

<!DOCTYPE html>

# AutomataNexus SBOM System - Comprehensive Feature Guide

---

## Executive Summary

**AutomataNexus SBOM System** is a production-ready, enterprise-grade Bill of Materials (BOM) and inventory management platform specifically engineered for HVAC business operations. This comprehensive system integrates project management, financial tracking, service quality management, and real-time business analytics into a unified platform that drives operational efficiency and profitability.

---

## Table of Contents

1. [System Overview](#)
2. [Core Architecture](#)
3. [Dashboard & Analytics Hub](#)
4. [Bill of Materials Management](#)
5. [Inventory Management System](#)
6. [Project Management System](#)
7. [Reports & Documentation](#)
8. [Service Quality Management](#)
9. [Time & Labor Management](#)
10. [Financial Calculations & Business Logic](#)
11. [Technical Architecture](#)
12. [Integration Capabilities](#)
13. [Administration & Security](#)

---

## System Overview

### Purpose & Mission

AutomataNexus SBOM System serves as the central operational hub for HVAC businesses, providing comprehensive management of: - **Equipment Bill of Materials** for complex HVAC installations - **Inventory & Supply Chain** management with real-time stock tracking - **Project Lifecycle** from estimation through completion - **Financial Performance** with real-time profitability analysis - **Service Quality** metrics and warranty management - **Business Intelligence** with industry-specific KPIs

## Target Users

- **HVAC Business Owners:** Complete business oversight and performance monitoring
- **Project Managers:** Project planning, resource allocation, and timeline management
- **Technicians:** BOM access, time tracking, and service documentation
- **Office Staff:** Inventory management, customer communications, and administrative tasks
- **Financial Teams:** Cost analysis, profitability tracking, and financial reporting

---

## Core Architecture

### Technology Foundation

- **Frontend:** React 18 + TypeScript + Vite (Production-optimized)
- **Backend:** FastAPI + SQLAlchemy + Pydantic (Enterprise-grade Python)
- **Database:** SQLite (Production-ready with 21 tables)
- **Process Management:** PM2 with auto-restart and monitoring
- **Real-time Updates:** 30-second refresh cycles across all modules

### Performance Characteristics

- **Response Time:** Sub-500ms for all standard operations
- **Concurrent Users:** Optimized for 10+ simultaneous users
- **Data Capacity:** Handles 10,000+ inventory items, 1,000+ projects
- **Uptime:** Auto-recovery with PM2 process management
- **Security:** Input validation, SQL injection protection, secure authentication

---

## Dashboard & Analytics Hub

### Executive Dashboard

The central command center providing real-time business intelligence and operational oversight.

### Key Performance Indicators (KPIs)

- **Total Revenue:** Live calculation based on completed projects and labor hours
- **Project Pipeline:** Active projects with status distribution
- **Inventory Value:** Current stock value with trend analysis
- **Service Quality:** First-Time Fix Rate and callback metrics
- **Technician Productivity:** Billable hours percentage and efficiency

### Real-time Metrics Display

- **Revenue Stream Analysis:** Labor revenue vs component profit breakdown

- **Project Status Distribution:** Visual pie charts showing project pipeline health
- **Inventory Alerts:** Low stock warnings and reorder requirements
- **Recent Activity Feed:** BOM-based activity tracking with timestamps
- **System Health:** Database connectivity and service status monitoring

## Advanced Analytics Module

### Financial Performance Analytics

- **Revenue Trends:** Historical revenue tracking with seasonal analysis
- **Profit Margin Analysis:** Gross profit trends with industry benchmark comparison
- **Cost Structure Breakdown:** Material vs labor vs overhead cost distribution
- **Project Profitability:** Individual project margin analysis with variance reporting
- **Customer Lifetime Value:** CLV calculation and trend analysis

### Operational Analytics

- **Equipment Performance:** BOM usage analysis by equipment type
- **Supplier Performance:** Vendor reliability and cost analysis
- **Location Efficiency:** Performance metrics by customer location
- **Work Order Analysis:** Completion times and resource utilization
- **Capacity Planning:** Resource allocation and utilization forecasting

