Work: **ISA8895 Implementation**

Section: **Structure**

Chapter: **Knowledge Asset**

Language: **English**

Version: **V3 - 05/2011**

Jean Vieille   www.syntropicfactory.info j.vieille@syntropicfactory.info
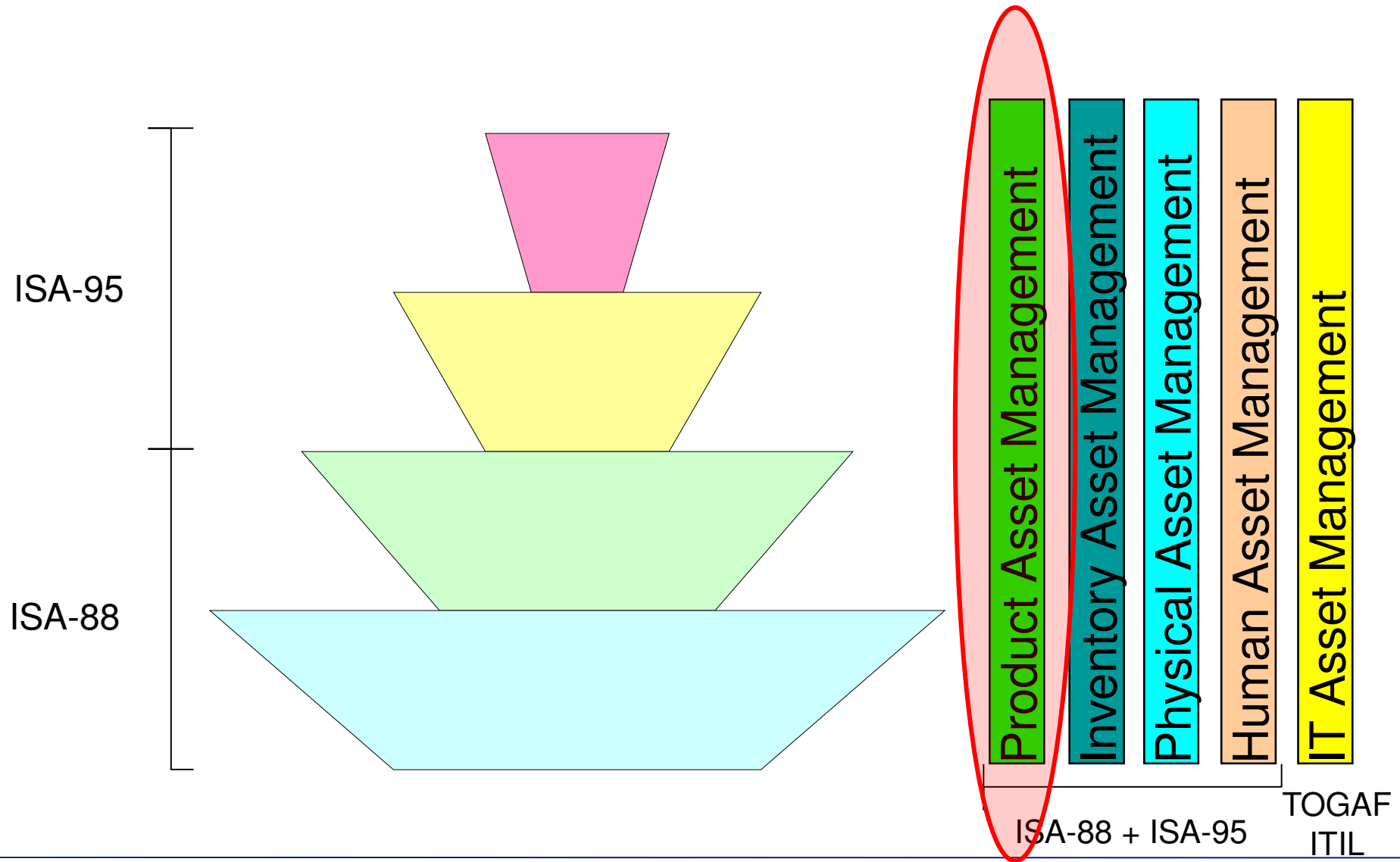
CCM Research community   www.controlchainmanagement.org
CCG Consulting group   www.controlchaingroup.com

Agenda

- **Introduction**

- **ISA88 Product Hierarchy Model**

- **ISA88 Equipment Independent Recipe Model**

- **ISA88 PPC representation**

- **ISA95 Operations Model**

- **Practice**

CC functional domains

ISA-95

ISA-88

Product Asset Management

Inventory Asset Management

Physical Asset Management

Human Asset Management

IT Asset Management

ISA-88 + ISA-95

TOGAF
ITIL

Information Elements

Domain	Model	Std	Information elements
Product Asset	Product Product	ISA88 ISA95	Product Hierarchy Product Definition
Inventory Asset	Material	ISA95	Material Resources
Physical Asset	Physical Equipment	ISA88 ISA95	Equipment Hierarchy Equipment Resources
Human Asset	Personnel	- ISA95	Personnel Hierarchy Personnel Resources
Equipment Control	Procedural	ISA88	Functional Hierarchy Equipment Procedural Elements
Physical Process Control	Procedural	ISA88	Physical Processes / Procedural Elements Physical Process Transform Components
Physical Process Mngt	Segment	ISA95	Segments
Operation Process Mngt	Operation Activity	ISA95	Operation Processes Activities / Tasks

Objective of the Knowledge Asset Modelling

- **The value of a product is set by the need of the market to own it**
- **Its manufacturing implies the combination of other products and their transformation**
- **The industrial solution to make the product is built on the specification of material combination and physico-chemical transformation required to obtain a congruent product**
  - ➢ It basically defines the value creation stream of the product
  - ➢ Several « synthesis routes » can be defined
- **Product Asset Modelling handles this specification that**
  - ➢ Enables the product industrialization
  - ➢ Decouples the product value creation stream and the operating procedure (See « From Product to Process »)

Objective of the Product Asset Modelling

- **Product Modelling provides an abstraction of the physical-chemical processing**
  - ➢ It is independent of facilities physical layout and machinery capabilities
  - ➢ Variant of the same product definition may exist for different sites
- **It highlights necessary material transformations to obtain the desired product**
  - ➢ The Energy Chain primitive breakdown
- **It is shared by all parties of the Money and Energy Chains**
  - ➢ Provides a basic, consistent framework for benchmarking manufacturing segment between product, facilities and batches / production runs
  - ➢ Must correspond to a specific level of Product Segment: bi-directional Design (PLM) / Supply Chain integration

Who's / What's concerned?

PRM	Usr/Rsp	Usage	Typ.IT app
Customer order processing	X	Material identification and equivalence	
Production planning & scheduling			
Production control			
Material and energy control			
Procurement			
Quality assurance	X	Determine quality criteria and protocoles	
Product inventory control			
Product cost accounting	X	Production costing	
Product shipping administration			
Maintenance management			
Research & development	R	Response to market, industrialize products	
Engineering		Build/adapt manufacturing facilities	

Cliquez sur l'icône pour ajouter un tableau

Models Overview

- **This asset is described in a hierarchical manner**
- **4 models address knowledge asset modelling**
  - ISA88 Product Hierarchy Model
    - Called "Process model" in ISA88
  - ISA95 Process Segment model
  - ISA95 Operations Definition model
  - ISA88 Equipment Independent Recipe Model
   - See « From Product to Process »

Agenda

- **Introduction**
- **ISA88 Product Hierarchy Model**
- **ISA88 Equipment Independent Recipe Model**
- **ISA88 PPC representation**
- **ISA95 Operations Model**
- **Practice**

ISA88 Product Hierarchy Model

- **Addresses to the structural description of the company product knowledge asset**
  - ➢ Hierarchical transformations to obtain a product
- **Highly flexible, not constraining,**
  - ➢ The hierarchy can be adapted: extended, collapsed, renamed
  - ➢ The "Batch taste" terminology can be adapted
  - ➢ Supports convergent / divergent processes
- **Independent of the facility**
  - ➢ No relationship with Physical Asset
  - ➢ Focuses on material transformation / combination
  - ➢ =/ equipment related operating procedure
  - ➢ Neutral basis for performance benchmarking

ISA88 Product Hierarchy Model

Process Procedure

Process Stage

*Process Elements*

Process Operation

Process Action
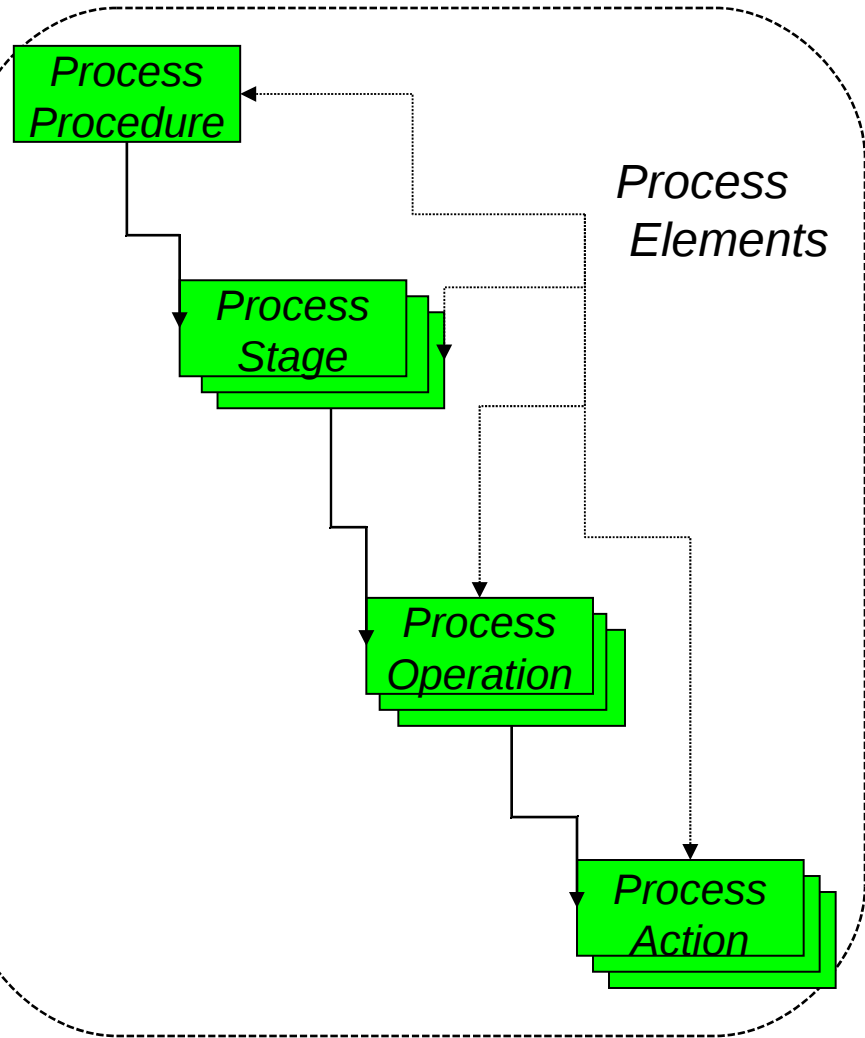
· A sequence of chemical, physical, or biological activities for the conversion, transport, or storage of material or energy.

· A part of a process that usually operates independently from other process stages and that usually results in a planned sequence of chemical or physical changes in the material being processed.

· A major processing activity that usually results in a chemical or physical change in the material being processed and that is defined without consideration of the actual target equipment configuration.

· Minor processing activities that are combined to make up a process operation.

