



Work: **ISA8895 Implementation**
Section: **Function**
Chapter: **Operations Management**

Language: **English**

Version: **V3 - 05/2011**



Jean Vieille

www.syntrropicfactory.info j.vieille@syntrropicfactory.info



Research community www.controlchainmanagement.org



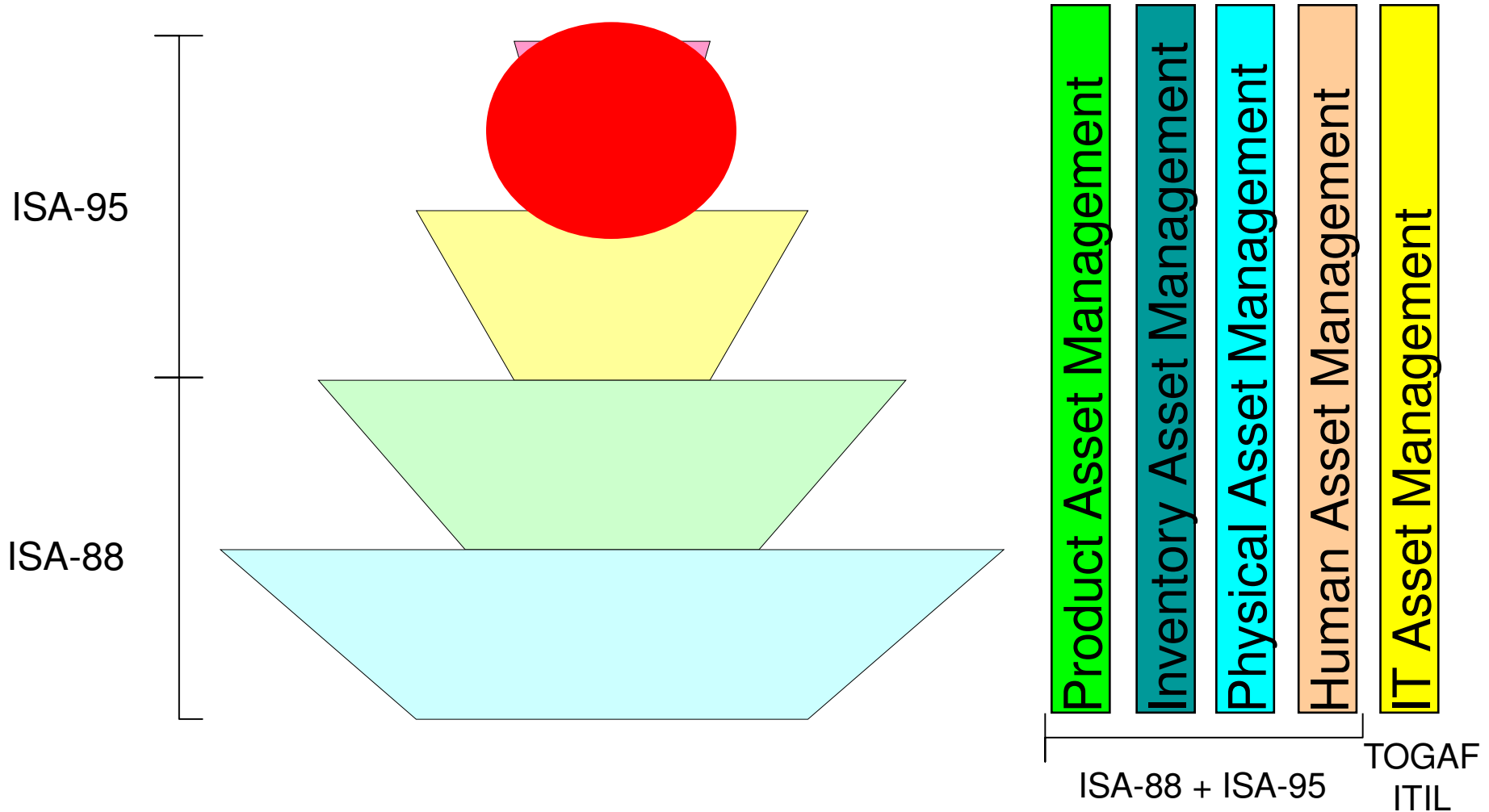
Consulting group www.controlchaingroup.com



Agenda

- Introduction
- **ISA95 Operations Activity Model (Production example)**
- **Operation Processes / Task definition**

CC functional domains



Information Elements

Domain sur l'icône	Model à ajouter	Standard	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

Who's / What's concerned?

PRM	Usr/Rsp	Usage	Typ.IT app
Cliquez sur l'icône pour ajouter un tableau			
Customer order processing	X		
Production planning & scheduling	X		
Production control	R		
Material and energy control	X		
Procurement			
Quality assurance	X		
Product inventory control	X		
Product cost accounting	X		
Product shipping administration			
Maintenance management	X		
Research & development			
Engineering			
3_40_ISA8895_Function_OperationsManagement			5



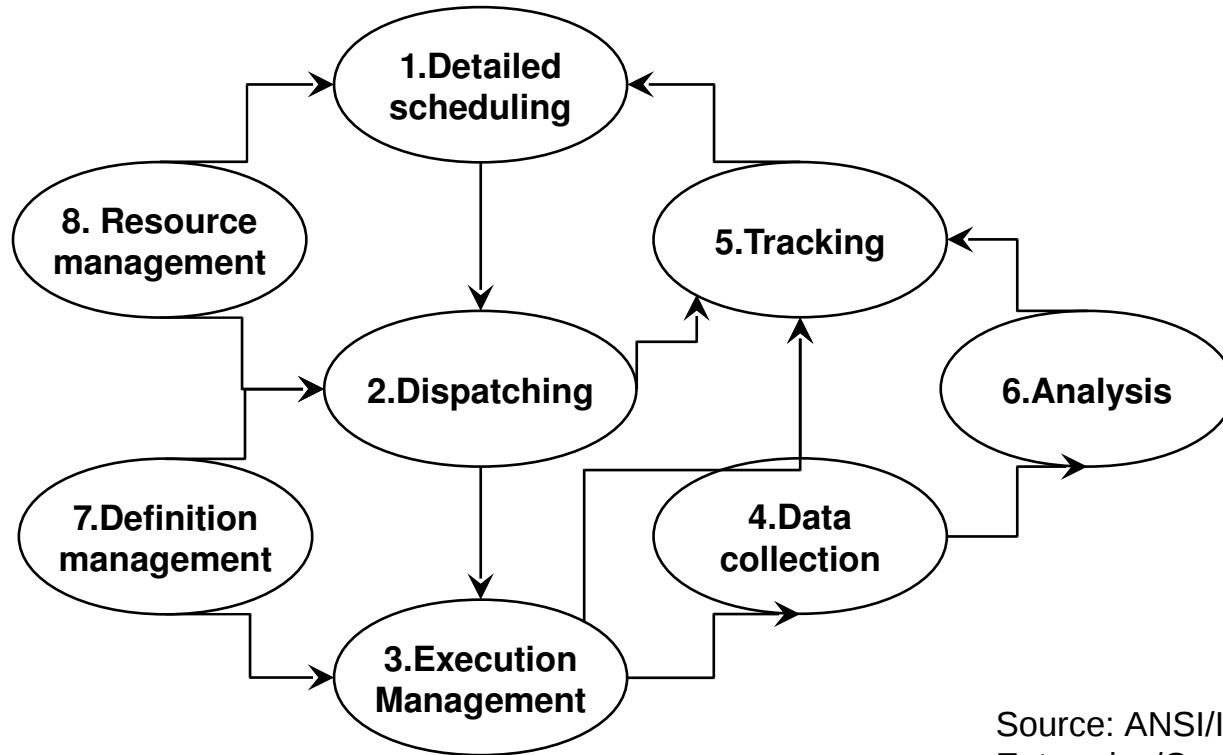
Operations Process Management Domain

- OPM typically corresponds to most of the ISA95 part 3 activity model
- However, ISA95 is unclear around the “Execution Management” bubble
 - This mirrors the current confusion about what is done in control systems and MES
 - Sometime “Automated” actions are handled by control system, while manual actions are handled by MES...
- **Basically, OPM deals with Management, not Control:**
 - It must not be constrained by Real Time focus
 - **Asynchronous Execution** - If a task’s completion is requested to move forward the physical process with impact on work throughput, it must be handled by the Physical Process Control level (Recipes / Operating procedures...)
 - It is typically not product dependent
 - **Asynchronous Definition** - A new product generally not lead to define new Operation processes

OPM domain

- **For example:**
 - Dispatching instruction for working on a particular work station is part of an OP
 - It is clearly defined in ISA95 part 3 activity model
 - It is done early enough to allow a delay in task's completion
 - Identifying a material to be added,
 - Forbidding the use of the material or making the production not acceptable if not completed upfront will make the function part of Physical Process Control, not a BP task
 - Being required only for information / reporting purpose make this function possibly handled as a BP Task.
- **Basically, no conceptual difference between**
 - OP/Task (Management)
 - RPE/EPE (Control)
 - Company specific policies must be set

Generic Activity model



Source: ANSI/ISA 95
Enterprise/Control System Integration

Different MES Focus

1. **Decisional focus**

- Business / Execution
- Decisional / Physical Hierarchy : Work station, Work cell, Area, Site, Enterprise...

2. **Operational Responsibility focus**

- Manufacturing, Inventory, Quality, Maintenance...

