

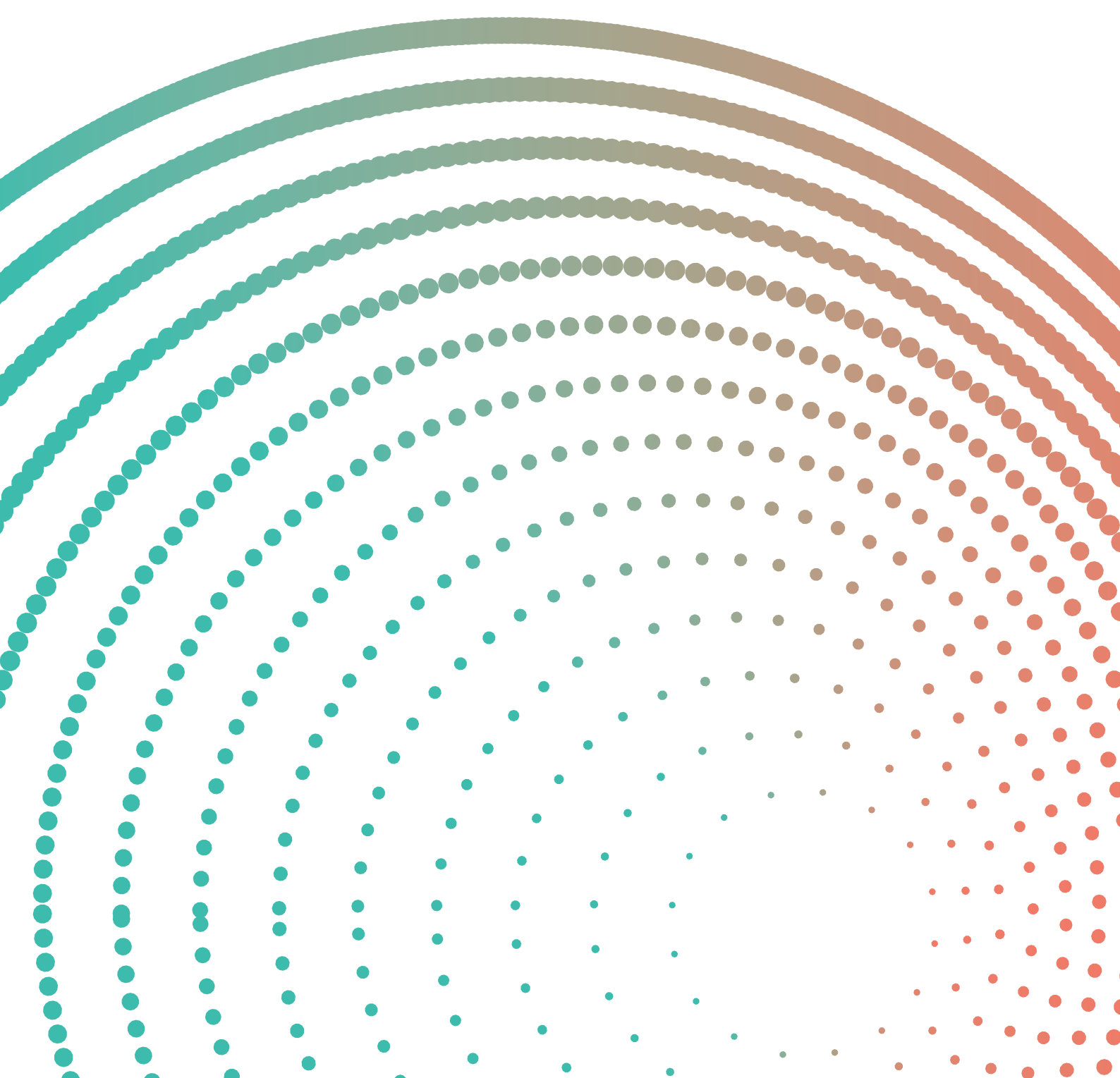
StarCS

General Control Suite



Advanced Control

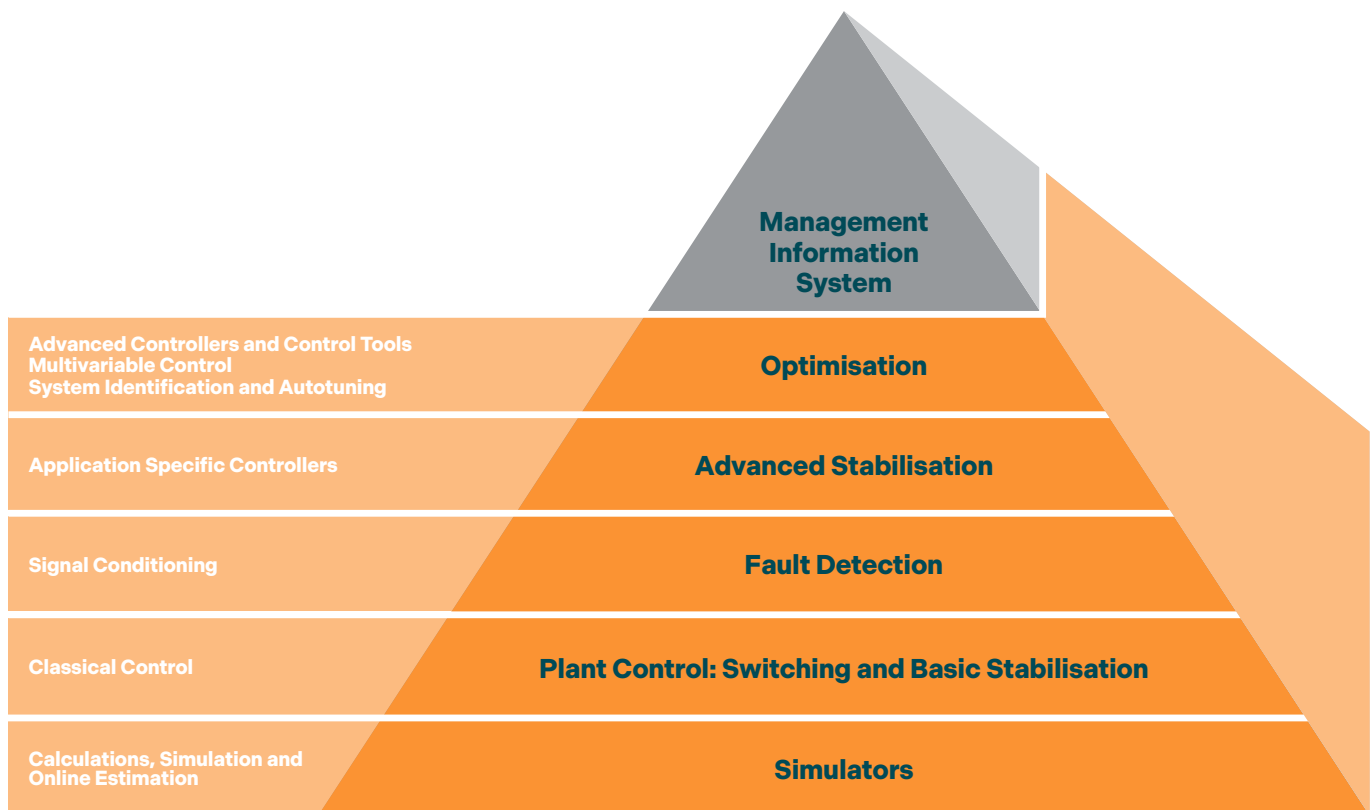
Process Optimisation



StarCS Overview

Specialised application-specific controllers from Mintek and distributed by Molycop (FloatStar, LeachStar and MillStar) are complemented by a comprehensive range of functional building blocks, allowing customisation of control solutions to clients' needs. These vary from basic matrix maths functionality to advanced multivariable controllers and scheduling applications.

The StarCS General Control Suite provides a comprehensive and diverse set of tools that can be applied at different levels in the control hierarchy. A summary of the major components is given below.



Classical Control

The use of classical controllers is not limited to customising specialised Mintek control systems, but also gives the client the flexibility of implementing simple control on any process using the StarCS control platform. The following classical controllers are available:

- PID control, incorporating intelligent windup prevention at limits
- Ratio control, including corrective action if the ratio setpoint cannot be achieved
- Deadbeat control: Model based control calculating a control action that will ensure that the setpoint is reached within a specified time
- Feed Forward control, based on user-defined process characteristics.

System Identification and Autotuning

Accurate model fitting and proper controller tuning is crucial in ensuring optimum controller performance. Automating the process of model fitting and tuning not only reduces the commissioning time, but also simplifies the subsequent retuning due to circuit changes or other factors degrading controller performance.

