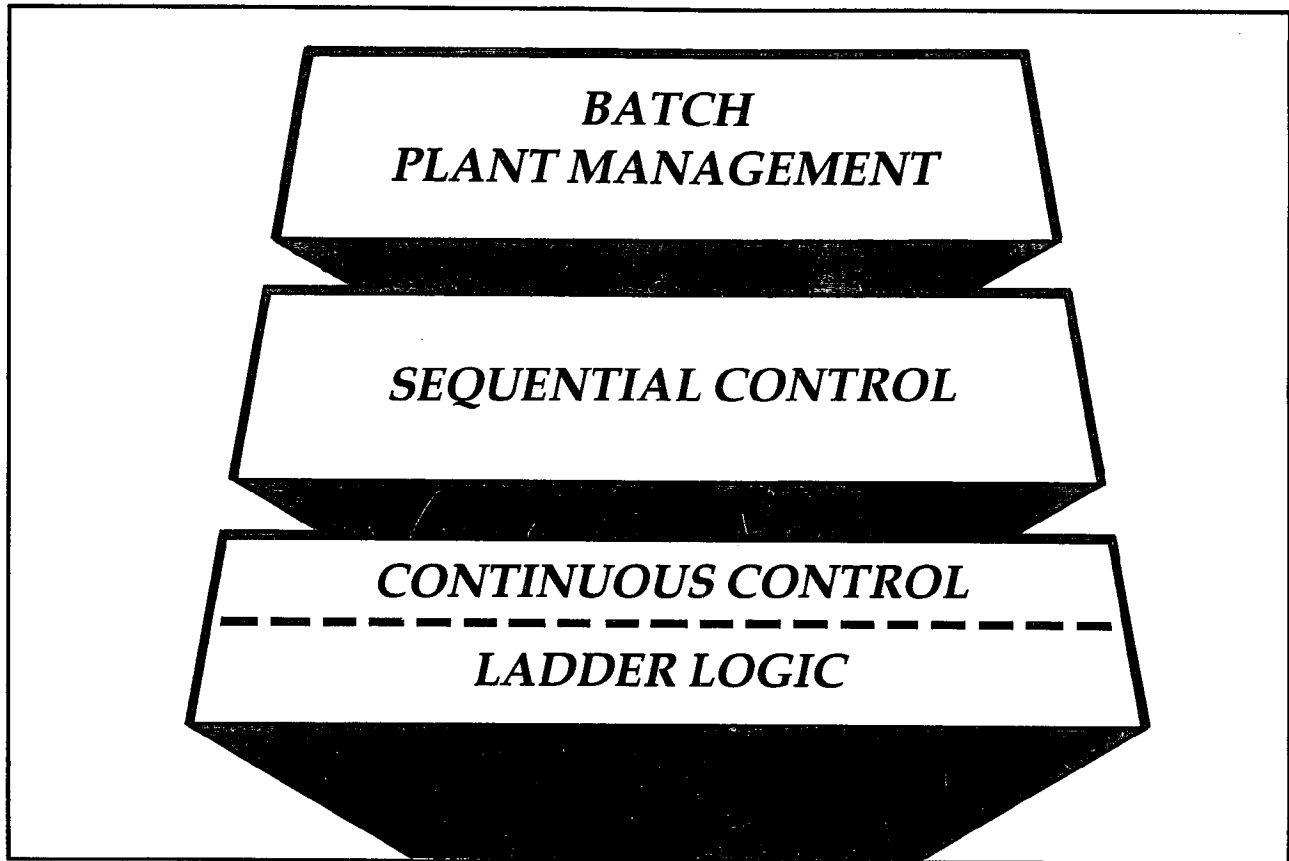# Intelligent Automation Series
Batch Plant Management

Batch Plant Management provides a means to automate batch process applications and coordinate continuous and sequential control functions

The Intelligent Automation Series Batch Plant Management software automates batch production control activities in a plant and provides extensive storage and retrieval of data associated with these activities. The automation of a batch plant can provide the following advantages:

- Faster batch processing resulting in greater production capability.