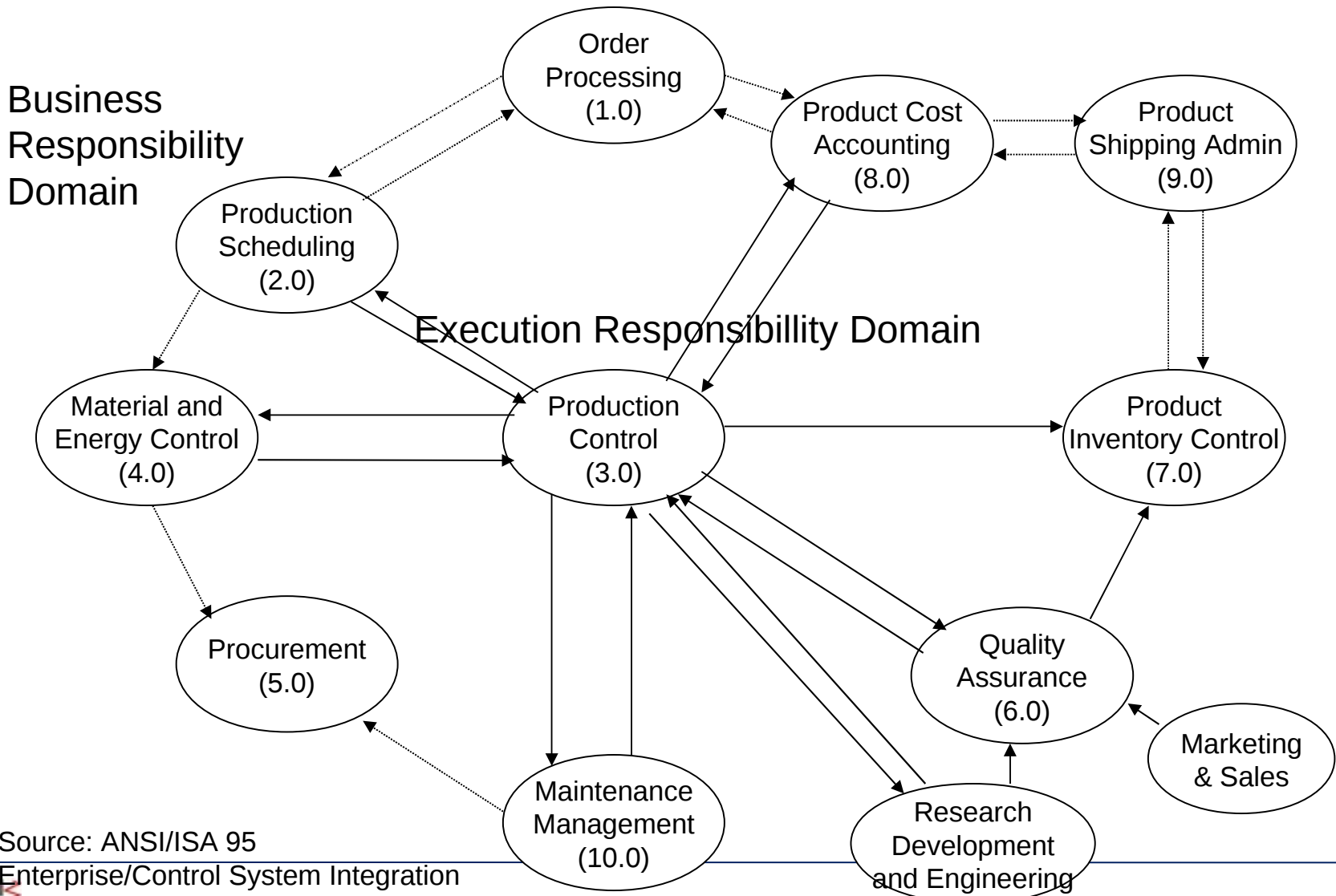
3. **Timing focus**

- Before, during, after work execution

4. **Maturity focus**

- Visibility, Control, Optimization

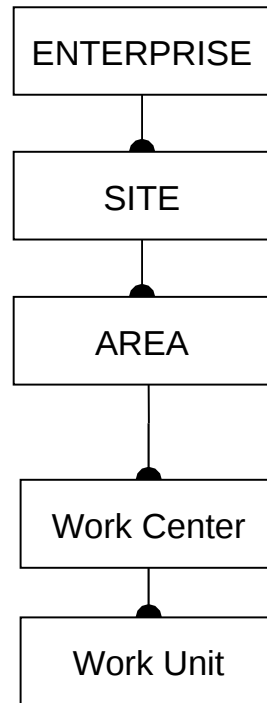
(1) Decisional focus : MES Domains and Functions



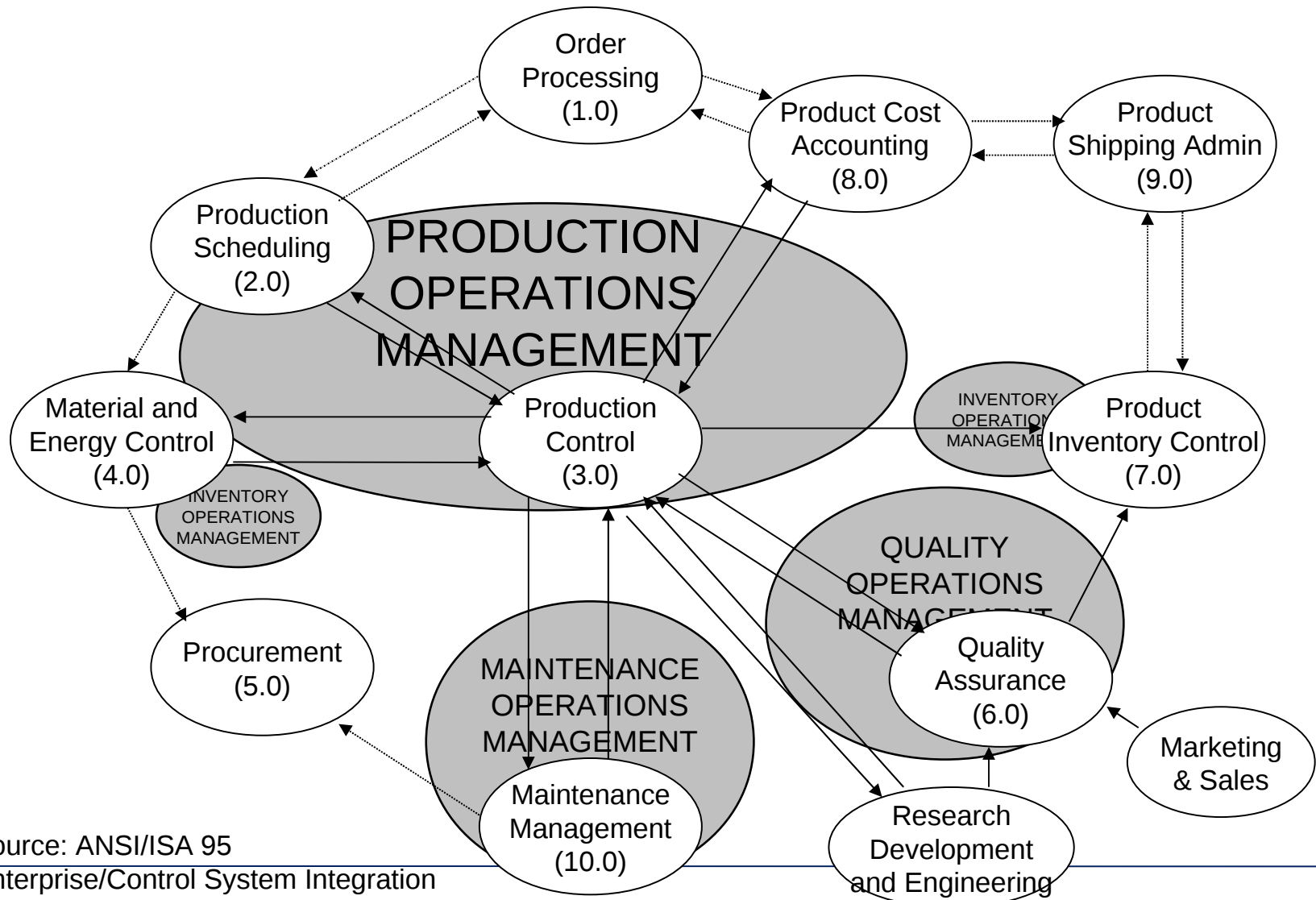
Source: ANSI/ISA 95
Enterprise/Control System Integration



(1) Decisional focus : Hierarchy according to ISA95



(2) Operational responsibility focus : Domains according to ISA95



Source: ANSI/ISA 95
Enterprise/Control System Integration



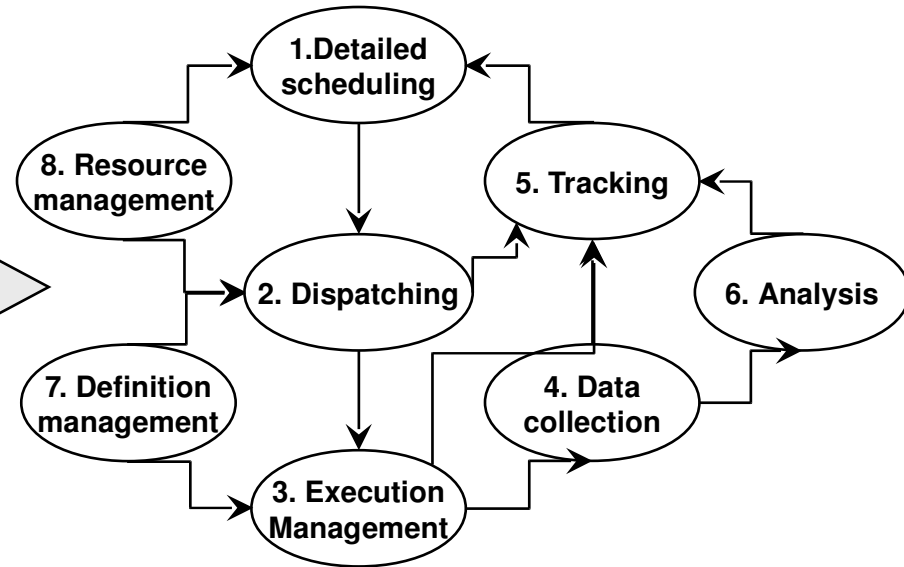
(2) Operational responsibility focus : Beyond Production

- **Manufacturing Operation Categories (MOCs) in ISA95:**

- Production
- Quality tests
- Maintenance
- Inventory control

- **Other possible MOCs :**

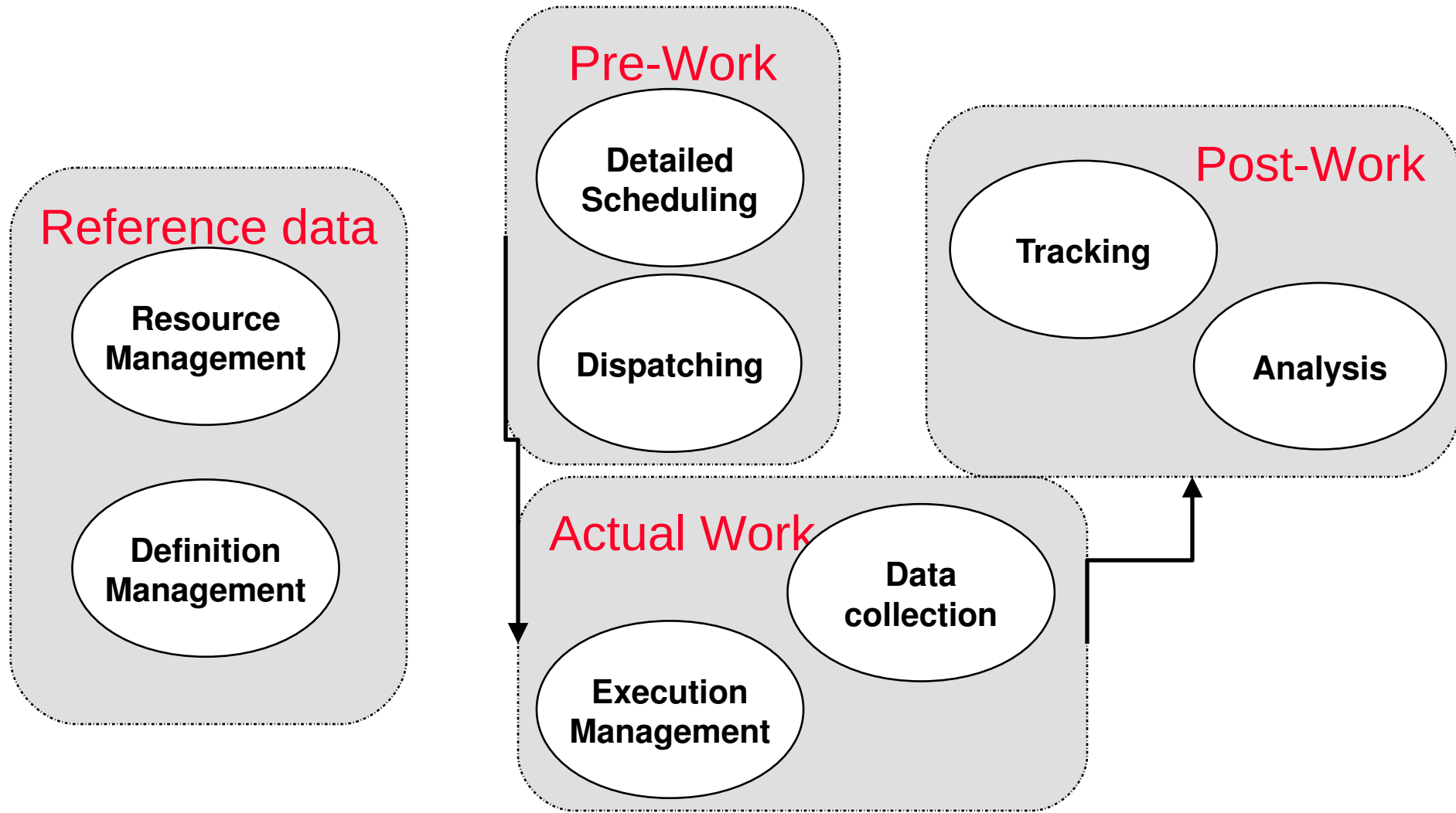
- Distribution, Transportation
- Inbound, Outbound logistics
- Internal transfers
- Tooling
- Cleaning
- ...



