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Automation systems and integration — Assessment on convergence of informatization and industrialization for industrial enterprises —

Part 2: Maturity model and evaluation methodology

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Foreword

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

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For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 184, [Automation systems and integration], Subcommittee SC 5, [Interoperability, integration, and architectures for enterprise systems and automation applications].

A list of all parts in the ISO 22549 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

Convergence of informatization and industrialization (CII) refers to a process that integrates information technology into industrial production. The purpose of convergence is to promote development of industry in a higher value-added direction through wide application of information and restructuring of traditional industry.

CII will promote production and resource allocation in a more comprehensive and dynamic as well as optimal way.

This document and its related parts serve as a framework and normalization guide for enterprises to promote the convergence of information technology, its research and development, into the processes of production and operations management.

The purposes of this document include, but not limited to, providing industrial enterprises guidance for:

- assessing the current situation of CII
- finding weakness within the CII
- identifying ways to improve CII

The intended users of this document can be grouped into the following categories:

- unaffected third-party assessor, e.g. a consulting company or government department, which conducts a convergence of informatization and industrialization assessment;
- responsible organization, e.g. production management department, quality management department, inventory management department, etc., which sponsor an assessment of itself or a subordinate organization;
- other industrial sector enterprises.

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Automation systems and integration — Assessment on convergence of informatization and industrialization for industrial enterprises —

Part 2: Maturity model and evaluation methodology

1 Scope

This document defines maturity model and evaluation methodology on convergence of informatization and industrialization in industrial enterprises. The scope of this document includes the followings:

- Maturity model definition;
- Principles of evaluation questionnaires; and
- Guidance for maturity evaluation method

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22549-1 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

maturity model

classification scheme for measuring the effect of policies, procedures, training and control that results in the capability to execute efficient operations based on information technologies

3.2

maturity level indicator

maturity level

identified extent of measured effect within *maturity model* (3.1)

Note 1 to entry: The extent of measured effect is divided into segments, referred to as levels, of increasing competence to achieve enterprise objectives.

3.3

evaluation questionnaire

list of questions used to evaluate and determine the *maturity level* (3.2)

3.4

maturity evaluation

method for determining the *maturity level* (3.2) of an industrial enterprise using responses to *evaluation questionnaire* (3.3)

4 Symbols (and abbreviated terms)

| | |
|-------|--|
| ACII | assessment on convergence of informatization and industrialization |
| BOM | bill of material |
| CAD | computer aided design |
| CPS | cyber-physical system |
| E-BOM | engineering BOM |
| ECO | engineering change order |
| ECR | engineering change request |
| EDI | electronic data interchange |
| EHS | environment, safety and health |
| ERP | enterprise resource planning |
| IoT | Internet of Things |
| IT | information technology |
| KPI | key performance indicator |
| M-BOM | manufacturing BOM |
| MSDS | material safety data sheets |
| MES | manufacturing execution system |
| PLM | product lifecycle management |
| SCM | supply chain management |
| SPC | Statistical process control |
| WIP | work in process |

5 Maturity model

The maturity model shall consist of maturity levels where each level consists of a maturity level indicator, descriptive name, and characteristics relevant to the desired assessment information as shown in [Table 1](#). These characteristics guide domain aspect relevant evaluation questions for which simple yes or no answers are appropriate.

Table 1 — Maturity model definition

| Maturity level indicator | Descriptive name | Characteristics |
|--------------------------|------------------|---|
| Level 0 | Unidentified | — Little or no systematic documentation available |
| Level 1 | Identified | — Tracking and traceability of materials, data and etc. — Registration and management of data using information collection devices and systems |
| Level 2 | Measured | — Real time data acquisition of materials, machinery, process and human roles, and data integration — Measurement, aggregation, classification and management of data using information collection devices and systems — Synchronous history of data for the same time, same lot and same product |
| Level 3 | Analysed | — Data analysis and optimized decision making using aggregated data |
| Level 4 | Optimized | — Automation of processes according to optimized decision making throughout the intra-enterprise and/or the inter-enterprises |
| Level 5 | Customized | — Self-diagnosis and self-healing through cyber-physical system (CPS), Internet of Things (IoT), artificial intelligence (AI), etc. — Flexible production of customized products through autonomous control |

NOTE Because maturity level 0 is the same for every questionnaire table, level 0 is not included in the separate tables.

Figure 1 shows maturity level and its inclusive relationship that all higher maturity level shall include characteristics of lower maturity level.