Process Definition

PROCESS PROCEDURE
PROCESS STAGE
PROCESS OPERATION
PROCESS ACTION

- **The hierarchical sequence of process stages, process operations and process actions that defines an ideal procedure for the manufacture of a successful product.**
  - ➢ Specific rework processes can be defined as separate Process Procedures

- **Inputs**
  - ➢ Raw materials, purchased products
  - ➢ Intermediate products
  - ➢ Energy

- **Outputs**
  - ➢ Intermediate products
  - ➢ Co-product, by-products,
  - ➢ Energy

Process Stage

PROCESS PROCEDURE

PROCESS STAGE

PROCESS OPERATION
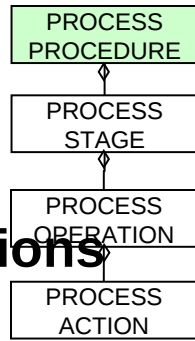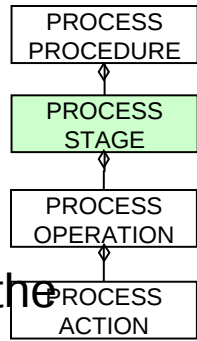
PROCESS ACTION

- **A major transformation activity / a main product breakdown**
  - ➤ a sequence of process operations = chemical or physical changes in the material being processed
  - ➤ Independent: produces stable intermediate products
  - ➤ For the product production information / planning / supervision / process engineering
- **Definition based on**
  - ➤ Chemistry / Physics
  - ➤ Logistics
  - ➤ Engineering
- **Inputs**
  - ➤ Raw materials, purchased products
  - ➤ Intermediate products
  - ➤ Energy
- **Outputs**
  - ➤ Intermediate products: not necessarily identified from on PS to another
  - ➤ Co-product, by-products,
  - ➤ Energy

Process Stages definition rules

- **Product physico-chemichal status**
  - Chemical synthesis route
  - Main parts manufacturing and main assembly steps
- **Major transformation**
  - Obvious change in the nature or shape
- **Combination / Separation**
  - Based on convergence/Divergence points
- **Intermediate**
  - Independent / Asynchronous / Managed
  - Usable for several products
  - Can be sold as finished product
  - Can be sourced from external vendors
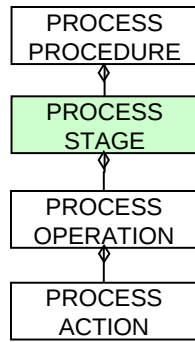
Process Stages definition rules

- **Target facility**
  - ➤ Common equipment constraints for the process stage
  - ➤ Alignment on existing Work Center (Process Cell): The Process Stage corresponds to one or several Master Recipes
- **Intermediate products planning**
  - ➤ Within or separately of the finished product
  - ➤ Process Stage = Process Procedure for an intermediate
  - ➤ Planning of an intermediate: the Process Procedure contains the only corresponding Process Stage
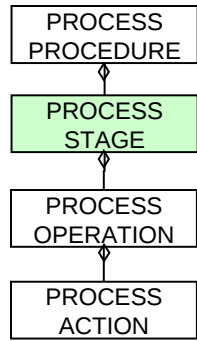
Process Operations

- **A major transformation activity**
  - ➤ A sequence of Process Actions
  - ➤ Operate in sequence on the material within the process stage
  - ➤ Irreversible chemical or physical change in the material being processed
  - ➤ Generally based on chemical or physical considerations
- **Inputs**
  - ➤ Raw materials, purchased products
  - ➤ Intermediate products
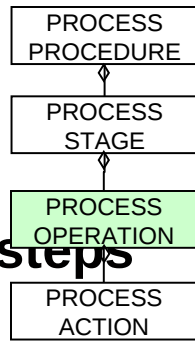 - ➤ Energy
- **Outputs**
  - ➤ Intermediate products: not necessarily identified from on PS to another
  - ➤ Co-product, by-products,
  - ➤ Energy
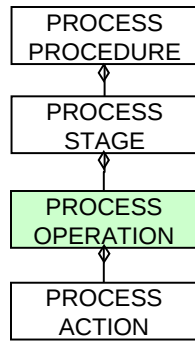
Process Operations definition rules

- **Natural organizational structure to identify major processing steps**
  - ➢ Obvious processing steps
  - ➢ Test and decision points
- **Alignment to Master Recipes**
  - ➢ Identification of possible operation boundaries for subsequently generated master recipes
- **Equipment requirements identification for actions within the operation**
- **Supervision requirement**
  - ➢ Long process breakdown
  - ➢ Finer granularity for manufacturing performance monitoring & benchmark

Process Action

- **A basic processing activity,**
  - ➤ like grind, cool, heat, delay, test or mix
  - ➤ Addition or removal of material or energy, setting environment
- **Process Actions within the operation**
  - ➤ Operate on the defined materials in a defined sequence that may be serial / parallel / contain multiple branches
- **Inputs / Outputs**
  - ➤ Normally no product related I/O identified for Process Action
    - ▪ However, Process Actions act on Operation I/O
  - ➤ Processing Parameters and Processing Data
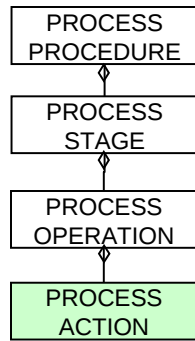
Process Action Rules

- **Process Actions can be of different types. For example:**
  - ➤ Material addition can be a fixed rate or controlled by a process variable such as a pressure, temperature, or pH
- **Company specific process actions**
  - ➤ unique company processing capabilities (separation, packaging…)
- **Industry specific process actions,**
  - ➤ such as catalytic conversions or property state changes.

Agenda

- **Introduction**
- **ISA88 Product Hierarchy Model**
- ISA88 Equipment Independent Recipe Model
- **ISA88 PPC representation**
- **ISA95 Operations Model**
- **Practice**

ISA88 Equipment Independent Recipe Model

- **ISA88 defines 2 categories of recipes**
  - **EIR**: Equipment Independent Recipes (General, Site) define how to manipulate materials to make a product
  - **EDR**: Equipment Dependent Recipes (Master, Control) specifies how to control equipment in order to make a product
- **The Product Hierarchy based EIR**
  - Describes the processing requirements
    - as a flow of material combinations and transformations
  - Identifies the produced and incorporated materials, parameters
  - Specifies the constraints applicable to the manufacturing equipment – not the equipment itself
  - Supports the requirement specification to develop the operating procedure applicable to a particular facility
    - Complete, consistent, unambiguous
    - Understandable by R&D and engineering, at corporate and local levels

ISA88 Equipment Independent Recipe Model

- **ISA88 Part 3 Extends the General/Site Recipe description in Part 1**
- **Provide a standard way to maintain and exchange general recipes**
  - Foreign plants, Contract manufacturing
- **Developed collaboratively**
  - Based on shared definition of processing capabilities, material master, equipment constraints
  - Within the enterprise and among its partners in manufacturing
  - Multiple different control system suppliers, integrators, and consultants

ISA88 Equipment Independent Recipe model

EIR Recipe

Process

Product hierarchy "Process model"

Process Stage

Process Operation

Process Action

Header

Formula

Equipment Constraints
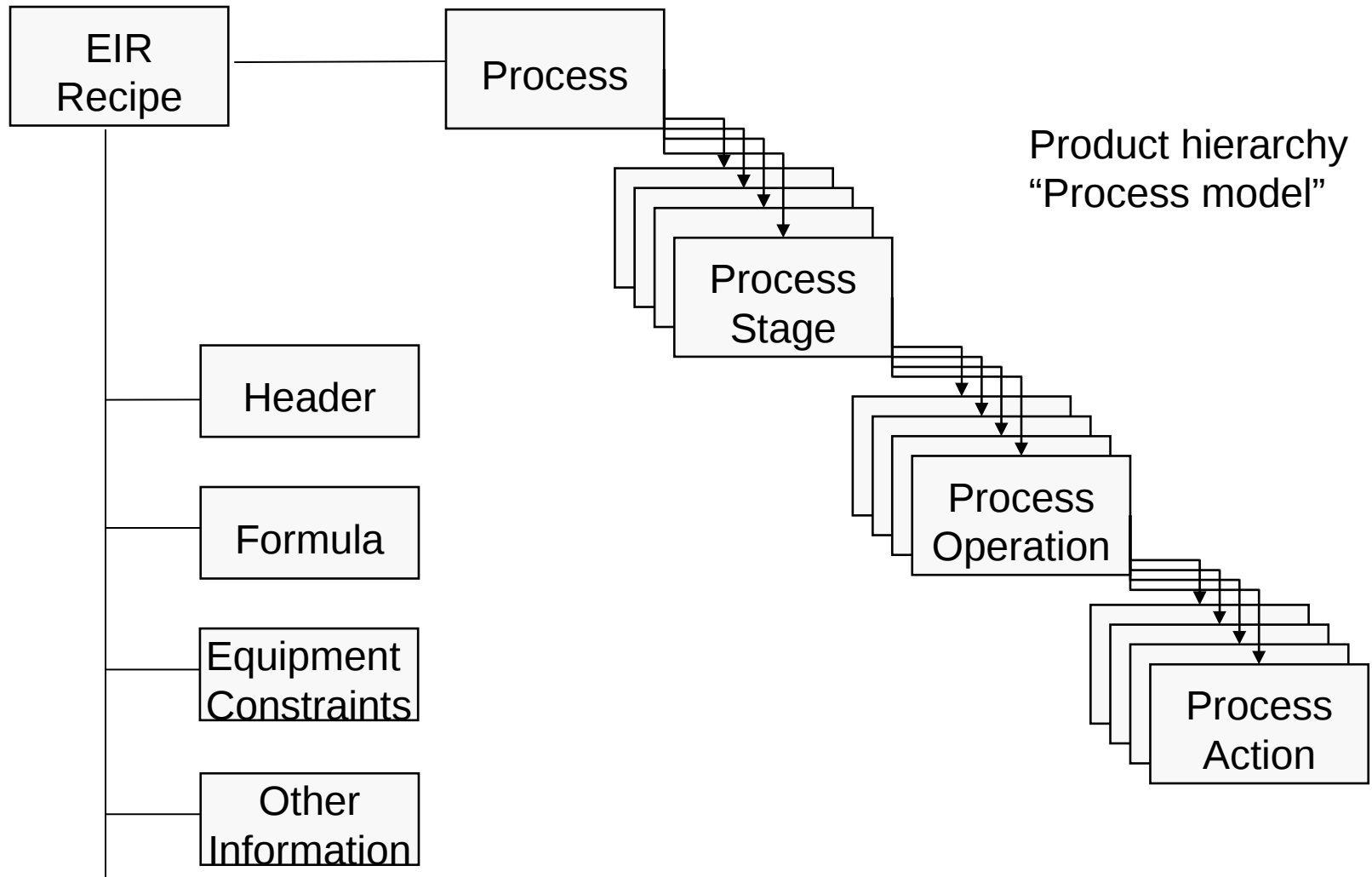
Other Information

Header

- **The administrative information in an equipment independent recipe is referred to as the header**

- **May include such items as**
    - Recipe identification
    - Version number
    - Product identification
    - Product family
    - Product grade
    - Originator
    - Lifecycle state

Formula

- **Includes**
  - Process inputs
  - Process parameters
  - Process outputs
- **Process inputs and process outputs identify**
  - Materials and quantities of materials
  - Resources and quantities of resources
    - (Energy, …)

Formula: Material

- **Materials used in equipment independent recipes shall be identified by material definitions or material classes as defined in the ANSI/ISA 95.00.01 standard**
  - ➢ Equipment independent recipes do not use material lot definitions
- **Material definitions and material class definitions should be maintained in a material definition library to ensure that only valid material definitions are used in equipment independent recipes**
- **A material definition shall have an associated lifecycle state**

