SGS Minerals Services is the industry leader in providing support and creating solutions for mining projects worldwide. SGS offers advanced process control solutions through the implementation of expert systems to improve your productivity. Developed by SGS, the MET (Modular Expert Technology) Platform is an expert system that uses advanced control technology in the creation and deployment of real-time, mission critical expert solutions.

MET PLATFORM

An expert system consists of a knowledge base and an inference (reasoning) engine. It is able to mimic the human thought process and make quantified, intelligent decisions by combining the knowledge base and inference engine.

Our inclusive and progressive project methodology is designed to extract best operating practices from your personnel, program it for automatic decision making and combine it with our in-house expertise. The resulting body of knowledge is then coded and deployed using our proven software platform, MET. Our approach brings understanding, consensus and a sense of ownership as the deployed solution demonstrates positive results.

SGS’ MET consists of a set of tools that support the easy and rapid development, commissioning and tuning of expert systems and advanced control applications. These are interfaced with external systems including DCSs, PLCs, and databases. With the MET Platform, SGS provides the ability to develop state-of-the-art solutions to meet your most complex requirements.

FEATURES AND BENEFITS

The SGS MET Platform allows the rapid development and implementation of a 24x7 real-time expert system and advanced control solutions. It includes features such as:

- Innovative custom solutions based on expert systems technology.
- A solid foundation knowledge database with process model classes, methods and functions.
- Coding knowledge of best operational practices.
- Reliable data communications including redundancy, diagnostics and monitoring.
- 24x7 operation with online process tuning requiring no downtime.
- A core module with calculations and algorithms for data validation, filtering, and statistics.
• Support for various communication interfaces (e.g. OPC, ODBC, Oracle, PI).
• Built-in application tuning and support tools.
• Effective tuning performed on live applications.
• Wide choice of control strategies such as rule-based fuzzy control, neural networks, model predictive control (MPC), multivariable stabilizer, and advanced regulatory control.
• User friendly debugging and maintenance tools.
• Large library of pre-defined process object classes, fuzzy/defuzzy membership functions, schematic models (equipment templates) and control models (advanced process controller templates).
• Remote access via network for multiple simultaneous users.
• Reporting, data recording, and data replay features.
• User friendly interface with many graphical presentation layer features that allow animation and data presentation including:
  • Graphs
  • Charts
  • Tables
  • Read-out displays
  • Action buttons
  • Message queues
• Process stabilization and optimization.

The advantages provided by the SGS MET Platform come from the large number of advanced tools offered. These allow for the integration of different control strategies and implementation of innovative custom solutions. The main benefits include:
• Ability to create applications from predefined templates.
• Ability to interface with external applications, for instance using the ActiveX framework.
• Ability to add modules for different unit operations.

• Consistent control strategy and improved decision making.
• Improved overall process performance, reliability and quality.
• Decreased application development time.
• Reduced downtime.
• System scalability.
• Easy navigation of the application.

APPLICATIONS

The Advanced Systems group at SGS has significant experience in the implementation of expert systems. We have installed close to one hundred implementations worldwide for mineral and mining operations. These include applications for processes including:
• Crushing
• Stockpiling
• Grinding
• Flotation
• Dewatering
• Concentrate transport
• Utilities management
• Logistics.

In addition, the MET Platform can provide advanced process control solutions to many other process units or industries.

MET SOLUTIONS APPROACH

SGS’ MET Platform is an object-oriented development environment that uses structured natural language with objects, rules, methods and procedures. This allows for the rapid development of powerful solutions based on expert system and standard programming technologies. Each MET solution has a unique structure and is designed to solve complex problems using reasoning rules and advanced control algorithms.

A typical MET solution consists of two main components – the inference engine and the knowledge base. The inference engine defines the algorithms that use reasoning rules to implement advanced control strategies. The knowledge base consists of the knowledge of the best operating strategies as defined by plant operators, engineers and process experts at your site.

The knowledge base is built using standard methodology:
• Interview – Our integration engineers lead an interview with the operators and process experts to determine the “site best operating practice”. The interview assists in identifying and characterizing the right control strategy. This is an initial identification phase which helps to gather information about:
  • Site best practices
  • Process conditions and constraints
- Equipment
- Instrumentation
- Working control systems
- Logic Diagram Development – The knowledge obtained during the interview and the knowledge of SGS' experienced engineers coalesces into a control strategy that is presented in logic diagrams. After a strategy is agreed, the logic diagrams are coded into MET using graphical language (blocks) and if-then reasoning rules.
- Tuning – after the application is developed and deployed in the plant, SGS’ integration engineers tune the application by adjusting and correcting limits, fuzzy/defuzzy functions, waits and other control parameters to ensure the desired performance is achieved.

## TECHNICAL FEATURES

SGS’ MET Platform functionality is contained in modules. They are divided into two groups – the MET core and the MET cartridges.

### MET CORE MODULES

The MET core modules are the foundation architectural components of the MET Platform. The following features are included in the MET core modules:

**Process Diagram** – The Process Diagram includes the fundamental class definitions that represent process measured variables (not directly controlled) and manipulated variables (directly controlled – setpoint, controller output). These diagrams also provide graphical representation of process objects such as equipment, instrumentation and controllers that we use to build your process schematics.

