C3.ai

Enterprise AI for Demand Forecasting and Production Scheduling

A global agribusiness and food manufacturer produces, distributes, and markets grains, meat and poultry, food ingredients such as starch and other key agricultural commodities. The company has a broad product portfolio and operates in over 120 countries. The company's top priority is to ensure its manufacturing operations can run efficiently by accurately forecasting demand to inform production plans and schedules.

Food manufacturing is a sophisticated process. Accurate demand and production planning is highly critical as raw materials and finished food products have limited shelf life. Manufacturers are constantly challenged by short lead times, last minute order changes, and strict regulatory requirements (e.g., ensuring workers have sufficient time to clean production line equipment). Potential inaccuracies in demand forecasts and suboptimal production schedules can lead to unfulfilled customer orders or excess production and waste.

Prior to engaging C3 AI, the global food manufacturer lacked an effective approach to forecast customer demand accurately for its primary beef manufacturing location. The legacy forecasting solution

relied on common statistical approaches using limited data (only historical shipments) that fell short in addressing the highly variable demand. Additionally, the company's existing scheduling solution lacked an optimization capability, was unable to account for uncertainties, and didn't provide scenario analysis capabilities. The legacy scheduling solution required ninety minutes to generate an inflexible schedule that quickly became outdated as demand forecasts changed.

Over the span of 16 weeks, the C3 AI team configured two applications for the global food manufacturer: C3 AI Demand Forecasting and C3 AI Production Schedule Optimization to improve demand and production planning. With C3 AI Demand Forecasting, the company was able to generate daily demand plans for the first time and improve forecast accuracy by leveraging new data sources. Using the optimal schedules generated by C3 AI Production Schedule Optimization, the company was able to improve fill rates, reduce transition times, reduce manual work for schedulers, and improve decision making by allowing users to compare scenarios based on changing business priorities.

Project Objectives

- Integrate and unify data from 18 disparate data sources (e.g., weekly demand forecasts, manufacturing specifications, material master data, shipping documents, inventory levels)
- Apply machine learning algorithms to generate daily demand forecasts from the customer's weekly demand forecast
- Apply optimization algorithm to generate production schedules by line and by shift
- Configure the C3 AI Demand Forecasting and C3 AI Production Scheduling Optimization user interfaces to expose AI insights

Results

$30M

in additional gross margin identified from increased order fill rate

8%

uplift in demand forecast accuracy

$1.5M

in additional savings identified from reduction in changeovers

96%

reduction in time and effort required to generate schedules

Challenges

The food processing plant operates 8 production lines, produces over 80 million pounds of food products per year across 90+ product codes and various raw materials. The protein plant's only customer — a global retailer — exhibited highly variable demand that resulted in gaps with the manufacturer's weekly demand forecast.

The company had attempted to address forecasting challenges using traditional demand forecasting solutions that relied on statistical algorithms that typically generated a demand forecasts every week. However, given short shelf life of food products, customer sales orders were sent to the plant with little lead time, sometimes on a daily basis. When these sales orders deviated from the forecast, demand planners lacked the time to modify the active demand forecasts and the downstream production schedules that lead to unfulfilled customer orders.

The company also procured traditional rule-based solutions to improve production scheduling. However, the following challenges continued to impact their ability to optimize schedules:

- The traditional solutions relied on user configured rules to generate schedules. It lacked the ability to account for uncertainties and constraints to generate an optimal schedule.

- Adjusting a manufacturing schedule was a heavily manual and time-consuming effort, consuming up to 90 minutes per production line schedule.

- Legacy systems lacked the ability for users to generate and compare different schedules based on different input parameters (e.g., simulating a labor shortage, an unexpected decline in demand).