Formula: Relationship with the Inventory Asset Model

- **A material can correspond to an output of a particular Process element**
  - ➢ A finished Product is the result of a Process Definition
  - ➢ An intermediate can be the result of a Process Stage or possibly of an operation
- **Product Hierarchy level as Material Classes**
  - ➢ Process Definition / Stage / Operation can be value for the class "ProductHierarchyLevel" = ProcessDefinition / ProcessStage / ProcessOperation
- **Product Hierarchy level as Material Property**
  - ➢ Process Definition / Stage / Operation can be value for the Property "ProductHierarchyLevel" = ProcessDefinition / ProcessStage / ProcessOperation

Formula: Parameter

- **Correspond to ISA-95 Operations segment parameters**

Equipment Constraints

- **Equipment Constraints are a statement of the specific requirements of the final manufacturing equipment necessary to bring about the process activities**

- **May also document certain important attributes to select the suitable equipment needed in this process**

- **Used when the equipment properties may impact the chemistry or physics of production**

- **Used to define "hints" to manufacturing where R&D knows the properties of the material will cause problems if not carefully handled**

- **Equipment constraints correspond to ISA-95 Equipment specification properties in ISA-95 Operations segment model**

Example of Equipment Constraints

Constraint	Description	Constraint Type
ExternalHeatingCoils	Specifies if any heating coils are external to the containing vessel, so they cannot be fouled by the batch material.	**TRUE or FALSE**
LiningGlass	Specifies if the containing vessel is glass lined and connecting pipes are Teflon lined.	**TRUE or FALSE**
LiningNickelFree	Specifies if the containing vessel and pipes are free of any elements containing nickel.	**TRUE or FALSE**
TransfersShort	Specifies if any transfers between vessels are short, so that unintended reactions (such as crystallize) will not occur in the piping.	**TRUE or FALSE**
TransfersStraight	Specifies if any transfers between vessels are relatively straight, so that highly viscous or material prone to plugging may be transferred.	**TRUE or FALSE**
AgtitationNonSheared	Specified that the agitation method does not shear the batch material.	**TRUE or FALSE**

Other Information

- **A general recipe is a container of production information required for manufacturing, but it may also contain information for other business activities**

- **Examples of other information that might be included with equipment independent recipes are:**
  - Spreadsheets detailing known process sensitivity models
  - Complete process models
  - Pictures of good products
  - Pictures of bad products and possible failure reasons
  - References to Test Methods & Test Specifications
  - References to material data safety sheets
  - Additional health and safety information
  - Packaging information

Process Action Information

PROCESS PROCEDURE
PROCESS STAGE
PROCESS OPERATION
PROCESS ACTION
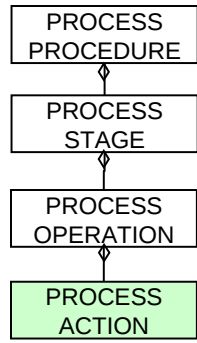
- **Process Action is the most detailed Process Element**
  - Its definition is critical for linking R&D to Process Engineering
    - Product Definition to ☐ manufacturing capabilities
    - Basis for optimizing the transformation of the product definition into executable operating procedure / Recipe

- **Information elements:**
  - Functionality resulting from its realization
  - Parameters to modify its behavior
  - Information resulting from its execution
  - Environment conditions for its execution
  - Pre-conditions for its correct execution
  - Post-conditions resulting of its execution to be taken into account
  - Known Exception conditions
  - Handling of these exception conditions

Classes Of Process Actions

PROCESS PROCEDURE

PROCESS STAGE

PROCESS OPERATION

PROCESS ACTION

- **General actions deal with**

  1. Adding materials
  2. Removing materials
  3. Adding energy
  4. Removing energy
  5. Setting the environment (pressure, agitation…)

- **Company specific actions may deal with unique**

  6. Material preparation
  7. Material extraction
  8. Material shaping
  9. Material packaging
  10. Material testing
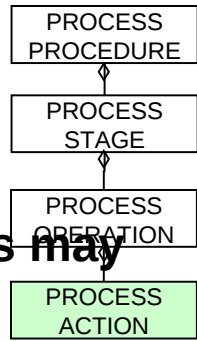
Examples – Adding Material
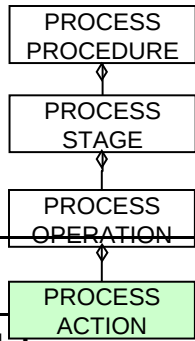
Cliquez sur l'icône pour ajouter un tableau

Process Action	Functional Description	Parameters
Charge	Add the specified material. There is no rate constraint on the material addition. Usually used where there is no expected chemical reaction.	Material To Add Amount to Add
ChargeAtRate	Add the specified material at the specified rate and tolerance. Usually used when mixing is required or too fast a rate will cause an undesired chemical reaction.	Material To Add Amount to Add Percent Per Minute % / Minute Tolerance
ChargeAtTemperature	Add the specified material so the temperature of the material being produced stays within the specified value. This can require heating or cooling capability. Usually used when an exothermic or endothermic chemical reaction will occur.	Material To Add Amount to Add Maximum Temperature Minimum Temperature Temperature Tolerance

Examples – Removing/Separating Materials
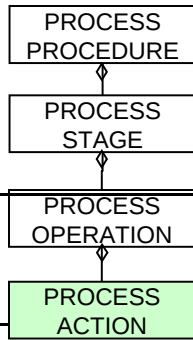
Process Action	Functional Description	Parameters
Dry	Dry the material to remove any water or other safely evaporated materials.	Material To Remove Expected Amount Removed Minimum Temperature
Evaporate-Solvent	Remove a solvent through evaporation. The solvent is to be retained and not dispersed into the atmosphere.	Material To Remove Expected Amount Removed Evaporation Temperature
Filter-Solids	Remove solids.	Material To Remove Expected Amount Removed

Cliquez sur l'icône pour ajouter un tableau

Examples – Adding Energy
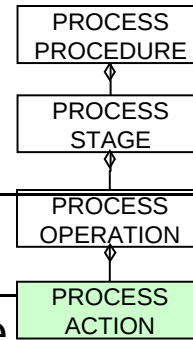
Process Action	Functional Description	Parameters
Heat	Induce energy to flow into the material.	Final temperature
HeatProfile	Control the rate at which energy is added to the material. There can be one or many sets of parameters for different profiles.	Rate to heat Holding temperature Holding time

PROCESS PROCEDURE

PROCESS STAGE

PROCESS OPERATION

PROCESS ACTION

Equipment Independent Recipe Object Model

- **Why,**
  - Because users wanted a standard way to maintain and exchange general recipes
  - To foreign plants
  - To contract manufacturing
  - To multiple different control system suppliers, integrators, and consultants
- **The model**
  - Does not define attributes
    - But it was enough to define a B2MML/BatchML XML exchange
  - Overlaps with ISA95 Product Definition Model
    - More dedicated, using ISA88 vocabulary

