Acumatica
The Cloud ERP

Multi-Modal Manufacturing

How ERP Systems Support Multiple Manufacturing Methods

RECENT TRENDS BLUR THE LINES BETWEEN MONOLITHIC MANUFACTURING METHODS

Manufacturing processes vary by industry, finished goods, raw materials, operations, customer preferences, and other factors. Traditionally, manufacturers deployed singular methods of manufacturing. This is partly due to the nature of their business and past limitations with legacy ERP business software. For example, most make-to-stock and make-to-order manufacturers employ a V-model manufacturing process where multiple raw materials result in a single finished good. Conversely, remanufacturing and some batch process manufacturers use an A-model process, in which a single raw material produces multiple finished goods.

However, times are changing, and manufacturers now leverage multiple manufacturing modes concurrently. This dramatic market shift is necessary to compete in today's digital world to meet demanding consumer and business customer needs. Further, modern ERP applications, additive manufacturing technologies, artificial intelligence with machine learning, and other advances continue to force manufacturers to reinvent business processes and go-to-market strategies.

Recent supply chain disruptions also impacted how manufacturers use their business systems to manage manufacturing processes. For example, many manufacturers responded by acquiring smaller suppliers to fortify their supply chains by bringing critical supplies in-house. However, many of the related products require drastically different methods of manufacturing.

Manufacturers leverage modern ERP systems to connect commerce applications for direct-to-consumer (D2C) and online business-to-business (B2B) sales and go-to-market strategies that enable job shops to develop standard product lines to fuel growth.

Manufacturing methods comprise a vital component of every manufacturing ERP business system. Some systems provide robust inventory and warehouse management capabilities to forecast demand and manage considerable inventories in make-to-stock environments. Other ERP systems provide deep engineering and design features for engineer-to-order manufacturers. Specialized ERP applications are designed for food, chemical, and other manufacturers with batch process requirements based on recipes and formulas.

This eBook identifies the industry trends impacting manufacturing strategies and business application features commonly found in ERP systems designed for each manufacturing method. Discover how to capitalize on modern technologies to adapt to changing customer requirements, fortify your supply chain, and boost sales by introducing innovative products in new markets.

MULTI-MODAL MANUFACTURING FOR TOMORROW'S MANUFACTURER


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"With Acumatica, we can double the size of the business without doubling the space and the people because we have power in the information. We can work more logically, provide better service and save millions in labor by not having to double the staff size."

– BEN LEINSTER, CEO
AFF | GROUP

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INTRODUCTION TO MULTI-MODAL MANUFACTURING

Methods of Manufacturing Play a Critical Role in Product Design, Production, and Planning

Manufacturing methods define the process of converting raw materials into finished goods. They use bills of material, recipes, or formulas to define raw material requirements and routings for labor operations to process the materials into finished goods. Varied manufacturing methods implement strategies to streamline the production process. For example, repetitive manufacturers often backflush raw materials and labor based on the reported quantity of finished goods. Backflushing eliminates manual steps to enter quantities for raw materials or labor time against operations.

Did you know that at least 14 different manufacturing methods impact how you produce items, track manufacturing costs, and meet customer demands? The nature of raw materials also affects production. For example, many liquids, gases, and powders are used in scalable recipes and formulas based on percentages with yield and loss throughout the manufacturing process. Conversely, most solid raw materials are defined in a bill of materials with discrete unit quantities.

Consumer products like toilet paper are produced repetitively to fulfill forecasted sales orders for consumer supply expectations. Consequently, demand forecasting remains crucial for make-to-stock manufacturers. This became painfully apparent when pandemic-related hoarding emptied shelves due to unpredictable and excessive consumer demand.

In addition, customers today expect personalization and customization options. Consider configured computers, monogrammed towels, and customized kitchen cabinets. These products require rules-based product configurators to guide consumers or business customers through the options and values available to complete the ordering process.

Complex products like industrial machinery and equipment are often engineered to order based on customer-supplied CAD drawings or specifications. Therefore, integration with CAD or PLM applications and engineering change control is vital for initial product designs and ongoing revision management.

