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

Part 1: **Overview**

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

Partie 1: Aperçu général

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Foreword

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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.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ISO 18828 series addresses standardized procedures for production systems engineering. A production planner can be a major beneficiary of a framework which approaches aspects such as production processes, information flows, key performance indicators (KPIs) and manufacturing changes. The composition of the ISO 18828 series at the time of publication is illustrated in Figure 1.

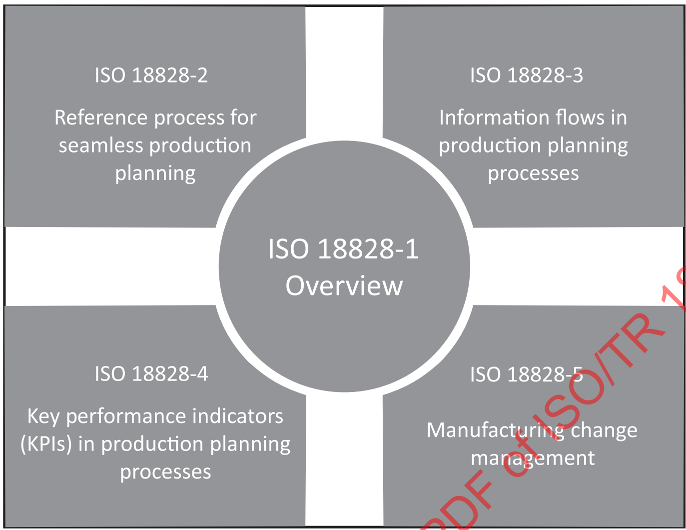

Figure 1 — Composition of the ISO 18828 series

Each part of the ISO 18828 series stands as a single document and can be understood in the context of its content without the other parts. However, ISO 18828-2, ISO 18828-3 and ISO 18828-4 are closely linked and there is added value in implementing them together. Annex A illustrates the domain and life-cycle context of the ISO 18828 series.

Figure 2 shows possible links and relations in between each part of ISO 18828 and their basic information flows. The overall recipient of all ISO 18828 activities is given within the standardized procedures for production systems engineers. Planning process information is the main outcome for production systems engineers derived from ISO 18828-2. However, planning process information can be seen as input to information flows (ISO 18828-3) and KPIs (ISO 18828-4) respectively. Data flows derive from information flows (ISO 18828-3) and statistical data from KPIs (ISO 18828-4). Both planning process information and statistical data can influence manufacturing change processes and they are input to manufacturing change (ISO 18828-5). From there, change process information is provided to the production system engineer in return.

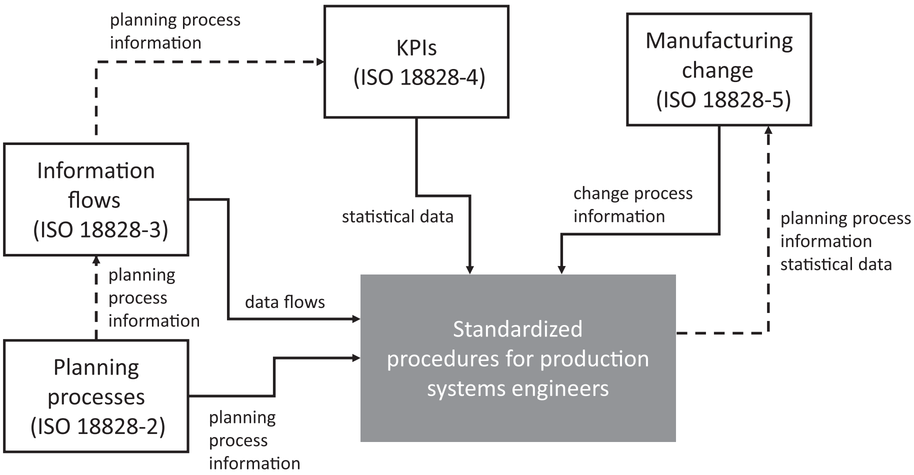

Figure 2 — Interrelations between the different parts of the ISO 18828 series

This document provides an overview of the ISO 18828 series:

— Clause 4 provides an overview of each part of the ISO 18828 series individually;

— Clause 5 describes the interrelations between the various parts of the ISO 18828 series and industrial use cases are used to explain the generic appliance of the standardized parts: ISO 18828-2, ISO 18828-3 and ISO 18828-4 are interrelated, whereas ISO 18828-5 provides details on the manufacturing change process that can be understood not only within the scope of work of production systems engineers, but also with respect to changes within whole production systems.