Mintek's SID tool fits models to recorded data and calculates suggested tuning parameters. It also forms the basis for customised, online autotuners for specific controllers.

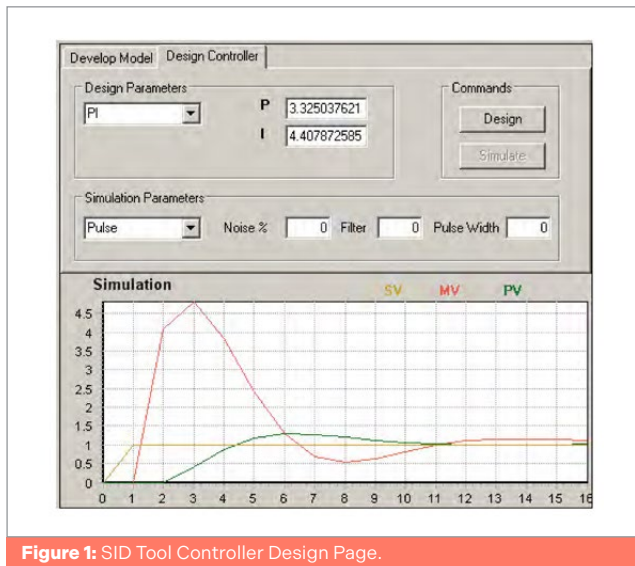


Figure 1: SID Tool Controller Design Page.

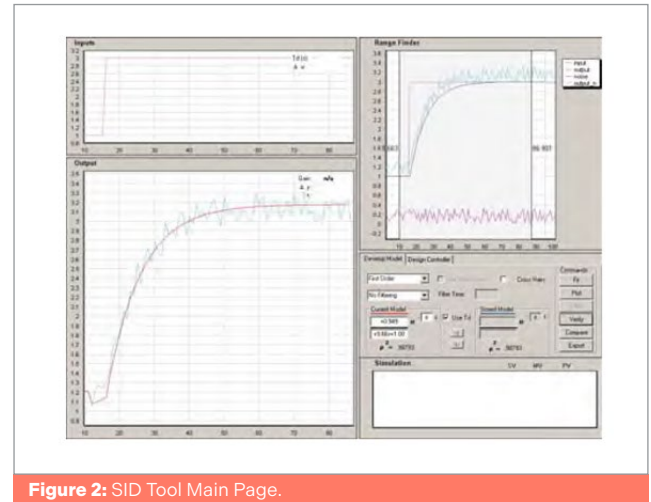


Figure 2: SID Tool Main Page.

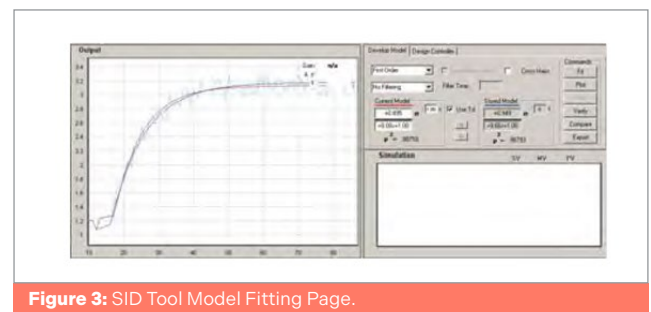


Figure 3: SID Tool Model Fitting Page.

Signal Conditioning

Fault Detection

Automation relies strongly on the validity of signals, and reactivity of actuators. For a control system to be truly robust, it is necessary to confirm that the signals being used are good representations of the process conditions, and that the actuators are responding correctly to the signals being supplied to them.

To this end a fault detection module has been designed to check the validity of signals, report faulty signals, and, if appropriate, provide a soft estimate of the signal in case of instrument failure. The fault detection module is capable of detecting out-of-range signals, frozen signals and spiking signals. Other modules are continually being developed.

Filters

First order exponential filters are capable of removing high frequency noise from measurements in most instances. However there are some specialised applications, where a sharper cut-off is required, or where filtering is not limited to separating high frequency noise and low frequency plant data.

The filtering toolbox provides a comprehensive package of higher order high pass, low pass, band pass and band reject filters. Noise-spike filtering and a specialised filter for integrating processes are also available, the latter removing the lag commonly associated with filtering.

