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Visualization elements of PLM-MES interface

Part 2: 3D error feedback in heavy industry

National foreword

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Visualization elements of PLM-MES interface —

Part 2: 3D error feedback in heavy industry

*Éléments de visualisation pour l'échange de données entre
systèmes d'information de gestion du cycle de vie de produits
(PLM) et de pilotage de la production (MES) —*

*Partie 2: Remontée d'informations d'erreur sous forme 3D pour
l'industrie lourde*

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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 document 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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This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 4, *Industrial data*, and Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 24, *Computer graphics, image processing and environmental data representation*, and Technical Committee ISO/TC 171, *Document management applications*, Subcommittee SC 2, *Document file formats, EDMS systems and authenticity of information*.

A list of all parts in the ISO 3151 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.

Industry-specific product groups can be classified based on their economic lifespan. For example, there are clear differences in the economic lifespan of a nuclear power plant, an aircraft, a ship, an automobile, a TV, a smartphone, and mechanical or electronic parts.

An engineering plant, such as a power plant, consist of one million parts and has a service life of several decades. Being made-to-order (or custom-made), the demand for a 3D interface between PLM and MES in these specific use cases is generally high. See [Annex C](#) for use cases that illustrate the challenges of the 3D interface between PLM and MES.

On the other hand, less complex products such as motors, electronic components or control components used for communication or control have relatively shorter lifecycles. These products must be mass-produced to ensure economy validity and have a short economic life due to rapid technological advancement. Consequently, the demand for 3D interfaces between PLM and MES is not high. Manufactured products with a small set of parts are relatively less complex.

Visualization elements of PLM-MES interface —

Part 2: 3D error feedback in heavy industry

1 Scope

This document specifies a data model of visualization elements for 3D data exchange for error information feedback between product lifecycle management (PLM) and manufacturing execution system (MES or MOM: manufacturing operations management) in the engineering plant industry.

The followings are within the scope of this document:

- a) data model of visualization elements for the engineering plant industry with complex and long-lifespan products;
- b) definitions of the properties of the data model for the visualization elements of the PLM-MES interface;
- c) relationship with the information model of visualization elements as defined in ISO 10303-239;
- d) relationship with the information model of the visualization elements as defined in IEC 62264 series;
- e) information flow with equipment used in production and related measuring equipment as managed inside MES.

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/IEC 20924, *Internet of Things (IoT) and digital twin — Vocabulary*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO/IEC 20924 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 Terms and definitions

3.1.1

port

located, oriented and directed feature of the product's geometry model (1) for connecting the product with other ports to transfer media or (2) to fasten the product to other products, accessories, walls, ceilings, floors, etc. or (3) for executing control

[SOURCE: ISO 16757-2:2016, 3.3]

3.1.2

3D note

text information attached to graphical information of a digital shape model of a product

[SOURCE: ISO/TR 3151-1:2023, 3.1.1, modified — "3D" has been removed at the beginning of the definition.]

3.1.3

level of detail

LoD

alternate representations of an object at varying fidelities based on specific criteria

[SOURCE: ISO/IEC 18023-1:2006, 3.1.8]

3.1.4

interface

set of services and related service mechanisms, available via a logical or physical access point, provided by a *resource* ([3.1.8](#)), in order to transfer or exchange information, material, energy, and other manufacturing aspects

[SOURCE: ISO 18435-1:2009, 3.11, modified — Note 1 to entry was removed.]

3.1.5

entity

concrete or abstract thing in the domain under consideration

[SOURCE: ISO 8000-2:2022, 3.3.3]

3.1.6

heavy industry

industry that uses large machines to produce large and heavy products, large and heavy equipment and facilities, large machine tools, huge buildings and large-scale infrastructure

Note 1 to entry: Modified from Oxford Learner's Dictionaries.

3.1.7

social network service

SNS

electronic service designed to allow users to establish a personal or organizational profile and contact other individuals for the purpose of communicating, collaborating, and/or sharing content with them

[SOURCE: ISO 18461:2016, 2.4.16, modified — Notes 1 and 2 to entry were removed.]

3.1.8

resource

stock or supply of money, materials, staff and other assets that can be drawn upon to achieve a specific function or outcome

[SOURCE: ISO 24389-1:2023, 3.1.5]

3.1.9

point cloud

collection of 3D points in space referenced by their coordinate values

Note 1 to entry: A point cloud constitutes the raw data from a 3D scanner and needs to be translated to a human axis system.

