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**MANUFACTURING TECHNOLOGY
WHITE PAPER SERIES**

EFFECTIVE RECIPE MANAGEMENT

Overview

One of issues challenging today's manufacturers is the need to manage recipe development effectively with less and less dependency on the process engineering staff. By combining industry standards with batching software, this need can be met successfully.

S88 Standards for Batch Execution

The first step in reducing the dependency on the process engineering group for recipe management, is utilizing the S88 Standards for Batch Execution developed by the ISA. The S88 standard provides the models to define equipment control, procedure control, and activity. Key to the standard is the ability to separate recipe development from equipment control. In this abbreviated version of the standard, equipment control is relegated to concept of the equipment module. For a given grouping of equipment, each process task is designated as a "phase" against that equipment module.

In Figure 1, a simple unit has been broken down into its equipment modules, which represent all the possible process tasks for the equipment grouping. Each blue box represents an organization of code in the automation controller that will perform the task each time it is called. This code is designed, tested, and implemented by the process engineering group. Each equipment module is also designed to accept one or more parameters. As an example, for Material Addition, two parameters would be used. One parameter would specify which material to add and a second parameter would specify how much. Under the S88 standard, this represents the "equipment model."

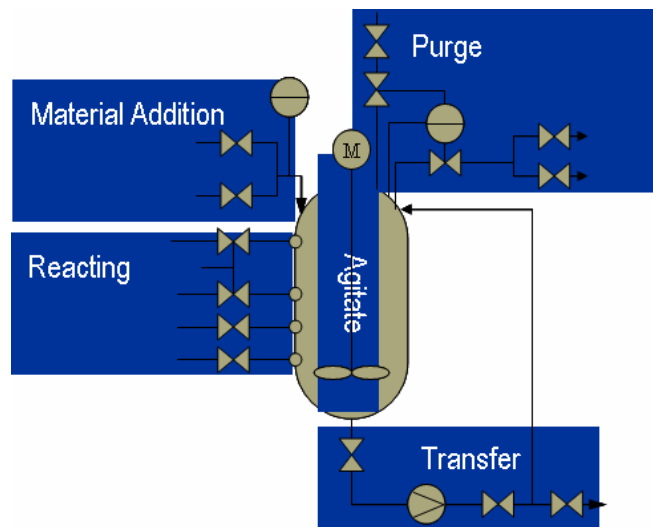


Figure 1

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Procedural Model

The next step in the S88 standard is to provide the procedural model. The model allows the process engineer to “map” out which equipment modules to call and in what order. This map is called an operation under the S88 standard.

In Figure 2, the process engineer has created a procedure that will support the ability to first purge the unit, add two materials, mix, react, and then transfer out. This becomes the foundation of a “recipe template.” This template is normally common to many different products, but can be differentiated by the parameters for each phase. Under this model, the parameters, or formulation, can be managed independently of the operation templates. The process engineers would then create a family of templates to cover multiple arrangements of equipment usage. The formulators would then be responsible to create the parameter sets. At runtime, the proper operation will be matched up with the proper formula set to create an S88 control recipe that can be executed against the equipment.



Figure 2

Batch software, such as FactoryTalk® Batch, fully supports these elements of the S88 model and also includes the ability to combine a specific operation with a specific formulation set. The software also provides the runtime execution engine to sequence the operation against the equipment.

In cases where the operation “map” needs to be adjusted, the formulator can be given access to the tools that are used to create the

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operations. FactoryTalk Batch includes a graphical interface to allow the modification of existing operations as well as create new ones. Even at this level, recipe management requires less and less dependency on the process engineers.

Real-world Example

Let's review an example of how this works in the real world. The customer has a chem-making process that consists of two upstream pre-making units that deliver semi-finished ingredients to a tank farm. A downstream units draws from the tank farm for these materials, as well as some other bulk ingredients, to make the final product.

The customer has a very large set of final products, but many use common steps and only vary by the BOM and/or process set points. These "common step" products are grouped into families and are identified by a single S88 procedure. The formulation parameters (BOM and process set points) are managed in an independent database by the formulators. At run time, a procedure is selected and merged with a formulation set to create a control recipe unique to the selected product.

In Figure 3, the operator is able to select the procedure list from a drop-down list inside the HMI. This list contains all the procedures released for production.