### HVAC Industry Metrics

- **First-Time Fix Rate:** Service quality measurement (Target: >85%)
- **Average Ticket Size:** Revenue per service call analysis
- **Customer Satisfaction:** Based on callback frequency and resolution time
- **Technician Productivity:** Billable hours vs total hours (Target: >75%)
- **Equipment Reliability:** Warranty callback tracking by equipment type

## Bill of Materials Management

### Core BOM Functionality

#### Equipment-Based Organization

The system organizes BOMs by HVAC equipment categories:

**Primary Equipment Types:** - **Air Handlers:** Central air handling units with component specifications - **Boilers:** Steam and hot water boilers with safety and control components - **Chillers:** Air-cooled and water-cooled chillers with refrigeration components - **Cooling Towers:** Evaporative cooling systems with water treatment components - **Pumps:** Circulation pumps, condensate pumps, and specialty pumping systems - **RTUs (Roof Top Units):** Package units with integrated controls - **DOAS (Dedicated Outdoor Air Systems):** Energy recovery ventilation systems - **VAV Boxes:** Variable air

volume terminal units - **Fan Coils**: Terminal fan coil units with controls - **Steam Systems**: Steam distribution and control systems - **Greenhouse Controls**: Specialized environmental control systems - **Geothermal Systems**: Ground source heat pump systems

## BOM ID Generation

Automatic BOM identification using the format: `LOCATION_CODE-PROJECT_NUMBER-BOM-YEAR`  
Example: `HOP-2024-001-BOM-2024` (Hopkins location, project 1, year 2024)

## Work Order Integration

- **Predefined Work Orders**: 20+ standard HVAC work orders
- **Auto-Location Matching**: Work order assignment based on customer location
- **Service Type Classification**: Installation, maintenance, repair, emergency service
- **Resource Estimation**: Automatic labor and material estimation based on work order type

## Advanced BOM Capabilities

### Cost Calculation Engine

Sophisticated cost modeling with multiple calculation layers:

**Component Markup Structure:** -  $\leq \$25$ : 3.5x markup (250% profit margin) -  $\leq \$100$ : 3.25x markup (225% profit margin) -  $\leq \$500$ : 2.75x markup (175% profit margin) -  $\leq \$1000$ : 2.5x markup (150% profit margin) -  $\leq \$1500$ : 2.25x markup (125% profit margin) -  $> \$1500$ : 1.75x markup (75% profit margin)

**Labor Calculations:** - **Customer Billing**: \$179/hour (industry-competitive rate) - **Internal Cost**: \$79/hour (including benefits and overhead) - **Gross Labor Margin**: \$100/hour (126% markup)

### BOM Version Control

- **Revision Tracking**: Complete version history with change logs
- **Approval Workflows**: Multi-stage approval process for BOM modifications
- **Template Management**: Standardized BOMs for common equipment configurations
- **Alternative Components**: Substitute component specifications with cost variations

### Production Integration

- **3D Print Integration**: Default 8.74-hour production time for custom components
- **Manufacturing Lead Times**: Supplier lead time integration for project scheduling
- **Quality Control**: Component specification validation and compliance checking
- **Assembly Instructions**: Detailed assembly procedures and safety requirements

---

# Inventory Management System

## Comprehensive Stock Management

### Multi-Category Organization

The system supports 12+ inventory categories with specialized management:

**Primary Categories:** - **Sensors & Controls:** Temperature, pressure, flow, and environmental sensors - **Valves & Actuators:** Control valves, isolation valves, and motorized actuators - **Electrical Components:** Contactors, relays, transformers, and control panels - **Mechanical Components:** Pumps, fans, motors, and mechanical assemblies - **Refrigeration:** Compressors, condensers, evaporators, and refrigerant components - **Piping & Fittings:** Copper, steel, PVC piping with fittings and insulation - **Fasteners & Hardware:** Bolts, screws, brackets, and mounting hardware - **Safety Equipment:** Personal protective equipment and safety systems - **Tools & Equipment:** Installation and maintenance tools - **Consumables:** Filters, gaskets, lubricants, and disposable items

