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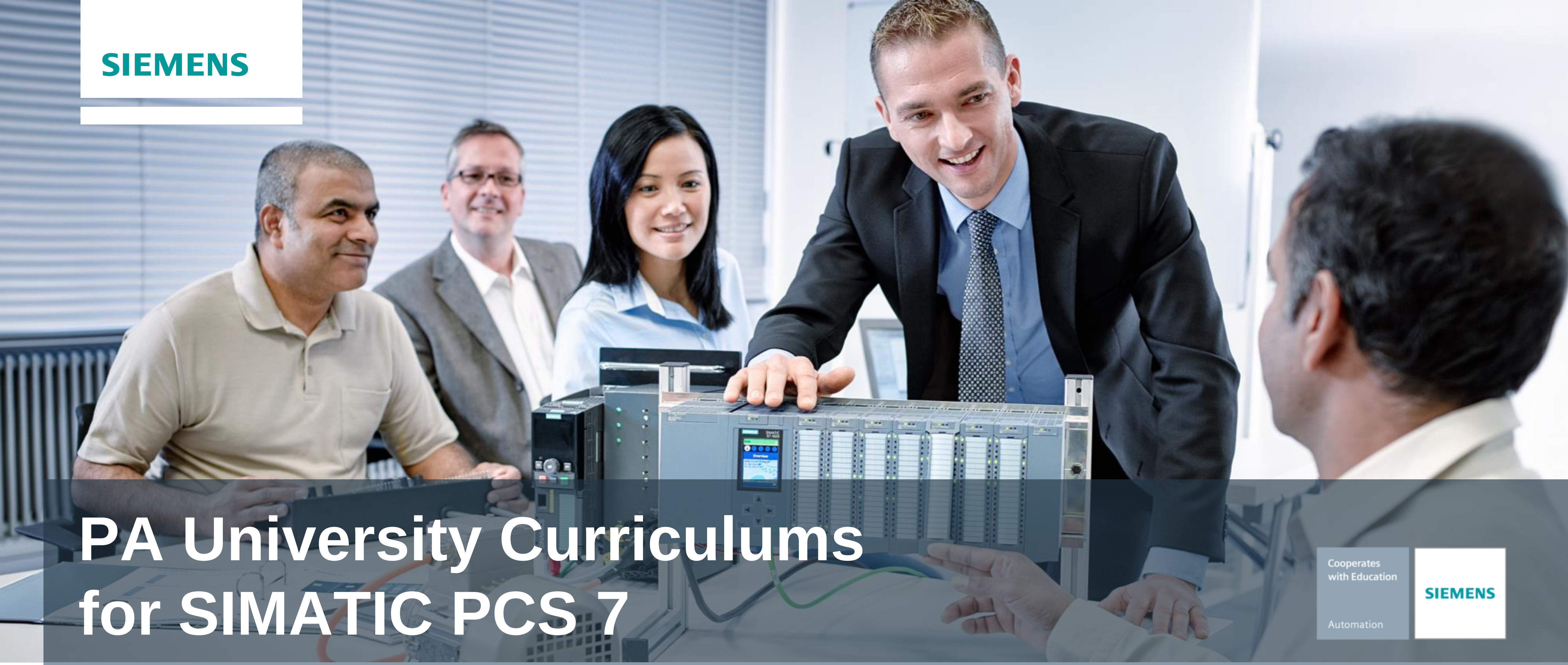

PA University Curriculums for SIMATIC PCS 7

Cooperates with Education
Automation
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Siemens Automation Cooperates with Education | 09/2015

PCS 7 University Curriculums
Contents

MODULE 1 + MODULE 2

- P01-01 Process description
- P01-02 and P01-03 Structuring
- P01-04 to P01-08 Basic automation
- P02-01 to P02-03 Higher process control functions

MODULE 3

- P03-01 Advanced layout of user interfaces
- P03-02 Vertical integration with OPC
- P03-03 Batch control with recipes

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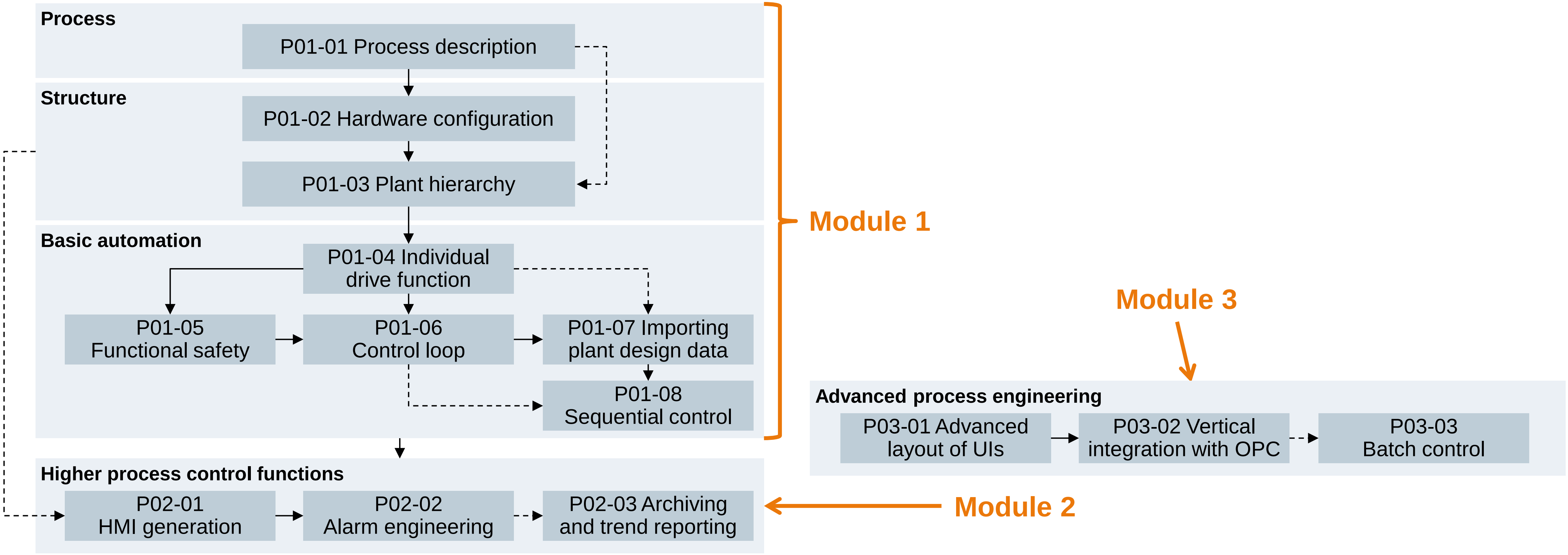
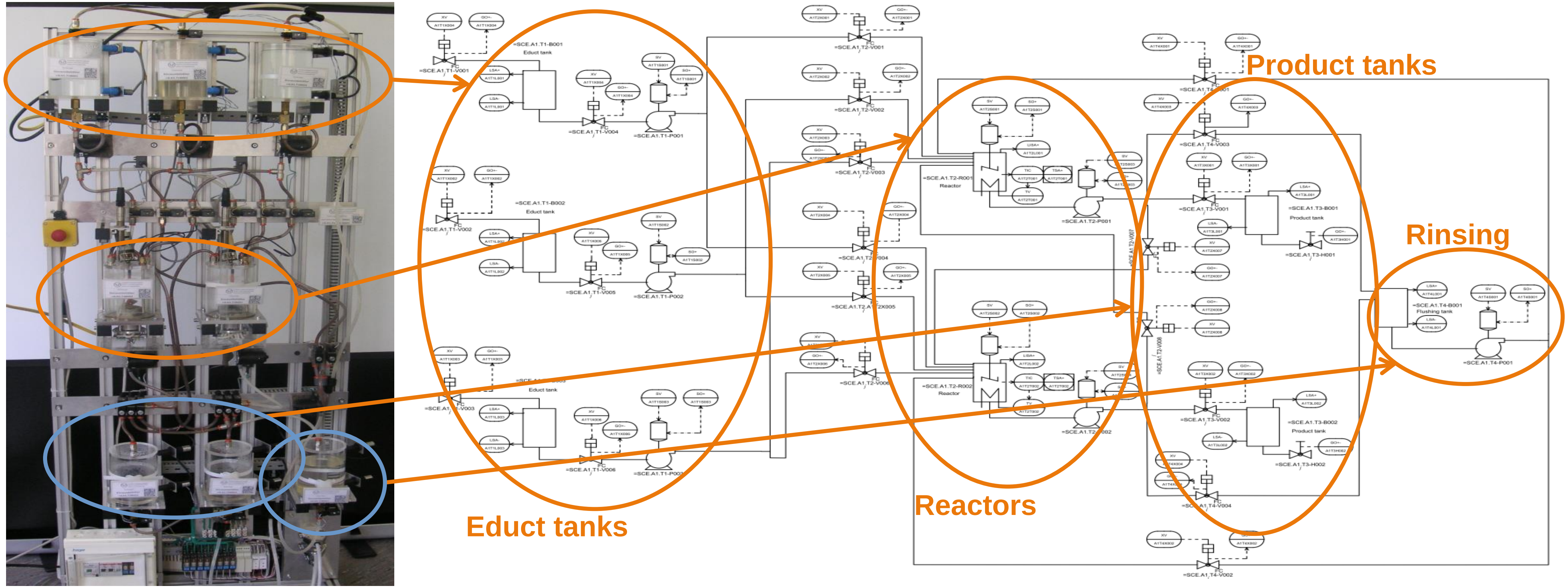
Module overview

