

Real-World Optimization Problems: The Flexport Challenge

Learn to solve million-dollar logistics problems with Excel, then turbocharge with AI

Problem 1: The Container Loading Crisis

You're the ops manager at FastShip Logistics. It's Black Friday week, and you've got chaos.

The Scenario

You manage a distribution center handling packages for 15 major retailers. Each day, you need to:

- Load 500 packages into 20 trucks
- Each truck has different capacity (weight AND volume limits)
- Some packages are fragile, some need refrigeration, some are urgent
- Delivery windows vary (4-hour to next-day)
- Driver overtime kicks in after 8 hours

The Real Pain: Your best dispatcher, Maria, just called in sick. She usually takes 3 hours to plan the daily routes. You have 30 minutes.

Part A: Excel Foundation (What Maria Does)

Build a spreadsheet that:

1. Lists all packages with attributes (weight, volume, priority, destination zone)
2. Creates a truck assignment matrix
3. Calculates utilization for each truck
4. Tracks total distance and estimated delivery time

Key Excel Skills:

- SUMIFS for capacity tracking
- INDEX/MATCH for zone lookups
- Conditional formatting to flag overloaded trucks
- Solver for basic optimization

Part B: The AI Transformation

Now let's do what Flexport does - use AI to find patterns humans miss.

Prompt Engineering Exercise:

You'll give ChatGPT/Claude this prompt:
"I have 500 packages with the following attributes [paste your data].
I have 20 trucks with these constraints [paste constraints].
Optimize for: 1) Minimize total miles, 2) Meet all delivery windows, 3) Keep driver hours under 8.
Give me the truck assignments in a format I can paste back into Excel."

Part C: The Comparison

- Maria's method: 85% truck utilization, 1,200 total miles
- Your Excel Solver: 88% utilization, 1,100 miles
- AI optimization: 94% utilization, 980 miles
- **Annual savings at scale: \$2.3 million**

Discussion Questions:

1. Why did AI beat Excel Solver? (It considered package combinations Solver didn't test)
2. What domain knowledge did YOU need to set this up properly?

3. Could AI have done this without your problem framing?

Problem 2: The Cross-Docking Puzzle

Welcome to the nightmare every logistics company faces daily.

The Scenario

You're managing cross-docking operations where:

- 50 inbound trucks arrive throughout the day
- Each carries mixed shipments for 30+ destinations
- You have 10 dock doors
- Products can't sit on the dock more than 2 hours (spoilage/theft risk)
- Some shipments can consolidate, others can't mix

The Real Pain: Yesterday, you had 3 trucks waiting 90 minutes for dock space while 2 docks sat empty. Customer complaints are flooding in.

Part A: Excel Foundation

Create a dock scheduling system:

1. Gantt chart showing dock utilization
2. Inbound/outbound matching matrix
3. Wait time calculator
4. Consolidation opportunity finder

Advanced Excel Techniques:

- Pivot tables for throughput analysis
- VLOOKUP arrays for matching shipments
- Macro to simulate different scheduling rules
- Dashboard showing real-time KPIs

Part B: AI-Powered Scheduling

Transform your static schedule into a dynamic AI system.

The AI Approach:

```
python
# Pseudocode for students to understand the logic
For each incoming truck:
  - AI predicts actual arrival time (using traffic, weather, driver history)
  - AI identifies optimal dock based on:
    * Current occupancy
    * Upcoming scheduled arrivals
    * Consolidation opportunities with current dock contents
    * Outbound truck schedules
  - AI suggests dock assignment and duration
  - System updates every 5 minutes with new data
```

GenAI Prompt Template:

```
"Here's my current dock status [paste data].
Incoming trucks: [paste schedule].
Constraints: No dock time >2 hours, these items can't mix [list].
Find the optimal dock assignments that minimize total wait time and maximize consolidation opportunities."
```

Part C: The Results

- Manual scheduling: 65% dock utilization, 45 min average wait

- Excel optimization: 78% utilization, 28 min wait
 - AI dynamic scheduling: 91% utilization, 12 min wait
 - **Weekly savings: 320 labor hours, \$45,000 in detention fees**
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Problem 3: The International Routing Challenge

This is Flexport's bread and butter - and your final boss battle.

The Scenario

You're shipping electronics from Shenzhen to 25 US cities:

- Sea freight: \$800/container, 30 days
- Air freight: \$8000/container, 3 days
- Rail + truck: \$2000/container, 18 days
- Each route has different reliability (60-95% on-time)
- Inventory holding costs: \$50/unit/day
- Stockout penalty: \$500/unit/day
- Demand varies by city (predictable + random components)

Part A: Excel Foundation

Build a multi-modal optimization model:

1. Cost calculator for each mode/route combination
2. Reliability-adjusted lead times
3. Safety stock calculator based on variability
4. Total cost of ownership model

Complex Excel Features:

- Monte Carlo simulation for demand uncertainty
- Scenario manager for different strategies
- Risk assessment matrix
- Seasonal adjustment factors

Part B: The AI Revolution

This is where AI truly shines - handling thousands of variables simultaneously.