A wizard is available to simplify the process of configuring the filters and also provides a graphical representation of the filter characteristics.

Advanced Controllers and Control Tools

Fuzzy Logic

Rule based control is often appropriate for processes where process models are discontinuous or cannot be determined accurately, but where manual control strategies are well defined. Mintek's fuzzy logic infrastructure allows the user to automate these control rules using fuzzy logic. Rules are structured using a wizard, and member functions are defined using a graphical interface.

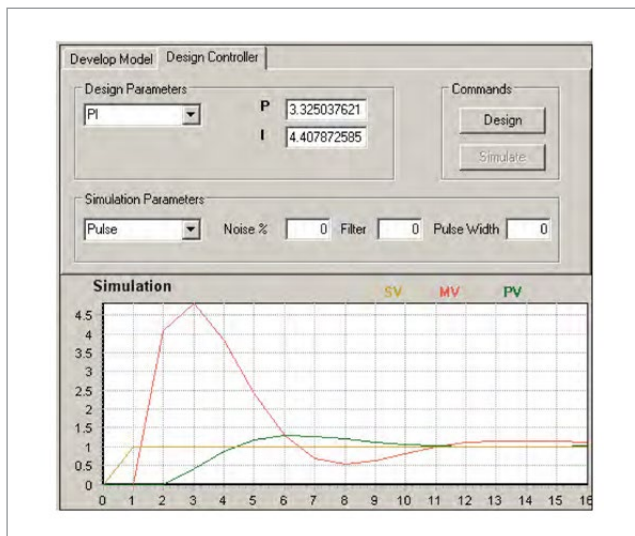


Figure 4: The Fuzzy Logic setup Wizard.

Gain Scheduler

Gain scheduling allows linear controllers to be implemented on non-linear processes, varying the controller gain depending on the operating region. Flexible gain specification and operating region selection criteria mean that the module can be used on a wide variety of processes.

MV Splitter

More than one manipulated variable (MV) is often available to control a single process variable. Mintek's MV splitter distributes a change in MV, as calculated by a controller, amongst a number of MVs. This distribution is done based on user defined weights, base values and limits, ensuring a linear controller response not susceptible to windup.

Safety Limit Controller

For some processes with more controlled than manipulated variables, certain process variables do not have to be controlled strictly to a setpoint, but only kept within limits. The Safety Limit Controller consists of an array of controllers, each of which is used to keep a specific process variable within its defined limits.

It will then prioritise the controllers so that the most crucial process variable is brought within limits first. When different controllers are switched on and off, the Safety Limit Controller will ensure bumpless transfer between controllers.

A second application of the Safety Limit Controller is handling circumstances where one manipulated variable occasionally is incapable of maintaining a critical variable within bounds.

A second manipulated variable can then be utilised to increase the resultant control action when necessary. Under normal operating conditions the second manipulated variable will be used to control a different process variable.

Soft Limiter

Soft limiting is particularly useful in cascade control. It is commonly used to keep master controller outputs within bounds, based on the achievable operating point of the slave controller.

Time Delay Compensator

Conventional control strategies have difficulty handling large time delays, often necessitating controller detuning with subsequent performance degradation. Mintek's time delay compensator control algorithm handles long time delays effectively, without the commonly associated performance penalty.

Multivariable Control

Model Predictive Control (MPC)

Model predictive control is a fully multivariable control technique. It uses a dynamic plant model to predict future changes in a process. A constrained optimisation technique is used to calculate control actions, with the objective of minimising the error between future prediction and the setpoint within the specified constraints.

Mintek's MPC controller is particularly suited for the following applications:

- Systems with a large number of manipulated and controlled variables with significant interaction
- Systems with unequal numbers of inputs and outputs
- Systems with constraints on the manipulated and/or controlled variables
- Processes with dynamically changing control objectives
- When equipment, for instance a sensor, fails
- Processes with long dead times.

