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

Part 2: Reference process for seamless production planning

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

Partie 2: Processus de référence pour la planification de la production sans couture

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Foreword

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The committee responsible for this document is 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

This document describes a reference planning process which aims to establish a consistent understanding of production planning processes in the lifecycle stage of production preparation addressing the phase in between design and manufacturing (see Figure 1). The primary application domain of the reference planning process is planning of production systems, e.g. “make-to-stock” or “assemble-to-order” production.

Investigations in the area of manufacturing lucidly show an increased utilization of digital planning tools to master product and process complexity and respond to continuous cost and time pressure. Production planning today uses many different IT-tools. These tools are mostly standalone solutions that are highly oriented towards specific use cases. The isolation of the IT-tools hinders sustainable system consistency. The heterogeneity and incompatibility of the IT systems hampers interdisciplinary planning across multiple phases. A lack of clear structures for each phase leads, for example, to inefficient planning and redundant processes, multiple work, transformation failures, and incomplete information. The comparison of planning results, as well as information transfer between different planning disciplines, is difficult. Despite this abundance of IT tools, as well as an overflow of various process descriptions on all kind of specialized production domains in literature, a lack of common standards is presently observable.

NOTE 1 For further reading, see Bibliography.

The reference planning process introduced within this document is illustrated in Figure 1. It is embedded between the product design process and the production process. This illustration depicts the sequential phases of the product life cycle, beginning with the concept phase, followed by the evaluation of the product design until the start of manufacturing. It stresses the major importance of a reference process for production planning as a link between product design and production itself. A detailed visualization of the planning processes is given in Annex B.

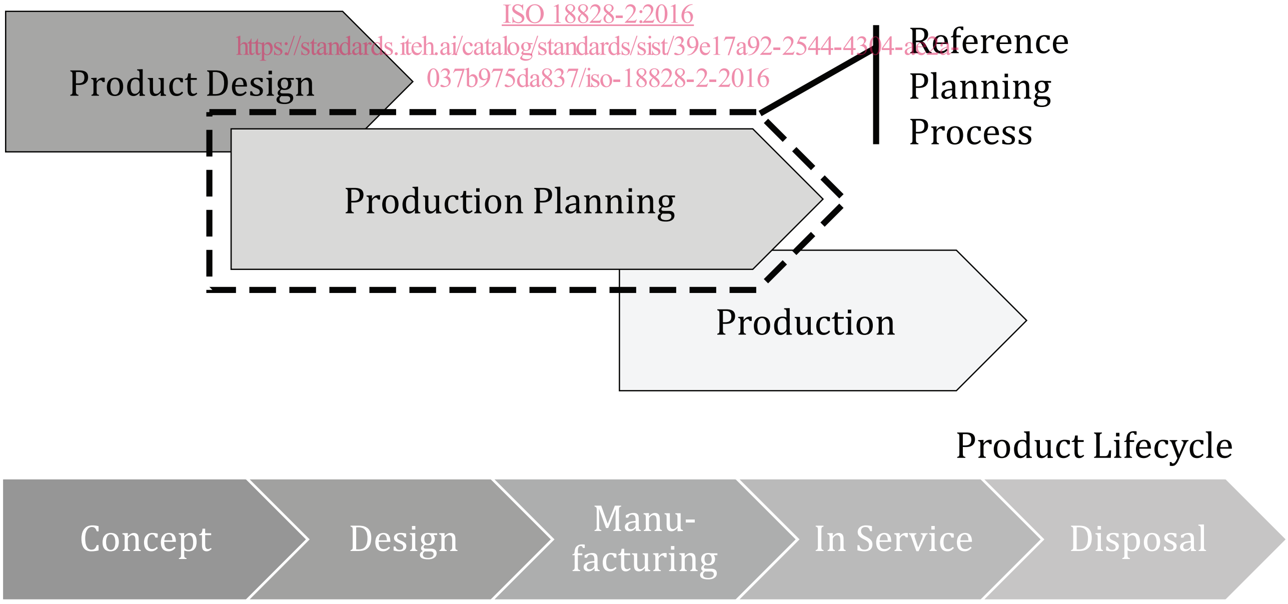

Figure 1 — Classification of the reference planning process (qualitative depiction)

To achieve the goal of a consistent planning and harmonization of the multiple processes, the development of a reference process for production planning is envisioned. Planning processes within the manufacturing phase will be analysed and merged to optimize the efficiency and transparency of each process activity. Thereby organizational, technological/technical and conceptual barriers are identified and with appropriate measures minimized or totally eliminated.