Consequently, traditional demand forecasting and scheduling solutions failed to significantly improve manufacturing operations. To address these challenges, the global food manufacturer decided to configure the C3 AI Demand Forecasting and C3 AI Production Schedule Optimization applications.
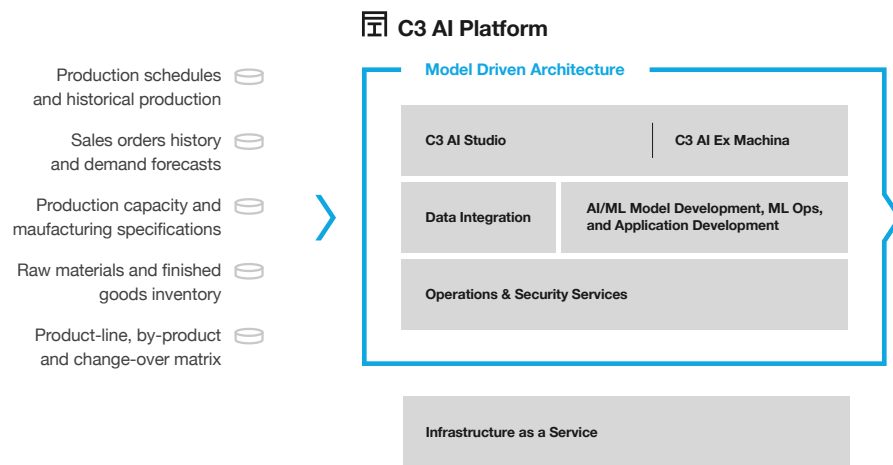
About the Company

- $100+ billion in annual revenue in 2020

- ~1400 manufacturing and distribution sites worldwide

- 150,000+ employees
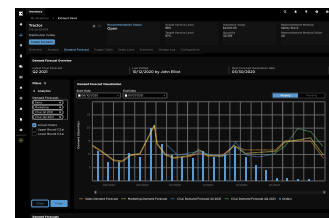
- 120+ countries of operation

Project Highlights

- Unified 72M rows of data for 88 product codes with 44 raw materials in 8 production lines

- Configured the proprietary C3 AI neural network to generate daily demand forecasts 21-days into the future with an 8% uplift in accuracy

- Configured scheduling optimizer to recommend a production plan by shift over a rolling 14-day schedule

- Exposed unified data and AI insights in 5 configurable user interfaces screens across C3 AI Demand Forecasting and C3 AI Production Schedule Optimization

- Demonstrated economic value in only 16 weeks with clear deployment roadmap to scale to over 30 manufacturing plants
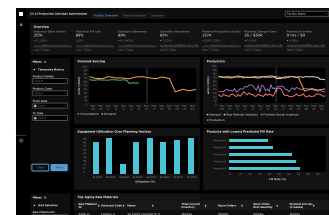
Solution Architecture

Production schedules and historical production

Sales orders history and demand forecasts

Production capacity and maufacturing specifications

Raw materials and finished goods inventory

Product-line, by-product and change-over matrix

C3 AI Platform

Model Driven Architecture

C3 AI Studio	C3 AI Ex Machina
Data Integration	AI/ML Model Development, ML Ops, and Application Development
Operations & Security Services	

Infrastructure as a Service

C3 AI Demand Forecasting

C3 AI Production Schedule Optimization

Approach

Over 16 weeks, four C3 AI team members configured the C3 AI Demand Forecasting and C3 AI Production Schedule Optimization applications for the company's key food processing plants in North America.

The team began by ingesting, cleansing, and unifying 18 different data sources that included historical demand forecasts, order history data, production history, manufacturing specifications and historical inventory levels, comprising of 72 million rows of data. The unified federated data image enabled the company to train and configure the C3 AI Demand Forecasting and C3 AI Production Schedule Optimization algorithms and applications.

During the project, the C3 AI team followed a four-step approach to configure C3 AI Demand Forecasting.

- Identified key data sets and generated the relevant machine learning model features

- Trained and tested various types of machine learning approaches with varying architecture by tuning hyperparameters and generating new features

- Selected a proprietary disaggregation neural network (C3 AI patent pending) as the best performing model that enables the breakdown of weekly forecasts into daily

- Presented the results against the customer's baseline forecast with an 8 percentage improvement in accuracy and provided over four evidence packages

To generate optimal production schedules, the C3 AI team then configured C3 AI Production Schedule Optimization across the following steps.

