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Industrial automation systems and integration — Industrial manufacturing management data —

Part 44:
Information modelling for shop floor data acquisition

Systèmes d'automatisation industrielle et intégration — Données de gestion de fabrication industrielle —

Partie 44: Modélisation de l'information de gestion de fabrication pour l'acquisition des données d'atelier

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Contents

Page

Figures:

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.

International Standards are drafted in accordance with the rules given in ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15531-44 was prepared by Technical Committee ISO/TC 184, *Automation systems and integration,* Subcommittee SC 4, *Industrial data.*

A complete list of parts of ISO 15531 is available from the Internet.

Introduction

ISO 15531 is an International Standard for the modelling of data used in the manufacturing management (excepted product and component data as well as catalogue or library data that are modelled using ISO 10303 and ISO 13584). ISO 15531-31 and ISO 15531-32 address the modelling of data used for the management of resources usage, whereas ISO 15531-43 addresses the modelling of manufacturing management data and ISO 15531-42 provides a time model.

The other data that are used for manufacturing management include some data that are captured at the control level of manufacturing, but that are stored at the management level and used at this level to manage manufacturing for quality, maintenance, rescheduling or any other management purpose.

These data are very often captured in various formats that are determined by the device and process constraints. The time stamping and time measure related to this data capture, as well as the batch and resource to which this capture is associated, are also needed to manage manufacturing in an efficient way. Each occurrence of time measure and time stamping is also specific to the resource and its result is further related to a unique time model and reference.

After several translation operations and handling, the raw data collected from level 2 become level 3 data. They are stored in a database that gathers and organizes all the collected data in accordance with level 3 models that are predefined to be reusable. Their subsequent usage in various manufacturing management software implies that the corresponding models are well defined and unique for given information, even if that kind of information can appear several times from several resources.

NOTE   The definitions of functional levels used here are those of IEC 62264-1 and are repeated for information in Clause 4 of this part of ISO 15531. The monitoring and control of physical devices belongs to level 2, while the management of manufacturing operations belongs to level 3. This part of ISO 15531 addresses the modelling of level 3 data that are the result of the collection at level 2 of raw data and the result of their translation and handling. The translation and handling are outside the scope of this part of ISO 15531.

It is the aim of this part of ISO 15531 to provide, for those data, models that are shareable by any software used to manage and improve manufacturing.

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Industrial automation systems and integration — Industrial manufacturing management data — Part 44: Information modelling for shop floor data acquisition

1 Scope

This part of ISO 15531 addresses the modelling of the data collected from data acquisition systems at control level to be stored at the manufacturing management level and processed further at this level for any management purpose.

The following is within the scope of this part of ISO 15531:

— quantitative or qualitative data collected from data acquisition systems at the control or management level to be stored at the management level and used later on to manage manufacturing;

— time stamping and time measurement provided from data acquisition systems for control and management data.

The following is outside the scope of this part of ISO 15531:

— any data only related to remote and real time measurement and management;

— product definition data as modelled in ISO 10303 (see ISO 10303-1);

— catalogue and library data as modelled in ISO 13584 and ISO 15926;

— control data that are only used at the control level as well as those that are not used for manufacturing management.

2 Normative references

The following referenced documents are indispensable for the application 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 10303-11, *Industrial automation systems and integration – Product data representation and exchange – Part 11: Description methods: The EXPRESS language reference manual*

ISO 13584-1, *Industrial automation systems and integration – Parts library – Part 1: Overview and fundamental principles*

ISO 13584-24, *Industrial automation systems and integration – Parts library – Part 24: Logical resource: Logical model of supplier library*

ISO 15531-1, *Industrial automation systems and integration – Industrial manufacturing management data – Part 1: General overview*

ISO 15531-31, *Industrial automation systems and integration – Industrial manufacturing management data – Part 31: Resource information model*

ISO 15531-32, *Industrial automation systems and integration – Industrial manufacturing management data: Resources usage management – Part 32: Conceptual model for resources usage management data*

ISO 15531-42, *Industrial automation systems and integration – Industrial manufacturing management data – Part 42: Time Model*

ISO 15531-43, *Industrial automation systems and integration – Industrial manufacturing management data – Part 43: Manufacturing flow management data: Data model for flow monitoring and manufacturing data exchange*

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
beginning date
instance of point in time that identifies an event that is the starting point of something noticeable and durable

NOTE   Point in time is defined in ISO 15531-42.