In order to integrate IT systems across the multiple phases of product development, the processes used in production planning need to be formalized and standardized.

For user specific applicability, the description of the model will be realized by the use of different levels of detail. The reference planning process, as shown in Figure 1, comprises the totality of processes within the production planning. Figure 2 depicts the reference planning process viewed as an embedded process taking input information from earlier phases of the product life cycle (e.g. as provided in ISO 10303-242) and releasing information such as work schedules to follow-up processes (e.g. as described in ISO 10303-238). A general overview and a detailed explanation of all processes within the reference planning process is given in Clause 4.

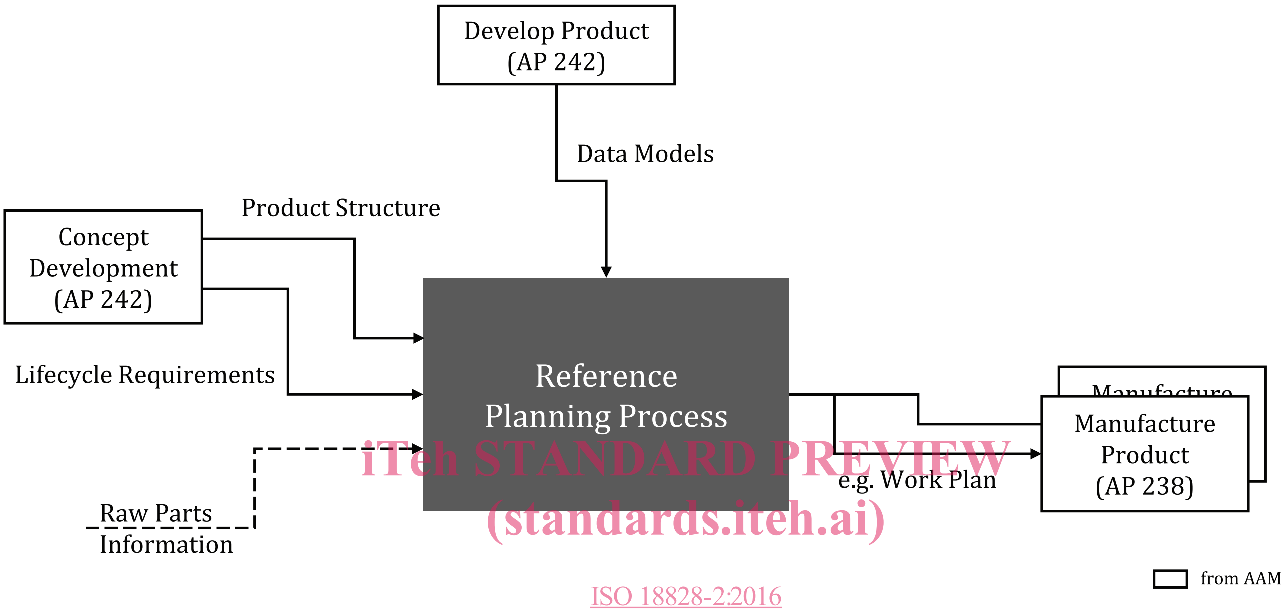

Figure 2 — Integration scenario of the reference planning process considering ISO 10303 Application Activity Modules (AAM)

NOTE 2 For further demarcation and possible integration to other standards considering industrial data, e.g. product data (see ISO 10303-1), component data (see ISO 13584-1), production data (see ISO 15531-1) and life-cycle data (see ISO 15926-1), see Bibliography.