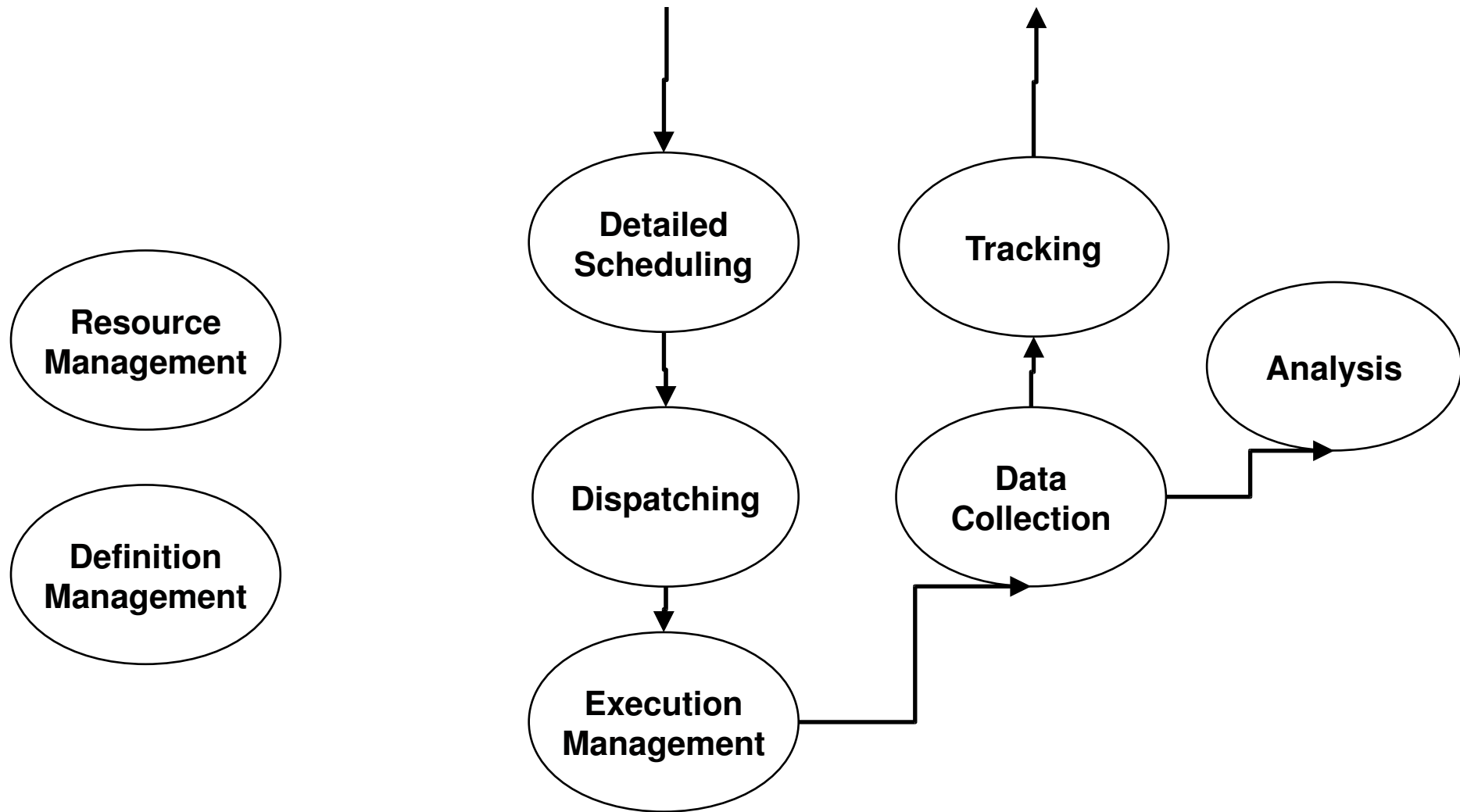
(3) Timing focus

- **Before operation execution**
 - These activities are performed before Production occurs
- **During operation execution**
 - These activities are performed while production continues
 - Real time interaction
- **After operation execution**
 - These activities are performed
 - After Production has been completed
 - While Production is performed, but not synchronously
- **Not time related**
 - These activities are performed independently of production
 - Provide necessary information for production
 - May be affected by production (resource status and usage)

(3) Timing focus MES Main Functional areas



(3) Timing focus : Main activity flows



(4) Maturity level

- **Visibility:**
 - Data collection, performance monitoring, reporting
- **Control:**
 - Work Specification enforcement,
 - Quality control,
 - Operation conformance against defined practices
- **Optimization, anticipation:**
 - Statistic or Real time process improvement
 - Resource usage optimization
 - Performance objectives and improvement processes against strategic criteria

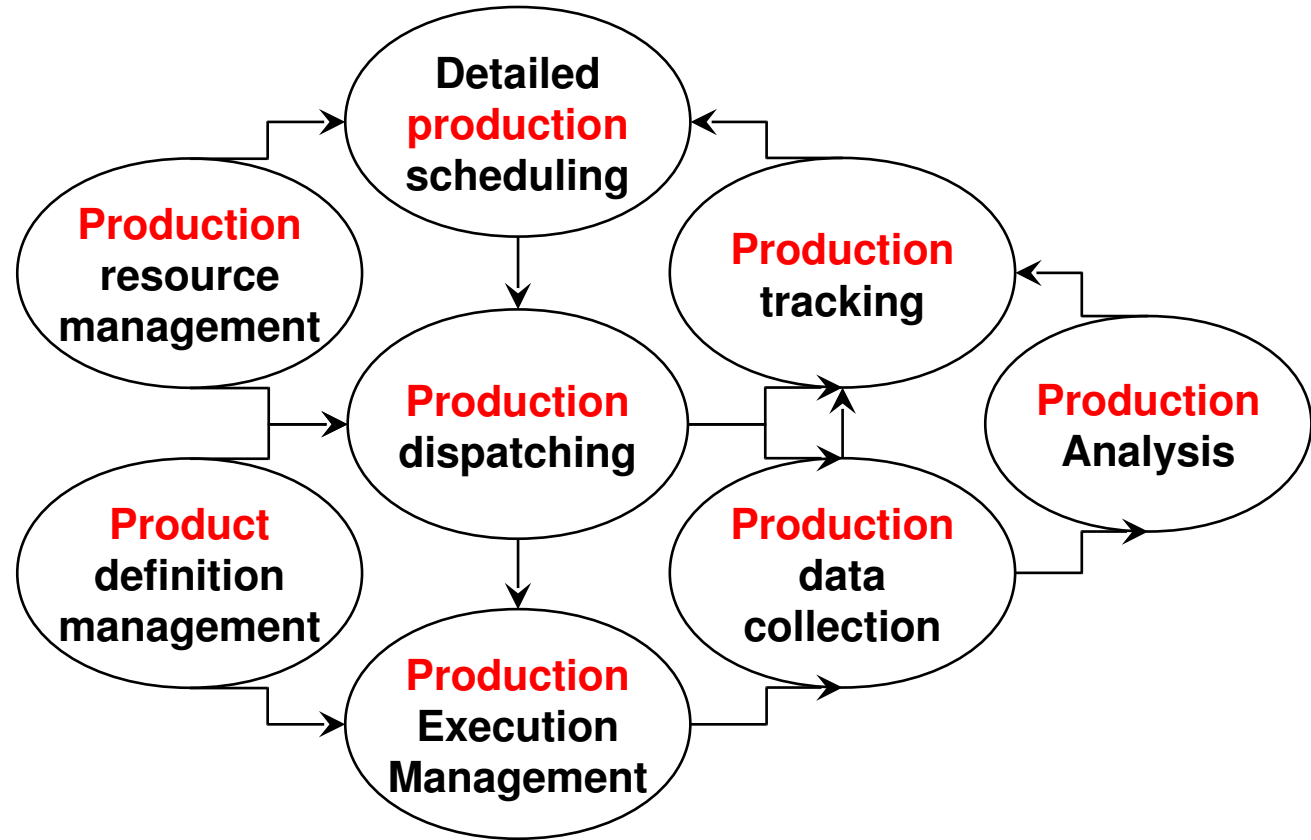
Agenda

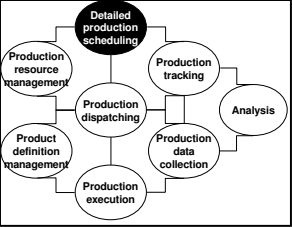
- Introduction
- ISA95 Operation Activity Model (Production example)
- Operation Processes / Task definition

Applying the Generic Activity model to Production MOC

Can be applied to:

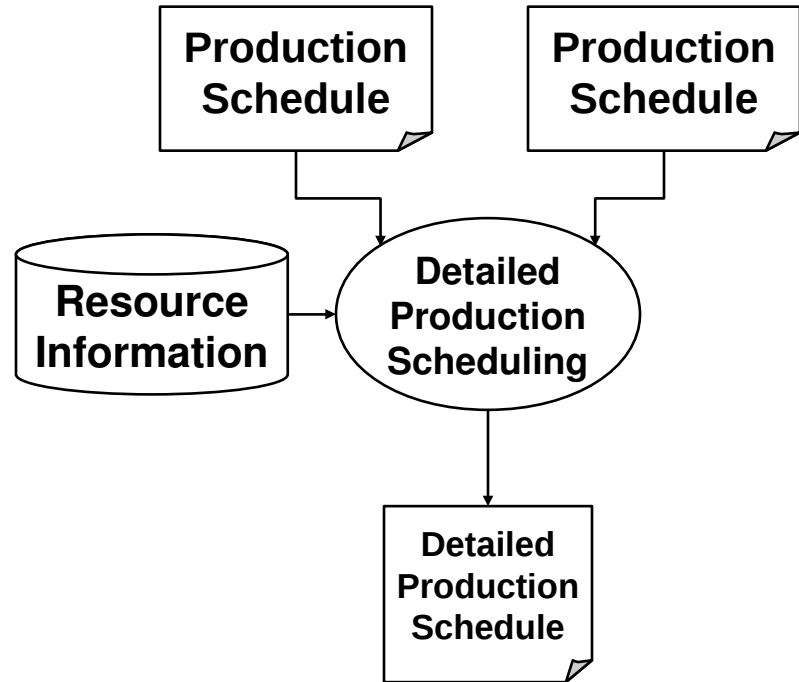
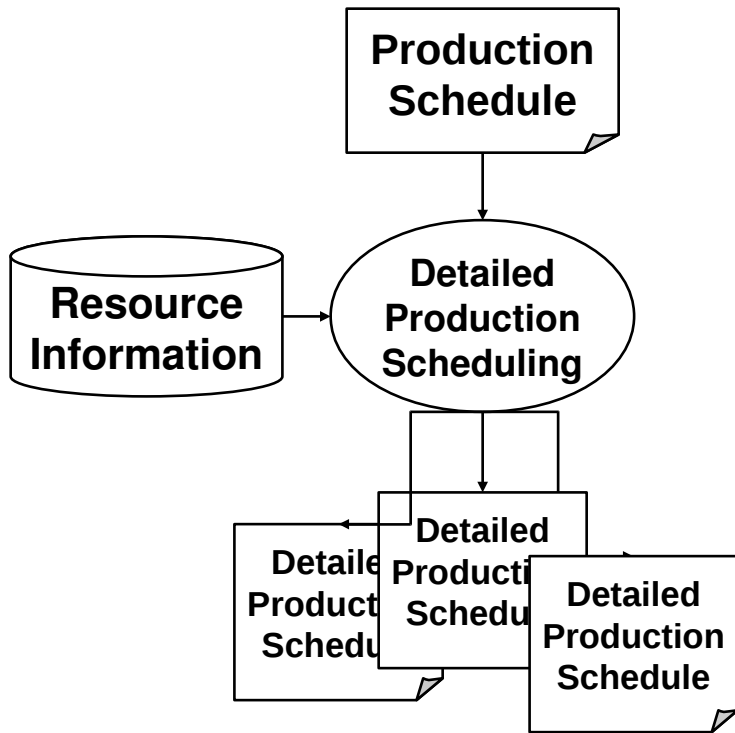
- Inventory
- Quality Control
- Maintenance
- +...

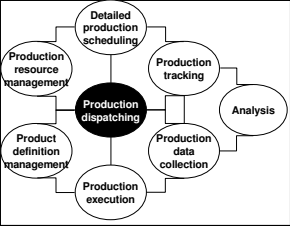




1. Detailed Production Scheduling (Before)

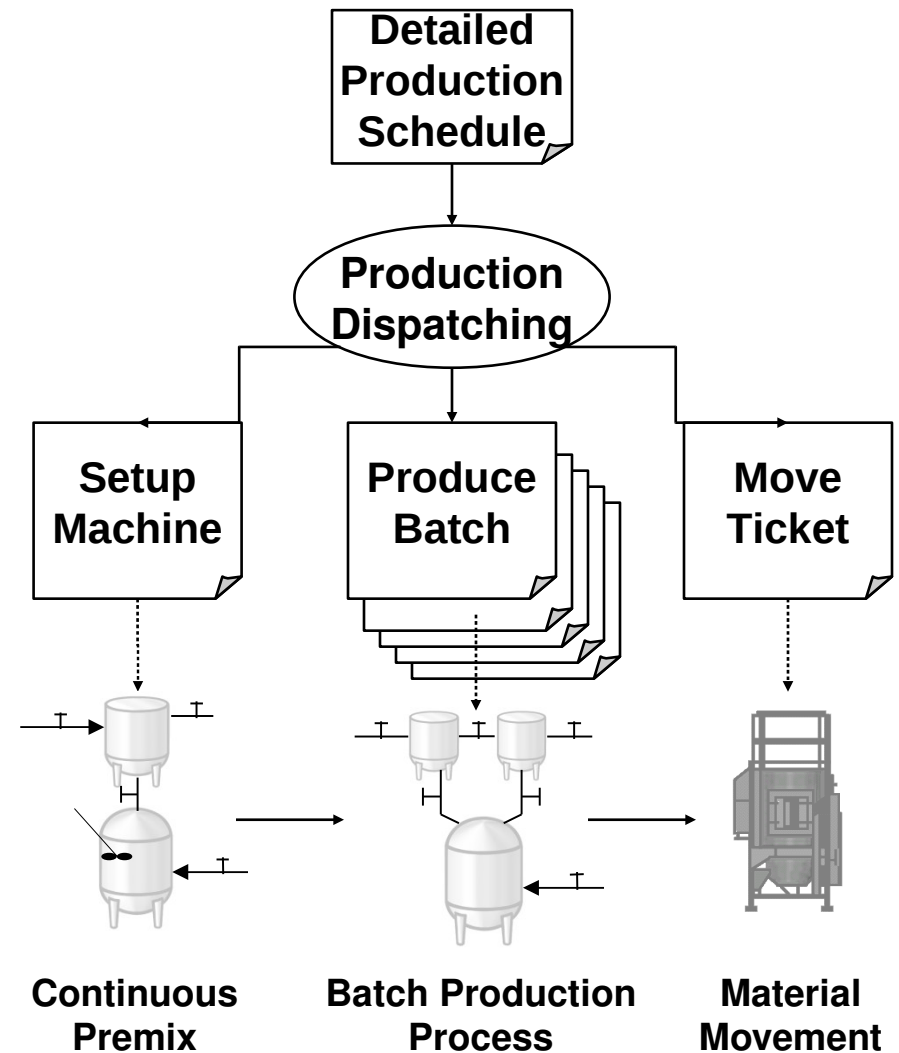
- **Production Plan Generation**
 - At a level of detail below corporate planning
- **Finite capacity scheduling**
 - Recognize alternative and parallel operations & exact timing

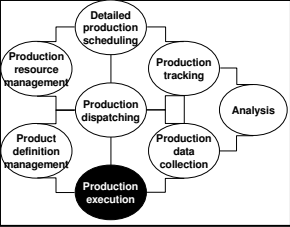




2. Production Dispatching (Before)

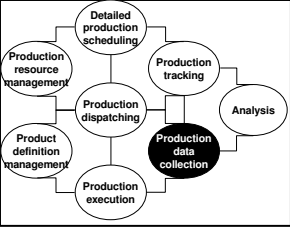
- **Managing flow of production by dispatching work**
 - Work orders/Batches to work units
 - Material movement request
- **Download automatically in response to the schedule or on request**
 - Recipes/Routings to equipment
 - Work instruction, SOP, drawings or electronic data to work stations





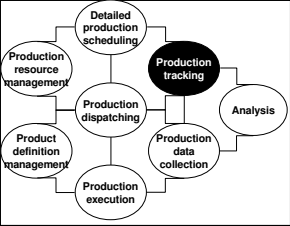
3. Production Execution (During)

- May be manual or automated
- Includes
 - operators actions based on instructions dispatched to operators
 - automated actions through control systems



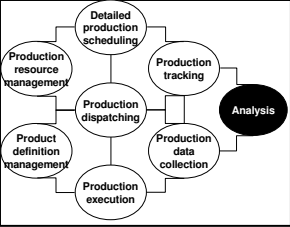
4. Production Data Collection (During)

- **Collecting operational data**
 - Production and parametric
 - Associated with production equipment and production processes
- **Concerns**
 - sensor readings, equipment states, event data, operator entered data, operator actions, and everything of importance in the making of a product or analysis of products, processes, or production
- **Includes**
 - Real time data collection
 - History of production data
 - Addressed in ISA88 part 4



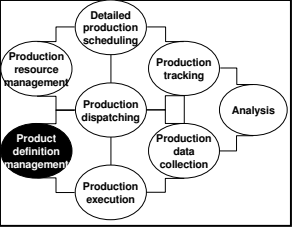
5. Production Tracking (After)

- **Track actual production and performance to the production plan**
- **Information transferred back to scheduling so that plans & schedules can be updated**
- **Monitor and track the status of production**
- **Data reconciliation**
 - Consolidate production information
- **Genealogy/Product Traceability**
 - Collects, prepares and provides material transformation and relationship information to inventory management systems



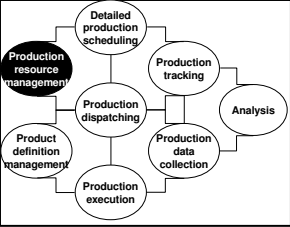
6. Production Analysis (After)

- **Product analysis**
 - product quality control, SPC / SQC tracking
 - In-Line control by operations staff
 - off-line inspection & analysis in Laboratory Information Management Systems (LIMS)
 - Addressed by Quality Operation MOC
- **Process analysis**
 - Analyses and optimizes physical process performance regarding Product quality and variability
- **Production analysis**
 - Analyses and optimizes production performance regarding Cycle times, Resource utilization, Procedure efficiencies, and Production variability



7. Product Definition Management (Reference data)

- **Manage recipes, work instructions, Product production rules, Product segment**
 - Synchronize this information with other systems
- **General/Master Recipes, Product / process segments mapping**
 - (alt. Resource management)



8. Resource Management (Reference data)

- **Personnel management**
 - Maintain personnel Attendance, availability, status, location, exposure qualification information ...
- **Material management**
 - Inventory operations, relationship with MM systems
 - Mostly addressed by Inventory Operation MOC
- **Equipment management**
 - Maintain equipment status, location, availability
 - Relationships with LIMS, Asset Management, Maintenance Management, Production Planning, Mostly addressed by Maintenance Operation MOC
- **Process Segment management**
- **Product / Process segment, General/Master recipes mapping**
 - (alt. Product definition)
- **Production capability**