EXAMPLE   Beginning date of a data capture occurrence, of a task, of a measure, or of a state change.

3.1.2
connection
junction of an identifier to another identifier related to an assembly operation

EXAMPLE   Joining of a part batch number to a subset.

NOTE   A connection does not have property or attribute while association is a semantic relationship.

3.1.3
ending date
instance of point in time that identifies an event which is the ending point of something noticeable that has had duration

NOTE   Point in time is defined in ISO 15531-42.

EXAMPLE   Ending point of an activity, of a data capture.

3.1.4
event
something noticeable that takes or can take place at a given place and point in time

EXAMPLE   The start of a given activity, the anniversary of another event, the end of machine failure.

3.1.5
genealogy
connection that relates unique identifiers

EXAMPLE   Joining a serial number to another serial number.

NOTE   Genealogy is not a semantic relationship. For example no property or attribute is associated to the junction between the serial numbers of the previous example.

3.1.6
hazard event
noticeable failure during a manufacturing process

NOTE   The failure is noticeable enough to be recorded in the database. It can be caused by the resource on which the event appears or by a previous event.

3.1.7
manufacturing
function or act of converting or transforming material from raw material or semi-finished state to a state of further completion

NOTE   Definition adapted from APICS dictionary.

[ISO 15531-1:2004, definition 3.6.22]

3.1.8
manufacturing order
document, group of documents, or schedule conveying authority for the manufacture of specified parts or products in specified quantity

NOTE 1   A manufacturing order identifies a unit of scheduled work to be manufactured; it includes, for example, a reference, a quantity and a due date. The manufacturing order is also the event that triggers a manufacturing operation.

NOTE 2   Adapted from APICS dictionary.

3.1.9
manufacturing process
structured set of activities or operations performed upon material to convert it from the raw material or a semi-finished state to a state of further completion

NOTE   Manufacturing processes may be arranged in process layout, product layout, cellular layout or fixed position layout. Manufacturing processes may be planned to support make-to-stock, make-to-order, assemble-to-order, etc., based on strategic use and placements of inventories.

[ISO 15531-1:2004, definition 3.6.25]

3.1.10
operation mode
one of the ways of operation expected from a resource and set up in a given application

NOTE 1   Each machine can have one or more operation modes (e.g. automatic, step-by-step, manual) determined by the type of machine and its application.

NOTE 2   The operation mode is selected from the available ones by the operator.

NOTE 3   The operation mode is represented in the model by the entity **mode** (see 6.7.2).

3.1.11
process
structured set of activities involving various enterprise entities, that is designed and organized for a given purpose

NOTE   The definition provided here is very close to that given in ISO 10303-49. Nevertheless ISO 15531 needs the notion of structured set of activities, without any predefined reference to the time or steps. In addition, from the point of view of flow management, some empty processes may be needed for a synchronisation purpose although they are not actually doing anything (ghost task).

[ISO 15531-1:2004, definition 3.6.29]

3.1.12
product defect
anomaly identified, during a control, on a badly manufactured product

3.1.13
resource
device, tool and means at the disposal of the enterprise to produce goods or services

NOTE 1   Resources as defined in ISO 15531-1 except raw material, products and components that are considered from a system theory point of view as parts of the environment of the system and do not belong to the system itself. Furthermore, this definition includes the definition from ISO 10303-49 but is included in the definition that applies for ISO 18629-14 and ISO 18629-44 that also includes raw materials and consumables as well as ISO 18629-13.

NOTE 2   Resources, as they are defined here, include human resources considered as specific means with a given capability and a given capacity. Those means are considered as being able to be involved in the manufacturing process through assigned tasks. That does not include any modelling of an individual or common behaviour of human resource excepted in their capability to perform a given task in the manufacturing process (e.g. transformation of raw material or component, provision of logistic services). That means that human resources are only considered, as the other ones, from the point of view of their functions, their capabilities and their status (e.g. idle, busy). That excludes any modelling or representation of any aspect of individual or common "social" behaviour.

NOTE 3   Adapted from ISO 15531-1:2004, definition 3.6.43.

3.1.14
state
condition or situation during the life of an object during which it satisfies some condition, performs some activity, or waits for some event

[ISO 15745-1:2003, definition 3.31]

NOTE   The meaning of state here is similar to the meaning of state in "state automaton".