EIR Object Model
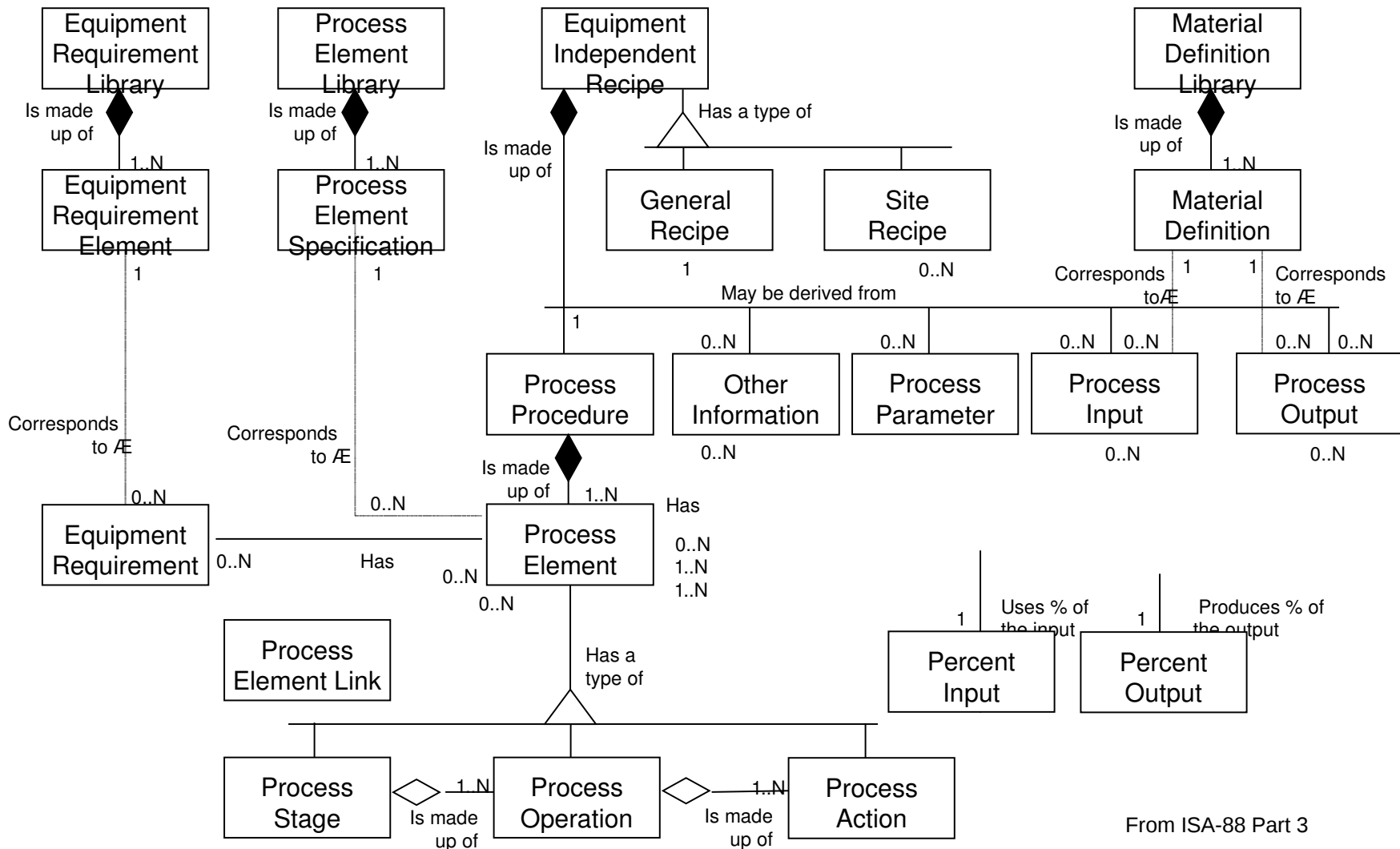
From ISA-88 Part 3

B2MML/BatchML implementation
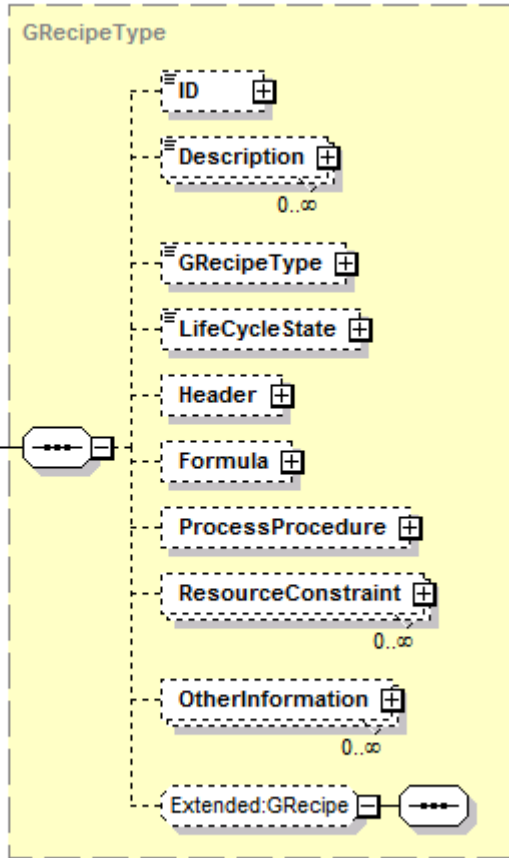
Generated by XMLSpy   www.altova.com
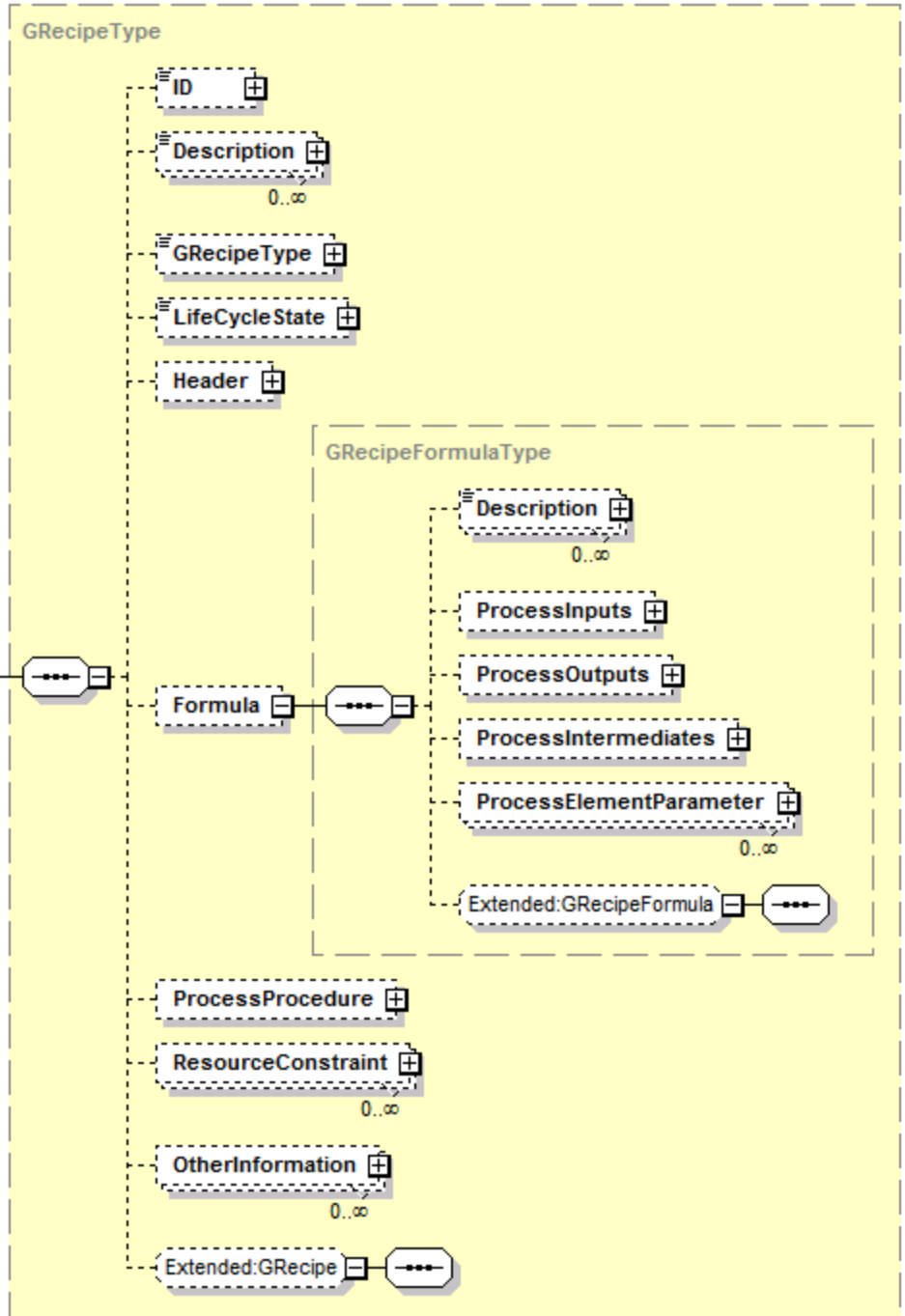
Generated by XMLSpy   www.altova.com
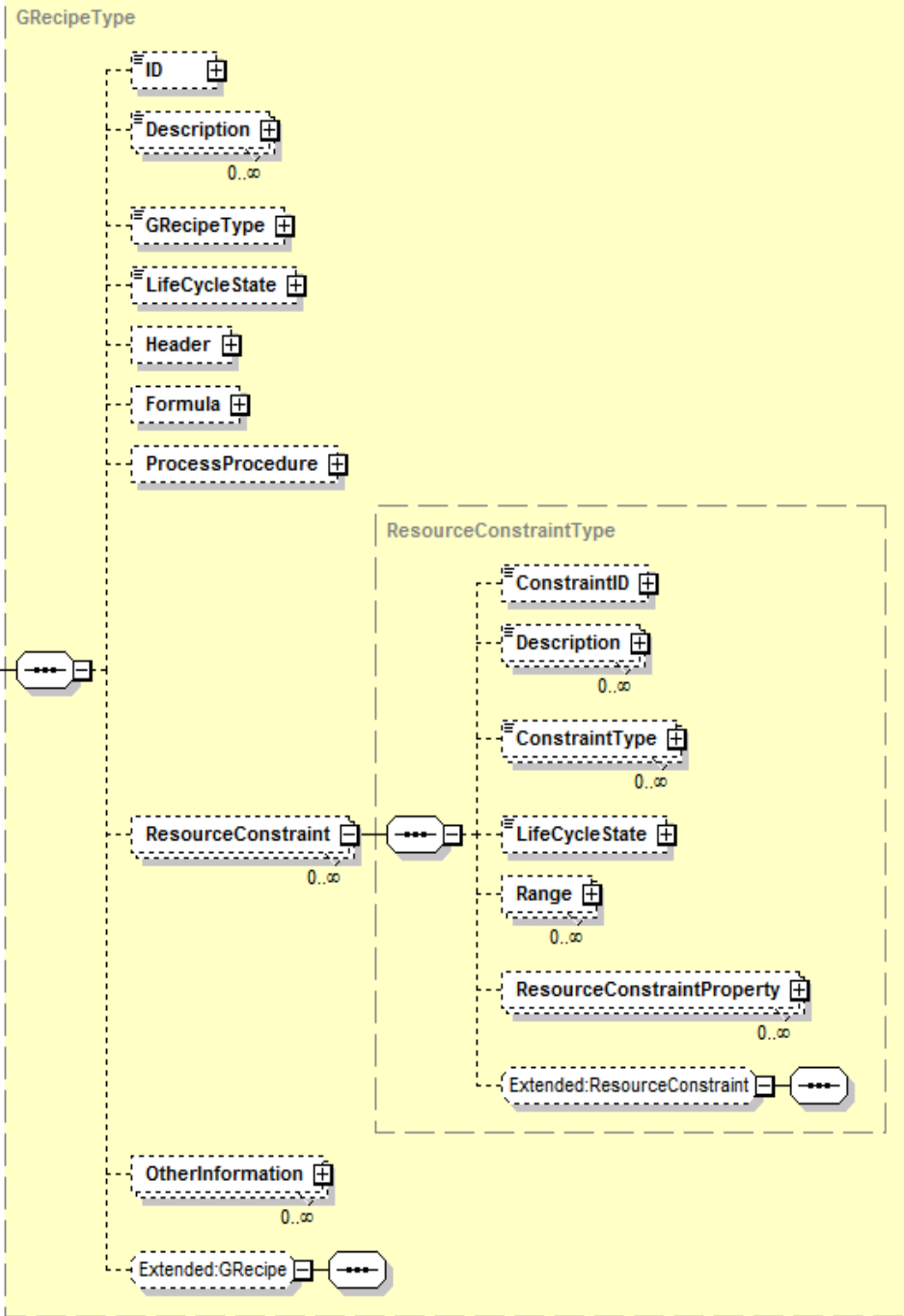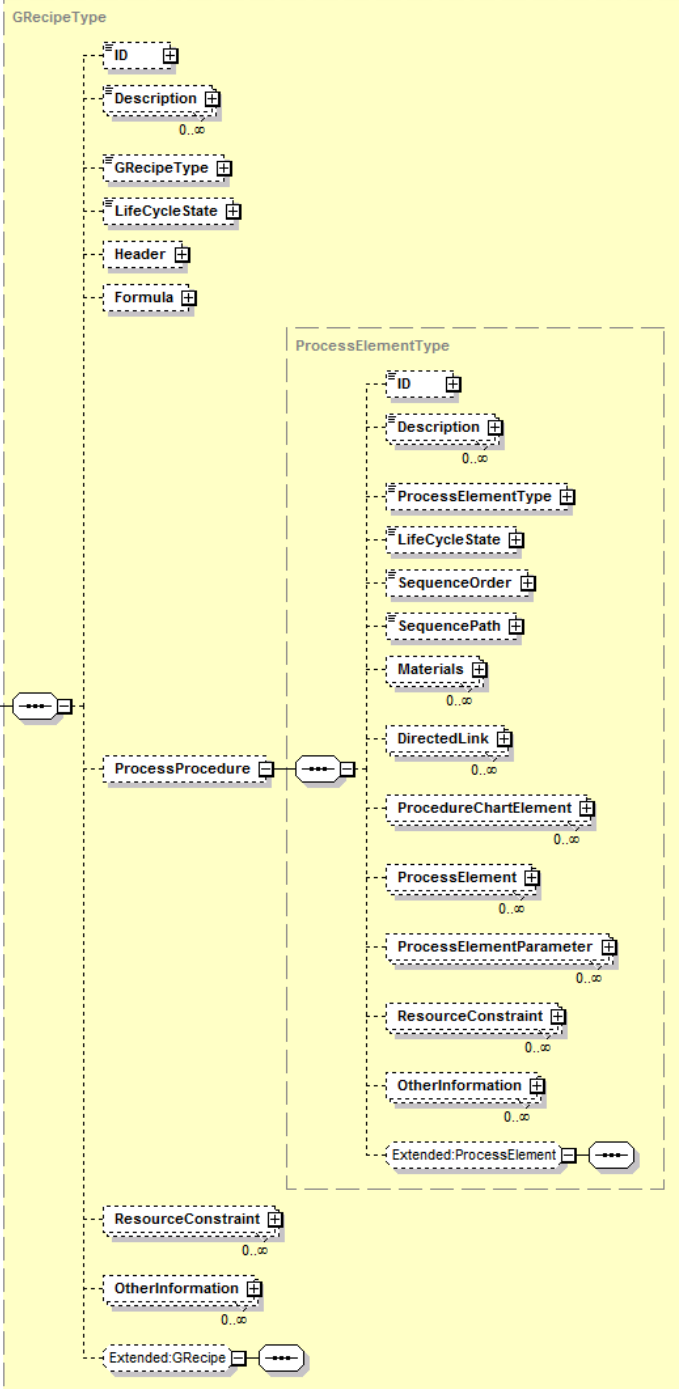
Handling General Recipe definition