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

Part 1: Overview

1 Scope

This document describes the framework of the ISO 18828 series in seamless production planning.

The following are within the scope of this document:

— general overview of the framework of the ISO 18828 series:

— quintessential description of each part;

— inter-relational aspects and appliance of the framework.

The following are outside the scope of this document:

— detailed process descriptions;

— detailed data flows;

— detailed KPIs;

— detailed data models;

— in-depth discussion of the parts of the ISO 18828 series.

2 Normative references

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

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

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

4 Overview and context of the individual parts of the ISO 18828 series

4.1 Overview of ISO 18828-2

ISO 18828-2 describes a reference planning process intended to establish a consistent understanding of production planning processes in the life-cycle stage of production preparation. This reference planning process is embedded between the product design process and the production process.

The reference planning process consists of two dimensions, the first of which is the dimension of planning disciplines. In order to identify the most important planning disciplines that can occur in manufacturing companies, data from various companies indicate a main focus. Four distinct planning disciplines are identified:

a) production;

b) assembly;

c) logistics;

d) layout planning.

Each process derived from these planning disciplines traverses all product design phases, and the product phases constitute the second dimension of the reference planning process. The reference planning process extends from the later stages of product design phases to the production phase. In the stage of production preparation, ISO 18828-2 identifies four different maturity-level related phases:

— the concept planning phase;

— the rough planning phase;

— the detailed planning phase;

— a subsequent optimization phase that reaches into the early production stages of the product life-cycle.

Based on two dimensions, i.e. planning discipline and maturity level, the reference planning process contains for each intersection a distinct, generic process step. Each process step includes a function, incoming information, controlling information and outgoing information. The structure follows a hierarchical approach: the interrelations at the higher levels occur rather densely, whereas the detailed levels resolve to clear process flow charts.

The detailed process models represented in ISO 18828-2 express and implement a uniform designation of input, control and output parameters involved in the production planning process and reflect the structuring of the planning process. Systematic narrowing of the scope under consideration of the basis of the planning dimensions, i.e. planning disciplines and maturity levels, permits a clear overview of the interfaces between processes and possible grouping effects. This representation can enable, for example, methodological and technical process chain support.

The main focus of ISO 18828-2 is on the detailed introduction of the focused planning disciplines with regard to maturity levels, as well as comprehensive, common patterns used to increase understanding. In addition, elaborative figures provide a graphical explanation of the process flows for each process level. An informative summary of the level structure precedes the detailed sector descriptions and conveys a clear and transparent picture of the overall structure of content, purpose and application of the document.

4.2 Overview of ISO 18828-3

ISO 18828-3 specifies the main information flows in production planning. These information flows derive from process steps identified in the context of the reference planning process. However, each flow stands alone and therefore can be regarded as an individual, isolated information flow, describing necessary data flows for the main objective. The information flows 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 and provide additional information that focuses on the transparency of the flows. The process interfaces include the process phases, i.e. conceptual, rough and detailed planning and the planning disciplines.

Within ISO 18828-3, identified planning disciplines are restricted to the most important, fundamental planning disciplines found in many manufacturing companies. An introduction to planning disciplines provides the main section of the reference planning process for seamless production planning

(ISO 18828-2). In accordance with ISO 18828-2, the main information flows employ the same production planning disciplines:

— manufacturing;

— assembly;

— logistics;

— layout planning.

ISO 18828-3 provides a general overview of the main information flows within the reference planning process. It also describes the five identified main information flows and their distinct setup and process models. Each information model takes all process interfaces that derive 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.

All information flows follow a basic pattern, which describes them uniformly. In addition, a detailed description of each part of the information flow explains its purpose and the related data objects, as well as the interconnection between the planning disciplines. All diagrams use a common state notation structure. Next to the detailed description of the process parts of the information flows, an in-depth explanation of each information object adds more substance to the involved entities.