3.1.15
work order
unit of scheduled work, that can be dispatched to a resource and addresses a specific phase of the manufacturing process

NOTE   A work order can be dispatched to a physical device and/or a human (or group of humans), that are the two subclasses of the entity resource. This work order consists of lower level elements and is a component of a manufacturing order.

3.2 Abbreviated terms

KPI	Key Performance Indicator
LAN	Local Area Network
PLC	Programmable Logic Controller
PLIB	Parts Libraries (ISO 13584)
MANDATE	Manufacturing Data Exchange (ISO 15531)
STEP	STandard for the Exchange of Product model data (ISO 10303)

4 General purpose and scope of ISO 15531

ISO 15531, also known as MANDATE, specifies the characteristics for a representation of manufacturing management information over the entire industrial process, with the necessary mechanisms and definitions to enable manufacturing management data to be shared and exchanged within the factory, with other plants or with companies.

Exchanges are made through different computer systems and environments associated with the complete industrial process. ISO 15531 (see ISO 15531-1, ISO 15531-31, ISO 15531-32, ISO 15531-42 and ISO 15531-43) focuses on discrete manufacturing but is not limited to it. Nevertheless, any extension to industrial processes which does not belong to discrete manufacturing is always under consideration when it does not imply any contradiction or inconsistency with the initial objective of ISO 15531.

The following are within the scope of ISO 15531:

— the representation of production and resources information including capability capacity, monitoring, maintenance constraints and control;

NOTE 1 Maintenance constraints and relevant maintenance management data are taken into account from the point of view of their impact on the flow control.

— the exchange and sharing of production information and resources information, including storing, transferring, accessing and archiving.

The following are outside the scope of ISO 15531:

— enterprise modelling;

NOTE 2 That means that tools, architecture and methodologies for the modelling of an enterprise as a whole are not within the scope of ISO 15531.

— product data (representation and exchange of product information);

— component data (parts library: representation and exchange of computer-interpretable parts library information);

— cutting tools (electronic representation for exchange of cutting tool data);

— technical maintenance information (technical information such as those included in devices repair, operation and maintenance manuals).

IEC 62264-1 identifies the following five levels for the functions related to manufacturing operation:

— Level 0 that addresses actual physical process;

— Level 1 that addresses functions involved in the sensing and manipulating the physical process;

— Level 2 that addresses functions involved in the monitoring and controlling of the physical; process

— Level 3 that addresses functions involved in managing the work flows to produce the desired end-products;

— Level 4 that addresses functions involved in the business-related activities needed to manage a manufacturing organization;
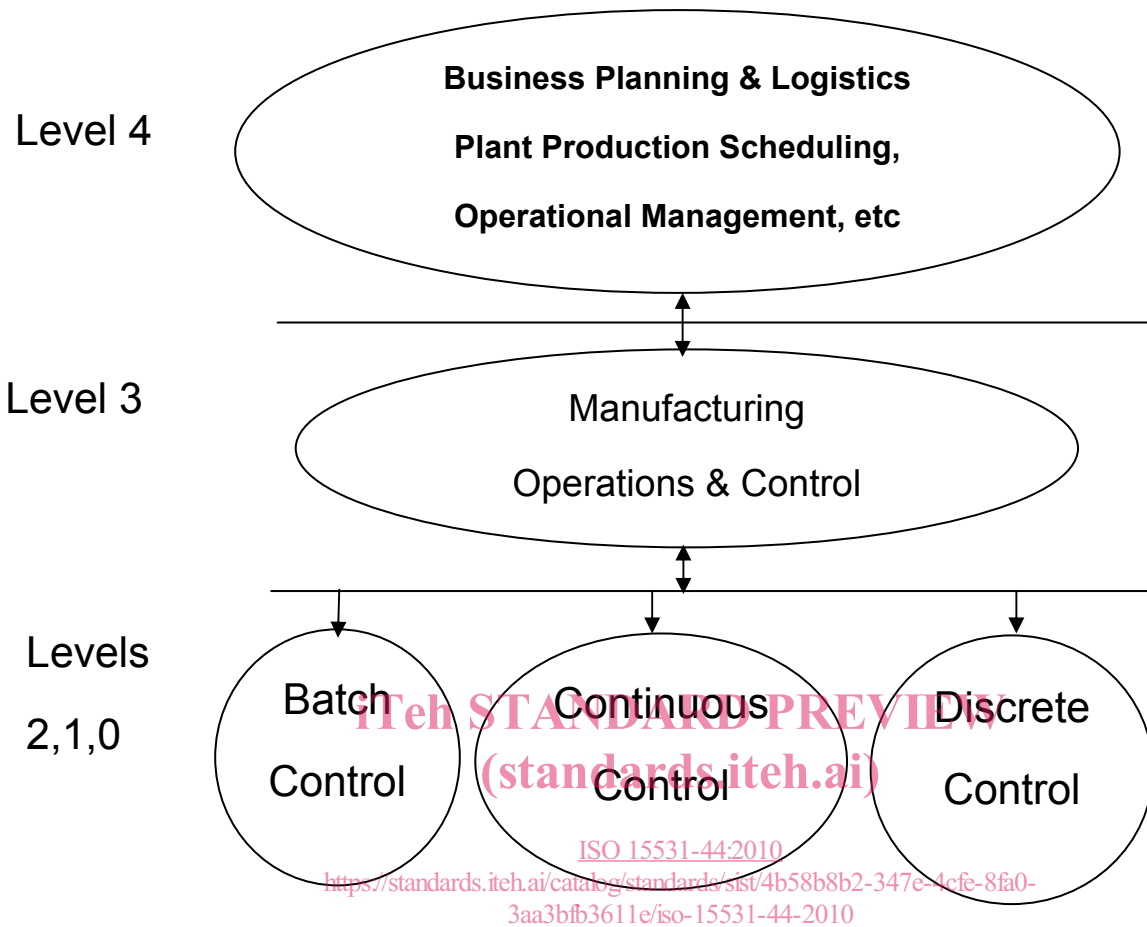
Figure 1 shows the hierarchy of functional levels