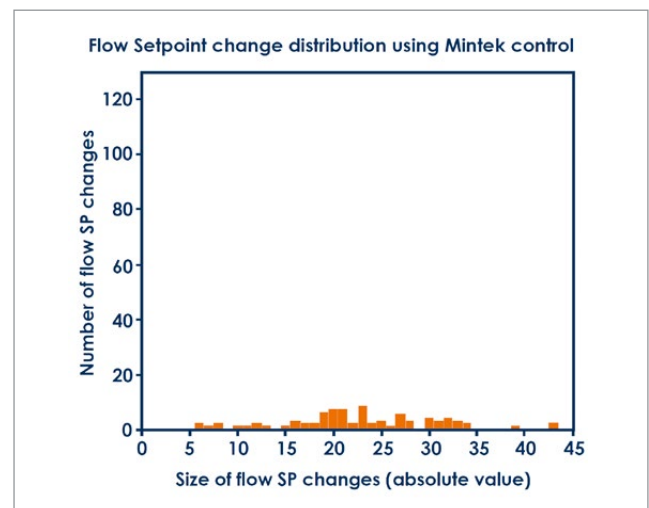
Application Specific Controllers

Surge Tank Control

Surge tanks typically act as a buffer reducing surges and disturbances to downstream processes. However there is a tendency to apply tight control to surge tanks to prevent them overflowing or running dry, and as a result the basic purpose of the surge tank as a buffer is nullified.

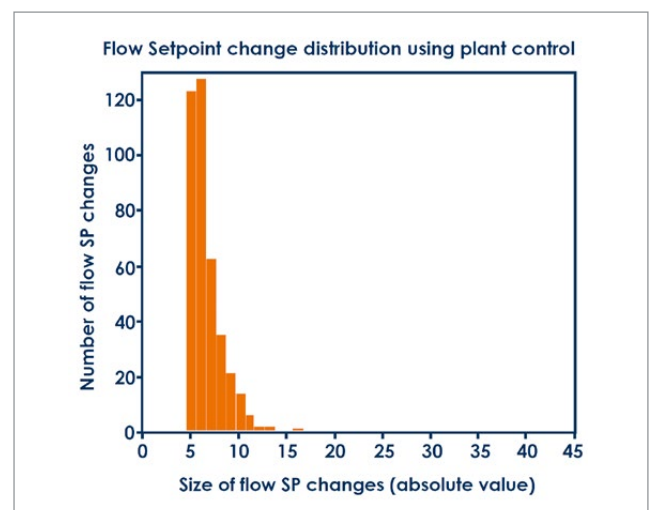
Mintek's surge tank controller uses a model-based approach to make optimal use of the surge capacity of these tanks. Flow variation out of the tank is minimised during normal operation, without degrading controller responses close to limits, thereby handling large disturbances effectively.

A significant reduction in flow setpoint changes can be achieved by utilising the surge capacity more effectively. Results of a case study indicating the benefits of using Mintek's surge tank controller is shown in the associated table below and figures on the right.



Mintek Surge Tank Controller Case Study

	Plant Control	Molycop Control
Average flow SP change / hour	175	26.1
Standard deviation of level	2.70	5.41
Max time SP remained unchanged	190 seconds	8.6 hours
Average time SP remained unchanged	30 seconds	47 minutes





Calculations

A number of matrix manipulation functions are available, including matrix addition, subtraction, multiplication and division, as well as extraction or modification of parts of the matrix.

All commonly used mathematical functions are supported by the matrix infrastructure. Statistics of a set of variables may be determined, including per-shift or per-day breakdowns.

Process Calculators

The StarCS Process Calculators product comprises a number of calculations commonly used in the minerals processing industry.

Calculations include:

- Calculation of the percentage solids in a slurry from the slurry density and vice versa
- Calculation of the percentage recovery of a mineral for a section of a process based on the available grade measurements.

Simulation and Online Estimation

Online Estimators

Curve fitting capabilities, including straight lines, parabolas, logarithmic and exponential functions are provided by the online estimators module. Process trends as well as dependencies of variables on others can be determined and fitted in real time. In addition to this, general mass, volume and energy balances can be performed, allowing unknown mass-, volume- or energy flows to be determined.

Simulators

The simulators package includes a range of generic simulators that can easily be adapted to simulate a specific process. Single input/output as well as multiple input/output simulators are provided. All simulators are based on Laplace or discrete transfer function models, and include noise addition and limit handling.

Additional Tools

Scripting

Scripting allows anyone with some knowledge of programming to adapt or develop new control strategies online using the StarCS control platform. Complex functionality may be implemented without need of a control module or extensive maths and rules structures. Scripting is supported for C#, JScript and VB Script.



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