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**Enterprise-Control System Integration –
Part 3: Activity Models of Manufacturing
Operations Management**

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Enterprise-Control System Integration - Part 3: Activity Models of Manufacturing Operations Management

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INTRODUCTION

This Part 3 standard shows activity models and data flows for manufacturing information that enables enterprise-control system integration. The modelled activities operate between Level 4 logistics and planning functions and Level 2 manual and automated process control functions. The models are consistent with the object models given in ANSI/ISA-95.00.02-2010 (IEC 62264-2 Mod), ANSI/ISA-95.00.04-2012, and the Level 3 (manufacturing operations and control) definitions.

The goal of the standard is to reduce the risks, costs and errors associated with implementing enterprise systems and manufacturing operations systems in such a way that they inter-operate and easily integrate. The standard may also be used to reduce the effort associated with implementing new product offerings.

This standard provides models and terminology for defining the activities of manufacturing operations management. The models and terminology defined in this standard are intended:

- to emphasize the good practices of manufacturing operations;
- to be used to improve existing manufacturing operations systems; and
- to be applied regardless of the degree of automation.

Some potential benefits produced when applying this standard may include:

- reducing the time to reach full production levels for new products;
- enabling vendors to supply appropriate tools for manufacturing operations;
- enabling more uniform and consistent identification of manufacturing needs;
- reducing the cost of automating manufacturing processes;
- optimizing supply chains; and
- improving efficiency in life-cycle engineering efforts.

It is not the intent of this part of the standard to

- suggest that there is only one way of implementing manufacturing operations;
- force users to abandon their current way of handling manufacturing operations;
- restrict development in the area of manufacturing operations; or
- restrict use only to manufacturing industries.

Changes from ANSI/ISA 95.00.03-2005 to this version are:

1. The document is based on the IEC/ISO 62264-3 version. This is the IEC version of ISA-95 Part 3 and includes additional changes made by the IEC SC65E and ISO TC 184 SC5 Joint Working Group (JWG 5).
2. Clause 4.1 *Manufacturing Operations Management* was moved to Part 1 and therefore was removed from Part 3.
3. Clause 4.2 *Functional hierarchy* was moved to Part 1 and therefore was removed from Part 3.
4. Clause 4.4 *Criterion for defining activities below Level 4* was moved to Part 1 and therefore was removed from Part 3.
5. Clause 4.5 *Categories of production information* was moved to Part 1 and therefore was removed from Part 3.

6. Clause 4.6 *Manufacturing operations information* was moved to Part 1 and therefore was removed from Part 3.
7. Clause 5.3 *Expanded equipment hierarchy model* was moved to Part 1 and therefore was removed from Part 3.
8. Clause 5.4 *Expanded decision hierarchy model* was removed from Part 3. The corresponding section was removed from Part 1 and replaced with a reference to ISO-15704 Industrial automation systems.
9. Annex A (informative) *Other enterprise activities affecting manufacturing operations* was moved to Part 1 and therefore was removed from Part 3.
10. Annex D (informative) *Associated standards* was moved to Part 1 and therefore was removed from Part 3.
11. Annex F (informative) *Applying the decision hierarchy model to manufacturing operations management* was removed from Part 3. The corresponding section was removed from Part 1 and replaced with a reference to ISO-15704 Industrial automation systems.
12. Annex G (informative) *Mapping PSLX ontology to manufacturing operations management* was removed from Part 3. The committee felt that this section is more appropriate as a PSLX white paper or TR.
13. The names for data were changed to match the Part 4 standard names. These name changes were made in all figures and in the text. The following data names were changed or added:
 - a. *Detailed Production Schedule* changed to *Work Schedule*
 - b. *Production Dispatch List* changed to *Job list*
 - c. *Production Work Order* changed to *Job Order*
 - d. *Work Order* changed to *Job Order*
 - e. *Detailed Maintenance Schedule* changed to *Work Schedule*
 - f. *Detailed Inventory Schedule* changed to *Work Schedule*
 - g. The addition of *Work Masters* as objects that define how work is to be done.

ENTERPRISE-CONTROL SYSTEM INTEGRATION –

Part 3: Activity models of manufacturing operations management

1 Scope

This Part 3 standard in the ISA-95 series defines activity models of manufacturing operations management that enable enterprise system to control system integration. The activities defined in this part of the standard are consistent with the object models definitions given in ANSI/ISA-95.00.02-2010 (IEC 62264-2 Mod) and ANSI/ISA-95.00.04-2012. The modelled activities operate between business planning and logistics functions, defined as the Level 4 functions and the process control functions, defined as the Level 2 functions of ANSI/ISA-95.00.01-2010 (IEC 62264-1 Mod). The scope of this standard is limited to:

- a model of the activities associated with manufacturing operations management, Level 3 functions; and
- an identification of some of the data exchanged between Level 3 activities.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- ANSI/ISA-95.00.01-2010 (IEC 62264-1 Mod), Enterprise-Control System Integration - Part 1: Models and Terminology
- ANSI/ISA-95.00.02-2010 (IEC 62264-2 Mod), Enterprise-Control System Integration - Part 2: Object Model Attributes
- ANSI/ISA-95.00.04-2012, Enterprise-Control System Integration - Part 4: Objects and Attributes for Manufacturing Operations Management Integration
- ANSI/ISA-88.00.01-2010, Batch Control - Part 1: Models and Terminology
- ISA-88.00.02-2001, Batch Control - Part 2: Data Structures and Guidelines for Languages
- IEC 61512-1:1997, Batch control - Part 1: Models and terminology
- IEC 61512-2:2001, Batch control - Part 2: Data structures and guidelines for languages

3 Terms, definitions and abbreviations

For the purposes of this document, the following terms and definitions apply.

