TECHNICAL REPORT

ISO/TR 3151-1

First edition

Visualization elements of PLM-MES interface —

Part 1: **Overview**

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) – vue d'ensemble —

Partie 1: Vue d'ensemble

PROOF/ÉPREUVE

Reference number
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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 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*.

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.

Introduction

This document is an overview of the ISO 3151 series of standards. It explains the main scope of the ISO 3151 series as well as why the Product Lifecycle Management and Manufacturing Execution System (PLM-MES) interface is needed. It also describes the elements constituting the PLM-MES interface and the visualization elements of the PLM-MES interface.

Product Lifecycle Management (PLM) is a technical item often covered within ISO/TC 184/SC 4 and in IEC/TC 65 where there is a standard for different lifecycles of various product parts. Conversely, Manufacturing Execution System (MES) is a technical item covered within ISO/TC 184/SC5, IEC/TC 65 and ISA (International Society of Automation). ISO/TC 184/SC 4 and SC 1 also cover the standard technology for the automatic machining of the product. Cooperation between these standards organizations is needed for standards in a PLM-MES interface.

Although literature is referenced to introduce the elements that make up the PLM-MES interface, more items are also referenced in [1-5] for the basis of this document.

Figure 1 shows the overall PLM-MES interface defined by this document and ISO 3151-2[1]. The left side in Figure 1 shows the contents of this document, and the right side shows the contents of ISO 3151-2.

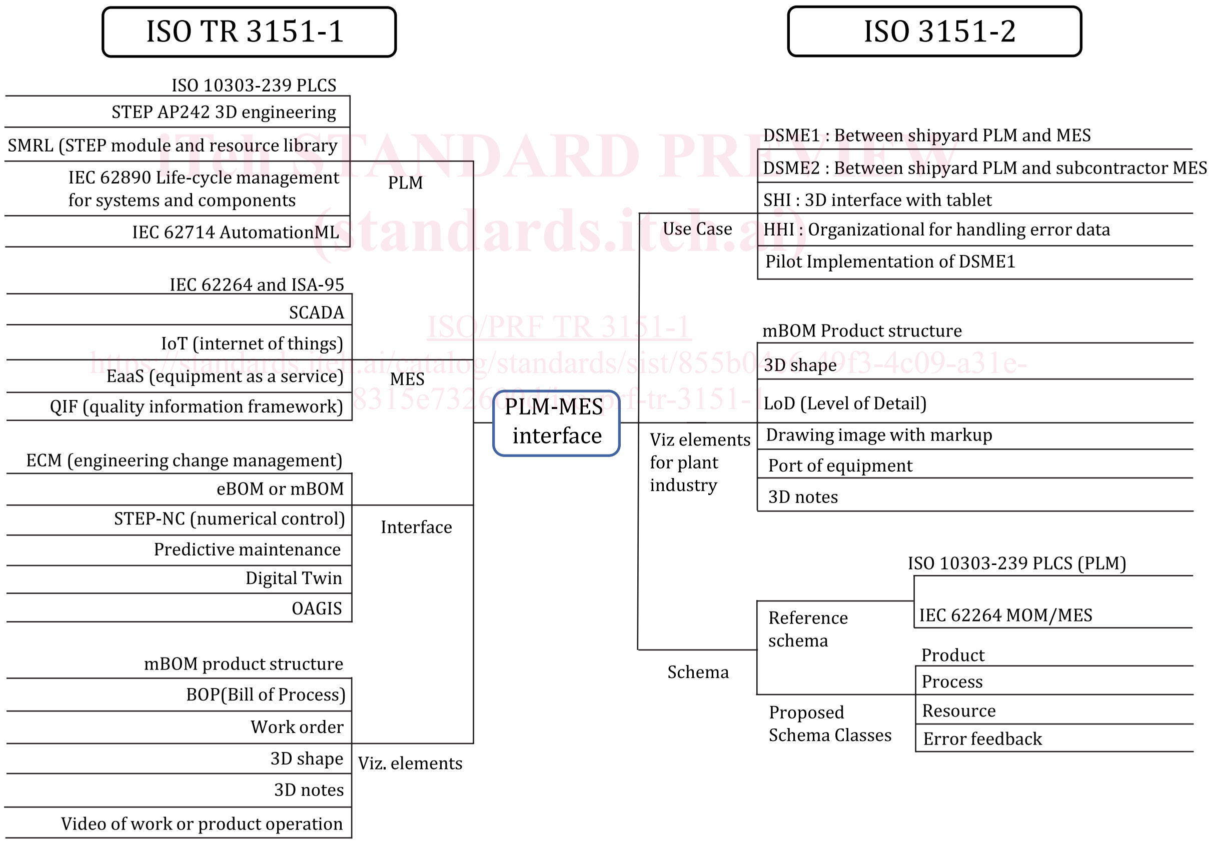


Figure 1 — Concept diagram of PLM-MES interface

The AP242 contains Product and Manufacturing Information (PMI), but its primary concern is to communicate design information to the manufacturing department. It is understood that the feedback loop from the manufacturing department to the design department is not well-supported. ISO 3151-2 focuses on a 3D interface that feeds back errors found by the production department to the design department.