- Documented all constraints related to the facility

- Defined the objective function in C3 AI Production Schedule Optimization based on key customer KPIs

- Generated production schedules with different time horizons (e.g., 2 days, 7 days, 14 days) and obtained feedback from the scheduling team and other supply chain experts

- Calibrated the optimization algorithm and achieved a 98% OTIF (a 2% improvement over baseline) with improved resource use and decreased production costs.

- Configured the scenario workflows to enable schedulers to run unlimited schedules based on changing constraints and landscape (e.g., reduced labor online, changes in beginning inventory balances, reduced line time)

C3 AI Production Schedule Optimization automatically generates schedules based on the latest available data and enables schedulers to reduce the time to generate schedules by 96%.

Finally, the C3 AI team configured the user interface across both C3 AI Demand Forecasting and C3 AI Production Schedule Optimization that enables users to view critical manufacturing KPIs (e.g., fill rate, schedule adherence, planned production volume), identify KPIs at risk, evaluate and approve AI-recommendations, and develop multiple scenarios by tuning inputs into the scheduling algorithm.
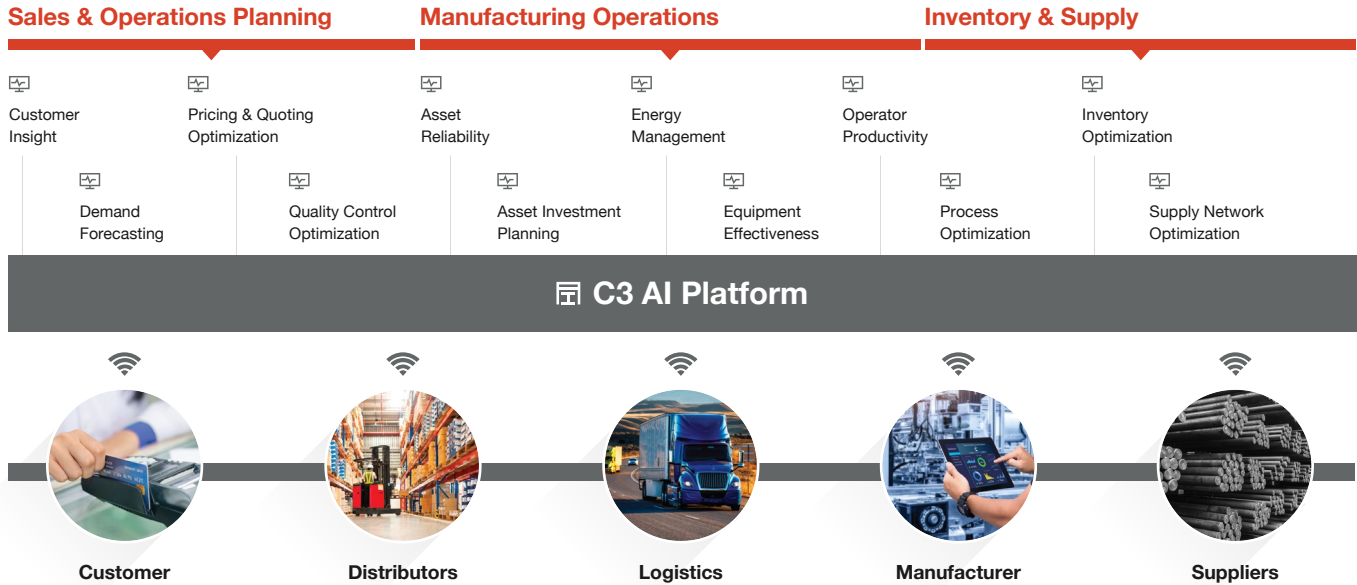
Benefits

