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Industrial automation systems and integration — Standardized procedures for production systems engineering —

Part 3: Information flows in production planning processes

Systèmes d'automatisation industrielle et intégration — Procédures normalisées pour l'ingénierie des systèmes de production —

Partie 3: Flux d'informations dans les processus de planification de la production

Reference number
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 4, *Industrial data*.

A list of all parts in the ISO 18828 series can be found on the ISO website.

Introduction

Increasing cost pressures in a competitive global environment, coupled with constantly growing levels of product and process complexity, means that advanced production planning skills are now a key factor of success for many manufacturing companies. To produce competitively, it is necessary not only to ensure the efficient operation of the production structures, but also to be in a position to plan and design these to respond to specific requirements and at a high level of quality. Constantly shortening planning and development times and, thus, reducing time-to-market is a crucial component of economic success in today's markets. In parallel with product design, and prior to the initial start of production (SOP), production planning is a business process that has great potential with respect to improving product and process planning. Researching, generating, processing, and transferring information are important aspects of production planning. Depending on the level of maturity of the planning and the respective planning discipline (see Clause 4), definable information packages emerge, which are generated iteratively during planning, and processed further through the overall planning process. The resulting information flows are followed via a reference planning process. This helps to specify the state of information at defined points during planning. The comparison of actual states against target states of information packages is performed at these defined points (see Annex A).

NOTE See Bibliography for further detail on research background.

The main information flows in production planning are specified in this document. They are examined in the context of the reference planning process (see Figure 1) described in ISO 18828-2. Also building on the reference planning process and on the information flows, this document describes key indicators for the transparency and assessment of the planning processes.

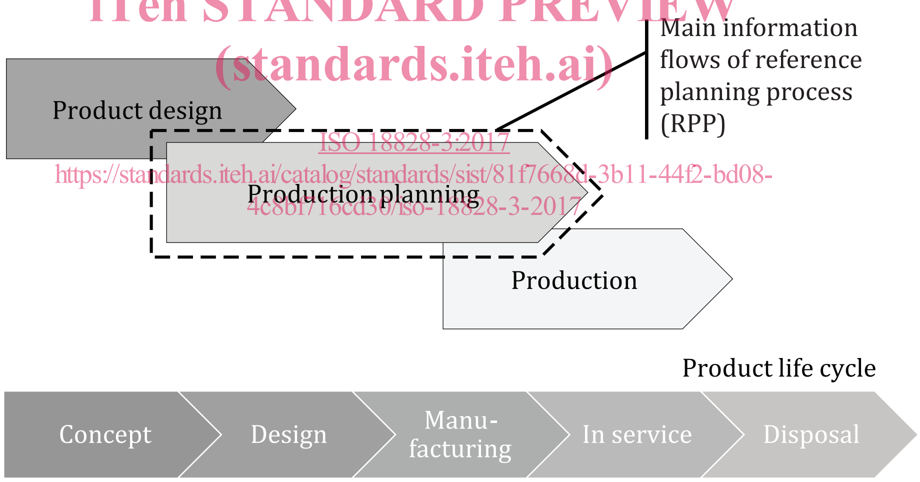


Figure 1 — Main information flows of the reference planning process (qualitative depiction)

Industrial automation systems and integration — Standardized procedures for production systems engineering —

Part 3: Information flows in production planning processes

1 Scope

This document describes the information flows identified for each planning discipline within production planning, according to ISO 18828-2.

The following aspects are within the scope of this document:

— general overview of the main information flows within the reference planning process;

— basic pattern to describe the main information flows;

— detailed description of every main information flow;

— state notation structure of the main information flows objects;

— detailed descriptions for each information object state;

— proposal of checklists for benchmarking information objects.

