
**Industrial automation systems and
integration — Manufacturing Automation
Programming Environment (MAPLE) —**

**Part 2:
Services and interfaces**

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*Systèmes d'automatisation industrielle et intégration — Environnement de
programmation d'automatisation de fabrication (MAPLE) —*

Partie 2: Services et interfaces

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 part of ISO 13281 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 13281-2 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 5, *Architecture, communications and integration frameworks*.

ISO 13281 consists of the following parts, under the general title *Industrial automation systems and integration — Manufacturing Automation Programming Environment (MAPLE)*:

— *Part 1: Functional architecture*

— *Part 2: Services and interfaces*

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Annex A forms a normative part of this part of ISO 13281.

Introduction

Over the recent past, manufacturing systems have become considerably more flexible and have acquired greater functionality. The numbers and types of component devices of manufacturing systems, such as NC machines, robots, automated guided vehicles, programmable controllers and manufacturing cells have increased. Manufacturing engineers are thus required to develop and update programs not only for many kinds of individual devices but also for combinations of devices. Due to this fact, the difficulty of integrating and programming the control of manufacturing operations has increased.

Manufacturing programs have an intense need for a large variety of manufacturing data, including product oriented data, process oriented data, operation oriented data and management oriented data. This diversity means that manufacturing data has a much more complicated and varied schema than the processing data encountered in other systems, e.g., business systems. Therefore, the use and management of manufacturing databases requires a manufacturing oriented approach. The concept of MAPLE is intended to provide assistance to address this need.

MAPLE assists program developers, planners and operators in a manufacturing automation environment to generate programs and prepare them for their execution.

MAPLE will assist in the following activities:

- a) generation of programs to control devices, cells, shop floors and factories, either manually or with computer assisted tools;
- b) manufacturing and process planning;
- c) checking and preparation of resources;
- d) preparation of manufacturing data sets for execution (e.g., post processing).

The outcomes of these activities are:

- a) manufacturing data sets (e.g., geometry, tools, technology, sequence of operations, setups, measuring, testing, handling);
- b) cell, shop floor and factory monitoring and control programs.

This standard for MAPLE services and interfaces builds upon the functional architecture as specified in ISO 13281-1. The functional architecture provides a manufacturing data dictionary and a manufacturing software dictionary that facilitate the separation of the underlying data sources and I/O requirements, in whatever format, from the executing manufacturing task. Hence, MAPLE provides a mechanism by which a number of diverse data sources and software tools can be integrated seamlessly.

ISO 13281-1 and 13281-2 are intended to guide software developers of MAPLE environments as well as system integrators and software tool developers. The standard for MAPLE services and interfaces relies on ISO/IEC DIS 14750 for the interface description language, and ISO/IEC 10746 for presenting Open Distributed Processing (ODP) view points.

Other relevant work such as aspects of STEP (ISO 10303, Product data representation and exchange) data and the content of data files used in the NC machining environment for example, will be addressed in a potential new work item on the MAPLE data dictionary and software program dictionary.

ISO 13281-1 provides an overview of the MAPLE functional architecture in order to aid in the understanding of how MAPLE services might be provided through a number of functional components within MAPLE, and their internal and external interfaces.

MAPLE is a building block that can be applied at any level within a manufacturing enterprise. Separate MAPLE implementations can be configured and connected within an enterprise as required.

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Industrial automation systems and integration — Manufacturing Automation Programming Environment (MAPLE) —

Part 2: Services and interfaces

1 Scope

This part of ISO 13281 specifies a minimum set of services to be provided and interface requirements for creating a MAPLE. The specifications in this part of ISO 13281 are specifically for software developers of MAPLE environments, system integrators, and software tool developers. Specifications that address the needs of users such as program developers, planners and operators in a manufacturing automation environment are outside the scope of this document.

This part of ISO 13281 only specifies the interface at the application layer between MAPLE and software programs.

The creation or deletion of a Manufacturing Database, as well as specifications for the MAPLE Data Dictionary and MAPLE Software Dictionary beyond the dictionary definition schema, are outside the scope of this part of ISO 13281.

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2 Conformance

To be conformant with this part of ISO 13281, an implementation shall use the concepts and rules of this part of ISO 13281.

