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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

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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.

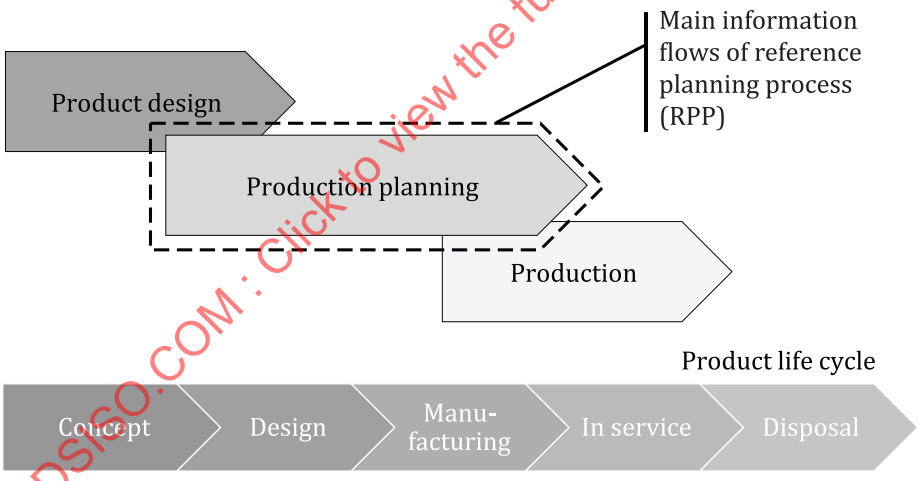

Figure 1 — Main information flows of the reference planning process (qualitative depiction)

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.

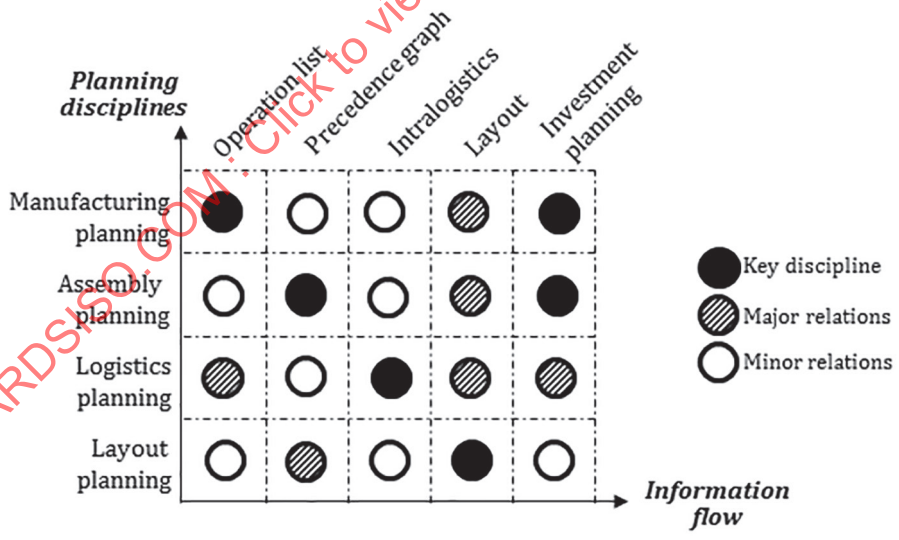

Figure 2 — Main information flows structured by planning discipline

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.

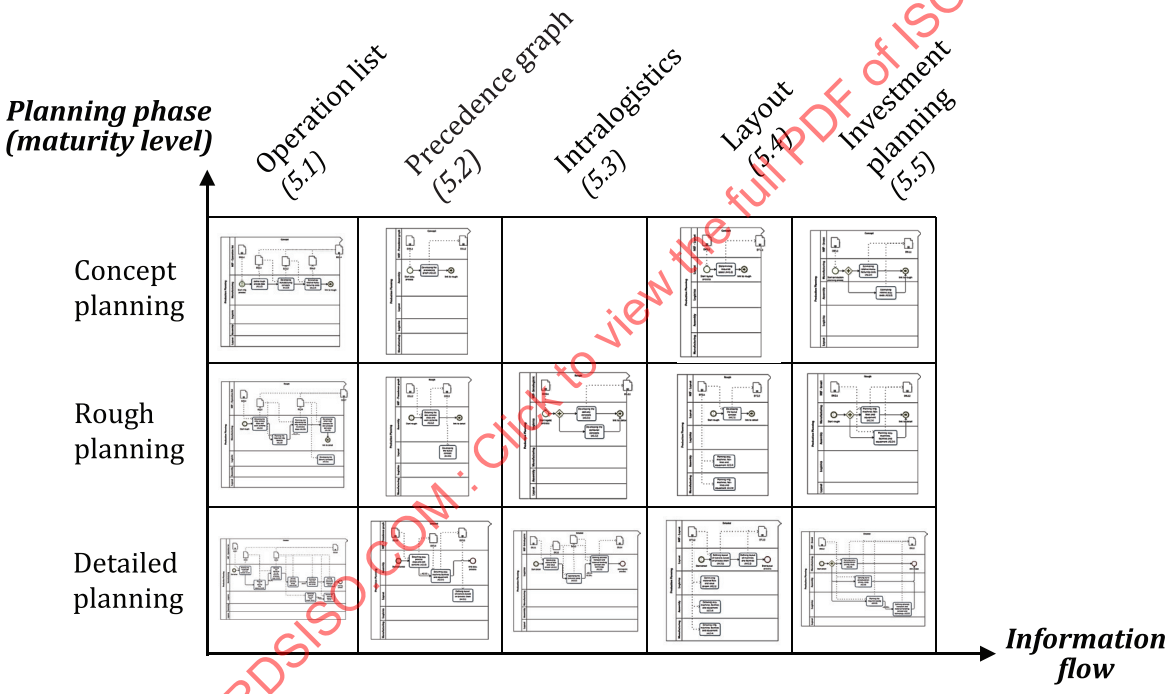

Figure 3 — Main information flows structured by planning phases

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.