**Data Pre-processing** – Data Pre-processing consists of raw process data preparation and filtering algorithms/methods/concepts that minimize the impact of errors that input data can introduce to succeeding control/analyses. The Data Pre-processing modules contain calculations such as normalization, rate of change calculations and a large number of filters:

- Exponential first/second/third order
- Average
- Weighted-average
- Limits
- Quality

**Fuzzy Module** – The Fuzzy Module includes the foundation for fuzzy logic reasoning. It includes the ability to create and customize fuzzy/defuzzy functions when the belief value of a fuzzy set is assigned to the certain value of the process conditions (e.g. high, low, increasing, decreasing) and the belief value of corresponding defuzzy set is a certain step value of a setpoint (e.g. increase, decrease).
Fuzzy Module

State Matrix
The Fuzzy Module provides a graphical representation of the fuzzy/defuzzy sets that can be grouped in families. The SGS fuzzy concept includes a fuzzy multistate functionality that covers the situation where a fuzzy function must have different ranges for changed process conditions (e.g. different ore types).

Fuzzy logic allows the creation of robust control strategies that handle changes in process characteristics over time (i.e. liner wear), over a wide range of operating regions (i.e. entire power and pressure range) and non-linearities and extreme (un-modeled) conditions with ease (e.g. overload detection).

**Data Recording and playback** – These modules include special recorder objects that were developed to record data to a CSV file that can be read in an Excel spreadsheet. The data can be recorded with a predetermined interval and later used for plant analysis and surveys. It is also possible to record real-time data (OPC variables) and later play the data back. As a result, this is a powerful tool for scenario replay and recreation of anomalous plant events. For example, the replay feature can be used to capture a mill overload situation and by playing back the event, logic can be modified and enhanced to eliminate future occurrences.

**Communication Interface Modules** – The SGS MET Platform provides a communication structure that allows communication with OPC servers, databases (SQL Server, Oracle) and other systems such as PI-Historian. The Communication Interface Modules also include heartbeat (communication health check), auto-recovery functionality and communication redundancy.

**State Matrix** – These include the process state utility and the function block library modules. The process state utility is used for organizational management of the logic diagrams and implementation of the process state engine functionality. The state objects are organized in a hierarchical diagram and each state’s status is defined by process classification logic assigned to this state as well as its position in the state diagram.

**Graphical Rules**

**Graphical Rules for Fuzzy Control** – The MET block modules provide function blocks for reasoning, statistical process control and arithmetic calculations. They provide graphical language to create complex diagnostic procedures such as a collection of connected blocks. Animation of blocks and connection paths provides a powerful feature for application tuning and diagnostics, as well as providing a powerful tool for process tracking.

**Hybrid Control Architecture** – This is a system architecture in which different control strategies can be combined. For instance, rule-based fuzzy control with linear/non-linear prediction or multivariable methods. This provides a way to combine various control strategies and then select the one that best optimizes a process.
**Statistics** – This module monitors and generates on-line statistical data for user-specified process parameters and expert system constraints. By default, the statistical data are reported to Excel, but database reports can be offered as a custom functionality. All monitored constraint data can be presented on plots providing the percentage of time the variable was in the high or constrained range and in the low and constrained range.

**MET CARTRIDGES**

SGS’ MET Platform includes many extended functionalities that are called cartridges. The MET cartridges are assigned different frameworks:

- Control
- Tuning
- Support
- Diagnostic
- Presentation layer

Examples include:

- Multivariable stabilizer
- Neural networks
- Process explorer

**MET SUPPORT**

SGS offers the most complete support service for our applications to ensure maximum long term returns from your expert system application. The support subscriptions combine on-site and remote assistance according your specific needs.

The SGS support service assures your company that the value added through the implementation of the SGS expert system will be consolidated and enhanced over the years.

With over 11 years of demonstrated results, SGS has more installed and operating expert systems than any other company in the world. Contact us today to find out how our advanced process control solutions can provide you with the decision making tools to streamline your production in real time.

**MINIMUM HARDWARE REQUIREMENTS**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory</td>
<td>4 GB, 667MHz, DDR2 SDRAM Memory, ECC (4 DIMMS)</td>
</tr>
<tr>
<td>Display</td>
<td>1280x1024 in 256 color</td>
</tr>
<tr>
<td>Storage</td>
<td>120GB SATA-3 HDD; DVD-ROM</td>
</tr>
<tr>
<td>Processor Speed</td>
<td>Intel Core 2 Proc E6700, 2.66 GHz/1066MHz/4MB, Dual Core, VT</td>
</tr>
<tr>
<td>Network</td>
<td>Ethernet connectivity required. Dual NIC recommended.</td>
</tr>
<tr>
<td>Architecture</td>
<td>1 PC required.</td>
</tr>
</tbody>
</table>

**CONTACT INFORMATION**

Email us at minerals@sgs.com
www.sgs.com/advanced-systems