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3 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 13281. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 13281 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC 9579-1:1993, *Information technology — Open Systems Interconnection — Remote Database Access — Part 1: Generic Model, Service and Protocol.*

ISO/IEC 9579-2:1998, *Information technology — Open Systems Interconnection — Remote Database Access — Part 2: SQL Specialization.*

ISO/IEC 9579-3:1996, *Information technology — Open Systems Interconnection — Remote Database Access — Part 3: SQL specialization Protocol Implementation Conformance Statement (PICS) proforma.*

ISO/IEC 10646-1:1993, *Information technology — Universal Multiple-Octet Coded Character Set (UCS) — Part 1: Architecture and Basic Multilingual Plane.*

ISO/IEC 10746-3:1996, *Information technology — Open Distributed Processing — Reference Model: Architecture.*

ISO 13281:1997, *Industrial automation systems — Manufacturing Automation Programming Environment (MAPLE) — Functional architecture.*

ISO/IEC 14750:1999, *Information technology — Open Distributed Processing — Interface Definition Language.*

4 Terms and definitions

For the purposes of this part of ISO 13281, the following terms and definitions apply. Italicized words in the definitions are terms that appear elsewhere in this clause. Components of the MAPLE architecture appear capitalized.

4.1

action

elemental description of a work request to external *Manufacturing Software Programs* or other *MAPLEs*

4.2

data classification

identifier of a computer-readable representation of data for a specific application

EXAMPLES Bill of materials, CL file format, STEP format.

4.3

data classification catalogue

user-specified or vendor-specified unique collection of *data classifications* used within *MAPLE*

4.4

data source

description of the data schema, data location and access method to the data for a particular data format that is registered in *MAPLE*

4.5

data storage type

particular type of data storage system used

EXAMPLES Directory files, Oracle database, Access database, ONTOS, ODBC data source.

4.6

data storage type catalogue

user-specified or vendor-specified unique collection of *data storage types* of the manufacturing databases connected to *MAPLE*

4.7

Data Translator

manufacturing software program for converting the representation of data

4.8

Dictionary Manager

manufacturing software program to facilitate the manipulation of the *Manufacturing Data Dictionary* and the *Manufacturing Software Dictionary*

4.9

Execution Manager

software that controls the sequence of execution of internal processes of *MAPLE* and the external *Manufacturing Software Programs*

4.10

logical-to-physical mapping

relationship between the *data sources* and the physical data stored in the *Manufacturing Data Dictionary*

4.11

Manufacturing Database

data repository, possibly distributed, containing product, process, facility and management oriented data

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4.12**Manufacturing Data Dictionary**

collection of storage types of the *Manufacturing Databases* and the description of the *data sources*

4.13**Manufacturing Data Manager**

Manufacturing Software enabling access to the *Manufacturing Databases*

4.14**Manufacturing Software Dictionary**

collection of descriptions of the capabilities and invocations of *Manufacturing Software Programs*

4.15**Manufacturing Software Programs**

software, registered in the *Manufacturing Software Dictionary*, which have command and information connections with *MAPLE* through the *MAPLE* interface

4.16**MAPLE**

Manufacturing Automation Programming Environment, a common vendor-independent neutral support facility for the programming of multiple manufacturing devices and controls

4.17**MAPLE Engine**

function for receiving and handling requests to *MAPLE*, initializing and shutting down the *MAPLE* environment

4.18**software capability catalogue**

user-specified or vendor-specified unique collection of software capabilities within *MAPLE*

4.19**software program capability**

classification of the functionalities of software programs connected to *MAPLE*

4.20**Software Tool Linker**

manufacturing software to analyse, select and sequence other *Manufacturing Software Programs* to fulfil *MAPLE Engine* requests

4.21**task**

elemental description of a work item internal to *MAPLE*

4.22**task list**

sequenced set of tasks that may include complex sequences of concurrent tasks

NOTE Depending on the instance, some entries of a task list may refer to either an internal task or an external action. In that case the word task is being used.

4.23**Task Planner**

function to analyse a request from the *MAPLE Engine* and to select and sequence *Manufacturing Software Programs* into a *task list* to be executed by the *Execution Manager*

5 Enterprise viewpoint of interfaces between MAPLEs and Manufacturing Software Programs

The classification of the interfaces between MAPLE and Manufacturing Software Programs using the interface description language given in ISO/IEC 14750 is based on objects which have related operations. From an enterprise viewpoint in ODP (ISO/IEC 10746-3) the interface objects can be described as follows.