1) Under development. Stage at the time of publication: ISO/CD 3151-2.

Visualization elements of PLM-MES interface —

Part 1:
Overview

1 Scope

This document outlines the visualization elements for data exchange between the Product Lifecycle Management and Manufacturing Execution System (PLM-MES) or Manufacturing Operations Management (MOM).

The following are within the scope of this document:

— the need for a PLM-MES interface;

— the technical elements that make up the PLM-MES interface;

— the visualization elements of the PLM-MES interface.

The following is outside the scope of this document:

— application of the PLM-MES interface and its visualization elements.

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, *Information technology — Internet of Things (IoT) — 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
3D note
3D text information attached to graphical information of a digital shape model of a product

3.1.2
batch size
number of jointly processed (semi-finished) products

[SOURCE: ISO 22468:2020, 3.1]

3.1.3
bill of material
BOM
listing of all the subassemblies, parts, and/or materials that are used in the production of a product, including the quantity of each material required to make a product

[SOURCE: IEC 62264-1:2013]

3.1.4
engineering bill of material
eBOM
list of part numbers and assemblies that make up the design engineering configuration that contains the raw stock size and the material specification.

[SOURCE: ISO 10303-240:2005, 3.4.3]

3.1.5
lot size
quantity of an item ordered for delivery on a specific date or manufactured in a single production run

Note 1 to entry: See [33].

3.1.6
manufacturing bill of material
mBOM
list of all the parts, labels, packaging, and assemblies required to build and ship a finished product to customers

Note 1 to entry: mBOM is different from an engineering bill of material (eBOM) which provides the as-designed BOM.

Note 2 to entry: See Annex A.

3.1.7
manufacturing execution system
MES
system for producing the desired products or services, including quality control, document management, plant floor dispatching, work-in-process tracking, detailed product routing and tracking, labour reporting, resource and rework management, production measurement and data collection

[SOURCE: ISO 16100-1:2009, 3.14]

3.1.8
manufacturing operations management
MOM
activities within Level 3 of a manufacturing facility that coordinate the personnel, equipment and material in manufacturing

[SOURCE: IEC 62264-1:2013, 3.1.22]

3.2 Abbreviated terms

3D	Three Dimensional
AAM	Application Activity Model
AIC	Application Interpreted Construct
AIM	Application Interpreted Model

ANSI	American National Standards Institute
AP	Application Protocol
ARM	Application Reference Model
ATO	Assemble-To-Order
BOD	Business Object Document
BOM	Bill of Material
BOP	Bill of Process
CAI	Computer-Aided Inspection
CAPP	Computer-Aided Process Planning
CC	Conformance Class
CMM	Coordinate Measuring Machine
DTO	Design-To-Order
EaaS	Equipment as a Service
eBOM	Engineering BOM
ECM	Engineering Change Management
ECN	Engineering Change Notification
ECO	Engineering Change Order
ECR	Engineering Change Request
ERP	Enterprise Resource Planning
ETO	Engineer-To-Order
GD&T	Geometric Dimensioning & Tolerancing
HVAC	Heating Ventilation Air Conditioning
IEC	International Electrotechnical Commission
IIoT	Industrial Internet of Things
IoT	Internet of Things
IR	Integrated Resource
ISA	International Society of Automation
ISO	International Organization for Standardization
mBOM	Manufacturing BOM
M2M	Machine-to-Machine
MES	Manufacturing Execution System

MOM	Manufacturing Operations Management
MS	Mapping specification
MTO	Make-To-Order
MTS	Make-To-Stock
NC	Numerical Control
OAGIS	Open Applications Group Interface Specification
OPC-UA	Open Platform Communications Unified Architecture
PDA	Personal Digital Assistant
PLC	Programmable Logic Controller
PLCS	Product Lifecycle Support
PLM	Product Lifecycle Management
PMI	Product Manufacturing Information
QIF	Quality Information Framework
SCADA	Supervisory Control and Data Acquisition
SMRL	STEP Module and Resource Library
STEP	Standard for the Exchange of Product model data
SW	Software
WSN	Wireless Sensor Network

3.3 Difference between MES and MOM

The terms MES (manufacturing execution system) and MOM (manufacturing operations management) system are often used interchangeably, so that by defining different functional spaces for manufacturing professionals it can be confusing.