### Advanced Stock Tracking

- **Real-time Stock Levels:** Continuous inventory tracking with immediate updates
- **Four-Tier Stock Status:**
  - **In Stock:** Adequate inventory levels (green indicator)
  - **Low Stock:** Below minimum threshold (yellow indicator)
  - **Out of Stock:** Zero inventory (red indicator)
  - **Excess Stock:** Above maximum threshold (blue indicator)

### Location Management

Detailed warehouse organization system: - **Zone-Based Storage:** Warehouse zones for different product categories - **Aisle/Shelf/Bin:** Precise location tracking for efficient picking - **Barcode Integration:** Barcode scanning for inventory transactions - **Pick Path Optimization:** Efficient picking routes for order fulfillment

## Supplier & Procurement Management

### Multi-Supplier Support

- **Supplier Profiles:** Complete vendor information with contact details
- **Preferred Vendor:** Primary supplier designation with backup options
- **Price Tracking:** Historical pricing data with trend analysis
- **Performance Metrics:** Vendor reliability, quality, and delivery performance

### Purchase Order Integration

- **Automated Reordering:** Automatic PO generation based on reorder points
- **Lead Time Management:** Supplier lead times for accurate delivery scheduling
- **Cost Analysis:** Price comparison across multiple suppliers

- **Quality Tracking:** Incoming inspection and quality metrics

---

## Project Management System

### Comprehensive Project Lifecycle

#### Customer Location Management

Pre-configured customer locations with complete profiles:

**Location Information Includes:** - **Primary Contact:** Customer contact information and communication preferences - **Site Details:** Address, access requirements, and site-specific notes - **Equipment Inventory:** Existing HVAC equipment and maintenance history - **Service History:** Previous projects and service calls - **Billing Information:** Payment terms and billing contact information

#### Project Workflow Management

**Project Status Hierarchy:** - **Planning:** Initial project setup and resource planning - **Active:** Work in progress with regular progress updates - **On Hold:** Temporarily suspended projects with hold reasons - **Completed:** Successfully finished projects with final documentation - **Cancelled:** Terminated projects with cancellation reasons

**Priority Management:** - **Critical:** Emergency projects requiring immediate attention - **High:** Important projects with urgent deadlines - **Medium:** Standard priority projects - **Low:** Non-urgent projects and future planning

#### Financial Project Tracking

**Budget Management:** - **Total Project Budget:** Overall financial allocation - **Material Budget:** Component and material cost allocation - **Labor Budget:** Labor hour and cost budgeting - **Overhead Allocation:** Indirect cost distribution

**Cost Control:** - **Actual vs Budget:** Real-time variance tracking - **Cost Overrun Alerts:** Automatic notifications for budget exceptions - **Progress Billing:** Milestone-based billing integration - **Final Cost Analysis:** Project profitability analysis upon completion

## Project-BOM Integration

### Multi-BOM Projects

- **BOM Assignment:** Multiple BOMs per project for complex installations
- **Material Allocation:** Component allocation from inventory to specific projects
- **Cost Roll-up:** Automatic project cost calculations from all assigned BOMs
- **Change Order Management:** BOM modifications with cost impact analysis

---

# Reports & Documentation

## Executive Reporting Suite

### Financial Performance Reports

- **Revenue Analysis:** Detailed revenue breakdown by project, location, and time period
- **Profit Margin Reports:** Gross and net margin analysis with trend identification
- **Cost Center Analysis:** Department and resource cost analysis
- **Budget Variance:** Actual vs budgeted performance with variance explanations
- **Cash Flow Projections:** Future cash flow forecasting based on project pipeline

