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Supply Chain Optimization through Risk Modeling and Automation

Getting the most out of your supply chain process

Derrick Fournier, Bristol-Myers Squibb

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APICS 2018 Session Evaluation

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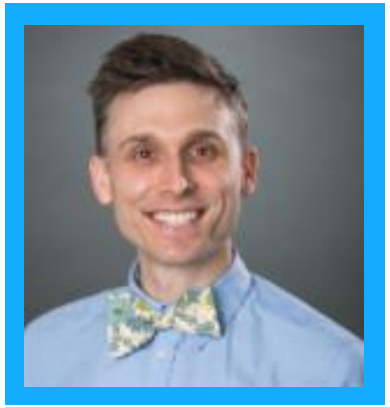
Let’s begin with introductions!



Derrick Fournier

Head - GPS Business Insights and Analytics
Bristol-Myers Squibb

Derrick Fournier leads the Global Product Development and Supply (GPS) Business Insights and Analytics team at Bristol-Myers Squibb. Previously at Bristol-Myers Squibb, he oversaw the commercial analytics operations team. Earlier in his career, he worked as a strategy consultant driving various consulting engagements at Accenture. Derrick holds an MBA from the University of Western Ontario Richard Ivey School of Business and a bachelor's degree in electrical engineering.

Vinodh Balaraman

Principal and Senior Partner
ZS Associates

- Supply Chain & Manufacturing Management practice lead at ZS
- Drive business transformation through leveraging analytics & advanced data science
- Experience across various industries including Life Sciences/ Healthcare, Manufacturing, Travel, Financial Services
- Previously was at Cognizant: VP and Head of Travel & Hospitality business at Cognizant that I quadrupled to $300 million annually; and Chief Strategy Officer for Products & Resources business unit where I owned strategic services lines including supply chain management, analytics, and digital
- Previously held various roles in Financial Services at Bank of America and strategy consulting at Booz Allen Hamilton

Our Agenda for today…

- Key challenges being faced by the industry
- Overview of our approach
- Additional Supply Chain & Manufacturing Analytics application
- Q&A

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The Pharmaceutical industry faces some unique challenges when managing its supply chain

High Inventory levels

Due to the Bull-whip effect, hundreds of millions of dollars are tied up in inventory, particularly API/DS, to maintain high customer service levels

Limited shelf life and long lead times

Particularly with the emergence of biologics, limited shelf life and long production lead times drive obsolescence risk and planning complexity

Supply Chain Volatility

Increased demand and supply volatility (particularly for biologics) exacerbated by CMOs lead to greater planning complexity (impact inventory and obsolescence cost)

S&OP in a silo

Traditional S&OP ownership is decentralized with each business unit doing its own thing

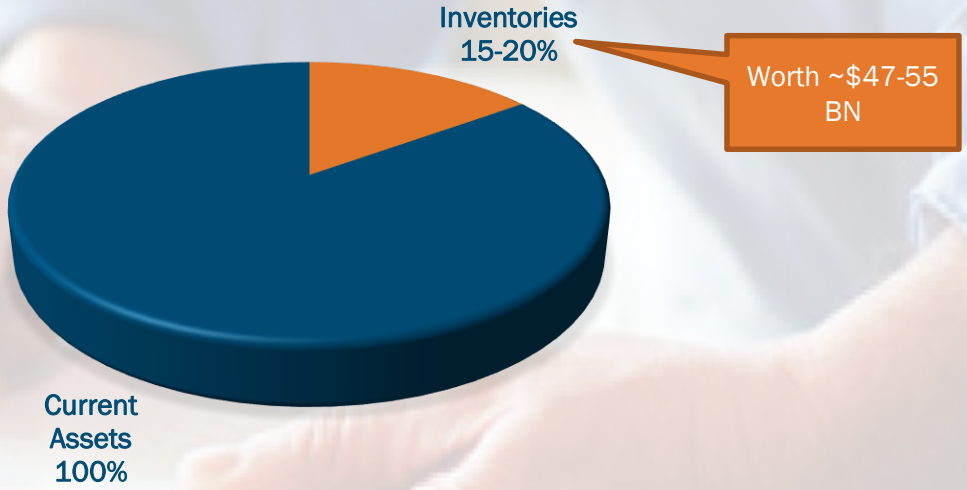
There is now an increased focus on working capital optimization and increased responsiveness to off-set top-line challenges

Pharmaceutical industry typically has high inventory levels to support high customer service level requirements

