



ISO/TC 184/SC 4/WG 15 "Digital manufacturing"
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Description

Enhancements to the core model of AP238 to support drill and fill, composite layup, powder bed fusion and cutting tool usage.

Core AP238 enhancements for E4

This document contains enhancements to the core AP238 Edition 3 model to support the new functionalities of Edition 4

1 Application Objects

1.1 Operation

The Operation_application object is extended to include points where messages containing properties are to be broadcast to other systems.

```
ENTITY Operation;
  its_id: Identifier;
  its_toolpath: OPTIONAL Toolpath_list;
  its_tool_direction: OPTIONAL Tool_direction;
  its_broadcast: OPTIONAL Broadcast;           -- new in E4
END_ENTITY;
```

NOTE: Broadcast content should be added to an operation so that an application can track the properties of geometry for the Digital Thread.

1.1.1 broadcast

points where data is to be broadcast about the progress and conditions of this operation.

1.2 Broadcast

The Broadcast application object describes points where messages are to be broadcast to other systems.

```
ENTITY Broadcast;
  broadcast_points: SET [0:?] OF cartesian_point;
  point_content: OPTIONAL Broadcast_content;
  start_content: OPTIONAL Broadcast_content;
  end_content: OPTIONAL Broadcast_content;
WHERE
  WR1: SIZEOF (BROADCAST_POINTS) = 0 OR EXISTS (TOOLPATH_LIST)
END_ENTITY;
```

1.2.1 broadcast_points

locations on the tool path where status information shall be broadcast to devices that are listening.

NOTE: The broadcast method is not described but may include sending a tweet, putting data into a UI, and writing a record into a log file.

1.2.2 point_content

the values to be broadcast at each broadcast_point.

1.2.3 start_content

the values to be broadcast at the start of the operation.

NOTE: start_content can also be broadcast by setting the corresponding attribute of the executable.

1.2.4 end_content

the values to be broadcast at the end of the operation.

NOTE: end_content can also be broadcast by setting the corresponding attribute of the executable.

1.3 Broadcast_content

The Broadcast_content application object identifies the thread and describes the content. If no property is given then a timestamp is written.

```
ENTITY Broadcast_content
  Measured_properties: SET [0:?] OF Measured_property;
  only_if_changed:    BOOLEAN;
  wait_for_reply:     BOOLEAN;
  export_stream:      OPTIONAL identifier;
  digital_thread:     OPTIONAL identifier;
END_ENTITY;
```

1.3.1 measured_properties

Broadcast the values of these measured_properties.

NOTE: the value of the measured property is updated if wait_for_reply is true.

1.3.2 only_if_changed

Only broadcast values that have changed since the last transmission

1.3.3 wait_for_reply

wait for a reply before continuing the operation.

1.3.4 export_stream

the identity of the stream to be used for the broadcast.

1.3.5 digital_thread

the identity of the digital thread linked to this information.

1.4 Executable

The Executable application object is extended to include broadcast content.

```
ENTITY Executable;  
    -- Many existing attributes  
    start_content:    OPTIONAL Broadcast_content;    -- new in E4  
    end_content:      OPTIONAL Broadcast_content;    -- new in E4  
END_ENTITY;
```

NOTE: Broadcast content should be added to an executable when an application needs to keep track of the start and end of processes.

1.4.1 start_content

the values to be broadcast at the start of the process.

1.4.2 end_content

the values to be broadcast at the end of the process.

1.5 Workpiece

The Workpiece application object is extended to include a reference to another workpiece that represents its material.

```
ENTITY Workpiece;  
    -- Many existing attributes  
    material_type:      Material_workpiece;      -- new in E4  
END_ENTITY;
```

1.5.1 material_type

the workpiece that describes properties of the material.

1.6 Material_workpiece

The Material_workpiece application object describes the properties of a material.

```
ENTITY Material_workpiece  
SUBTYPE OF (Product_view_definition);  
    its_material_properties:  SET [0:?] OF Material_property;  
END_ENTITY;
```

NOTE: the Material Workpiece can be a Product_view_twin if it includes measured properties containing measurements that are specific to this instance of the material.

1.6.1 its_material_properties

a set of material properties.

1.7 Material_property

The Material_property application object describes a property that has been measured in an environment.

```
ENTITY Material_property;  
    Data_environment:      measure_representation_item;  
    Property_representation:  SET [1:?] OF Property;  
END_ENTITY;
```

1.7.1 data_environment

the environment that existed when the material property was measured.

1.7.2 property_representation

the set of properties measured in the given environment .

1.8 Feedstop

The Feedstop application object shall be as defined by ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Feedstop is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY Feedstop
  SUBTYPE OF (Toolpath);
  dwell: Value_with_unit;      -- ED4 CHANGE
END_ENTITY;
```

NOTE – The type of the dwell attribute has been relaxed from a Duration to the more general Value_with_unit to permit the value to be given as a time or as a number of revolutions. This usage was identified in AP238 testing.

1.9 Program_structure

The Program_structure application object shall be as defined by ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Program_structure is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY Program_structure
  ABSTRACT SUPERTYPE OF (ONEOF(Workplan, Parallel, Non_sequential, Selective,
    If_statement, While_statement, Assignment))
  SUBTYPE OF (Executable);
  planning_operation: OPTIONAL Operation;  -- ED4 ADDITION
END_ENTITY;
```

1.9.1 planning_operation

The planning_operation specifies an Operation object that describes requirements that are met by the Executables that comprise the Program_structure.

EXAMPLE – A planning operation may describe a 3D operation that is decomposed into several 2D operations performed by the workingsteps of a workplan.

1.10 Toolpath_list

The Toolpath_list application object shall be as defined by ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Toolpath_list, as adapted by this document, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY Toolpath_list;  
  its_list: LIST [1:?] OF Toolpath_list_element;  -- ED4 CHANGE  
END_ENTITY;  
TYPE Toolpath_list_element = SELECT(Toolpath, NC_function); END_TYPE;
```

NOTE – The toolpath list has been relaxed to hold NC functions as well as toolpaths, to permit an NC function between toolpaths without breaking a process into two separate operations and workingsteps. This usage was identified in AP238 testing.