The term MES is commonly used in commercial products, whereas the term MOM is often used to summarize the technical features. While MOM covers the set of functions defined in this document, MES is the commercial product that implements the set of functions as a SW system, so there are variations in MES depending on the commercial product.

Because the term MES is used in many different senses, it is difficult to give an unambiguous, agreed-upon definition. However, many manufacturers mention MES in their daily work, and software vendors also use MES as their product name, so it is difficult to exclude the use of MES from a general discussion. Therefore, this document uses the term MES in high-level abstractions where there is no confusion.

MOM is used to represent a standard management process, while MES is used to represent a software system for MOM. Therefore, MES has a different scope or level depending on the implementation of the system. In this document, MES is mainly used, and if there is confusion and a clear definition is needed, the problem is solved by using the term of MOM defined by IEC and ISA.

As shown in Figure 2, ISA-95 defines the term MOM to cover Level 3 architecture and its functions. As smart manufacturing is integrated into the Industrial Internet of Things (IIoT) in the future, changes to the Figure 2 model are expected.

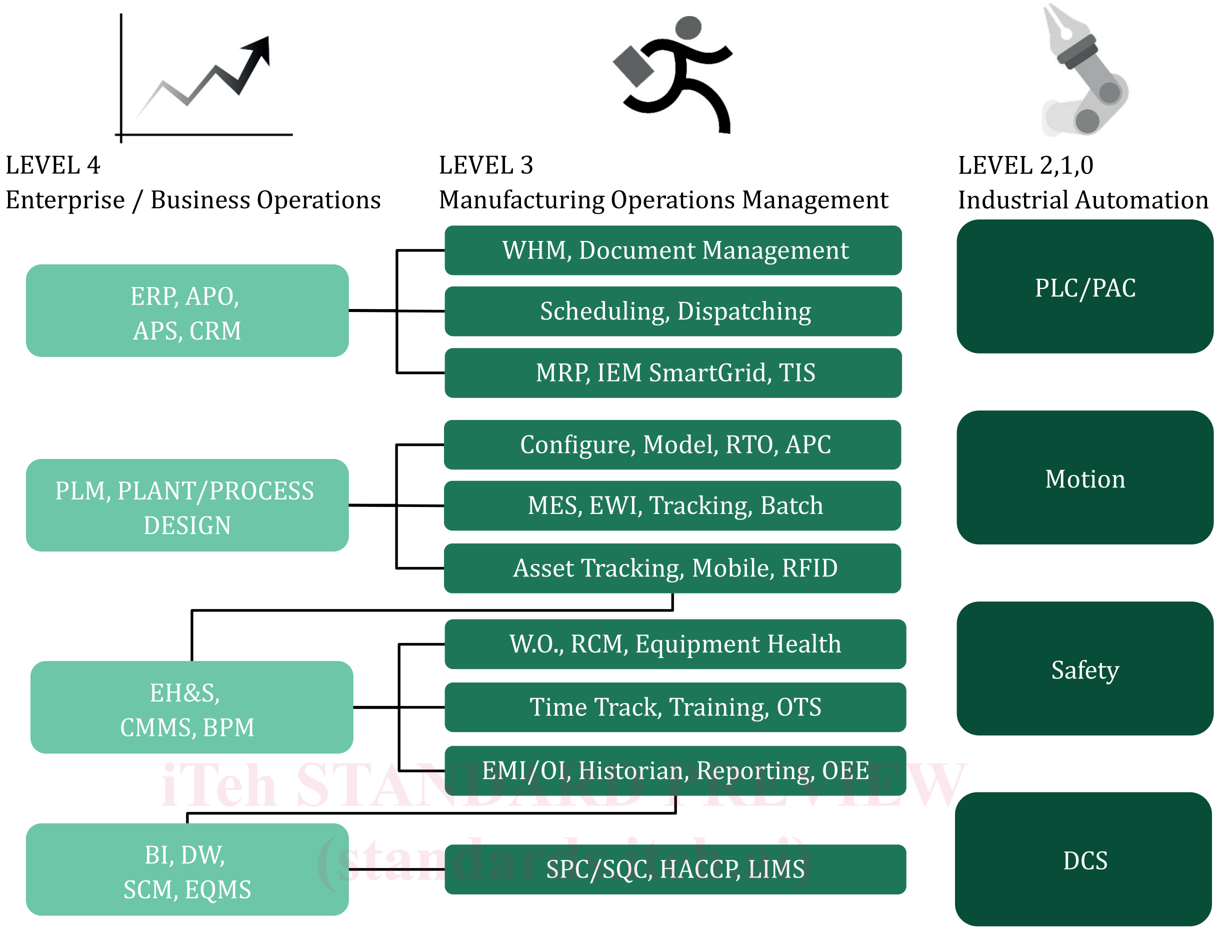


Figure 2 — 3 level architecture of MOM[6]