Module overview

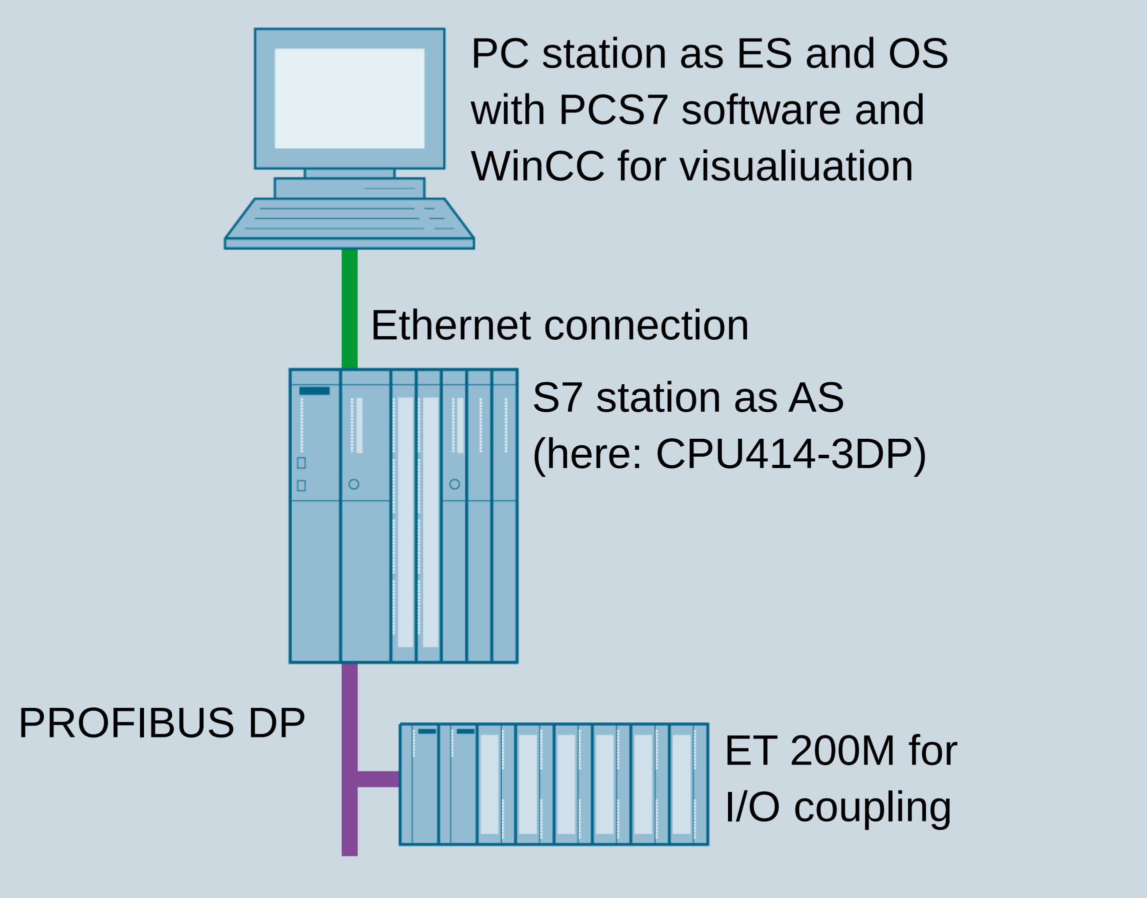


P&ID of the laboratory process cell



Hardware configuration of the laboratory process cell

- AS
  - PS
  - CPU (with PROFIBUS)
    - ET200M (with PROFIBUS)
      - 7x DI
      - 3x DO
      - 1x AI
      - 1x AO
    - CP (with Ethernet)
- OS
  - PC (with Ethernet)



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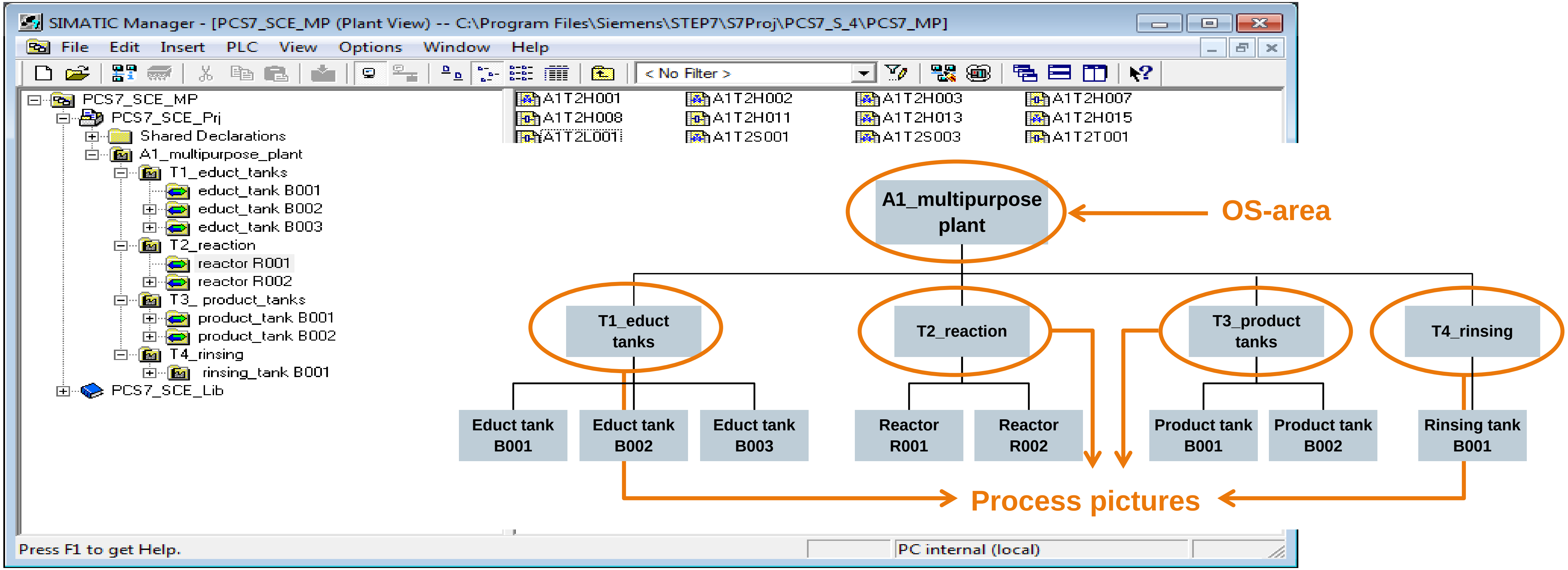
Plant hierarchy and effect on visualization