Figure 1: Functional Levels (From IEC 62264-1)

ISO 15531 addresses the modelling of any data (excepted product data) that are suitable to manage manufacturing operations (See ISO 15531-31, ISO 15531-32 and ISO 15531-43). Even if in this context ISO 15531 addresses level 3 or level 4 functions it models any data suitable for the management of manufacturing operations including data that are collected at other levels.

5 Purpose, principles and structure of this part of ISO 15531

5.1 Purpose of this part of ISO 15531

The data acquisition process in a shop floor collects data at level 2 (shop floor level), it provides their identification and their content before their provision to the level 3 (Manufacturing management level). These manufacturing data may address the devices, the manufacturing batches, the products or the staff. They are requested for the KPI calculations, for the manufacturing and quality monitoring and for the improvement of manufacturing operations. They enable also the validation of shop floor models and scheduling scenario.

The compliance to a model eases the collection and organization as well as the handling of the data in the database built at level 3 (Manufacturing management level) for historic and management purpose and the set up, of shop floor monitoring systems as well of their interoperability,

5.2 Basic principles of this part of ISO 15531 and overview of the main entities

According to the fact that the model shall be as generic as possible and easy to specialize, the entities described in the model are themselves as generic as possible. Their specialisation, if needed, shall be obtained through the use of PLIB libraries (See ISO 13584-1 and ISO 13584-24). In that case the specialisation process is roughly described in the standard.

The model is mainly focused on the relationships between the manufacturing process events, activities, state changes, it enables nevertheless the modelling of any data collected at level 2 for a manufacturing management and or improvement purpose (level 3).

The main entities defined or used in the model are listed and outlined below:

NOTE 1   Some entities that are referenced from other schema and/or are service entities are just described and specified in clause 6, but they are not listed nor described below

— **Duration_reference;**

— **Equipment;**

— **Equipment_header;**

— **Hazard_event;**

— **Manufacturing_batch;**

— **Manufacturing_order;**

— **Manufacturing_order_header;**

— **Manufactured_product;**

— **Material_consumption;**

— **Measurement_result;**

— **Mode;**

— **Product_defect;**

— **State;**

— **Stock;**

— **Time_reference;**

— **Work_order.**

The **batch** entity addresses the lot of products or components scheduled to be produced or the lot of products or components that is produced in a range of operation.

NOTE 2   For discrete products or components the batch may be a standard set of products or components scheduled to be manufactured, while for non-discrete products the batch is the quantity that is planned to be produced in a given period based on a formula or recipe that is often developed to produce a given number of end items (APICS dictionary).