The following items are outside the scope of this document:

— information flows to intersecting areas, including high-level planning;

— data models for production planning;

— complete description of all possible information flows/objects within production planning;

— workflow engines for automated production planning;

— production facilities planning/manufacturing facilities planning (physical plant and equipment); including any kind of resource that is not directly related to the manufacturing process;

— value chain (inbound logistics, operations management, outbound logistics, marketing and sales);

— process simulation/safeguarding;

— investment planning during production process management.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 15531-1, *Industrial automation systems and integration — Industrial manufacturing management data — Part 1: General overview*

ISO 18828-2, *Industrial automation systems and integration — Standardized procedures for production systems engineering — Part 2: Reference process for seamless production planning*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15531-1, ISO 18828-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
intralogistics
internal logistics
delivery methods and means of transport at the production site and detailed description of the container concept

Note 1 to entry: The delivery methods include buffers and supermarkets (having defined and simulated ranges), transport capacity, and delivery cycles. They are supported by electronic tools such as product data management (PDM) or enterprise resource planning (ERP) systems that map all required resources and the infrastructure. The detailed container concept includes a complete description of all containers used, the container types, the container size, their sequences, and the partition and packaging concepts for parts and assemblies.

3.1.2
investment planning
detailed calculation of all costs during production planning that determine the investments and overhead for a planning alternative of a production system

Note 1 to entry: This calculation is carried out bottom-up for all processes and resources (with respect to concrete machines, facilities, etc.). It is supported by calculation templates, additional calculation tools, and digital planning tools featuring extended planning functions.

3.1.3
layout planning
information needed for planning and implementing a production layout, including the arrangement and sizing of lines, stations, machines, circulation areas, and road network

Note 1 to entry: An additional component of layout planning is the cost calculation for structural measures and utilities installations for planned facilities.

3.1.4
operation list
list of information including flow charts and personnel allocations, required concrete resources (manufacturing, assembly or personnel resources), infrastructure for production and associated required manipulators (operating resources such as cranes and steel constructions)

Note 1 to entry: This list of information is normally stored in digital tools, e.g. ERP systems.

3.1.5
precedence graph
graph that displays all required manufacturing and assembly operations and the associated process times and work content for a work system in the correct sequence

3.1.6
product
thing or substance produced by a natural or artificial process

[SOURCE: ISO 10303-1:1994, 3.2.26]

3.2 Abbreviated terms

BPMN	business process model and notation
CAD	computer-aided design
ERP	enterprise resource planning
PDM	product data management
UML	unified modelling language

4 Classification of information flows in the reference process

When describing the information flows in production planning, it is sensible to restrict it to the most important planning disciplines found in manufacturing companies. The structure of the reference model for seamless production planning is given in ISO 18828-2. The following production planning disciplines are used to identify the main information flows (see Figure 2): manufacturing, assembly, logistics and layout.

NOTE For further details and decomposition of planning discipline and relations, see ISO 18828-2.

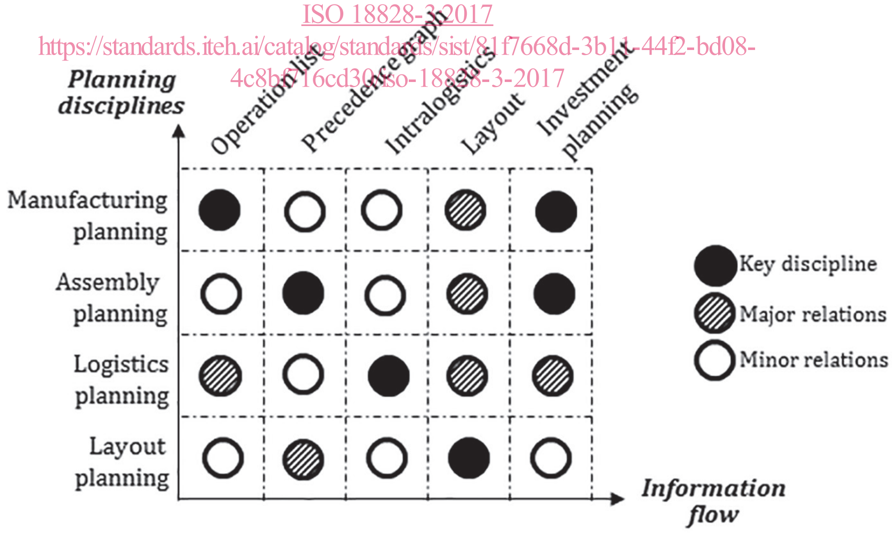


Figure 2 — Main information flows structured by planning discipline

The information flows described in Clause 5 originate from the reference planning process. They represent an information-oriented view of the overall planning process and take into account both the planning disciplines and planning phases. This document provides additional information that focuses on the transparency of the information flows. The process interfaces include the process phases (i.e. conceptual, rough, and detailed planning) in one dimension, and the planning disciplines of manufacturing, assembly, logistics, and layout, in the other.