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

Part 2:
Reference process for seamless production planning

1 Scope

This document describes a reference planning process for seamless production planning.

NOTE In this context, "seamless" means the consideration of multiple planning aspects (relevant planning disciplines) within the product life cycle, as illustrated in Figure 1 and Figure B.1.

The scope of the discussed reference process focusses on the planning of production systems such as make-to-stock or assemble-to-order production. The analysis of the process activities has been limited to those within the production planning. The following aspects are within the scope of this document:

— general overview of the reference planning process;

— basic principles of the process model;

— description of each level identified within the reference planning process for production planning;

— structure of activities and relations within each planning discipline;

— dependencies of interdisciplinary activities.

The following items are outside the scope of this document:

— material requirement planning/manufacturing resource planning;

— production order control;

— production process;

— early stage product design;

— order management, inventory management, purchasing, transportation, warehousing;

— 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);

— resource visualization;

— process simulation.

2 Normative references

There are no normative references in this document.

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 and the following apply.

3.1.1
container concept
explicit choice of a transport container, such as blister packs, lattice boxes or small parts containers

3.1.2
delivery concept
strategy adopted to supply individual parts, modules or finished products to the assembly and manufacturing resources

3.1.3
product
thing or substance produced by a natural or artificial process

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

3.1.4
production process management
planning process during the production phase

Note 1 to entry: After the start of production, the production process management is involved if process or product changes (requests) occur which lead to a new planning iteration. It does not include the operation planning, planning of materials and resources or the planning and control of production.

3.1.5
operating resources
movable and immovable resources that contribute to production

3.1.6
planning scenario
combination of certain planning variants from all planning disciplines

3.1.7
process chain
sequence of process activities

3.1.8
product design process
process of design of a product from the idea for a product through to the last engineering bill of materials (EBOM)

3.1.9
product structure
structure providing a functional classification of all items, parts, components, sub-assemblies and assemblies of a product

Note 1 to entry: The hierarchical "as-designed" product structure which is defined during product design allows the creation of an engineering bill of materials (EBOM).

3.1.10
reference planning process
process from the initial product definition to delivery of the last work plan in series planning

Note 1 to entry: The reference planning process does not include production control.

Note 2 to entry: The initial product definition usually corresponds to the end of the concept phase.

3.1.11
work system
system used to fulfil a work task and described by the seven system terms (work task, work progress, human, resource and equipment, input, output, environmental influences)

3.2 Abbreviated terms

assy	assembly
BOM	bill of materials
EBOM	engineering bill of materials (BOM from the design perspective)
EOP	end of production
ext	extended
MBOM	manufacturing bill of materials (BOM from the production perspective)
mfg	manufacturing
PLC	product life cycle
SADT	structured analysis and design technique
SOP	start of production

4 Reference model for production planning process

To provide information for different user groups and use cases, the reference process model for production planning is based on a multi-level structure. The process is detailed by progressive stages in a top down approach. The degree of abstraction decreases by drilling down the levels. The number of available levels depends on the processes and the connected sub processes. Here, the main processes are broken down into several sublevels. To reach an appropriate degree of abstraction, especially for the main planning functions, five levels are defined. These levels are illustrated in Figure 3. The notation of the elements within the process represents their respective model level in order to reach a better orientation while going through the description of each process. Except for the root process A0 at model level 0, each process refers to the model level according to the number of numeric digits in the notation (e.g. the process A2.2.1 contains three numeric digits and belongs to the model level 3).

NOTE 1 Syntax and semantics are used according to the functional modelling language ANSI/IEEE 1320.1.

NOTE 2 A functional model describes the functions (e.g. activities, actions, processes, operations) of a system (e.g. product design, production planning, production) and their relationships. The functional model represents what is done rather than how it is done. The content of the model represents all possible functions of a system. For company specific implementation not every function needs to be applied. Functional models such as activity models are frequently used in normative context (see Bibliography).