- **Develop a standard corporate library of General Recipe elements**
  - Material Definition
  - Equipment requirement definitions
    - These define what will be expected in final manufacturing equipment
    - Each site can use this to determine how "capable" they are to meet R&D requirements
    - They describe to manufacturing sites exactly what equipment requirements will be asked for in production
  - Process actions definitions
    - Have manufacturing site determine its best manufacturing processes for each process action
    - These are used when creating master recipes
    - They describe to manufacturing sites exactly what processing they will be asked to perform to make products

They define a common language and provide a "contract" between manufacturing and R&D

- **Define all general and site recipes based on these standard definitions**
  - Provide document management and change management of the definitions

Summary

- **General and site recipes follow the same model as master recipes**
  - ➢ Except they define a process not a procedure
- **The standard includes guides to help identify the recipe elements (process stages, process operations, and process actions)**
- **Use of general and site recipes requires, as a minimum, libraries of process actions, materials, and equipment requirements**
- **Result will be faster and more reliable technology transfers**

Agenda

- **Introduction**
- **ISA88 Product Hierarchy Model**
- **ISA88 Equipment Independent Recipe Model**
- **ISA88 PPC representation**
- **ISA95 Operations Model**
- **Practice**

Equipment Independent Recipe Representation

- **Required within a company to standardize how they represent product definitions**
    - Few companies have standard, formal, and unambiguous ways to describe pilot plant or R&D instructions to manufacturing
- **ISA88 Part 3 defines the minimal representation method,**
    - Graphical and table views defined
    - PFC for Process Function Chart

General Recipe PPC (Process Procedure Chart)

Process Input representation (Material)

Recipe annotation

Process Note:
Make sure that process temperature is maintained between ring expansion and hydrolysis

Intermediate Material representation

Stage , operation, or action representation

Process Output representation (Material)
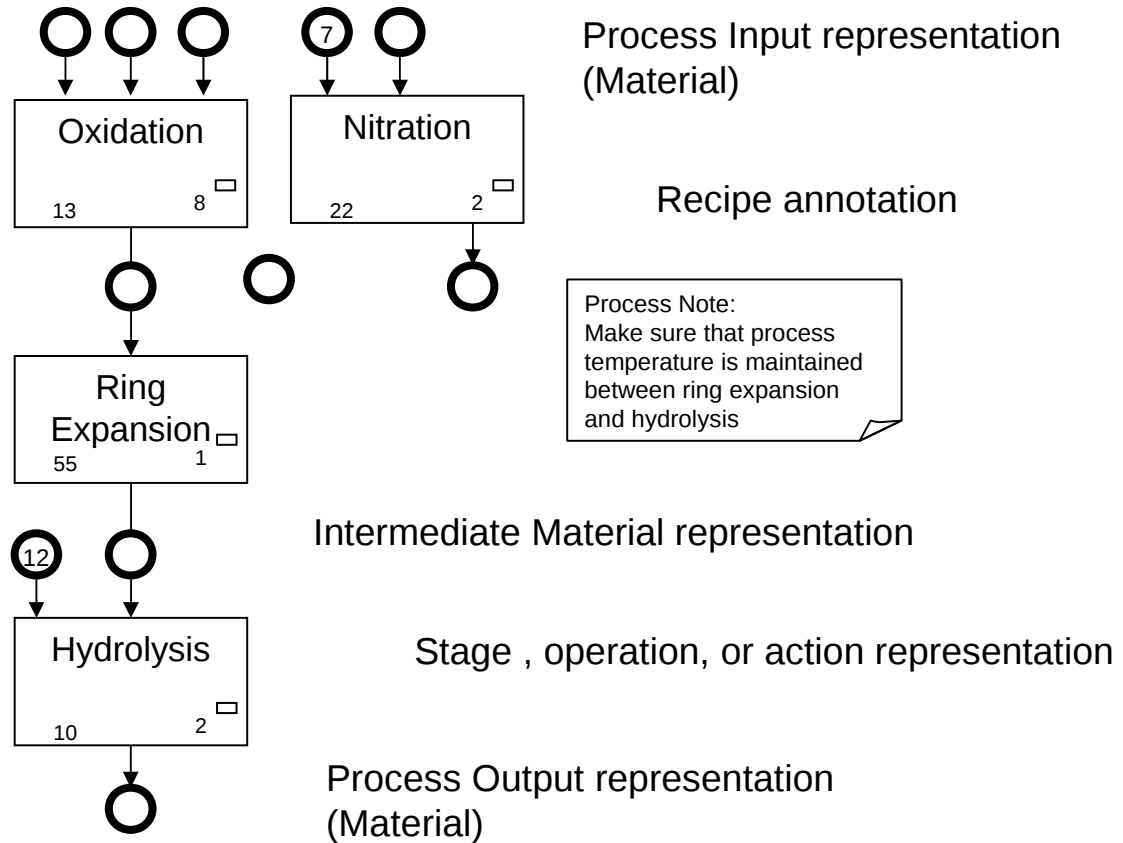
Graphical Recipe Representation

- **Use the material flow "PFC" notation within a Procedure Diagram**
- **Use SFC like notation within a Process Operation Diagram**
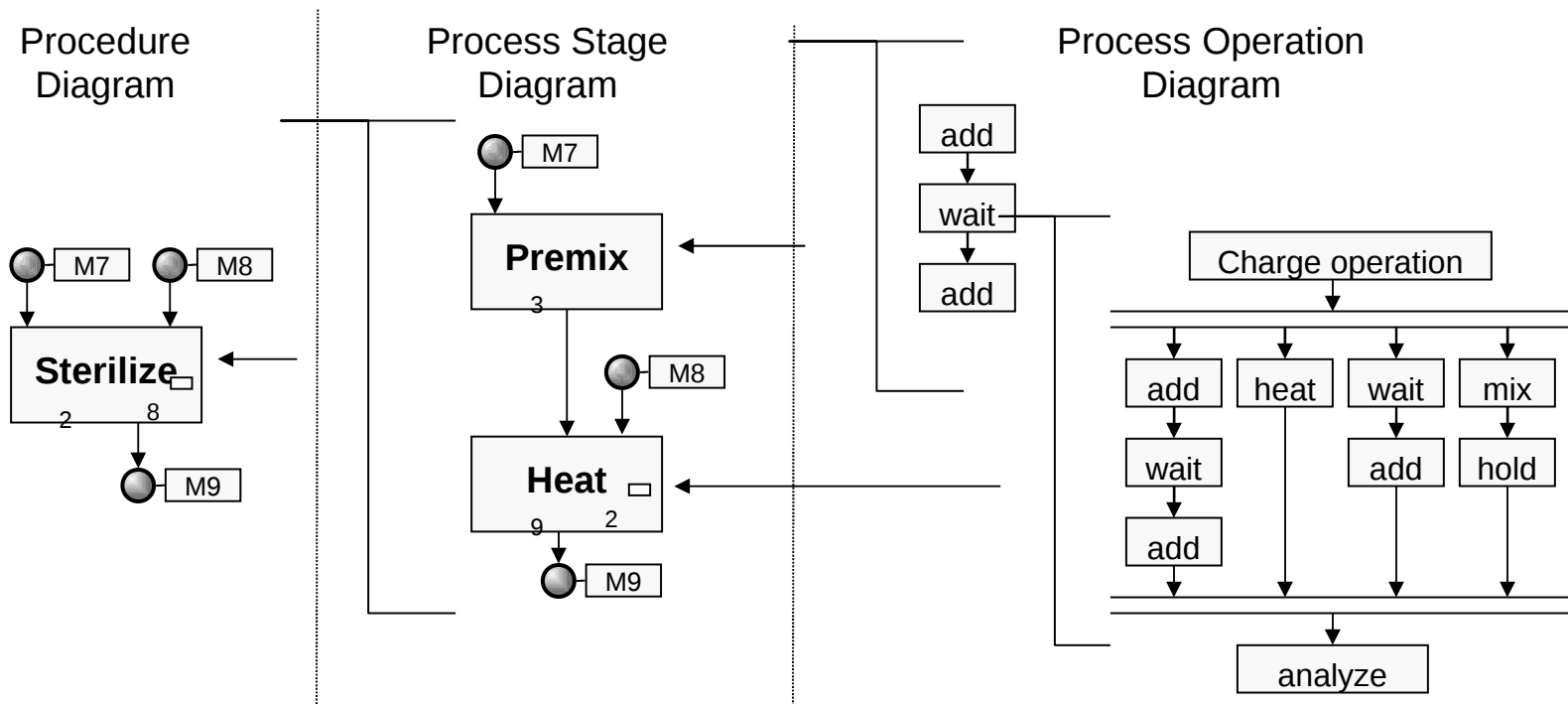
Stage, Operation, and Action Graphical Representation

- **Rectangle represents a process stage, a process operation, or a process action**
- **The rectangle may be annotated**
  - An identification
  - The number of underlying elements
  - The number of equipment requirements

Name _(nn ... nn)_	Stage, Operation, or Action Name
	Stage, Operation, or Action Representation
12	Indication on Underlying Elements
04	Equipment Requirement Indication
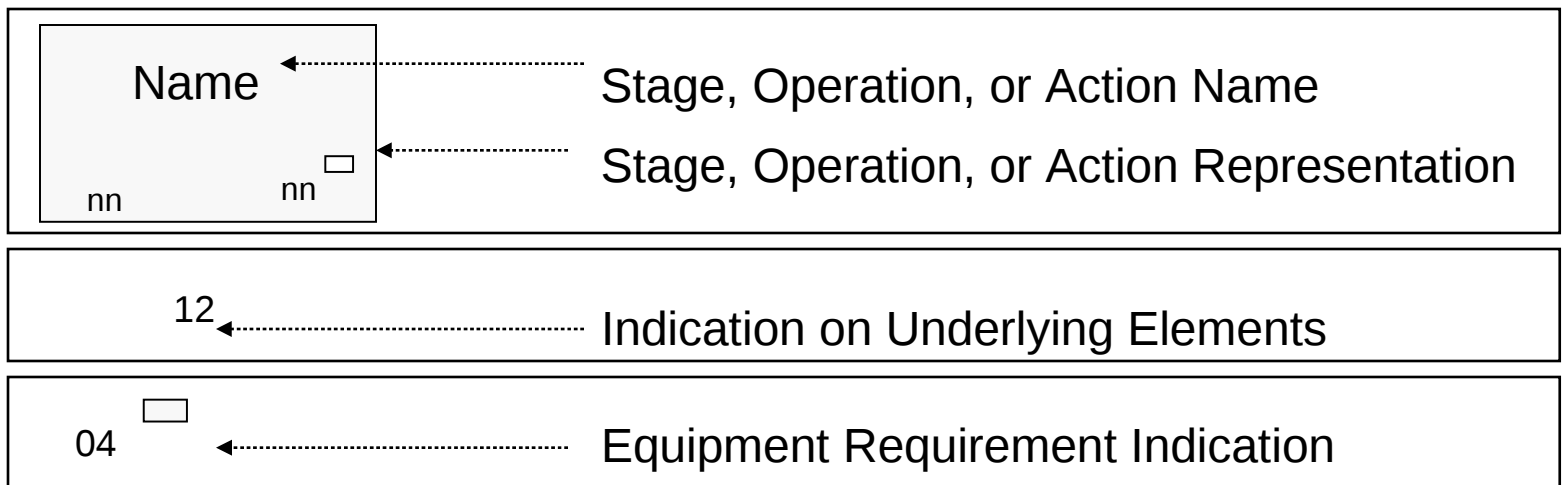
Material Representation

