INCREASE THROUGHPUT, REDUCE ERROR AND STABILIZE CIRCUITS WITH The KSX™ EXPERT SYSTEM

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SGS is a proven supplier of turnkey advanced process control solutions. We can help you take advantage of the proven benefits of advanced control with the implementation of an expert system, advanced modeling, scheduling and simulation, or optimization.

SGS’s advanced process control solution improves your:

- Quality
- Safety
- Production
- Operational stability
- Control performance

The heart of SGS’s advanced process control systems lies in the skillful implementation of the KSX™ expert system.

An expert system consists of a knowledge base and an inference (reasoning) engine. It enables the timely and consistent application of best operating practice in response to variability. An expert system makes better control decisions because it is able to

- Consider more variables than a human operator can monitor.
- Act consistently time-after-time.

Today’s expert system technology is proven to be effective at both small and large scale operations.

Properly employed, it is the control strategy that provides the largest improvement in circuit stability and production rates both immediately and over time. Expert systems consist of a rules-based fuzzy logic control strategy that pushes against process constraints to improve throughput while maintaining process parameters within safe and sustainable levels – at all times. The development of rules-based fuzzy logic applications in circuit control has matured to the point that circuit condition definitions and their place in the logic structure can be reliably incorporated into expert systems. Significant operational improvements can then be realized when expert systems are combined with:

- Existing monitoring technologies
- In-house operational expertise
- Advanced system and mineral processing experience.

Easy to install

Expert control systems have proven successful at both large and small scale operations. The technology and software they incorporate is mature, robust and proven at operations worldwide. Typically, installation will involve a knowledge capture process and design stage followed by an interface setup and tuning process. Training and final calibration are optimized through live feedback sessions prior to final project acceptance and handover to operational staff.
Real Time Trends
KnowledgeScape provides real time trends to track the process and control logic. The colors, time span and scale are user configurable with any number of traces allowed. Trends are a valuable tool to the strategy implementer for monitoring and troubleshooting the process and control.

Intuitive Fuzzy Logic Configuration
In KnowledgeScape each attribute can be configured to have multiple fuzzy sets representing different states. This configuration window is accessed from one of the tabs in the attributes configuration pane. Adding fuzzy sets is easily accomplished.

Real Time Tables
KnowledgeScape includes real time value tables to track the process values and control states. The colors, time span and scale are user configurable. Data can be viewed or edited making these a valuable tool for monitoring your process and making changes as needed.

Unlimited, Distributed Neural Network Models
KnowledgeScape provides advanced modeling tools including feed-forward neural network models. The models can be configured quickly and easily. The user can specify the inputs, outputs, layers, training details etc. KnowledgeScape allows an unlimited number of neural networks, and multiple neural networks may be configured to compete with one another, automatically selecting the best model for control.

Hierarchical Process Representation
KnowledgeScape provides a node tree graphical user interface. This is the center point for configuring the expert system. An object oriented approach is utilized, and the user can build “nodes” and “attributes” representing the various unit operations and data from the process to be controlled.

Graphical Rule Logic Diagram (Schematic)
KnowledgeScape includes a powerful visual rule parser that allows you to track the logic for any rule. This rule schematic is real time and...

Distributed Computing
KnowledgeScape can distribute its computational load over a local area network, or an internet virtual private network. This allows the user to configure as many neural networks and optimizers as desired and run them in parallel in real time and on-line. Each neural network and optimizer can be assigned to a client machine when it is started, or KnowledgeScape can determine the client with the least CPU load and distribute the task to that machine.

Standard Communications
KnowledgeScape communicates with the outside world using the OPC (OLE for Process Control) protocol. OPC is a standards based open communications protocol widely adopted in process control industries. We have been developing drivers for many years and can develop custom drivers where needed. No matter what, we can connect to your system.