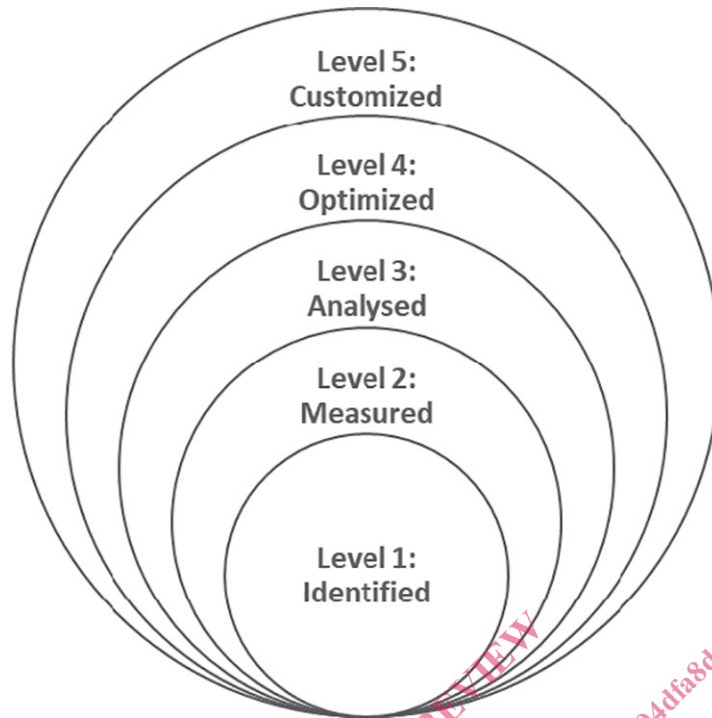


Figure 1 — Maturity level (inclusive)

Assessment of maturity level is done by evaluating assessment on convergence of informatization and industrialization (ACII) reference model components based on the answers to the evaluation questions.

6 Principles of evaluation questionnaires for ACII reference model components

6.1 General

Figure 2 presents assessment reference model defined in ISO 22549-1. Four aspects are grouped by blue-dotted line and twenty-four subordinate components to four aspects are grouped by red-dotted line.

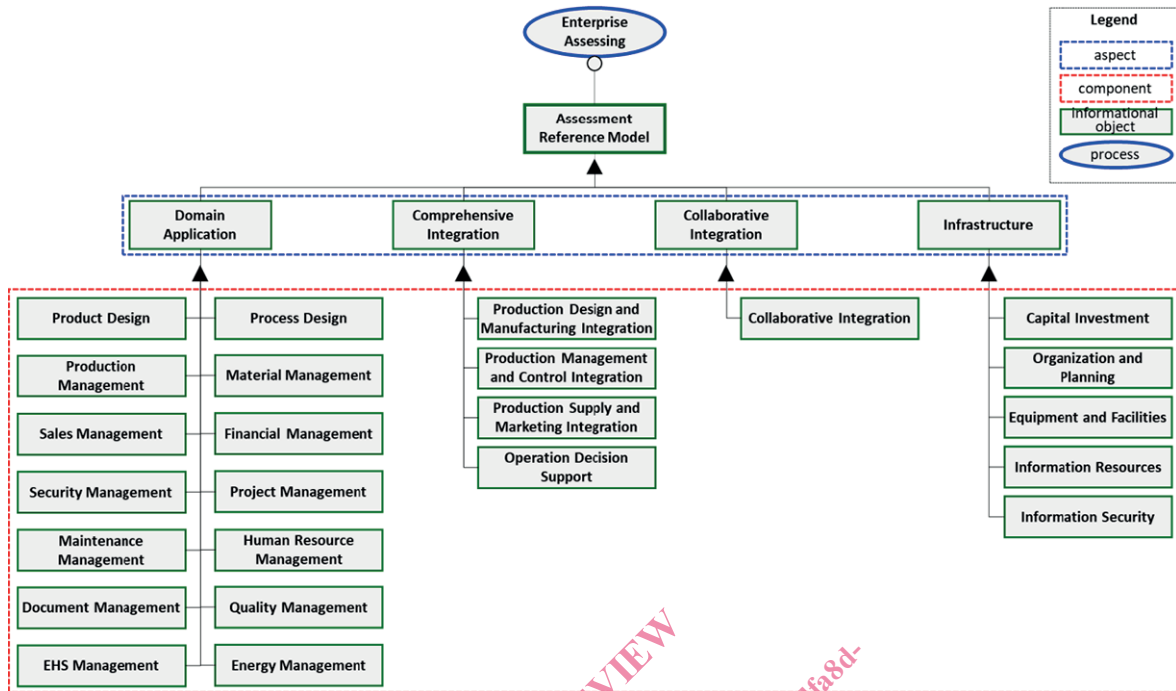


Figure 2 — Assessment reference model (aspect and its subordinate component)

In general, each ACII reference model component consists of one or more activities, for example, product design requires commodity planning, design automation, bill of material (BOM)/Parts management, engineering change management, etc.

