

SCE Training Curriculum

Siemens Automation Cooperates with Education (SCE) | 09/2015

PA Module P01-03 SIMATIC PCS 7 – Plant Hierarchy



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Matching SCE Trainer Packages for these curriculum

- SIMATIC PCS 7 Software block of 3 packages Order No. 6ES7650-0XX18-0YS5
- SIMATIC PCS 7 Software block of 6 packages Order No. 6ES7650-0XX18-2YS5
- SIMATIC PCS 7 Software Upgrade block of 3 packages
 Order No. 6ES7650-0XX18-0YE5 (V8.0 → V8.1) or 6ES7650-0XX08-0YE5 (V7.1 → V8.0)
- SIMATIC PCS 7 Hardware Set including RTX Box Order No. 6ES7654-0UE13-0XS0

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Additional information relating to SCE

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PLANT HIERARCHY

TRAINING OBJECTIVE

The students learn to structure an automation project according to technical aspects. A project structure, called **Plant Hierarchy (PH)**, is implemented by setting up hierarchy folders. In the folders of this plant hierarchy, CFCs and SFCs are then stored for the automation systems, displays and reports for the operator stations as well as supplementary documents (such as unit descriptions, process tag sheets, planning documents from other applications such as Word, Excel, etc.). A well-planned plant hierarchy facilitates locating objects and is the prerequisite for the reuse of generic solutions as well as automatic generation mechanisms.

THEORY IN BRIEF

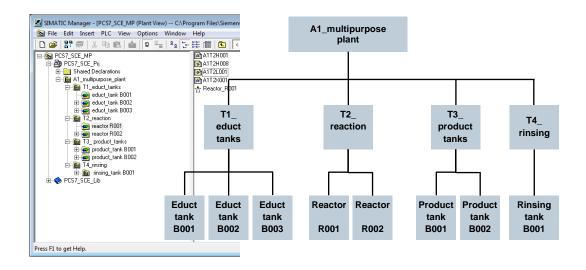


Figure 1: From plant model to plant hierarchy

The plant hierarchy essentially has three functions:

- It maps a hierarchical name scheme that can be used to break down a complex system into partial tasks that can be solved with acceptable effort.
- It is used for the structured storage of documents and objects in this hierarchical name scheme.
- It allows for the automatic generation of the picture hierarchy for operator control and monitoring.

THEORY

STRUCTURING ACCORDING TO DIN EN 81346-1

To specify, plan, create, maintain or operate a system effectively, the system as well as the information about it is usually broken down into units. Each of these units can be subdivided further. This successive subdivision into units and the organization of these units is called **Structuring**.

Two general rules apply in this case:

Rule 1: A technical system has to be structured based on '*is part of*' relationships, applying the concept of *Aspects* of objects.

Aspects act as filters for an object that is used to emphasize relevant information. Standard aspects focus on the following:

- Function aspect: What is the object's task, or what is it actually doing?
- Product aspect: What are the means the object uses to perform its task?
- Location aspect: Planned or actual location of the object

Figure 2 shows that the 'object for filling' '*is part of*' the object for manufacturing Product 1' under the function aspect.

Rule 2: Structuring is carried out either from top to bottom (*top down*) or from bottom to top (*bottom up*).

For the top down method, we usually:

- 1. Select an object
- 2. Select the suitable aspect
- 3. Determine the sub-objects in the selected aspect if there are any: Steps 1 to 3 can be repeated iteratively for the defined sub-objects as often as required.

For the bottom up method, we usually:

- 1. Select the aspect we want to work with
- 2. Select the objects that are to be considered together
- 3. Introduce a higher level object for which the selected objects are parts in the selected aspect.

As for the top down method, steps 1 to 3 can also be repeated iteratively here as often as necessary for each added higher level object. If an aspect is retained in the entire structure, the structure is called aspect-related according to the standard, which means function-oriented, product-oriented or location-oriented. A process engineering system is structured under the function aspect (function view). A function-oriented structure is based on the purpose of a system. The purpose of a technical system is to perform a technical process whereby input variables (energy, Information, material) are processed into output variables (energy, information, material) taking into account specific parameters. Figure 2 shows an example.