Each information flow revolves around a specific flow object. Such a concentrated focus increases the transparency of interactions and data flows for each object and thereby the benefits of the flow itself. End users who have interest in a specific flow can easily check the entirety of their data and traverse along their specific flow. Software providers can 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.

The annexes include a proposal of checklists for benchmarking information objects and apply the contents of ISO 18828-3 to a business case.

4.3 Overview of ISO 18828-4

ISO 18828-4 elaborates the usage of KPIs in the production planning phase. It originates from the identified lack of adequate control parameters and results in the development of a framework to monitor and improve the production planning processes. The KPIs described in ISO 18828-4 concern basically performance tracking of planning processes for engineering production systems. They aim to improve the process of standardizing the quality of production process monitoring. Key indicators identified in ISO 18828-4 describe an abstract mathematical condition in such a way that they are consistently applicable, according to their definition, in the various planning areas and, if adapted accordingly, in other areas as well.

The KPIs discussed in ISO 18828-4 relate to the tasks carried out within production planning process. However, all key indicators presented are recommendations and can also be used in accordance with general validity of the reference process from ISO 18828-2 and relate to content described there.

Due to their nature, KPIs can only be set in relation to, and used for purposes of continuous comparison with process improvement, if thresholds are well defined and applied. Therefore, with regards to the production planning processes, paying attention to the system boundaries of the analysis is imperative.

ISO 18828-4 describes the organization of KPIs in a multi-level system that provides different key indicator levels for processes, ranging from evaluation of the planning processes in process-oriented key indicators to evaluation of the specific results of planning tasks. In this organizational structure, while the more process-oriented key indicators are valid across different disciplines, the result-oriented key indicators tend to bear a strong relationship to the predefined planning disciplines of the production planning processes. The employed multi-level system indicates a significant key indicator on all levels. In addition, each KPI uses a common template to structure and document each indicator in the same standardized way. The structure includes the explicit formula and corresponding unit/dimension, as well as the respective, generally valid input parameters and variables.

The distinction between process and result-related KPIs covers a major part of the document, and there is an explanation of the difference between process-oriented and result-oriented key indicators. Process-oriented indicators can be identified by their broad scope of use, since they are neither discipline-specific nor specific to the individual stage of development. Result-oriented key indicators based on concrete planning results are far more dependent on the context and have a narrow, predefined scope of validity. Based on the core planning disciplines identified in the reference planning process, ISO 18828-4 focuses on presenting sample result KPIs applicable for use.

Having this document available enhances the options for benchmarking within a company and, if required, even across multiple companies.

4.4 Overview of ISO 18828-5

ISO 18828-5 addresses manufacturing change processes and their management. In practice, the product systems required for the manufacturing and assembling of the products are likewise subject to many different changes. Some of these are planned and implemented specifically to achieve increased efficiency of production systems. Other changes, however, are subject to processes that are less structured or planned. Typical for all of these types of change measures is the fact that the applicable documentation of production systems and the actual state of production are temporarily or permanently inconsistent. This means that all producers will experience their manufacturing processes deviating from the original planning to some degree. A permanent supervision of the actual state and planned state of the system enables a manufacturer to test, evaluate and ultimately reach the goals set in terms of quality, required time and cost-effectiveness.

Any late changes to the manufacturing process involve the agreement of numerous participants and require a time intense, iterative decision-making process. ISO 18828-5 develops a formal description of the Manufacturing Change Management (MCM) processes and provides organizational and technical concepts for a comprehensive mapping and processing of manufacturing changes between production planning and operations. It offers the methodological means to capture and track change measures, and to sensibly forecast and coordinate the capacities required for change processes in the planning and production departments. In addition, data model charts provide an object-oriented view on MCM. The data model presents an implementable software view, enabling IT-vendors to develop standardized tools. An important aspect of the data model lies within the central change object type. It is linked to the objects of the digital factory, i.e. the process, the product and the resource. The change object relates to all objects of the digital factory and provides a relationship-oriented *n*-th grade view to the MCM process.

