# Analyzing, Rationalizing and Optimizing the Inventory/Risk Trade-off in Biopharmaceutical Supply Chains

## Project # UCB11-RISK

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## Motivation

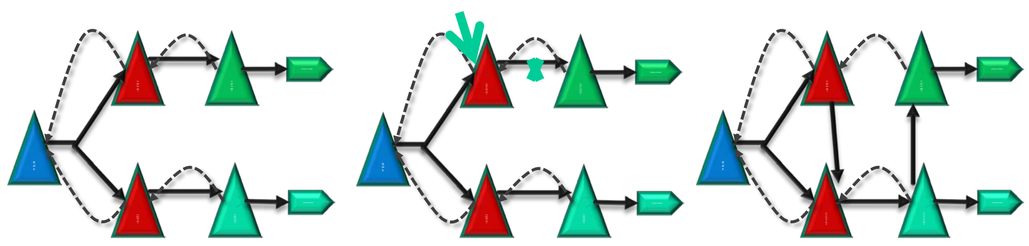
**Customer service level is crucial** to pharmaceutical firms because stock-outs can cost lives.

Maintaining high service levels is particularly **difficult due to uncertainties** in yields, raw material supply, quality control tests, and demand.

Most firms have developed **ad hoc strategies** to deal with supply chain disruptions. These strategies utilize backup production capacity, alternative warehouse sites, and safety stocks of WIP and finished goods to maintain customer service levels during disruptions.

**Our goal is to develop a tool to**:

- **Efficiently model** the dynamics and uncertainties of the supply chain in the presence of disruption risks.
- **Optimize policy parameters** so that operating costs are minimized but customer service levels can be maintained during disruptions.
- **Quantify the tradeoff** between costs and service levels.



## Expected Results

New **techniques to optimize** inventory placement in supply chains for **efficient day-to-day operations and effective risk mitigation**.

**Interactive** models that are **customized** for each of our industrial research partners in order to:

- **Model** both the **daily operations** of the corresponding supply chain accounting for variability, and the **dynamic impact of supply chain disruptions** when interactively triggered in the model.
- **Optimize** supply-chain-wide **inventory levels** to minimize inventory holding costs and maintain service levels.
- **Determine** the most cost effective supply chain **operating parameters** for a given required customer service level and disruption risk coverage.
- **Generate** a **three-dimensional efficient frontier graph** that explicitly visualizes the cost/customer service/disruption-risk-coverage tradeoff.

**Computerized implementations** of these models with a graphical user interface that allows a user to specify:

- "Triage" strategies in case of supply chain disruption.
- Inventory policy.
- Demands, yield, lead times, and production scheduling data.

**A tool that quantifies the tradeoff between operating cost and customer service level while determining optimal parameters for supply chain risk mitigation strategies.**

## Details

We use **time series analysis** to capture demand risk, lead time of production processes and random production yields.

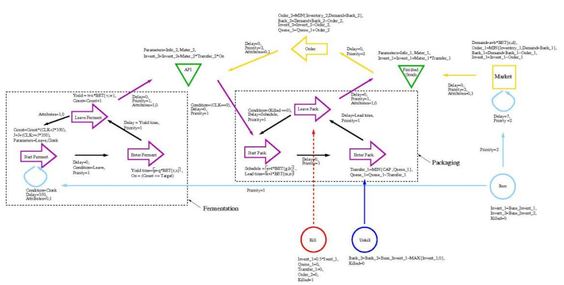
We **model information and material flows** to capture the dynamics and the "triage" strategies in case of supply chain disruptions and recoveries.

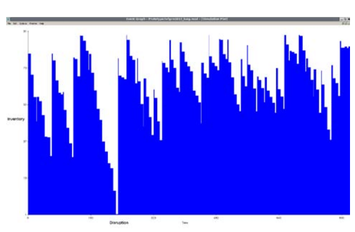
We are developing retrospective optimization algorithms that use integer programs to optimize operational supply chain decisions along randomly generated supply chain sample paths:

- We answer the question: **What if we could look into the future, see what demands, yields, etc., are, and pick the best set of parameters?**

We are analyzing convergence properties of our retrospective optimization model on disrupted supply chains to determine the appropriate **horizon length for the simulated data**, and **the appropriate frequency of disruption events** on the sample path.

We are developing **algorithms to translate** pictorial or verbal descriptions of supply chain networks into simulation-retrospective optimization models.



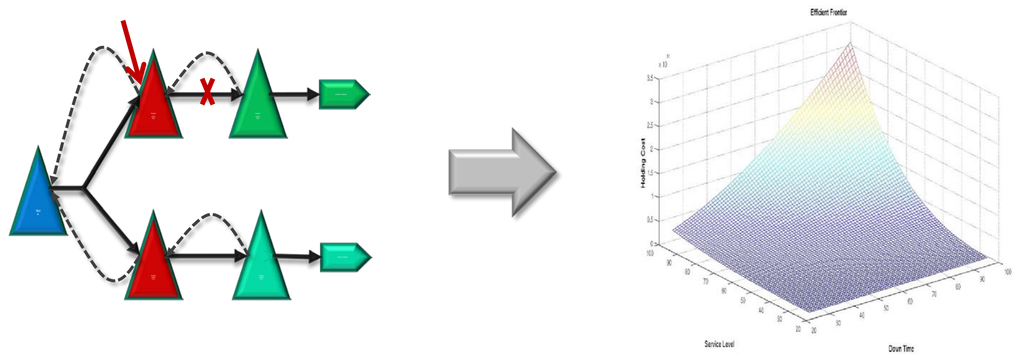


## Broader Applicability

Although the current focus of our project is on biopharmaceutical supply chains, our approaches and software can be **used to optimize risk mitigation strategies in any dynamically changing supply chain** environment.

Our tools can be used by any firm with a geographically distributed supply chain to **understand the relationship between inventory levels and risk mitigation**.

Our retrospective optimization algorithms generate quantitative solutions that help firms with complex supply chains to manage the **tradeoff between day-to-day operational costs and strategic risk mitigation** through effective inventory strategies.

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