For ACII, each ACII reference model component has to be evaluated in the level of its activities, and each activity has a set of questions to answer for each maturity level. Question answers shall be “YES” or “NO.”

Evaluation of maturity level using questionnaires is well-known and a common way, since it is easy to make answers to the given questions and evaluate the maturity level based on the answers.

Table 2 shows the structure of questions for evaluation.

Table 2 — Structure of question for maturity evaluation

| Activity | Question | Maturity level indicator |
|------------------------|---------------------------------|--------------------------|
| Activity name 1 | Questions for maturity level 1. | 1 |
| | Questions for maturity level 2. | 2 |
| | Questions for maturity level 3. | 3 |
| | Questions for maturity level 4. | 4 |
| | Questions for maturity level 5. | 5 |
| Activity name 2 | Questions for maturity level 1. | 1 |
| | Questions for maturity level 2. | 2 |
| | Questions for maturity level 3. | 3 |
| | Questions for maturity level 4. | 4 |
| | Questions for maturity level 5. | 5 |

Table 2 (continued)

| Activity | Question | Maturity level indicator |
|-------------------------|---------------------------------|--------------------------|
| Activity name... | Questions for maturity level 1. | 1 |
| | Questions for maturity level 2. | 2 |
| | Questions for maturity level 3. | 3 |
| | Questions for maturity level 4. | 4 |
| | Questions for maturity level 5. | 5 |
| Activity name N | Questions for maturity level 1. | 1 |
| | Questions for maturity level 2. | 2 |
| | Questions for maturity level 3. | 3 |
| | Questions for maturity level 4. | 4 |
| | Questions for maturity level 5. | 5 |

- **Activity:**
activity of ACII reference model component.
This document specifies a number of activities to be evaluated for each ACII reference model component.
- **Question:**
questions to assess maturity level satisfaction, and the answer shall be “YES” or “NO”.
All questions in all activities in a given level need to be evaluated and all must be “YES” to proceed to the next level questions by applying guidance for maturity evaluation method given in 7.
[Annex A](#) gives examples of a whole set of questions for all ACII reference model components.
- **Maturity level indicator:**
maturity level used for maturity evaluation.

6.2 Activity of ACII reference model component for evaluation

6.2.1 Infrastructure aspect assessment

6.2.1.1 Capital investment

Capital investment should be evaluated in terms of construction of automation and informatization, operation and maintenance of the information system.

Table 3 — Activity of capital investment for evaluation

| Activity | Description |
|---------------------------|---|
| Capital Investment | Investment to the IT equipments and systems |

6.2.1.2 Organization and planning

Organization and planning should be evaluated in terms of team of personnel, establishment of the organization, authority and defining of strategy related to the field of automation and informatization.

Table 4 — Activity of organization and planning for evaluation

| Activity | Description |
|----------------------------------|---|
| Organization and Planning | Team, organization, authority and strategy for automation and informatization |

6.2.1.3 Equipment and facilities management

Equipment and facilities management should be evaluated in terms of management of information equipments and facilities, industrial equipments and facilities.

Table 5 — Activity of equipment and facilities management for evaluation

| Activity | Description |
|--|--|
| Equipment and Facilities Management | Management of IT equipments and facilities |
| | Management of industrial equipments and facilities |

6.2.1.4 Information resources management

Information resources management should be evaluated in terms of construction of the information resources.

Table 6 — Activity of information resources management for evaluation

| Activity | Description |
|---|---|
| Information Resources Management | Collection, standardization, accumulation, integration, analysis, and management of information resources |

6.2.1.5 Information security management

Information security management should be evaluated in terms of protection of information security such as.

Table 7 — Activity of information security management for evaluation

| Activity | Description |
|---|--|
| Computer and Network Security Management | Implementation of protection of computer and networking security |
| System and Application Security Management | Implementation of protection of system security, application security and construction of the prevention mechanism |

6.2.2 Domain application aspect assessment

6.2.2.1 Product design

Product design should be evaluated in terms of digitalized model of the product, digital examination, comprehensive design and optimization, and intelligent design of a product.