ISO 18828-5 covers process models of MCM based on a multi-level structure. Each process model is detailed by progressive stages in a top-down approach. MCM consists of two structural stages, which constitute the root level of the MCM process:

— the manufacturing change request;

— the manufacturing change order.

There is a detailed description of both process steps and further relationships to roles and objects. The degree of abstraction decreases by drilling down the levels. As a result, the bottom level of the process models provides clear and structured process steps consisting of input and output data. In addition, next to a detailed description of the processes themselves, a role model presents key players, their tasks, their responsibilities and their purpose in the course of a manufacturing change.

ISO 18828-5 concludes with detailed information on the included data model in the course of a generic work flow of the MCM process.

5 Application of the ISO 18828 framework

5.1 General

Each part of the ISO 18828 series can be applied as an individual part and the understanding of a single part does not necessarily depend on the other parts. However, major benefit can be gained by combining parts of ISO 18828 during application. Figure 3 illustrates three use case examples of the implementation of the ISO 18828 series in a framework. These use cases are described in 5.2 to 5.4 and are based on real implementation scenarios of the ISO 18828 series by major German industry partners.

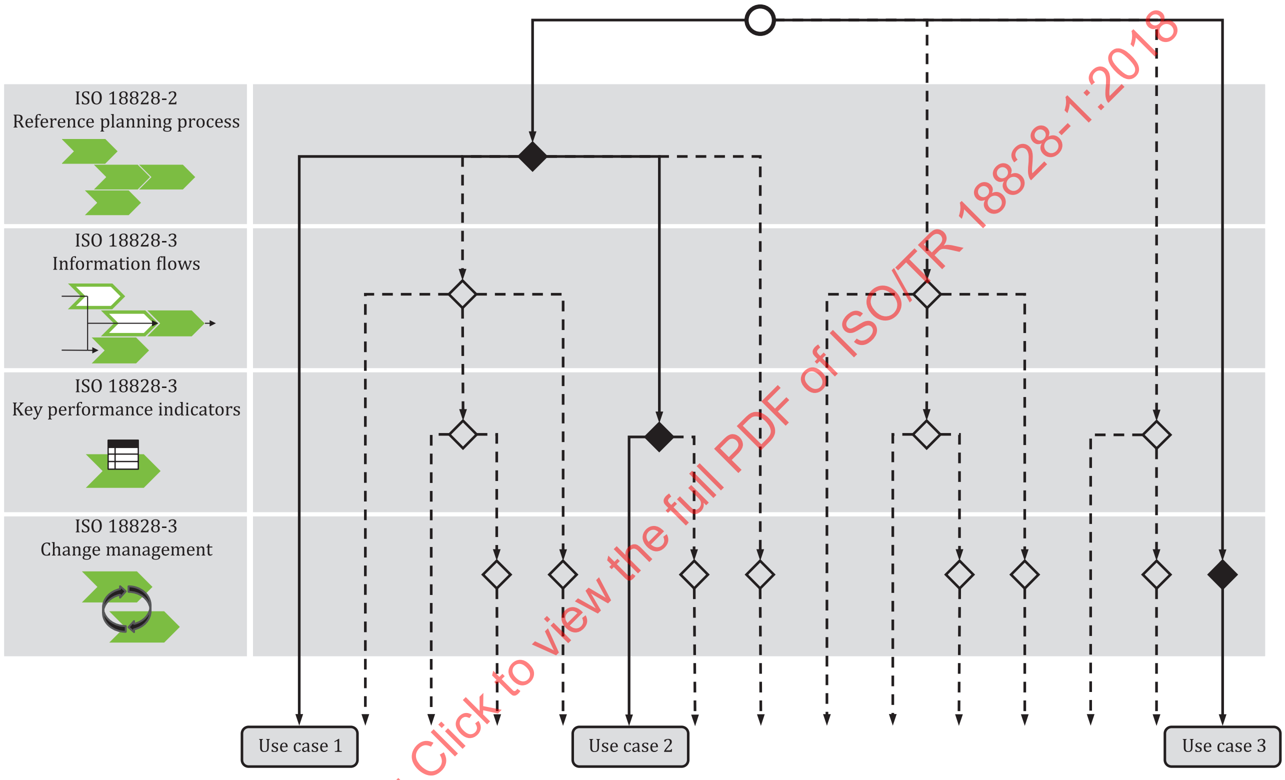

Figure 3 — Use case examples of application of the ISO 18828 framework

5.2 Use case 1: Benchmark of product life-cycle management software functionality based on planning processes

Digital planning support has grown steadily in the last few years and promises time and cost savings by securing products and production already in the early phases of product creation. Due to the many forms of support systems, selection and integration of appropriate systems for a specific application has become a challenge for the industry. In this use case, evaluation and selection of digital planning tools was tested using the reference planning process model. The reference planning process provided a comparison basis with regard to the planning functionalities. The objective of the use case was the assessment and selection of digital planning support. In most companies, different software solutions are used. Using the reference planning process, the essential planning functions were identified that need to be supported by a digital planning tool in the use case. In doing so, the interfaces with the adjacent planning functions were taken into account. Due to the functional design of the reference planning process, nine planning functions could be taken over for the use case. Based on these planning functions, two major software solutions in the field of product life-cycle management were evaluated. In conclusion, the reference planning process successfully provided a basis for evaluating a software selection.

5.3 Use case 2: Evaluation of planning process performance in automotive prototyping