Inventory turn-over is quite low compared to other industries

Source: fielo.com and ZS research of Top 10 pharma companies

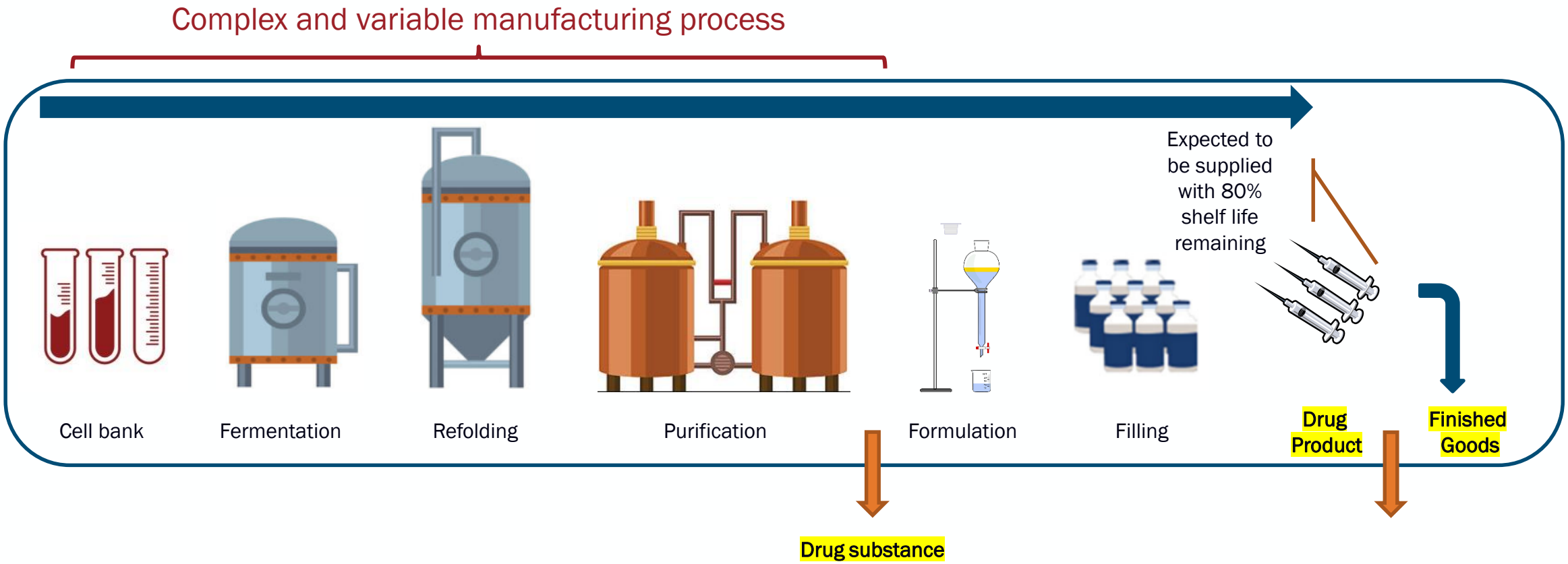
A considerable portion of current assets is tied up in inventory



Source: ZS Analysis of Top 11 pharma companies 2017 annual reports

Key Driver: High opportunity cost of stock-outs – as high as $30K for a single vial – in addition to the reputation hit.
Key Question: Will these high inventory cushions be sustainable in the future?

It is imperative to plan for shelf-life with the advent of biologics and relatively higher lead times



* Based on ZS client interviews

Supply chain volatility is another reason to stock-up on inventory

Market and Ecosystem Complexity

Variability

Demand Side

- Natural events and disasters
- Competitive launches and regulatory
- Consumer behavior and macro-economic factors

Supply Side

- Variability in manufacturing process
- Global supply chain logistics & supplier delays
- Regulatory and compliance

Ignoring this inherent variability can increase risk of stock-outs and increase costs

The S&OP process is brand-centric with opportunities to leverage synergies

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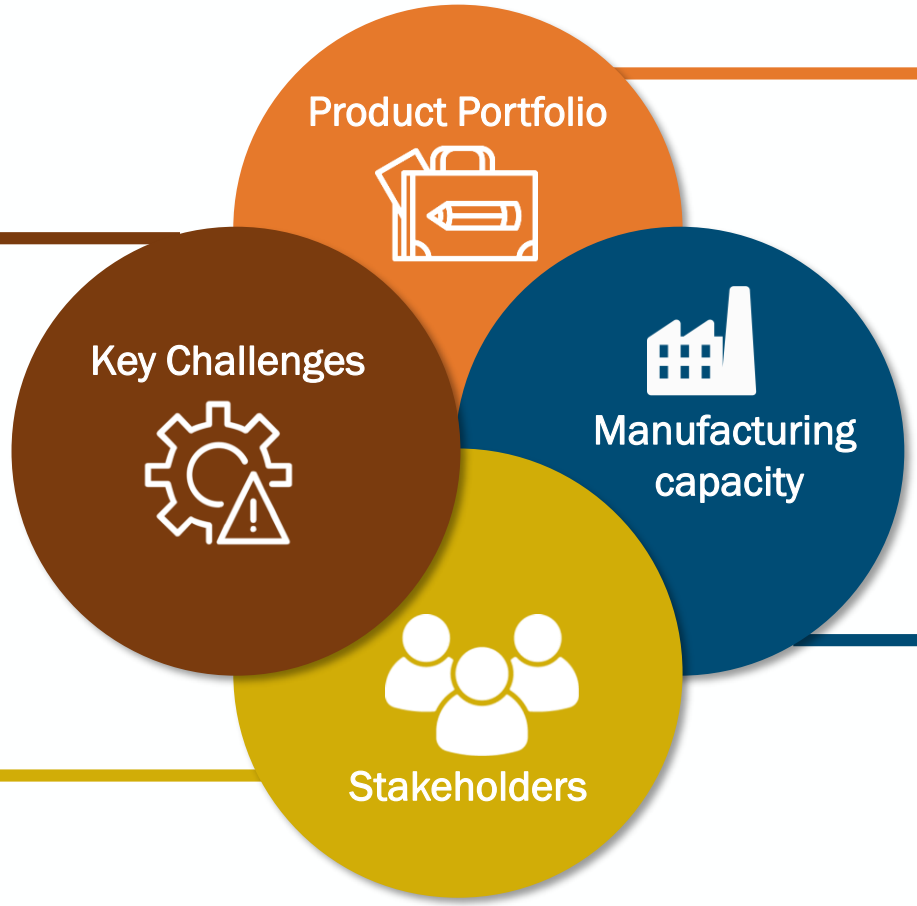
Q&A

A glimpse of the opportunity

- Uncertain and volatile demand
- Complex combo products
- Manual, Black-box models
- Alliance agreements
- Stock-out risk



- 8 branded products in scope
- Mix of biologics and small molecules
- Annual Revenues of $20 Bn +

- Supply Chain Product Leads
- Network Planning Leads
- Business Insights and Analytics

- Mix of CMOs and in-house capability
- Global presence

Key Question: How do we create standardized, risk-adjusted supply chain planning models across large and small molecule lines?