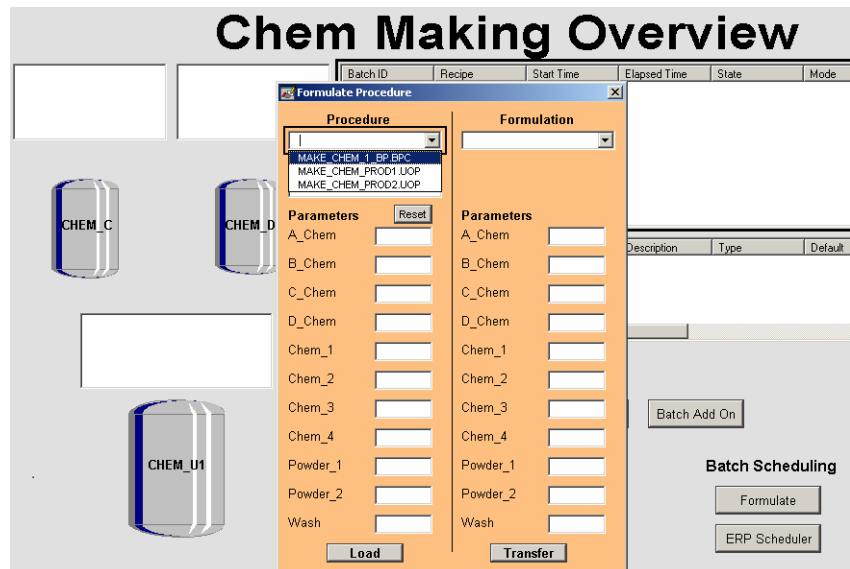


Figure 3

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Once the procedure is selected, the default parameters are exposed for review. In Figure 4, the operator could manually adjust these parameters from product worksheets prior to creating the control recipe.

The screenshot shows a software window titled "Formulate Procedure". It is divided into two main sections: "Procedure" and "Formulation".

- Procedure Section:**
 - Contains a dropdown menu with "MAKE CHEM 1 BP BPC" selected.
 - A "Batch ID" text input field.
 - A "Parameters" section with a "Reset" button and ten numerical input fields:
 - A_Chem: 100
 - B_Chem: 60
 - C_Chem: 40
 - D_Chem: 70
 - Chem_1: 30
 - Chem_2: 45
 - Chem_3: 10
 - Chem_4: 32
 - Powder_1: 6
 - Powder_2: 10
 - Wash: 5
 - A "Load" button at the bottom.
- Formulation Section:**
 - Contains a dropdown menu that is currently empty.
 - A "Parameters" section with ten empty numerical input fields, corresponding to the labels in the Procedure section.
 - A "Transfer" button at the bottom.

Figure 4

Since the formulation data is being managed in a separate database, the operator can choose which product formulation set to use from the drop-down list.

This screenshot is similar to Figure 4, but the "Formulation" dropdown menu is open, showing a list of three options: "060105", "060205", and "060305".

- Procedure Section:** Identical to Figure 4, with the "MAKE CHEM 1 BP BPC" procedure selected and the "Parameters" section showing the same numerical values.
- Formulation Section:**
 - The dropdown menu is open, displaying the list: "060105", "060205", "060305".
 - The "Parameters" section below it remains empty.
 - The "Transfer" button is visible at the bottom.

Figure 6

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Once the formulation set has been selected, the parameters are exposed, as shown in Figure 7, and the Transfer button is used to move the database parameters over into the Procedure column.

Procedure		Formulation	
MAKE CHEM 1 BP.BPC		060105	
Batch ID			
New Parameters	Reset	Parameters	
A_Chem	95	A_Chem	95
B_Chem	55	B_Chem	55
C_Chem	35	C_Chem	35
D_Chem	65	D_Chem	65
Chem_1	25	Chem_1	25
Chem_2	40	Chem_2	40
Chem_3	8	Chem_3	8
Chem_4	28	Chem_4	28
Powder_1	5	Powder_1	5
Powder_2	8	Powder_2	8
Wash	3	Wash	3

Figure 7

A Batch ID is entered, and the Load button is pressed to create the control recipe on the batch list.

Batch ID	Recipe	Start Time	Elapsed Time	State	Mode
PRD506554	MAKE_CHEM_1_BP	0.00.00		READY	Q_AUTO

Figure 8

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The control recipe is now on the batch list and ready to execute.