Advanced Rule Scheduling
KnowledgeScape allows for four different types of rule scheduling. Theses types allow complete time or event based rule control. The rule scheduling option are:
At server configuration start up, allowing you to initialize variables or initiate start up processes.
Interval timing allows rules to be scheduled at a set time interval, every X seconds.
Calendar timing allows date intervals or recurring schedules such as the first Monday of the month or every day at 6 am.
Trigger rule scheduling looks for changes in specified attributes and then fires the rule.

Easy, English-based Rule Syntax
KnowledgeScape includes an easy to use rule editor that provides real-time parsing and syntax validation. It uses an intuitive, intention revealing, English based rule syntax. Syntax help lists display functions and keywords as well as context specific objects such as nodes and attributes. These syntax suggestions are updated in real time as the user types limiting the options and making rule creation as simple as possible. Process Engineers, Metallurgists, Chemists can write rules to clearly control the process. No programming expertise is required, and it is not necessary to learn a new programming language. This allows for the end user to maintain, and develop new applications in the plant with virtually no obstacles.

Genetic Algorithm Optimizer
KnowledgeScape provides genetic algorithm optimizers to quickly and effectively search large model spaces for user defined optima. They are robust, easy to use and quickly find global maxima that traditional search methods can miss. Optimizers can be configured to automatically select the best of many competing models when searching for optimum set points for the plant.
Expert Ball Mill Control

The first state in the decision hierarchy confirms whether the ball mills are operational and available. If true, the control system will continue to evaluate downstream operational states, and any associated control actions will be implemented whenever a true result is achieved. For a ball mill circuit, several measurements are considered when defining the process states:

- Power draw
- Mass-flow to cyclone
- Sump level
- Mill discharge as % solids
- Cyclone feed as % solids
- Cyclone overflow particle size.

Expert fuzzy logic is used to determine the process variables in an evaluation hierarchy. For example, a high mass rate to the cyclone can imply a high load, but if the overflow particle size is on-target then less weighting is given to the high mass situation. This means that the expert fuzzy logic response will be mitigated by the presence of an on-target, validated, overflow particle size. In “Overload” situations, the expert system implements control actions based on the current power draw, circulating load levels and rates of change of circuit values. The control actions range from a partial flushing without a feed tonnage decrease, to a feed tonnage reduction with a full mill flushing. The existence of multiple possible actions ensures that the appropriate control procedure is taken in relation to the severity of the condition. Once at the “OK Load” state, the expert system attempts to optimize and increase tonnage with the knowledge that the recirculation load is not increasing. The expert system simultaneously verifies that other key variables such as power draw, sump pump amps, and cyclone feed density are stable. In scenarios where densities are out of range, the expert system corrects the situation by modifying the water addition at the ball mill feed location or cyclone feed sump. Simultaneously, the stability of variables such as cyclone overflow...
The Best Companies Use the KSX™ Expert System

Over three decades, KSX™ has been established as an industry leading expert system, and it is used in the biggest and best concentrators in the world. SGS has the expertise and experience needed to provide the highest level of performance to any concentrator.

Mineral processing operations involve massive capital outlays and high operating costs due to ever increasing energy and material costs. Effective use of processing circuits and equipment is a must in these environments when even small increases in throughput can amount to millions of dollars in added revenue.

Expert systems using rules–based fuzzy logic control allow existing operations to increase their throughput by as much as 6% after installation and tuning. Expert systems technology and the incorporation of fuzzy logic have earned a reputation for robustness, sustainability and flexibility within the minerals industry. A well-designed and installed expert system will reduce gross operator error, stabilize existing or future processing circuits, and optimize product quality and throughput.

With decades of practical experience and a unique depth and breadth of operational expertise, SGS understands your plant processes. We have completed over 90 successful installations across the globe, and can help push your processes to new levels of performance and optimization. Our proven 3-step methodology seeks to extract best operating practices from your personnel, program it for automatic decision making and combine it with our in-house expertise. The result is a product that encompasses your operating philosophy and reinforces the operators’ confidence and beliefs. SGS expert systems are always on duty, optimizing your output on every shift.

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