In addition, the information flows per se can be regarded as individual, isolated information flows.

Five main information flows have been identified and modelled, each of which takes all the process interfaces that were derived from the reference planning process. They describe the total information exchange between the accompanying activities and the type of data exchanged. In this respect, they resemble unified modelling language (UML) activity diagrams.

Each information flow has been modelled around a specific flow object. This approach has the benefits of increased transparency of the interactions and data flows for each object. End users who are interested in a specific flow can easily check the entirety of their data and complete this specific flow. Software providers also benefit from the object/process-oriented approach. Defining inputs and outputs for each activity enables the rapid derivation of an initial rough information flow. In addition, the function flow indirectly defines user interfaces, existing business and application logic, and applicable programming environments.

Figure 3 provides a general overview of the networked interactions of the planning phases and planning disciplines, with respect to each main information flow. Figure 3 also shows all the required and accompanying activities, relationships, and decisions for each information flow. Software providers can also use this information in a work flow process.

NOTE For further details and decomposition of planning phases and relations, see ISO 18828-2.

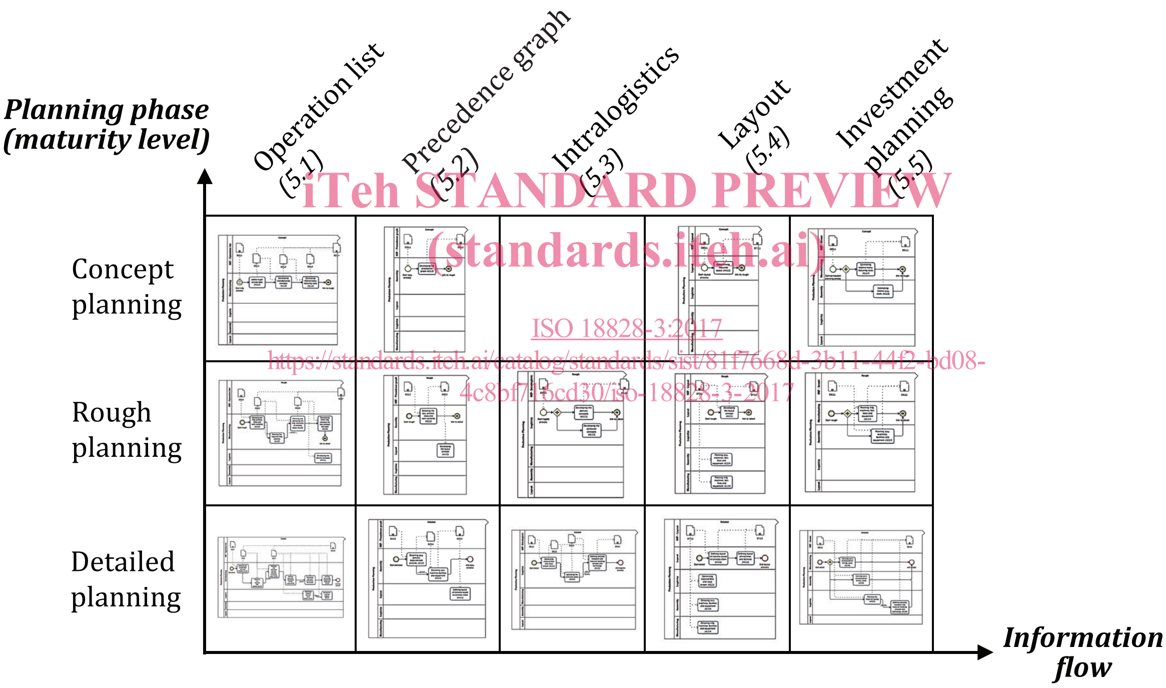


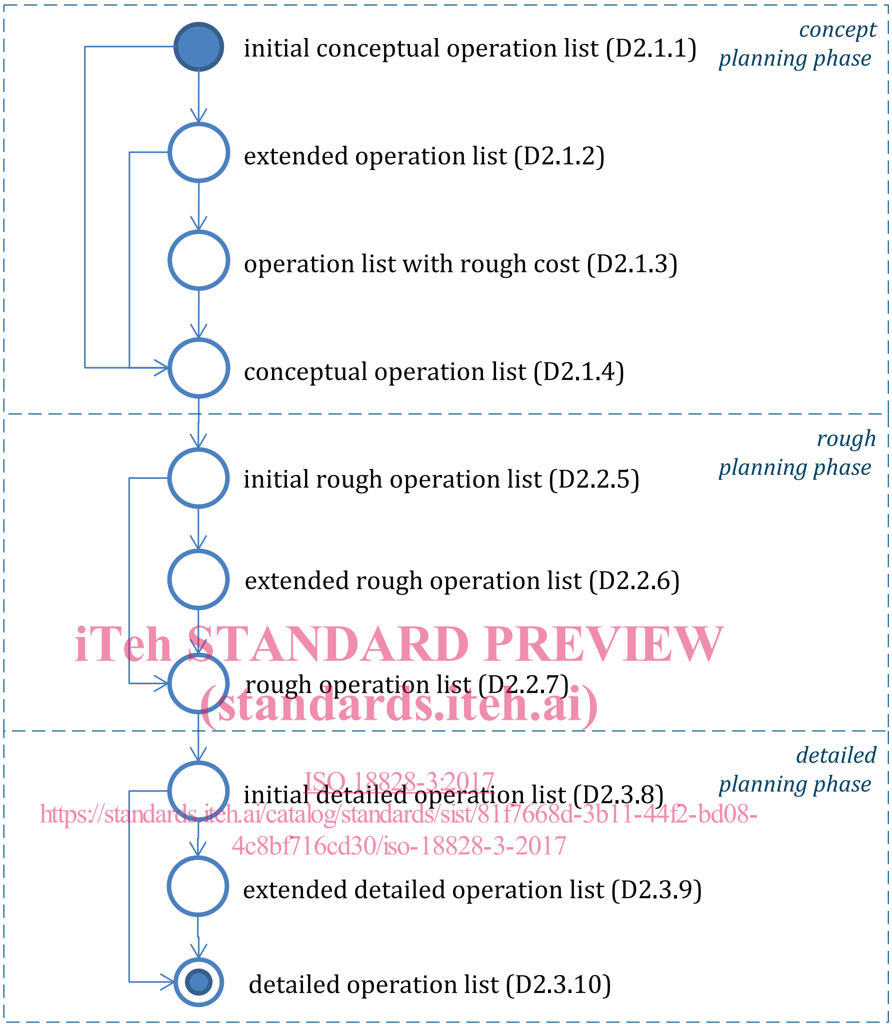
Figure 3 — Main information flows structured by planning phases

In order to graphically depict the interaction between processes and information flows, the business process model and notation (BPMN) has been selected. The BPMN language uses semantically unique graphical elements for flows, connectors, and artifacts, which are similar to the activity diagrams of the UML. The formal visualization characteristics primarily used in this document are described in Annex D.

5 Main information flows

5.1 Operation list/process plan

The main information flow for an operation list or a process plan includes two information objects. The first object is referred to as "preliminary information for the operation list" and includes prerequisites for planning. It has only one single state and is not considered further in the planning process. The second information object is referred to as an “operation list” and assumes various states during the course of the planning process. Each state converts data from a previous state and supplements it with additional information or aggregates it into a subsequent state object. Ten different states have been identified for the operation list information object. They are depicted in Figure 4.



Key

→ transition of state

start state

end state

internal version state

Figure 4 — States of the operation list information object

NOTE The depicted states are described in greater detail in Annexes B and C.

Each state has been provided with a unique identifier, which follows a specific classification scheme. The first digit represents the information object; the middle digit stands for the current planning phase; and the last digit represents the current version number of the information object. Accordingly, the last digit also contains the information state of the object. The accompanying letter “D” identifies the type of information, in this case, “data.”