3.1 Terms and definitions

3.1.1

finite capacity scheduling

scheduling methodology where work is scheduled for a set of manufacturing resources, in such a way that no capacity scheduled exceeds the capacity available

3.1.2

inventory operations management

activities within Level 3 of a manufacturing facility which coordinate, direct, manage and track inventory and material movement within manufacturing operations

3.1.3**job list**

collection of job orders for one or more work centers and/or resources for a specific time frame

NOTE 1 This may take the form of job orders for the set-up instructions for machines, operating conditions for continuous processes, material movement instructions, or batches to be started in a batch system.

NOTE 2 Job lists are applicable to all operations management areas, such as maintenance, quality test and inventory.

3.1.4**job order**

unit of scheduled work that may be dispatched to a work center

3.1.5**maintenance operations management**

activities within Level 3 of a manufacturing facility which coordinate, direct and track the functions that maintain the equipment, tools and related assets to ensure their availability for manufacturing and ensure scheduling for reactive, periodic, preventive, or proactive maintenance

3.1.6**manufacturing facility**

site, or area within a site, that includes the resources within the site or area and includes the activities associated with the use of the resources

3.1.7**manufacturing operations management**

activities within Level 3 of a manufacturing facility that coordinate the personnel, equipment, physical assets and material in manufacturing

NOTE This standard details manufacturing operations management in terms of four categories (production operations management, maintenance operations management, quality operations management and inventory operations management) and provides references for other enterprise activities affecting manufacturing operations.

3.1.8**production operations management**

activities within Level 3 of a manufacturing facility which coordinate, direct, manage and track the functions that use raw materials, energy, equipment, personnel and information to produce products, with the required costs, qualities, quantities, safety and timeliness

3.1.9**quality operations management**

activities within Level 3 of a manufacturing facility which coordinate, direct and track the functions that measure and report on quality

3.1.10**tracing**

activity that provides an organized record of resource and product use from any point, forward or backward, using tracking information

3.1.11**tracking**

activity of recording attributes of resources and products through all steps of instantiation, use, change and disposition

3.1.12**work center**

process cell, production unit, production line, storage zone, or any other equivalent level equipment element defined as an extension to the equipment hierarchy model

NOTE For compatibility with existing schema implementations the defined term “work center” is used in place of the UK English spelling “work centre”.

3.1.13

work schedule

detailed schedule that may define production, maintenance, inventory or quality operations activities, or any combination of the activities

3.2 Abbreviations

For the purposes of this standard, the following abbreviations apply.

AGV	Automated guided vehicles
AMS	Asset management system
ASRS	Automated storage and retrieval system
CAPE	Computer-aided process engineering
CAD	Computer-aided design
CAE	Computer-aided engineering
CIM	Computer integrated manufacturing
CNC	Computerized numerical control
DCS	Distributed control system
ERP	Enterprise resource planning
EWI	Electronic work instructions
HR	Human resources
KPI	Key performance indicator
LIMS	Laboratory information management system
MES	Manufacturing execution system
MPS	Master production schedule
MRP	Material resource planning
OEE	Overall equipment effectiveness
PAT	Process analytical technology
PDM	Product data management
PLC	Programmable logic controller
PLM	Product life-cycle management
PRM	Purdue reference model for computer-integrated manufacturing
QA	Quality assurance
R&D	Research and development
RFQ	Request for quote
ROA	Return on assets
SCADA	Supervisory control and data acquisition
SOC	Standard operating conditions
SOP	Standard operating procedure
SQC	Statistical quality control

SPC	Statistical process control
WIP	Work in process
WMS	Warehouse management system

4 Structuring concepts

4.1 Activity models

Figure 1 illustrates the activity models of this standard in relationship to ANSI/ISA-95.00.01-2010 (IEC 62264-1 Mod) and ANSI/ISA-95.00.02-2010 (IEC 62264-2 Mod) – that is, ISA-95 Part 1 and ISA-95 Part 2. The activities in this Part 3 standard exchange information with activities defined as Level 4 and Level 2 activities. The grey circles indicate the activities detailed in this standard. The information flows between the activities of this standard, indicated as heavy dashed lines, are described in general in this standard. In addition, the information flows between the activities of this standard and dependent Level 2 activities are identified.

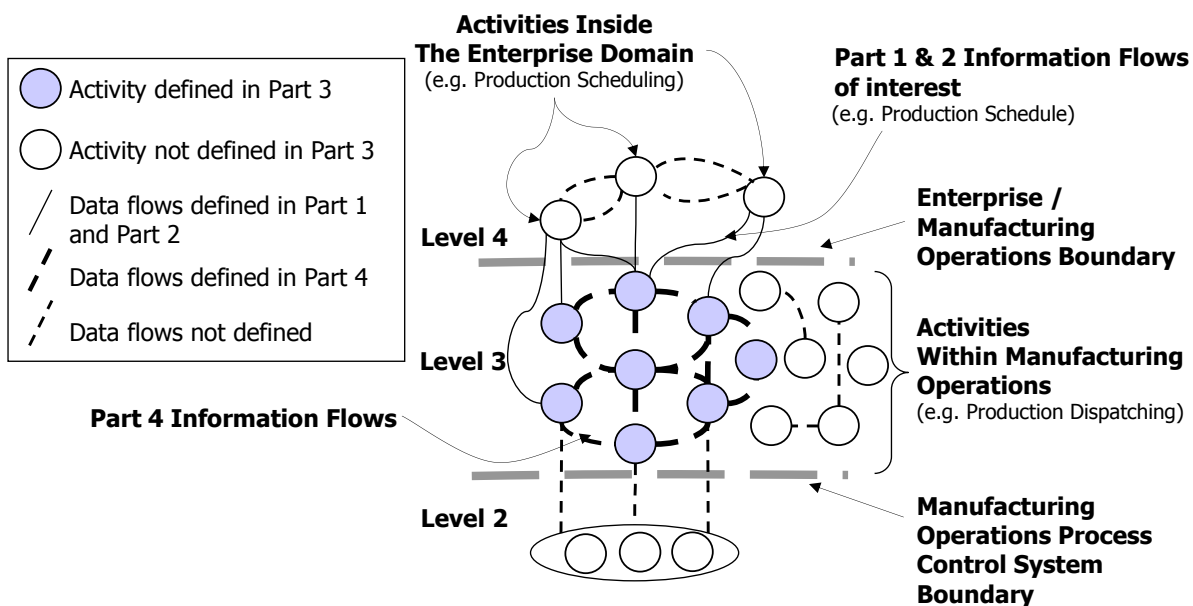


Figure 1 – Activity relationships

4.2 Manufacturing operations management elements

The shaded areas in Figure 1 represent the manufacturing operations management activities modelled in this standard. Manufacturing operations management is the collection of production operations management, maintenance operations management, quality operations management, inventory operations management and other activities of a manufacturing facility.