Other manufacturing processes also pose unique challenges for material planners and production schedulers. For example, a manufacturer may use by-products discarded from beer manufacturers as raw materials to produce protein-rich animal feed and drinking water. Environmental conditions associated with each by-product batch, such as humidity and chemical composition, impact each finished good batch.

Discover Why Manufacturers Rely on Acumatica for their Success

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INDUSTRY TRENDS

How Consumer Demand, Supply Chain Issues, and Technologies Impact Manufacturing Methods

Multi-modal manufacturing is not a new concept. Many manufacturers have offered varied product lines requiring different manufacturing methods for decades. However, recent trends force traditionally monolithic manufacturers to adopt alternative manufacturing methods. These trends include personalized products, shorter lead times, and innovative products that are stronger and easier to produce.

"The most important reason why we chose Acumatica was that it is flexible . . . We also looked at SAP and Oracle, but those systems were not flexible or easy to customize to our needs . . . Everything—manufacturing, sales, and accounting—is processed in one system."

– VAN KIM THANH, ERP PROJECT MANAGER
TIEN PHONG PLASTIC

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PERSONALIZED PRODUCTS

A 2019 Deloitte study claims that more than 50% of customers want personalized or custom products.[1] A similar report by Lanieri US Fashiontech Insights in 2017 shows that nearly half (49 percent) of US adults desire custom-made fashion products.[2] Personalization is everywhere today in business-to-business (B2B) and business-to-consumer (B2C) markets. Customization trends drive traditional make-to-stock manufacturers to offer personalized products through commerce storefronts or 3D printers.

MODERN TECHNOLOGY

Rules-based product configurators appeared decades ago. However, integration with consumer-facing platforms, like commerce storefronts, brings new opportunities to consumers and businesses looking for tailored products. A recent McKinsey report revealed that Shoes of Prey increased commerce sale conversions by 50 percent using commerce-enabled configuration technologies.[3] Digital printing has replaced offset and lithographic printers. Alongside 3D printers, customization has taken off in the textile and apparel industry with new applications in other industry segments. Robotics, advanced analytics, and artificial intelligence also play a role in personalizing products like custom-fit prosthetics and more.

SUPPLY CHAIN CONCERNS

The unprecedented COVID pandemic and recent civil unrest illuminated problems with global supply chains. Manufacturers reacted by returning to on-shore production with customized product offerings. Customers are willing to pay a premium for faster and more reliable order fulfillment. Traditional make-to-stock manufacturers leverage technology to offer entirely new product lines. Job shops and other make-to-order manufacturers now deploy commerce sites to launch their own standard product lines.

OTHER TRENDS

Labor shortages forced manufacturers to invest in technology to streamline production. Smart factory advances include new manufacturing methods to augment labor-intensive processes. COVID forced workers into home offices in droves. While COVID concerns wane, many workers remain in home offices. Smart home and office technology manufacturers responded with installation services requiring project-driven manufacturing strategies. Demand for home delivery and subscription services opens new doors to expand product lines that require varied manufacturing methods.

[1] Source: Made-to-order: The Rise of Mass Personalization, Deloitte 2019
[2] Source: Lanieri US Fashiontech Insights 2017
[3] Source: McKinsey: How Technology Can Drive the Next Wave of Mass Customization



METHODS OF MANUFACTURING

Understanding 14 Unique Methods of Manufacturing

Manufacturers convert diverse raw materials through various operations producing unique finished goods. However different, the manufacturing process falls into one of several standard manufacturing methods. Generally, most fall into three categories—make-to-stock, make-to-order, or batch process with variations of make-to-order and batch process such as engineer-to-order, configure-to-order, and continuous flow manufacturing. There are specific methods used across other industry segments.

"[With Acumatica], drivers can automatically notify . . . project owners that a truck has left, making it easier to monitor throughout the delivery process . . . Acumatica really is an all-in-one, adaptable solution that quickly enables everything you need to run your business. And it is effortless to use"

– GRAHAM LEONARD, FINANCE AND OPERATIONS MANAGER
DUKATHOLE GROUP

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MAKE-TO-STOCK (MTS)

MTS manufacturers produce finished goods to stock in advance of orders based on actual and forecasted demand. Incoming orders are fulfilled from stock instead of manufacturing. For example, a boat manufacturer produces standard products with few variables. Sales demand is predictable based on historical data. The manufacturer builds to stock in advance of customer orders.