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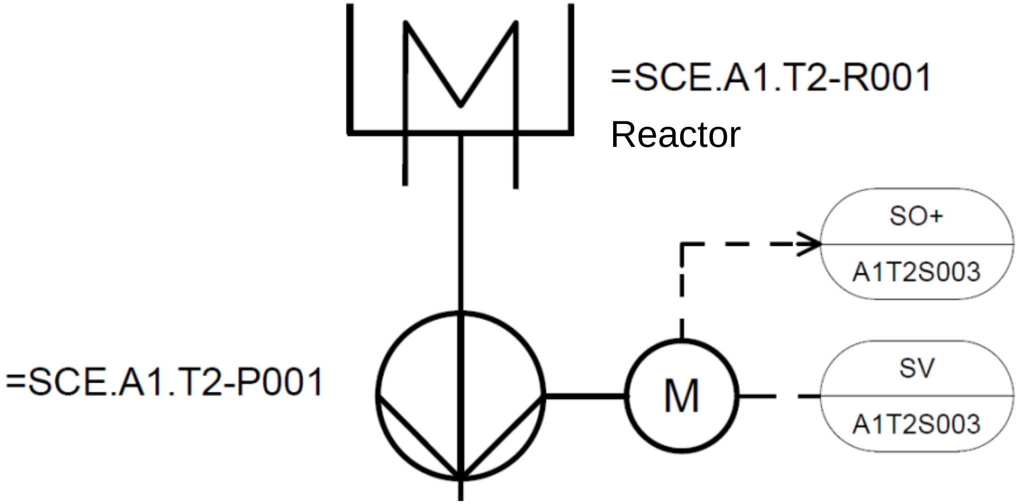
Implementation of a pump of the laboratory process cell

- Pump SCE.A1.T2-P001 to empty the reactor
- Pump is driven by a motor
- The motor has the following signals
  - Signal for control
  - Signal for running feedback
- Template from PCS 7 AP library
  - MotorLean



Symbol	Address	Data type	Symbol comment
A1.T2.A1T2S003.SO+.O+	I 1.3	BOOL	pump outlet reactor R001 feedback running on
A1.T2.A1T2S003.SV.C	O 3.4	BOOL	pump outlet reactor R001 actuating signal

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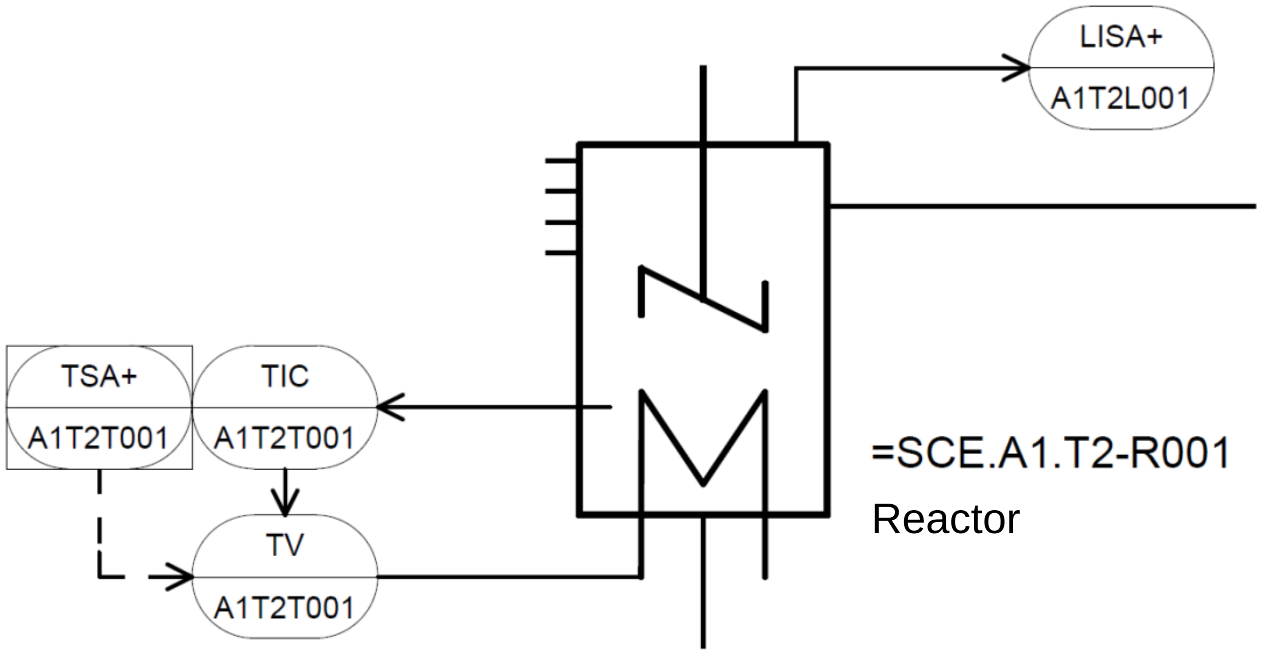
Design of a lock for the pump of the laboratory process cell

- The pump may only be turned on when the main switch of the plant is switched on and the EMERGENCY OFF switch is unlocked
- The pump must not take in air, which means the level of the reactor has to be at least 50 ml
- The pump must not work against closed valves, which means at least one valve has to be open

Symbol	Address	Data type	Symbol comment
A1.A1H001.HS+-.START	I 0.0	BOOL	Switch on multipurpose plant
A1.A1H002.HS+-.OFF	I 0.1	BOOL	Activate EMERGENCY OFF
A1.T2.A1T2L001.LISA+.M	IW 72	WORD	Current value level reactor R001
A1.T2.A1T2X007.GO+-.O+	I 66.3	BOOL	Open/Closed valve … feedback signal
A1.T3.A1T3X001.GO+-.O+	I 67.4	BOOL	Open/Closed valve … feedback signal
A1.T4.A1T4X003.GO+-.O+	I 68.2	BOOL	Open/Closed valve … feedback signal

