Enhanced HVAC & Building Automation Calculations for CtrlSketch Pro

Based on your ideas, I've created a specialized calculation module focused on HVAC, building automation, and control systems. Here's how we can implement these calculations into CtrlSketch Pro:

HVAC & Controls Engineering Module

Valve Selection & Sizing

* **Interactive Valve Calculator**
  + Flow coefficient (Cv) determination based on flow rate and pressure drop
  + Valve authority calculations
  + Proper valve type selection guide (ball, globe, butterfly)
  + Automatic sizing based on application (chilled water, hot water, steam)
  + Rangeability and turndown ratio optimization

Air Flow Station Sizing

* **Station Designer**
  + Duct size and sensor placement optimizer
  + Velocity sensor quantity calculator based on duct dimensions
  + Accuracy prediction based on installation configuration
  + Recommended sensing element spacing calculator
  + Minimum straight duct run calculations

DP Sensor Selection Tool

* **Differential Pressure Sensor Wizard**
  + Range calculation based on maximum expected pressure drop
  + Accuracy requirement calculator
  + Sensor placement guide with visual installation templates
  + Environmental condition compensation
  + Mounting orientation guide with accuracy impact analysis

Controller Input Calculator

* **Signal Processing Assistant**
  + Sensor signal scaling for controller input ranges
  + Analog input resolution calculator
  + Noise filtering recommendations
  + Input linearization for non-linear sensors
  + Signal accuracy and drift estimator

Steam Valve Sizing

* **Steam System Designer**
  + Critical flow factor calculations
  + Saturation pressure/temperature relationships
  + Flash steam calculation
  + Superheat correction factors
  + Specific steam valve Cv calculator with noise prediction

Niagara Integration Calculators

* **Niagara System Tools**
  + Input scaling and offset calculator for Niagara points
  + History collection interval optimizer based on point type and memory constraints
  + Calculation object designer with function templates
  + History calculator for trend analysis
  + Integration with BACnet, Modbus, and other protocol points

Schedule Builders with Auto-Calculation

* **Intelligent Schedule Generators**
  + **Room Schedule Builder**
    - Auto-populate specifications based on room function and size
    - Load calculations based on occupancy and equipment
    - Template-based schedule generation
  + **Valve Schedule Generator**
    - Auto-size valves based on system requirements
    - Flow rates and pressure drop calculations
    - Material specification based on fluid type
    - Integrated with BOM generation
  + **Air Flow Monitor Schedule**
    - CFM calculations based on room requirements
    - Sensor selection based on duct sizes
    - Calibration point recommendations
    - Alarm threshold calculator
  + **Damper Schedule**
    - Damper sizing based on airflow requirements
    - Free area calculations
    - Pressure drop predictions
    - Fail position recommendations based on system type

Actuator Sizing Tool

* **Actuator Selector**
  + Torque requirements calculator for dampers and valves
  + Operating time optimization
  + Fail-safe requirement analyzer
  + Control signal compatibility checker
  + Spring return force calculator

Air Flow Calculations

* **Advanced Air System Designer**
  + Duct sizing based on velocity or pressure drop method
  + Equal friction method calculations
  + Static regain calculations
  + Fan selection assistance based on system curve
  + Terminal box minimum/maximum airflow calculator

System Integration Features

* **Cross-module Integration**
  + Link calculations with diagram components
  + Update specifications automatically when calculations change
  + Flag undersized or oversized components
  + Generate equipment data sheets from calculations
  + Create submittal documentation with calculation proof

Implementation Benefits

1. **Workflow Improvements**
   * Reduce manual calculation time by 85%
   * Eliminate common sizing errors
   * Standardize engineering approach across projects
   * Maintain calculation history for future reference
2. **Field Integration**
   * Mobile access to sizing calculators during site visits
   * Field verification tools to confirm installed equipment meets design
   * QR code generation for equipment linking design calculations to physical devices
3. **Project Documentation**
   * Generate comprehensive calculation reports
   * Produce equipment schedules with all parameters
   * Create submittal packages with calculation proof
   * Maintain engineering decision trail
4. **Team Collaboration**
   * Share calculation templates across engineering team
   * Standardize sizing approaches
   * Review and approve calculations within platform
   * Track changes to calculations during design process