- **Materials are identified by arrows (directed lines) or arrows with circles**

Process Input Representation

Intermediate Material Representation

Process Output Representation

Unidentified intermediate material
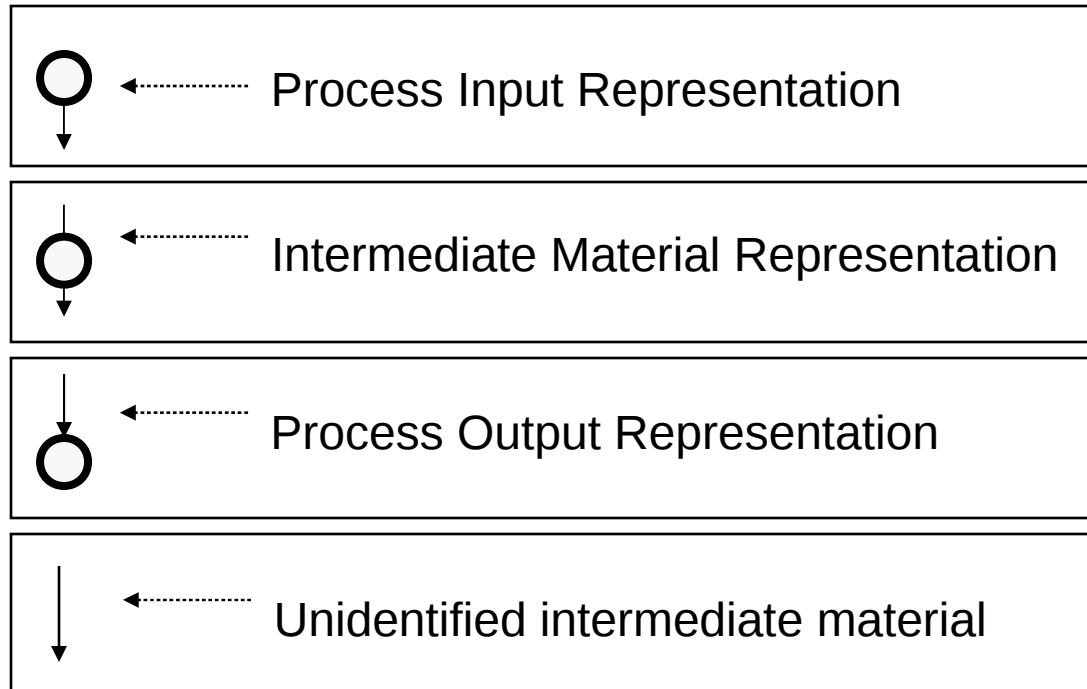
Any material may represent more than one material, with the addition of number inside the circle

Material Annotation

- **Materials may be annotated with the material ID**
- **May be annotated with material ID and selected properties**

ABC101

Material ID	ABC435
Nominal pH	6.3
Color	Pale Yellow
Density	1.42

DEF202

GHI303

Material ID	XGH435
Nominal pH	7.0
Color	Yellow
Density	1.35
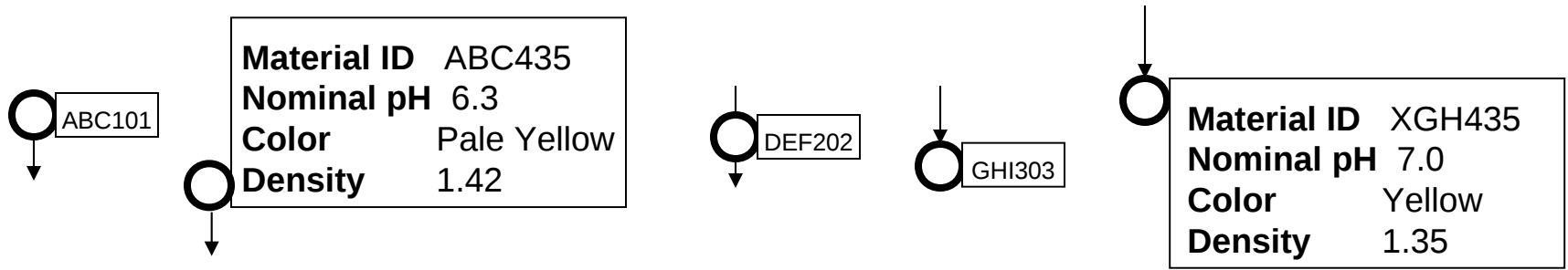
Diagram Annotation

- **Diagrams may also be annotated**
- **May be used to include additional process, equipment, or other information of importance**
- **If a process annotation is used then the annotation shall be associated with an object or with the encapsulating process definition.**

Process Note: If the mixture turns bright red, then the process temperature was to high and the material must be discarded.

Process Note: Make sure that process temperature is maintained between ring expansion and hydrolysis

Process Operation Diagrams

- **Process Operation diagrams show Process Actions**
- **These are assumed to operate on the same material**
- **They need to show parallel and sequential actions**
  - ➢ Similar structure to an SFC
    (IEC 61131-3 Sequential Function Chart)
  - ➢ Similar structure to a PFC
    (IEC 61512-2 Procedure Function Chart)

Decide On A Process Action Model For Setting the Environment

- **There are at least two alternatives to setting the environment of the process**
  - ➢ A non-persistent action model
  - ➢ A persistent action model
- **Whichever model is chosen it is necessary to unambiguously communicate it to people who create master recipes from equipment independent recipes**

Environment Setting Process Action Model

- **One model has process actions that alter processing conditions**
  - ➤ The environment within which further processing occurs
- **Typically defined in terms of temperature, pressure, mixing state**
- **Process actions set the environment**
  - ➤ Start mixing, stop mixing
  - ➤ Set pressure, …

```
┌─────────────────────┐
│  Charge Operation   │
└─────────────────────┘
          ↓
┌─────────────────────┐
│      Heat On        │
└─────────────────────┘
          ↓
┌─────────────────────┐
│      Mix ON         │
└─────────────────────┘
          ↓
┌─────────────────────┐
│       add1          │
└─────────────────────┘
          ↓
┌─────────────────────┐
│       add2          │
└─────────────────────┘
          ↓
┌─────────────────────┐
│      Mix Off        │
└─────────────────────┘
          ↓
┌─────────────────────┐
│      Heat Off       │
└─────────────────────┘
          ↓
┌─────────────────────┐
│       Hold          │
└─────────────────────┘
```
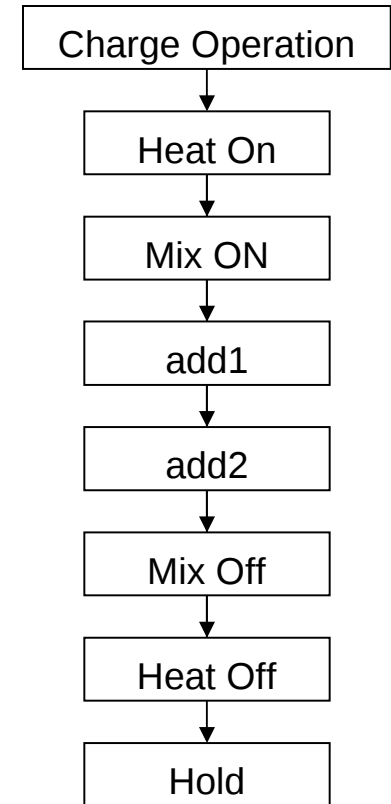
Non-persistent Process Action Model

- **The non-persistent model defines process actions that define the environment only when they are active**
- **In this model a representation method is needed to document the parallel execution of process actions**
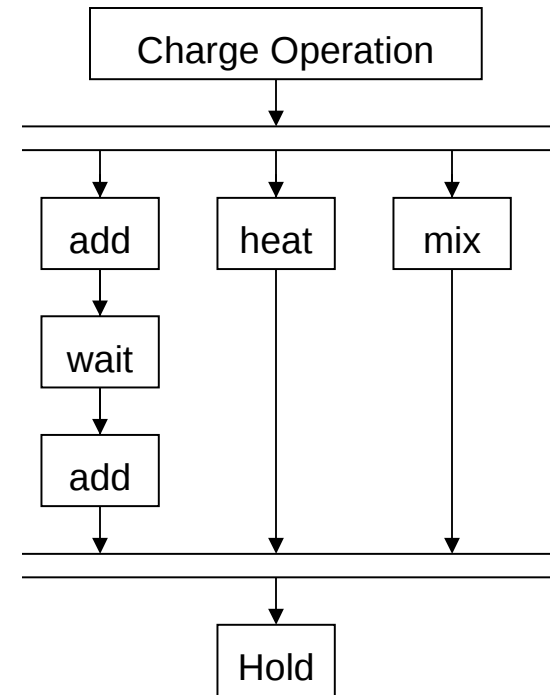
Sequential and Parallel Actions

- **Use the symbols below on a process operation diagram to construct complex sequential and parallel diagrams**
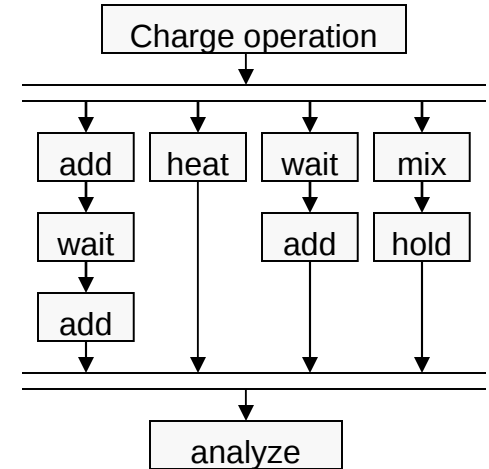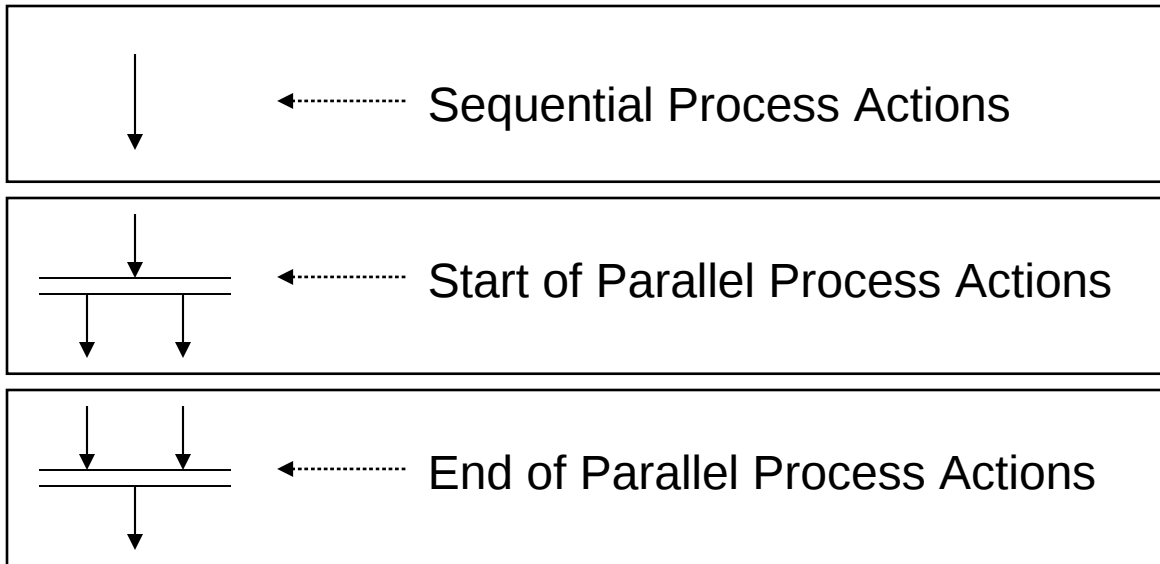
Optional Parallel Actions

