Automated Coil Nesting & Slitting Optimization

Overview

Norfolk Iron & Metal (NIM) is a leading steel distributor and service center operating across the United States. The company specializes in processing and distributing a wide range of carbon steel products, including value-added services such as coil slitting and cut-to-length processing. These services allow customers to receive steel in precise dimensions tailored to their manufacturing needs.

With the continued growth of NIM's customer portal, the company is increasingly enabling customers to quote and order material digitally. While pricing and quoting for processed materials (such as slit coil and cut-to-length) are now available through the portal, downstream operational processes remain partially manual.

One of the most critical of these processes is **coil nesting**, where customer orders are grouped and optimized into production runs. Today, this process requires significant manual effort and relies on experienced operators to balance competing constraints such as scrap minimization, machine setup time, and delivery deadlines.

As portal-driven order volume increases, manual nesting becomes a bottleneck that limits scalability, consistency, and speed of fulfillment.

Key Context

- Coil slitting and cut-to-length operations require grouping multiple orders into efficient production "nests."
- Nesting decisions directly impact:
    - Material yield (scrap)
    - Machine efficiency (knife changes, setup time)
    - On-time delivery performance
- Slitting operations require **arbor layouts**, which define knife positioning for each run.
- Existing nesting processes are:
    - Manual and time-intensive
    - Dependent on individual expertise
    - Difficult to scale with increasing order volume
- Portal adoption is increasing demand for **end-to-end automation**, from quote → order → production.

Problem Statement

NIM currently lacks a standardized, automated system for coil nesting and slitting optimization. While orders can be generated digitally through the customer portal, the transformation of those orders into executable production plans requires manual intervention.

There is no centralized system that:

- Matches incoming orders against existing inventory and scheduled production runs
- Optimizes nesting decisions across multiple competing constraints
- Automatically generates slitting patterns and arbor layouts
- Produces production-ready work orders aligned with operational capacity and due dates

This results in inefficiencies, inconsistent decision-making, and limited ability to scale operations alongside growing digital demand.

Goal

Build an automated nesting and optimization system that converts incoming orders, inventory data, and production constraints into executable coil slitting and cut-to-length production plans.

Objectives

Order & Inventory Matching Engine

- Ingest customer orders, inventory availability, and existing scheduled nests
- Match and group compatible orders based on:
    - Material type, thickness, width
    - Due dates
    - Processing requirements

Constraint-Based Optimization Engine

- Design and implement an optimization engine that generates nesting plans subject to:
    - Machine constraints (width limits, knife configurations)

    - Inventory availability
    - Order requirements and tolerances
    - Production scheduling constraints

Slitting Pattern Generation

- Automatically generate optimal slitting patterns for coil processing
- Determine:
    - Number of cuts
    - Width allocations
    - Residual scrap

Arbor Layout Generation (Slitting Only)

- Translate slitting patterns into **machine-executable arbor layouts**
- Optimize for:
    - Minimal knife changes between runs
    - Operational feasibility

Multi-Objective Optimization

- Design the system to balance multiple competing objectives:
    - Minimize material scrap
    - Minimize knife/setup changes (slitting)
    - Meet customer due dates
    - Balance machine utilization and throughput

Production Output Generation

- Generate production-ready outputs including:
    - Work orders
    - Nest groupings
    - Slitting instructions
    - Arbor layouts (slitting only)

System Design & Integration

- Structure the solution as a system that can:
    - Accept new orders dynamically
    - Recompute nesting decisions as conditions change
    - Integrate with existing ERP or portal workflows (conceptually)

Data Sources

- **Customer Orders (Portal / Internal Systems):**
    - Material specs, dimensions, quantities, due dates
- **Inventory Data:**
    - Available coils, dimensions, locations
- **Production Constraints:**
    - Machine capabilities (min/max widths, knife limits)
    - Setup times and operational rules

Most of this will be available through the outputs of our Service Network Optimization model. More info on this when we begin the project.

Desired Deliverables

1. **Optimization Engine (Core System)**

- System implementing nesting and optimization logic
- Modular architecture for matching, optimization, and output generation

2. **Slitting & Nesting Output Generator**

- Automated generation of:
    - Slitting patterns
    - Arbor layouts
    - Work orders

3. **Simulation & Testing Framework**

- Ability to test system performance across different scenarios:
- Varying order volumes
- Inventory constraints
- Scheduling conditions

4. **Visualization / Interface (Lightweight)**

- Simple interface or dashboard to:
    - View nesting decisions
    - Inspect scrap, utilization, and efficiency metrics

5. **Documentation & System Design**

- Clear documentation including:

- Architecture diagrams
- Assumptions and constraints
- Instructions for extending or integrating the system

Areas of Strategic Impact for NIM

This system enables Norfolk Iron & Metal to fully automate one of the most complex operational steps in its value chain. By removing manual bottlenecks in nesting and slitting, the company can scale its customer portal into a true end-to-end digital platform.

Automated nesting improves material efficiency, reduces operational variability, and ensures consistent decision-making across facilities. It also positions NIM to handle increased order volume without proportional increases in labor, directly supporting growth and margin expansion.

Glossary

Coil Nesting: The process of grouping and arranging multiple orders into a single production run to maximize material utilization.

Slitting: Cutting a wide steel coil into multiple narrower coils.

Arbor Layout: The configuration of knives and spacers on a slitting machine used to achieve a specific cutting pattern.

Scrap: Material that cannot be used to fulfill customer orders after processing.