System 800xA Minerals Library – Advancement through parameterized process control

ABB’s System 800xA Minerals Library is a suite of unique object-oriented software control modules that makes it possible to design process control and power applications in a highly efficient and fully parameterized fashion.

Successfully operating at more than 150 cement and minerals sites worldwide, the technology significantly increases the standardization, functionality and quality of process control software over the complete life cycle of a production facility - enabling downtime caused by abnormal situations to be minimized and the facility’s production process and assets to be efficiently operated and maintained.

![Jura Cement's facility at Wildegg, Switzerland](image)

**Figure 1** – Jura Cement’s facility at Wildegg, Switzerland, is one of more than 150 cement and minerals processing plants that benefit from ABB’s parameterized and object-oriented process control solutions

**Traditional control design**

In process control applications, software is traditionally designed using function blocks that are interconnected by various single information variables. In such designs, the interfacing between the function blocks does not follow a set pattern but is left to the discretion of the programmer. Even if the function blocks have been tested and approved, the code between the blocks allows plenty of room for error and inconsistency in the coding and behavior of the software.

Consequently, it takes a system specialist to interpret the software’s control strategies. Since the interface between the function blocks is not pre-defined, the potential of a library upgrade to deliver improvements is limited to the function blocks only; it does not enhance the important code between the blocks.
A new way of thinking
The first concepts on how to simplify the interface between group/sequence function blocks and motor/valve function blocks were developed in the late 1990s. At that time, however, the available technology in the process controllers was not sufficiently advanced to allow the concepts’ implementation. This all changed when ABB introduced its fully object-oriented Extended Automation System 800xA control platform, which made it possible to develop and implement a complete new library concept using parameterization and an innovative approach to data exchange called ‘control connections.’

Control connections
In this unique concept, all software modules exchange data through defined interfaces called control connections. A control connection is a logical connection between a parent object and as many child objects as required. It is a data highway over which all the information defined for exchange between a parent object and its child objects is submitted. The communication is bi-directional, enabling parent objects to send commands and retrieve status information from child objects and vice versa. The amount of information exchanged over the inherited control connections interface is changeable in runtime.
Parameterization

Once ABB had designed the communication interface between software modules, the next step was to capture the functionality that was traditionally programmed with code between the function blocks. ABB Minerals has put a lot of effort into the systematic analysis of typical cement and minerals processing application program solutions and operational situations. The captured results have been used to develop generic parameterized functions.

As a result of this process, the System 800xA Minerals Library comprises a comprehensive set of software modules that make it possible to design process control applications simply by parameterizing well-test software modules. The readability of the application code has become much easier, enabling operators and process engineers to understand the control solution and improve it when required.
Functionality
Today the System 800xA Minerals Library covers the following three functional areas:

- Group/sequence control (GCC)
- Process equipment interlocking (PCC)
- Electrical energy management

Group/sequence control
In cement, mining and minerals applications, group control - like the sequential or cyclic start and stop of process equipment including routing and duty standby - is essential. ABB’s System 800xA Minerals Library provides the following fully parameterized functions:
- Group control modules for continuous or cyclic processes
- Unlimited number of process equipment items per group (motors, valves, actuators, loops)
- Starting and stopping of all process equipment according to the parameterized sequence
- Selector modules for parameterized routing and duty standby applications
- Connection of process equipment to several groups (several parents for one child)
- Summary status (run, warning, failure, etc) from connected process equipment visible in the group header process graphic and faceplate
- First fault detection - the tag of the process equipment causing the group to fail is presented in the group faceplate, including a hyperlink to navigate directly to the faulty equipment
- All key parameters like group name, step numbers, start and stop delay as well as routing information is visible in the faceplate of each item of process equipment
- The group status viewer presents detailed information of the group and all connected process equipment including start order and routing information

![Figure 5 – Example of a process graphic display showing one group and all related equipment](image)
Figure 6 – Group status viewer presenting one group and all related process equipment

The concept allows users to add, remove or change the start/stop order as well as the routing of the process equipment in runtime. The group status viewer automatically updates as soon as the changes are loaded into the process controller. Thus, the operator gets reliable, up-to-date and easy to understand information on the status and behavior of all groups.

Process equipment interlocking

Much of the process equipment in the heavy industry market requires interlocking signals for human and machine safety or process control. Traditionally, the interlock code that was programmed between the digital and analogue signal function blocks and the process equipment function blocks (motors and valves, etc) was not or only partly visible to operators and process engineers. The non-availability of this information makes it difficult to operate the plant in an efficient and safe manner.