- More consistent product that meets tighter tolerances.

- Greater plant/product security with exception logic.

- Extensive data collection and reporting, associated with batch production, that assists with production tuning.

FOXBORO®

A SIEBE COMPANY

Batch Plant Management provides a flexible set of tools which can meet the needs of a wide variety of applications. Because the tools can work independently, you can select the appropriate tools required for your application.

Capabilities

While Batch Plant Management is oriented towards batch process applications, the batch material tracking capability can easily be applied for continuous process applications. Also, the procedure logic available with batch software can assist you with the startup, shutdown, and monitoring of continuous units.

Batch Plant Management contains the following capabilities:

- Production view—collects the process control details of compounds, blocks, and parameters and organizes them into units.

- Unit level control—organizes the process control details into production commands such as unit operations to fill, heat, or drain a unit.

- Batch Monitoring—tracks material in a process and provides data retrieval for that material as it moves through the process units. Batch monitoring also allows production commands associated with batches.

- Procedure logic—automates execution of production commands.

- Formulas—which are sets of variables used by the procedure logic, vary the results of procedure logic.

Batch Plant Management uses the power of a relational data base to store current information about the production activities that it coordinates and manages. In addition, the batch software maintains historical records of production activities by sending this information to the Historian.

Production View
Batch Plant Management uses a view (data base query) which describes how the lower level control blocks are organized to work with process units. This view originates from the Production Model data base. The Production Model hierarchy together with its entities is shown in Figure 1. An example associated with each entity is shown in parentheses.
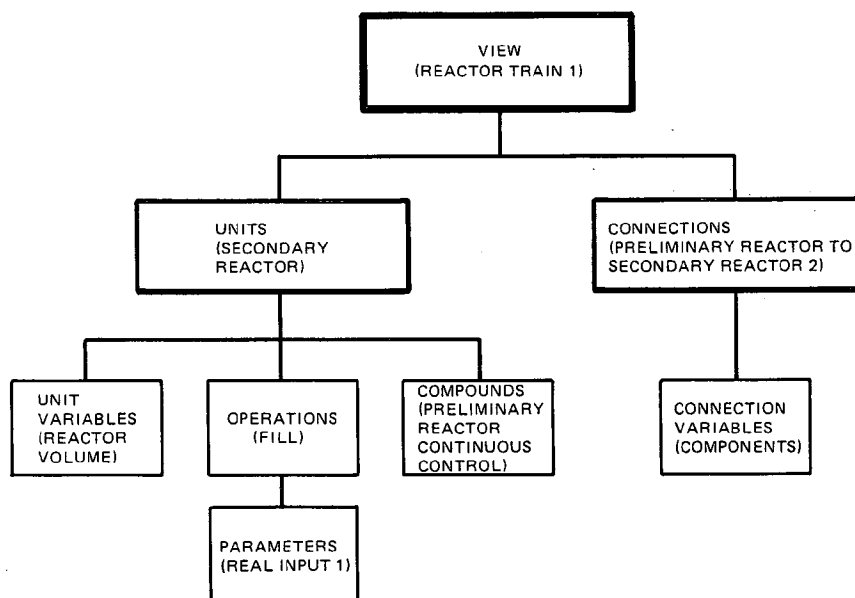
Figure 1. Production Model Hierarchy from Batch Production View

Batch Plant Management uses the view to translate production commands into specific control block actions, which are directed toward selected loops. This translation comes from the operation definition. The batch software allows you to work with process operations such as fill, heat, or drain, that are defined in the Production Model data base. The view associates a Sequence Control Block of the Control and I/O data base with each of the operations that is defined for a unit. The process control actions are carried out by the Sequence Block that is defined for an operation.

Unit Level Control
Units are defined in the Production Model data base. Associated with the units are the operations to be carried out on the unit, the compounds in the Control and I/O data base that act on the unit, and the unit variables that describe important details about the unit.