- a) There are three relevant objects: MAPLE; ManufacturingSoftwareProgram, and; MAPLEFinder with respect to these interfaces.
- b) The roles of these relevant objects are:
 - 1) MAPLE is a supplier of MAPLE services;
 - 2) ManufacturingSoftwareProgram is a user or consumer of MAPLE services. MAPLE itself may also be a user;
 - 3) MAPLEFinder is used to find a MAPLE which can provide a service request forwarded by another MAPLE.
- c) MAPLE has a structure, which is composed of the MAPLE Engine, Dictionary Manager, Manufacturing Data Manager, Software Tool Linker and the Execution Manager. (See ISO 13281-1 for the MAPLE functional architecture.)
- d) MAPLE services are defined in clause 8.
- e) MAPLE users can access a MAPLE only through an interface defined in clause 9.

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6 Symbols and abbreviations

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- a) DST_ data_storage_type;
- b) DS_ data_source;
- c) SP_ software program.

7 Dictionary Definition Schema

7.1 General

This clause corresponds to the ODP-Information viewpoint, as in ISO/IEC 10746-3.

The dictionaries allow the handling of both object-based and non-object-based data sets and programs.

7.2 Catalogues

There shall be these three catalogues:

7.2.1 Data Classification Catalogue

Examples of entries in this catalogue are NC program, tool data, setup data and product data.

7.2.2 Software Capability Catalogue

Examples of entries in this catalogue are post processing, monitoring and simulation.

7.2.3 Data Storage Type Catalogue

Examples of entries in this catalogue are file, relational database, object database and image database.

7.3 Manufacturing Data Dictionary

The Manufacturing Data Dictionary is related to the Data Storage Type Catalogue, and contains two main parts: description of data sources, and Logical-to-physical Mapping. The description of data sources contains information about how to handle related manufacturing data.

Examples of entries in this dictionary are an NC program for one specific machine, and STEP product data.

7.4 Manufacturing Software Dictionary

The Manufacturing Software Dictionary is related to the Data Storage Type Catalogue and the Software Capability Catalogue, and contains a description of software programs. This description consists of the capabilities and the invocation of the particular software programs.

Examples of entries in the Manufacturing Software Dictionary are NC program editor, post processor for vendor-specific control, and simulator for CL files.

8 MAPLE services

8.1 General

This clause corresponds to the ODP-Engineering viewpoint, as in ISO/IEC 10746-3.

8.2 Required services

A MAPLE shall, at a minimum, provide the following services:

- a) plan task (see 8.5);
- b) register data source (see 8.6.2);
- c) list data source (see 8.6.3);
- d) deregister data source (see 8.6.4);
- e) modify data source (see 8.6.5);
- f) register software program capability (see 8.6.6);
- g) list software program capability (see 8.6.7);
- h) deregister software program capability (see 8.6.8);
- i) modify software program capability (see 8.6.9);
- j) register catalog entry (see 8.6.11);
- k) list catalog (see 8.6.12);
- l) deregister catalog entry (see 8.6.13);
- m) modify catalog entry (see 8.6.14);

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- n) insert data (see 8.7.2);
- o) list data (see 8.7.3);
- p) delete data (see 8.7.4);
- q) update data (see 8.7.5);
- r) retrieve data (see 8.7.6);
- s) check out data (see 8.7.7);
- t) check in data (see 8.7.8);
- u) pass through query (see 8.7.9);
- v) translate data (see 8.8);
- w) transfer intermediate data (see 8.9);
- x) invoke software program capability (see 8.10);
- y) start manufacturing software program (see 8.11.1);
- z) execute task list (see 8.11.2);

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- 1) start task list (see 8.11.2.1);
- 2) terminate task list (see 8.11.2.2);
- 3) suspend task list (see 8.11.2.3);
- 4) suspend after (see 8.11.2.4);
- 5) resume task list (see 8.11.2.5);
- 6) StepMode (see 8.11.2.6);
- 7) StepTask (see 8.11.2.7);
- 8) StepTo (see 8.11.2.8);
- 9) OutOfStep (see 8.11.2.9);
- 10) SkipN (see 8.11.2.10);
- 11) SkipTo (see 8.11.2.11);
- aa) show task list (see 8.11.3.1);
- bb) delete task list (see 8.11.3.2);
- cc) create task list (see 8.11.3.3);
- dd) start trace (see 8.11.4.1);
- ee) Stop trace (see 8.11.4.2);
- ff) Check task list status (see 8.11.4.3);

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- gg) Initialize MAPLE (see 8.12.2);
- hh) Shut down MAPLE (see 8.12.3);
- ii) Administrate system (see 8.12.4);
- jj) Communicate MAPLE to MAPLE (see 8.12.5);
- kk) Access MAPLE (see 8.13).

