

White Paper written for  
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## White Paper S88 for Engineers

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Towards the end of the eighties of the last century, the SP88 committee, that consisted of various end users, suppliers and consultants from the batch processing industry, started to develop a standard for batch control. The purpose of the standard was to emphasize good practices for the design and operation of batch manufacturing plants and to improve control of batch manufacturing plants. The standard was developed especially for batch processes, but can also be applied in continuous and discrete processes that require a certain amount of flexibility. The standard currently consists of three parts that each has its own specific subjects, but they are closely related. Part one (published in 1995) consists of a consistent set of models and terminology concerning batch processes, part two (published in 2000) consists of data structures and a graphical language for displaying recipes, and part 3 (published 2003) deals with enterprise wide representation of recipes.

The following aspects of S88 are especially of interest for engineers: the physical model, procedural model, equipment logic, and master recipe.

### **The Physical model**

The Physical model is a modular, hierarchical structure of the physical assets of a manufacturing facility. The highest level in this model is the *Enterprise*, which can have one or more *Sites*. A *Site* can have one or more *Area's*, that consist of one or more *Process cells*. For S88 the *Process cell* level and the lower levels, i.e., the *Unit*, the *Equipment Module*, and the *Control Module*, are the most important.

A *process cell*, named e.g., PC-juice, can be designed for “making juice”. The process cell contains several units, one of them being a squeezer-machine. The squeezer-machine can perform the following activities; “squeeze oranges”, “peel oranges” and “press apples”. The squeezer machine contains several equipment modules and

control modules such as e.g., valves, pumps, input-transportation-belt, sensors and actuators.

### **The Procedural Model**

The *Procedural Model* describes a hierarchical representation of the functions that can be performed. It has four levels referred to as; procedure, unit-procedure, operations and phase. The *Procedure* consists of one or more *Unit procedures*, which consists of one or more *Operations*, which consists of one or more *Phases*.

Imagine a procedure for the “making of orange juice”. “Make orange juice” requires the functions “squeeze oranges” and “bottle the orange juice”. The function “squeeze oranges” can be broken down into the lesser functions “peel oranges”, “squeeze oranges” and “add sugar”. In this case, “make orange juice” is a *procedure*, “squeeze oranges” and “bottle the orange juice” are *unit-procedures* and “peel oranges”, “squeeze oranges” and “add sugar” are *operations* or *phases*.

### **Equipment logic**

The Procedural hierarchy is a hierarchical description of the functions that should be carried out. It is, of course, not enough to only describe the function, software code, or *Equipment logic*, is also needed. For example, to execute the phase “Add sugar”, logic that opens a valve, starts a pump, controls the amount of sugar added, stops the pump, stops and closes the valve is needed. The *Equipment logic* must be able to respond to commands such as “start/stop/hold/abort/etc”, deal with exceptions and give information about status. S88 suggests an example set of commands and statuses that may be used.

It is important to note that the Procedural description is independent of the *Equipment logic*. For example; “make orange juice” requires the execution of procedures to “squeeze oranges” and “bottle orange juice”. This is true independently of how the *Equipment logic* for e.g., “squeeze oranges” is written. This decoupling of description and logic (implementation) is a very powerful concept, well described and presented in the S88 standard.

### **Master Recipes**

The complete description of all the information needed for the production of a batch is referred to as the Master recipe. The Master recipe contains the procedural description, the formula (i.e., the parameters to be used in production), the equipment requirements and the header.

The header contains information about who wrote the recipe and when etc. The formula corresponds to the parameters to be used in production, the procedure is a reference to the procedural description (for example “Make orange juice”) and the equipment requirement contains a reference to the equipment to use (for example “squeezer-machine”).

Simply by changing the amount of sugar in the formula, you can create “sweetened orange juice” and “unsweetened orange juice” or simply by changing the procedure from “make-orange juice” to “make apple juice”, different juices are produced.

### **Practical use of the standard**

ISA S88 will help you structure the equipment and the procedures. It will help you develop Equipment logic that is well designed and with a clear focus. Equipment logic that has been developed according to the S88 standard can be changed or adapted, without (big) adjustments being necessary in other implementation modules or in the Master recipes. The Procedures can be developed and changed without taking any implementation aspects into consideration. The effort of understanding and adopting the ISA S88 standard is well worth.

The ISA S88 standard fully describes the concepts of Equipment Model, Procedural Model, Equipment logic, Master recipes, as briefly presented above. In addition it presents the recipe/equipment separation, the execution modes, and procedural states and commands, and it mentions batch reports and batch history and many many other useful, interesting and powerful concepts. More information is available on [www.wbf.org](http://www.wbf.org) and [www.isa.org](http://www.isa.org).