This part of the standard defines four formal models: production operations management, maintenance operations management, quality operations management and inventory operations management. These are detailed in Clauses 6, 7, 8 and 9 and are listed below.

- The production operations management model, which shall include the activities of production control (3.0) that operate as Level 3 functions and the subset of the production scheduling (2.0) that operate as Level 3 functions and as shown in Figure 1.
- The maintenance operations management model, which shall include the activities of maintenance management (10.0) that operate as Level 3 functions.

- c) The quality operations management model, which shall include the activities of quality assurance (6.0) that operate as Level 3 functions.
- d) The inventory operations management model, which shall include the activities of management of inventory and material including product inventory control (7.0) and material and energy control activities (4.0) defined as operating as Level 3 functions.

NOTE 1 The numbers in parenthesis “()” refer to the functional model depicted in Part 1.

NOTE 2 Other categories of operation management may exist depending on company policy or organization. They are not formally modelled in this standard but they can make use of the generic standard model.

5 Structuring models

5.1 Generic template for categories of manufacturing operations management

5.1.1 Template for management of operations

A generic model for management of operations shall be used as a template to define the production operations management, maintenance operations management, quality operations management, and inventory operations management models. This model is shown in Figure 2. This generic model is extended for each specific area in later clauses.

NOTE The fine details of the generic model are different for each of the manufacturing operations management areas.

5.1.2 Use of the generic model

The generic model is instantiated for the four categories listed in 5.1.1. However, this same template may be instantiated for other possible manufacturing operations categories or for other operations areas within the enterprise.

EXAMPLE 1 A company could apply the model to receiving operations management and shipping operations management where these are separately managed.

EXAMPLE 2 A company could apply the model to cleaning and sterilization operations management, where these are separately managed.

EXAMPLE 3 A company could apply the model to independent logistics operations management categories for inbound logistics, outbound logistics, internal transfer and inventory control.

NOTE This clause is normative so that companies that apply the generic model to areas other than the four detailed in this standard can determine and document their degree of conformance to the model.

When the generic model is instantiated for a new category, the activities within a category shall include the definitions of resource management, definition management, dispatching, tracking, data collection, analysis, detailed scheduling, and execution management.

5.1.3 Generic activity model

There shall be a hierarchy used in this standard that starts at a category of operations management. Each category is composed of a collection of activities and each activity is composed of a set of tasks. The generic model applies to the sets of activities.

The generic activity model defines a general request-response cycle that starts with requests or schedules, converts them into a work schedule, dispatches work according to the schedule, manages the execution of work, collects data and converts the collected data back into responses. This request-response cycle is supported with

- analysis of the work performed for improvements or corrections;
- management of the resources used in execution of the performed work;
- management of the definitions of the performed work.

The generic activity model and the detailed models are not intended to represent an actual implementation of a manufacturing information system. However, they do provide a consistent framework for such systems. Actual systems may use different structures supporting other task arrangements. The purpose of these models is to identify possible data flows within manufacturing operations. The generic model is illustrated in Figure 2. The ovals in the model indicate collections of tasks, identified as the main activities. Lines with arrowheads indicate some of the information flows between the activities.