The current tools landscapes had limitations that we had to work around

01	Lack of advanced simulation
02	Comprehensive outputs pertinent to decision making
03	Adaptability across product models
04	Drill down and event-based alerts

These gaps meant we had to consider a bespoke approach

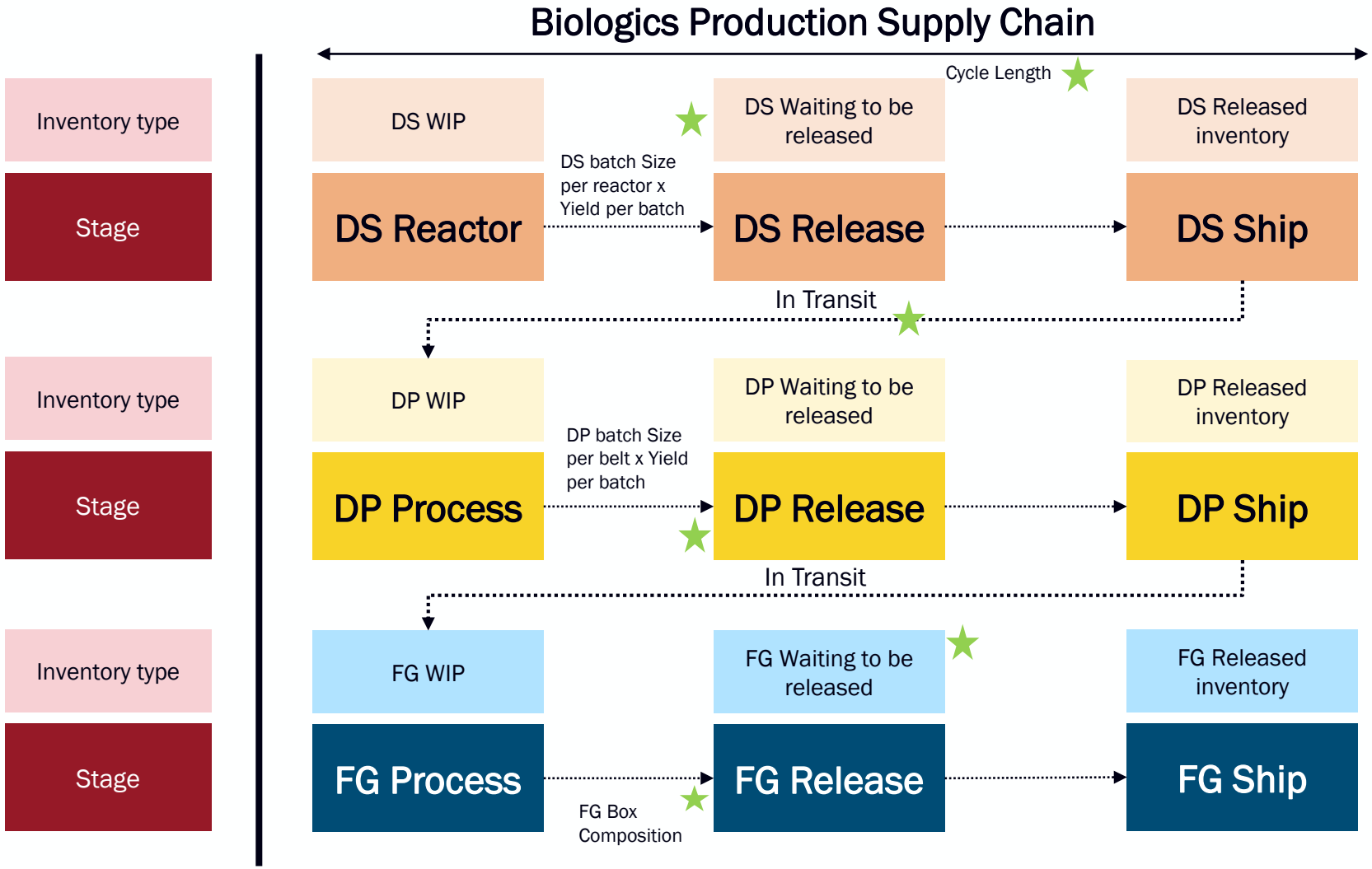
Immersion workshops helped us devise a standard framework that could be adapted for individual brands

Multiple stakeholders involved in the process to achieve alignment on model design – Product leads, Steering committee, ZS Experts etc

Clear documentation of requirements with sign-off from stakeholders at each stage

Use-case based approach to ensure focus during model flow design

A multi-stage pharma process inventory approach helped us bring the models to a common platform



Model Parameters

- Product, Dosage, Formulation
- Cluster, Site
- Sourcing strategy at each stage
- Starting inventory, Safety stock
- Historic distributions for variables