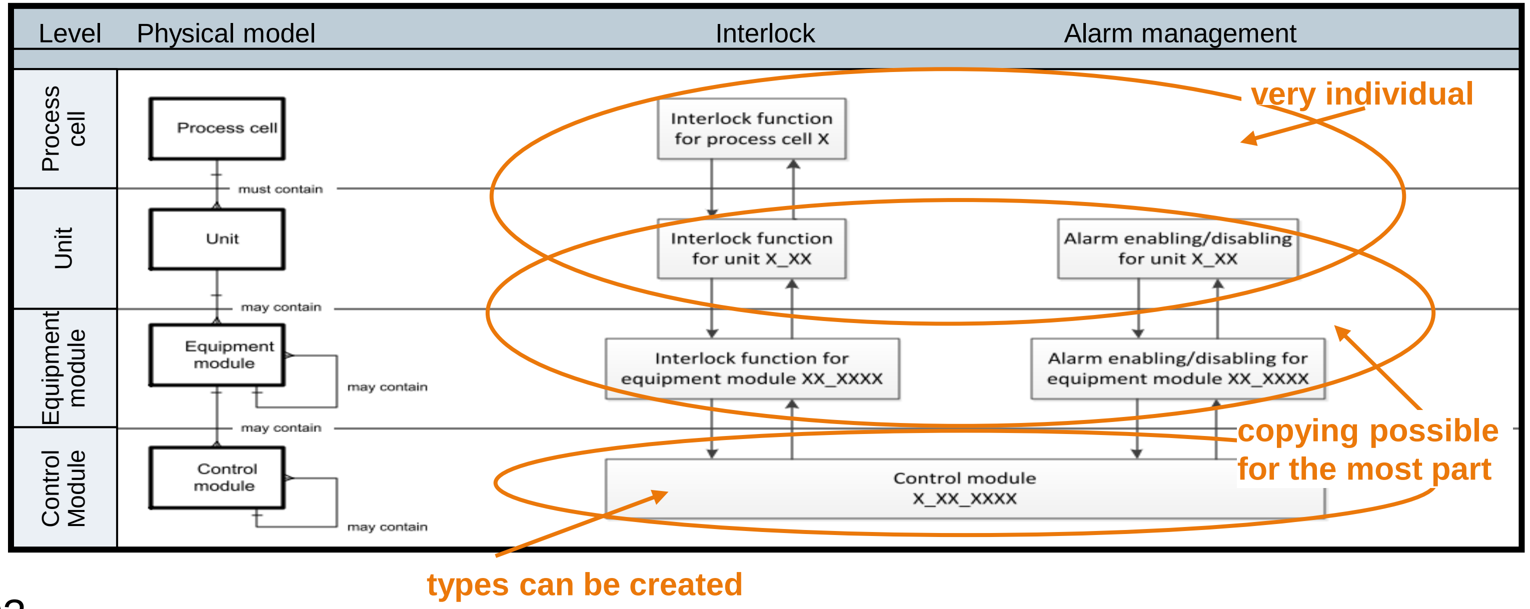
Temperature control of the laboratory process cell

- Control loop
  - Process variable is A1.T2.A1T2T001.TIC.M
  - Manipulated variable is A1.T2.A1T2T001.TV.S
  - Setpoint is
    - Determined by recipe
    - Determined by operator
    - Locked
- Conditions for locking
  - Level in the reactor has to be at least 200 ml
  - Temperature must not exceed 60 ° C



Process tag types and models of the laboratory process cell

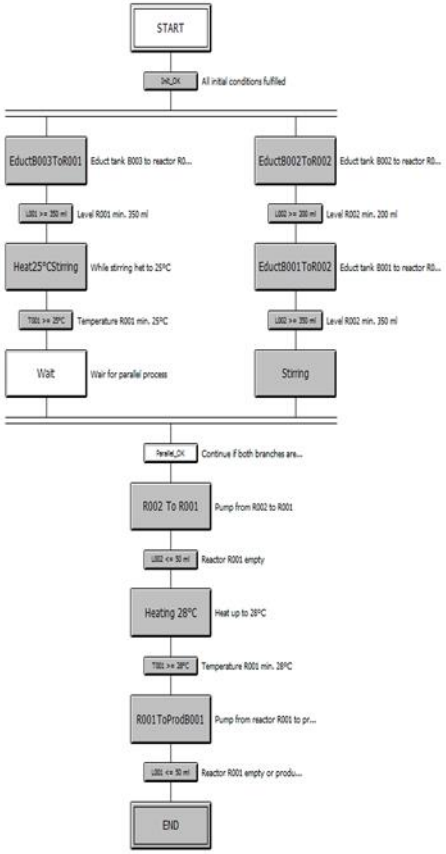
- Similar control modules
  - Pumps
    - A1T1P001 .. A1T1P003
    - A1T2P001 and A1T2P002
  - Valves
    - A1T1V001 .. A1T1V006



- Similar equipment modules
  - Tanks
    - A1T1B001, A1T1B002 and A1T1B003
    - A1T2R001 and A1T2R002
    - A1T3B001 and A1T3B002

Recipe of the laboratory process cell

- First, 350ml are to be drained from educt tank A1.T1.B003 into the reactor A1.T2.R001 and at the same time 200ml from educt tank A1.T1.B002 into the reactor A1.T2.R002.
- When reactor A1.T2.R001 is filled, the liquid is to be heated to 25 ° C with the agitator switched on.
- When reactor A1.T2.R002 is filled, 150ml from educt tank A1.T1.B001 is to be added to reactor A1.T2.R002. When this is completed, 10s later the agitator of reactor A1.T2.R002 is to be switched on.
- If the temperature of the liquid in reactor A1.T2.R001 has reached 25 ° C, the mixture is to be pumped from reactor A1.T2.R002 to reactor A1.T2.R001.
- Now, the mixture in reactor A1.T2.R001 is to be heated to 28 ° C and then drained into product tank A1.T3.B001.



Graphics of the laboratory process cell

- Hierarchy to include levels 1 and 2
  - A1_multipurpose_plant - A1_multipurpose_plant.pdl
    - A1_multipurpose_plant/T1_educt_tanks - T1_educt_tanks.pdl
    - A1_multipurpose_plant/T2_reaction - T2_reaction.pdl
    - A1_multipurpose_plant/T3_ product_tanks - T3_product_tanks.pdl
    - A1_multipurpose_plant/T4_rinsing - T4_rinsing.pdl
- Plant display
  - Displaying all units
  - Displaying the most important information
  - Abstract
- Area display
  - Presentation of a unit
  - Displaying faceplate icons of motors and valves
  - Displaying similar to the P&ID

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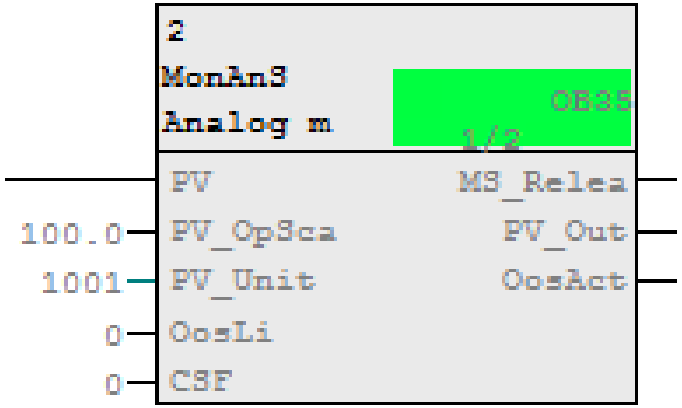
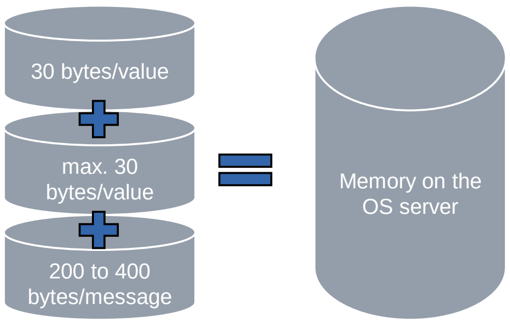
Alarms for the laboratory process cell

- Monitoring the levels
- Monitoring the temperatures
- Using MonAnS (FB 1912) block from Monitor folder of the PCS 7 Advanced Process Library V8.1
  - Monitoring a measurement value (analog signal)
  - Adjustable parameters
    - Warning limit (high/low)
    - Alarm limit (high/low)
- Presentation of faceplate icon
  - In unit T2_reaction
  - Positioning and compiling