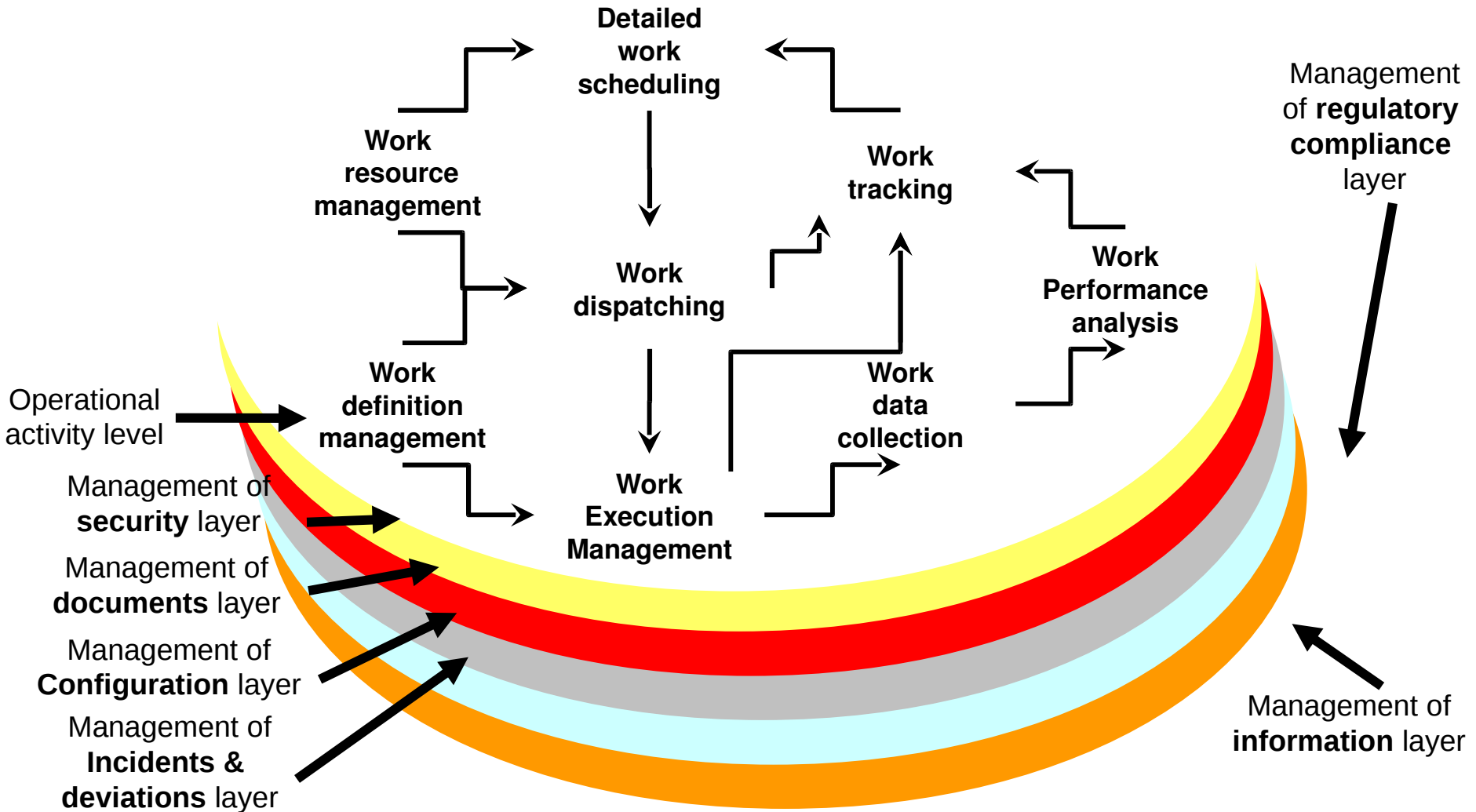
Applying the Activity model to other MOCs

- **Inventory**
- **Quality Control**
- **Maintenance**
- **+...**

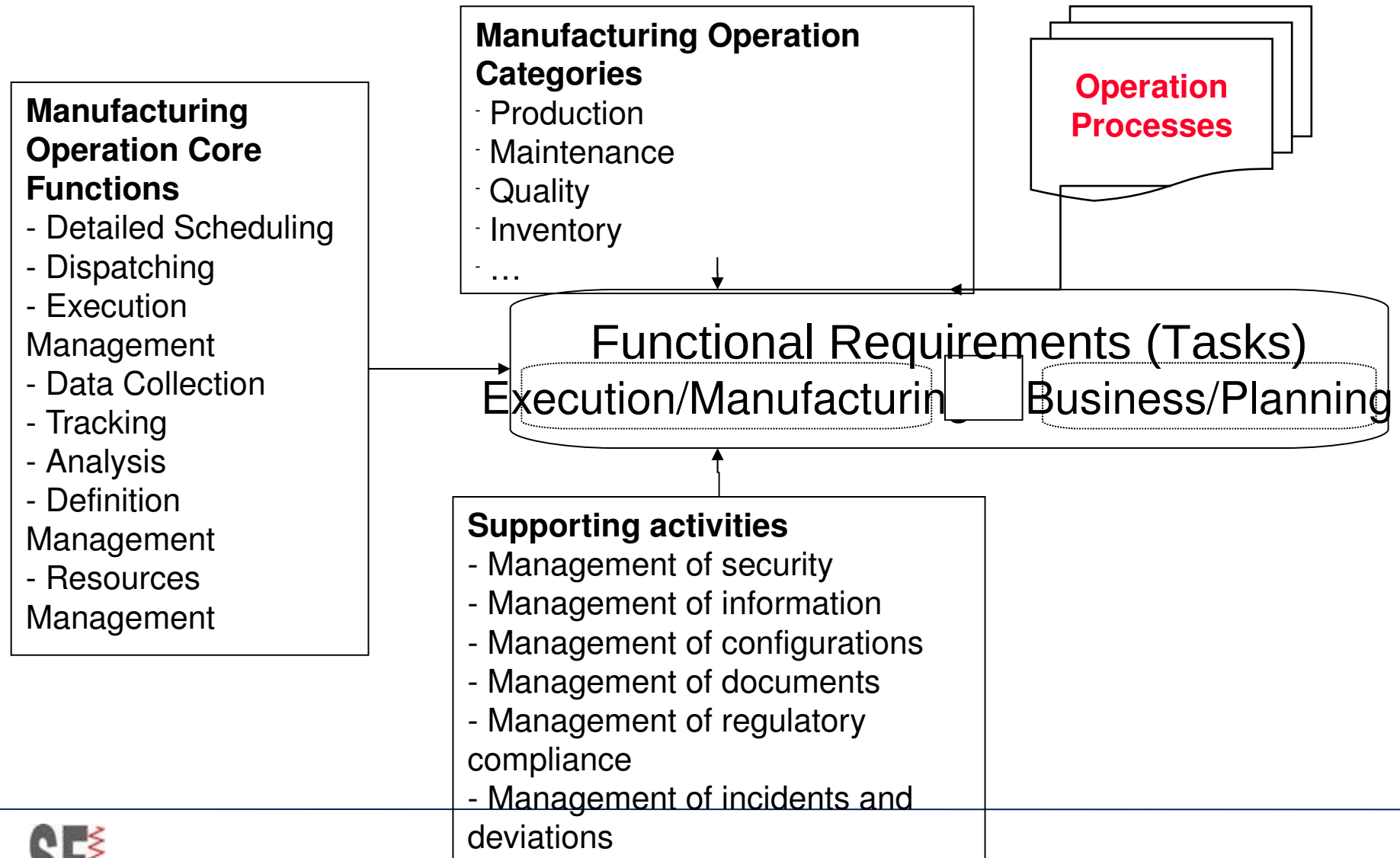
Supporting functions

- **These functions provide**
 - Suitable technical framework
 - Global services and procedures
 - Not directly linked to Production's main purpose

Supporting Functions: McDo model



A Tri-dimension functional framework



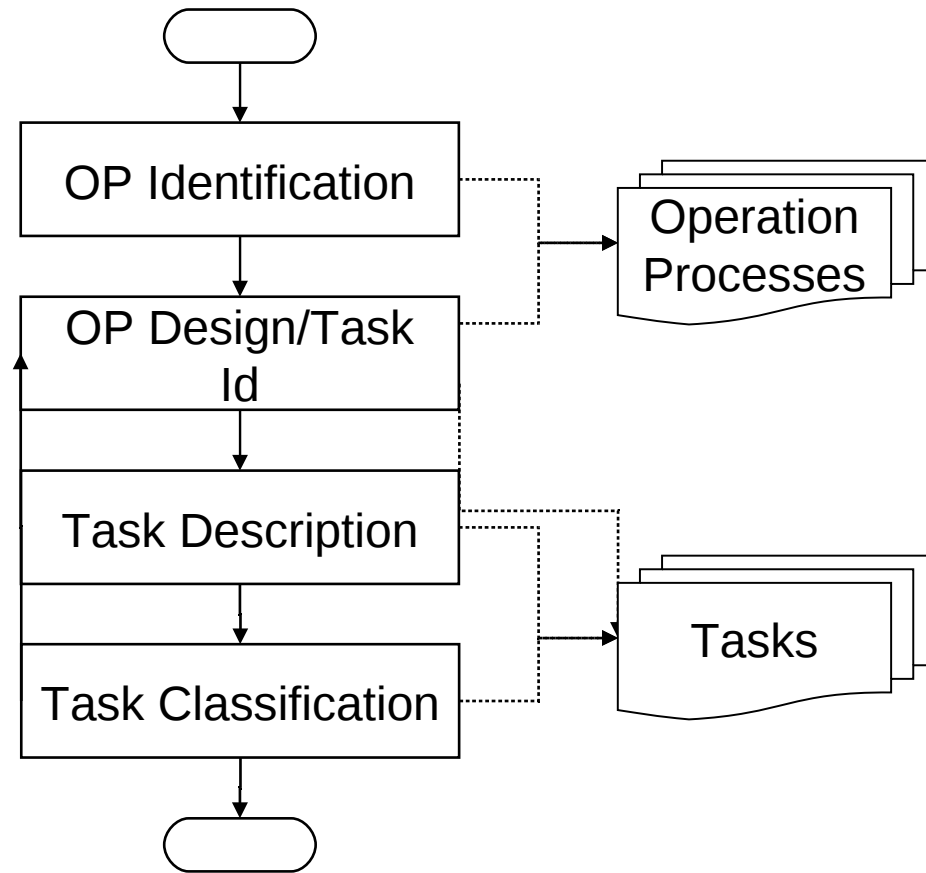
Agenda

- Introduction
- ISA95 Operation Activity Model (Production example)
- Operation Processes / Task definition

Terminology

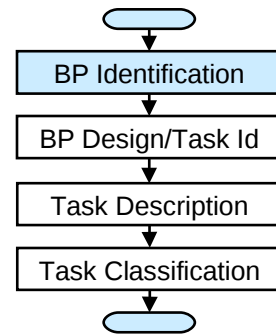
- **Operation Process, Activity, Task**
 - ISA95 uses the term of “Activity” for the main breakdown of its “activity model”.
 - It further details these activities into “Tasks”, which are the appropriate level for functional requirements.
 - ISA95 Activity is a task classifier
 - ISA95 ignores Operation Processes.
 - BPM standard terminology uses Activity in the sense of ISA95 Tasks
- **CCM uses the terms**
 - Operation Processes
 - Activity as a Task classifier (consistent with ISA95)
 - Tasks (in the ISA95 sense),

Iterative OP/Task Definition

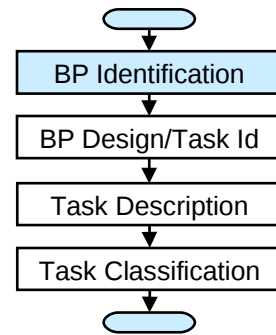


Operations Processes

- **The highest level in the Control Chain**
- **They define**
 - Operation contexts
 - Task (functional services) activation scenarii / orchestration applicable in these situations
- **They can be:**
 - Manual
 - Automated
 - Assisted
- **They can be hierarchical:**
 - High level processes trigger lower level processes
 - **Elementary processes are Tasks**