5.1.1 Concept planning phase

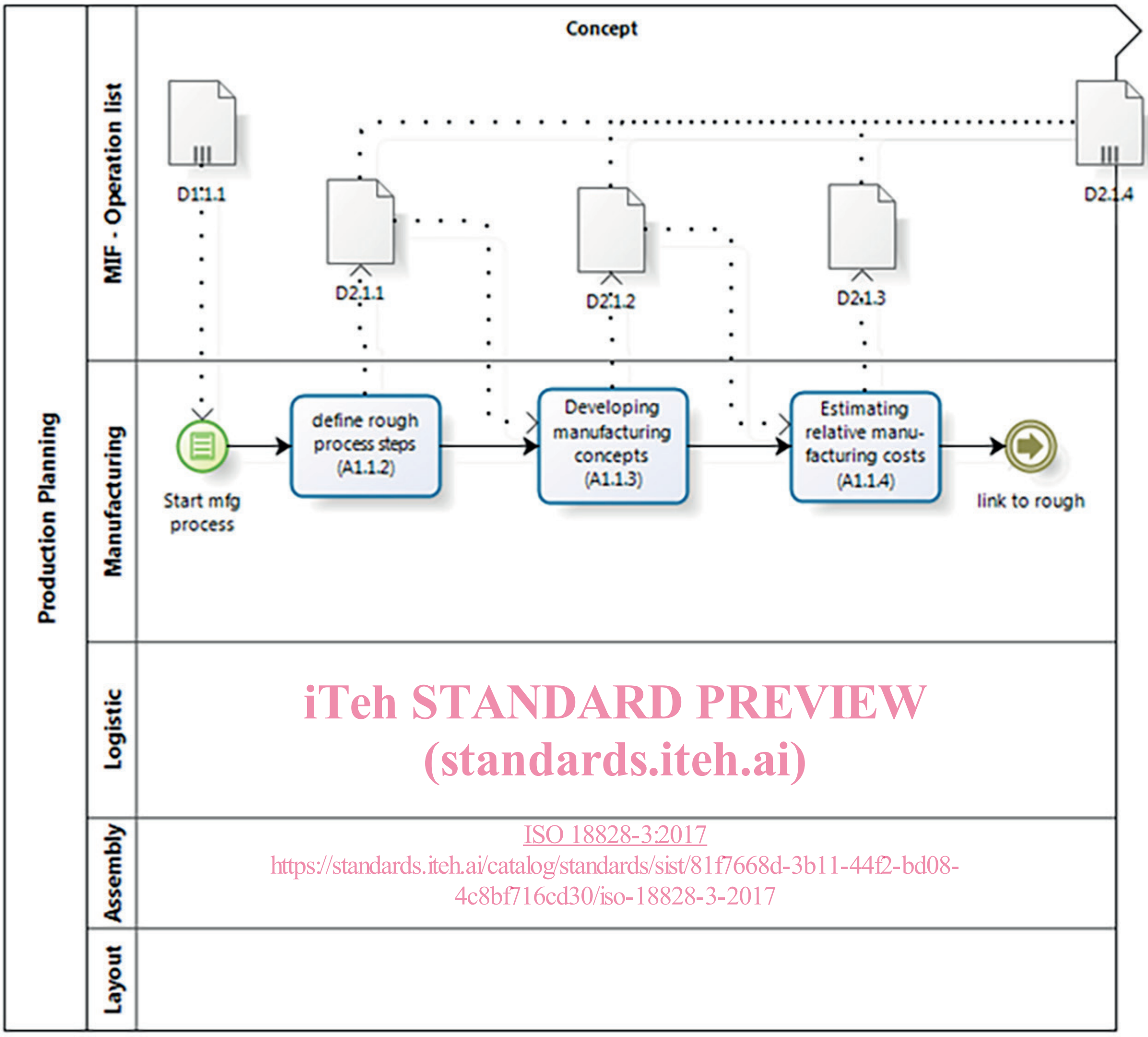


Figure 5 — Concept planning phase of the operation list information flow

Based on preliminary information (D1.1.1 in Figure 5) that has been compiled from various relevant sources, the concept planning phase generates an initial conceptual operation list (D2.1.4).

To start the concept planning phase, various preliminary information is required for defining an operation list. It generally includes:

— product information (e.g. parts and assemblies);

— number of pieces;

— applicable technologies (e.g. welding, milling, stamping, etc.);

— additional brown field information (e.g. available resources);

— additional green field information (e.g. applicable resources);

— available time database (e.g. process times for operations).