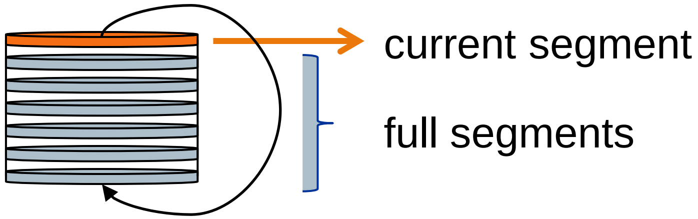


Archiving on the OS server

- Archiving on the OS server = short-term archiving
  - Process values
    - Slow cycle → Tag logging slow
    - Fast cycle → Tag logging fast
  - Messages/events → Alarm logging



- Structure of the archives (Tag logging slow/fast, Alarm logging)
  - Cycling logging consists of segments



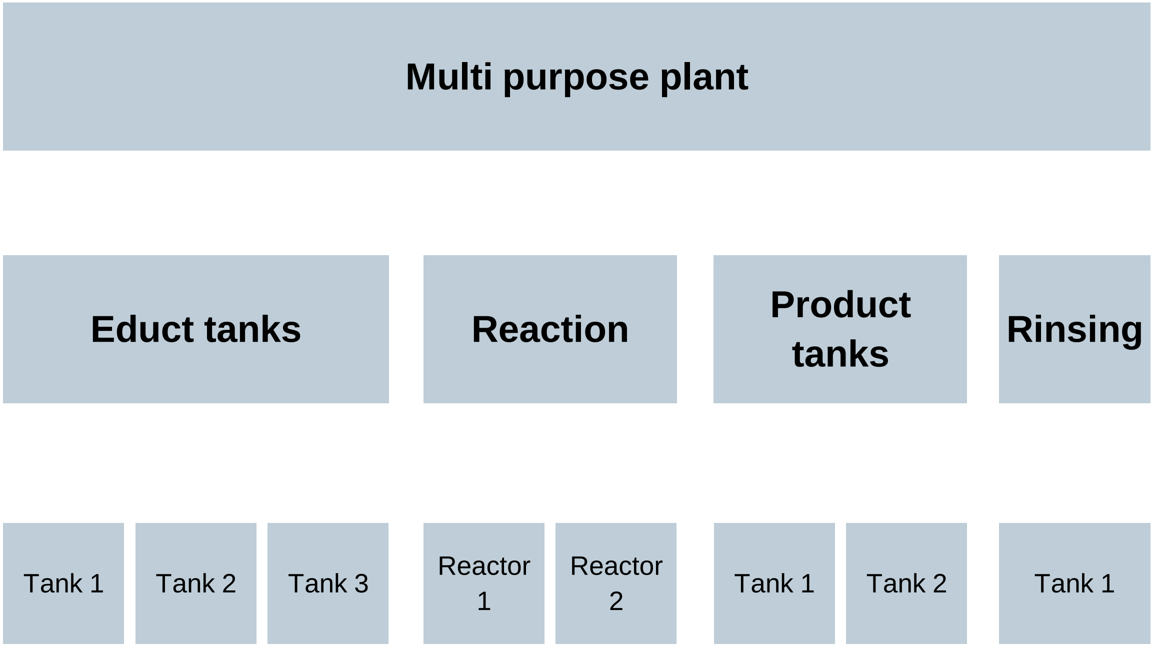
Objectives

- Theory
  - Hierarchical levels of flowcharts
  - Trends to enhance the detailed visualization
  - ActiveX Controls and User Defined Objects

- Step-by-step instruction
  - New structure of the plant hierarchy
  - Creating user defined objects (short: UDO)
  - Expansion of detail displays by ActiveX Controls

Hierarchical levels of flowcharts

- Levels of flowcharts
  - Plant display
  - Area display
  - Unit display/group display
  - Detail display



- Higher levels (plant and area display)
  - Overview of the plant/area status
  - Direct link to the displayed areas
- Lower levels (unit/group display, detail display)
  - Visualization of context and detailed information
  - Usage of filtered alarm lists and adapted trends

Trends to enhance the detailed visualization

Trends = Displaying the course of process values relative to the time

Depending on the timeline, different tasks can be implemented

- History = past without present is used, for example, for disturbance analysis and process control optimization
- Previous history = present with recent past is used for detecting trends and is the most frequently used display
- Predictive display = recent past, present and future is used for predicting a process value and is to support the operator in early intervention

Advantages of trends

- Compressed and clear form to display many characteristics of a process value, for example, essential changes of the course, gradients, dependencies, extreme values, magnitude of fluctuations, setpoint deviations, frequency

ActiveX Controls and User Defined Objects

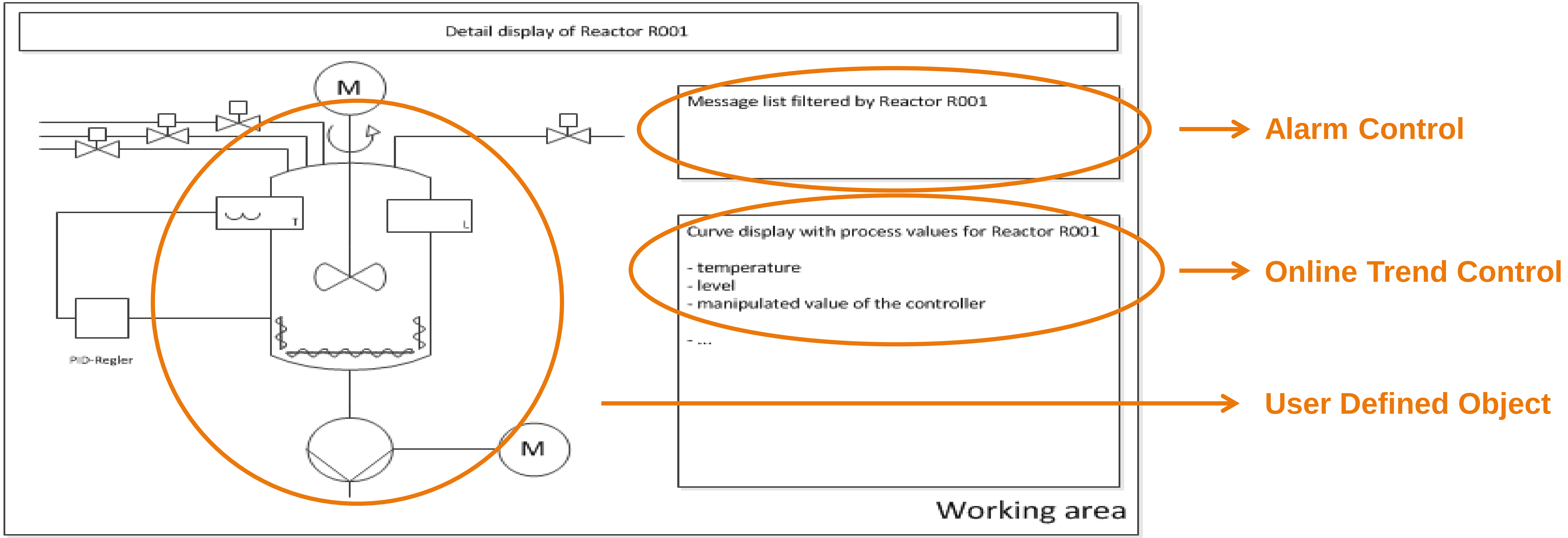
ActiveX Control (provides additional information on detail level)

- Online Trend Control, Function Trend Control
  (display of process values in diagrams, definition of process values to be displayed)
- Online Table Control (display of process values in tables)
- Alarm Control (display of messages and events in lists, filter by criteria such as source)

User Defined Object

- Grouping of individual objects into one object
- Reduces the parameters of all objects to defined parameters of the object
- Storage in library for reuse
- Increases the performance for C-Actions used for dynamic visualization