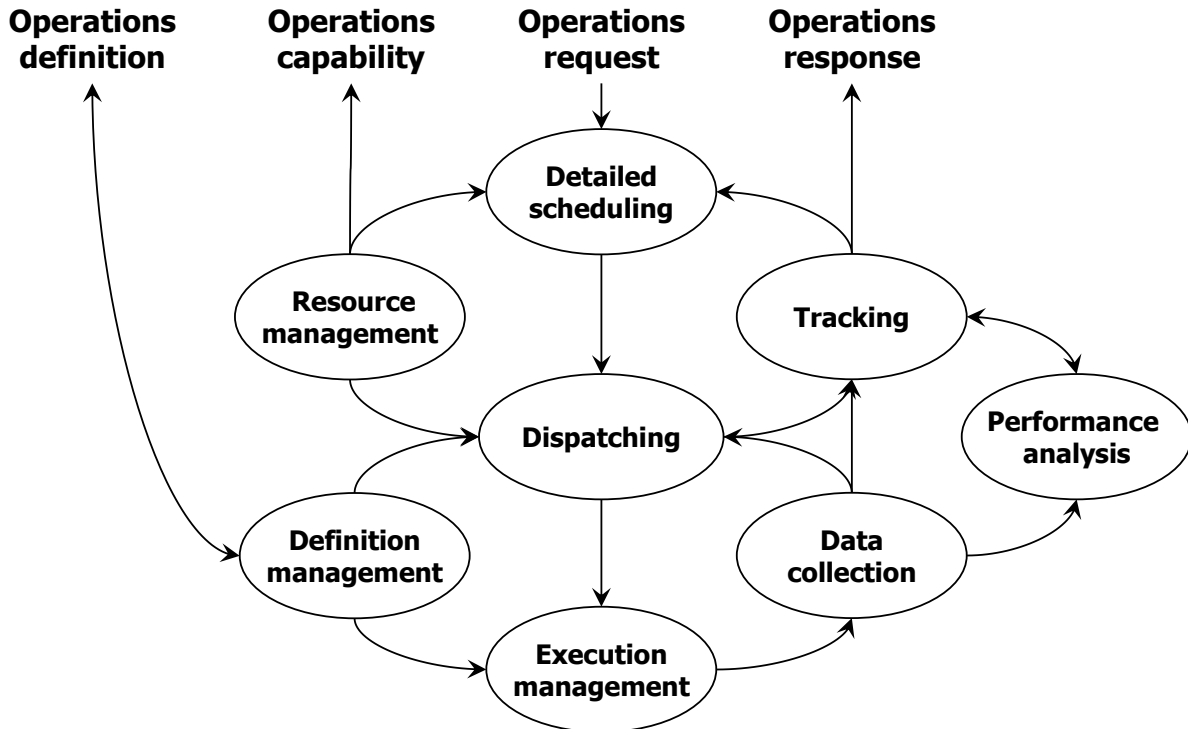


Figure 2 – Generic activity model of manufacturing operations management

NOTE Not all information flows are depicted in Figure 2. In any specific implementation, information from any activity may be required by any other activity. Where the model is expanded for specific activities, the lines indicating information flows are not intended to be exclusive lists of information exchanged.

5.2 Interaction among generic activity models

5.2.1 Information flows between generic activity models

In addition to the information flows within the activities of specific operations categories, there are also information flows between the different categories. Some of this information is defined in the following clauses, but not all information flows are explicitly defined in this standard.

NOTE Specific implementations of activity models may give prominence to one specific activity model over others.

EXAMPLE 1 In pharmaceutical industries, quality operations may provide the direction for other operations.

EXAMPLE 2 In distribution centres, inventory operations may provide the direction for other operations.

EXAMPLE 3 In consumer packaged goods, production operations may provide the direction for other operations.

EXAMPLE 4 In refining, inventory operations may provide the direction for production operations.

5.2.2 Handling resources within the generic activity models

Information about resources (materials, personnel, equipment, and physical assets) may be handled within any one of the four activity models of manufacturing operations (production, quality, maintenance and inventory) presented in this standard.

Although data for different resources may be found in different models, there are primary reporting paths through which information should be obtained.

- a) Personnel information specific to each activity model may be obtained from the specific activity model.
- b) Equipment information specific to each activity model may be obtained from the specific activity model.
- c) Material information specific to each activity model may be obtained from the specific activity model. However, material inventory information, including finished goods and raw materials, may be obtained from the inventory activity model. Material movement operations may be managed by activities in the production, quality, maintenance, or inventory activity models. A specific material movement instance only exists within one activity model at any given point in time.

5.2.3 Scheduling interactions

An activity in a detailed activity model has interactions with other activities in the same model and interactions with equivalent activities in other activity models. Interactions within each activity model are described in Clauses 6, 7, 8 and 9.

There are many interactions associated with detailed scheduling between activity models because of the need to coordinate between many work tasks assigned to a same resource on a given time interval. Also, the definitions of work tasks in the different types of operations management are closely related.

Clear definition of interactions between detailed production scheduling, detailed inventory scheduling, detailed maintenance scheduling and detailed quality-test scheduling should be specified. For interactions with production the following three interactions shall be defined, as illustrated in Figure 3.

- 1) Interaction between detailed production scheduling and detailed inventory scheduling. This is defined as coordination of information, at the start or completion of production, of the quantity of materials that is consumed or produced during production and stored or moved by inventory operations.

NOTE Scheduling of transportation can be defined in either detailed production scheduling or detailed inventory scheduling.

EXAMPLE 1 Production not scheduled to start before the scheduled issuing of the corresponding inventory of materials.

EXAMPLE 2 Completion of scheduled production triggers a scheduled inventory operation.

- 2) Interaction between detailed production scheduling and detailed maintenance scheduling. This is defined as coordination of information about equipment that provides capability and capacity during production and needs to be reserved for maintenance depending on the equipment condition.

EXAMPLE 3 Not scheduling corrective maintenance and production on equipment simultaneously.

EXAMPLE 4 Scheduling maintenance based on scheduled use of equipment for production.

- 3) Interaction between detailed production scheduling and detailed quality-test scheduling. This is defined as coordination of information about the quality of produced and consumed materials, which need to be quality-tested depending on the required level of quality and the latest production performance.

EXAMPLE 5 Detailed inspection schedule embedded in the work schedule.

EXAMPLE 6 Inspection operations requests production operations to schedule rework of the product.