Operations Process Classification



- **1. Execution Management**

- Concerns directly the organization, the launch and the follow-up of work execution
- Specific to MOC or shared by several MOCs
 - Example : Scheduling of production

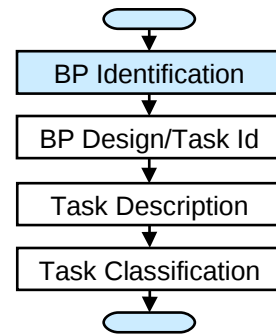
- **2. Resources Management**

- Concerns activities related to resources, but not directly to work orders
 - Example : Monitoring employee qualifications, follow up of equipment performance, of material obsolescence ...; Genealogy, equipment and personnel performance

- **3. Global Operations Management**

- Dashboards, performance indicators not directly related to work orders
- Activity reports per shift/day/week/year

Operations Process Classification



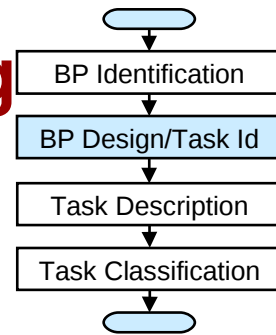
- **4. Definition/Synchronisation of Master Data**

- Concerns maintenance of technical data (Products, resources)
 - Example: Conception of a new product, involving synchronized processing at management and execution systems level

- **The classification strongly depends on management options**

- The conception of a product could be integrated in the execution management (dynamically) or in synchronization of master data (statically) depending on the instances

Operations Process Design: BPMN Language



- Developed by BPMI (www.bpmi.org www.waria.com)
 - Business Process Management Initiative / Workflow and Reengineering International Association
 - Member du Workflow Coalition W3C, OASIS, OAG, WFMC

BPMI.org

Standard BPM Stack

BPMN

Business Process Modeling Notation

(From BPMI.org | Defined using OMG's UML 2.0 Diagram Interchange Specification and Ad Hoc XML Serialization Schema)

BPSM

Business Process Semantic Model

(From BPMI.org | Defined using OMG's MOF and influenced by OMG's Business Process Definition Metamodel)

BPXL

Business Process eXtension Layers

(From BPMI.org | Extends BPEL4WS 1.1 to cover Transactions, Business Rules, Task Management, Human Interactions)

WS-CDL

Choreography Description Language
(From W3C)

BPEL

Business Process Execution Language
(From OASIS)

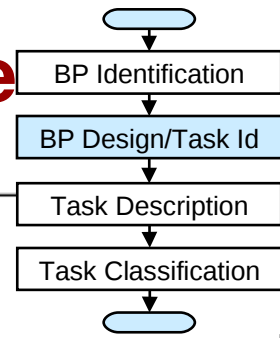
BPQL


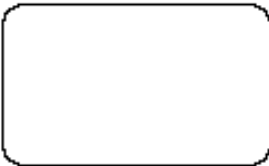
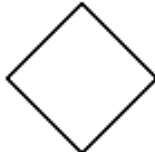
Business Process Query Language
(From BPMI.org)

Web Services Stack

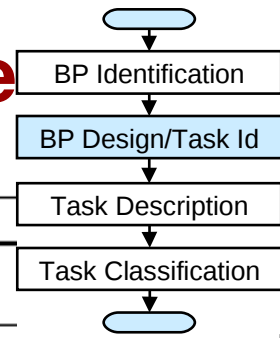
[WSDL, UDDI, and other relevant specifications]
(From OASIS & W3C)



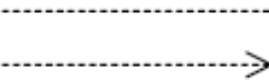

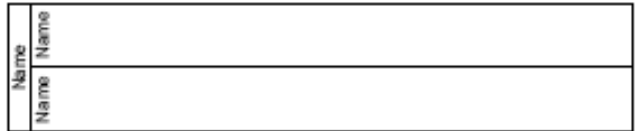
Business Process Design : BPMN Language



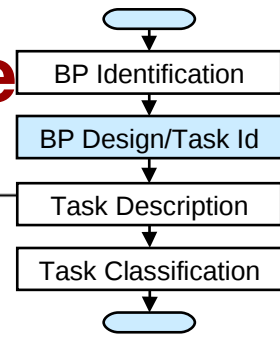
<p>Event</p>	<p>An event is something that “happens” during the course of a business process. These events affect the flow of the process and usually have a cause (trigger) or an impact (result). Events are circles with open centers to allow internal markers to differentiate different triggers or results. There are three types of Events, based on when they affect the flow: Start, Intermediate, and End.</p>	
<p>Activity</p>	<p>An activity is a generic term for work that company performs. An activity can be atomic or non-atomic (compound). The types of activities that are a part of a Process Model are: Process, Sub-Process, and Task. Tasks and Sub-Processes are rounded rectangles. Processes are either unbounded or a contained within a Pool.</p>	
<p>Gateway</p>	<p>A Gateway is used to control the divergence and convergence of Sequence Flow. Thus, it will determine branching, forking, merging, and joining of paths. Internal Markers will indicate the type of behavior control.</p>	



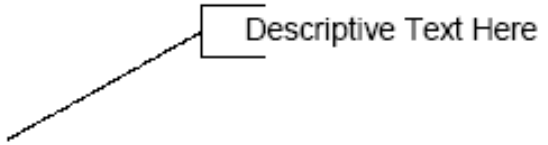
Business Process Design : BPMN Language



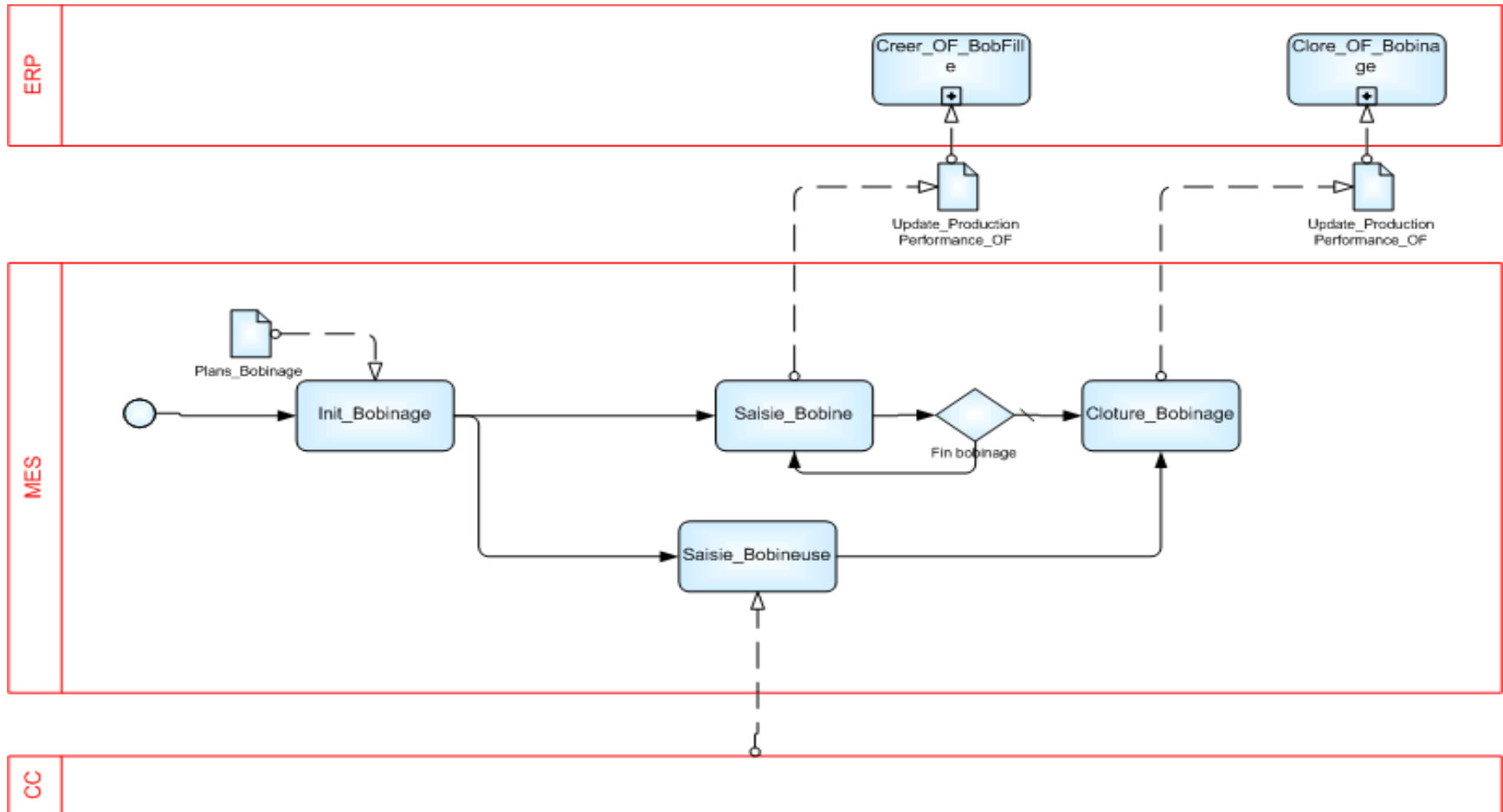
Sequence Flow	A Sequence Flow is used to show the order that activities will be performed in a Process.	
Message Flow	A Message Flow is used to show the flow of messages between two participants that are prepared to send and receive them. In BPMN, two separate Pools in the Diagram will represent the two participants (e.g., business entities or business roles).	
Association	An Association is used to associate information with Flow Objects. Text and graphical non-Flow Objects can be associated with the Flow Objects.	
Pool	A Pool represents a Participant in a Process. It is also acts as a "swimlane" and a graphical container for partitioning a set of activities from other Pools, usually in the context of B2B situations.	
Lane	A Lane is a sub-partition within a Pool and will extend the entire length of the Pool, either vertically or horizontally. Lanes are used to organize and categorize activities.	

Business Process Design : BPMN Language



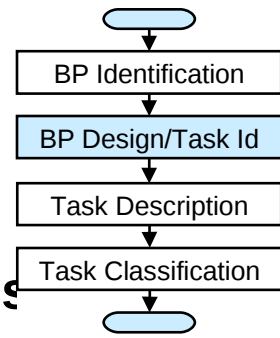
<p>Data Object</p>	<p>Data Objects are considered Artifacts because they do not have any direct effect on the Sequence Flow or Message Flow of the Process, but they do provide information about what activities require to be performed and/or what they produce.</p>	
<p>Group (a box around a group of objects for documentation purposes)</p>	<p>A grouping of activities that does not affect the Sequence Flow. The grouping can be used for documentation or analysis purposes. Groups can also be used to identify the activities of a distributed transaction that is shown across Pools.</p>	
<p>Text Annotation (attached with an Association)</p>	<p>Text Annotations are a mechanism for a modeler to provide additional information for the reader of a BPMN Diagram.</p>	

Example



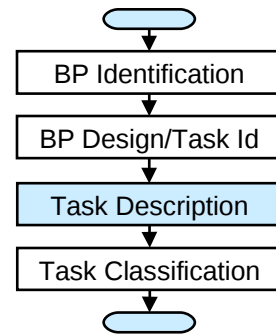
Processus d'exécution	author: Joan Vieille	created: 31/01/2006 12:47:52	
Suivre_Bobinage (1)	version: 1.0	modified: 01/02/2006 09:50:05	
	status: created		
ec_ADAPACK_NES4_SpecProcessus_V1 vtd			

Task Identification



- **The definition of operation processes in the preceding steps to build the list of tasks handled by these processes.**
- **The tasks are defined and organized within the activities of ISA95-3 models**
- **The following steps will modify this list by rapprochement, consolidation, “objectification”**
 - The operation processes will be arranged to take into account the tasks actually defined
 - These 2 steps are thus carried out in a simultaneous and iterative manner.