These planning prerequisites determine an initial operation list. The information list is the result of a first rough definition of process steps (A.1.1.2). The following step of developing manufacturing concepts (A1.1.3) supplements the initial operation list with additional information and results in an extended conceptual operation list (D2.1.3). The estimation of rough manufacturing costs (A1.1.4) based on the data of the conceptual operation list makes it possible to add rough costs to the extended conceptual operation list (D2.1.4).

The last version of the concept planning phase generally includes four to five alternative operation lists for manufacturing a part or an assembly. This version also determines process times for each alternative operation list (for example, milling four min., machining three min., etc.), and is passed on to the rough planning phase.

5.1.2 Rough planning phase

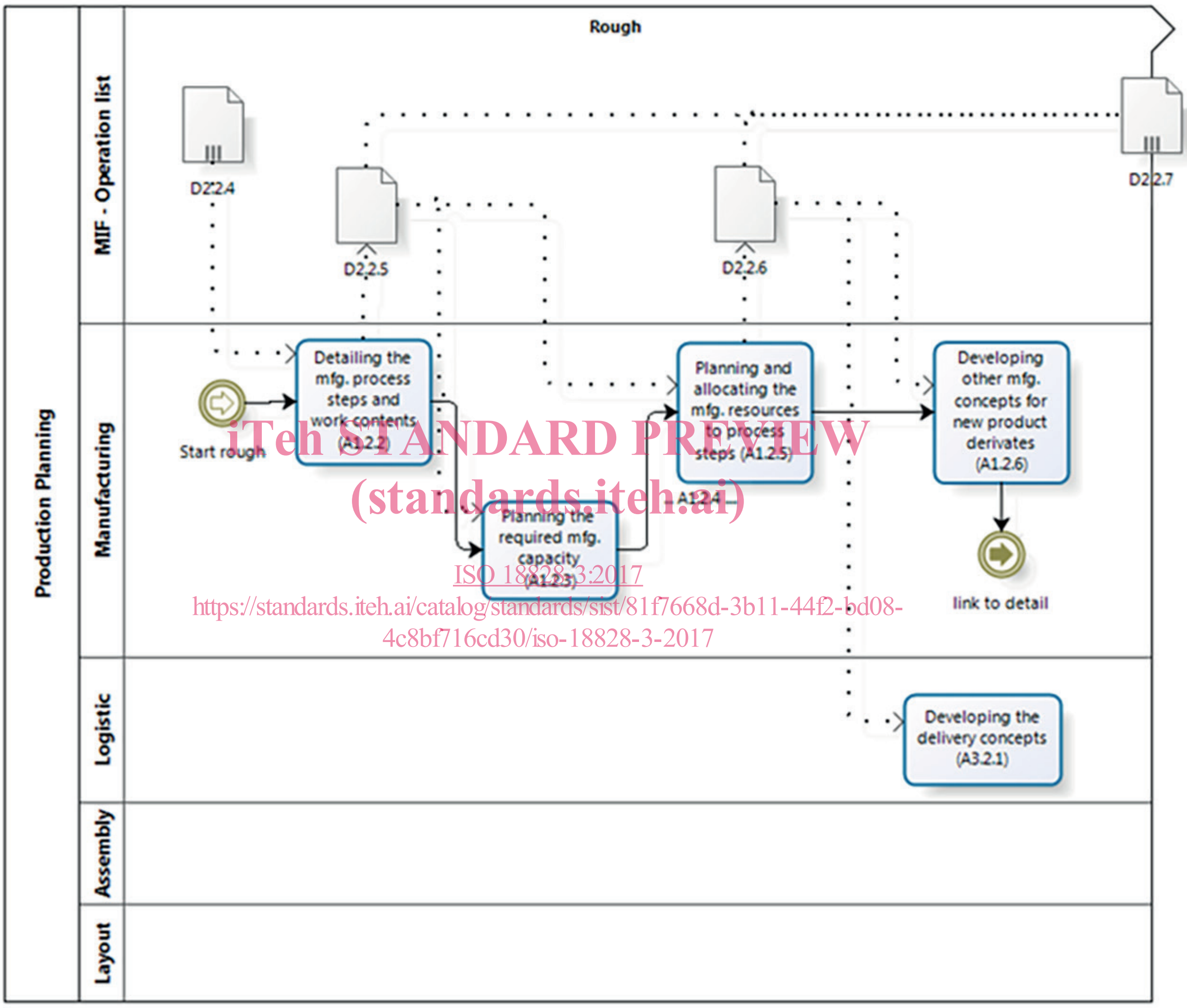


Figure 6 — Rough planning phase of the operation list information flow

During the rough planning phase, more detail is added to the conceptual operation list (D2.2.4 in Figure 6) in accordance with relevant continuing planning process steps, to create a rough operation list (D2.2.7).