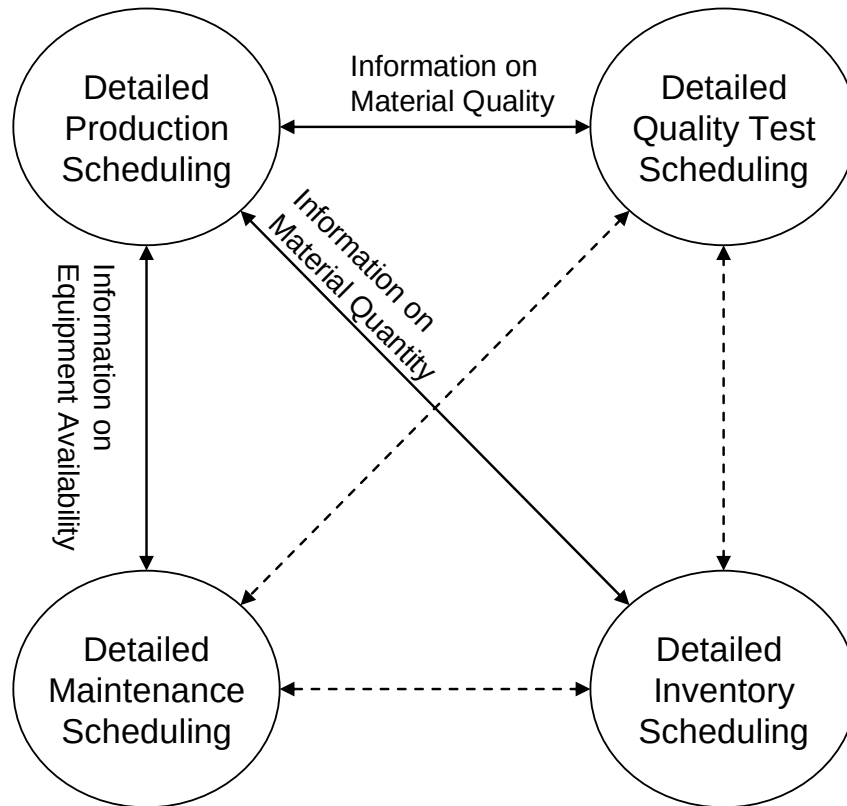


Figure 3 – Detailed scheduling interactions

5.3 Hierarchy of planning and scheduling

In this subclause, planning is defined as an activity for clarifying actions or operations to achieve a given goal and reserving enough amount of resource capacity to hit minimum targets. Scheduling is defined as an activity for allocating actions and operations to particular resources at particular times, taking into account various actual constraints and optimization of several evaluation parameters.

Figure 4 illustrates that in terms of the hierarchy, planning ranks higher than scheduling because a schedule is made using the results of a plan. Planning determines the goals for scheduling. Some constraints and sub-goals for objective functions in scheduling problems are determined in advance by planning activities. The results of scheduling show whether or not the result of planning is feasible and efficient. If it is not feasible, planning usually generates another result for scheduling. Feasibility and efficiency of scheduling are types of constraints of planning.

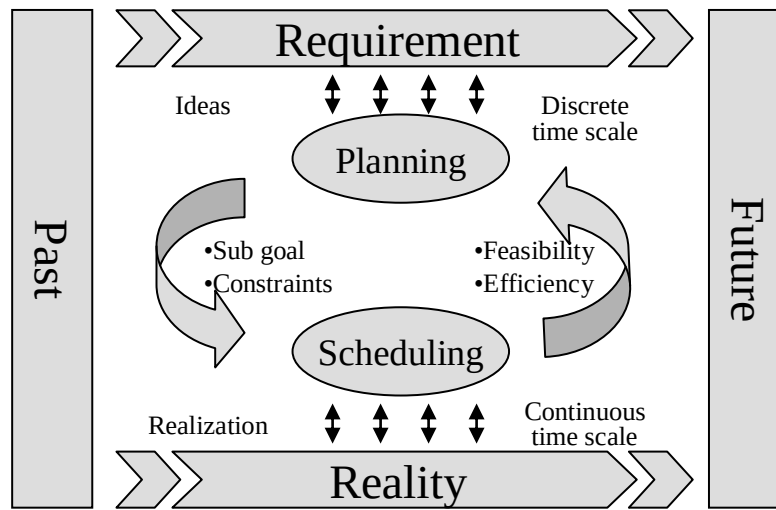


Figure 4 – Schematic relationship of planning and scheduling

The differences between planning and scheduling are the kinds of results which are related to different aspects of time concepts.

In planning, the main results will be target quantities that apply over certain periods of time. The results of planning are represented on a discrete time scale as periodic times.

EXAMPLE 1 Results of planning might be “50,000 widgets this month”, “divisional sales of \$480,000 next month”, “summary of overtime hours for next week”, etc.

Results in scheduling represent the specific timing of actions, for example, start time and completion time of operation, inventory issue time, shipping time, etc. The results of sequence information for operations are represented on a continuous time scale as relative or absolute times.

EXAMPLE 2 Results of scheduling might be “9:00 Monday run Work Order 2345 for 6 shifts at 100 % utilization”, “9:00 Wednesday perform preventative maintenance on E887e”.

5.4 Resource definition for scheduling activities

5.4.1 Consumable resources and non-consumable resources

A resource is defined in ISA-95 Part 1 as personnel, equipment and/or material. In this standard, particularly from the viewpoint of detailed scheduling activities, resources can be divided into two different groups: consumable resources generally corresponding to personnel hours worked, materials (including energy) and non-consumable resources generally corresponding to personnel skills and equipment use. Consumable resources and non-consumable resources are typically handled differently in scheduling activities.

A consumable resource is produced or consumed by production processes. This type of resource usually includes raw materials (including energy), WIP inventories final products, and may also include personnel hours worked or equipment time. The quantity of the resource is measureable and typically changes before or after production. The amount of the utilized resource is a direct expense to the product production processes.

A non-consumable resource is not depleted by production processes but is scheduled on the basis of capability. The quantity of the resource typically does not change before or after production.

5.4.2 Resource capacity and availability

In ISA-95 Part 1 and ISA-95 Part 2, production scheduling depends on the availability of both consumable and non-consumable resources. Available capacity in this standard is a portion of production capacity that can be attained but is not committed to current or future production and may be defined as a rate.

- Example 1 For a bicycle factory, the available capacity for production is 10 bicycle seats per hour of operation, during first shift, Monday through Friday.
- Example 2 For a bicycle factory, the available capacity for consumption is 30 bicycle seats per hour of operation, during first shift, Monday through Friday.
- Example 3 Projected inventories for bicycle seats within a bicycle factory is 380 seats at the start of the first shift on Monday and 360 seats at the end of the first shift. Sixty seats would have been consumed (2 h of consumption) and 40 seats would have been produced (4 h of production).