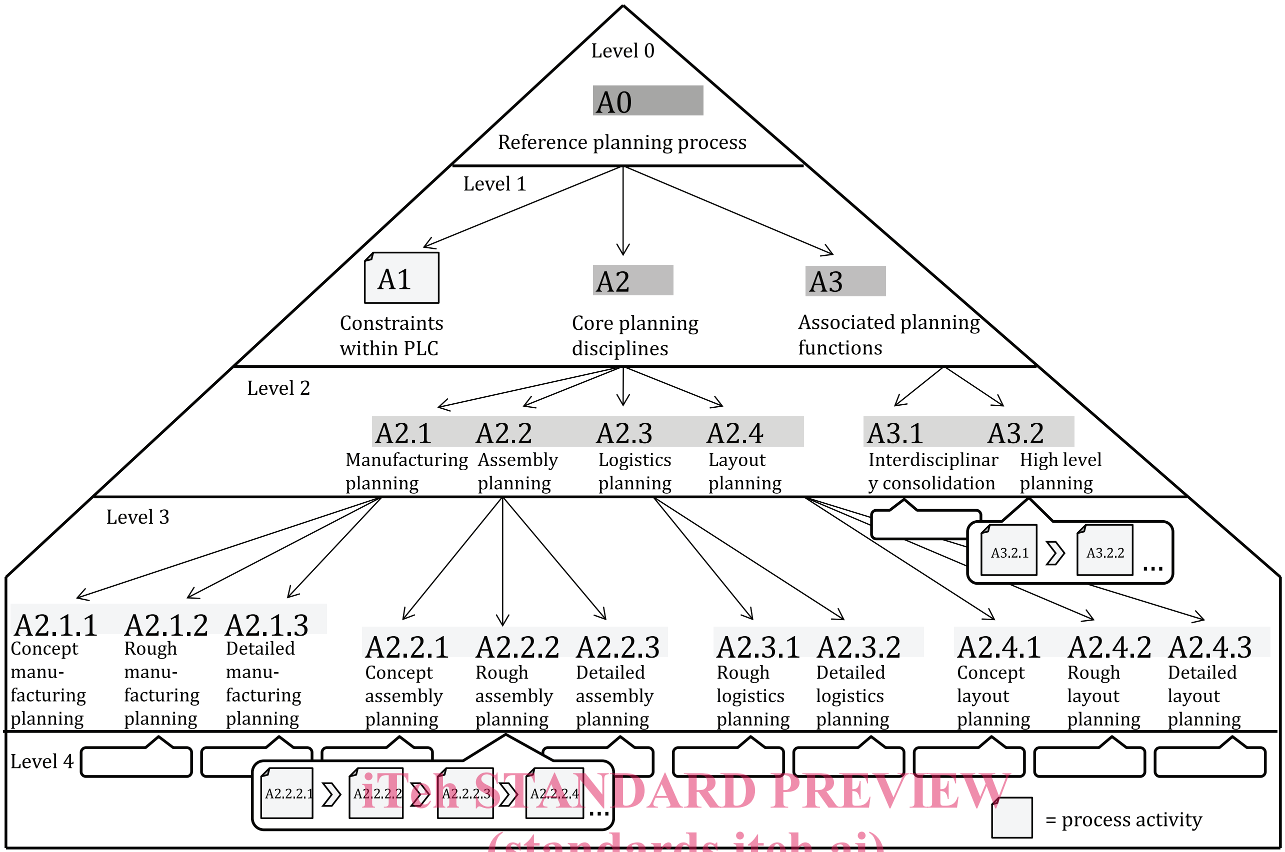

Figure 3 — Structure of the reference planning process model

The consideration and control of the complexity are essential for the development of the reference planning process. The modelling makes use of combining recurrent functions and constraints into aggregated modules. As a result, clear structured planning processes consisting of input and output data, control mechanism and methodical support have been modelled. Thereby both, functions at the interface of the reference planning process and consolidations within the planning disciplines are combined at the root level. This aggregation leads to a significant increase of clarity of description and enables a prioritized view for the user at the given core discipline. The description of the detailed model levels follows the same top down approach. First the level with the highest degree of abstraction will be described (referred to as level 0), following a description of the level consisting of the main function of the reference planning process. In reference to this basis every possible characteristic planning element will be consecutively described. To ensure a consistent description of the different model levels the detailed description of the levels contains the following structure:

— the graphical abstract of the detailed process activities using structured analysis and design technique (SADT) notation;

— the textual description of the process activities;

— the additional explanation of specific model details.