Push-button process to create model template

DS: Drug Substance; DP: Drug Product; FG: Finished Goods Variable factors to model risk

We adopted a three-pronged strategy to address the problem

Project Process

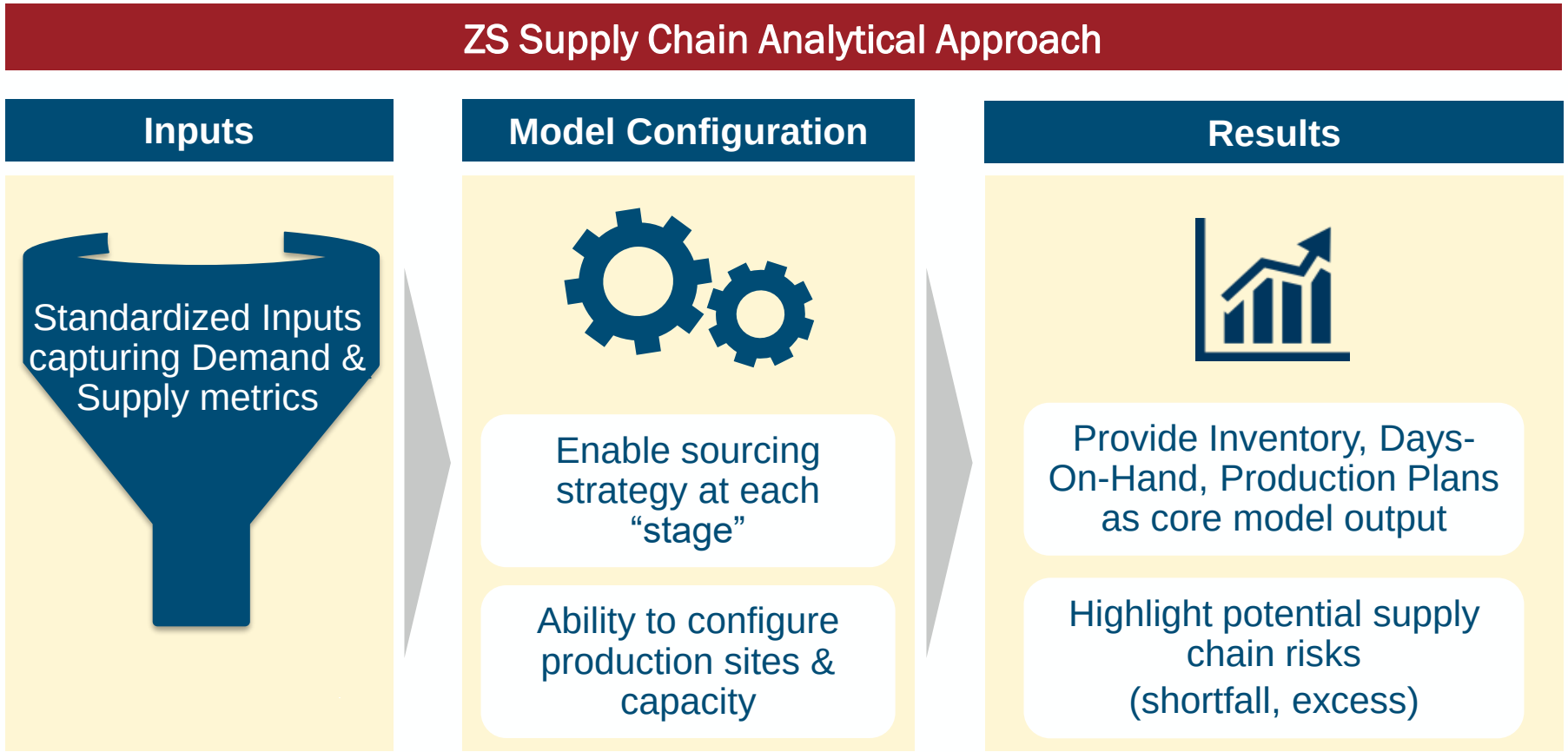
Modeling Volatility	Standardization	Decision Support Simplification and Automation

▪ **Introduce simulation-based risk modeling** for both Demand and Supply side variables
▪ **Robust analysis of historical** data to fit probability distributions
  ▪ **Integration** into modeling framework
  ▪ Incorporate **production constraints**
	▪ **Immersion-based workshops** to understand current cross-brand practices
	▪ Evolution of a **common modeling framework**
	▪ **Parameterized** "configuration" of models for flexibility and brand-specific nuances
	▪ **Scalable** to other portfolio products
		▪ Automation of **"what-if"** analyses
		▪ **Ranged output charts** based on simulation results
		▪ **Drill-down capability at various levels** (time, site, product, sub-product, stage)
		▪ Flagging of **key indicators** such as potential stock-out and obsolescence

Key Questions

1) Will I have enough inventory? How do I optimize service levels and inventory?
2) What are the supply & demand side risks?
3) How can I plan better to minimize re-work?