Acumatica Features:

- Inventory Management with Replenishment
- Native Warehouse Management
- MRP with Demand Forecasting
- Native Commerce Connectors
- Customer Portals

MAKE-TO-ORDER (MTO)

MTO manufacturers do not fulfill orders from inventory. Instead, they make products when they receive orders, making job costing critical for financial reporting and analysis. Various MTO manufacturers use assemble-to-order, configure-to-order, engineer-to-order, and job shop manufacturing strategies. Some process manufacturers also make-to-order. For example, a boat manufacturer may make specialty parts only when new orders are received.

Acumatica Features:

- Manufacturing Estimates
- Rules-Based Product Configurator
- Engineering Change Control
- CAD and PLM Connectors

ASSEMBLE-TO-ORDER (ATO)

Some manufacturers buy or build components to stock. However, the final assembly is not built until customers place orders. Some manufacturers use inventory kits for ATO, while others use production orders with lead times for scheduling, work in process (WIP), and job costing. For example, a boat manufacturer purchases seat components stocked in inventory. The pieces are then assembled when customers place an order.

Acumatica Features:

- Inventory Kits with Disassembly
- Bill of Materials & Routing
- Production Orders

ENGINEER-TO-ORDER (ETO)

ETO manufacturers create custom products for customer needs or a supplied CAD design. They may stock raw materials. However, the bill of materials is not defined, and production does not begin until the design is approved. New materials may be sourced using purchase requisition systems. For example, a boat manufacturer offers custom awnings. The manufacturer designs the awning in a CAD application. Production begins when the design and the order are approved.

Acumatica Features:

- Multi-Level Bill of Materials and Routing
- Engineering Change Control
- Certified CAD Connectors
- Native PLM Connector
- PO Requisitions with Vendor Bidding

PROJECT-DRIVEN OR PROJECT-BASED

Architectural, engineering, and construction (AEC) firms, government contractors, and manufacturers who make, install, and service machinery and equipment rely on project-based ERP systems. These systems drive material requirements for manufactured items used in projects. Material requirements are sourced or produced just before they are required for the project phase or task. For example, a yacht restoration company may create a project to repair a customer's yacht. Project managers identify replacement items that must be manufactured at each project stage. The ERP system recognizes project material demand for material planning and production scheduling.

Acumatica Features:

- Project Accounting
- Production Management
- Service Management
- MRP with Project Demand

JOB SHOP

Job shops are common in fabricated metal and rubber and plastic industries. They perform multiple operations using few raw materials for specific customer orders. Demand proves challenging to forecast, and they encounter few repeat orders. Most sales begin with an estimate. Some job shops ship finished goods directly from work-in-process (WIP), while others produce to inventory with a simplified fulfillment process. Outside process operations are common, where in-process products are shipped to vendors for painting, heat treating, coating, or other services and returned for upstream manufacturing operations. Raw materials are often explicitly purchased for customer orders. For example, a marine product manufacturer makes replacement parts for older boats. An estimate is created for the material and labor with markups to derive a cost and price quote. The quote is accepted and converted to a sales order. The estimate is used to create the bill of materials, routing, and production order. The item is produced and shipped.

Acumatica Features:

- Manufacturing Estimates
- Native CRM for Opportunities and Quotes
- PO Requisitions with Vendor Bidding
- Outside Process Operations

CONFIGURE-TO-ORDER (CTO)

Manufactured goods are often available in many sizes, styles, colors, and other options. A rules-based product configurator defines valid attributes and option combinations to create a unique bill of materials, labor routings, configured costs, and customer pricing. For example, product configuration rules may restrict engine models based on the boat model and year to prevent compatibility issues.