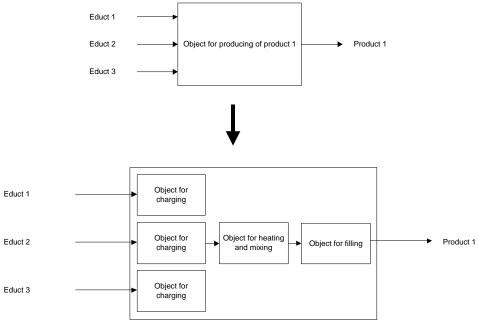


Figure 2: Function of the reactor and its sub-functions

Structuring on this basis provides a system that can be used during all phases of the life cycle: planning the plant, automating the plant, operating the plant.

STRUCTURE OF THE PLANT HIERARCHY

The plant hierarchy can be taken directly from the plant structuring that was carried out when the plant was planned. It has to be taken into account, however, that this structure is mapped 1:1 when deriving the picture hierarchy from the plant hierarchy.

While planning a process plant, the planning engineer creates a reference identification system that allows for the unique identification of an object in an observed plant. This reference identification system is based on structuring according to an aspect (for process plants, according to the function aspect).

In *PCS* 7, the reference identification system is called *Higher Level Designation System (HID)*. The structure of the plant is implemented *PCS* 7 with a folder structure. By nesting the hierarchy folders, complex plants can also be mapped. By setting the number of levels, the depth of the structure can be specified project-wide. The maximum structural depth is limited to 8 levels.

DERIVING THE PICTURE HIERARCHY AND OS AREAS FROM THE PH

The OS picture hierarchy for the plant operator on the operator station can be derived completely from the configured data of the plant hierarchy. This takes place automatically during a generation run which generates an operating screen for each level. In this screen, associated operator symbols are set up for all automation blocks, if available, that are used in the charts of this level. In addition, the corresponding group alarms and navigation hierarchies are set up. It is possible to connect individual areas of the plant structure in the plant hierarchy to OS areas. In the case of large plants, plant operators can thus be assigned only certain plant areas. In the process mode, plant operators only see and operate those areas for which they have the corresponding user permissions. Plus only those messages that are relevant to this area are displayed. As a rule, a unit corresponds to an OS area in the plant hierarchy.

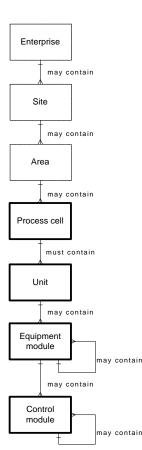
In the general settings of the plant hierarchy we specify the hierarchy level that is to be the OS area level for the plant hierarchy. For each hierarchy folder of this level, an area identifier is defined. The standard setting for the area identifier corresponds to the name of the hierarchy folder in the plant hierarchy. As soon as a hierarchy folder is provided with an area identifier, all lower level hierarchy folders and objects also receive the area identifier. The representation of the hierarchy levels always starts with the hierarchy level that is defined as OS area.

AS-OS Assignment

For each hierarchy folder, an operator station has to be assigned to an automation system in the plant view. This AS-OS assignment has the following consequences for the Component view:

- All CFCs and SFCs that are inserted in the plant view are stored in the chart folder of the assigned automation system.
- All displays and reports that are inserted in the plant view are stored in the folder of the assigned operator station.

TYPE DEFINITION ACCORDING TO ISA-S88.01



If, when structuring the plant, the physical model according to DIN EN 61512-1 is used (refer to Figure 3) which is largely identical to the U.S. standard ISA-S88.01-1995, **PCS 7** enables the setup of a type-defined hierarchy.

Only the four lower levels of the model (process cell, unit, equipment module and control module) are specified in greater detail. They refer to certain types of facilities. Such a type is a group of process and control facilities that were combined for a certain purpose.

If the type-defined hierarchy is to be used in *PCS* **7** according to the standard ISA-S88.01, the uppermost folder of the plant hierarchy has to represent the process cell level.

Below the process cell level, the hierarchy folders can then be type-defined as unit, and below that as an equipment module.

Folders or levels that are not type-defined are designated as neutral and can be used for further structuring, or represent the level of the control modules.

Type definition is the basis for working with the **PCS 7** BATCH module. It should be noted that only one process cell can be defined for each project.

Figure 3: Physical model according to DIN EN 61512

LITERATURE

- [1] Online Help PH Siemens
- [2] DIN EN 81346-1 (Ed. 2010-05): Industrial systems, installations and equipment and industrial products Structuring principles and reference designations.
- [3] DIN EN 61512-1 (Ed. 2000-01): Batch control

STEP BY STEP INSTRUCTIONS

TASK

In this chapter, a folder hierarchy will be created and documented in the plant view (plant hierarchy) corresponding to the Multi-Purpose Plant project and the associated nomenclature.