The parameterized interlock concept of the System 800xA Minerals Library closes this gap and at the same time simplifies plant operations. All the interlocking signals for each item of process equipment are connected to the interlocking control connection. The parameters of the signal software modules allow configuration of the required interlock behavior. Functions include:

- Analogue and digital input signals, as well as PID loop controller modules, provide parameters for the configuration of the control interlock and automatic process start/stop of one or several items of process equipment
- Unlimited number of signals per item of process equipment
- Signals read the process equipment status (on, off, local operation, maintenance, etc) to execute the required alarm and start the inhibit function
- First fault detection and suppressing of unnecessary subsequent alarms
- Automatic indication of the signal tag causing a failure in the process equipment faceplate, including a hyperlink to navigate directly from the process equipment to the faulty signal
- All key parameters like threshold limit, warning and failure delay, interlock type, local operation override and start inhibit time are visible in the faceplate of each signal.
- The interlock viewer presents detailed information of all signals controlling the equipment. Beside the actual status (no interlock, warning or failure), the viewer informs the operator on temporary overrides made for maintenance or abnormal situations.

Figure 7 – Definition of an interlock by parameters. The example shows a digital signal DIS configured as equipment interlock, and an analogue signal with H2 and L2 limits configured as safety interlocks.
The concept allows users to add, remove or change interlocks in runtime. The interlock viewer automatically updates as soon as the changes are loaded into the process controller. Thus, the operator gets reliable, up-to-date, and easy to understand information on all interlocks.

Figure 8 – Viewer showing all implemented interlock conditions for one item of process equipment

<table>
<thead>
<tr>
<th>Interlock Type</th>
<th>Name Description</th>
<th>Status</th>
<th>Forcing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>561-BM1.F1</td>
<td>CEMENT MILL - Flow Low Low - Alarm</td>
<td>Blocked</td>
<td></td>
</tr>
<tr>
<td>561-BM1.F2</td>
<td>CEMENT MILL - Flow Low Low - Alarm</td>
<td>Blocked</td>
<td></td>
</tr>
<tr>
<td>561-BM1.F3</td>
<td>CEMENT MILL - Flow Low Low - Alarm</td>
<td>Blocked</td>
<td></td>
</tr>
<tr>
<td>561-BM1.T1</td>
<td>C.M.BEARING TEMP 1 - H2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>561-BM1.T2</td>
<td>C.M.BEARING TEMP 2 - H2</td>
<td>H2 Alarm</td>
<td></td>
</tr>
<tr>
<td>561-BM1.T3</td>
<td>C.M.WINDING TEMP 1 - H2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>561-BM1.T4</td>
<td>C.M.WINDING TEMP 2 - H2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>561-BM1.T5</td>
<td>C.M.WINDING TEMP 3 - H2</td>
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<td>(2) 561-L01.M2</td>
<td>C.M.LUB. OIL PUMP 2 - Pump 2</td>
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<td></td>
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<tr>
<td>Equipment</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>561-BM1.P1</td>
<td>CEMENT MILL - Pressure Low Low - Alarm</td>
<td>Blocked</td>
<td></td>
</tr>
<tr>
<td>561-BM1.P2</td>
<td>CEMENT MILL - Pressure Low Low - Alarm</td>
<td>Blocked</td>
<td></td>
</tr>
<tr>
<td>561-BM1.P3</td>
<td>CEMENT MILL - Pressure Low Low - Alarm</td>
<td>Blocked</td>
<td></td>
</tr>
<tr>
<td>Equipment Start</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>561-BM1.T1</td>
<td>C.M.BEARING TEMP 1 - H1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>561-BM1.T2</td>
<td>C.M.BEARING TEMP 2 - H1</td>
<td>H1 Warning</td>
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<td>C.M.WINDING TEMP 1 - H1</td>
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<td>C.M.WINDING TEMP 2 - H1</td>
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<td>C.M.WINDING TEMP 3 - H1</td>
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<tr>
<td>561_BM1</td>
<td>Mill Restart Interlock (1 out of 1)</td>
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<td></td>
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<tr>
<td>(1) 561-BM1.M1</td>
<td>CEM. MILL MAIN DRIVE - Time Since Mill Stop</td>
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</tr>
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<td>Previous Drive</td>
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</tr>
<tr>
<td>561-BM1.M1</td>
<td>CEM. MILL MAIN DRIVE - 561_BE1_M1 - PD</td>
<td>Alarm</td>
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</tr>
</tbody>
</table>
**Electrical energy management**
Integration of the power distribution monitoring and management systems into the plant control system is becoming more and more important in today’s liberalized energy markets. The ABB System 800xA Minerals Library is equipped with object-oriented software modules for the following electrical applications:

- Circuit breaker control
- Power factor correction
- Energy, power and tariff limit scheduler, including overrun warning and load shedding

In combination with System 800xA’s comprehensive communication capabilities - which include Ethernet-based protocols, IEC 61850, Modbus TCP/IP and Profinet IO - the power and process automation systems not only run in one single system but are covered by one common software module library as well.