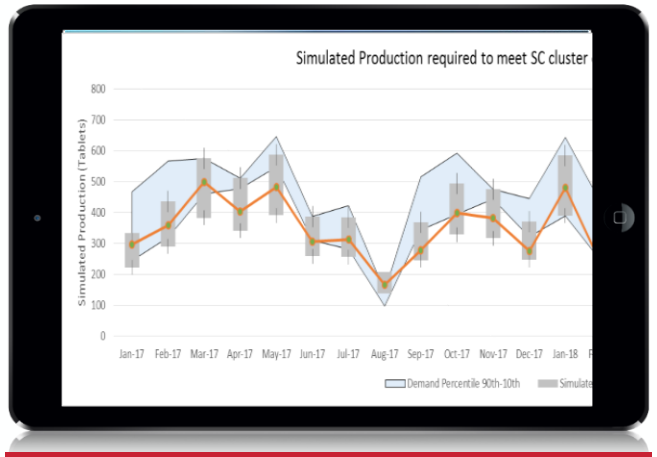
Our approach enables advance flagging of potential risks and faster execution of 'what-if' scenarios for network and product planning



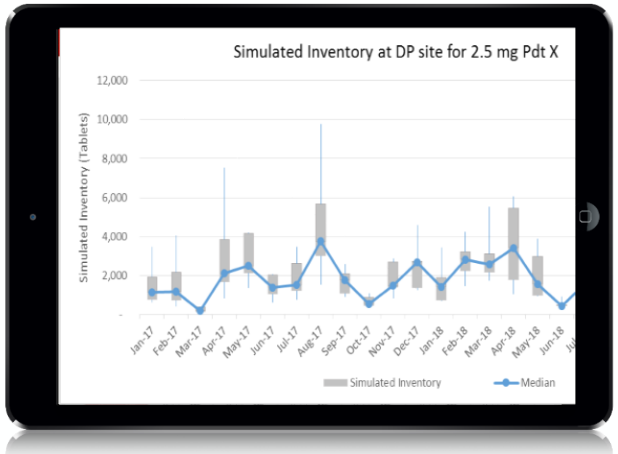
- Addresses variability in demand and supply (e.g. manufacturing yield, success rate, release time) through risk modeling
- Demand-driven approach with ability to incorporate production constraints

Multiple ranged outputs were developed for decision-making

Simulated MoH v/s SS



Simulated Production



Simulated Inventory

Sensitivity Analysis

Suite Utilization

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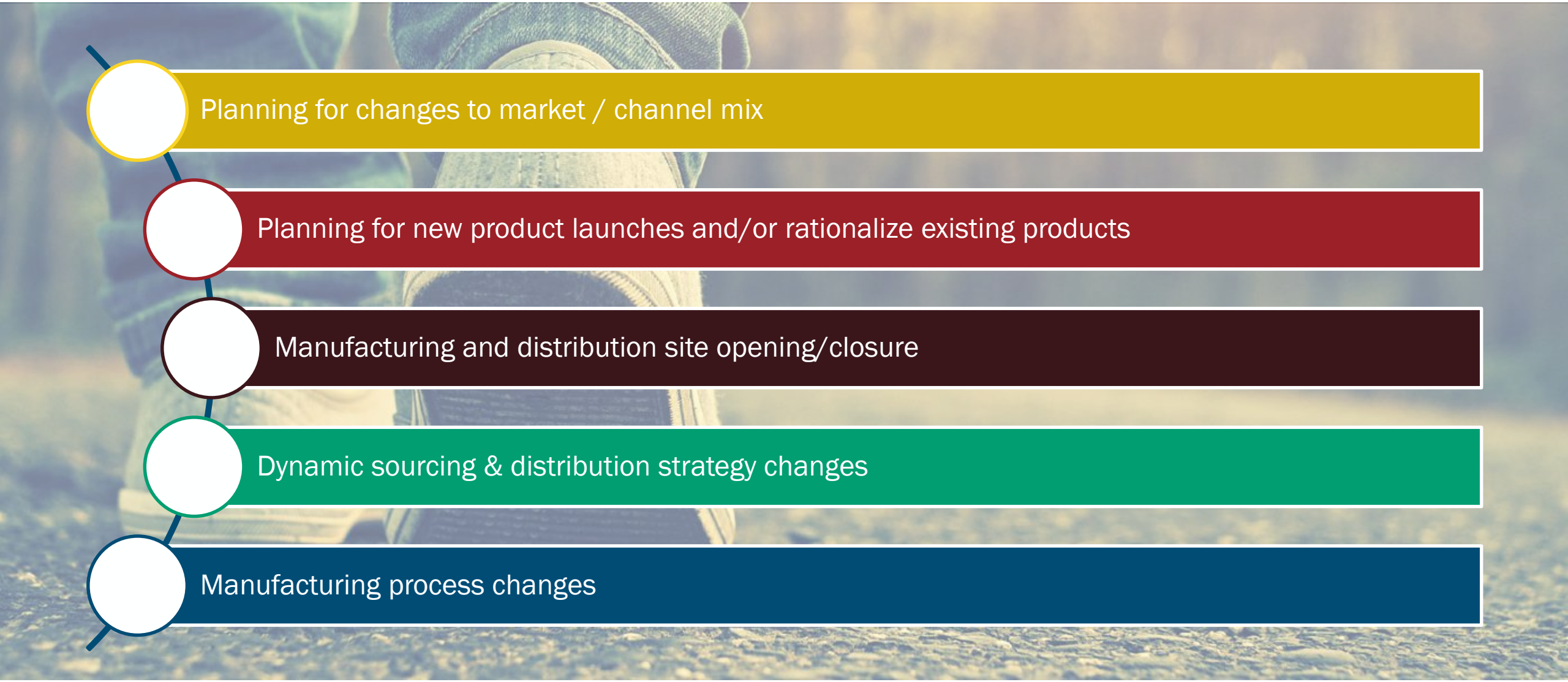
The stochastic model outputs can be used for a variety of supply chain decision scenarios