Layout of a detail display



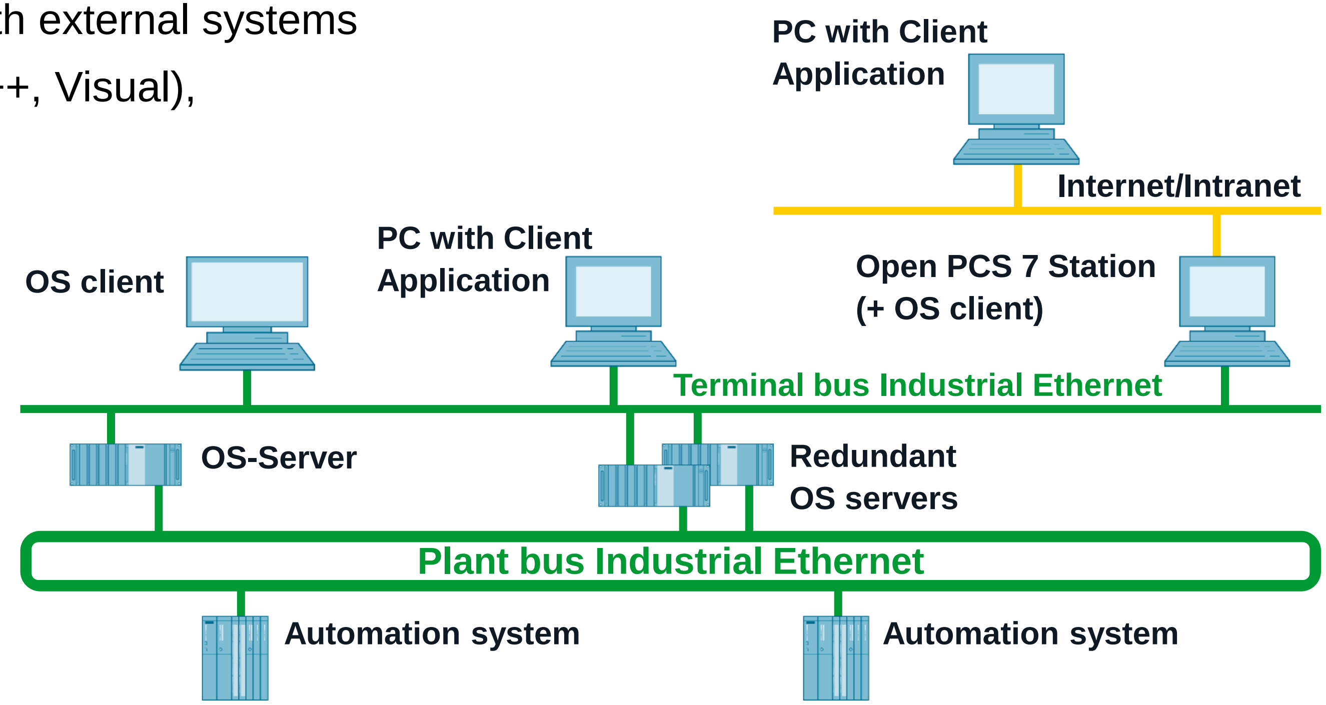
Objectives

- Theory
  - Integration of automation systems from different manufacturers to higher-level programs of the operating management level
  - Basics for structure and operating principle of OPC
  - Integration by means of PCS 7

- Step-by-step instruction
  - Configuration of the PCS 7 project
  - Parameterization of the OPC server
  - Reading of OPC variables in Office applications

Overview

- OPC (OLE for Process Control) provides a standardized, open and manufacturer-independent software interface
- Based on the OLE/COM technology from Microsoft
- PC station with Open PCS 7 can exchange data with external systems
- As viewed from higher programming languages (C++, Visual), OPC is a bridge to process and device data of automation systems
- Equipment manufacturers must develop one OPC server instead of specific drivers



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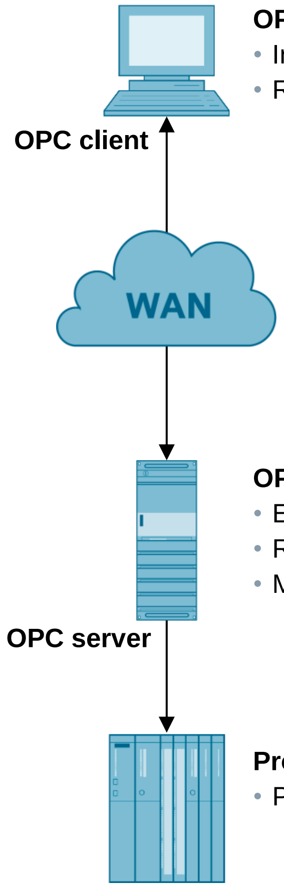
Client-Server model

- OPC communication is based on the client-server model
- **OPC server:** Component which offers data after the request from an OPC client
  - Is connected to the automation system
- **OPC clients** use OPC servers as a data source
  - Usually a component of a user program that must be configured



OPC client e.g. Excel application
- Initiates OPC communication
- Read / write requests for the process values

OPC server
- Executes client requests
- Reads the process variables cyclically
- Monitors process variables for value changes

Programmable controller
- PLC (process values)

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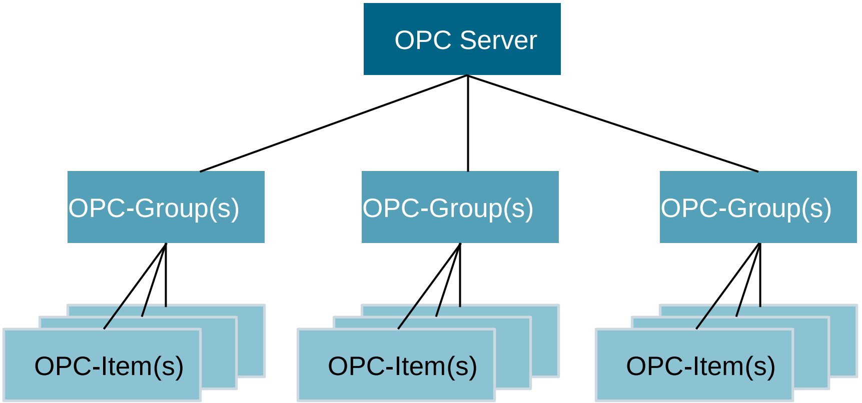
OPC Specification

- **OPC Data Access (OPC DA):** Specification for access to process data through variables
  - Read, change (overwrite), monitor value of one or more process variables or report changes
- Hierarchical class model of Data Access
  - **OPC-Group** structures process variables
  - **OPC-Item** represents the process variables

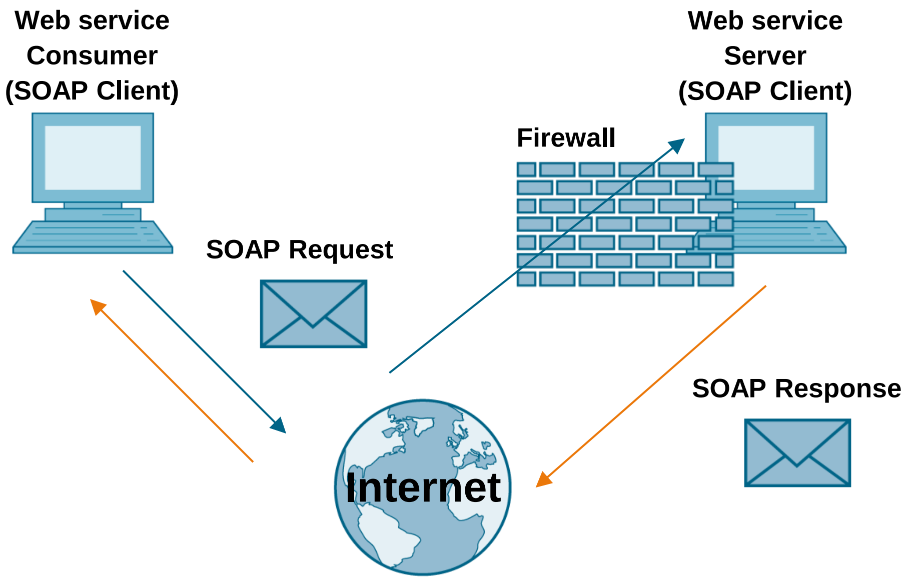


Provided variables:

- Process variables (measured und controlled variables of input/output devices)
- Controlled variables (triggers additional services, such as transmission of passwords)
- Information variables (information about status of connections, devices, etc.)