4.1 Summary of the process A0 (level 1)

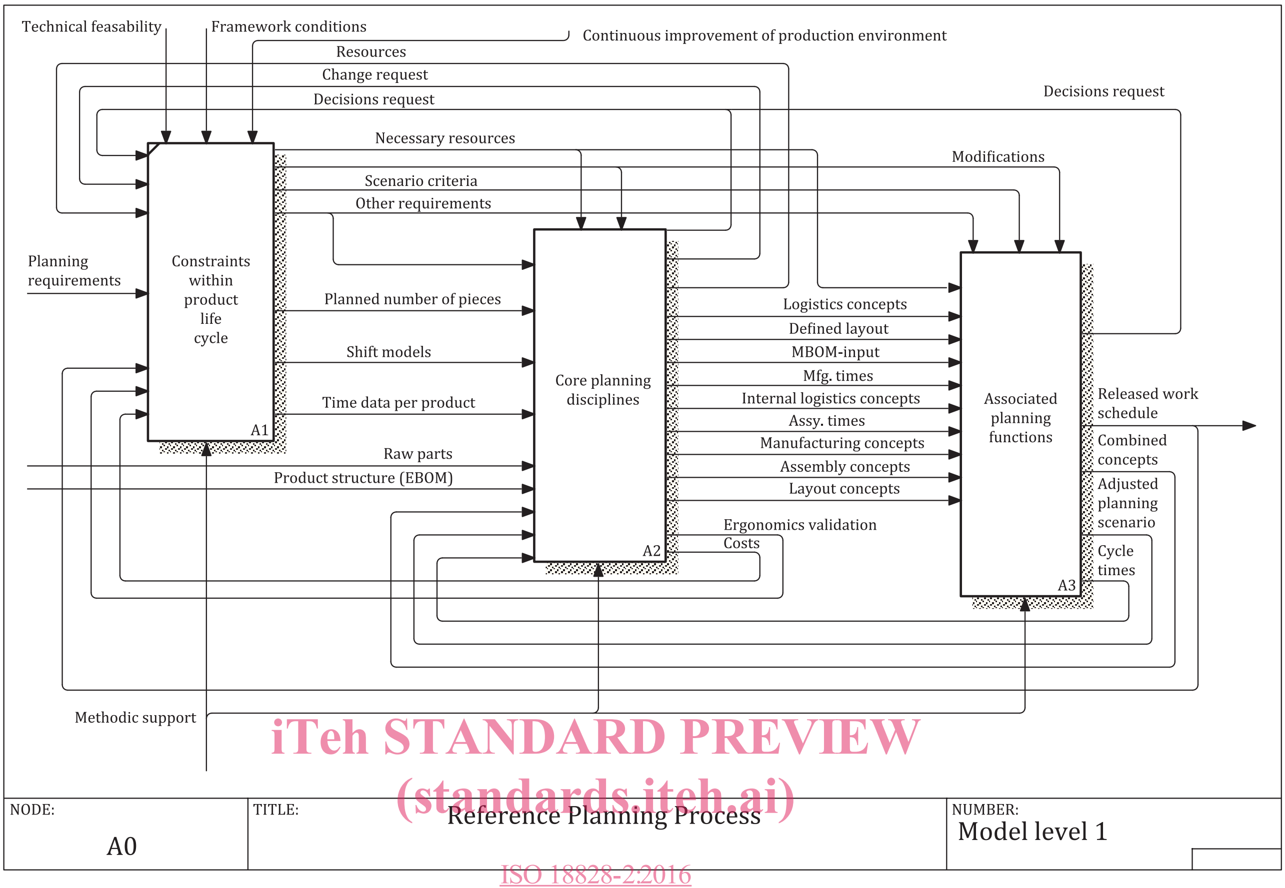

Figure 4 — Structure of the reference planning process at model level 1

Relating to the abstraction of the reference planning process, the starting point for the modelling of the reference planning process are the constraints derived from the production planning. Beside these constraints several control factors impact the production planning. As previously shown in Figure 2, the constraints from higher levels are separated into different quantities and are provided for the reference planning process. The product structure (EBOM), information about the raw parts and several planning requirements are first level inputs derived from the production planning. The control functions are represented by the framework conditions. Methodical support is provided for every process. All information and processes combined constitute the output of the reference planning process represented by the work schedule. Every iteration of the reference planning process leads to an updated version of the work schedule and in the end to the last released work schedule. These iterations are also represented in the detailed structure of the reference planning process as shown in Figure 4.

Due to the top down approach of the model the complexity of the considered process activities increases for every level. To handle this complexity, the reference process for production planning is divided into three main functions, described by the following:

— constraints within the product life cycle;

— core planning disciplines;

— associated planning functions.

The constraints within the product life cycle provide information for different planning disciplines and associated planning functions through several levels of the model. The constraints operate as a control function for other processes during the product life cycle. The constraints affect every element in every level of the model (top down approach). Through the described structure the changes caused by the decision making function can be precisely applied. The constraints provide planning requirements as input information for the core planning disciplines, as well as control input for the associated planning functions. Additional information needed in the detailed model levels that are not generated by the remaining planning disciplines is provided by other requirements.

The core planning disciplines represent the considered planning function during production planning. They receive the production information as controlled by the constraints and generate the planning data output for the start of production. The core disciplines can contain various planning functions. In the production planning field it is possible to distinguish between several types of planning disciplines. The most important, fundamental planning disciplines are identified and detailed in the structure of the reference process (see 4.2).

The core disciplines strongly interact with the associated planning functions and their constraints from higher level. The constraints provide the external input and control parameters. The internal consolidation of the output from the remaining planning functions is performed within the associated planning functions (see A3 in Figure 4). The associated planning functions are able to realize operations like the combination of the developed planning concepts during the different steps of the production planning or the request for a management decision. Another essential aspect, which is part of the associated planning function, is the production process management. The Production process management runs parallel to production. If any changes to the planning requirements or other constraints are necessary, the production process management is capable of triggering the iteration of the preliminary planning steps to which the changes apply to.