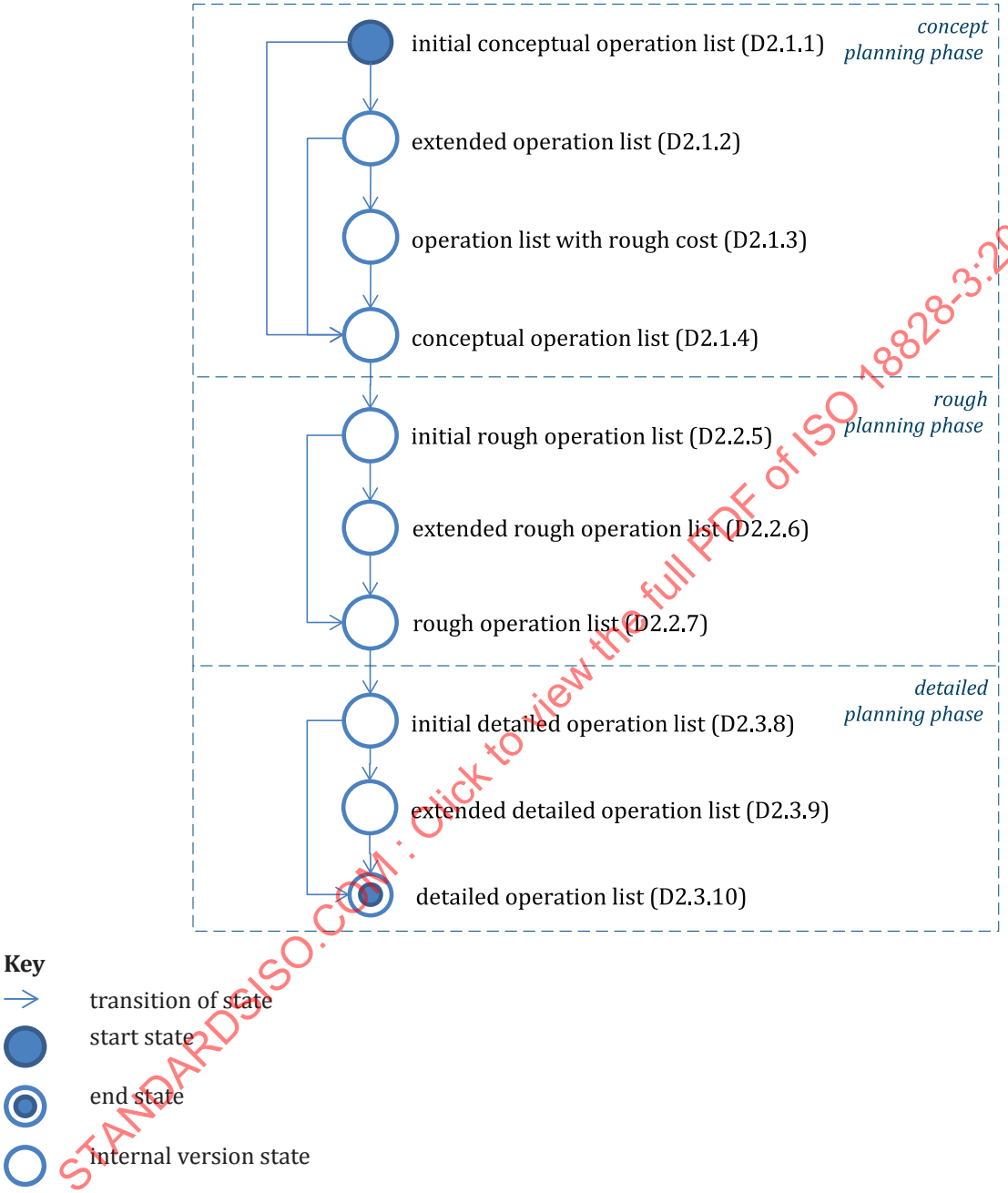

Figure 4 — States of the operation list information object

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

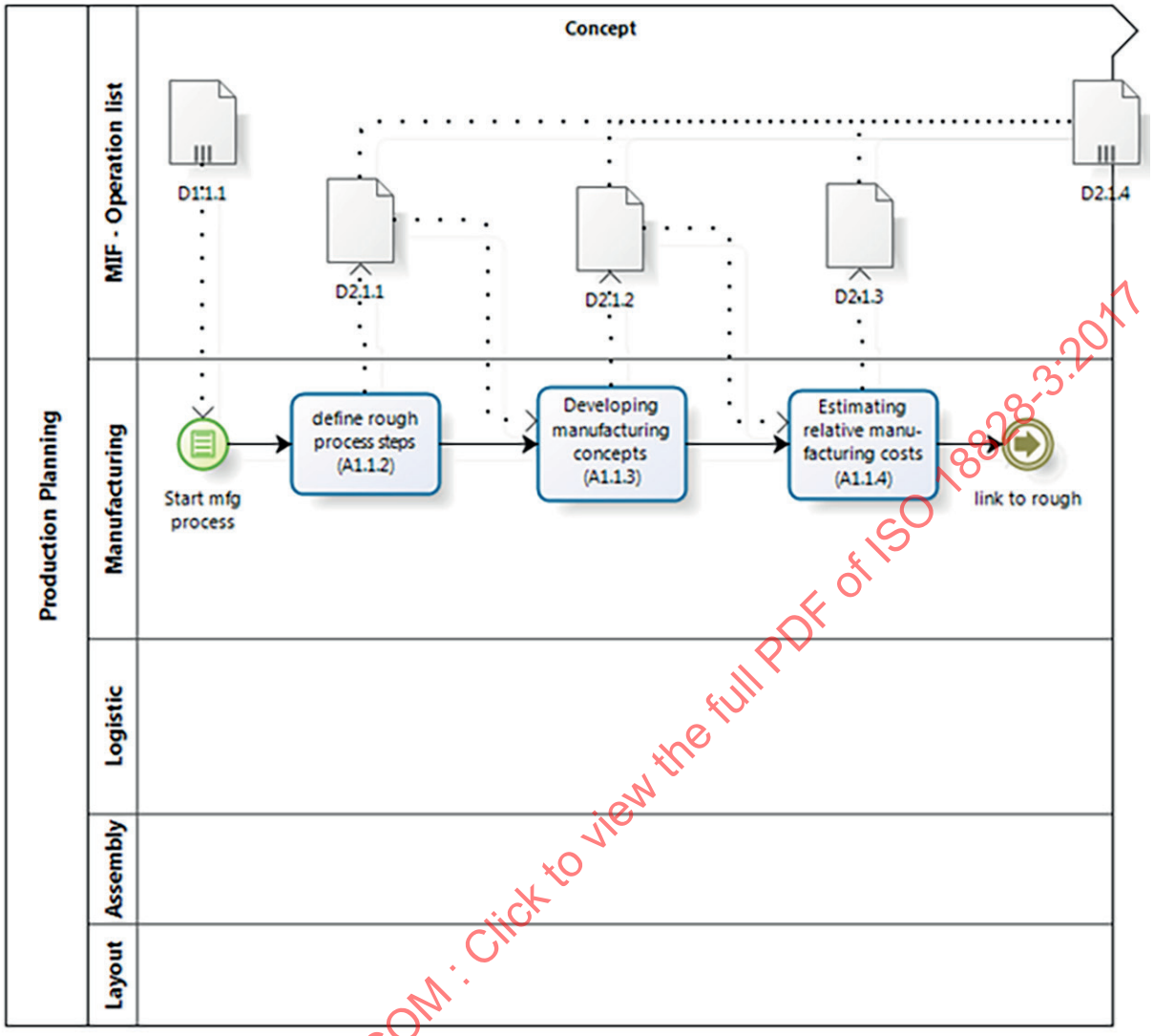

Figure 5 — Concept planning phase of the operation list information flow

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

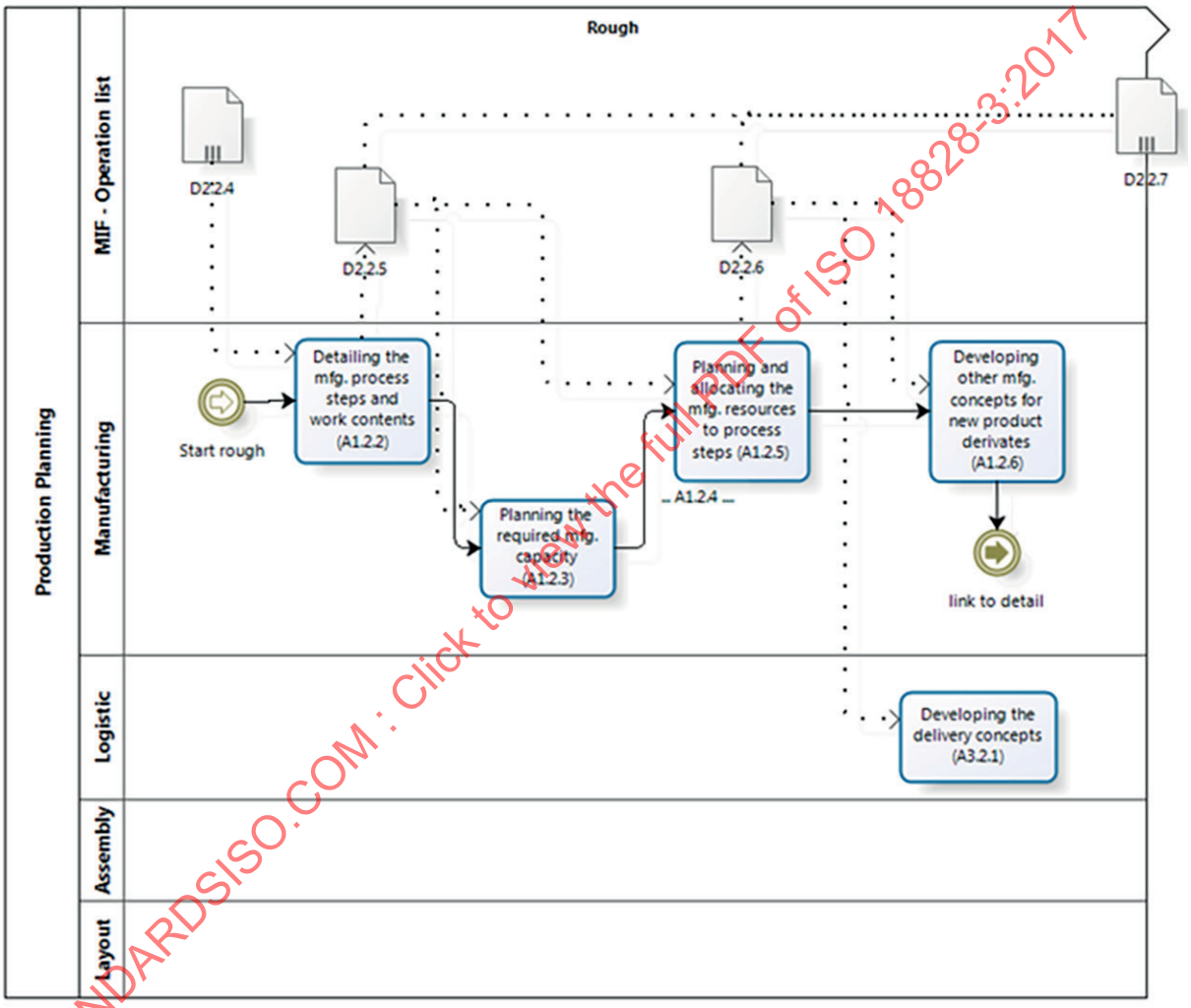

Figure 6 — Rough planning phase of the operation list information flow

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

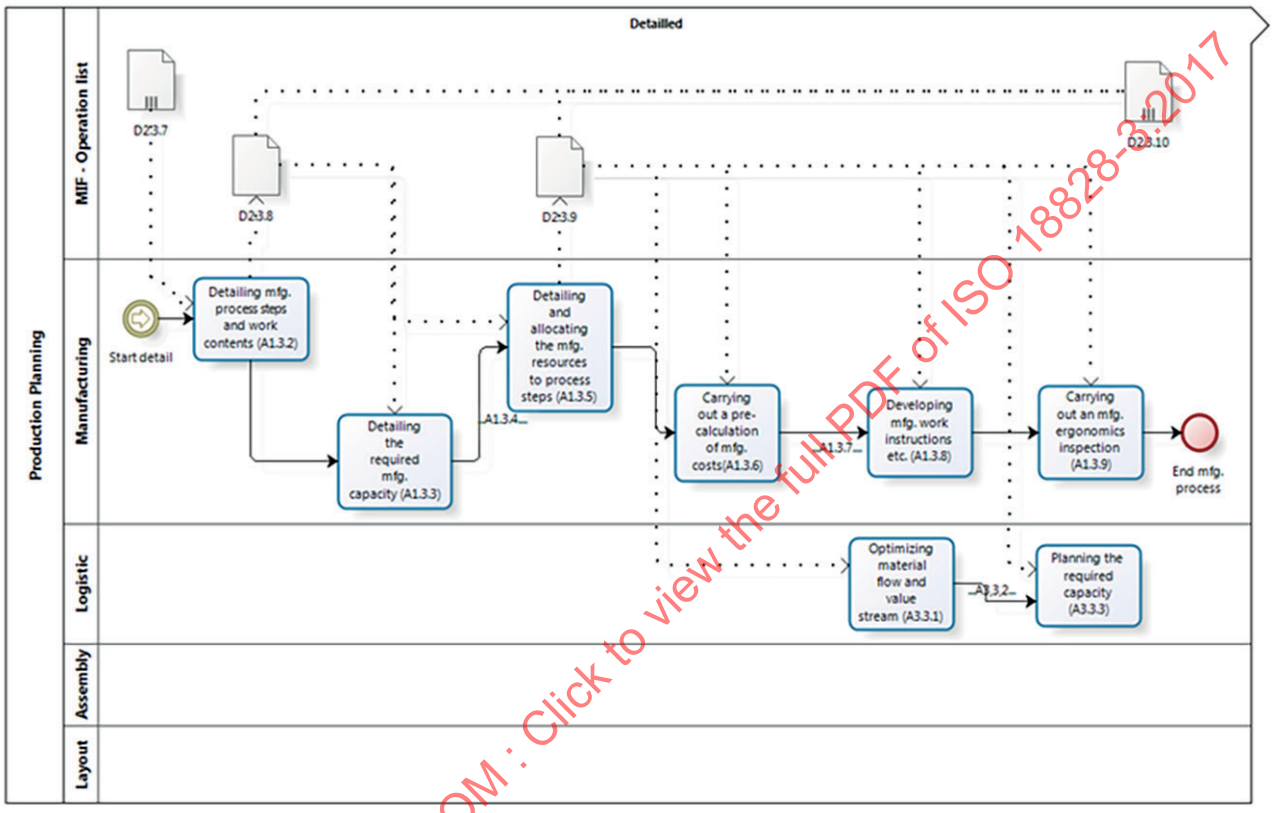

Figure 7 — Detailed planning phase of the operation list information object

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.

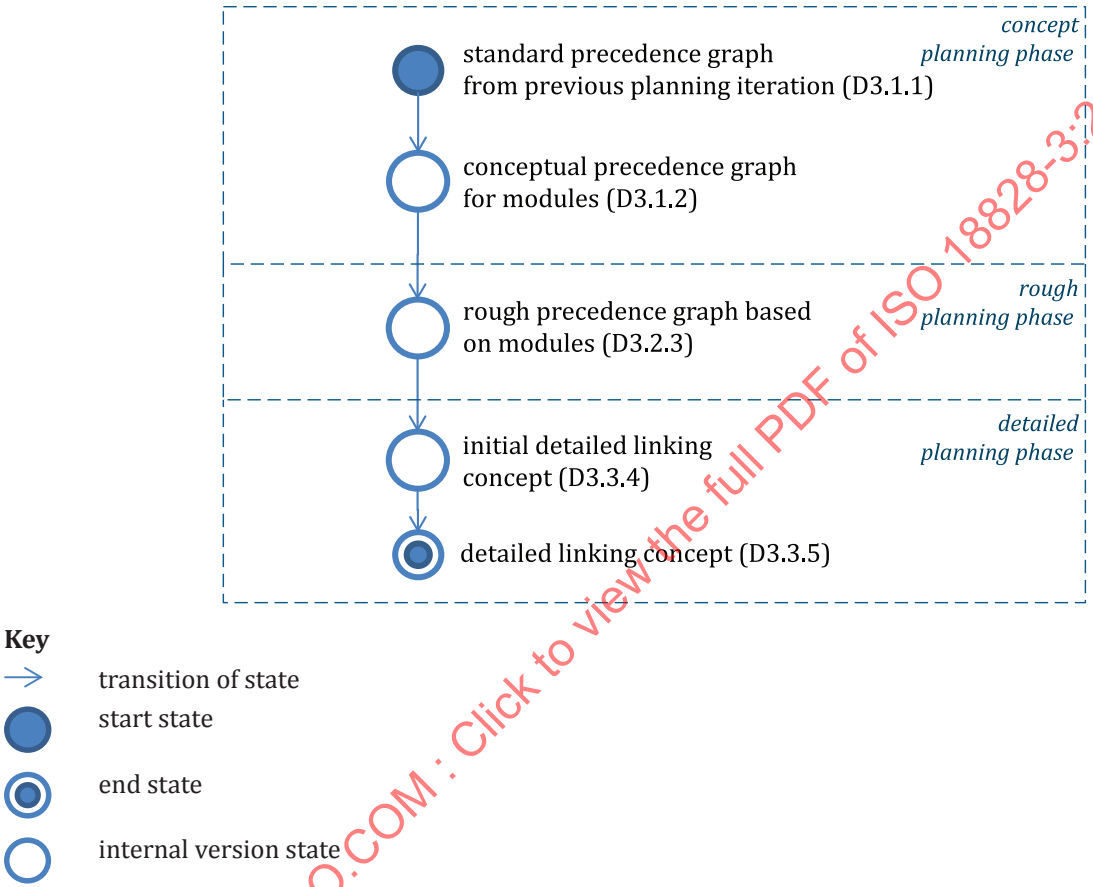

Figure 8 — States of the precedence graph information object

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

5.2.1 Concept planning phase

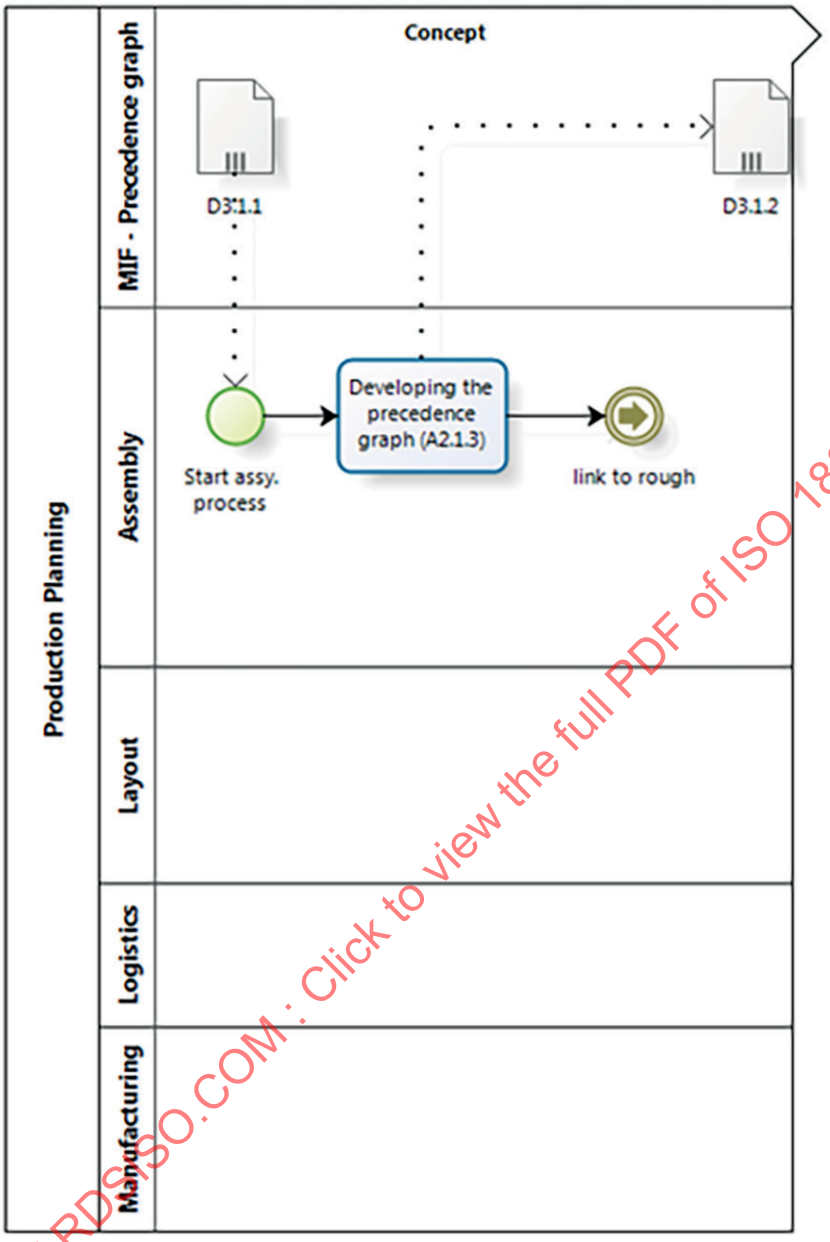

Figure 9 — States of the precedence graph information object

During the concept planning phase, initial steps for developing a precedence graph are carried out. This phase results in a conceptual precedence graph for the sequence of various combined operations, called modules (D.3.1.2 in Figure 9).