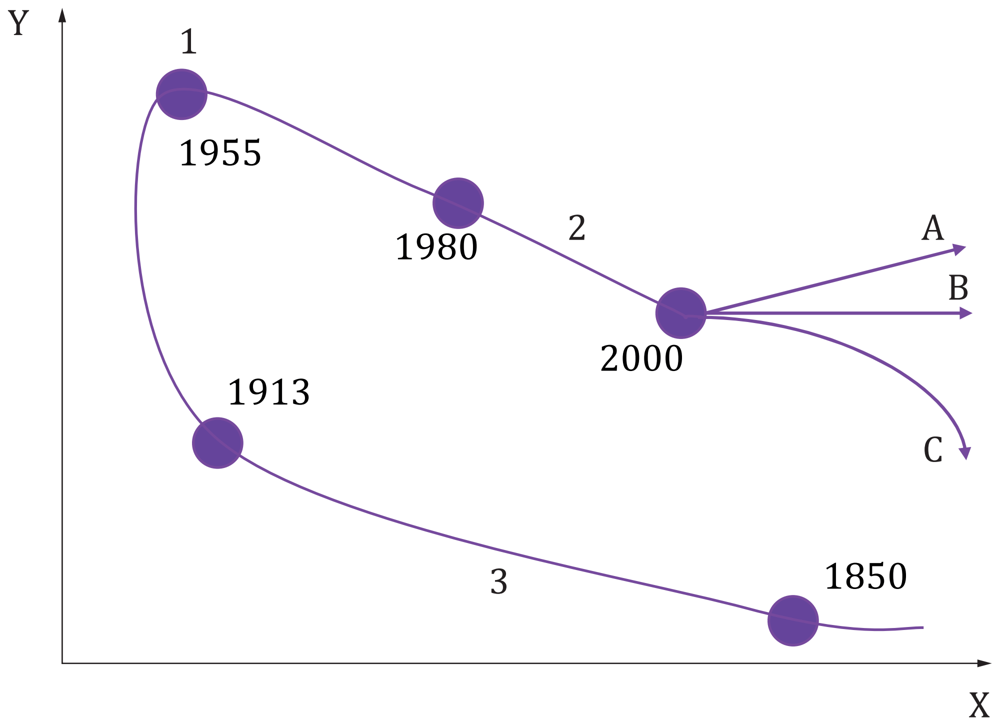
4 Needs for a PLM-MES interface

4.1 General

The modern commercial market has more suppliers than demand, so customers have more power than suppliers. Because of this imbalance, suppliers promote 'mass customization' to satisfy customers, and that force drives the concept of 'personalized production'.

The problem with customization is that it can increase manufacturing costs and time. The PLM-MES interface technology can help to provide personalized products with mass-production-level prices.

Figure 3 shows the technological development history of growing customer demand moving from manual production in the mid-19th century to mass production methods symbolized by the conveyor belt of Ford Motor Company in the early 20th century emerge and mature until the mid-20th century, with technological advancements as customer demand expands. Mass customization has been introduced since the late 20th century due to oversupply caused by the development and automation of production. It also shows the development process of personalized production, which has been introduced in line with the globalization trend of the 21st century.



Key

X product variety
Y product volume per variant
1 massive production
2 mass customization
3 craft production
A globalization
B regionalization
C personalized production

Figure 3 — Personalized production[7]

Another issue other than the cost issue of personalized production is the maturity level of the design. In the case of mass production environment, a small design error causes a big problem (high cost and time delay) in automated production lines. Therefore, a higher level of maturity of the design is needed. Through a series of test production cycles, the level of design maturity is further increased. This requires a high design cost through multiple stages of design cycles and verification. Since the design cost is relatively low compared to the mass production and production cost, it is possible to increase the design maturity level.

In the case of personalized production, it is difficult to increase the maturity level of the design due to cost or time constraints. Since only one is produced using the design, the design cost cannot be large, and the design time must be short for economic reasons. In many cases, production begins before the design is finished, so there is more possibility of production problems due to the immature design. In order to correct errors found after the design is completed, the design is sometimes modified during the production process. Modification of the errors found during production increases the total time of production, and the cost increases accordingly.

Figure 4 shows the current (As-Is) interface between PLM, ERP and MES systems optimized for mass production environments. Typically, ERP does not deal with 3D engineering information such as 3D CAD models, a separate direct 3D link between PLM and MES is sometimes required. A typical mass production situation is that a production system is optimized for mass production through a series of