Batch Plant Management contains a set of production commands that are associated with unit level control:

- Book/Release a unit (to prevent multiple users from simultaneously working with the unit)

- Start/Abort an operation on a unit

- Add/Remove a batch of material to/from a unit

- Retrieve current data on unit activities

The unit level control actions can be included in the automatic procedure logic or they can be individually executed manually by an operator via the Batch Plant Management operator interface.

Batch Monitoring
The batch material monitoring capability of Batch Plant Management provides data collection and retrieval associated with batches of material as they are processed in a plant. This capability supports:

- The simultaneous monitoring of many different batches of material.

- Monitoring of relationships among batches of material as the materials separate and merge within the process.

- Monitoring user-defined stages of the batch. For example, stages could be Pre-Process, Production, Post Production.

Procedure Logic
The user defines logic for automating production commands. The language used for Batch Plant Management procedure logic is the same language used for Sequence Block logic. In addition to the statements allowed for

Sequence Blocks are the production commands used for Batch Plant Management logic. The following types of statements make up the high level language used for procedure logic:

- Production commands (provide higher level control actions on units and batches of material)

- Exception control statements (provide inter-procedure communication and handling of abnormal conditions)

- Subroutine calls

- Comments and remarks

- Logic flow control statements

- Operators

- Type conversion functions

- Arithmetic functions

- Assignment statements

- Procedural statements

Procedures can run in parallel, can activate each other, or a procedure can call another procedure as a subroutine. Thus, hierarchies of procedures can be established representing different levels of a control hierarchy.

The procedure logic can reference formula variables or unit variables directly within the logic to create very versatile and reusable logic. By referencing formula variables, one set of logic can be used to make different grades of simliar products. By referencing unit variables, one set of logic can be used on different units.

Formulas
Batch Plant Management maintains a library of formulas that represent variations of products. Each formula contains formula variables that can be of type: real, integer, Boolean, or string.

Formulas exist as part of the Batch Plant Management relational data base. You define formulas through the process engineer's environment. The definition and updating of the formulas is through a menu-driven interface. Formula variables have a description, a data type, a value, engineering units, high and low limits, and an operator-modification-allowed flag.

The formulas are used in conjunction with procedure logic. A formula is assigned for use, and a working copy of the original formula is created called the "assigned formula." You can specify which formula variables can be modified by the operator on-line.

Operator Interface to Batch Plant Management

The operator interface to Batch Plant Management is through process graphics and menus associated with the various batch capabilities just described. Menus for these capabilities provide a means to retrieve data about the current status of production activities. Examples are:

- Show a unit or show all units
- Show a batch or show all batches
- Show an assigned formula
- Show a procedure or show all procedures

Batch Plant Management provides a versatile manual-control interface that allows the operator to issue all of the production commands that can be automated in the procedure logic.

The process engineer's interface to Batch Plant Management includes all of the operator's capabilities as well as the additional capabilities associated with the creation of the Batch Plant Management data base. These additional capabilities are:

- Creation and updating of procedure logic
- Creation and updating of formulas

Batch Plant Management Interfaces

Figure 2 shows the Batch Plant Management interfaces with the following Intelligent Automation Series features:

1. The display interface provided with Batch Plant Management allows you to interface with Batch Plant Management software. This facilitates retrieval of information about current plant activities and provides an interface for issuing commands to Batch Plant Management.

2. Control and I/O data base blocks. Batch Plant Management procedure logic directly reads or writes to parameters in the Control and I/O data base. To generalize, Batch Plant Management supervises the lower level Sequence Control block activities to achieve production objectives.

3. Production Model data base. Each view groups together information from the Control and I/O data base to form the units on which batch software performs production commands.