Multi-Agent AI System:

Agent 1 (Demand AI): Predicts demand for each city using:

- Historical patterns
- Social media trending data
- Economic indicators
- Competitor behavior

Agent 2 (Route AI): Optimizes routing considering:

- Real-time capacity on each mode
- Current port congestion
- Weather patterns
- Geopolitical risks

Agent 3 (Inventory AI): Balances stock levels:

- Minimizes holding costs
- Prevents stockouts
- Considers product lifecycle
- Handles substitutable products

Master Prompt for Integration:

"I need to ship electronics worth \$10M from Shenzhen to 25 US cities.
Here's my demand forecast [paste], current shipping rates [paste], and reliability data [paste].
Create an optimal shipping plan that:

1. Minimizes total landed cost
2. Maintains 95% service level
3. Considers these constraints [list]

Show me the split between air/sea/rail and timing for each city."

Part C: The Bottom Line

- Human planner: \$2.8M total cost, 89% service level
 - Excel optimizer: \$2.3M cost, 92% service level
 - AI system: \$1.9M cost, 96% service level
 - **Annual impact: \$10.8M savings, 7% service improvement**
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Problem 4: The Last-Mile Delivery Dance

The most expensive and complex part of any shipment.

The Scenario

You're running last-mile delivery for an e-commerce giant:

- 300 daily deliveries across the city
- 15 drivers with different skill levels
- Time windows: some flexible, some rigid
- Traffic patterns change hourly
- Customer not home? Need redelivery strategy
- Some packages need signatures, others don't

Part A: Excel Foundation

Design a route optimization system:

1. Distance matrix between all delivery points
2. Driver skill scoring system
3. Time window compliance tracker
4. Cost per delivery calculator

Excel Techniques:

- Google Maps API integration for real distances
- Clustering analysis for zone creation
- Linear programming for route optimization
- Performance dashboard with KPIs

Part B: AI That Learns and Adapts

Your AI system gets smarter every day.

Machine Learning Components:

Historical Learning:

- Which customers are usually home when
- Real delivery times vs estimates
- Driver performance patterns
- Traffic patterns by time/day

Real-time Adaptation:

- Reroute based on current traffic
- Predict no-shows before arriving
- Dynamically batch nearby deliveries
- Suggest optimal delivery sequence

Prompt for Route Optimization:

"I have 300 deliveries today with these addresses [paste] and time windows [paste].
My 15 drivers start from [location] and have worked [X] hours already this week.
Current traffic shows [paste traffic data].
Create optimized routes that:
- Minimize total distance
- Meet 95% of time windows
- Balance driver workload
- Keep routes under 8 hours
Format the output as driver assignments I can upload to our routing app."

Part C: The Performance Leap

- Manual routing: 18 deliveries/driver/day, 78% on-time
- Excel optimization: 22 deliveries/driver/day, 85% on-time
- AI dynamic routing: 28 deliveries/driver/day, 94% on-time
- **Daily impact: \$3,000 saved, 60 fewer customer complaints**

The Meta-Lesson: Why Domain Knowledge Still Matters

What AI Can't Do (Yet):

1. **Understand unstated constraints** - You know drivers hate that one neighborhood
2. **Navigate politics** - The warehouse manager and transport head don't talk
3. **Handle true black swans** - When the Suez Canal gets blocked by a ship
4. **Make ethical trade-offs** - Prioritizing medicine over electronics
5. **Explain decisions to angry customers** - AI can optimize, but you do the talking

What You Learn from Excel:

1. **The underlying math** - You can't audit what you don't understand
2. **Where AI might fail** - You recognize impossible solutions
3. **How to frame problems** - AI needs good questions
4. **Constraint identification** - You know what rules can bend
5. **Sanity checking** - When AI says ship everything by air, you know to dig deeper

The Winning Formula:

Domain Knowledge + Excel Fundamentals + AI Tools = Logistics Superhero

You're not competing with AI. You're conducting an orchestra where AI plays every instrument, but you're the only one who knows what song the audience wants to hear.

Homework Challenge: Build Your Own Flexport

The Assignment:

1. **Pick a real local business** (restaurant, retail store, service company)
2. **Identify ONE optimization problem** they face daily
3. **Build an Excel model** that captures the problem (even if simplified)
4. **Create an AI prompt** that could solve it better
5. **Calculate potential savings** (even rough estimates)
6. **Present to class:** "How I'd save [business] \$[amount] per year"

Grading Rubric:

- Problem identification (20%) - Is it real and painful?
- Excel model quality (30%) - Does it capture key constraints?
- AI prompt engineering (30%) - Clear, specific, actionable?
- Business impact (20%) - Realistic savings calculation?

Bonus Points:

- Actually talk to the business owner
 - Get real data (anonymized)
 - Build a working prototype
 - Show before/after comparison
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Resources for Deep Dive

Excel Templates Provided:

1. Basic route optimizer
2. Inventory balance calculator
3. Dock scheduling Gantt
4. Multi-modal cost comparison
5. KPI dashboard template

AI Prompt Library:

- 20 tested prompts for common scenarios
- Tips for data formatting
- Common pitfalls to avoid
- How to validate AI outputs

Reading List:

- "How Flexport Uses AI" (case study)
- "The Last Mile Problem" (MIT article)
- "When Algorithms Fail" (cautionary tales)
- "Excel to AI Pipeline" (technical guide)

Remember: Every Amazon package, every Uber ride, every DoorDash delivery uses these exact concepts. You're not learning abstract theory - you're learning how the modern world actually works.