The assembly planning uses the information provided by previous planning iterations (D3.1.1) (e.g. from the previous product generation) to develop the precedence graph (A2.1.3).

The result of this process is a conceptual precedence graph for modules. This information consists of a rough flow chart that describes the sequence of combined operations. It can be used in subsequent planning processes, especially the rough planning phase.

5.2.2 Rough planning phase

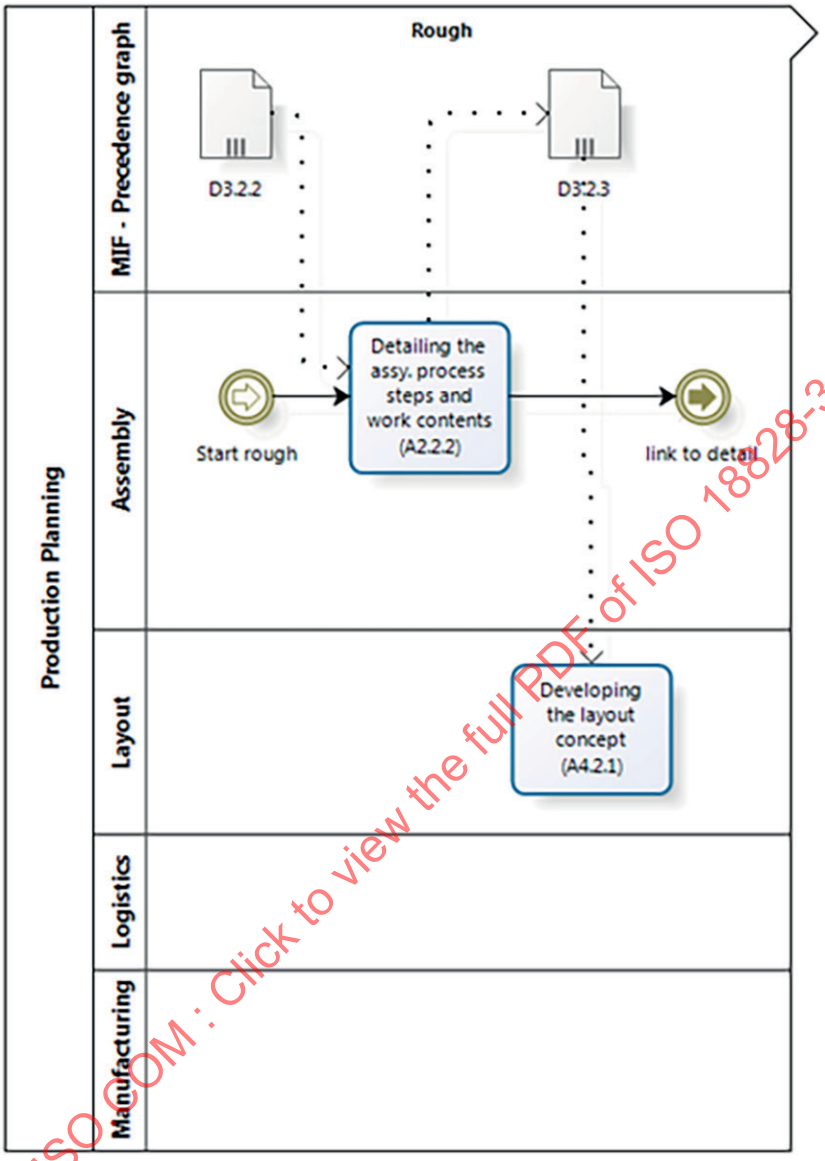

Figure 10 — Rough planning phase of the precedence graph information flow

The general information based on the conceptual precedence graph (D3.2.2 in Figure 10) is converted into a rough precedence graph (D3.2.3) that is based on modules from the rough planning phase.

The conceptual precedence graph consists of a rough flow chart that defines the sequence of combined modules. It represents the information input for detailing the assembly process steps and work content (A2.2.2). The information it processes generates a rough precedence graph that is based on modules to which work content has already been allocated. The precedence graph is a significant input for developing the layout concept (A4.2.1). As the output of the current phase, it is linked to the detailed planning phase as input information.

5.2.3 Detailed planning phase

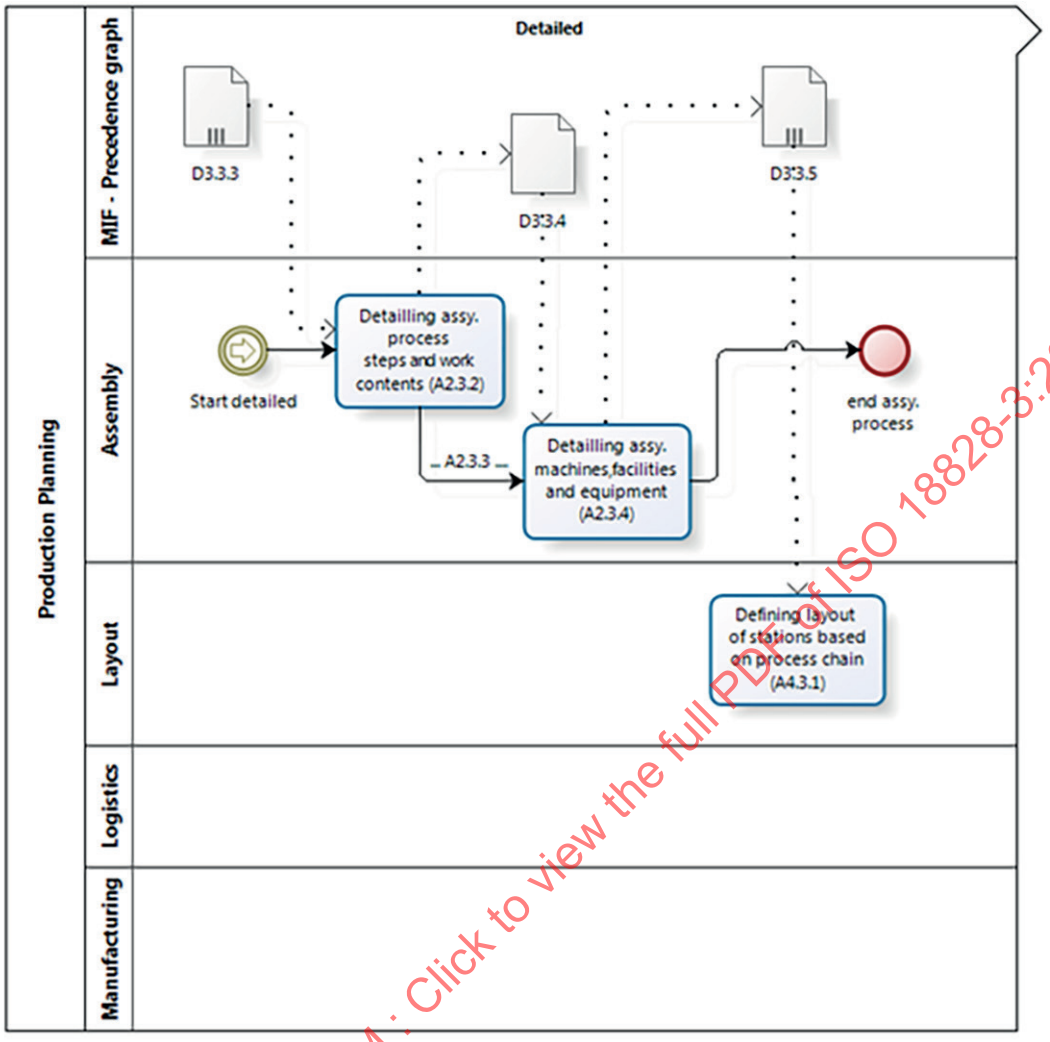

Figure 11 — Detailed planning phase of the precedence graph information flow

Building on required information supplied by the rough planning phase, the detailed planning phase converts the rough precedence graph (D3.3.3 in Figure 11), which is based on modules, into a detailed linking concept (D3.3.5), which constitutes the information basis for the precedence graph.

The detailed planning phase starts with the detailing of the assembly process steps and work contents (A2.3.2), which converts the rough precedence graph into an initial detailed linking concept (D3.3.4). The rough flow chart, which defines the sequence of combined modules, serves as the input.

The detailed planning phase does not use assembly capacity (A2.3.4) as input information. Determining the assembly capacity is the next step and it consists of detailing of the assembly facilities and equipment (A2.3.4). This step converts the initial detailed linking concept into a detailed linking concept (D3.3.5). The detailed linking concept consists of a more highly detailed precedence graph, which includes required manufacturing and assembly operations as well as allocated process times and work content.

The detailed linking concept is a significant input for determining the layout of stations based on the process chain (A4.3.1) and precedence graph.

5.3 Intralogistics

The intralogistics information flow consists of two information objects. The first object is referred to as “preliminary information for intralogistics” and includes prerequisites for planning. It has only one

single status and is not be considered further in the planning process. The second information object is referred to as the "logistics concept" and assumes various states during the course of the planning process. Each state converts data from a previous state and supplements it or aggregates it with additional information into a subsequent state object. Four different states have been identified for the "intralogistics" information object, which are depicted in Figure 12.

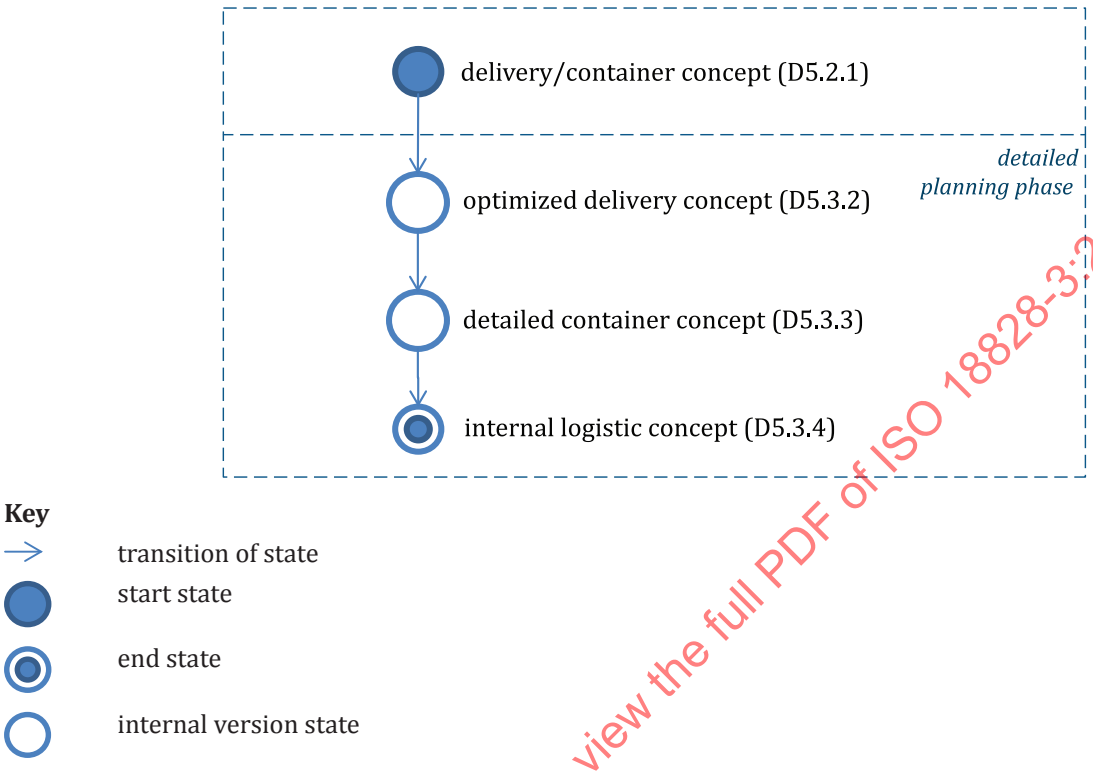

Figure 12 — States of the intralogistics information object

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

The main information flow of the internal logistics includes no data objects in the concept planning phase. For this reason, the initial information object starts with D5.2.1.