The services listed can be extended with vendor-specific services.

8.3 Status return

All services shall return a status.

8.4 Input and output type definitions

The following general type definitions shall apply:

```
typedef int status
```

```
typedef wstring DataSource
```

```
typedef wstring SPCapability
```

```
typedef wstring CatalogEntry
```

```
typedef sequence<wstring> AttributeList
```

```
typedef sequence<any> ValueList
```

```
typedef sequence<wstring> ArgumentList
```

```
typedef sequence<wstring> TaskList
```

```
typedef sequence<CatalogEntry> CatalogEntryList
```

```
enum IdentifierType {logical, physical};
```

```
struct DataIdentifier {
    IdentifierType logical_or_physical;
    wstring data_identifier;
};
```

```
enum CheckOutStatus {true, false};
```

8.5 Plan task

This service shall provide pre-processing of requests passed from the MAPLE Engine before being executed by the Execution Manager service. The plan task service shall expand the given request into a task list which can be performed directly by the Execution Manager service.

The Task Planner service shall support the following functions:

- a) build a task list by replacing parameters and input/output;
- b) search in the Software Dictionary for the requested capability;

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- c) resolve multiple search results by selection;
- d) retrieve the dictionary information;
- e) ensure that the requested capability can be resolved;
- f) references with their actual values;
- g) check for format compatibility between inputs and outputs, and insert translation task where necessary;
- h) if not able to meet the requested capability, issue an error message to the MAPLE Engine.

The inputs to this service are:

- a) SP_capability of type SPCapability;
- b) SP_capability_input argument_list of type ArgumentList.

The output from this service is a TaskList.

8.6 Data and Software Dictionary maintenance

8.6.1 Hierarchy

Data source is considered to have a hierarchy, such that a data set is made up of data records. The services that need to be supported to implement the maintenance of the dictionaries and of their associated catalogues shall be as specified in subclauses 8.6.2 to 8.6.14. (standards.iteh.ai)

8.6.2 Register data source

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This service provides the ability for the MAPLE user to register a data source with the Manufacturing Data Dictionary.

The inputs to this service are:

- a) data_source_name of type wstring;
- b) DST_name of type wstring;
- c) DST_parameter_set of type wstring;
- d) data_source_command_set of type wstring.

8.6.3 List data source

This service provides the ability for the MAPLE user to query the Manufacturing Data Dictionary and find those data sources currently registered with MAPLE.

The input to this service is the data_source_filter of type wstring, which defines a selection of the existing data_sources based on the value of its attributes.

The output from this service is a set_of_data_sources with the relevant attributes of type DataSourceList.

8.6.4 Deregister data source

This service provides the ability for the MAPLE user to deregister a data source from the Manufacturing Data Dictionary.

The input to this service is the `data_source_name` of type `wstring`.

8.6.5 Modify data source

This service provides the ability for the MAPLE user to modify a data source in the Manufacturing Data Dictionary.

The inputs to this service are:

- a) `data_source_name` of type `wstring`;
- b) `data_source_attributes` of type `AttributeList` (defining those attributes to be modified);
- c) `data_source_attribute_values` of type `ValueList` (provides the corresponding values of the attributes to be modified).

8.6.6 Register software program capability

This service provides the ability for the MAPLE user to register a capability of a software program with the Manufacturing Software Dictionary.

The inputs to this service are:

- a) `SP_capability_name` of type `wstring`;
- b) `SP_name` of type `wstring`;
- c) `SP_location` of type `wstring`;
- d) `SP_argument_template` of type `wstring`;
- e) `SP_capability` of type `SPCapability`;
- f) `SP_argument_set` of type `ArgumentList`.

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8.6.7 List software program capability

This service provides the ability for the MAPLE user to query the Manufacturing Software Dictionary and find those software program capabilities currently registered with MAPLE.

The input to this service is the `SP_capability_filter` of type `SPCapability` which defines a selection of the existing `SP_capabilities` based on the value of its attributes.

The output from this service is a `set_of_SP_capabilities` of type `SPCapabilityList` with the relevant attributes `SP_capability_attributes` of type `AttributeList`.

8.6.8 Deregister software program capability

This service provides the ability for the MAPLE user to deregister a `SP_capability` from the Manufacturing Software Dictionary.

The input to this service is the `SP_capability_name` of type `wstring`.

8.6.9 Modify software program capability

This service provides the ability for the MAPLE user to modify a software program capability in the Manufacturing Software Dictionary.