In this use case, evaluation of planning processes was tested using the production planning KPIs. KPIs are the prerequisite for controlling planning processes, as well as their continuous improvement. The planning processes of product prototyping in the automotive industry, which occupy a special position in the product creation process, were used here as a case study. The planning processes included the assembly of product prototypes of all development stages, as well as its equipment with measuring and testing technology. The planned work content included not only the construction of individual assemblies or aggregates, but that of an entire vehicle. In previous planning iterations, it increasingly occurred that similar planning activities differed in the planning cycle time from a few hours or days to several months. In order to gain a deeper understanding of these deviations and to identify possible causes and subsequently to master them, the production planning KPIs were used. With the help of the functional reference planning process, a company-specific planning process was derived, on the basis of which an evaluation can be carried out in a processor-oriented manner. The evaluation showed that information waiting times and response times were a significant part of throughput time of planning the prototype assembly. In addition, the information procurement time was rather high. Together, this increased the risk of possible repetitive planning due to incorrect or subsequently changed information. Basically, iterations occurred regularly in planning, since framework conditions often change at such an early stage of planning. However, an iteration due to misinformation needs to be avoided. To avoid such misinformation within the planning process, dedicated IT-supported workflows were implemented to ensure that the right information content was passed from one planning process to another. In conclusion, main aspects for planning improvements in this use case were identified with help of planning KPIs.

5.4 Use case 3: Change management between shop floor and planning

Continual changes during running production processes, whether on the shop floor or, for instance, in planning, operating equipment construction, idea management, or industrial engineering, are among the recurring challenges for employees of modern industrial companies. Changes for the shop floor can be introduced from any of these areas and have reciprocal effects on planned changes or those that are currently being implemented. An overview of all these change measures is necessary for whichever work area is considered, to facilitate assessment of the effects of new changes and their efficient implementation. Management of change in production (i.e. MCM) is required. The first step in introducing such an MCM concept in use case 3 to run processes was an evaluation within the scope of a pilot project. Yet even introducing a pilot project while processes are underway poses a challenge. New work methods needed to be incorporated and evaluated alongside the operative processes. The extent of the pilot project was defined together with persons and areas involved. Sensible workflows were detailed and changes during running production operation were recorded in a formalized way. In addition to very formal application cases such as the company’s suggestion system, a recommendation for utilizing MCM for highly dynamic change processes was also included. Here, the concept concentrated on the support of existing processes within the company. The information process described in the MCM collaboration concept represents an aid to transparent communication in this case and does not attempt to duplicate or replace existing planning or implementation processes. Nonetheless, due to its neutral definition, the MCM concept needs to be adapted to company-specific processes. In conclusion, the MCM implementation in this use case provided a structural help for organizational and functional application of change management between shop floor and planning.