4.2 Summary of the process A2 (level 2)

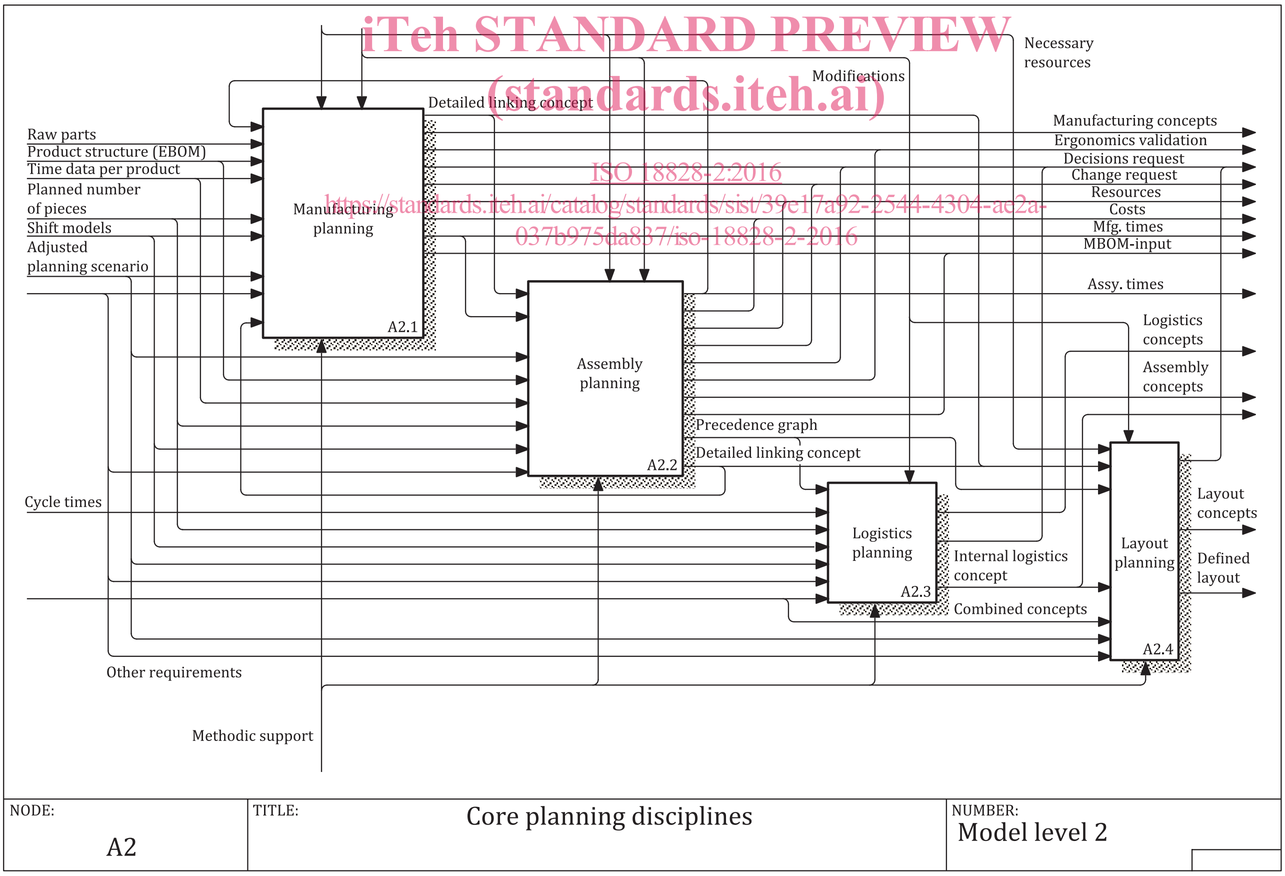

Figure 5 — Structure of the reference planning process at model level 1

When describing the production planning it is sensible to restrict these to the most important, fundamental planning disciplines that can be found in many manufacturing companies. As shown in Figure 5, these disciplines are:

— manufacturing planning;

— assembly planning;

— logistics planning;

— layout planning.

Each discipline will be structured by the degree of maturity of the planning. Thereby the manufacturing, assembly, logistics and layout planning will be broken down into three subphases:

— concept planning;

— rough planning;

— detailed planning.

The structure based on the degree of maturity will be applied to all four core disciplines (see 4.2.1 to 4.2.4).

Manufacturing planning (A2.1) comprises all the measures taken in order to design a manufacturing system, as well as the selection of the necessary manufacturing resources and processes. When performing manufacturing planning, it is particularly important to take account dependencies with the remaining planning disciplines such as assembly, logistics and layout planning.

Assembly planning (A2.2) defines the steps involved in the assembly of various individual parts to create an end product and determines the necessary equipment (e.g. lifting cranes, robot arms). This planning activity, which also includes the draft design of the assembly systems, is frequently performed by the department which is responsible for work preparation.

The aim of **logistics planning** (A2.3) is to ensure that the raw materials and semi-finished products, assemblies, subassemblies or fastening elements such as screws are available at the right place at the right time and in the correct, economically optimized quantities.

As the last of the four focused planning disciplines, **layout planning** (A2.4) ensures that operating resources are located optimally in the production area (e.g. the processes in an assembly line or in an assembly cell can run as efficiently as possible). To perform this task, it is very important that the knowledge and experience derived from the other planning disciplines is available during layout planning.

NOTE For more detailed information about the core planning disciplines, see Annex B.