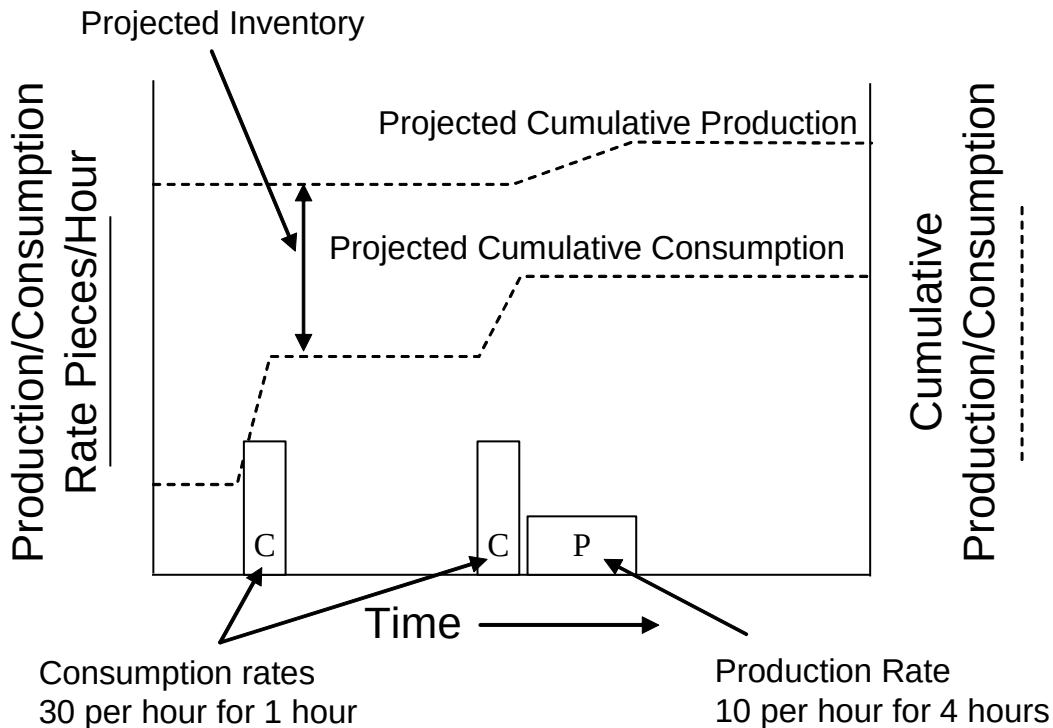


Figure 5 – Projected inventory for a consumable resource

NOTE Consumable resources and non-consumable resources are typically handled differently in scheduling activities. In ISA-95 Part 1 and ISA-95 Part 2, production scheduling depends on the availability of both consumable and non-consumable resources. Production capacity is determined by both the availability of consumable resources (inputs such as raw material, components) and the availability and capacity of non-consumable resources (the physical system such as equipment, facilities and people).

6 Production operations management

6.1 General activities in production operations management

Production operations management shall be defined as the collection of activities that coordinate, direct, manage and track the functions that use raw materials, energy, equipment, personnel and information to produce products, with the required costs, qualities, quantities,

safety and timeliness. The general activities in production operations management are listed in ISA-95 Part 1 and include:

- a) reporting on production including variable manufacturing costs;
- b) collecting and maintaining data on production, inventory, manpower, raw materials, spare parts and energy usage;
- c) performing data collection and off-line analysis as required by engineering functions;

NOTE: This may include statistical quality analysis and related control functions.

- d) performing needed personnel functions, such as work period statistics (for example, time, task), vacation schedule, work force schedules, union line of progression and in-house training and personnel qualification;
- e) establishing the immediate work schedule for its own area accounting for maintenance, transportation and other production-related requests;
- f) locally optimizing the costs for individual production areas while carrying out the production schedule established by the Level 4 functions;
- g) modifying production schedules to compensate for plant production interruptions that may occur in its area of responsibility.

6.2 Production operations management activity model

The production operations management model defined in ISA-95 Part 1 is expanded to a more detailed activity model of production operations shown in Figure 6. The four elements of information (product definition, production capability, production schedule and production performance) correspond to the exchanged information defined in ISA-95 Part 1. The oval-labelled production Level 1-2 functions represent the Level 1 and Level 2 sensing and control functions. The other ovals (with solid outlines) represent the activities of production operations.

The activities defined here are not intended to imply an organizational structure of systems, software, or personnel. The model is provided to help in the identification of activities that may be performed and in the identification of roles associated with the activities. It defines what is done, not how it should be organized. Different organizations may have a different arrangement of roles and assignment of roles to personnel or systems.



Not all production requests and production responses cross the boundary to business systems. While production operations may be driven by production schedules there can be production requests and production responses used internally within manufacturing operations management to handle situations such as rework, local intermediates, or consumable production.

6.3 Information exchange in production operations management

Equipment and process specific production rules shall be defined as the specific instructions sent to Level 2 based on the specific assigned tasks.

NOTE See IEC 61131-3 Programmable controllers - Part 3: Programming languages, for examples of this type of data.

6.3.2 Operational commands

Operational commands shall be defined as the request information sent to Level 2. These are typically commands to start or complete elements of a work order. This information may also be SOPs displayed or given to operators, such as procedures for setting up machines or cleaning of machines.

NOTE This information exchange corresponds to the recipe-equipment interface defined in IEC 61512-1 (see Clause 2).

6.3.3 Operational responses

Operational responses shall be defined as information received from Level 2 in response to commands. These typically correspond to the completion or status of elements of work orders.

NOTE This information exchange corresponds to the recipe-equipment interface defined in IEC 61512-1 (see Clause 2).

6.3.4 Equipment and process specific data

Equipment and process specific data shall be defined as information received as a result of monitoring Level 2. This is typically information about the process being performed and the resources involved.

6.4 Product definition management

6.4.1 Activity definition

Product definition management shall be defined as the collection of activities that manage all of the Level 3 information about the product required for manufacturing, including the product production rules.

Product definition information is shared between product production rules, bill of material and bill of resources. The product production rules contain the information used to instruct a manufacturing operation how to produce a product. This may be called a work master (ISA-95 Part 4), general, site, or master recipe (ANSI/ISA-88.00.01 and IEC 61512-1 definitions), standard operating procedure (SOP), standard operating conditions (SOC), routing, or assembly steps based on the production strategy used. The product definition information is made available to other Level 3 functions and to Level 2 functions as required.

Product definition management includes management of the distribution of product production rules. Some of the product production rules may exist in Level 2 and Level 1 equipment. When that is the case, downloads of this information shall be coordinated with other manufacturing operations management functions to avoid affecting production. This information may be included as part of operational commands when the download is part of a production execution management activity.