- **A special set of symbols are used when it is optional for actions to be executed either in parallel or in series**
- **It looks like a start and end of parallel, but using dashed lines, and an arrowhead on the parallel**

Start of Optional Parallel Process Actions

End of Optional Parallel Process Actions
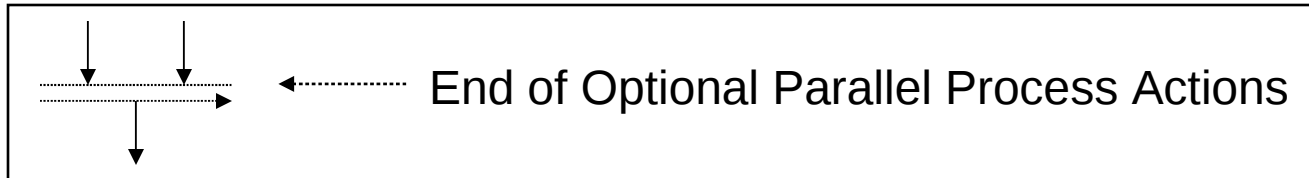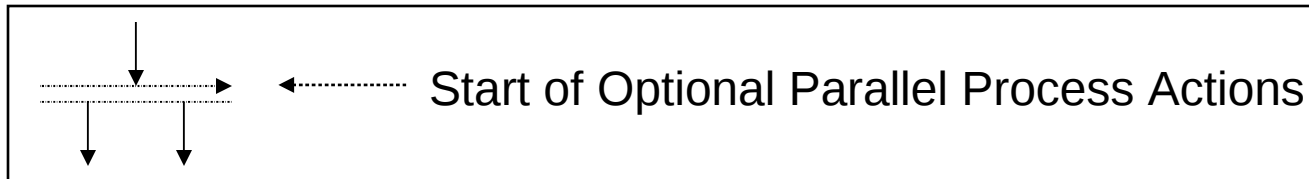
Optional Parallel Actions

- **Usually used in mixing where it can occur in parallel, if the target equipment allows it, or can occur in series if it does not**
- **Usually related to measuring (weighing) materials**
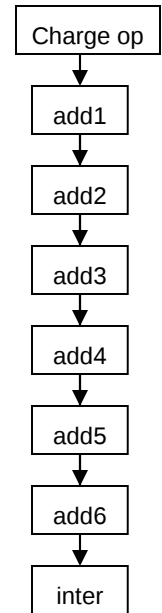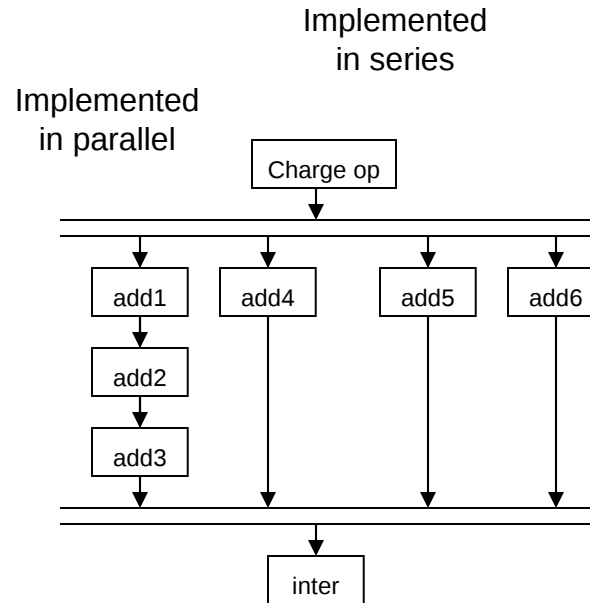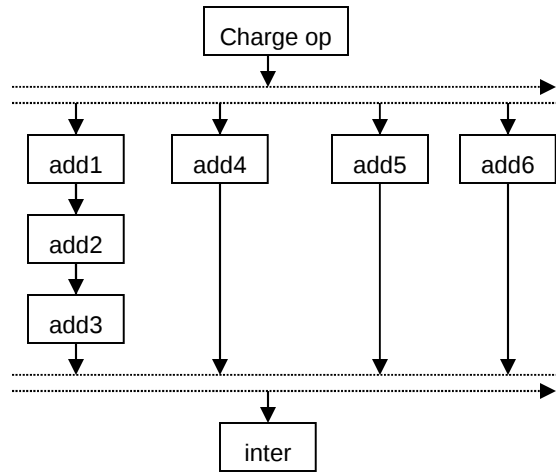
Rules for Valid Diagrams

- **All of the elements in a PPC shall be <u>connected</u>.**
  - ➤ Valid PPCs only have a single network of material flows.
- **Valid PPCs shall <u>start with one or more process inputs</u>.**
- **Valid PPCs shall <u>end with one or more process outputs</u>.**
- **Valid PPCs shall have <u>no loops</u> of material dependencies.**

Table Representation

- **A graphical representation is not always needed**
- **Process operations are assumed to execute sequentially**
- **Many process operations only have sequential sets of process actions**
- **A simple table format may be easier to read and understand**
- **The table format also allows simple parallel definitions**

Table Representation

- **Assumed to execute from top to bottom**
- **The exact format is not defined, but it should show the action and any associated material(s)**
- **Sequence Order and Sequence Path can be used to show limited parallel and sequential actions**
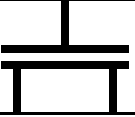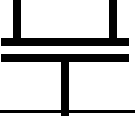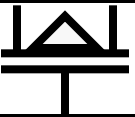
Sequence Order	Sequence Path	Process Action	Material
	0	Shot Add	ABC101
	0	Temp Controlled Add	DEF202
	0	Wait	
	0	Rate Controlled Add	GHI303
	0	Strip Top	XYZ909

Sequence Order and Sequence Path

- **Sequence path is used to indicate which sequential list the action is in (see figure below)**
- **Sequence order is used to indicate where in the parallel the action is (see figures next page)**
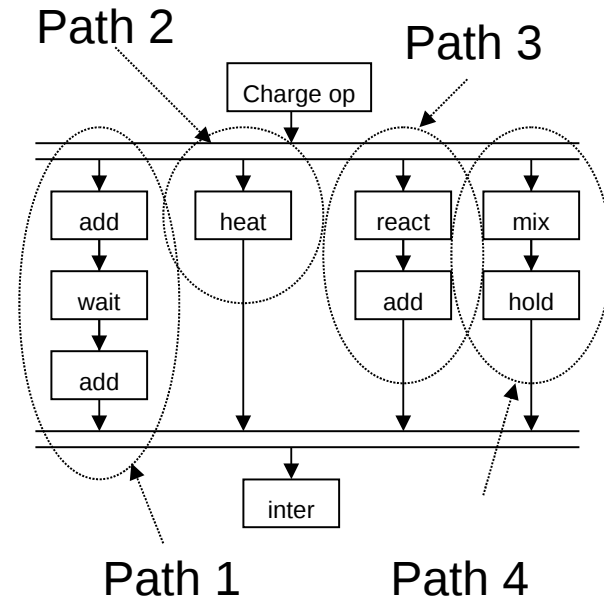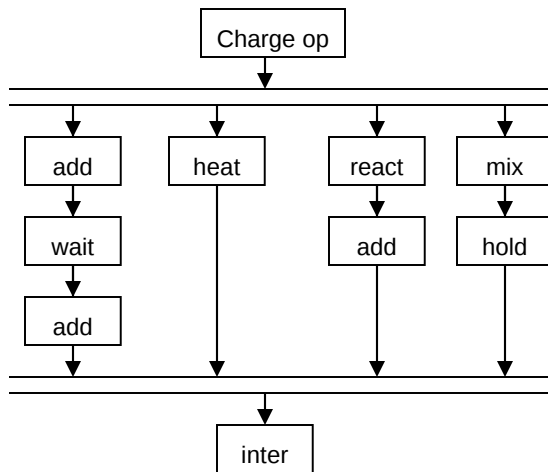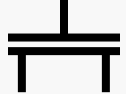
Table representation - Symbols

Action not under a parallel	
⊼ Action not under a parallel	
⊤	Single action at start of a parallel (only action in path)
| |	Single action under a parallel (only action in path)
⊥	Single action at end of parallel (only action in path)
△	First in first series under a parallel (first action in first path)
△	Action in middle of series under a parallel (not first or last in path)
△	Last in last series of actions under a parallel (last action in last path)
⊠	First in a series of actions under a parallel (first action in path)
⊠	Last of series of actions under a parallel (last action in path)

Displaying a Parallel in a Table

- **Hopefully, not frequently used for complex process operations**
- **But, useful for occasional complexity**
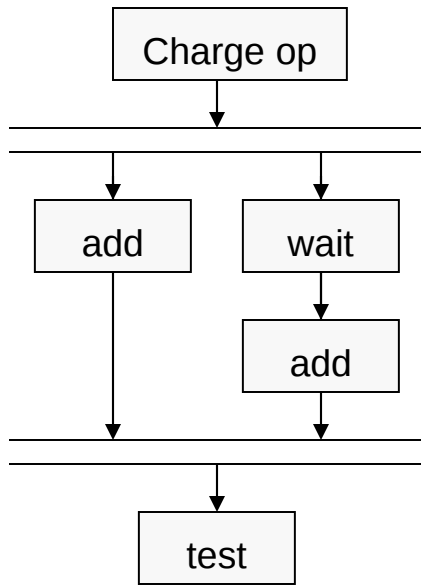
Sequence Order	Sequence Path	Process Action	Material
	0	**Charge Operation**	
	0	**Add**	**ABC101**
	0	**Wait**	
	0	**Add**	**DEF202**
	0	**Test**	

PPC – A Minimal Representation

- **Process Procedure Charts are a minimal representation**
- **Other views of the process definition may be needed by other users**
- **For example, a chemical view may be better for R&D chemists**
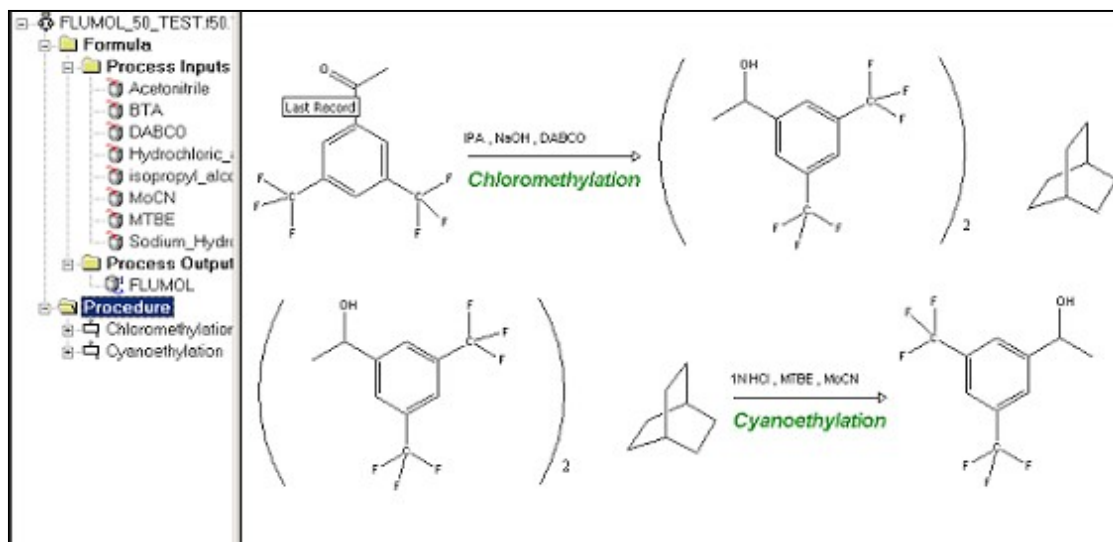
Summary