Tasks Description



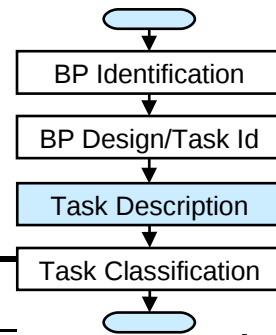
- **The description of tasks includes 3 types of information:**
 1. The Characterization which defines the attributes of use and justification of the task
 2. The Informational / Interface Requirements which links tasks to handled information
 3. The Functional Requirements which defines the services expected from the task

Only the first type is considered here.

The Informational / Functional requirements are discussed in

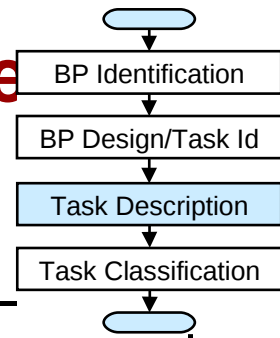
CCM4 Information Service Specification

(1) Tasks Characterization



Characteristic	Description
1. Decisional applicability <ol style="list-style-type: none"> 1. MOC 2. Usage Level 3. User Profile 	<ul style="list-style-type: none"> - Relative Manufacturing Operation Categories - Applicable Physical/decisional level (Area, Work Centre, Work Unit...) - Personnel Classes involved in the execution of the task (access to the system)
2. Restrictions	Applicable Segment, Personnel, Material, Equipment (resources)
3. Typology <ol style="list-style-type: none"> 1. IT Service Levels 2. Style of processing 	<ul style="list-style-type: none"> - What are the technical constraints (>>) - The type of information processing the task fulfils (>>)
4. Dependency	Other necessary tasks in order to implement this one. The dependences can “technically” impose tasks considered not to be economically profitable

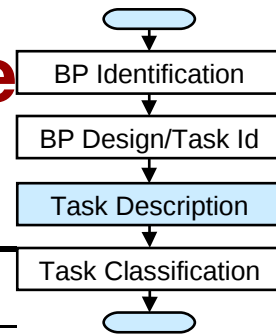
(1) Tasks Characterization – Example of IT Service Levels



Cliquez sur l'icône pour ajouter un tableau

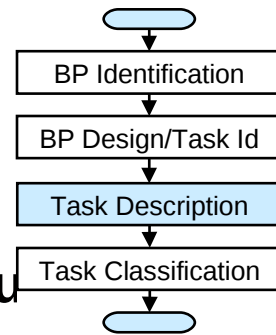
Criteria	Exemple of criteria value per type		
	<i>« Control »</i>	<i>« Operation »</i>	<i>« Business »</i>
<i>IT Service Level</i>	<i>« Control »</i>	<i>« Operation »</i>	<i>« Business »</i>
Data Synchronism	Synchronous	Synchronous and Asynchronous	Asynchronous
Data Acquisition Cycle time	Real Time	< 5 seconds	N/A
Calendar of opening	6D/7 24H/24	6D/7 24H/24	5D/7 8H/24
System availability	Very high	High	Average
Data integrity	Average	Very high	Very high
Environment	Industrial	Semi-industrial	Office

(1) Tasks Characterization - Processing Style



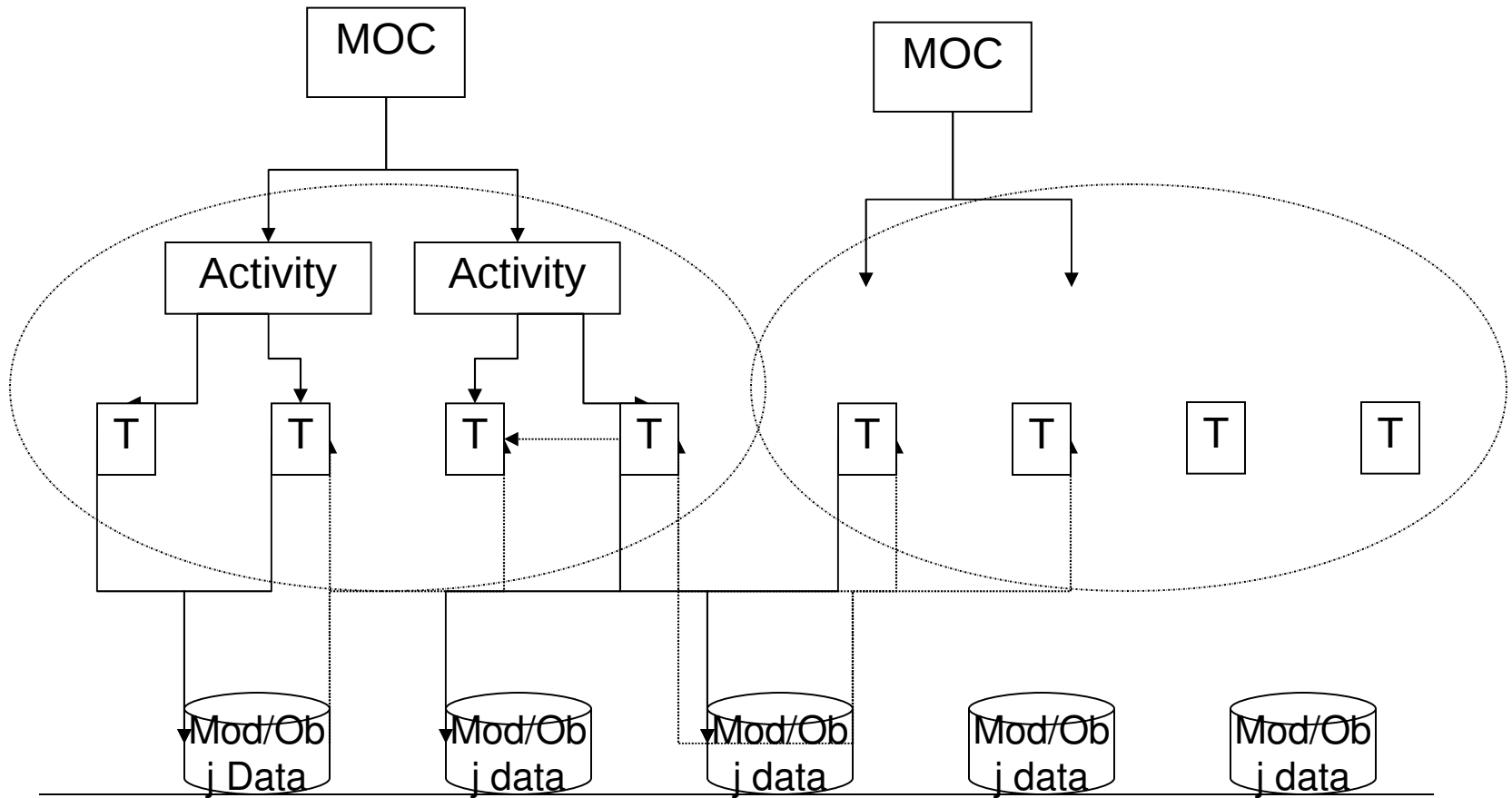
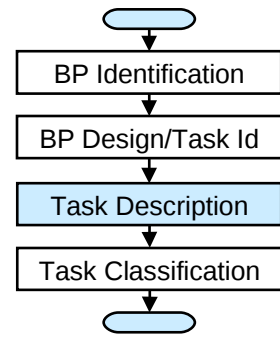
#	Type	Description
RT	Real Time	Interaction with the process or the operator which directly impacts the production (normally excluded from the field of BPM)
TS	Transactional	Involves data requiring a high level of precision and reliability
ST	Data Storage	Collection, selection, consolidation, validation of information for purposes of later use
KM	Knowledge Management	Shaping of the collected information to facilitate and improve the operations
AN	Analytical	Information Analysis to help in decision-making. Can be coupled with manufacturing process or quality assurance
MD	Modelling and simulation	Asynchronous preparation processes of a principal activity, such as scheduling
CL	Collaborative	Connects independent activities and responsibilities for obtaining a common objective (non-structured)
WF	Workflow	Connects activities in a preset and structured manner

(2) Information

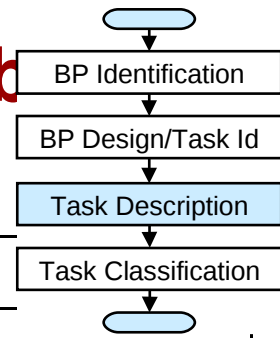


- **The informational dimension of ISA95-2 can be introduced under the following angles:**
 - To associate each task to models and objects of data used (inputs) and affected (outputs)
 - Allows logical regroupings of tasks
 - Particular information which the user needs
 - Data presented / entered
 - Contents of the publishing relating to the task
 - Reports, labels, delivery order...
- **This sets a basis for standardized Information Service framework**
 - Enforcing independence of solutions
 - Enabling SOA architectures
- **The following slides list the ISA95 data objects**
 - They are modified / generalized to apply to all MOCs
 - See ISA95 part 2 for details of object attributes

(2) Information



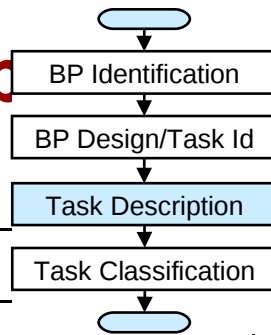
(2) Information – Generalized ISA95 model ob



Cliquez sur l'icone pour ajouter un tableau Capability Model	Work capability
	Personnel capability
	Personnel capability property
	Equipment capability
	Equipment capability property
	Material capability
	Material capability property
	Work segment capability
	Segment personnel capability
	Segment personnel capability property
	Segment equipment capability
	Segment equipment capability property
	Segment material capability
	Segment material capability property

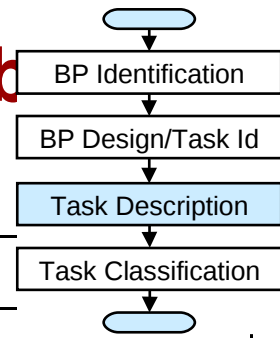


(2) Information – Generalized ISA95 model ob



Personnel Model Cliquez sur l'icône pour ajouter un tableau	Person
	Person property
	Personnel class
	Personnel class property
	Qualification test specification
	Qualification test result
Equipment Model	Equipment
	Equipment property
	Equipment class
	Equipment class property
	Equipment capability test specification
	Equipment capability test result

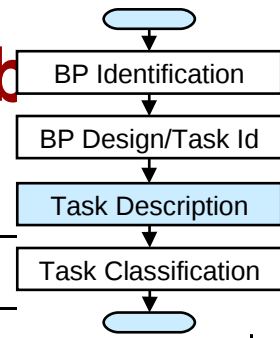
(2) Information – Generalized ISA95 model ob