6.4.2 Activity model

Figure 7 illustrates some of the interfaces to product definition management.

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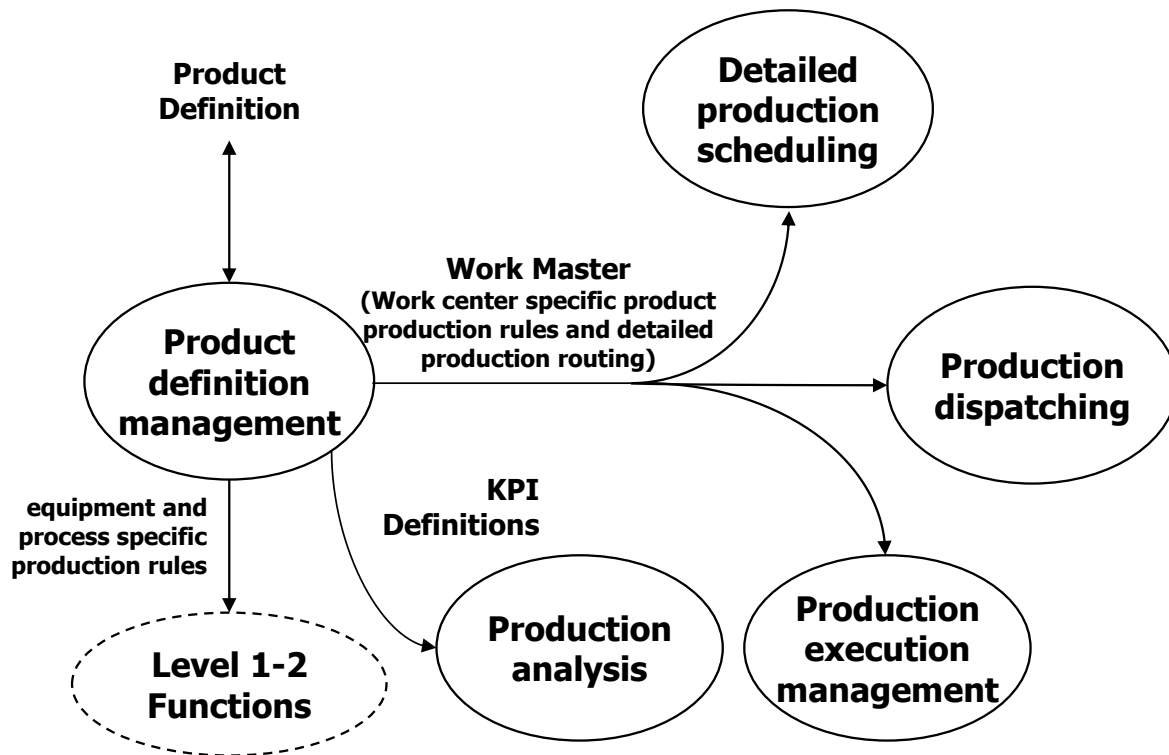


Figure 7 – Product definition management activity model interfaces

6.4.3 Tasks in product definition management

Product definition management tasks may include:

- a) managing documents such as work masters, manufacturing instructions, recipes, product structure diagrams, manufacturing bills and product variant definitions;
- b) managing new product definitions;
- c) managing changes to product definitions;

NOTE 1 This may include the ability to route work masters, designs and manufacturing bill changes through an appropriate approval process, management of versions, tracking of modifications and security control of the information.

- d) providing product production rules to personnel or other activities;

EXAMPLE These may take the form of work masters, manufacturing steps, master recipes, machine set-up rules and process flow sheets;

- e) maintaining the feasible detailed production routings for products;
- f) providing the route to manufacturing operations in the level of detail required by manufacturing operations;
- g) managing the exchange of product definition information with Level 4 functions at the level of detail required by the business operations;
- h) optimizing product production rules based on process analysis and production performance analysis;
- i) generating and maintaining local production rule sets indirectly related to products, such as for cleaning, start-up and shutdown;
- j) managing the key performance indicator (KPI) definitions associated with products and production.

NOTE 2 There are a number of tools to assist in the product definition management activity, including mechanical and electronic computer-aided design (CAD), computer-aided engineering (CAE), recipe management systems, computer-aided process engineering (CAPE) and electronic work instructions (EWIs).

6.4.4 Product definition management information

Product definition is the information exchanged with engineering, R&D and others to develop the site-specific product production rules or work masters. This information may include R&D manufacturing definitions that are translated and extended by product definition management into site-specific definitions using local material, equipment and personnel. This may also involve translation of product definition information to elements of a work master.

EXAMPLE Translation to work masters, master recipes, machine set-up rules and process flow diagrams.

Product definition management may also include managing other product information in conjunction with manufacturing information. This may include:

- customer requirements, product design and test specifications;
- process design and simulation;
- technical publications and service materials;
- regulatory filings requirement information.

The product definition management activity interacts with production scheduling, production dispatching and production execution management to get the work done and interacts with research development and engineering to obtain the product production rules for executing the work.

EXAMPLE Production dispatching activities may need to refer to production dependencies to identify when a specific resource will be required.

The product production rule can contain information regarding personnel, equipment, material, and product parameters. To perform these functions, product definition management may need to exchange information with resource management.

6.4.5 Detailed production routing

The product definition information may contain a finer granularity of definition than is visible to business systems, but is required for detailed routing of work between workcenters (process cells, production lines and production units). Detailed work order element routing is organized by the physical production process.

NOTE A detailed production routing is sometimes called a production route, master business system route, master route, or business route.

6.5 Production resource management

6.5.1 Activity definition

Production resource management shall be defined as the collection of activities that manage the information about resources required by production operations, and relationships between resources. The resources include machines, tools, labour (with specific skill sets), materials and energy, as defined in the object models given in ISA-95 Part 1. Direct control of these resources in order to meet production requirements is performed in other activities, such as production dispatching and production execution management. Management of information about segments of production is also an activity in resource management.

Management of the resource information may be handled by computer systems but it may be partly or entirely handled by manual processes.