Subsequent scalability can be achieved through network models for mid- and long-term planning

	Supply Chain Product Models	Mid-Term Network Models	Long-Term Network Models
Description	Scenario planning at a product level (to identify production plans, raw material plans, etc.) based on demand & safety stock targets	Near to Mid-term scenario planning across all products in the network	Long term strategic planning across all products in the network – for e.g. to assess the need for capacity additions, sites, etc.
Best suited for	Supply Chain Product Leads responsible for priority / launch products	Supply Network Planners responsible for planning & operations in the mid-term	Supply chain strategic planners responsible for assessing and planning long-term network capacity needs

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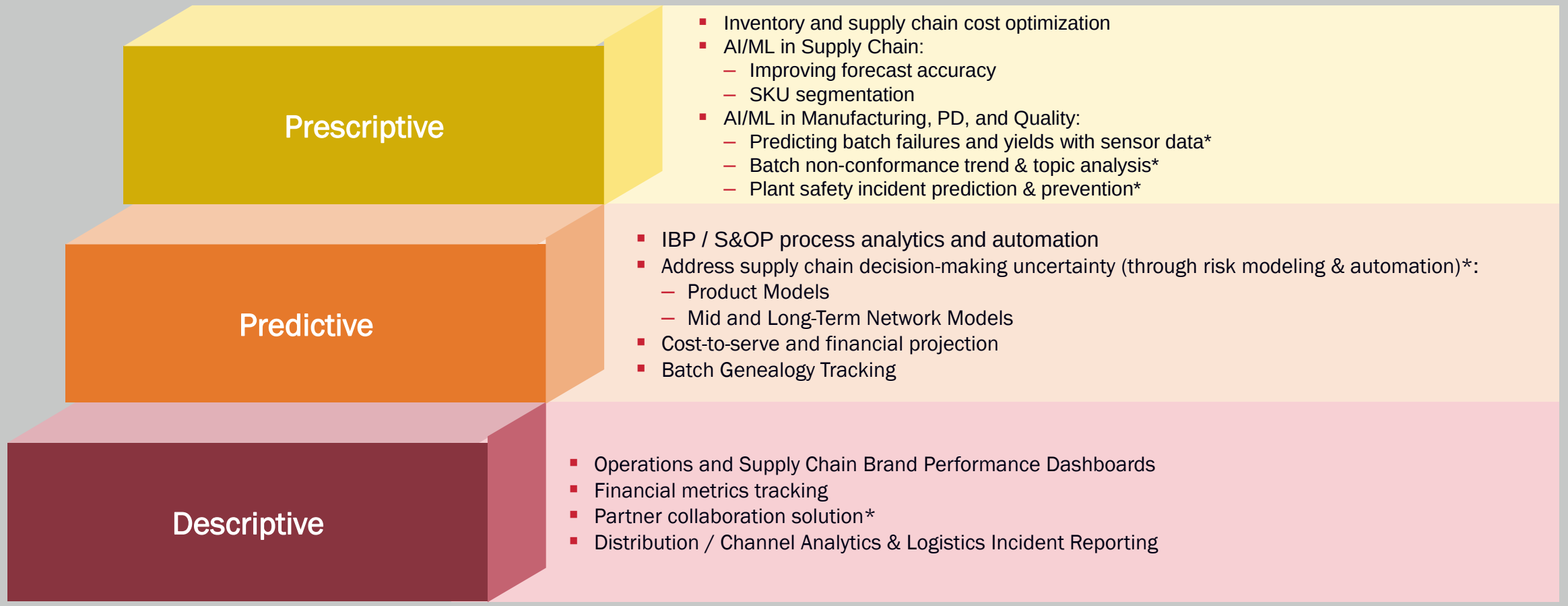
Applications of analytics exist through the spectrum of needs in the supply chain space

Strategy — Supply Chain Framework Design | Make or Buy Analysis | Planning & Program Management



Prescriptive

- Inventory and supply chain cost optimization
- AI/ML in Supply Chain:
  - Improving forecast accuracy
  - SKU segmentation
- AI/ML in Manufacturing, PD, and Quality:
  - Predicting batch failures and yields with sensor data*
  - Batch non-conformance trend & topic analysis*
  - Plant safety incident prediction & prevention*

Predictive

- IBP / S&OP process analytics and automation
- Address supply chain decision-making uncertainty (through risk modeling & automation)*:
  - Product Models
  - Mid and Long-Term Network Models
- Cost-to-serve and financial projection
- Batch Genealogy Tracking

Descriptive

- Operations and Supply Chain Brand Performance Dashboards
- Financial metrics tracking
- Partner collaboration solution*
- Distribution / Channel Analytics & Logistics Incident Reporting

Data Management — Data Integration and MDM | Data Lake | Data Wrangling and Reporting

