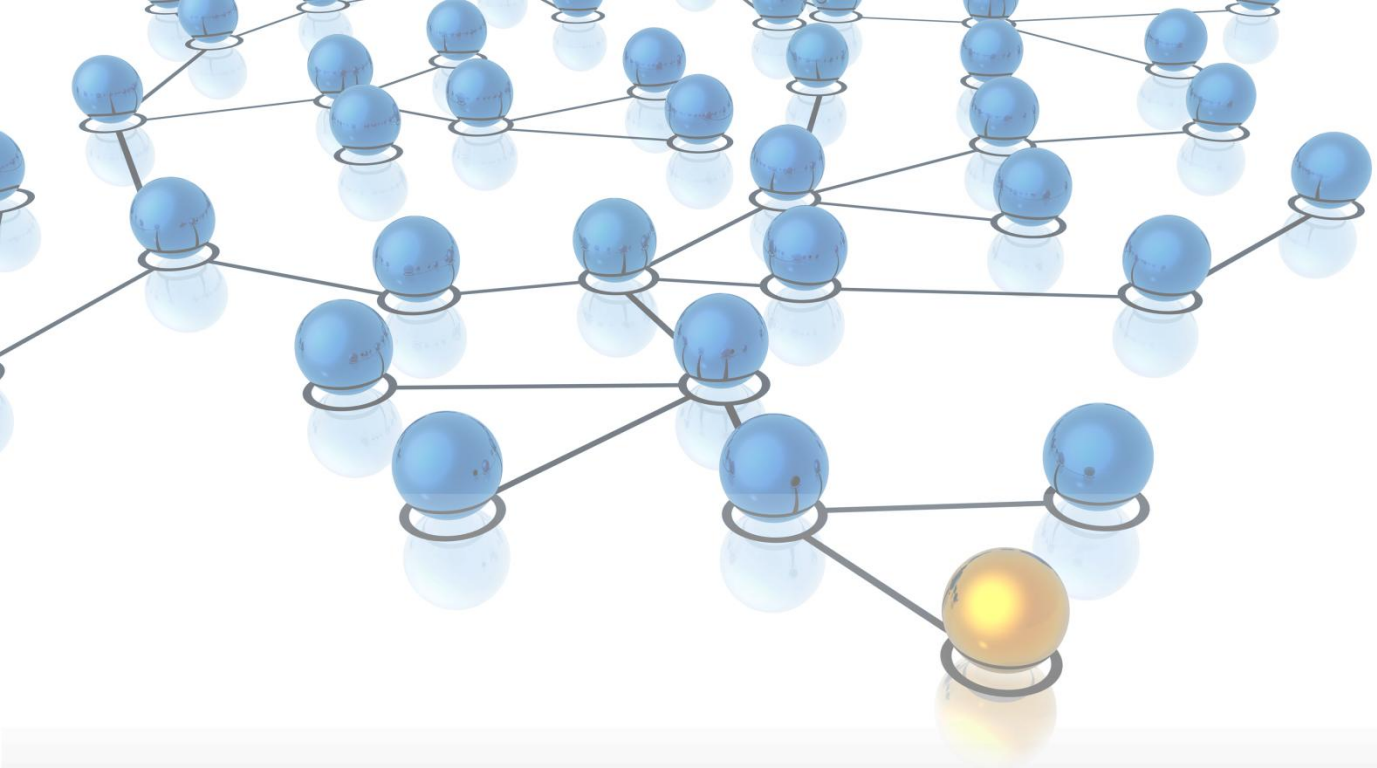
CHAINalytics

Modern Supply Chain Design Technology



This is only the beginning…

- External factors will keep pushing companies to improve and adapt
  - Complexity and change will keep accelerating (fuel, disasters, customer req'ts…)
  - Supply chain design will grow increasingly critical
- Firms will depend more on collaboration and consortium-driven insights
- The scope that we can address in a single model will continue to grow
- The frequency of analysis will keep increasing (weekly, real-time "anomaly detection"?)
- In the move from Intelligent to Cognitive, we will have to decide how much *cognitive autonomy* we permit…
  - M&A targets?
  - Opening and closing facilities?
  - Staffing decisions???



Questions?

Steve Ellet
sellet@chainalytics.com