Management of the resources may include local resource reservation systems to manage information about future availability. There may be separate reservation systems for each

managed critical resource. There may be separate activities for each type of resource, or combined activities for sets of resources.

Information about resources and relationships between resources needed for a segment of production must be maintained and provided on the available, committed and unattainable capacity for specific periods of time of specified resources as defined in ISA-95 Part 1.

6.5.2 Activity model

Figure 8 illustrates some of the interfaces to production resource management.

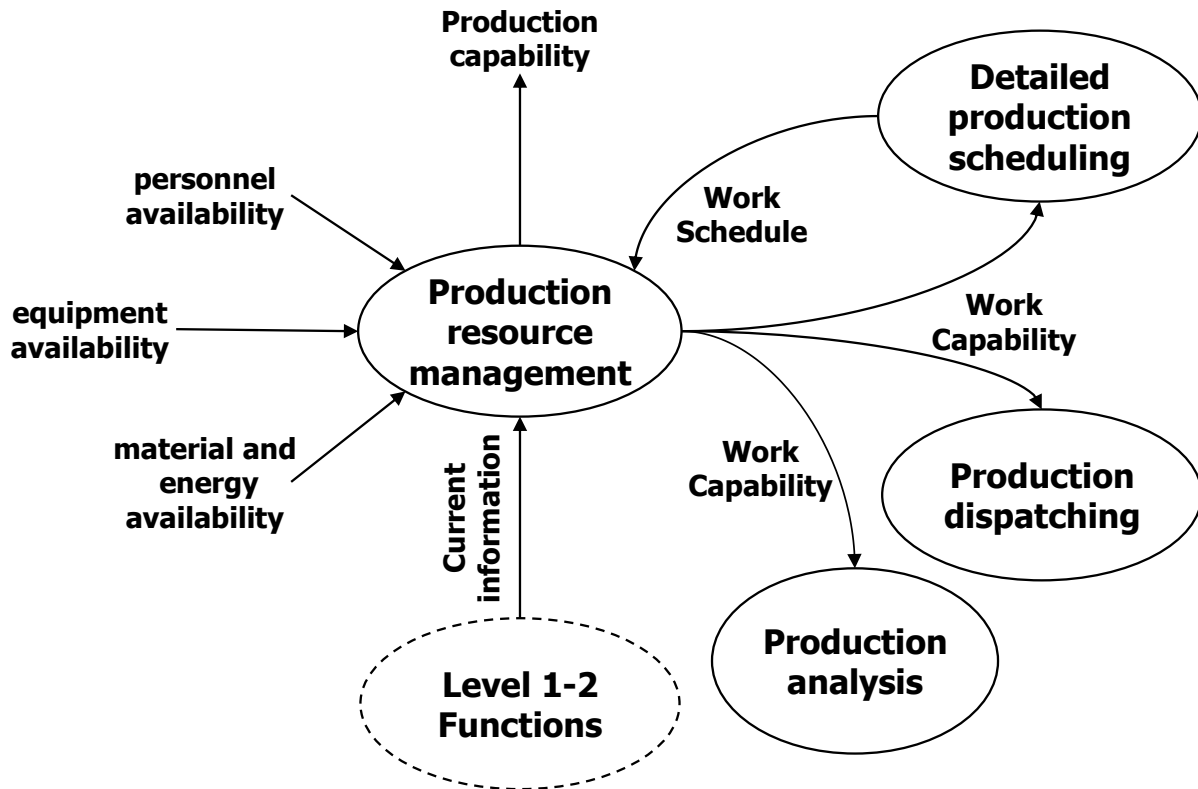


Figure 8 – Production resource management activity model interfaces

6.5.3 Tasks in production resource management

Production resource management tasks may include:

- providing personnel, material and equipment resource definitions. The information may be provided on demand or on a defined schedule and may be provided to people, to applications, or to other activities;
- providing information on resource (material, equipment, or personnel) capability (committed, available, or unattainable). The information is based on the current statuses, future reservations and future needs (as identified in the production plan and work schedule) and is specific for resources, for defined time spans and process segments. It may include information on current balance and losses to product cost accounting and may be provided on demand or on a defined schedule and may be provided to people, to applications, or to other activities;
- ensuring that requests for acquisition of resources to meet future operational capabilities are initiated;

- d) ensuring that equipment is available for the assigned tasks and that job titles are correct and training is current for personnel assigned to tasks;

EXAMPLE 1 Checking that an equipment sterilization status is correct ("clean") before it is assigned to a production operation.

- e) providing information on the location of resources and assignment of resources to areas of production;

EXAMPLE 2 Providing a location for a mobile inspection machine that can be used in multiple locations.

- f) coordinating the management of resources with maintenance resource management and quality resource management;

- g) collecting information on the current state of personnel, equipment and material resources and on the capacity and capability of the resources. Information may be collected on the basis of events, on demand and/or on a defined schedule and may be collected from equipment, people and/or applications;

- h) collecting future needs such as from the production plan, current production, maintenance schedules, or vacation schedules;

- i) maintaining personnel qualification test result information;

- j) maintaining equipment capability test result information; and

- k) managing reservations for future use of resources.

6.5.4 Resource availability

Resource availability provides time-specific definitions needed for scheduling and reporting on a resource. The resource availability must take into account elements such as working hours, labour regulations, holiday calendar, breaks, plant shutdowns and shift schedules.

EXAMPLE The available time can be a fixed time or a flexible time. For example, in personnel resource management, the time for lunch may be flexible between 11:00 a.m. and 2:00 p.m., or a machine may be unavailable for 8 h within a 16-h period. Personnel availability may define working days and days off; Monday to Friday are available for work, Saturday and Sunday are unavailable for work, or available for 2 days early shift, 2 days late shift, 2 days night shift and 3 days off.

Figure 9 illustrates the types of information about the capacity of a single resource that may be provided by resource management.

Figure 9 illustrates the types of information about the capacity of a single resource that may be provided by resource management.