5.3.1 Rough planning phase

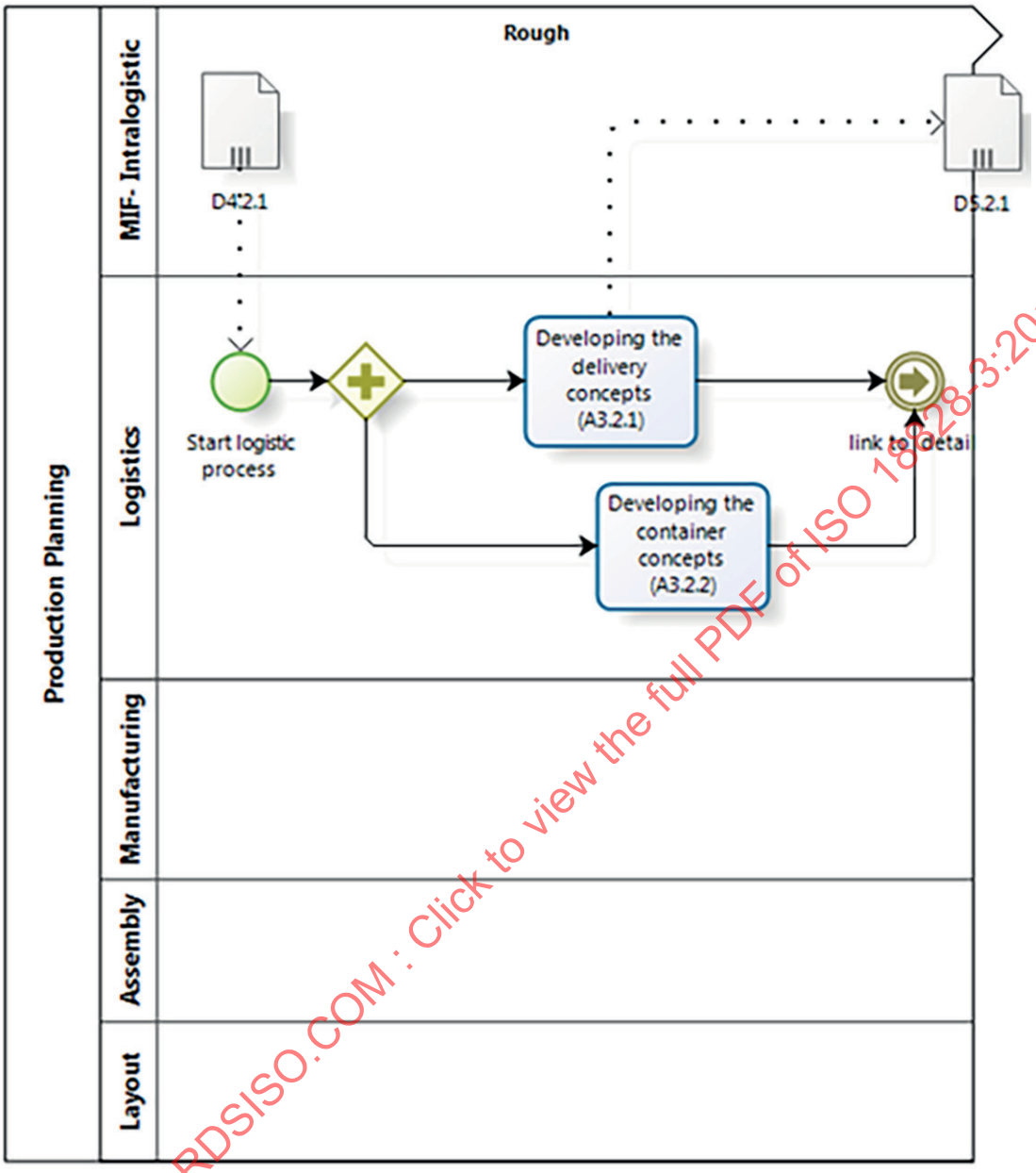

Figure 13 — Rough planning phase of the intralogistics information flow

Based on preliminary information (D4.2.1 in Figure 13), the rough planning of the information flow generates a rough internal logistics concept (D5.2.1).

During the rough planning phase, a range of preliminary information is used to define an initial rough internal logistics concept. Preliminary information for intralogistics planning consists mainly of:

— conceptual layouts;

— precedence graphs;

— cycle time;

— number of pieces or lot sizes.

During the rough planning phase, this information is used as input for developing a delivery concept (A3.2.1) and a container concept (A3.2.2). Both planning steps are necessary to develop a rough internal logistics concept that results in alternative delivery and container concepts from which one is later chosen.

The delivery concept includes defined delivery methods and transport options (kanban principle, milkrun, demand or inventory orientation, tugger trains, buffers, supermarkets, etc.). The delivery concept determines (transport) capacity, cycle time, and required general resources (means of transport and personnel) that depend on the corresponding logistics concept, and the infrastructure (operating resources, for example, cranes, charging stations, racks). The container concept defines the type and size of the container and often also packaging concepts, which are limited to A-class items (in context of an ABC analysis; e.g. 20% of the items accounts for 70% of the annual consumption value of the items) in this planning phase. Both the delivery concept and the container concept constitute the rough intralogistics concept.

5.3.2 Detailed planning phase

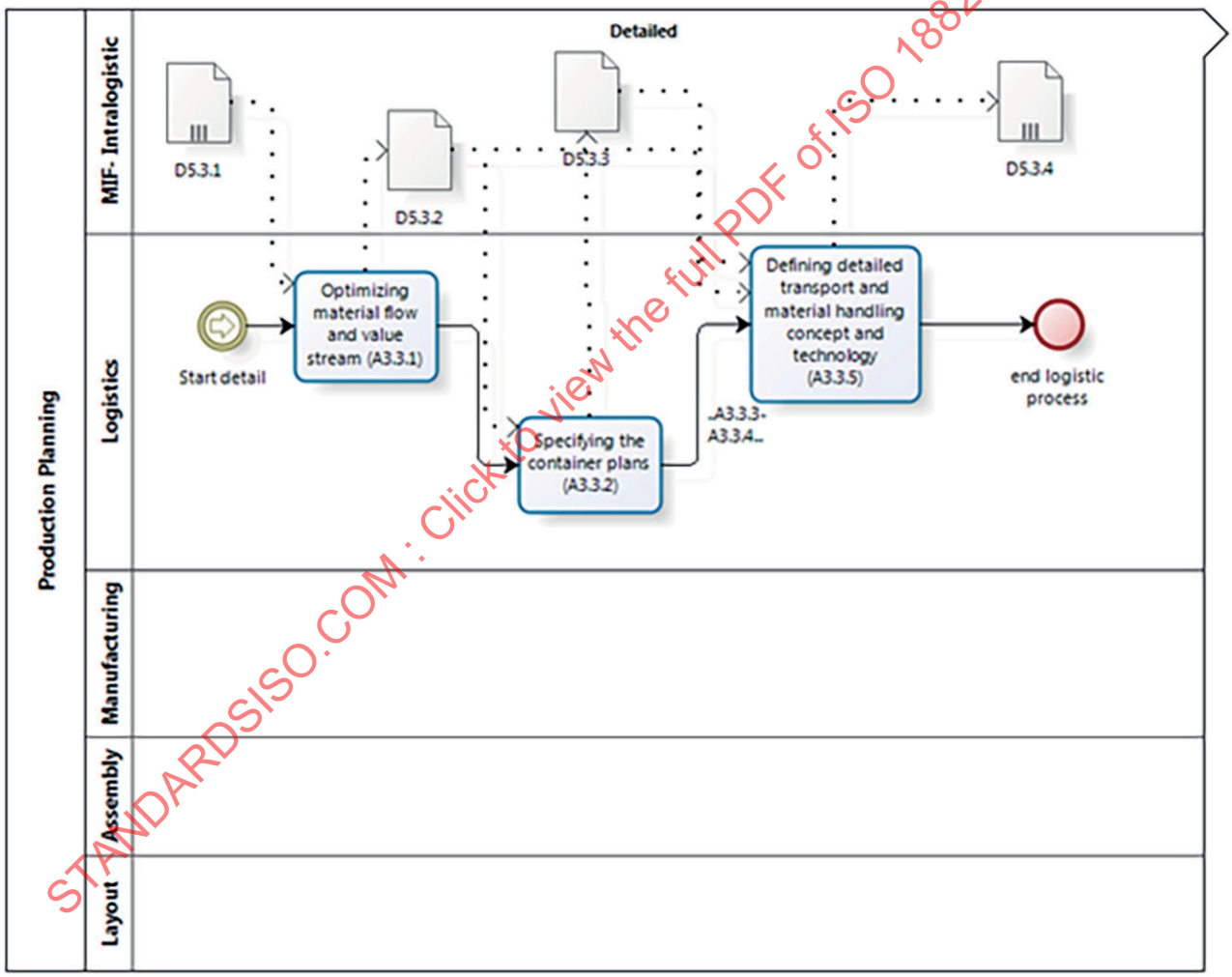

Figure 14 — Detailed planning phase of the intralogistics information flow

In the detailed planning phase, the rough intralogistics concept (D5.2.1 in Figure 14) is developed further in various steps and is converted into an internal logistics concept (D5.3.4) as a final output of the information flow of the logistics planning.

An optimized delivery concept (D5.3.2) is defined during the optimization of the delivery concept, regarding its material flow and value stream (A3.3.1). A detailed container concept (D5.3.3) is elaborated in the following process step of specifying the container plan (A3.3.2). The resulting information is

used for defining technologies and a detailed transport and material handling concept (A3.3.5). At the conclusion of the last logistics planning step, an internal logistics concept (D.5.3.4) is created. This concept is frequently in the form of a presentation or any other type of document, as preferred.

The intralogistics concept defines delivery methods and means of transport (similarly to the rough planning phase). It includes buffers and supermarkets (having defined and simulated ranges), as well as (transport) capacity and cycle time. A logistics layout (for example in the CAD system) and a material flow (for example, in a simulation system) are additional components of an internal logistics concept. Such a concept is frequently stored in a PDM or ERP system with all required concrete resources (means of transport and personnel), as well as the infrastructure (operating resources, for example, cranes, charging stations, and racks). Compared to the rough internal logistics concept, the intralogistics concept is enriched with detailed planning, documentation on storage location and an additional detailed container concept. This detailed container concept includes a complete description of the containers and their sequences, the type of containers, the container size, and disassembly and packaging concepts for parts and assemblies. The intralogistics concept includes this relevant information and forms the basis for the final information output of the information flow of the internal logistics.

5.4 Layout

The main information flow for the layout includes two information objects. The first object is referred to as “preliminary information for the layout” 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 “layout” 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. Three different states have been identified for the “layout” information object, which are depicted in Figure 15 .