Acumatica Features:

- Rules-Based Product Configurator

BATCH PROCESS OR PROCESS MANUFACTURING

Food, chemical, and life science industries mix, blend, distill, cook, and formulate products in batches. Rather than discrete bills of material, ingredients scale based on quantities and potency. Process manufacturers use formulas with complex unit of measure conversions. Quality testing, expiration dates, first-expired-first-out (FEFO) picking, and lot tracking are common. For example, a boat paint company makes large batches of coatings for freshwater and saltwater applications. Products are stocked in vats and barrels but sold in different units of measure. Total inventory is assessed in gallons for each packaging variant.

Acumatica Features:

- Batch Orders with Recipes or Formulas
- Lot and Serial Traceability
- Expiration Dates with FEFO Picking
- Native Quality Management System
- Certified Process Manufacturing Application

CONTRACT SERVICES

Metal service centers, contract packaging firms, and outsourced service companies have similar production needs as manufacturers. Some service-driven organizations resemble project-based manufacturers, while others have field service requirements. For example, a boat manufacturer may send products to a vendor for painting or refurbishing the vessel at a customer location.

Acumatica Features:

- Project Accounting or Service Management
- Production Management or Kitting

"If a system is easy to use, then it will get used, and that, ultimately, is what we want as a business."

– TIM PATTON, ICT DIRECTOR
SAM

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MIXED-MODE (MM)

There are two definitions for mixed-mode manufacturing. Initially, companies that deployed discrete manufacturing methods (MTS, MTO, etc.) with process manufacturing were classified as mixed-mode. The term is used less frequently for companies using MTS and MTO methods (without process requirements). For example, a marine products manufacturer may produce boats and resin or adhesive. Boat production is discrete, while resin and adhesive production would be classified as batch process.

Acumatica Features:

- Production Orders with Bills of Material
- Connected Process Manufacturing with Batch Orders, Recipes, and Formulas
- Native Quality Management System

REMANUFACTURING

Most manufacturers produce items from multiple raw materials. Conversely, remanufacturing often produces a single refurbished finished good from a single raw material or core. Remanufacturing cores are worn parts returned for repair or recycling. It is common in automotive industries for batteries, transmissions, and engines, as well as printer toner (recharge, refurbish, and resell). Customers returning worn cores often receive core credits toward purchasing replacement parts. Recycling is similar, where old products like electronics are disassembled into salvageable components. Co-products may be required when multiple finished goods are produced. For example, a boat restoration business buys older boats and recycles or refurbishes and resells salvaged parts if it cannot fully restore the boat.

Acumatica Features:

- Bill of Materials and Routings
- Production Management with Disassembly

HYBRID MANUFACTURING (ADDITIVE MANUFACTURING)

Hybrid manufacturing is a newer method for companies with traditional subtractive manufacturing processes and modern additive manufacturing using three-dimensional printers. For example, a boat manufacturer uses conventional techniques to machine hull supports and 3D printers to make components or replacement parts that are not commonly stocked.

Acumatica Features:

- Work Centers and Machines for 3D Printers
- Open APIs to Integrate 3D Printers

REPETITIVE MANUFACTURING

Repetitive manufacturing is the production of goods in rapid succession. Repetitive manufacturing often accompanies automated assembly processes. This proves practical when producing the same (or similar) products over an extended time. It is common when making a standard product for a particular model year, such as appliances or automotive products when they have a known or expected demand for the period. Many repetitive manufacturers operate assembly lines or fixed work centers that continuously produce the same product, unlike other environments that produce multiple products through the work center over time. Production is often scheduled by item as opposed to a work order. Materials and labor are commonly backflushed to production at standard quantities and costs. Repetitive manufacturing may use lean drum-buffer-rope (DBR) strategies to optimize bottleneck resources. For example, a boat manufacturer may produce thousands of the same boats for a model year on an assembly line.

