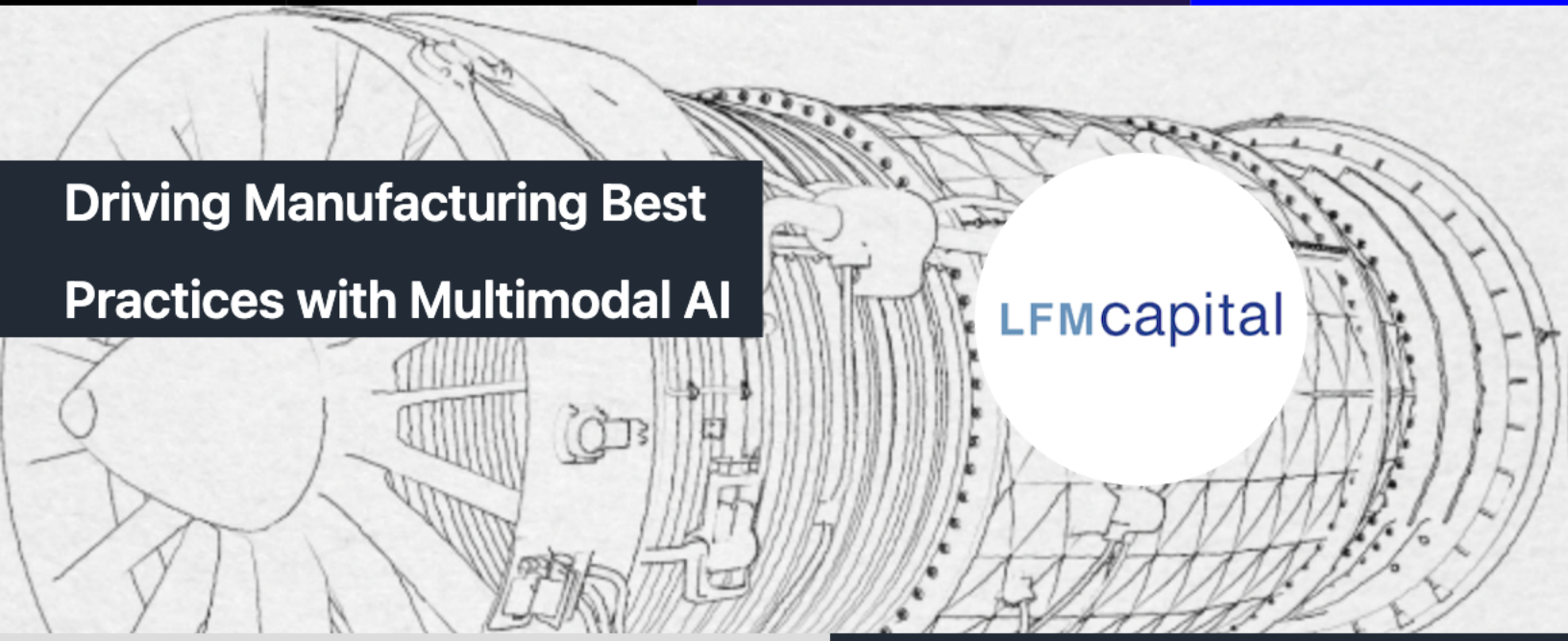
Engineering | Aerospace and Defense | Digital standard work / training | K-nearest neighbors



Driving Manufacturing Best Practices with Multimodal AI

LFMcapital

BUSINESS PROBLEM

The main problem is inconsistent quoting and engineering processes in contract manufacturing. Quoting relies heavily on individual estimator experience, causing significant variations that affect profitability and customer satisfaction. Engineers plan manufacturing processes from scratch for new projects despite having produced similar components previously, creating bottlenecks and preventing standardization. This is especially challenging in aerospace manufacturing where material and scale significantly impact production approaches beyond geometric similarity.