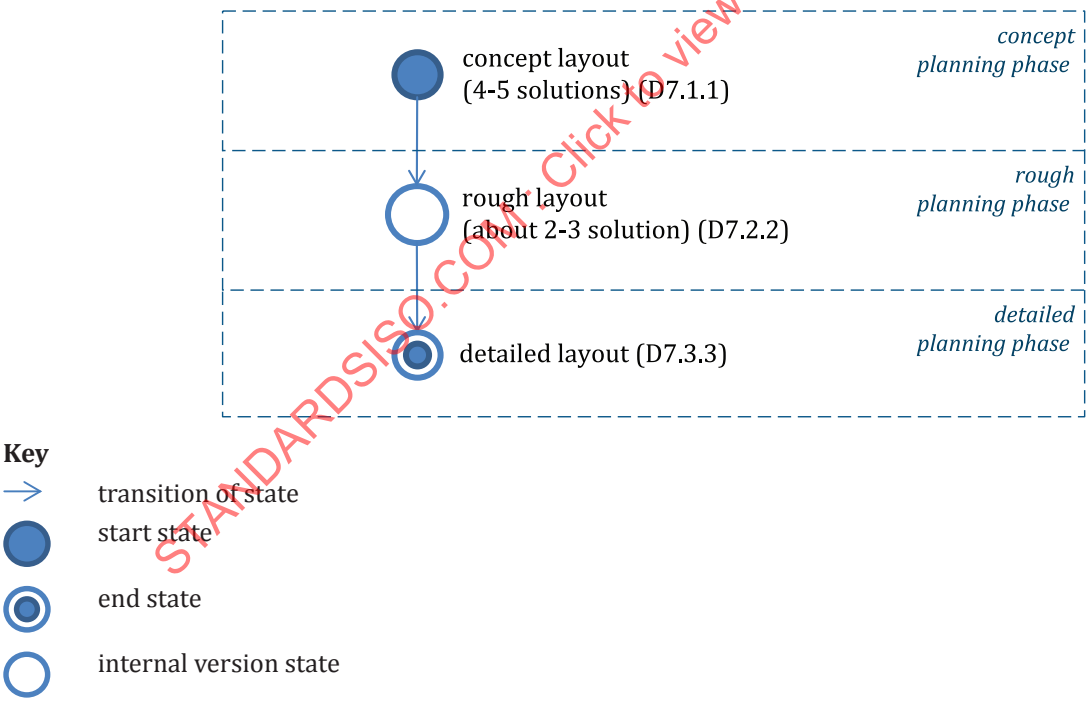

Figure 15 — States of the layout information object

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

5.4.1 Concept planning phase

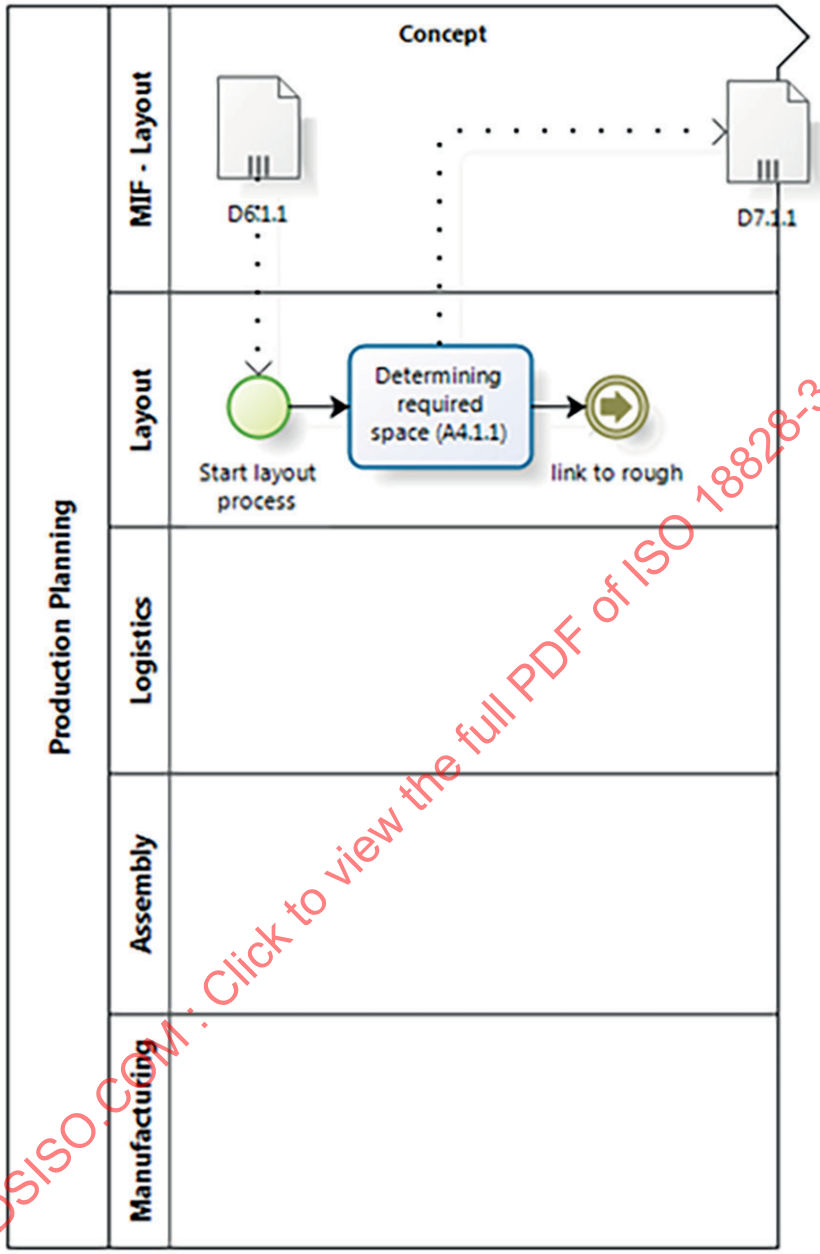

Figure 16 — Concept planning phase of the layout information flow

Based on preliminary information, the concept planning phase of the layout information flow aims to define a conceptual layout (D7.1.1), similarly to that of logistics planning (D6.1.1 in Figure 16).

The following preliminary information is frequently referred to as general layout planning prerequisites and is required in order to start the information flow:

— number of stations;

— type and dimensions of the stations (footprint, work area);

— adjacent areas (percentage);

— logistics areas (paths, area for containers, etc.);

— factory bill of materials (if available).

These layout prerequisites are used in order to define a conceptual layout. During the determination of the required areas (A4.1.1), four to five different solutions are generated and documented for the conceptual layout.

These layouts include the determination of sites and rough block arrangements (often a sketch or drawing with associated calculation of the required space) and an initial cost estimate for each proposed layout. At the conclusion of the concept planning phase, all layout alternatives are reviewed and are released for the rough planning phase.

5.4.2 Rough planning phase

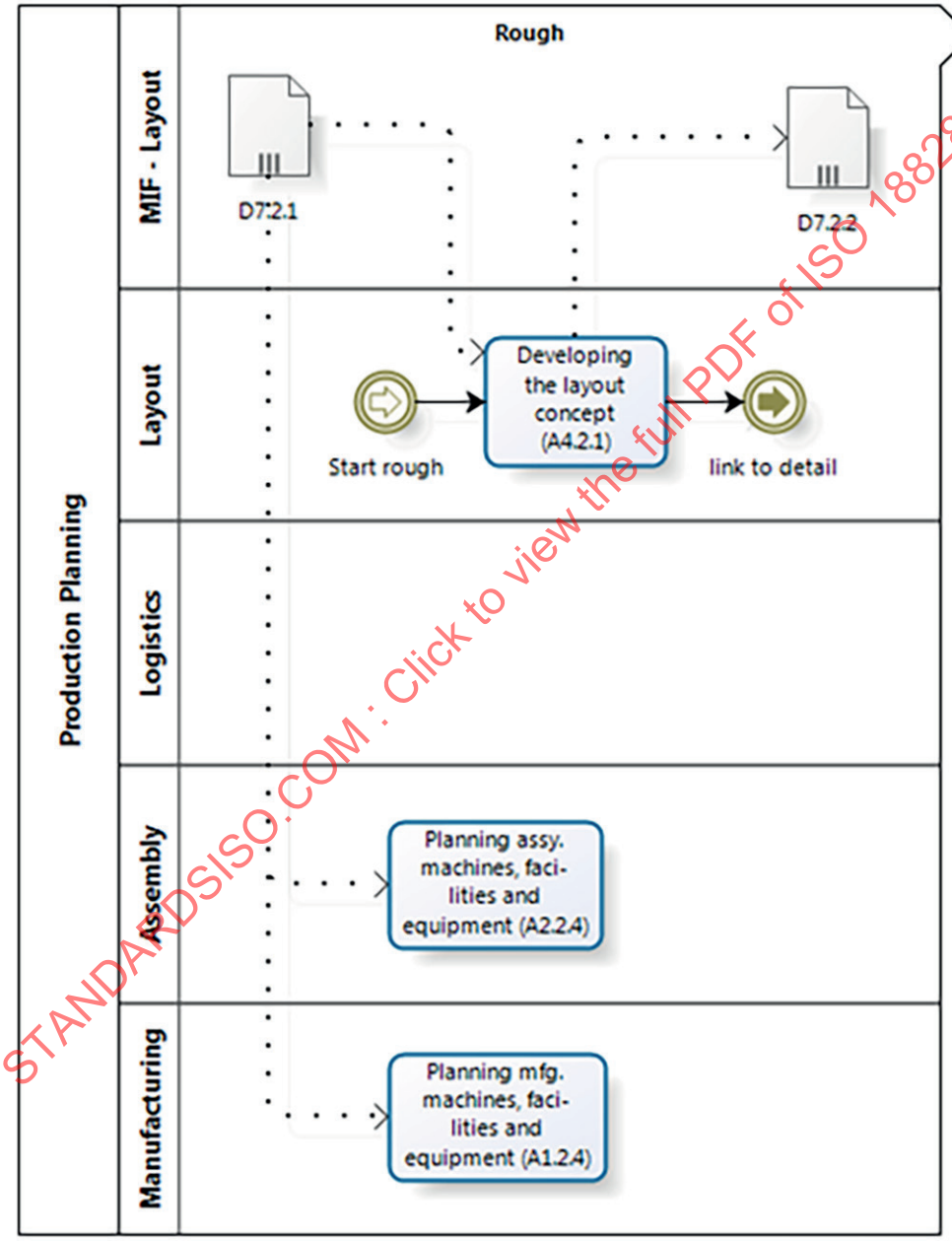

Figure 17 — Rough planning phase of the layout information flow

During the rough planning phase, the conceptual layouts (D7.2.1 in Figure 17) are converted into rough layouts (D7.2.2), and the initial output of the layout information flow for this planning phase is developed.

The conceptual layouts are used for planning manufacturing machines (A1.2.4) and assembly machines (A2.2.4), facilities, and general operating resources. For further detailing of the layout planning, rough layouts are developed with elaboration of selected layout concepts (A4.2.1). This step frequently includes the definition of two or three rough layouts.

Rough layouts define the rough arrangement and dimensioning of lines and stations, and include:

— footprint (e.g. ± 10 %);

— road network (overhead tracks, paths for forklifts, etc.);

— infrastructure (office space, toilet space, break room space, etc.);

— logistics areas (container space, inventory space, buffer space, delivery space, shipping area);

— cost estimates for the layout (for each solution).

At the conclusion of the rough planning phase, two to three layout solutions are reviewed, and at least one is released for the detailed planning phase.

5.4.3 Detailed planning phase

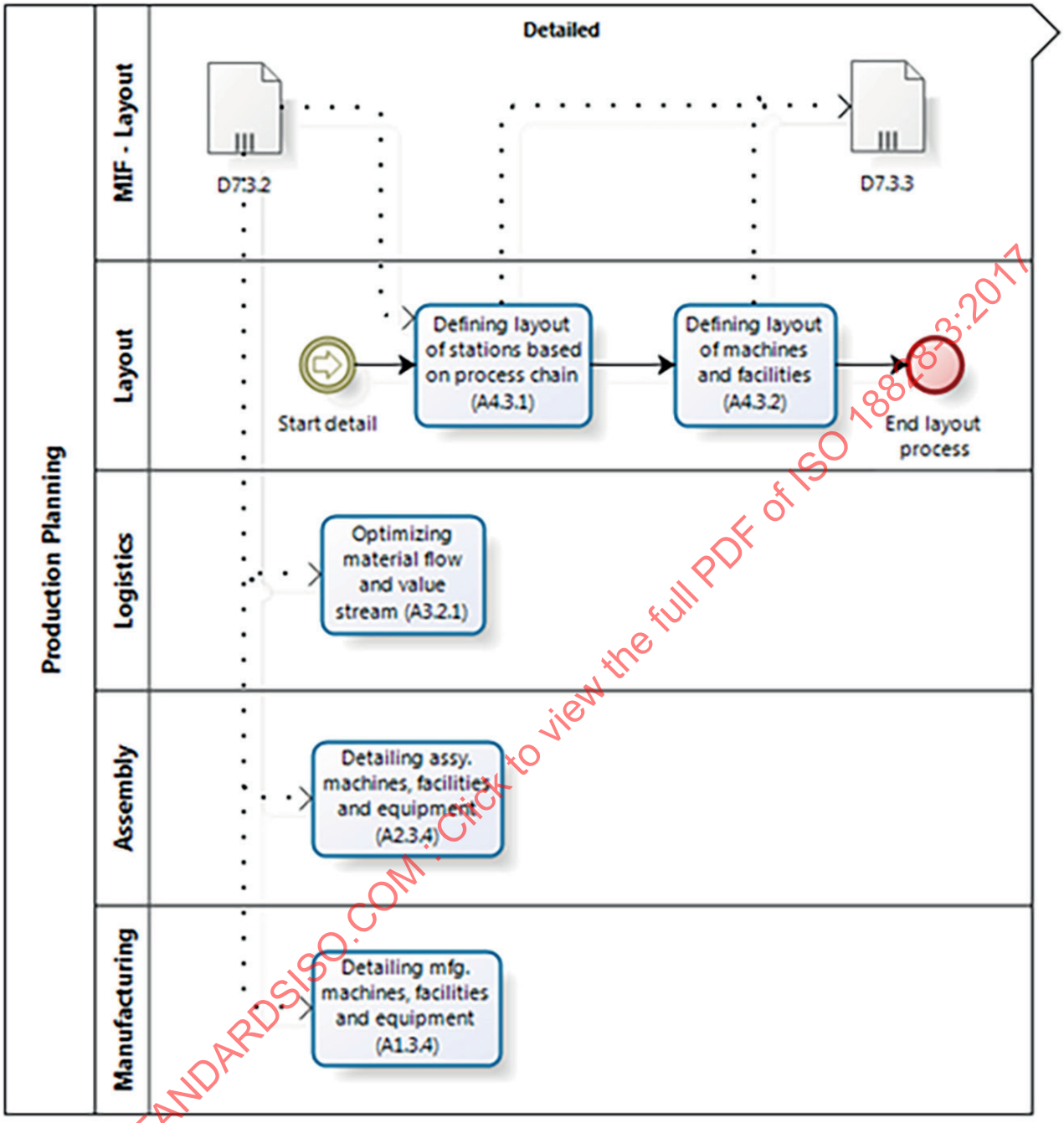

Figure 18 — Detailed planning phase of the layout information flow

In the detailed planning phase, rough layouts of the preceding planning steps (D7.3.2 in Figure 18) are developed further in order to elaborate a detailed layout (D7.3.3) as a final output of the layout information flow.

In this phase, the optimization of material flows and value streams (A3.2.1), detailing of manufacturing machines (A1.3.4), and assembly machines (A2.3.4) facilities, and general operating resources directly depend on rough layouts. During the definition of detailed workstation layouts, the required information is generated from the process chain (A4.3.1) and layouts of machines and facilities (A4.3.2).

At this planning level, a detailed layout is described by the accurate definition of the following aspects:

— arrangement and dimensioning of lines, stations, and machines;

— circulation areas;

— road network (overhead tracks, transport equipment, etc.);

— logistics areas (containers, etc.);

— infrastructure and utilities installations (electricity, air, and fluids);

— disposal;

— cost calculation (including structural measures and utilities installations for planned facilities, etc.);

— final release for purchase of physical resources.

5.5 Investment planning

The main information flow for investment planning includes two information objects. The first object is referred to as "preliminary information for investment planning" 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 "costs" 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. Three different states have been identified for the "cost" information object, which are depicted in Figure 19.