### Operational Reports

- **Project Status Reports:** Comprehensive project portfolio status
- **Inventory Reports:** Stock levels, valuation, and reorder requirements
- **BOM Analysis:** Component usage analysis and cost optimization opportunities
- **Service Quality Reports:** Customer satisfaction and service performance metrics
- **Technician Performance:** Individual and team productivity analysis

### Compliance & Documentation

- **Regulatory Compliance:** Documentation for industry regulations and standards
- **Quality Assurance:** Quality control documentation and audit trails
- **Safety Reports:** Safety incident tracking and compliance reporting
- **Warranty Documentation:** Equipment warranties and service agreement tracking

## Interactive PDF Generation

### Professional Document Creation

- **Company Branding:** Automatic company logo and branding integration
- **Dynamic Charts:** Plotly.js charts embedded directly in PDF documents
- **Real-time Data:** Reports generated from live database with current information
- **Custom Templates:** Standardized report layouts for consistency
- **Multi-format Export:** PDF, HTML, and JSON export options

### Automated Distribution

- **Email Integration:** Automatic report distribution via Resend API
- **Scheduled Reports:** Automated daily, weekly, and monthly report generation
- **Stakeholder Distribution:** Role-based report distribution to appropriate personnel
- **Archive Management:** Historical report storage and retrieval

---

## Service Quality Management

### Callback & Warranty Tracking

#### Comprehensive Service Documentation

- **Callback Recording:** Complete documentation of service callbacks
- **Work Order Linkage:** Direct connection to original work orders
- **Problem Classification:** Categorization of service issues and root causes
- **Resolution Tracking:** Detailed resolution procedures and outcomes
- **Cost Impact Analysis:** Financial impact of callbacks on project profitability

#### Warranty Management

- **Equipment Warranties:** Tracking of manufacturer warranties
- **Service Warranties:** Company-provided service guarantees
- **Warranty Claims:** Integration with manufacturer warranty claim processes
- **Cost Recovery:** Warranty cost recovery tracking and billing

### Service Quality Analytics

#### First-Time Fix Rate (FTFR)

Calculation methodology:  $FTFR = (\text{Total Service Calls} - \text{Callbacks in 30 Days}) / \text{Total Service Calls} \times 100$

Target: >85% (Industry Best Practice)

#### Service Performance Metrics

- **Response Time:** Average response time to service calls
- **Resolution Time:** Time from initial call to problem resolution
- **Customer Satisfaction:** Based on callback frequency and feedback
- **Technician Performance:** Individual technician service quality metrics

---

## Time & Labor Management

### Work Order Time Tracking

#### Comprehensive Time Management

- **Project Time Allocation:** Time tracking by specific projects and work orders
- **Billable vs Unbillable:** Clear categorization for accurate billing
- **Location-Based Tracking:** Time spent at different customer locations
- **Activity Classification:** Detailed activity tracking (installation, maintenance, travel, etc.)

## Production Time Analysis

- **BOM Production Time:** Estimated vs actual production time analysis
- **Efficiency Metrics:** Productivity analysis and improvement opportunities
- **Learning Curve:** Time reduction tracking for repetitive tasks
- **Resource Optimization:** Optimal resource allocation based on historical data

## Payroll Integration

### Labor Cost Management

- **Internal Cost Tracking:** \$79/hour fully-loaded labor cost
- **Customer Billing:** \$179/hour customer billing rate
- **Overtime Management:** Regular vs overtime hour tracking and costs
- **Productivity Analysis:** Revenue per technician hour analysis

### Performance Metrics

- **Target Productivity:**  $\geq 75\%$  billable hours (industry standard)
- **Revenue per Technician:** Target \$250K-\$450K annually
- **Efficiency Tracking:** Individual and team performance monitoring
- **Training ROI:** Training investment return through productivity improvements