*Covered in more depth in this document

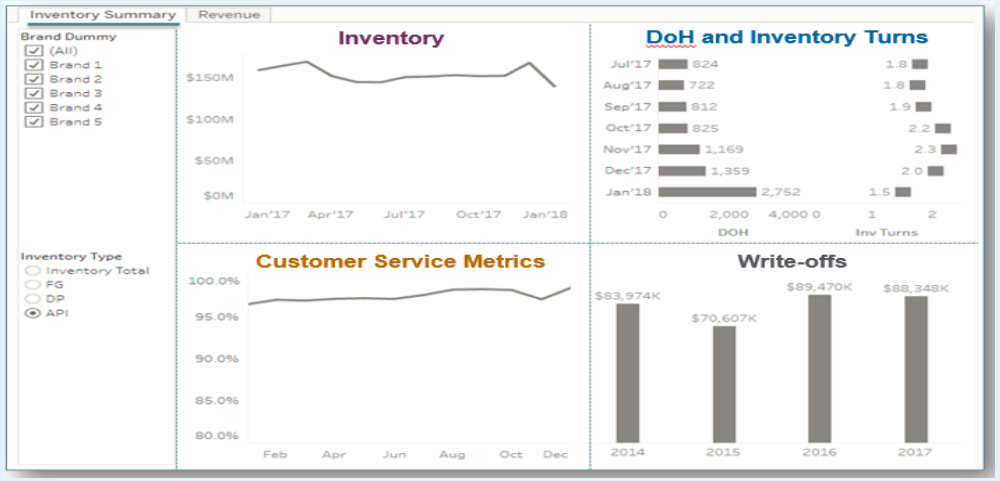
Descriptive Analytics: *Supply Chain Performance Dashboard*

Business Question

- Review supply chain KPI across products portfolio on a monthly cadence
- Unify KPI data and standardize business definition across brands

Approach

Supply Chain Brand Performance Dashboard



- **Mapped and Integrated** multiple data sources
- Involved **UX experts** to design the right experience
- Standardized and integrated KPIs across **finance and supply chain** to provide a holistic overview

Impact

- Empower strategic decisions such as **rationalization** of SKU and **resource allocation**
- Integrate "**alerts**" to prompt the decision makers for right actions
- **Single source of truth** to devise a long term strategy

Learnings

- Key decisions to be made vary considerably across the supply chain operations hierarchy
- Designing the right solution that meets the business needs is critical to successful adoption

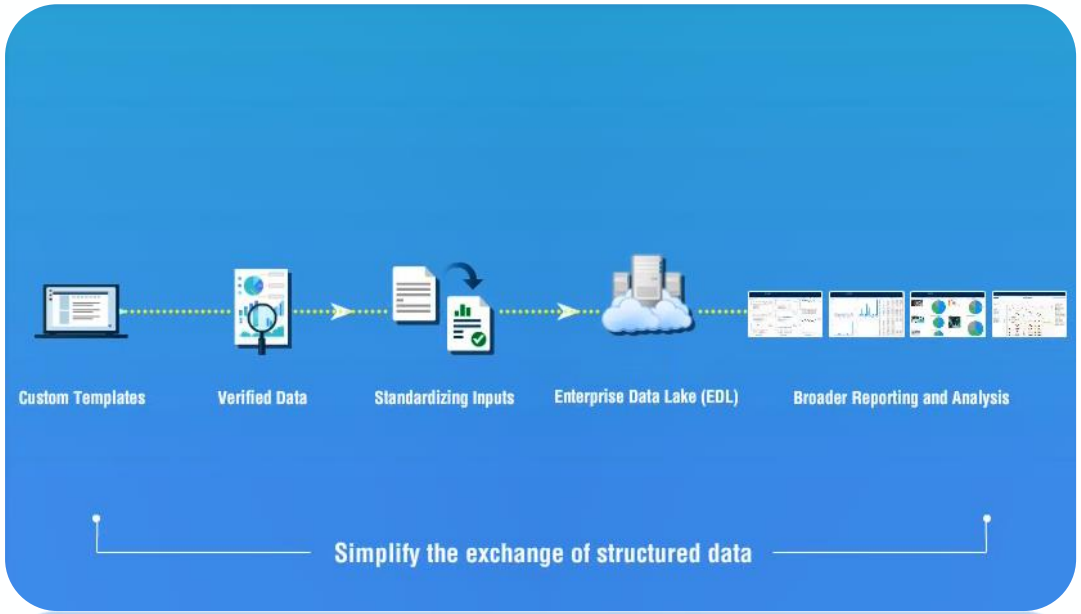
Digital Partner Collaboration (DPC) solution streamlines data acquisition, validation & integration across external partners

Current Challenges

- Disparate Sources following different entry channels
- Traceability of vendor submitted data
- Long approval cycles impacting time & financials
- High degree manual intervention to validate data
- Limited usability of data due to non-standard terms

Outcome

- Single source of data entry and standardized process across vendors
- Customized Data templates for different vendors
- Automated data verification and standardization
- Multi-layer security and audit logging
- Standard reporting and analysis



*Enterprise Data Lake

NC Trending Weak Signals: Clustering Non-conformances to extract trends based on long descriptions

Situation & Objective

Situation – Long descriptions are currently not being used in the process of Trending due to their lengthy nature

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Have a look at this URL ignoring the page margin within the text flow `example.com/donc_oe/longurl` lorem ipsum.

The very strange plugin Java-JDT (*en. Java Development Toolkit*) „Plugin-Entwicklungsumgebung“ – what's wrong with this German word?