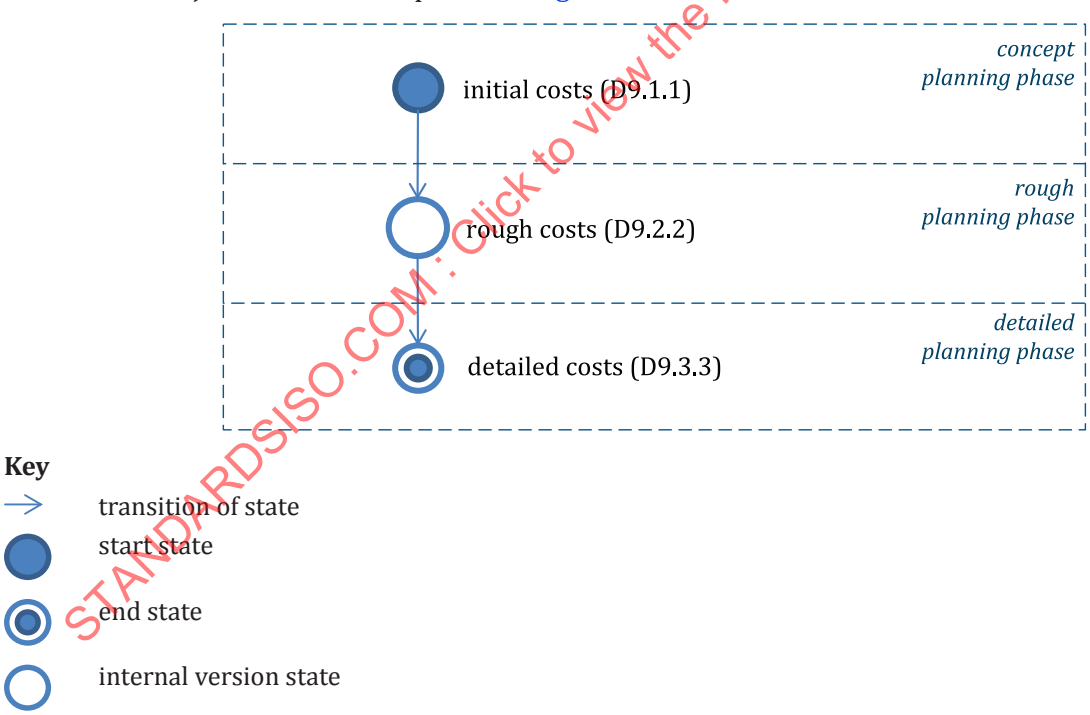

Figure 19 — States of the costs information object

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

5.5.1 Concept planning phase

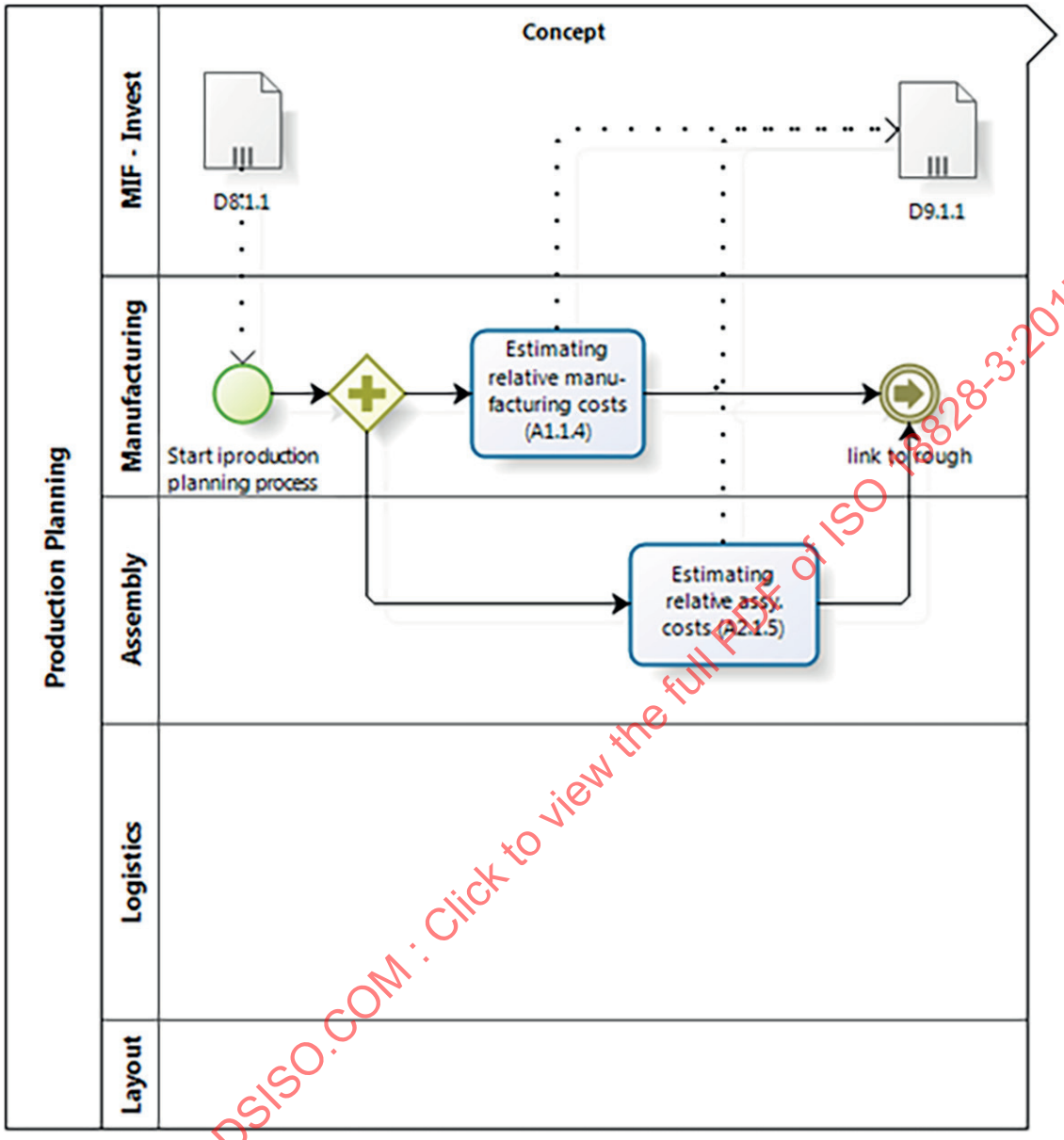

Figure 20 — Concept planning phase of the investment planning information flow

The concept planning phase of investment planning establishes initial costs (D9.1.1) based on the preliminary information for investment planning (D8.1.1 in Figure 20).

In this context, prerequisites for cost planning frequently consist of framework conditions that include:

— expected and planned cost types;

— the breakdown of cost types (for example, investments and overhead);

— estimated cost progress.

These planning prerequisites constitute an essential information input for estimating the relative manufacturing costs (A1.1.4) and the relative assembly costs (A2.1.5). The planning steps determine the initial costs as an output.

The initial costs are a rough assessment of the investment costs and overhead for each planning alternative. The costs often serve as supporting information to answer important questions, such as "is it possible to manufacture/assemble/install on existing lines?" or "is a new production facility/factory required?" In summary, the initial cost process assesses the planned capacity and compares it with the existing capacity. The decision at the conclusion of the concept planning phase is released to start the rough planning phase. This decision is frequently supported by company-specific calculation templates.

5.5.2 Rough planning phase

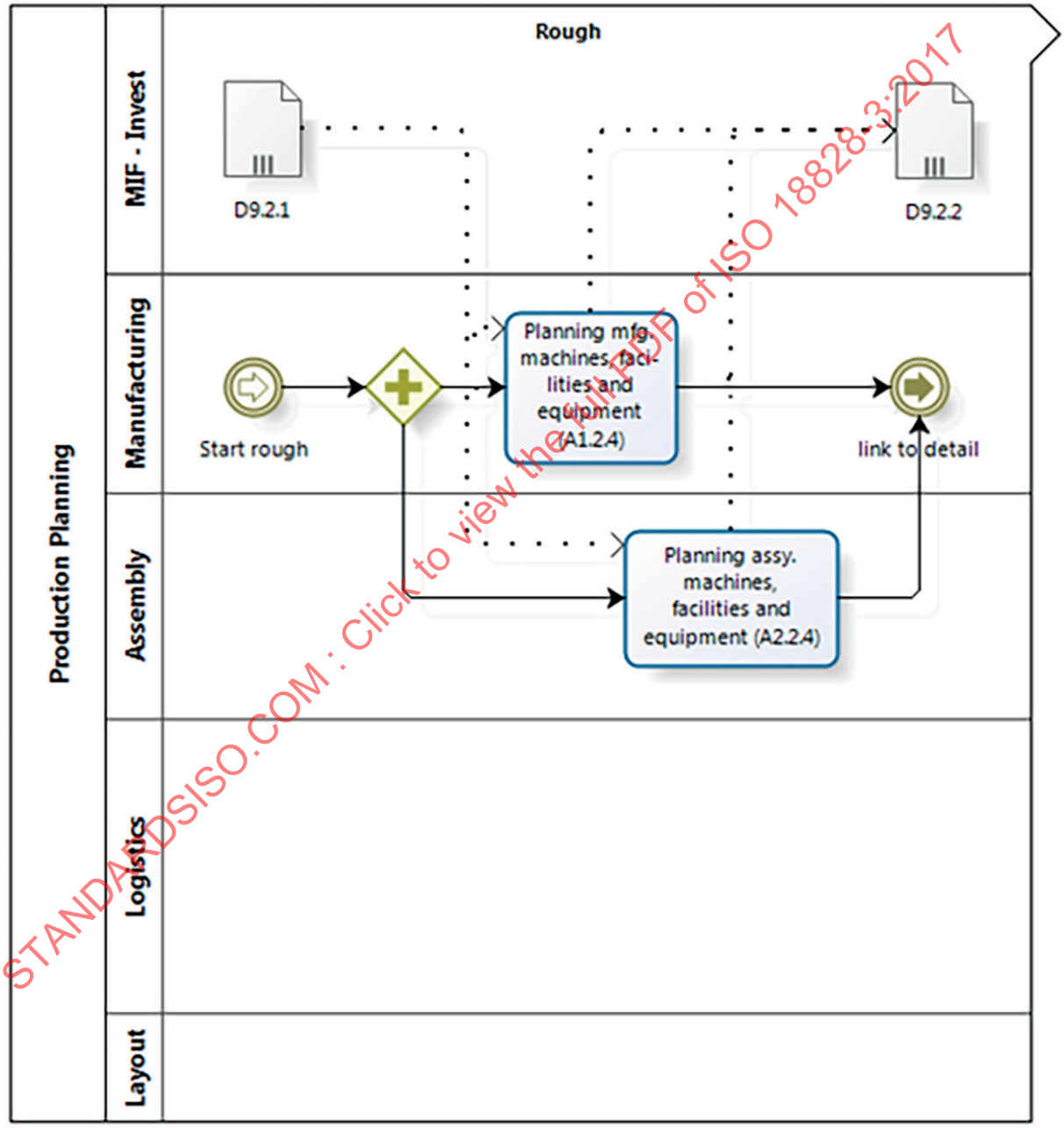

Figure 21 — Rough planning phase of the investment planning information flow

During the rough planning phase, initial costs (D9.2.1 in Figure 21) are further detailed to derive rough costs (D9.2.2). These costs are the basic investment information for planning alternatives.

The initial cost information is used for planning machines, facilities, and equipment for manufacturing and assembly (A1.2.4 and A2.2.4). Following this step, rough costs are defined and they include investment costs and overhead. Three or four planning alternatives are usually developed.

The rough costs have an accuracy that is sufficient for business plans, but they are still based on estimated values. In many cases, rough costs are aligned with the technology requirements and are not yet broken down into actual expenditures on machines. Investment planning in the rough planning phase is frequently supported by elaborated calculation templates and should be documented for each planning alternative.