TRAINING OBJECTIVE

In this chapter, the student will learn the following:

- Plant view of the PCS 7 project
- Basic settings for the plant hierarchy
- Creating and renaming folders in the plant hierarchy

These instructions are based on the project 'PCS7_SCE_0102_Ueb_R1305_en.zip'.

PROGRAMMING

1. To set up the plant hierarchy in a **PCS 7** project, we have to switch to the Plant view.

SIMATIC Manager - [PCS7_SCE_MP (Component view) C:\Program Files\Siemens\STEP7\S7Proj\PCS7_SCE\PCS7_MP]									
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E-B PCS7_SCE_MP		Plant View							
E-Pri AS1		Process Object View							
🚊 🔣 CPU 414-3 DF		Process Device Plant View							
		Process Device Network View							
⊕	✓	Offline							
		Online							
È⊗ PCS7_SCE_Lib È፼ S7 Program(1)		Large Icons							
- D Sources		Small Icons							
Blocks	•	List							
		Details							
		Filter							
		Define Columns							
		Show All Levels	Num*	-					
		Hide All Levels	Num-						
	✓	Toolbar							
	<	Status Bar							
		Update	F5						
-				-					
Changes to the Plant View.									1.

 $(\rightarrow \text{View} \rightarrow \text{Plant View})$

2. For the automatic compilation runs for the OS (operator system) to be executed correctly later, a few basic settings have to be made for the plant hierarchy.

SIMATIC Manager - [PCS7_SCE_MP	(Plant View) C:\Program Files\Siemen	s\STEP7\S7Proj\PCS7_SCE\PCS7_MP]	
😼 File Edit Insert PLC View	Options Window Help		_ <i>6</i> ×
📙 🗅 🚅 🕌 🚟 🛛 X 🖻 🖻 I I	Customize	Ctrl+Alt+E	
E-B PCS7_SCE_MP	Access Protection	•	
N 199	Change Log	•	
	SIMATIC Logon Service		
	Text Libraries	•	
	Language for Display Devices		
	Manage Multilingual Texts	•	
	Rewire		
	Run-Time Properties		
	Compare Blocks		
	Reference Data	•	
	Define Global Data		
	Configure Network		
	Simulate Modules		
	SIMATIC PDM	F	
	Configure Process Diagnostics		
	PCS 7 License Information		
	Charts	F	
	Shared Declarations		
	Plant Hierarchy	 Settings 	
	Process Objects	Check Consistency	v
	Process Objects (Online)	Open Check Log	
	Process Tags	• · · · · · · · · · · · · · · · · · · ·	
	Models	Create/Update Blo	
	Control modules	Open Block Icons	Log
	SIMATIC BATCH	Change AS Assign	
	os	Change OS Assign	
	OS Import	Cancel Assignmen	11
	'Compile Multiple OSs' Wizard	Create/Update Dia	gnostic Screen
		Display Diagnostic	Screens Log
	CAx Data	Advanced Diagnos	stics Settings
	Set PG/PC Interface	Configured Object	ts
		Update in the Mul	tiproject
		Clear Shortcut	
Defines the labeling system in the plant	hierarchy.	Import Process Ce	II //

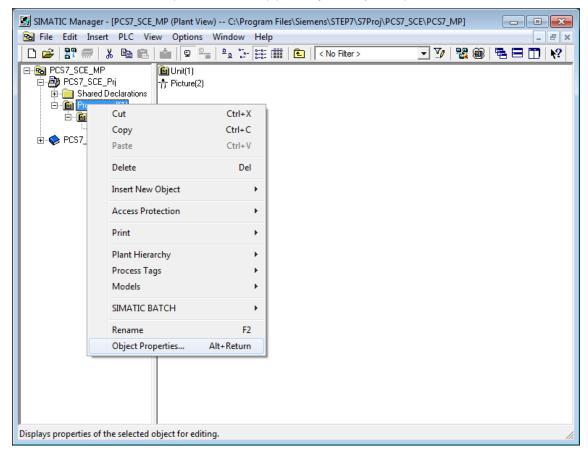
- 3. The following settings are made and accepted with OK (\rightarrow OK)
 - The number of hierarchy levels is set to 3, matching the project hierarchy. The hierarchy then maps our plant as follows:
 - Process cell (Level 1)
 - Unit (Level 2)
 - Containers/Equipment modules (Level 3)
 - 24 as the maximum number of characters in each level will be relevant to the automatic generation of variable names for the OS.
 - In our project, levels 1 and 2 generate plant identifiers.
 - The names have a separator ,/' between the names of levels 1 and 2.
 - The OS area specifies the level from which the process images are integrated in the picture hierarchy.
 - For the picture hierarchy to be generated automatically, it is important to set the checkmark at 'Derive picture hierarchy from the plant hierarchy'.