[SOURCE: ISO 20685-1:2018, 3.9]

3.2 Abbreviated terms

3D	three dimensional
AP	application protocol
BOM	bill of material
eBOM	engineering BOM
ERP	enterprise resource planning
HHI	Hyundai heavy industries
ID	identifier
IEC	international electrotechnical commission
ISA	international society of automation
ISO	international organization for standardization
mBOM	manufacturing BOM
MES	manufacturing execution system
MOM	manufacturing operations management
P&ID	pipng and instrument diagram
PDA	personal digital assistant
PLCS	product life cycle support
PLM	product lifecycle management
R&D	research and development
SHI	Samsung heavy industries
STEP	standard for the exchange of product model data
xBOM	any BOM including eBOM, mBOM
X3DOM	X3D document object model
JT format	Jupiter tessellation format

4 PLM-MES interface

4.1 Needs for a PLM-MES interface in the heavy industry

In heavy and construction industries, 'custom-made' production (or 'personalized' production) has existed since the industry's early days, hundreds of years ago. Every product has an individual design, and due to the pressure to design products quickly, the production cycle begins even when the design is not yet complete.

In the electronics or automotive industries where mass production occurs, production begins after improving design quality through repetitive design. However, in the 'custom-made' industry, repetitive design is not possible due to design cost issues.

Procedures with partial overlap between design and production phases are widely used in concurrent engineering. In this context, design and production departments must work closely together and exchange data to avoid design errors. Since both the design and production departments operate in a 3D environment, 3D data needs to be shared between the two departments.

Even in a mass production industry such as the automotive industry, the need for a PLM-MES interface is growing as smart manufacturing spreads. The automotive industry is gradually moving from the mass production toward the mass customization and finally to the personalized production (lot size 1) similar to the heavy industry or the construction industry. As mass production industries move toward the personalized production, the needs for a PLM-MES interface between the production department and the design department are increasing.

Similarly, the PLM-MES interface is needed to compensate for the deviations between R&D (prototype production) facilities and mass production (volume production) facilities in mass production industries. In order to minimize deviations or errors between R&D facilities and mass production facilities, a PLM-MES interface including a 3D interface is needed. As personalized production progresses, it is expected that R&D (prototype production) facilities and mass production (volume production) facilities will become similar.

Because heavy industries have been engaged in 'custom-made' production since the early days of the industry, there are many use cases and extensive know-how for 'custom-made' production. On the other hand, it is still challenging to find good use cases for 'custom-made' production in mass-production manufacturing industries such as the automotive or electronics industries.

ISO 10303-239 and the IEC 62264 series

ISO 10303-239 (AP239) is an International Standard for PLM that defines an information model for product design, production processes and resources throughout the entire lifecycle of a product, as shown in [Figure 2](#).

AP239 is an application protocol (AP) that manages the lifecycle of a product. Therefore, [Figure 2](#) shows the relationship with other APs of the ISO 10303 series along the time axis of product development. The core of AP239 is to manage product overview data for the entire period, while other APs handle more detailed areas at specific points along the time axis.