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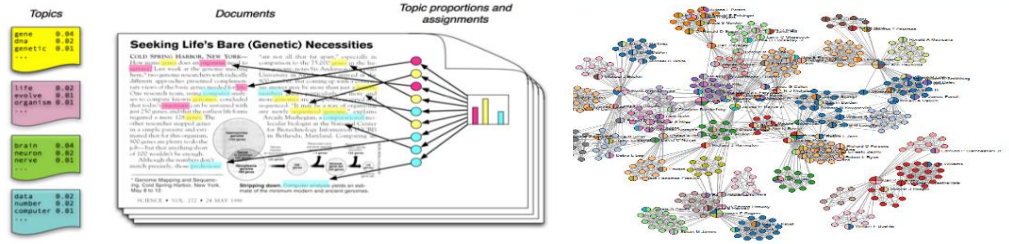
Objective – Automate the analysis of **long descriptions** to better understand the subtle trends within the NC data and Improve accuracy of NC trends by examining the granular details



Vision

- **Enhance the quality of NC trending** by enabling the analysis of granular details
- **Allow exploratory analysis of NCs** though network diagrams
- Analyze how NCs are tie to specific named entities (SOPs, Batches, etc.)

Challenges

- **Heavy textual nature** of long descriptions
- **Unknown expectations** in terms out outcome
- Long descriptions written in **short hand text** with **differences in dialect** across different sites around the world

Approach

- Used **Machine Learning** and **Natural Language processing**
- Explored different **modeling techniques** to ensure relevant and cohesive clusters
- Use **contextual** and **semantic similarities** between NCs for clustering

Impact

- More efficient, effective and informed decision making
- Better analysis of NC's allows for reduction of cycle time enabling faster delivery of medication to clusters and patients
- Domain Dictionaries which can be leveraged by future projects

Prescriptive Analytics: *Early detection of batch non-conformance*

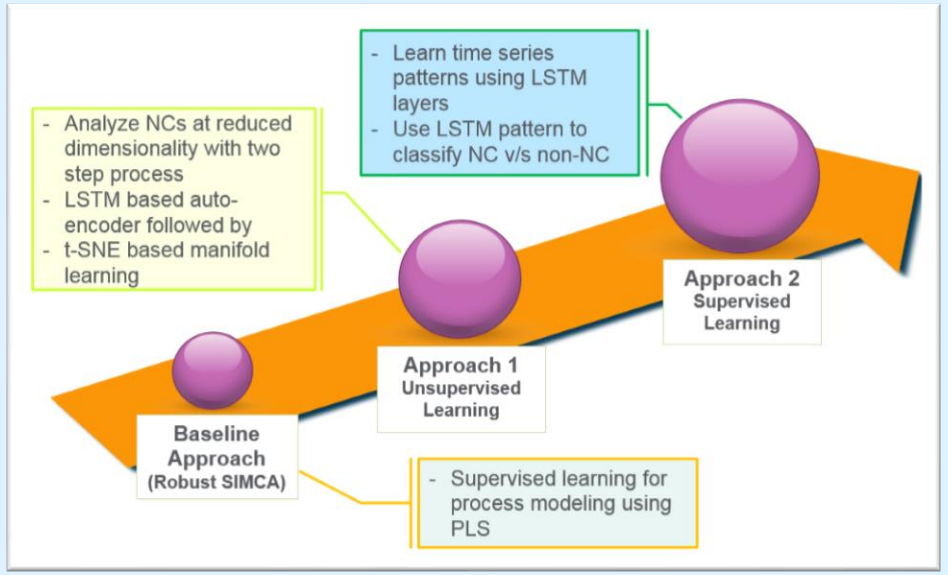
Business Question

- Batch non-conformance was resulting in significant impact to bottom line of a Biopharma manufacturer
- Detailed sensor data was available, monitored and reported but not utilized for any prescriptive analysis

How can sensor data be used to predict batch non-conformance?

Approach

Model Evolution Approach



- **LSTM Deep Learning Classifier** resulted in significantly higher accuracy
- Model design (unsupervised and supervised learning) was set up and evolved to improve the prediction accuracy

Impact

75-90% overall accuracy,

- False positives indicate an opportunity to tighten quality control protocols further

Learnings

- Real-time alerts on the shop floor could be setup to flag the 'risk'
- Model can be further enriched with inspector comments using NLP techniques to enable predictive maintenance

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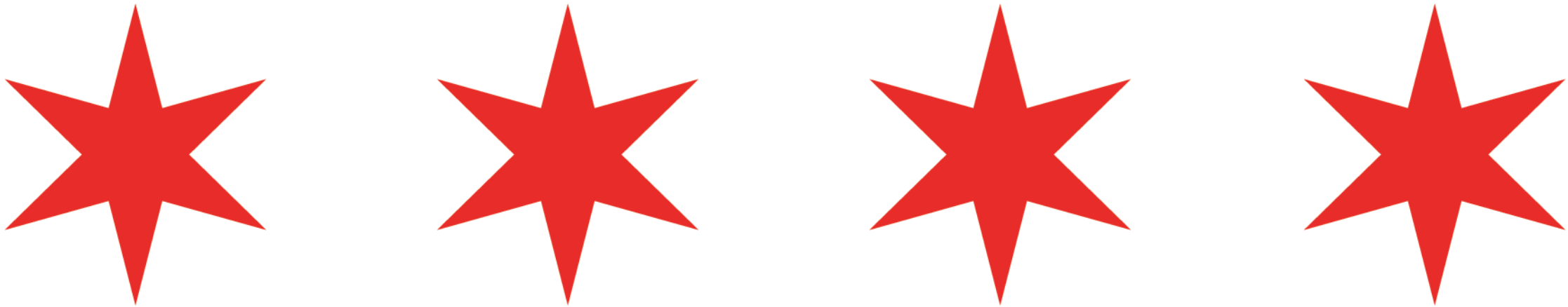

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