4. Historian data collection. Batch Plant Management sends messages to the Historian recording important events. This information can be retrieved later via the Report Writer of the Data Base Management System.
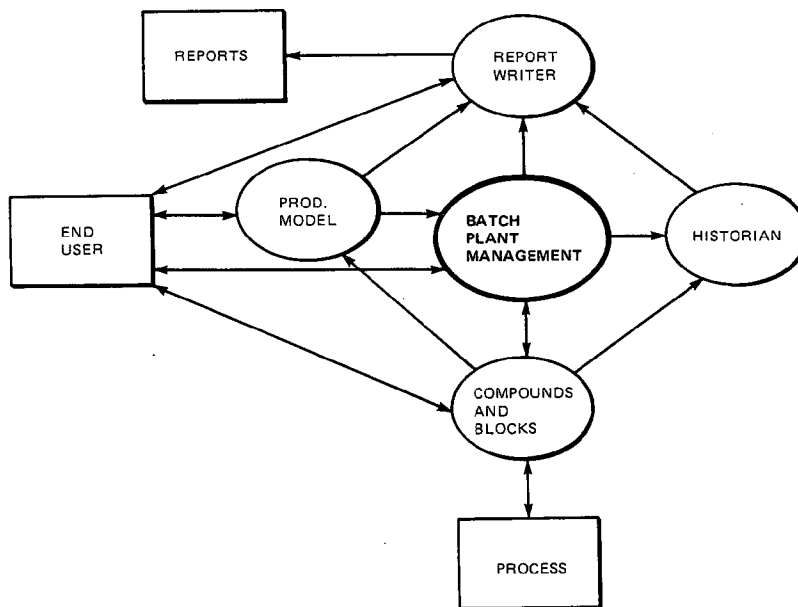

Figure 2. Batch Plant Management Interfaces

Application Example

Figure 3 shows a simple set of batch reactors that are used for polymer production. In this example, the pre-reactor performs a short preliminary polymerization before feeding the secondary reactors. Secondary polymerization requires a long reaction time. From a manufacturing standpoint, the desired goal (or the production objective) is to make a batch of polymer of a particular grade (GP 6__43054). To achieve the production objective, the following tools are assembled:

OBJECTIVE: POLY__6__43054
PROCEDURE: poly__train1
FORMULA: grd__6__43054

In addition to these tools, the first procedure calls other procedures necessary for this production objective. Also, a number of process units are booked for this objective.

Data Base Definition
After carefully planning the design of the control strategy, the Batch Plant Management user defines the following data bases:

1. Continuous Control and I/O data base to define all of the loops and ladder/interlock logic used to control the process.

2. Sequential control data base to define the actions that must be taken on the process to achieve the desired production objective.

3. Production Model data base to define the five units used in this example.

4. Procedure logic to define the desired series of production control actions. The procedure logic source code is defined using a full screen text editor (the standard Interactive Character Editor). This editor is accessed from the process engineer's environment, and allows the engineer to perform the following functions for creation and maintenance of procedures:

    • Create procedure

    • Modify procedure

    • Copy procedure

    • Delete procedure

    • Compile procedure

5. Formulas that allow variations of the product. The formulas are created through an interactive configuration process in the process engineer's environment with the following support functions:

    • Create Formula

    • Modify Formula
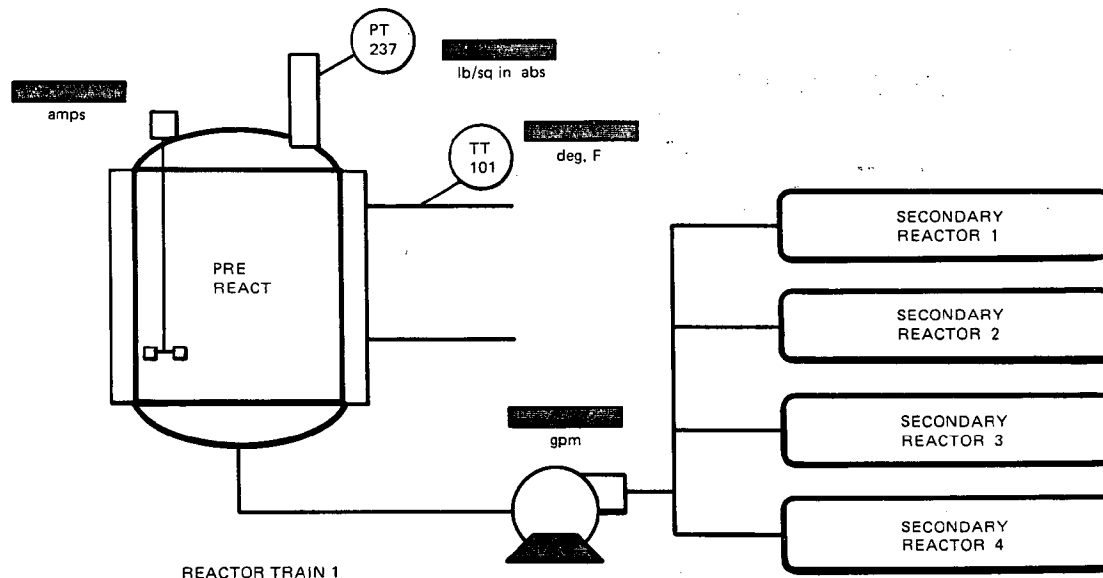
    • Copy Formula

    • Delete Formula

Figure 3.   Batch Application Example

Application Design Description

In the example given for the five reactors, Figure 4 describes the logic hierarchy that could be used for control of the batch reactors. At the highest level of the hierarchy, the procedure poly__suprvsr serially executes the pre__react procedure and then the sec__react procedure as subroutine calls. The logic between these two procedures calls determines which of the secondary reactors to select for the secondary reaction procedure.

The lower level procedures interface with Sequence Control blocks via the start operation commands. The following unit level control actions act as an example of a solution to this control application:

Supervisory Procedure

1. Book pre__react1 unit for objective: POLY__6__43054

2. Start procedure pre__react for objective: POLY__6__43054

3. Determine which secondary reactor to run

4. Start secondary__reactor procedure passing sec__unit name as argument

Lower Level Procedures

At the next level of hierarchy, the pre__react procedure performs a number of unit Level control actions as follows:

1. Book pre__react unit for objective: POLY__6__43054

2. Start reactor__fill operations

3. Add batch: POLY__6__43054 to pre__react unit

4. Start reactor__heat operation

5. Start reactor__react operation

6. Start reactor__cool operation

After completion of the preliminary reaction, the secondary reaction takes place with a set of unit level control actions that is similar to the preliminary reaction logic.
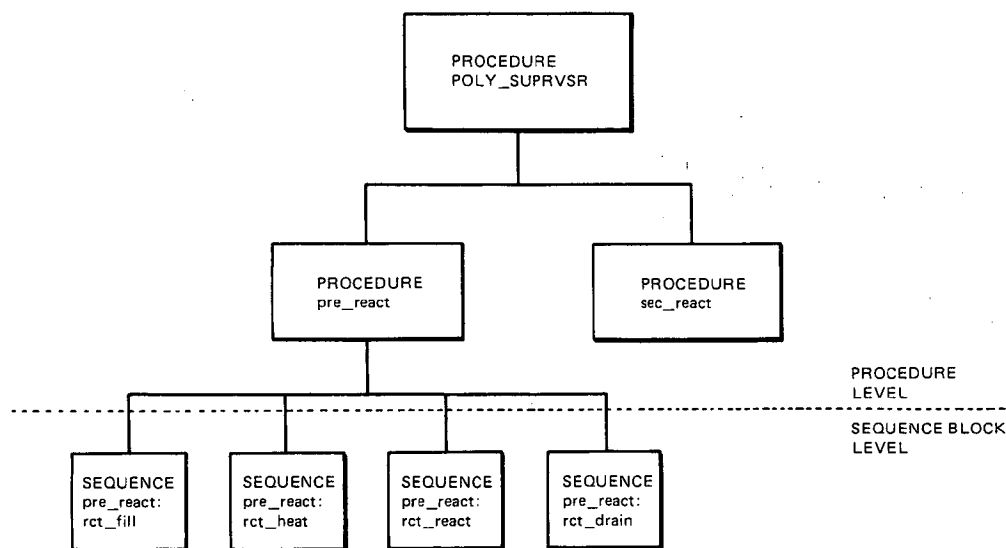

Figure 4.   Logic Hierarchy for Batch Application Example