---

## Financial Calculations & Business Logic

### Revenue Calculation Formula

#### Comprehensive Revenue Model

``` Total Project Revenue = (Labor Revenue + Component Profit) - Overhead Allocation

Where: - Labor Revenue = Production Hours  $\times$  \$179/hour (Customer Rate) - Labor Cost = Production Hours  $\times$  \$79/hour (Internal Cost) - Component Profit = (Component Cost  $\times$  Markup) - Component Cost - Overhead Allocation = Production Hours  $\times$  \$79/hour ```

#### Component Markup Strategy

Sliding scale markup based on component cost: - **High-value items:** Lower markup percentage, higher absolute profit - **Low-value items:** Higher markup percentage for handling costs - **Volume discounts:** Automatic adjustment for quantity purchases - **Supplier negotiations:** Dynamic markup based on supplier costs

## HVAC Industry Benchmarks

### Key Performance Indicators

- **Gross Profit Margin:** Target 45-60% (industry competitive)

- **Customer Lifetime Value:** Approximately 15% of annual revenue
- **Average Ticket Size:** \$350-\$600 per service call
- **Project Completion Rate:** >95% on-time completion
- **Safety Metrics:** Zero workplace injuries target

## Financial Health Metrics

- **Cash Flow Management:** Positive operating cash flow maintenance
- **Accounts Receivable:** <45 days average collection period
- **Inventory Turnover:** 6-8 turns per year target
- **Working Capital:** Optimal working capital management
- **Return on Investment:** >20% ROI on equipment and technology investments

---

## Technical Architecture

### Database Structure

#### Core Data Model (21 Tables)

**BOM Management:** - `bom_headers` : Master BOM information - `bom_lines` : Individual BOM line items - `bom_alternatives` : Alternative component options - `bom_versions` : Version control and revision history - `bom_templates` : Standardized BOM templates

**Inventory Management:** - `items` : Master item catalog - `categories` : Inventory categorization - `suppliers` : Vendor management - `item_suppliers` : Supplier-item relationships - `locations` : Warehouse location management - `units_of_measure` : Measurement standardization - `stock_transactions` : Inventory transaction history

**Project Management:** - `projects` : Master project information - `project_boms` : Project-BOM relationships - `project_reports` : Project reporting data - `material_allocations` : Material assignment to projects

**Operations:** - `work_order_hours` : Time tracking - `callbacks` : Service quality tracking - `unbillable_hours` : Non-billable time tracking

**System Administration:** - `users` : User management and authentication - `sqlite_sequence` : Database sequence management

### Data Relationships

- **Many-to-Many:** Items ↔ BOMs (through BOM lines)
- **One-to-Many:** Projects → BOMs, Suppliers → Items
- **Hierarchical:** Categories → Subcategories → Items
- **Temporal:** Version control across all major entities

## API Architecture

### RESTful API Design

- **Consistent Endpoints:** Standardized URL patterns and HTTP methods
- **JSON Communication:** Standardized JSON request/response format
- **Error Handling:** Comprehensive error codes and messages
- **Authentication:** Secure authentication and authorization
- **Rate Limiting:** API usage controls for performance management

### Core API Endpoints

``` Inventory Management: GET/POST /api/inventory/ # CRUD operations GET /api/inventory/{id} # Individual item details

BOM Management: GET/POST /api/bom/headers/ # BOM operations GET/POST /api/bom/lines/ # BOM line management

Project Management: GET/POST /api/projects/ # Project lifecycle GET /api/projects/{id}/boms # Project BOMs

Reporting: GET /api/reports/generate/ # Report generation GET /api/analytics/metrics # Analytics data

Service Quality: GET/POST /api/callbacks/ # Callback management GET /api/analytics/callback-rate # FTFR calculations

Time Tracking: GET/POST /api/timesheet/ # Work order hours GET /api/timesheet/unbillable # Unbillable time ```

---

## Integration Capabilities

### External System Integration

#### Email Service Integration

- **Resend API:** Professional email service for notifications
- **Automated Notifications:** Project updates, inventory alerts, service reminders
- **Report Distribution:** Scheduled report emailing to stakeholders
- **Customer Communications:** Professional customer correspondence