Acumatica Features:

- Demand Forecasting
- Material Requirements Planning (MRP)
- Material and Labor Backflushing

CONTINUOUS FLOW MANUFACTURING

Continuous flow manufacturing is like repetitive manufacturing where the same, or similar, finished good is produced for an extended time. However, continuous flow applies primarily to process manufacturing environments using gases, liquids, or powders. In continuous flow, ingredients are continuously fed into production to make the finished good instead of smaller batch orders. Continuous flow is rarely used because tracking the ingredient lots used in production is challenging. Consequently, most process manufacturers create larger batch orders to simulate a continuous flow environment providing traceability for ingredient lots issued or backflushed to the batch order. For example, a marine chemical processor makes descaling chemicals continuously. They create a batch order for the week for labor and material reporting.

Acumatica Features:

- Certified Process Manufacturing Application
- Lot and Serial Traceability
- Expiration Dates with FEFO Picking
- Native Quality Management System

"Having that stock control is incredible. That's put us at the forefront, especially in the craft beer industry. Now we can track it all; everything we do is in Acumatica . . . vWe know what's in each warehouse and when goods are sold."

– COLIN GILHESPY, CO-OWNER AND MANAGING DIRECTOR
CAVE DIRECT

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Methods of Manufacturing Comparison

The table below compares critical elements in each method of manufacturing. Some manufacturing methods are exclusively found in discrete or process manufacturing, while others apply to both classifications. Further, some manufacturing methods produce inventory to stock or to order, while others produce for both disciplines.

Method	Classification	Production	Distinguishing Characteristics
Make-to-Stock	Discrete	To Stock	Demand Forecasting, Warehouse Management
Make-to-Order	Both	To Order	Estimating and Job Costing
Assemble-to-Order	Discrete	To Order	Backflushing, Light Manufacturing, or Kitting
Engineer-to-Order	Discrete	To Order	Engineering ECO/ECR, CAD, and PLM Connectors
Configure-to-Order	Discrete	To Order	Rules-Based Product Configuration
Job Shop	Discrete	To Order	Estimating, Ship from WIP, Outside Processes
Project-Driven	Discrete	To Order	Project Accounting
Hybrid Manufacturing	Discrete	To Order	Additive Manufacturing with 3D Printing
Repetitive	Discrete	To Stock	Demand Forecasting, Backflushing
Batch Process	Process	Both	Batch Orders, Recipes, and Formulas
Continuous Flow	Process	To Stock	Long-Term Batch Orders
Mixed-Mode	Both	Both	Bill of Materials with Recipes or Formulas
Remanufacturing	Both	Both	Core Tracking, Co-Products
Contract Services	Both	Both	Project Accounting, Service, Manufacturing

"We can grow with the solution by continually implementing existing features and utilizing new system enhancements . . . I'll be surprised if there ever comes a time in 5 to 10 years where I will say, 'Oh gosh, Acumatica can't do that . . . I know if we want to expand with more warehouses, I can easily do it; if we want to expand to new countries, I can do it easily with Acumatica."

– JO YOUNG, MANAGING DIRECTOR
ADDITIVE-X

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LEAN MANUFACTURING

Lean Strategies for Multi-Modal Manufacturing

Some people believe lean manufacturing is a distinct method of manufacturing. At the same time, lean strategies impact manufacturing processes and business systems, but are best classified as a strategy that applies to many manufacturing methods.

Lean manufacturing focuses on minimizing waste and maximizing productivity within manufacturing systems. Waste is viewed as anything that does not add value to the product or the process. Lean manufacturing benefits include reduced lead times, lower operating costs, and improved product quality. Lean manufacturing, also known as lean production, or simply lean, is a practice that crosses industry segments to organizations outside manufacturing. Some well-known companies that use lean include Toyota, Intel, John Deere, and Nike. The Toyota Production System (TPS) is a popular lean approach. Companies that use enterprise resource planning (ERP) may benefit from a lean production system.

Lean encompasses a lot more than just a production philosophy. It is sometimes called just-in-time manufacturing. It can be associated with Kanban or pull systems using physical cards to signal replenishment orders from vendors, warehouse stock transfers, or movement from another work center. Other lean strategies include kaizen (continuous improvement), single-minute exchange of dies (SMED for faster machine setup), 5S (Sort, Straighten, Shine, Standardize, and Sustain), Poka-Yoke (error-proofing), and more.