<p>Material Model</p> <p> Cliquez sur l'icône pour ajouter un tableau</p>	<p>Material class</p> <p>Material class property</p> <p>Material definition</p> <p>Material definition property</p> <p>Material lot</p> <p>Material lot property</p> <p>Material subplot</p> <p>QA test specification</p> <p>QA test result</p>
<p>Segment model</p>	<p>segment</p> <p>Personnel segment specification</p> <p>Personnel segment specification property</p> <p>Equipment segment specification</p> <p>Equipment segment specification property</p> <p>Material segment specification</p> <p>Material segment specification property</p>

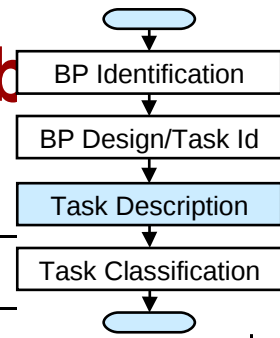


(2) Information – Generalized ISA95 model object



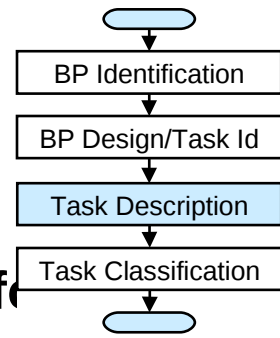
Cliquez sur l'icone pour ajouter un tableau Schedule model	Schedule
	Request
	Segment requirement
	Parameter
	Personnel requirement
	Personnel requirement property
	Equipment requirement
	Equipment requirement property
	Material requirement
	Material requirement property

(2) Information – Generalized ISA95 model ob



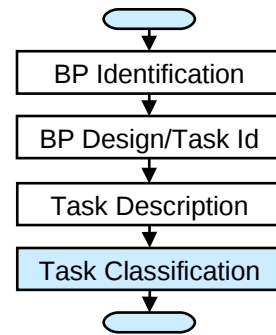
Performance model Cliquez sur l'icône pour ajouter un tableau	Performance
	Response
	Segment response
	Data
	Personnel actual
	Personnel actual property
	Equipment actual
	Equipment actual property
	Material actual
	Material actual property

(3) Functional Requirements



- **The behavioural description of the tasks is declined under four headings:**
 - Description of the normal behaviours
 - Description of exceptions
 - Description of behaviours on exceptions
- **The level of detail will evolve during the project,**
 - the initial indications can be limited to the constraints and provisions specific to the business and the company
 - The implicit requirements will be completed during the course of realization
- **See example of description sheet**

Classification of the tasks



- **The task carries the detail of the functional requirements,**
 - the ISA-95-3 activities constitute an element of classification
 - The standard provides rather complete indications on the scope of the tasks within an activity.
 - The tasks are described without concern on their implementation on a target system.
- **The tasks defined during the preceding steps are the fruit of a reflexion by category of exploitation**
 - In reality, some tasks are in common, are shared or similar and must thus consequently be brought together to offer a consistent breakdown
- **We obtain a reduced and more consistent task list.**
 - The functional descriptions and elements of characterization are amended if necessary (Iteration)
 - This step leads to a classification of these reusable business object tasks within the company

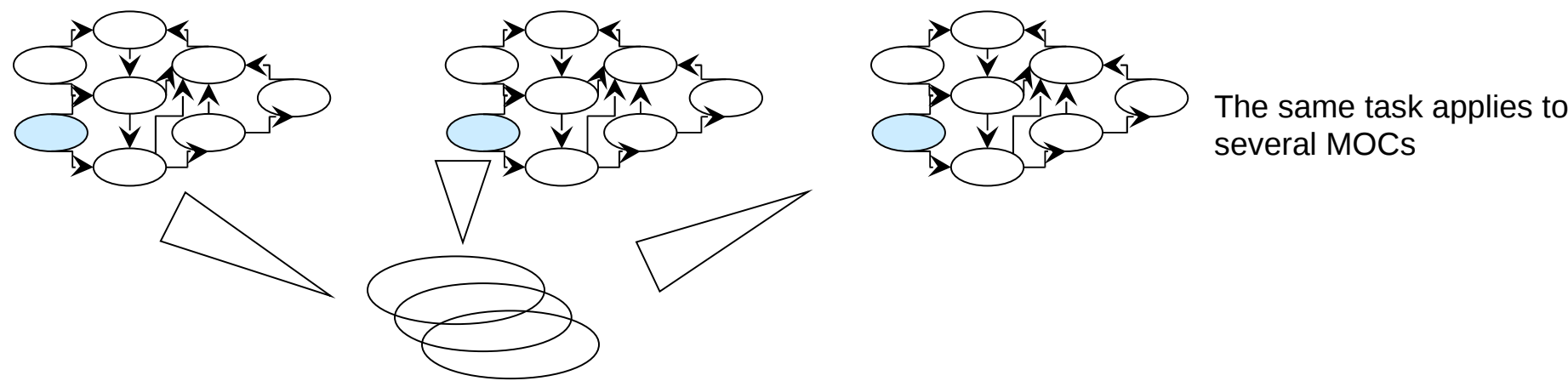
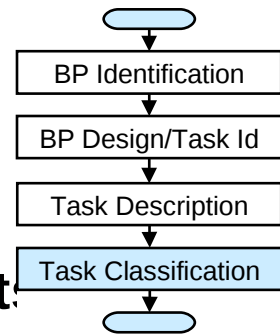
Multi-purpose tasks

- **The same task is defined for independent operation context.**

- only one specification
- Deals only one MOC at a time: independent data bases and users

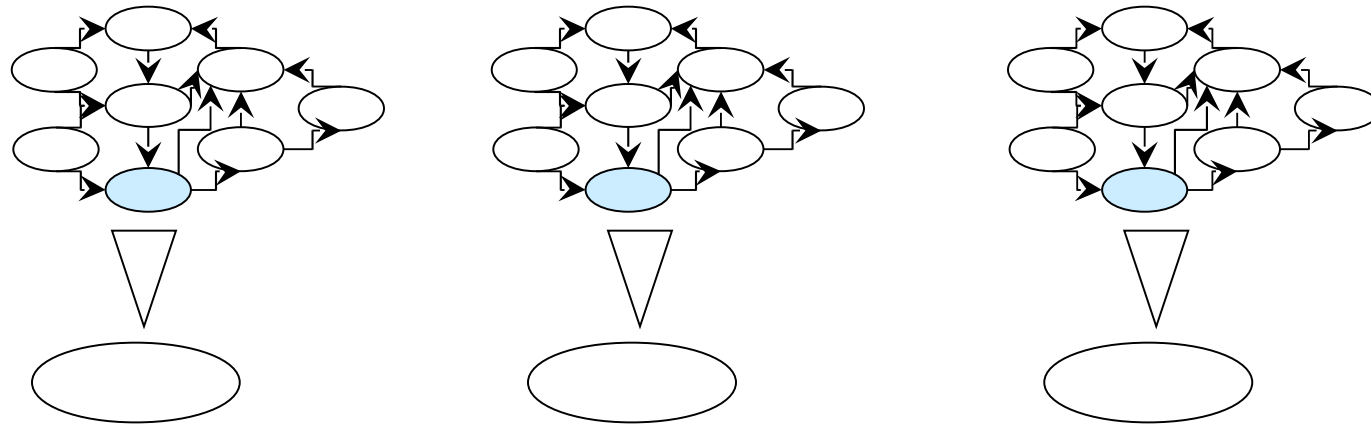
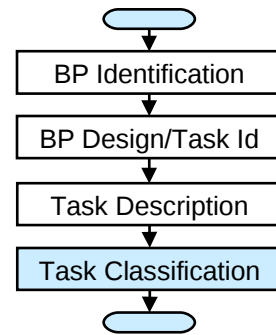
- **Examples:**

- Tasks involved in Work Definition Management can be handled by the same application using different databases.
- Analogy: MS Office



Specific Tasks

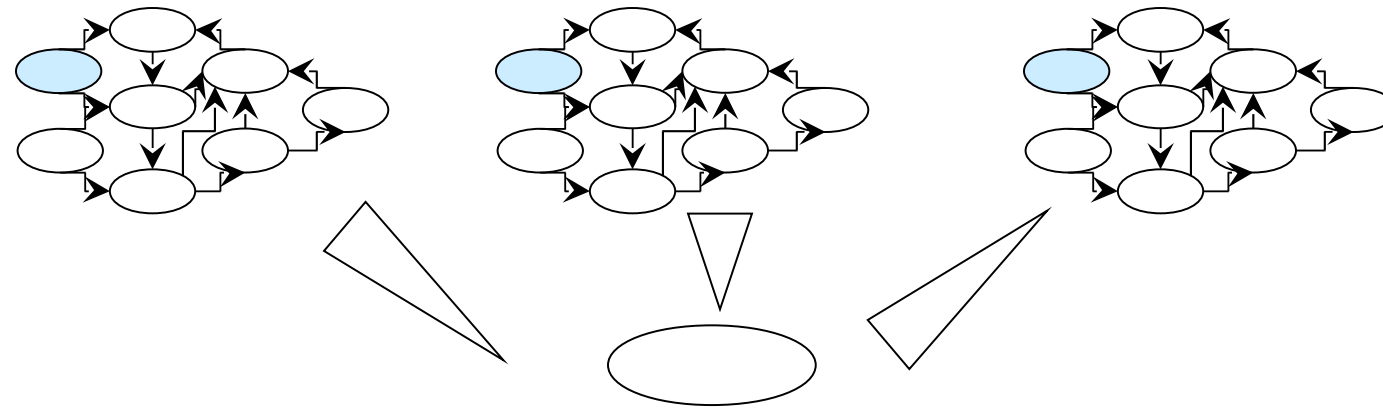
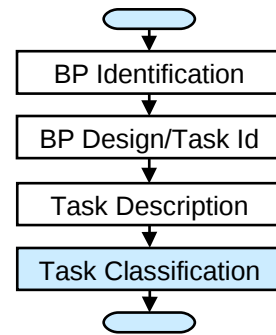
- **The task is specific to a MOC**
 - tasks fulfilling similar roles in other MOCs are different
- **Examples:**
 - Tasks involved in executing a production or a maintenance order require significantly different functional capabilities
 - analogy: Ms Project, SAP APO



The task is specific to the MOC

Common tasks

- **The task handles problems for several MOCs globally.**
- **Example:**
 - Tasks involved in Resource Management can be ensured in a centralized manner
 - Analogy: human resources management



The task covers several MOCs

Exercises: Model Operation Management – Excel spreadsheet

- **(1.1) Define / Discuss Operation Process Categories**
- **(1.2) Define / Discuss Manufacturing Operation Management Categories**
- **(1.3) Define / Discuss Operation Activities**
- **(1.4) Define / Discuss IT Service Level**
- **(1.5) Define / Discuss Operation Task Styles**
- **(2.1) Define Operation Process Classes**
- **(2.1) Define / Consolidate Task Classes**
- **(3.1) Instantiate Operation Processes on an actual facility**