5.5.3 Detailed planning phase

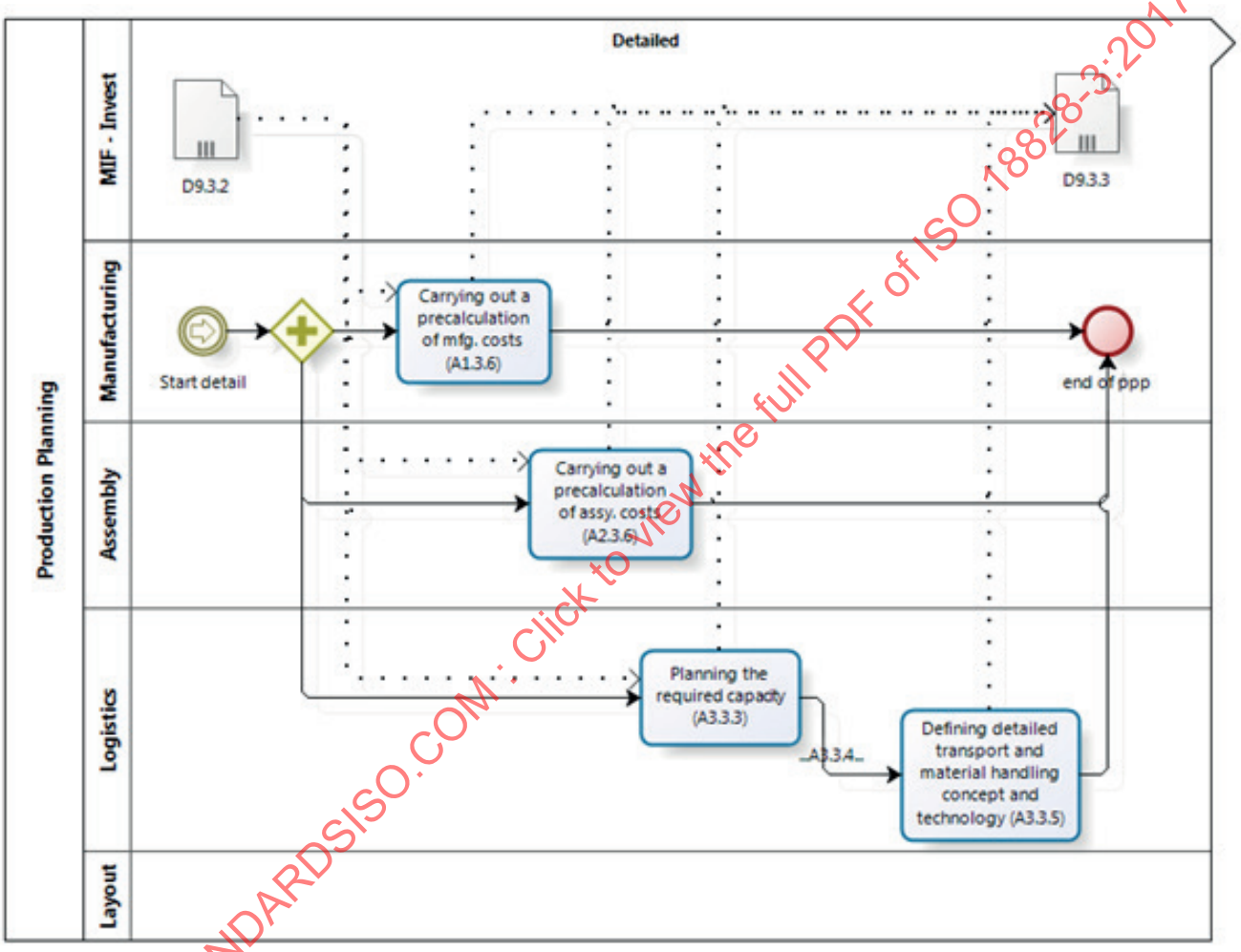

Figure 22 — Detailed planning phase of the investment planning information flow

During the detailed planning phase, the rough costs (D9.3.2 in Figure 22) are developed further into detailed costs (D9.3.3), which constitute the final output of the information flow of investment planning.

The rough costs are used for pre-calculation of manufacturing costs (A1.3.6), assembly costs (A2.3.6), planning required capacity (A3.3.3), and defining a detailed transport and material handling concept, and their technologies (A3.3.5). The information generated and converted during this planning process is combined and used for determining the detailed costs.

The detailed costs determine investment costs and overhead for the selected planning alternatives in a detailed bottom-up calculation for all processes and resources (based on concrete machines, facilities, etc.). The calculation of the detailed costs is supported by calculation templates, additional cost

calculation tools, and the storage of processes and resources in digital planning tools (such as Process Designer, SAP, etc.) having extensive functionalities.

Annex A
(informative)

Information checklist (target-actual comparison)

A.1 Operation list

Input	Process element	Output
Concept planning phase		
Planning requirements ☐ Product (part, assembly) ☐ Number of pieces ☐ Applicable technology (catalogue) - brown field (available resources) ☐ Applicable technology (catalogue) - green field (applicable resources) ☐ Applicable technology - time data base (process time for operations)	Defining rough process steps (A1.1.2)	Initial operation list ☐
☐ Initial operation list	Developing manufacturing concepts (A1.1.3)	Extended operation list ☐
☐ Extended operation list	Estimating relative manufacturing costs (A1.1.4)	**Operation list with rough costs** ☐ **Conceptual operation list** 4-5 operation lists for manufacturing/ assembly of part/assembly (different possible alternatives) ☐ Process times for operation lists/alternatives (e.g. milling 4 min, drilling 3 min, etc.) ☐
Rough planning phase		
Conceptual operation list ☐ 4-5 operation lists for manufacturing/ assembly of part/assembly (different possible alternatives) ☐ Process times for operation lists/alternatives (e.g. milling 4 min, drilling 3 min, etc.)	Detailing the mgf. process steps and work contents (A1.2.2)	Initial rough operation list ☐
☐ Initial rough operation list	Planning the required mfg. capacity (A1.2.3)	
	Planning mfg. machines, facilities and equipment (A1.2.4)	
☐ Initial rough operation list	Planning and allocating the mfg. resources to process steps (A1.2.5)	Extended rough operation list ☐

Input	Process element	Output
☐ Extended rough operation list	Developing other mfg. concepts for new product derivates (A1.2.6)	
☐ Extended rough operation list	Developing the delivery concepts (A3.2.1)	**Rough operation list** Alternatives of operation lists including process times ☐ Generic manufacturing resources ☐ Generic assembly resources ☐ Generic personnel resources ☐ Infrastructure (manipulators, e.g. cranes, charging stations, racks) ☐ Digital operation list in planning ☐ Digital operation list in spreadsheet ☐ Digital operation list in ERP systems ☐
Detailed planning phase		
Rough operation list ☐ Alternatives of operation lists including process times ☐ Generic manufacturing resources ☐ Generic assembly resources ☐ Generic personnel resources ☐ Infrastructure (manipulators, e.g. cranes, charging stations, racks) ☐ Digital operation list in planning tool ☐ Digital operation list in spreadsheet ☐ Digital operation list in ERP systems	Detailing the mfg. process steps and work contents (A1.3.2)	Initial detail operation list ☐
☐ Initial detail operation list	Detailing the required mfg. capacity (A1.3.3)	
	Detailing mfg. machines, facilities and equipment (A1.3.4)	
☐ Initial detail operation list	Detailing and allocating the mfg. resources to process steps (A1.3.5)	Extended detail operation list ☐
☐ Extended detail operation list	Carrying out a detailed pre- calculation of mfg. costs (A1.3.6)	
	Planning of mfg. control systems, equipment configurations etc. (A1.3.7)	

Input	Process element	Output
☐ Extended detail operation list	Developing mfg. Work instructions etc. (A1.3.8)	
☐ Extended detail operation list	Carrying out an mfg. ergonomics inspection (A1.3.9)	
☐ Extended detail operation list	Optimizing material flow and value stream (A3.3.1)	
	Specifying the container plans (A.3.3.2)	
☐ Extended detail operation list	Planning the required capacity (A3.3.3)	**Detail operation list** Detailed operation list including times and allocation of personnel ☐ Concrete manufacturing resources ☐ Concrete assembly resources ☐ Concrete personnel resources ☐ Infrastructure (manipulators, e.g. cranes, charging stations, racks) ☐ Digital manufacturing plan (work schedule) in planning tool ☐ Digital manufacturing plan (work schedule) in spreadsheet ☐ Digital manufacturing plan (work schedule) in ERP systems ☐

A.2 Precedence graph

Input	Process element	Output
Concept planning phase		
☐ Standard precedence graph from previous planning	Developing the precedence graph (A2.1.3)	**Conceptual precedence graph for modules** Rough flow chart ☐ Succession of operation blocks/modules ☐
Rough planning phase		
Conceptual precedence graph for modules ☐ Rough flow chart ☐ Succession of operation blocks/modules	Detailing the assy. process steps and work contents (A.2.2.2)	Rough precedence graph based on modules ☐
☐ Rough precedence graph based on modules	Developing the layout concept (A4.2.1)	
Detailed planning phase		
☐ Rough precedence graph based on modules	Detailing assy. process steps and work contents (A2.3.2)	Initial detailed linking concept ☐

Input	Process element	Output
	Detailing the required assy. capacity (A2.3.3)	
☐ Initial detailed linking concept	Detailing assy. machines, facilities and equipment (A2.3.4)	**Detailed linking concept** Detailed precedence graph including operations ☐
Detailed linking concept ☐ Detailed precedence graph including operations	Defining layout of stations based on process chain (A4.3.1)	

A.3 Intralogistics

Input	Process element	Output
Rough planning phase		
Input information for intralogistics ☐ Conceptual layout ☐ Precedence graph ☐ Cycle time ☐ Number of pieces/lot size	Developing the delivery concepts (A3.2.1)	**Delivery/container concept** **Delivery concepts to be selected in detailed planning** Kanban principle ☐ Milkrun ☐ Demand or inventory oriented ☐ Logistics train ☐ Buffer ☐ Supermarkets ☐ (Transport) capacity/delivery cycles ☐ Generic resources (means of transportation) ☐ Generic resources (personnel) ☐ Infrastructure (manipulators, e.g. cranes, charging stations, racks) ☐ **Container concept** Type of container/container size ☐ Packaging concept (A-class items) ☐
Input information for intralogistics ☐ Conceptual layout ☐ Precedence graph ☐ Cycle time ☐ Number of pieces/lot size	Developing the container concepts (A3.2.2)	Operation list with rough costs ☐

Input	Process element	Output
Detailed planning phase		
Delivery/container concept **Delivery concepts to be selected in detailed planning** ☐ Kanban principle ☐ Milkrun ☐ Demand or inventory oriented ☐ Logistics train ☐ Buffer ☐ Supermarkets ☐ (Transport) capacity/delivery cycles ☐ Generic resources (means of transportation) ☐ Generic resources (personnel) ☐ Infrastructure (manipulators, e.g. cranes, charging stations, racks) **Container concept** ☐ Type of container/container size ☐ Packaging concept (A-class items)	Optimizing material flow and value stream (A3.3.1)	Optimized delivery concept ☐
☐ Optimized delivery concept	Specifying the container plans (A.3.3.2)	Detailed delivery concept ☐
	Planning the required capacity (A3.3.3)	

Input	Process element	Output
	Create work schedule for logistics (A3.3.4)	
☐ Detailed container concept ☐ Optimized delivery concept	Defining detailed transport and material handling concept and technology (A3.3.5)	**Internal logistic concept** **Detailed delivery concept (presentation or other documentation)** Buffer (including defined ranges, simulated) ☐ Supermarkets (including defined ranges, simulated) ☐ (Transport) capacity/delivery cycles ☐ Logistics layout (digital factory layout in CAD system), material flow (simulation system) ☐ Depending on logistics concept required concrete resources (means of transportation) ☐ Depending on logistics concept required concrete resources (personnel) ☐ Depending on logistics concept required infrastructure (manipulators, e.g. cranes, charging stations, racks) ☐ Inventory location documentation (ERP system, manufacturing control system) ☐ **Detailed container concept (ERP system)** Full description of containers, sequences ☐ Type of containers, container sizes and partition ☐ Packaging concept ☐

A.4 Layout

Input	Process element	Output
Concept planning phase		
Layout planning premises ☐ Number of stations ☐ Type and dimension of stations (solid measure, working scope) ☐ Adjacent areas (percentage) ☐ Logistics areas (paths' areas, space for containers etc.) ☐ Factory EBOM	Determining required space (A4.1.1)	**Concept layout (4-5 solutions)** Determination of location ☐ Block layout sketch, drawing/calculated space needed ☐ Cost estimation for layout ☐ Release for rough planning phase ☐

Input	Process element	Output
Rough planning phase		
Concept layout (4-5 solutions) ☐ Determination of location ☐ Block layout sketch, drawing/calculated space needed ☐ Cost estimation for layout ☐ Release for rough planning phase	Planning mfg. machines, facilities and equipment (A1.2.4)	
Concept layout (4-5 solutions) ☐ Determination of location ☐ Block layout sketch, drawing/calculated space needed ☐ Cost estimation for layout ☐ Release for rough planning phase	Planning assy. machines, facilities and equipment (A2.2.4)	
Concept layout (4-5 solutions) ☐ Determination of location ☐ Block layout sketch, drawing/calculated space needed ☐ Cost estimation for layout ☐ Release for rough planning phase	Developing the layout concept (A4.2.1)	**Rough layout (about 2-3 solutions)** Rough arrangement and dimensioning of lines and stations (solid measures exact ± 10%) ☐ Road network (overhead tracks, fork lift paths) ☐ Infrastructure (office space, toilet space, break room space, etc.) ☐ Logistics areas (container space, inventory space, buffer space, delivery space, shipping area) ☐ Cost estimation for layout ☐ Release for detailed planning phase ☐
Detailed planning phase		
Rough layout (about 2-3 solutions) ☐ Rough arrangement and dimensioning of lines and stations (solid measures exact ± 10%) ☐ Road network (overhead tracks, fork lift paths) ☐ Infrastructure (office space, toilet space, break room space, etc.) ☐ Logistics areas (container space, inventory space, buffer space, delivery space, shipping area) ☐ Cost estimation for layout ☐ Release for detailed planning phase	Detailing mfg. machines, facilities and equipment (A1.3.4)	

Input	Process element	Output
Rough layout (about 2-3 solutions) ☐ Rough arrangement and dimensioning of lines and stations (solid measures exact ± 10%) ☐ Road network (overhead tracks, fork lift paths) ☐ Infrastructure (office space, toilet space, break room space, etc.) ☐ Logistics areas (container space, inventory space, buffer space, delivery space, shipping area) ☐ Cost estimation for layout ☐ Release for detailed planning phase	Detailing assy. machines, facilities and equipment (A2.3.4)	
Rough layout (about 2-3 solutions) ☐ Rough arrangement and dimensioning of lines and stations (solid measures exact ± 10%) ☐ Road network (overhead tracks, fork lift paths) ☐ Infrastructure (office space, toilet space, break room space, etc.) ☐ Logistics areas (container space, inventory space, buffer space, delivery space, shipping area) ☐ Cost estimation for layout ☐ Release for detailed planning phase	Optimzing material flow and value stream (A3.2.1)	