The first process step in the rough planning phase consists of detailing the manufacturing process steps and work content (A1.2.2) and thus converts the conceptual operation list into a rough operation list (D2.2.5). The information in this list is used to estimate the required manufacturing capacity (A.1.2.3) and for planning and allocating operating resources (A1.2.5). The rough operation list is developed further into an extended rough operation list (D2.2.6). This list contains further information and is used in developing manufacturing concepts for new product variants (A1.2.6) and supply concepts (A3.2.1). All this information is finally aggregated and documented in a rough operation list (D2.2.7).

The rough operation list normally includes various alternative operation lists that, similarly to the conceptual operation list, identify corresponding process times. Depending on these alternative operation lists, the rough operation list defines generic required resources (manufacturing, assembly, personnel resources, etc.). Furthermore, the rough operation list determines the required infrastructure as well as manipulators and operating resources (for example, cranes and steel constructions). Due to the level of detail, the list is often managed in digital form (for example in ERP systems, or specialized planning tools).

5.1.3 Detailed planning phase

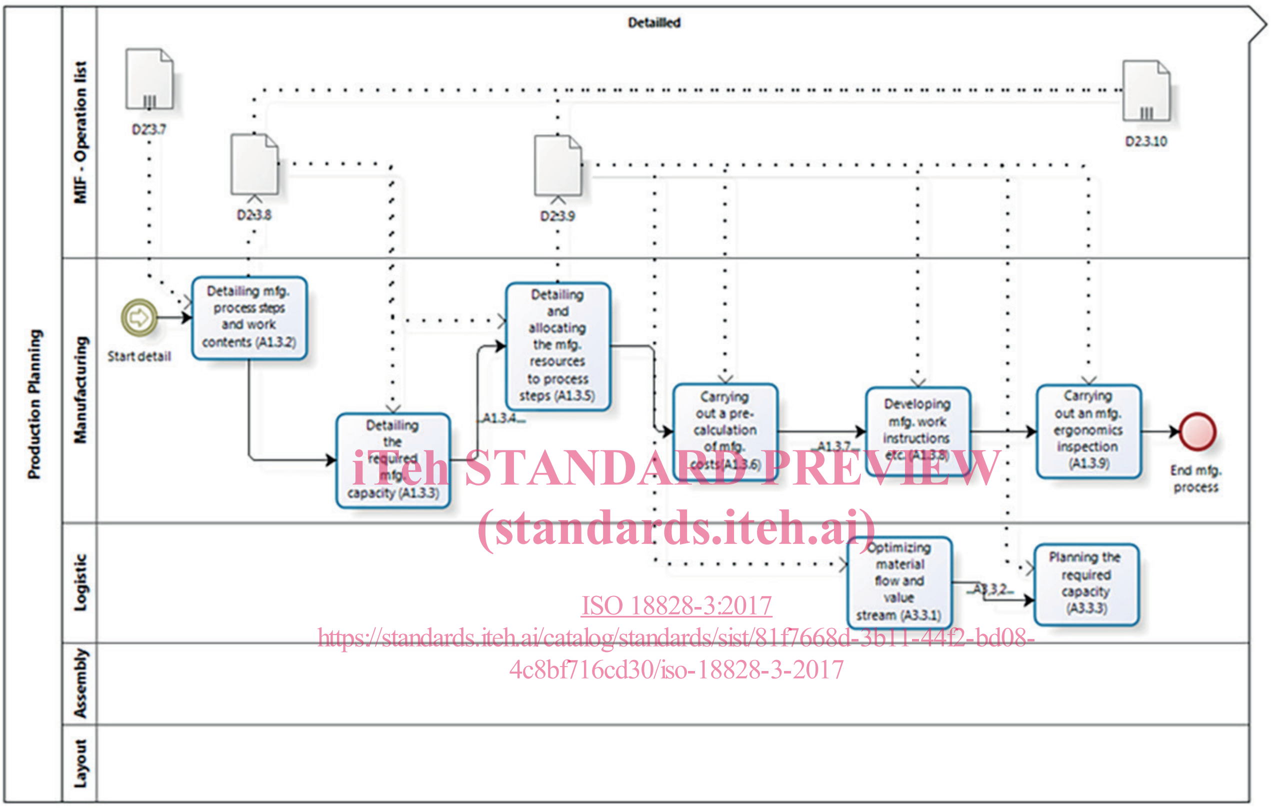


Figure 7 — Detailed planning phase of the operation list information object

During the detailed planning phase, more detail is added to the rough operation list (D2.3.7 in Figure 7), which is developed into an elaborated complete operation list (D2.3.10).

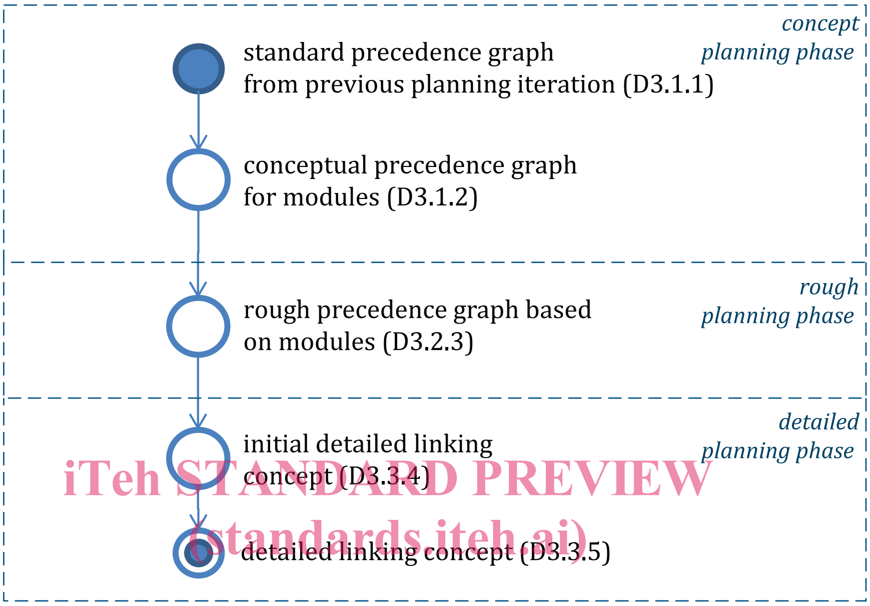
In the detailed planning phase, the rough operation list (D2.3.7) is used to establish the details of manufacturing process steps and work content (A1.3.2). The rough operation list is converted into an initial detailed operation list (D2.3.8), which is used to determine the required manufacturing capacity (A1.3.3) and for allocating operating resources to process steps (A1.3.5).