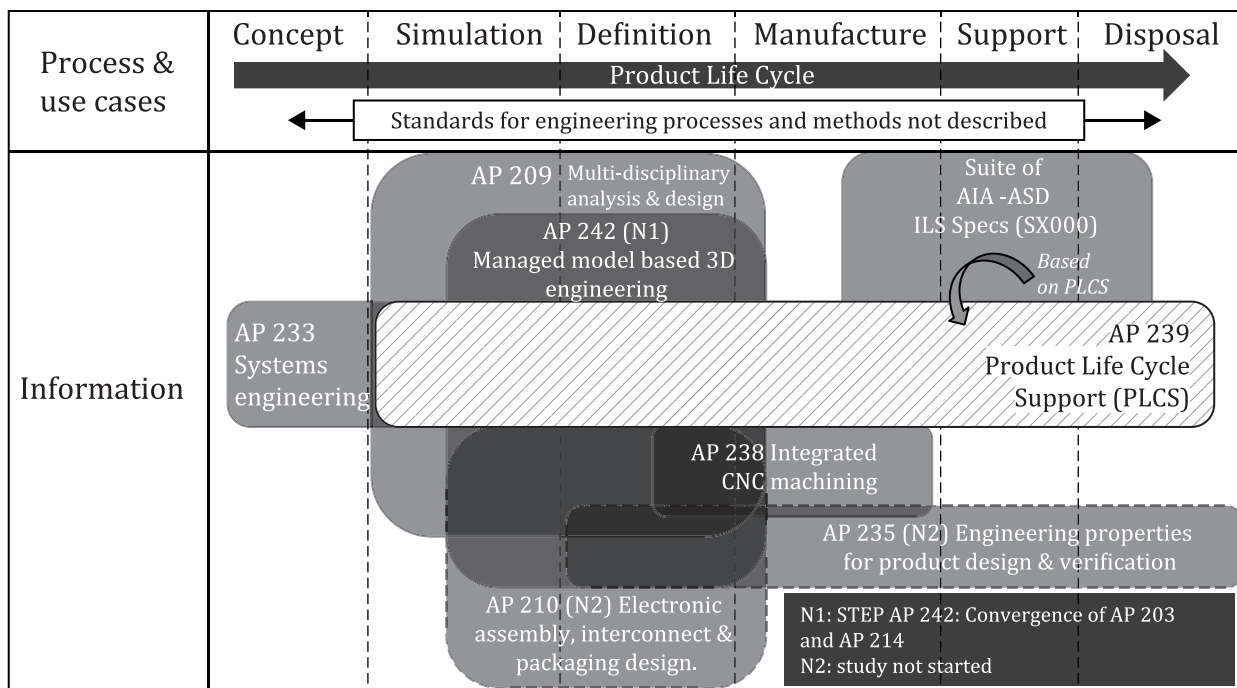
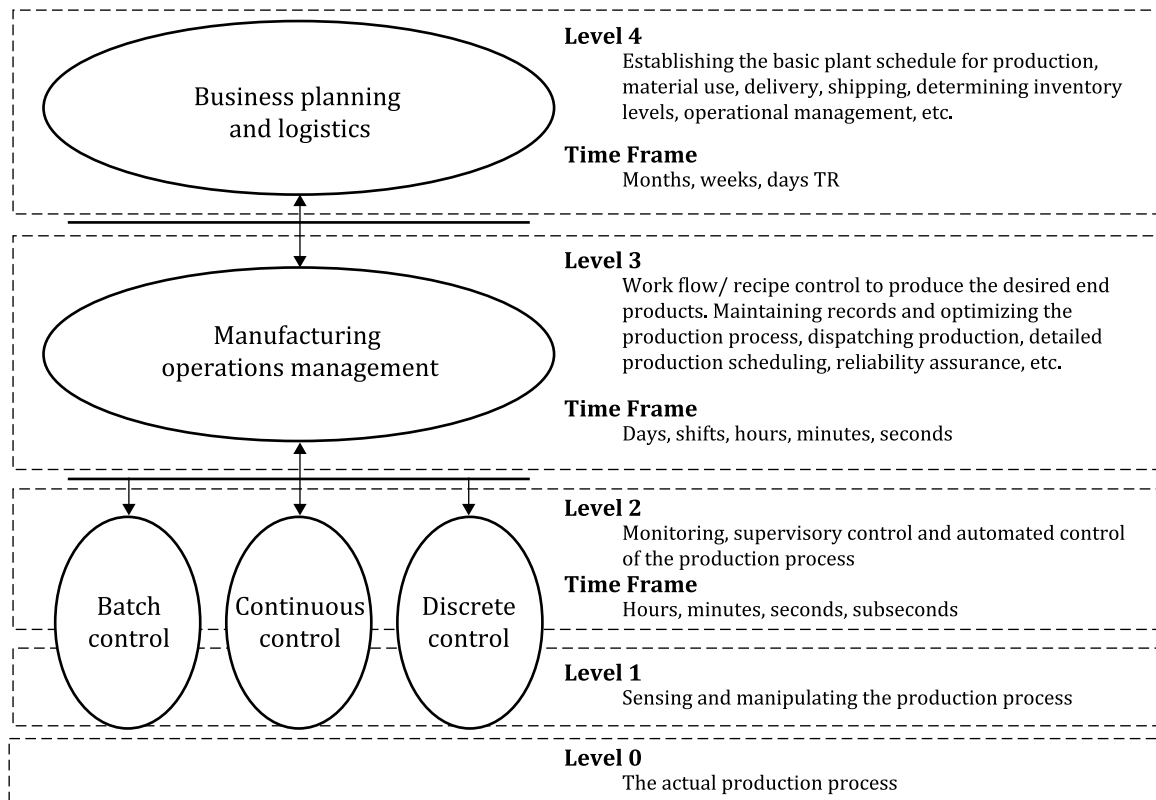


Figure 2 — Scope of ISO 10303-239 and related standards for PLM[21]

The PLM-MES interface between ERP and MES is standardized in IEC 62264-1, IEC 62264-2 and IEC 62264-5. The ERP-MES interface defines information models and methods for exchanging ERP and MES data. IEC 62264-3, IEC 62264-4 and IEC 62264-6 define the functions and properties of the MES (see [Figure 3](#)). The IEC 62264 series is developed based on ANSI/ISA-95.^[19] The entity correspondence between ISO 10303-239 and the IEC 62264 series is presented in [Annex A](#). The entity mapping is described in [Annex B](#).



