# UX/UI Requirements Specification – CNC Data Analysis Platform

## 1. Objective of the User Interface

The user interface shall transform complex, high-frequency machine data into comprehensible, actionable information. It supports monitoring, analysis, and interpretation of machine behavior with focus on operational states (Running / Idle / Alarm), energy consumption, program execution, and contextual alerts. The UI must be intuitive, responsive, and insight-driven.

## 2. Target Users and Usage Context

| **User Group** | **Goals / Tasks** | **Usage Context** |
| --- | --- | --- |
| Machine Operator | Monitor real-time machine state; detect alerts. | Shop floor environment; touch display. |
| Process / Production Engineer | Analyze energy usage; review program duration; optimize process. | Office or control room. |
| Maintenance Technician | Analyze and trace alarms; investigate failures. | Workshop; possible mobile use. |
| Management / Production Lead | Get overview of utilization; review efficiency KPIs. | Dashboard view in office. |

## 3. Functional UX/UI Requirements

### 3.1 Dashboard Design

| **Requirement** | **Description** | **Priority** |
| --- | --- | --- |
| Real-time Status | Show current machine state (Running, Idle, Alarm) using clear color coding. | High |
| KPI Widgets | Display key metrics: runtime, energy use, alarms, and program information. | High |
| Interactive Charts | Zoomable time-series plots with tooltips and markers. | High |
| Customizable Dashboard | Allow users to add, move, or remove widgets. | Medium |
| Machine Overview (Fleet View) | Show status and energy consumption of multiple machines. | Medium |
| Dark/Light Mode | Adaptable to environment (shop floor vs. office). | Low |

### 3.2 Data Analysis View

| **Requirement** | **Description** | **Priority** |
| --- | --- | --- |
| Timeline Visualization | Display machine operation periods as colored bands (Running, Idle, Alarm). | High |
| Program-based Analysis | Filter and visualize data by program name. | High |
| Energy Analysis | Show energy consumption per program or time frame. | High |
| Comparison View | Compare performance, energy, or duration across programs or periods. | Medium |
| Drill-down Function | Clicking data points opens detailed analysis (parameters, alarms, time). | High |
| Export Function | Export charts or tables (PNG, CSV, PDF). | Medium |

### 3.3 Alarm and Event Management

| **Requirement** | **Description** | **Priority** |
| --- | --- | --- |
| Alarm Overview | List of active and past alarms with time, machine, and cause. | High |
| Alarm Context View | Show alarms within the timeline and correlate with machine status. | High |
| Filtering & Sorting | Filter by type, time range, or severity. | Medium |
| Acknowledge & Comment | Allow operators to acknowledge and add comments to alarms. | Medium |
| Contextual Hints | Provide insights like 'Alarm occurred during Tool Change'. | High |

### Concrete performance metrics 1. Machine Performance Indicators (Operational Efficiency)

### These measure how well the CNC or 5-axis machines are running.

| KPI | Formula / Description | Why It’s Important |
| --- | --- | --- |
| Machine Utilization Rate | (Active machining time / Total available time) × 100 | Shows how much the machines are actually used. Low utilization = underused equipment or downtime. |
| Overall Equipment Effectiveness (OEE) | Availability × Performance × Quality | Global measure combining uptime, speed, and quality — a key manufacturing KPI. |
| Downtime Rate | (Downtime hours / Total hours) × 100 | Identifies maintenance or setup issues reducing production. |
| Cycle Time | Average time to complete one machining operation | Helps evaluate efficiency and compare machines or programs. |
| Spindle Load / Power Consumption | Real-time sensor data (if available) | Detects overloads, inefficiencies, or maintenance needs. |

### 2. Production Quality Indicators

### These connect machine precision to output quality.

| KPI | Formula / Description | Why It’s Important |
| --- | --- | --- |
| Scrap Rate / Rejection Rate | (Number of defective parts / Total parts produced) × 100 | Tracks waste and cost of rework. |
| Rework Rate | (Parts requiring re-machining / Total parts) × 100 | Measures process stability. |
| First Pass Yield (FPY) | (Good parts at first attempt / Total parts) × 100 | Indicates process capability and setup accuracy. |

## 3. Production & Throughput Indicators

### Measure overall manufacturing output and bottlenecks.

| KPI | Formula / Description | Why It’s Important |
| --- | --- | --- |
| Production Volume | Number of parts produced per day/week | Tracks output trends. |
| Throughput Time | Time from raw material to finished part | Reflects production efficiency end-to-end. |
| Work-In-Progress (WIP) | Parts currently in production | Helps manage flow and capacity planning. |

### 4. Cost & Business Impact Indicators

### Link machine data to financial outcomes.

| KPI | Formula / Description | Why It’s Important |
| --- | --- | --- |
| Cost per Unit Produced | (Total operating cost / Units produced) | Shows efficiency improvements over time. |
| Energy Cost per Hour / per Part | (Energy consumed × cost rate) | Important for sustainability and profitability. |
| Machine Return on Investment (ROI) | (Profit generated / Machine cost) | Evaluates capital efficiency of each machine. |

### 5. Maintenance & Reliability Indicators

### Especially relevant for CNC and multiaxis systems.

| KPI | Formula / Description | Why It’s Important |
| --- | --- | --- |
| Mean Time Between Failures (MTBF) | Total operating time / Number of failures | Measures reliability. |
| Mean Time to Repair (MTTR) | Total repair time / Number of repairs | Measures maintainability. |
| Preventive Maintenance Compliance | (Completed maintenance / Planned maintenance) × 100 | Ensures machines are serviced on schedule. |

### Chat’s suggestions Example Dashboard Metrics

### If you build this in Power BI, Tableau, or watsonx.data, you could include:

### OEE trend over time

### Utilization by machine or operator

### Defect rate vs. production volume

### Energy cost per machine

### Downtime causes breakdown (planned vs. unplanned)