By using C3 AI Demand Forecasting and C3 AI Production Schedule Optimization, the global food manufacturer company is able to:

- Improved demand forecasting accuracy by 8 percentage points and improved the frequency of forecasting by 7x

- Improved end-customer satisfaction by increasing OTIF by 2 percentage points leading to ~$1M in gross margin per facility, ~$30M in gross margin when scaled out across customer's other manufacturing sites

- Reduced transition costs by 3% and overtime by 2%, leading to ~$0.05M in savings per plant, and an estimated ~$1.5M in savings across all manufacturing sites after scaling

- Reduced the time and effort to generate schedules by 96% from 90 minutes to 3.5 minutes per schedule

- Leveraged the supply chain digital twin underpinning C3 AI Demand Forecasting and C3 AI Production Schedule Optimization to explore additional supply chain use cases

Enterprise AI for Manufacturing

The C3 AI Platform provides the necessary, comprehensive services to build enterprise-scale AI applications up to 25x faster than alternative approaches. The C3 AI Platform uses all relevant data sources to rapidly generate predictive insights, enhance grid asset management and forecasting systems, boost energy efficiency initiatives, and enrich customer engagement. Many of the largest global utilities are already using the C3 AI Platform to drive their digital transformation efforts, generating hundreds of millions of dollars in economic value annually.

Sales & Operations Planning		Manufacturing Operations			Inventory & Supply
Customer Insight	Pricing & Quoting Optimization	Asset Reliability	Energy Management	Operator Productivity	Inventory Optimization
Demand Forecasting	Quality Control Optimization	Asset Investment Planning	Equipment Effectiveness	Process Optimization	Supply Network Optimization

▤ C3 AI Platform

Customer	Distributors	Logistics	Manufacturer	Suppliers

C3 AI manufacturing applications are built on the C3 AI Platform and use AI at scale to provide ever-smarter actionable insights for business-critical challenges. These applications include:

C3 AI Reliability

Increase operations, process, and equipment uptime and reduce unplanned downtime through AI-based early identification and prioritization of high-risk conditions. Apply advanced machine learning models to unified asset and operational data to identify anomalies, raise alerts, and generate prescriptive actions. Actionable insights increase production, reduce unplanned downtime, and improve safety in operations.

C3 AI Inventory Optimization

Reduce inventory holding costs, improve cash flow and supply chain visibility, and increase the productivity of inventory analysts. C3 AI Inventory Optimization uses advanced machine learning to analyze variability in demand, supplier delivery times, quality issues, and product line disruptions to build real-time recommendations for users to optimize operations by confidence level and receive real-time notifications and root cause analysis.

C3 AI Production Schedule Optimization

Optimize planning and scheduling across manufacturing and distribution operations using advanced AI and machine learning. C3 AI Production Schedule Optimization generates dynamic manufacturing and distribution plans and optimal industrial schedules using a holistic view of customer demand, supply chain, manufacturing, and distribution.

C3 AI CRM for Manufacturing

Grow revenues, maximize customer lifetime value, prevent customer churn, and increase customer satisfaction. C3 AI CRM for Manufacturing unifies all available enterprise and extraprise data and uses advanced machine learning algorithms to prioritize leads, recommend new product offers, detect clients at risk of churn, and drive more accurate revenue and product forecasts.

C3 AI Process Optimization

Improve product quality, operational efficiency, and overall yield across batch or continuous processes by applying advanced machine learning models on top of unified process and operational data to identify risk drivers and generate contextualized alerts and actionable insights to drive interventions.

C3 AI Sustainability for Manufacturing

Achieve end-to-end sustainability management with comprehensive energy, water, waste, and greenhouse gas emissions monitoring for tracking and prediction at every level of manufacturing. Apply advanced AI to measure and reduce product carbon footprints, unlock energy savings, enable emissions reduction strategies, create alerts for efficiency degradation and emissions anomalies, and forecast progress against sustainability goals.

Proven Results in 8-12 Weeks | Visit c3.ai/get-started