APPROACH

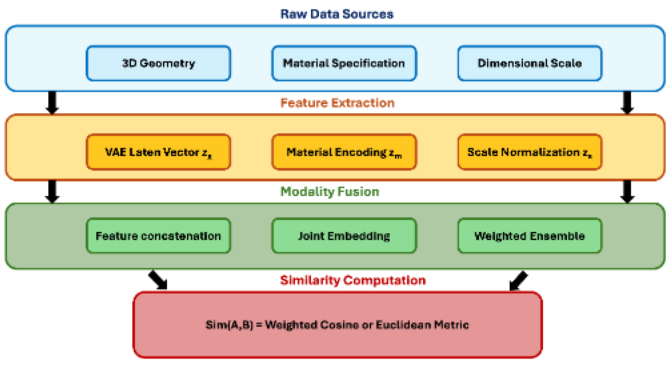
A multimodal AI system that analyzes multiple aspects of manufacturing parts was developed. The system examines 3D models alongside material and scale information to find historically similar components. This approach helps estimators make more consistent quotes based on past data and allows engineers to reuse existing manufacturing strategies instead of starting from scratch with each new part.

DATA SOURCES

The solution leverages three primary data sources from the company's systems: 3D CAD models stored on company drives, material specifications from the enterprise resource planning (ERP) database, and dimensional information extracted from technical drawings. Historical cost and production time data was also utilized from completed work orders.

Data Types and Format

3D geometric data (CAD models), categorical data (material specifications), numerical data (dimensional measurements), and structured tabular data (historical cost & production records)



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IMPACT

The part similarity tool delivers significant operational and financial benefits across multiple facets of the contract manufacturing business. In the quoting process, the solution reduces subjectivity and variability by enabling estimators to base new quotes on historically similar parts with known costs and production times. This data-driven approach improves quote accuracy, preventing both underpricing that erodes margins and overpricing that loses business opportunities. The consistency in quoting also enhances customer confidence and improves win rates on new bids. For engineering operations, process planning team can now quickly identify similar parts with proven manufacturing approaches, allowing them to adapt existing methodologies rather than creating them from scratch. This drastically reduces manufacturing process time for new components and standardizes manufacturing methods across similar part families, leading to shorter lead times and more predictable production schedules. The system also supports knowledge retention and transfer within the organization. As experienced personnel retire or leave, their tribal knowledge about manufacturing approaches becomes embedded in the system through historical part relationships, making this expertise accessible to newer staff members. This institutional memory helps maintain consistent manufacturing quality and efficiency despite workforce changes.

DRIVERS	Industry inefficiencies in aerospace and defense contract manufacturing was the catalyst behind the part similarity tool enabled by multimodal AI approaches. Fragmented quoting, inconsistent engineering processes, and siloed expertise led to high costs and delays, highlighting the need for a data-driven, AI approach to standardize workflows and improve overall operational efficiency.
BARRIERS	Barriers included fragmented data systems, inconsistent documentation, and limited data quality. Legacy infrastructure and high process variability compounded these issues, while heavy reliance on tacit expertise further hindered data standardization and integration, challenging the deployment of a robust multimodal AI solution.
ENABLERS	Supportive leadership, strong cross-functional collaboration, and a culture of innovation were key enablers. The team's deep technical expertise and commitment to continuous digital improvement provided the foundation to integrate multimodal AI into manufacturing processes, driving operational excellence and digital transformation.
ACTIONS	We built a part similarity tool by training a VAE to encode 3D geometries and integrating material and scale data. We then implemented an ANN indexing system for rapid similarity retrieval, piloted the solution at Company X, and refined it iteratively using feedback from quoting and engineering teams.
INNOVATION	Innovative aspects include multimodal integration of 3D geometry, material properties, and scale data using VAEs to create a unified latent space. This approach enables rapid similarity retrieval through ANN indexing, streamlines quoting and engineering workflows, and leverages human feedback for continuous improvement.
IMPROVEMENT	Our solution improves quoting accuracy, reduces manufacturing cycle times, and shortens lead times. By standardizing workflows and leveraging multimodal AI, it delivers quantifiable cost savings and boosts competitive positioning through data-driven, consistent decision-making.
BEST PRACTICES	Standardize and pre-process all data sources to ensure high-quality input. Use robust multimodal models (e.g., VAEs) with efficient ANN indexing for similarity search. Engage cross-functional teams early, pilot in real-world settings, iteratively refine based on feedback, and document each step for replicability.
OTHER APPLICATIONS	Our approach extends to quality control and predictive maintenance, streamlining defect detection and process optimization. It also supports design reuse in rapid prototyping, digital twin creation, and cost estimation across industries like automotive, medical devices, and consumer electronics, where integrated multimodal insights drive efficiency.