- **ISA 88 Part 3 defines a minimal standard representation**
- **Actually contains two types of diagrams**
  - Material flows (showing stages and operations)
  - Sequence diagrams (showing operations and actions)
- **A table format is also defined, usable for simple sequences and limited parallelism**

Agenda

- **Introduction**
- **ISA88 Product Hierarchy Model**
- **ISA88 Equipment Independent Recipe Model**
- **ISA88 PPC representation**
- **ISA95 Operations Model**
- **Practice**

ISA-95 Operations Definition Model

- **The ISA-95 Operation definition model describe the purpose oriented activities of the industrial facilities**
  - ➢ The "knowledge" about making the product, processing inventory operations, testing/qualifying resources and product, maintaining the facility equipment...
  - ➢ However, it does not expose the knowledge itself, but identifies its breakdown and resource commitment
- **This model describes the product as a kind of achievement (here, the product) in terms of hierarchical stages, the "Operations segments"**
- **It shares the common segment pattern**
  - ➢ See Physical Process Management

ISA-95 Operations Definition Model for Product

- **ISA95 focuses on supervising manufacturing,**
  - ➢ It does not care much about processing details
  - ➢ It essentially manages resources
- **The Operations Definition model implements a resource view of Product Asset**
  - ➢ Can implement the product hierachy and EIR models
  - ➢ Based on the common Segment pattern
- **It defines**
  - ➢ Resource (Equipment, Personnel, Material) specification
  - ➢ Specific parameters
  - ➢ Links to external business information

Operations Definition Model Elements (for Product)

- **Operations Definition (product)**
  - ➢ "collection of information about materials, production rules and scheduling required to create a product"

- **Operations Segment (product)**
  - ➢ "logical grouping of resources (personnel, equipment, and material) specifications required of a process segment to complete a production step for a specific product

- **Operations Material Bill (product)**
  - ➢ "the subset of the bill of material that is related to production"

- **Parameter**
  - ➢ "Information that is required by the operation system for correct manufacturing"

- **Resource (Personnel, Equipment, Physical Asset, Material) specification**
  - ➢ "An identification, reference, or correspondence to a resource capability"
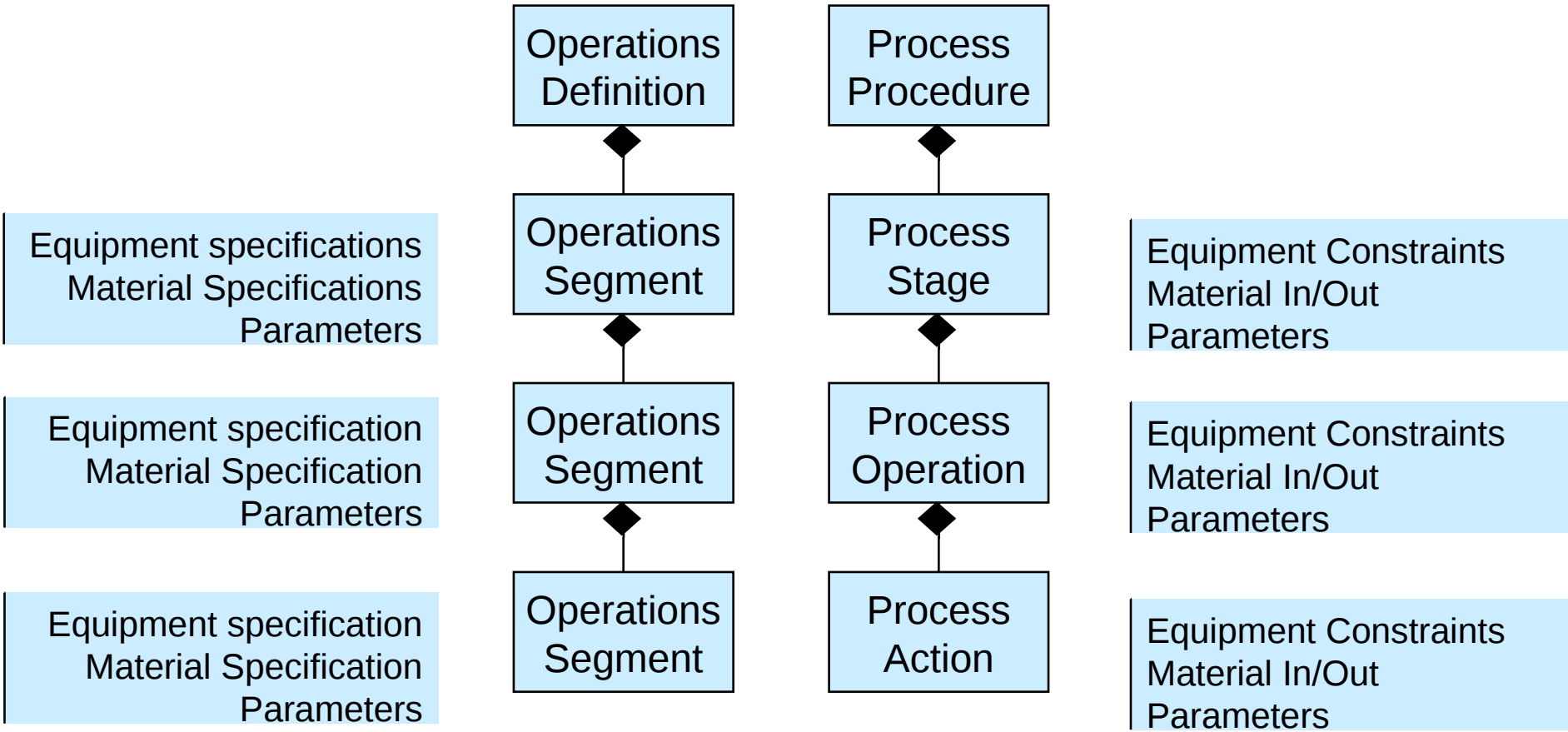
Operations Definition Model
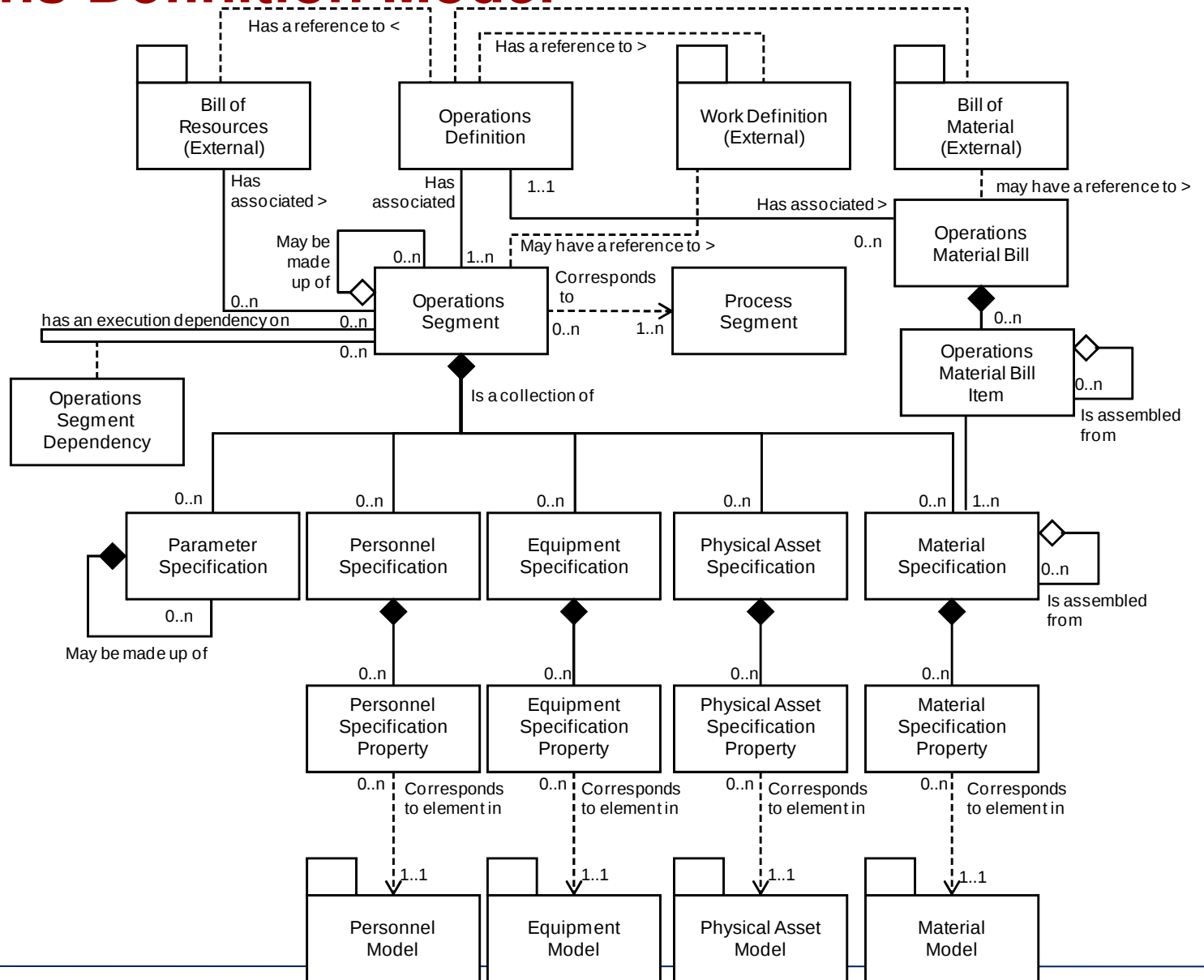
Operations Definition Model Elements (for Product)

- **Bill of materials**
  - ➤ "listing of all the subassemblies, parts, and/or materials that are used in the production of a product including the quantity of each material required to make a product"
  - ➤ MRP II planning information
- **Bill of resources**
  - ➤ "listing of all resources and when in the production process they are needed to produce a product"
  - ➤ Production scheduling / Advanced planning and optimization information
- **Work Definition**
  - ➤ information used to instruct manufacturing operation how to produce a product - Refers to detailed Control system information, Manufacturing instructions (Recipes, Setup / assembly instructions…)

Implementing the ISA Product Hierarchy model in ISA95

	ISA 95 Operations Definition	ISA 88 Product Hierarchy	
	Operations Definition	Process Procedure	
Equipment specifications Material Specifications Parameters	Operations Segment	Process Stage	Equipment Constraints Material In/Out Parameters
Equipment specification Material Specification Parameters	Operations Segment	Process Operation	Equipment Constraints Material In/Out Parameters
Equipment specification Material Specification Parameters	Operations Segment	Process Action	Equipment Constraints Material In/Out Parameters

Agenda

- **Introduction**
- **ISA88 Product Hierarchy Model**
- **ISA88 Equipment Independent Recipe Model**
- **ISA88 PPC representation**
- **ISA95 Operations Model**
- **Practice**

Practice

- **(1) Product Hierarchy**
  - ➢ Give possible names and examples for the product hierarchy level
- **(2) Product Parameter**
- **(3) Process Element Classes**
  - ➢ For some process actions, define
    - Parameters (settings)
    - Data (Relevant information to collect)
    - Environment requirements
    - Pre-conditions
    - Post-conditions
    - Exception and handling
- **(4) Process Definition**
  - ➢ Define a Product procedure using the 4 standard levels
    - Up to the detail of an operation using some of the above Process Actions
    - Identify IN/OUT material from Exercises (1)

Thank You !