Number of	hierarchy levels:	3	*	
-Level Settir	ngs			
Level	Max. number of characters	Included in HID	With separator	OS area
1:	24 📫		\checkmark	(•
2:	24 ÷		$\overline{ \forall}$	0
3:	24 📫		$\overline{\mathbf{V}}$	0
4:	24		$\overline{\mathbf{M}}$	
5:	24		$\overline{\mathbf{M}}$	
6:	24 👘			
7:	24			
8:	24			
o. Preview:		11111111111111	\222222222222	22222222222222
Preview:	1111111111 picture hierarchy fr	om the plant hier	archy	222222222222222
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 Accept the changed properties also for the hierarchy folders that have already been set up. (→ Yes)

Settings (3283:5052)						
1	You have changed the "Included in HID" property. Do you want the changes to be applied to the already existing hierarchy folders?					
	Warning! If you answer "Yes" then you will change the naming scheme for your plant. If these changes affect many OCM variables, the command to compile OS changes may take a long time. It is therefore recommended to do a complete compilation. After a complete compilation, downloading is only possible if the OS is deactivated.					
Ye	No					

 The object properties are now set for each hierarchy folder. Here, for example, for the folder of the first level. (→ Process cell(1) → Object Properties)



 In the subheading 'General', the name, the author and above all a pertinent comment are entered. (→ General)

Properties - Hierarchy Folder A1_multipurpose_plant							
General Control and Monitoring Attributes AS-OS Assignment S88 Type Definition							
Name:	A1_multipurpose_plant						
Project path:	PCS7_SCE_Prj	_					
Storage location of project:	D:\PCS7\SCE\P01-03\S4S en\PCS7_SCE\PCS7_Prj	-1					
Author:	Hahn						
Date created:	10/01/2012 08:16:27 AM						
Last modified:	05/21/2015 06:59:52 PM						
Comment:	multipurpose plant for training of prozess control technology with PCS7	4					
ОК	Cancel H	elp					

7. The subheading 'Control and Monitoring Attributes' indicates whether the name is part of the plant designation. The system enters the name automatically based on the settings for the plant hierarchy. (→ Control and Monitoring Attributes)

Properties - Hierarchy Folder Process cell(1)					
General Control and Mo	nitoring Attributes AS-OS Assignment S88 Type Definition	1			
Plant designation:	Process cell(1)				
	$\overline{{\boldsymbol{\checkmark}}}$ Name of the hierarchy folder is part of the HID				
OS area ID:	Process cell(1)	_			
Picture name for OS:	Process cell(1)	_			
	\square No modification when renaming the hierarchy folder				
	Order				
ок	Cancel	Help			

8. In the subheading 'AS-OS Assignment' a hierarchy folder is assigned to an automation system (AS) and to an operator system (OS). In our project, two ASs (AS1 = CPU 414-3 DP and AS2 = AS RTX Box) and one OS are available for selection. The system enters the latter automatically. We select AS1 as the AS. All properties are accepted with OK.

$(\rightarrow$ AS-OS Assignment -	\rightarrow AS1 \rightarrow OK)
-----------------------------------	-------------------------------------

Properties - Hierarchy Folder Process cell(1)	×
General Control and Monitoring Attributes AS-OS Assignment S88 Type Definition	
Assigned AS (chart folder):	
AS1\CPU 414-3 DP\S7 Program(1)\Charts	•
Cover-level objects	
All lower-level objects have the selected assignment.	
Write-protection for charts	
Assigned OS:	
OS\WinCC Appl.\OS(1)	•
Lower-level objects	
All lower-level objects have the selected assignment.	
OK	Help

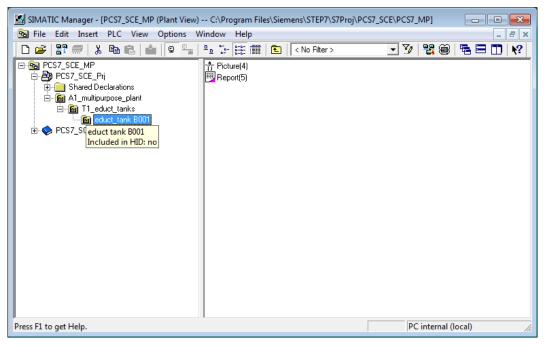
\triangle

Note: The subheading 'S88 Type Definition' is not relevant at this point. It will be needed when batch processes are implemented.