![Figure 9 – Integrated electrical energy monitoring and management](image)
Next generation of integrated electrical, instrumentation and control engineering
All functions and devices for electrical, control and instrumentation engineering can be centrally managed and configured by using the comprehensive link between Aucotec’s Engineering Base (EB) and the System 800xA engineering tools.

Both EB and System 800xA complement each other ideally and enable significantly more efficient project processing with far greater consistency and quality of data. This does not work with every electrical computer aided engineering (ECAE) tool. Such a tight connection is only possible through the open structures and application interfaces that EB and 800xA provide, thus enabling direct export of the functions and devices between EB and System 800xA that are relevant for process control systems. The export takes place in one single step and can be refined in multiple iterations.

ABB’s mining business unit will be introducing this solution into all its local operations in stages. The solution is also ideal for plant maintenance – with only one simple click within System 800xA, the electrical schematic for the relevant function can be opened in EB, from there all electrical data is available. The user can navigate between the two systems at any time, making system boundaries disappear.

Benefits
Using Aucotec’s Engineering Base (EB) as the platform for electrical and control system engineering with a unique integration into ABB System 800xA makes huge inroads into the time taken to create software.

Fully parameterized object-oriented application software provides significant benefits over the complete life cycle of the plant:

- **Engineering, testing and commissioning**
  - Objects with defined two-way interfaces reduce the engineering effort
  - Parameterized group start/stop/routing/changeover
  - Parameterized safety, equipment and process interlocks
  - Reduction of individual code between objects to 10 percent of a traditional application software
  - Increased quality and structure of application software
  - Powerful graphics library for easy implementation of a consistent and ergonomic look and feel
  - Reduced risk thanks to proven software modules with known behavior
  - Powerful testing and simulation with built-in simulation on soft controller
  - Improved commissioning time
Figure 10 – Relative engineering effort required per method of implementation

- **Operation**
  - Consistent, flexible and proven operation concept
  - Indication by color, shape and labels instead of by color only
  - Display design focuses attention on abnormal situations
  - Alarm management and abnormal situation monitoring
    - Alarm list messages may be suppressed in case:
      - the parent object is off – alarm on active parent only
      - the parent object is starting up – start up alarm inhibit
      - the parent object is in local control mode – auto acknowledge in local operation mode
    - First fault and highest priority alarm detection and forwarding to consumer and group
    - Automatic reduction of alarm severity for consumers defined as standby
  - Good diagnostic functions presenting objects and their relation for fast and correct decisions
    - Dynamic hyperlinks between parent and child faceplates
    - Group status viewer
    - Interlock viewer
  - Operator training with built-in simulation
Figure 11 – Easy navigation with dynamic hyperlinks between objects is one of many features that help operators to find the root cause of abnormal situations

- **Maintenance**
  - Extensive alarm, event, tracking and trending functionalities
  - Group status and interlock viewer
  - Device diagnostic viewers – enabler for remote diagnostics
  - Object-oriented and structured application design
  - Direct link from HMI process displays to the corresponding software module in the controller software
  - Life cycle support
    - Large installed base
    - ABB policy for long-term life cycle support and compatible software upgrades

**Launch of new version of 800xA Minerals Library**
In June this year ABB launched Minerals Library Release 5.1/4, a new version of the proven process control system library to reduce operating costs and increase productivity of cement and mineral processing plants.

Minerals Library 5.1/4 comes with the following new features:
- Control diagrams for better process-oriented visualization of the application software
- Integration into Engineering Base, AUCOTEC’s plant engineering tool, which is successfully implemented in ABB’s cement and mining projects
- Advanced drive and equipment group modules for today’s demanding material handling, grinding and mineral processing applications
• Extended parameterized solutions, which further reduce implementation costs and increase functionality
• Support of ABB’s System 800xA 5.1 Feature Pack 4

“The latest Minerals Library enables system engineers to develop new applications faster and at highest quality”, said Martin Knabenhs, Product Manager for Minerals Libraries at ABB. “Maintenance teams and operators further benefit from easy fault-finding procedures including access to plant documentation. In addition, our customers can benefit from our long-lasting experience. More than 300 sites in the cement and minerals industries are already yielding positive results by using the library every day.”

**Conclusion**

ABB’s System 800xA Minerals Library and tools are designed for greenfield plants as well as for control system upgrades. Based on parameterized object-oriented software modules, it helps to reduce engineering complexity, minimize downtime caused by abnormal situations, and simplify fault-finding. Its ability to reduce operating costs and increase productivity over the life cycle of the production facility is widely attested.

*Figure 12 –Main cement process overview using ABB’s System 800xA Extended Operator Workplace*