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Figure 3 — Manufacturing functional hierarchy of IEC 62264-1

4.2 Generic workflow for 3D error feedback data exchange between PLM and MES

4.2.1 General

3D visualization elements for error feedback of the PLM-MES interface and the overall steps of data exchange are defined in [Figure 4](#). They are based on analysis of the PLM standards and MES standards, respectively. These definitions result from use case analysis, as shown in [Annex C](#), regarding the error data feedback from the production department in three heavy industries.

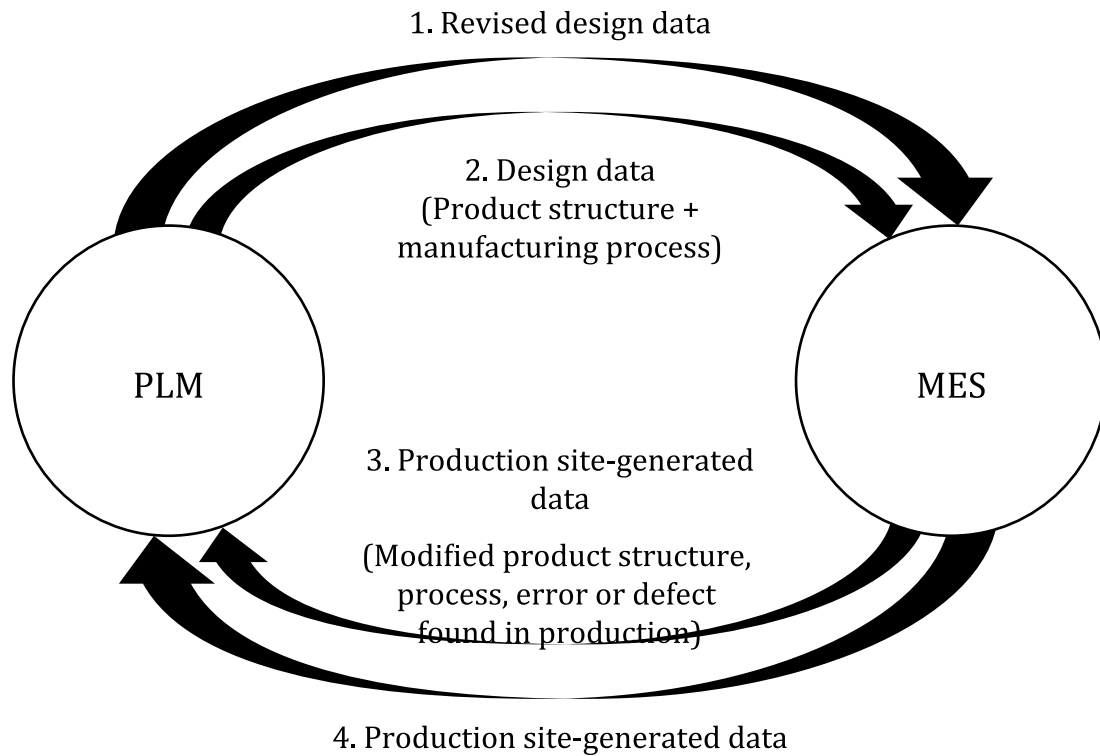


Figure 4 — Steps of error feedback data exchange between PLM and MES

[Figure 4](#) shows the use case of data exchange between the PLM of the design department and the MES of the production department. The use cases shown in [Annex C](#) have been collected from three shipbuilding and offshore companies in the Republic of Korea. The numbered business steps in [Figure 4](#) are described below.

4.2.2 Steps of error feedback data exchange between PLM and MES

4.2.2.1 Step 1

The design department uses PLM to transmit information such as 3D configuration data, drawings and process information to the production department, and the production department uses MES to produce products.

4.2.2.2 Step 2

The production department feeds back error information such as design error, process change, equipment change and equipment malfunction found during production planning or manufacturing to the design department through PLM.

4.2.2.3 Step 3

The design department updates the design data and delivers the updated information back to the production department. Depending on the type of design change, additional small-scale purchase requests to ERP and the purchasing department may occur.

4.2.2.4 Step 4

The production department can feed back the operation status data of the production equipment such as on-site information, indicating the normal operation status of the production equipment, temperature, RPM, pressure and product status such as deformation to the design department through the PLM-MES interface.