For example, a lean boat manufacturer may use Kanban instead of MRP to trigger vendor purchase orders for consumable items and MRP for stocked component planning. A bin system would be developed where there may be two or three bins holding the consumable items. When a bin is emptied, a physical card on the bin is scanned, creating a request to replenish the bin from the vendor or manufacturing.

Acumatica Features:

- **Acumatica's xRP platform provides Open APIs and low-code and no-code integration tools to connect third-party lean manufacturing systems.**
- **Acumatica enables customized tasks and workflows supporting Kanban pull systems.**
- **Tailored dashboards provide real-time production insights to monitor lean strategies.**
- **Manufacturing Data Collection provides real-time data collection directly from the shop floor**



ERP IMPACT

Multi-Modal Manufacturing Impacts ERP Software

Historically, most legacy ERP systems were developed for niche manufacturing markets requiring a single manufacturing method. While many manufacturers use multiple manufacturing methods today, few ERP applications are adapted for multi-modal manufacturing. For example, most ERP systems are either discrete or process, rarely both. Further, many make-to-order and job shop systems on the market lack robust inventory and native warehouse management required by make-to-stock manufacturers. Likewise, few engineer-to-order or configure-to-order systems offer robust inventory management, demand forecasting, or warehouse management required by make-to-stock companies.

Implementation of multiple manufacturing methods impacts ERP configuration and employee training. Making changes to the system for one manufacturing method may impact other methods. Further, the unit of measure setup and conversion in discrete manufacturing methods are not designed for batch process manufacturing scenarios. Consequently, talk to vendors, consultants, and value-added resellers to understand specific requirements for each method of manufacturing supported in your ERP system and learn how to use them effectively.

Choose a Future-Proof ERP Application for Multi-Modal Manufacturing

Limited legacy ERP support for multi-modal manufacturing creates roadblocks for direct-to-consumer markets. Companies struggle to retrofit legacy ERP systems for multiple manufacturing methods, often resulting in disparate ERP deployments—especially in mixed-mode environments.

Conversely, modern ERP systems like Acumatica provide a singular platform for multi-modal manufacturing with native commerce connectors to expand into new channels.

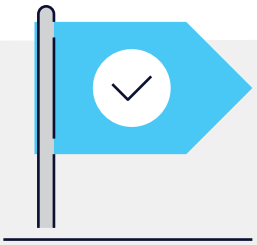
Robust inventory, demand forecasting, and native warehouse management make Acumatica the perfect fit for make-to-stock manufacturers.

Acumatica is also ideal for MTO manufacturers due to its embedded apps for product configuration and engineering change control that streamline operations for ETO and CTO manufacturers. Further, manufacturing estimates and outside processing provide last-mile features for job shops.

Certified apps extend Acumatica for batch process manufacturers with recipes or formulas. Lastly, hybrid manufacturers leverage open source connectivity via low-code or no-code integration to innovative technologies like additive manufacturing.

Built on a future-proof cloud platform with native artificial intelligence and machine learning, Acumatica provides unparalleled manufacturing depth with robust financials, native customer relationship management, and powerful business intelligence applications.

Boost sales, maximize resources, automate business processes, and improve profits with best-in-class applications for production, estimating, engineering, material planning, scheduling, product configuration, and manufacturing data collection.



"As the world has moved on from bespoke on-premises solutions that are clunky, monolithic, and don't integrate well, to cloud-based ERP systems, Acumatica had everything we were looking for . . . It is fully managed with round-the-clock support, it is modular and easily integrates with our HR & Payroll system, and mobile phones and tablets can be used on the factory floor."

– DEVIN SAMAYAMANTHRI
CHIEF OF STAFF
DESIGN STUDIO

Acumatica
The Cloud ERP

Acumatica Cloud ERP is a comprehensive business management solution that was born in the cloud and built for more connected, collaborative ways of working. Designed explicitly to enable small and mid-market companies to thrive in today's digital economy, Acumatica's flexible solution, customer-friendly business practices, and industry-specific functionality help growing businesses adapt to fast-moving markets and take control of their future.

For more information on Acumatica, visit www.acumatica.com or follow us on LinkedIn.