OPC Specification

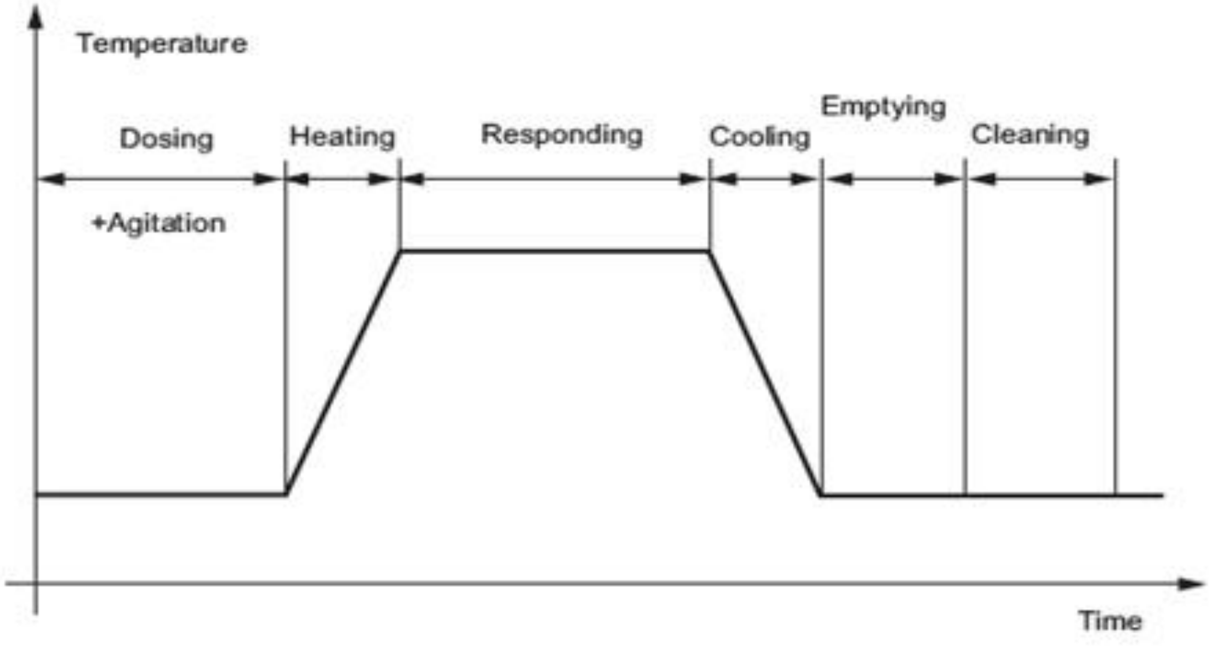
- **OPC extensible Markup Language DA (OPC-XML DA):**
  Standard for communication with a platform-independent protocol over the Internet
  - Based on HTTP and SOAP
  - Functionality similar to OPC Data Access
- **OPC Alarms & Events (OPC A&E):** Additional specification for transfer of process alarms and events
- Three types of events
  - Condition related events
  - Tracking events
  - Simple events



Objectives

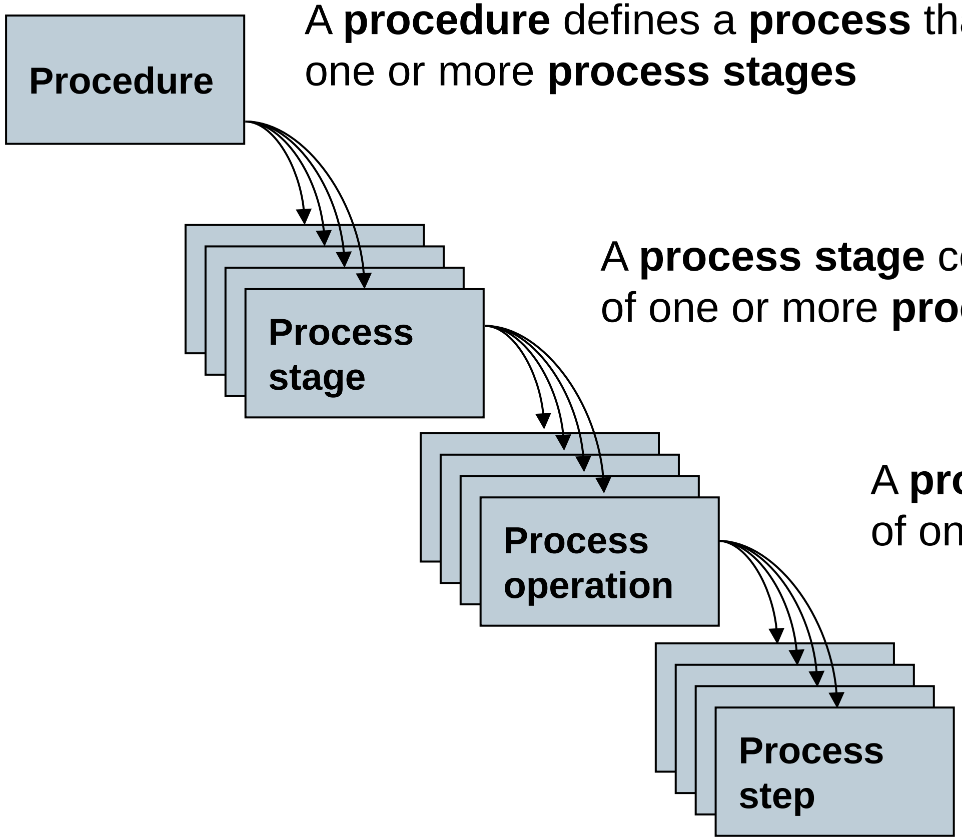
- Theory
  - Modeling a procedural batch process
  - Recipe control for production of batch products
  - Definition of process steps

- Step-by-step instruction
  - Setting up an ISA S88 hierarchy
  - Preparing the PCS7 project with prepared SFC types
  - Setting up project in BATCH Control Center



Hierarchical modeling

- Managing the complexity of a batch process by hierarchical structure



A **procedure** defines a **process** that consists of an orderly set of one or more **process stages**

A **process stage** consists of an arranged set of one or more **process operations**

A **process operation** consists of one arranged set of one or more **process steps**