The aforementioned processes enrich the initial detailed operation list into an extended detailed operation list (D2.3.9). This list is applied in various subsequent planning steps within the scope of manufacturing planning, for example, when performing a preliminary calculation of manufacturing costs (A1.3.6), developing work instructions for manufacturing (A1.3.8), and an initial ergonomic assessment (A1.3.9). The extended detailed operation list is then used to plan logistics for optimizing the material flows and the value stream (A3.3.1), and to plan the required capacity (A3.3.3).

At the end of the detailed planning phase, all relevant information, consisting of the operation list including schedules, personnel allocations, required concrete resources (operating resources, assembly resources, personnel), the infrastructure, and operating resources (cranes, steel constructions), is collated in a detailed operation list (D2.3.10). At this stage, the management of the list is generally supported by digital planning instruments. For this purpose, work schedules are stored in special planning tools, such as spreadsheet analysis or ERP systems.

5.2 Precedence graph

The main information flow for the precedence graph consists of an information object that assumes various states during the planning process. Each state converts data from a previous state and supplements it with additional information or aggregates it into a subsequent state object. Five different states have been identified for the precedent information object, which are depicted in Figure 8.



Key

→ transition of state

start state

end state

internal version state

Figure 8 — States of the precedence graph information object

NOTE The depicted states are described in greater detail in Annexes B and C.