#### File Management

- **Upload/Download:** Secure file handling with validation
- **Document Storage:** Project documents and technical specifications
- **Image Management:** Equipment photos and technical diagrams
- **Version Control:** Document versioning and access control

## Future Integration Readiness

- **API-First Design:** RESTful APIs for third-party system integration
- **Webhook Support:** Real-time notifications for external systems
- **Export Capabilities:** Data export for accounting and ERP systems
- **Mobile App Ready:** API structure prepared for mobile application development

## Business System Integration

### Accounting System Compatibility

- **QuickBooks Integration:** Ready for accounting system synchronization
- **Financial Data Export:** Structured data export for financial analysis
- **Tax Reporting:** Organized data for tax preparation and compliance
- **Audit Trail:** Complete transaction history for financial audits

### CRM Integration Potential

- **Customer Data:** Structured customer information for CRM systems
- **Service History:** Complete service record for customer relationship management
- **Sales Pipeline:** Project data for sales forecasting and management
- **Marketing Analytics:** Customer behavior data for targeted marketing

---

## Administration & Security

### System Administration

### Process Management

- **PM2 Integration:** Automatic process restart and monitoring
- **Service Commands:** Simple start/stop/restart service management
- **Log Management:** Centralized logging with automatic rotation
- **Health Monitoring:** Continuous system health checks and alerts
- **Performance Monitoring:** System performance metrics and optimization

### Configuration Management

- **Environment Variables:** Secure configuration through environment variables
- **Feature Flags:** Granular feature control for different user groups
- **Database Management:** Automated backup and recovery procedures
- **Migration Support:** Database schema migration capabilities

## Security Features

### Data Protection

- **Input Validation:** Comprehensive input sanitization and validation
- **SQL Injection Protection:** Parameterized queries and ORM protection
- **XSS Prevention:** Cross-site scripting attack prevention
- **CSRF Protection:** Cross-site request forgery protection
- **Secure Authentication:** Password hashing and secure session management

### Access Control

- **Role-Based Access:** User roles with appropriate permission levels
- **Session Management:** Secure session handling and timeout
- **Audit Logging:** Complete user action logging for security audits
- **Data Encryption:** Sensitive data encryption at rest and in transit

## Backup & Recovery

### Data Backup Strategy

- **Automated Backups:** Daily automated database backups
- **Version Retention:** Multiple backup versions for point-in-time recovery
- **Off-site Storage:** Secure backup storage for disaster recovery
- **Recovery Testing:** Regular backup integrity and recovery testing

### Business Continuity

- **Disaster Recovery:** Documented disaster recovery procedures
- **High Availability:** System uptime optimization strategies
- **Data Integrity:** Transaction integrity and consistency maintenance
- **Performance Optimization:** Continuous performance monitoring and tuning

---

## Conclusion

The AutomataNexus SBOM System represents a comprehensive, enterprise-grade solution specifically designed for HVAC business operations. With its integrated approach to inventory management, project tracking, financial analysis, and service quality management, the system provides the foundation for operational excellence and business growth.

### Key Business Benefits

- **Operational Efficiency:** Streamlined workflows and automated processes
- **Financial Visibility:** Real-time profitability analysis and cost control
- **Service Quality:** Comprehensive service tracking and quality improvement

- **Scalability:** Designed to grow with business expansion
- **ROI:** Measurable return on investment through efficiency gains and cost reduction

## Competitive Advantages

- **Industry-Specific:** Purpose-built for HVAC business requirements
- **Integrated Platform:** Single system for all business operations
- **Real-time Analytics:** Live business intelligence and decision support
- **Proven Technology:** Production-tested with enterprise-grade reliability
- **Future-Ready:** Designed for integration and expansion

The system's comprehensive feature set, robust technical architecture, and focus on HVAC industry requirements make it an invaluable tool for businesses seeking to optimize their operations, improve profitability, and deliver superior customer service.

---

**Document Information:** - **Version:** 1.0.0 - **Last Updated:** December 2024 - **System Status:** Production-Ready - **Support:** Comprehensive documentation and technical support available