Input	Process element	Output
Rough layout (about 2-3 solutions) ☐ Rough arrangement and dimensioning of lines and stations (solid measures exact ± 10%) ☐ Road network (overhead tracks, fork lift paths) ☐ Infrastructure (office space, toilet space, break room space, etc.) ☐ Logistics areas (container space, inventory space, buffer space, delivery space, shipping area) ☐ Cost estimation for layout ☐ Release for detailed planning phase	Defining layout of stations based on process chain (A4.3.1)	**Detailed layout** Accurate circulation areas ☐ Accurate road network (overhead tracks, transport equipment) ☐ Accurate logistics areas (container etc.) ☐ Accurate infrastructure ☐ Utilities installations (electricity, air, fluids) and disposal ☐ Accurate cost calculation including structural measures and utility installations for planned facilities, etc. ☐ Release of craft planning ☐
Rough layout (about 2-3 solutions) ☐ Rough arrangement and dimensioning of lines and stations (solid measures exact ± 10%) ☐ Road network (overhead tracks, fork lift paths) ☐ Infrastructure (office space, toilet space, break room space, etc.) ☐ Logistics areas (container space, inventory space, buffer space, delivery space, shipping area) ☐ Cost estimation for layout ☐ Release for detailed planning phase	Defining layout of machines and facilities (A4.3.2)	**Detailed layout** Accurate circulation areas ☐ Accurate road network (overhead tracks, transport equipment) ☐ Accurate logistics areas (container etc.) ☐ Accurate infrastructure ☐ Utilities installations (electricity, air, fluids) and disposal ☐ Accurate cost calculation including structural measures and utility installations for planned facilities etc. ☐ Release of craft planning ☐

A.5 Investment planning

Input	Process element	Output
Concept planning phase		
Planning requirements ☐ Basic conditions, planned, expected costs ☐ Breakdown of cost types: invest and overhead ☐ Cost progress	Estimating relative mfg. costs (A1.1.4)	**Initial costs** Rough evaluation of invest and overhead costs for each planning alternative ☐ Answer to question if product can be manufactured/assembled on existing lines ☐ Answer to question if a new plant/factory building is necessary ☐ Assessment of planned and existing capacity ☐ Target decision: start of rough planning ☐ Support by calculation templates ☐

Input	Process element	Output
Planning requirements ☐ Basic conditions, planned, expected costs ☐ Breakdown of cost types: invest and overhead ☐ Cost progress	Estimating relative assy. costs (A2.1.5)	**Initial costs** Rough evaluation of invest and overhead costs for each planning alternative ☐ Answer to question if product can be manufactured/assembled on existing lines ☐ Answer to question if a new plant/factory building is necessary ☐ Assessment of planned and existing capacity ☐ Target decision: start of rough planning ☐ Support by calculation templates ☐
Rough planning phase		
Initial costs ☐ Rough evaluation of invest and overhead costs for each planning alternative ☐ Answer to question if product can be manufactured/assembled on existing lines ☐ Answer to question if a new plant/factory building is necessary ☐ Assessment of planned and existing capacity ☐ Target decision: start of rough planning ☐ Support by calculation templates	Planning mfg. machines, facilities and equipment (A1.2.4)	**Rough costs** Invest and overhead costs for 3 planning alternatives ☐ Sufficient accuracy for business plan but still on estimated values ☐ Aligned to technological demand, e.g. not yet broken down to concrete machines ☐ Support by calculation templates ☐
Initial costs ☐ Rough evaluation of invest and overhead costs for each planning alternative ☐ Answer to question if product can be manufactured/assembled on existing lines ☐ Answer to question if a new plant/factory building is necessary ☐ Assessment of planned and existing capacity ☐ Target decision: start of rough planning ☐ Support by calculation templates	Planning assy. machines, facilities and equipment (A2.2.4)	**Rough costs** Invest and overhead costs for 3 planning alternatives ☐ Sufficient accuracy for business plan but still on estimated values ☐ Aligned to technological demand, e.g. not yet broken down to concrete machines ☐ Support by calculation templates ☐
Detailed planning phase		
Rough costs ☐ Invest and overhead costs for 3 planning alternatives ☐ Sufficient accuracy for business plan but still on estimated values ☐ Aligned to technological demand, e.g. not yet broken down to concrete machines ☐ Support by calculation templates	Carrying out a precalculation of mfg. costs (A1.3.6)	**Detailed costs** Invest and overhead costs for selected planning alternative ☐ Detailed bottom-up calculation of all processes and resources ☐ Concrete machines etc. ☐ Support by calculation template, additional cost calculation and storage for processes and resources in planning tool (Process Designer, ERP system, etc.) ☐

Input	Process element	Output
Rough costs ☐ Invest and overhead costs for 3 planning alternatives ☐ Sufficient accuracy for business plan but still on estimated values ☐ Aligned to technological demand, e.g. not yet broken down to concrete machines ☐ Support by calculation templates	Carrying out a precalculation of assy. costs (A2.3.6)	**Detailed costs** Invest and overhead costs for selected planning alternative ☐ Detailed bottom-up calculation of all processes and resources ☐ Concrete machines etc. ☐ Support by calculation template, additional cost calculation and storage for processes and resources in planning tool (Process Designer, ERP system, etc.) ☐
Rough costs ☐ Invest and overhead costs for 3 planning alternatives ☐ Sufficient accuracy for business plan but still on estimated values ☐ Aligned to technological demand, e.g. not yet broken down to concrete machines ☐ Support by calculation templates	Planning the required capacity (A3.3.3)	**Detailed costs** Invest and overhead costs for selected planning alternative ☐ Detailed bottom-up calculation of all processes and resources ☐ Concrete machines etc. ☐ Support by calculation template, additional cost calculation and storage for processes and resources in planning tool (Process Designer, ERP system, etc.) ☐
	Create work schedules for logistic (A3.3.4)	
Rough costs ☐ Invest and overhead costs for 3 planning alternatives ☐ Sufficient accuracy for business plan but still on estimated values ☐ Aligned to technological demand, e.g. not yet broken down to concrete machines ☐ Support by calculation templates	Defining detailed transport and material handling concept and technology (A3.3.5)	**Detailed costs** Invest and overhead costs for selected planning alternative ☐ Detailed bottom-up calculation of all processes and resources ☐ Concrete machines etc. ☐ Support by calculation template, additional cost calculation and storage for processes and resources in planning tool (Process Designer, ERP system, etc.) ☐

Annex B
(normative)

Classification

B.1 Encoding of the information objects

Annex B is used for identifying information objects in the information flows. A specific code is used for each information flow object. The first character of the code describes the type of information, while the letter "D" stands for "data". The following sequence of three characters represents the consecutive numbering, the maturity level in the production planning, and the version of the information object. The complete classification is listed below.

Level			Data from information flow
1	2	3	
D1			Preliminary information for operation list
	D1.1		Concept planning phase
		D1.1.1	Planning requirements • Product (part, assembly) • Number of pieces • Applicable technology (catalogue) o Brown field (available resources) o Green field (applicable resources) o Time data base (process time for operations)

D2	Operation list
D2.1	Concept planning phase
D2.1.1	Initial operation list
D2.1.2	Extended operation list
D2.1.3	Operation list with rough costs
D2.1.4	Conceptual operation list • 4-5 operation lists for manufacturing/assembly of part/assembly (different possible alternatives) • Process times for operation lists/alternatives (e.g. milling 4 min, drilling 3 min, etc.)
D2.2	Rough planning phase
D2.2.4	Corresponds to D2.1.4
D2.2.5	Initial rough operational list
D2.2.6	Extended rough operation list
D2.2.7	Rough operational list • Alternatives of operation lists including process times • Required, depending on operation list: o Generic resources (manufacturing resources, assembly resources, personnel) o Infrastructure (manipulators, e.g. cranes, charging stations, racks) o Digital operation list in planning tool, spreadsheet, ERP system
D2.3	Detailed planning phase
D2.3.7	Corresponds to D2.2.7
D2.3.8	Initial detail operation list
D2.3.9	Extended detail operation list
D2.3.10	Detail operation list • Detailed operation list including times and allocation of personnel • Depending on operation list, required o Concrete resources (manufacturing resources, assembly resources, personnel) o Infrastructure, manipulators (equipment, e.g. cranes, steel constructions) • Digital form: manufacturing plan (work schedule), work schedules in planning tools, spreadsheet, ERP system

D3	Precedence graph
D3.1	Concept planning phase
D3.1.1	Standard precedence graph from previous planning iteration
D3.1.2	Conceptional precedence graph for modules • Rough flow chart, succession of operation blocks/modules
D3.2	Rough planning phase
D3.2.2	Corresponds to D3.1.2
D3.2.3	Rough precedence graph based on modules
D3.3	Detailed planning phase
D3.3.3	Corresponds to D3.2.3
D3.3.4	Initial detailed linking concept
D3.3.5	Detailed linking concept • Detailed precedence graph including operations

D4	Preliminary information for intralogistics
D4.1	Rough planning phase
D4.1.1	Input information for intralogistics • Operation lists to derive consumption points o Conceptual layout o Precedence graph o Cycle time o Number of pieces, lot size

D5	Intralogistics
D5.1	Rough planning phase
D5.1.1	Delivery/container concept • Delivery concepts to be selected in detailed planning • Delivery concepts/means of transportation o Kanban principle o Milkrun o Demand or inventory oriented o Logistics train o Buffers o Supermarkets • (Transport) capacity/delivery cycles • Depending on logistics concept, required o Generic resources (means of transportation and personnel) o Infrastructure (manipulators, e.g. cranes, charging stations, racks) • Container concept o Type of container, container size o Packaging concept (A-class items)
D5.2	Detailed planning phase
D5.2.1	Corresponds to D5.1.1
D5.2.2	Optimized delivery concept
D5.2.3	Detailed container concept
D5.2.4	Internal logistic concept • Detailed delivery concept (presentation or other documentation) o Delivery concept/means of transportation (compare rough planning) – Buffers (including defined ranges, simulated) – Supermarkets (including defined ranges, simulated) o (transport) capacity/delivery cycles o Logistics layout (digital factory layout in CAD system), material flow (simulation system) o Depending on logistics concept, required (PDM system, ERP system) – Concrete resources (means of transportation and personnel) – Infrastructure (manipulators, e.g. cranes, charging stations, racks) o Inventory location documentation (ERP system, manufacturing control system) • One detailed container concept (ERP system) o Full description of containers, sequences o Type of containers, container sizes and partition o Packaging concept

D6	Preliminary information on layout
D6.1	Concept planning phase
D6.1.1	Layout planning requirements • Number of stations • Type and dimension of stations (solid measure, working scope) • Adjacent areas (percentage) • Logistics areas (paths areas, space for containers, etc.) • "Factory EBOM"

D7	Layout
D7.1	Concept planning phase
D7.1.1	Concept layout (4-5 solutions) - • Determination of location • Block layout o Sketch, drawing/space needed calculated • Cost estimation for layout • Release for rough planning phase
D7.2	Rough planning phase
D7.2.1	Corresponds to D7.1.1
D7.2.2	Rough layout (about 2-3 solutions) • Rough arrangement and dimensioning of lines and stations o Solid measures exact ± 10 % • Road network (overhead tracks, fork lift paths) • Infrastructure (office space, toilet space, break room space, etc.) • Logistics areas (container space, inventory space, buffer space, delivery space, shipping area) • Cost estimation for layout • Release for detailed planning phase
D7.3	Detail planning phase
D7.3.2	Corresponds to D7.2.2
D7.3.3	Detailed layout • Accurate arrangement and dimensioning of lines, stations and machines • Accurate: o Circulation areas o Road network (overhead tracks, transport equipment) o Logistics areas (container, etc.) o Infrastructure • Utility installations (electricity, air and fluids) and disposal • Accurate cost calculation including structural measures and utility installations for planned facilities etc. • Release of craft planning

D8	Preliminary information for investment planning
D8.1	Concept planning phase
D8.1.1	Planning requirements • Basic conditions, planed, expected costs • Breakdown of cost types: invest and overhead • Cost progress

D9	Investment planning
D9.1	Concept planning phase
D9.1.1	Initial costs • Rough evaluation of invest and overhead costs for each planning alternative • Decision supporting information: o Can be manufactured/assembled on existing lines o A new plant/factory building is necessary o Assessment of planned and existing capacity • Target decision: start of rough planning • Supported by calculation templates
D9.2	Rough planning phase
D9.2.1	Corresponds to D9.1.1
D9.2.2	Rough costs • Invest and overhead costs for 3 planning alternatives o Sufficient accuracy for business plan but still on estimated values o Aligned to technological demand, not yet broken down to concrete machines for example • Supported by calculation templates
D9.3	Detailed planning phase
D9.3.2	Corresponds to D9.2.2
D9.3.3	Detailed costs • Invest and overhead costs for selected planning alternative o Detailed bottom-up calculation of all processes and resources o Concrete machines, etc. o Supported by calculation template, additional cost calculation and storage for processes and resources in planning tool (Process Designer, ERP system, etc.)

Annex C
(informative)

Comprehensive information flow models