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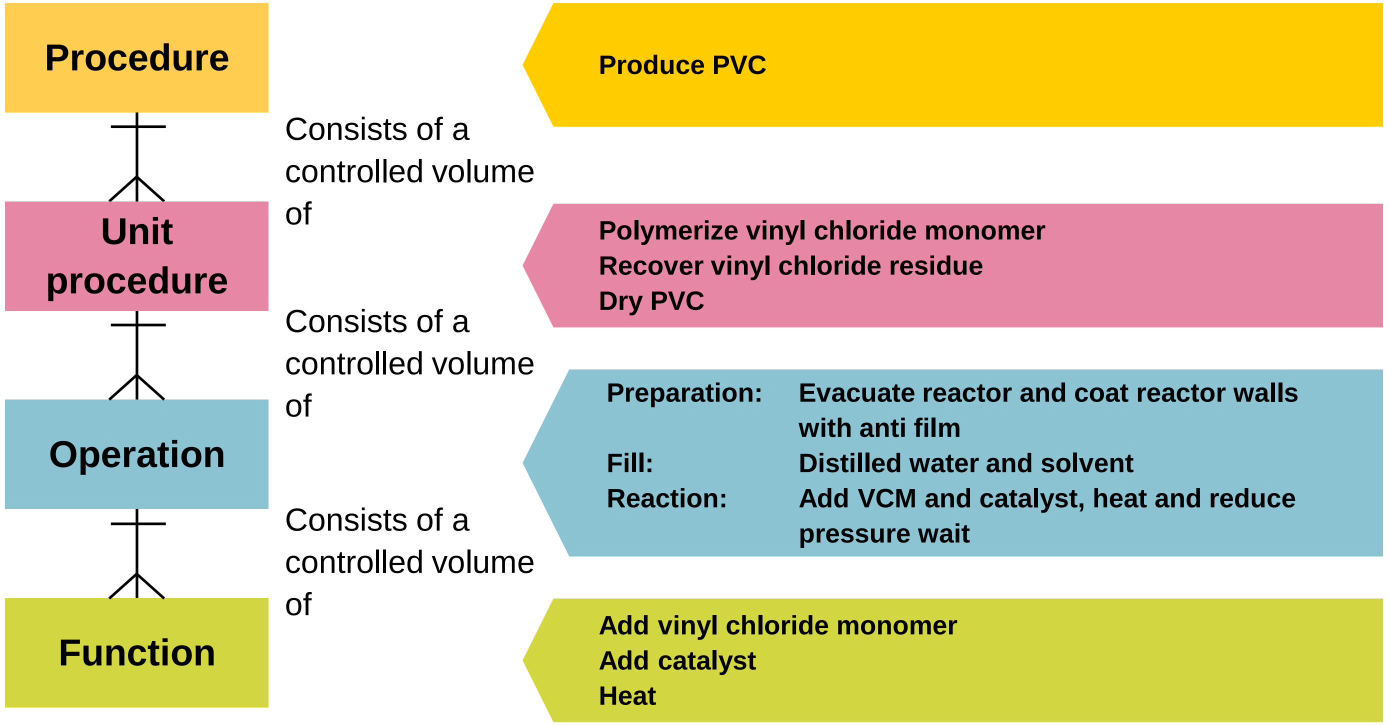
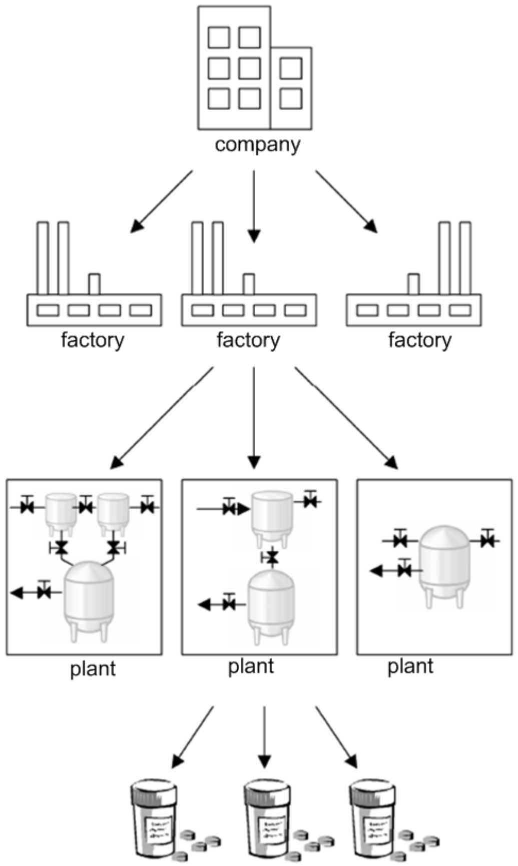
Concepts of batch control

- Requirement is **basic automation** (Module Basic automation)
- **Procedural control:** equipment-oriented actions takes place in an ordered sequence
- **Procedure** is highest level in the hierarchy and defines the strategy
- **Unit procedure** consist off operations for continuous production sequence
- **Operation** is a set of functions and transfer the materials from one state to another
- **Phase(Function)** is smallest element of procedural control



Recipes and recipe types

- Company wide standardized recipes and location differences require
  - Abstract definition, independent of concrete plant
  - Simple adaptation and mapping to the concrete plant
- **General recipe** Recipe at company level
- **Site recipe** Combination of plant-specific information and general recipe
- **Master recipe** specific recipe for plant or a group of equipment of a plant
- **Control recipe** a copy of a specific version of the master recipe
  - Changed according to planning and execution to be specific for an individual batch



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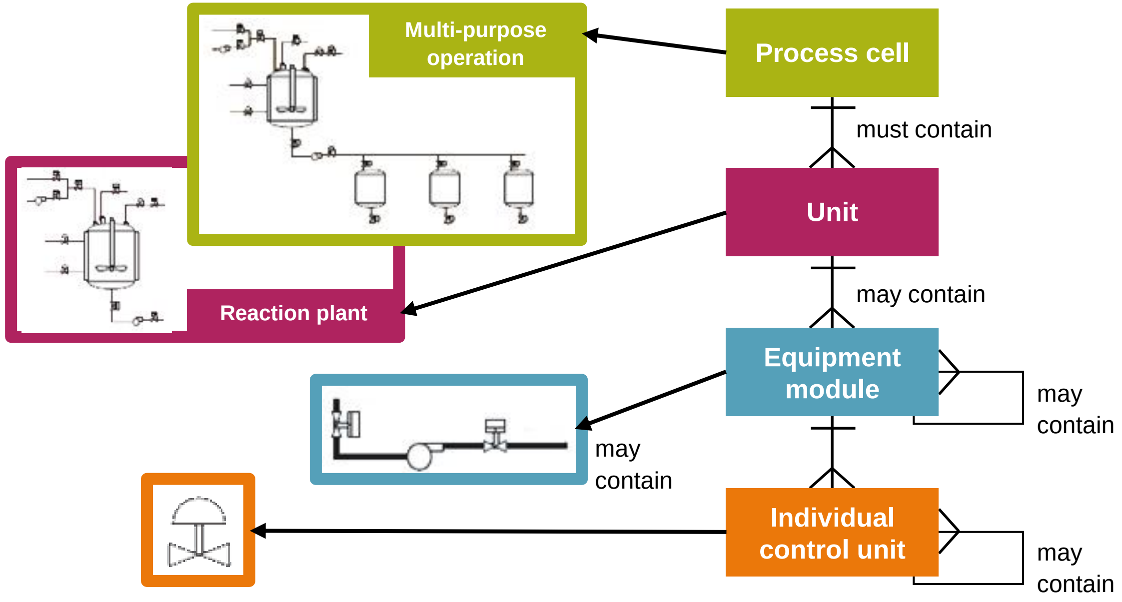
Physical model

- **Process cell** contains all equipment required to make a batch
- **Unit** is made up of equipment modules and control modules, such as a mixing tank or reactor
- **Equipment module** can be made up of control modules and subordinate equipment modules, such as a filter
- **Control module** is usually a collection of sensors, actuators, other control modules and associated processing equipment



PCS 7 University Curriculums
Usage

Theoretical and applied introduction to process control engineering of an industrial plant – in general and with PCS 7 at the university/college level

Guided implementation based on the present projects, or implementation of your own designs is possible

Testing the implementation in a simulated plant

PCS 7 University Curriculums
Outlook

Use of the documents in training/education

- As a lecture (= theory) with practice (= exercises) to design a solution and to implement the design in PCS 7
- As practical training (= exercises) to design a solution and to implement the design in PCS 7

or

- As self-study to implement projects with PCS 7

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Thank you for your attention!

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