Now make the corresponding changes for all three hierarchy folders:

Name Folder old	Name Folder new	Comment
Process cell(1)	A1_Multi-purpose plant	Multi-purpose plant for training of process control engineering with PCS 7
Unit(1)	T1_Educt storage	Educt storage unit
Function(1)	Educt tank B001	Educt container with Educt 1

9. The folder hierarchy now looks like this. By moving the mouse over a folder, the comment is displayed. (→ educt_tank B001)

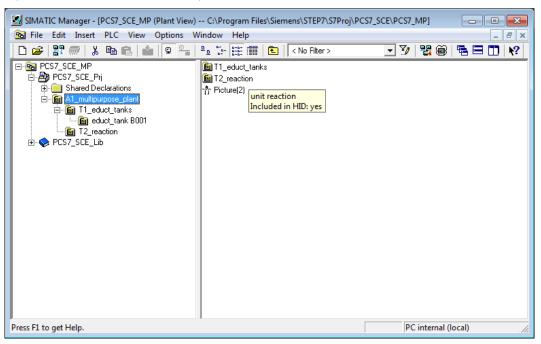


- 10. We need more folders for our project. To this end, right-click on the hierarchy under which you want to create a new folder. Then select 'Insert New Object' and 'Hierarchy Folder'.
 - $(\rightarrow A1_multipurpose_plant \rightarrow Insert New Object \rightarrow Hierarchy Folder)$

SIMATIC Manager - [PCS7_SCE_MP (Plant View) C:\Program Files\Siemens\STEP7\S7Proj\PCS7_SCE\PCS7_MP]							
			€ Ko Filter >	y 1 📽 🎯 1 着 🗖 🕅 😽			
		i T1_educt_tanks ↑∱ Picture(2)					
🖻 🙆 T1_edu	Cut	Ctrl+X					
⊡ @ edu ⊡ - 😪 PCS7_SCE_Lit	Сору	Ctrl+C					
	Paste	Ctrl+V					
	Delete	Del					
	Insert New Object	۱.	Hierarchy Folder				
	Access Protection	۱.	CFC				
	Print	۱.	SFC				
	Plant Hierarchy	۰.	Additional Document				
	Process Tags	+	Picture				
	Models	۲.	Report				
	SIMATIC BATCH	۲	Equipment Properties				
	Rename	F2	Equipment Property				
Inserts Hierarchy Folder a	Object Properties	Alt+Return					

11. The name of this folder and the comment are also entered.

 $(\rightarrow T2_reaction \rightarrow unit reaction)$

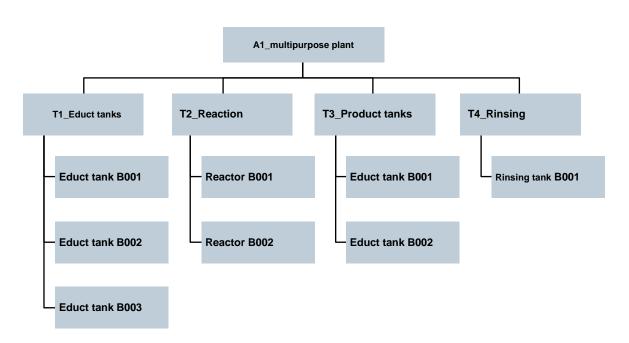


EXERCISES

In the exercises, we apply what we learned from the theory and from the step by step instructions. The existing multi-project from the step by step instructions (PCS7_SCE_0103_R1305_en.zip) will be used and expanded.

TASKS

1. Implement the entire plant hierarchy of the multi-purpose plant according to the diagram below.



2. Add pertinent comments to the individual levels of the plant hierarchy.



Note: If you prefer to use AS2 as the automation system instead of AS1, you can make that change in the uppermost folder of the hierarchy, and accept it for all subfolders.