In this example, basic recipe management is done by the formulation group through the use of formulation sets stored in a database. Because the product procedure families have already been created by the process engineering group, there is little or no reliance on the process engineering group for most recipe management needs.

If procedural changes are required, formulators are given access to the graphical editor that will give them the ability to create new, or edit existing procedures.

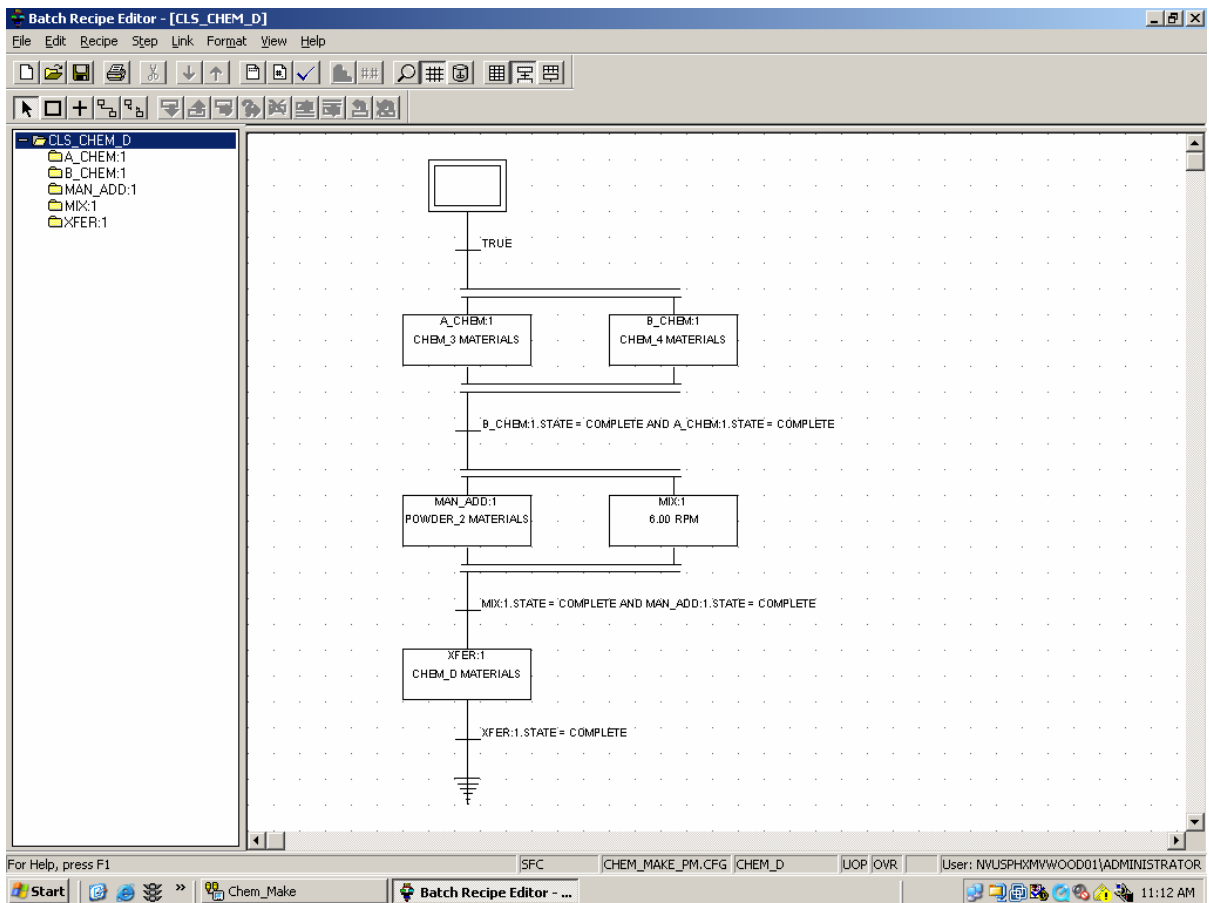


Figure 9

Figure 9 shows the graphical environment. Based on Sequential Function Charts, the formulators can add steps, change the order, or delete steps as required. While this is a bit more “low level” in terms of effort, much of this work can successfully be completed by the formulators with little support from the process engineering group.

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In conclusion, the proper leveraging of the S88 model and batch management software provides the proper abstracting of the process layer from recipe management. This supports the ability of the formulation group to focus on new products and the maintenance of existing products with less and less dependency on the process engineering group.

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