IfcAxis2Placement3D

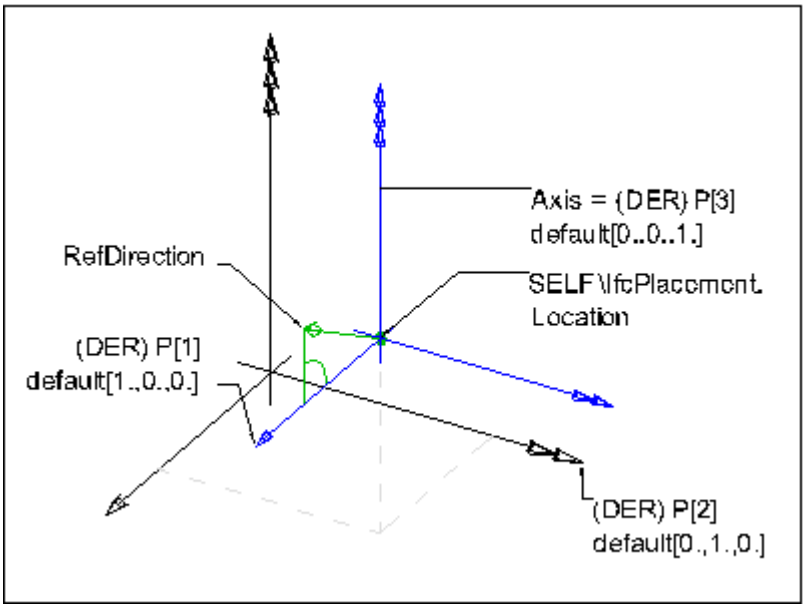
Definition from ISO/CD 10303-42:1992: The location and orientation in three dimensional space of three mutually perpendicular axes. An axis2_placement_3D (*IfcAxis2Placement3D*) is defined in terms of a point (inherited from *IfcPlacement* supertype) and two (ideally orthogonal) axes. It can be used to locate and originate an object in three dimensional space and to define a placement coordinate system. The entity includes a point which forms the origin of the placement coordinate system. Two direction vectors are required to complete the definition of the placement coordinate system. The axis is the placement Z axis direction and the ref_direction (RefDirection) is an approximation to the placement X axis direction.

Definition from IAI: If the attribute values for *Axis* and *RefDirection* are not given, the placement defaults to P[1] (x-axis) as [1.,0.,0.], P[2] (y-axis) as [0.,1.,0.] and P[3] (z-axis) as [0.,0.,1.]. The WR5 is added in IFC to ensure that either both attributes (*Axis* and RefDirection) are given, or omitted.

NOTE Corresponding STEP name: axis2_placement_3d, please refer to ISO/IS 10303-42:1994 for the final definition of the formal standard.

HISTORY New class in IFC Release 1.5, the IFC Release 1.0 entity IfcPlacement_3D was using three normalized and orthogonal axes. This definition is replaced in IFC Release 1.5 by the STEP definition of axis placement.
ISSUE: See issue log for changes made in IFC Release 1.5.1

Illustration



Definition of the *IfcAxis2Placement3D* within the three-dimensional coordinate system.

EXPRESS specification:

```
ENTITY IfcAxis2Placement3D
  SUBTYPE OF (IfcPlacement);
    Axis                      : OPTIONAL IfcDirection;
    RefDirection              : OPTIONAL IfcDirection;
  DERIVE
    P                         : LIST [3:3] OF IfcDirection :=
                                IfcBuildAxes(Axis, RefDirection);
  WHERE
    WR1           : SELF\IfcPlacement.Location.Dim = 3;
    WR2           : (NOT (EXISTS (Axis))) OR (Axis.Dim = 3);
    WR3           : (NOT (EXISTS (RefDirection))) OR (RefDirection.Dim = 3);
    WR4           : (NOT (EXISTS (Axis))) OR (NOT (EXISTS (RefDirection))) OR
                    (IfcCrossProduct(Axis,RefDirection).Magnitude > 0.0);
    WR5           : NOT ((EXISTS (Axis)) XOR (EXISTS (RefDirection)));
END_ENTITY;
```

Attribute definitions:

Axis : The exact direction of the local Z Axis.
RefDirection : The direction used to determine the direction of the local X Axis. If necessary an adjustment is made to maintain orthogonality to the Axis direction. If Axis and/or RefDirection is omitted, these directions are taken from the geometric coordinate system.
P : The normalized directions of the placement X Axis (P[1]) and the placement Y Axis (P[2]) and the placement Z Axis (P[3]).

Formal Propositions:

WR1 : The dimensionality of the placement location shall be 3.
WR2 : The Axis when given should only reference a three-dimensional IfcDirection.
WR3 : The RefDirection when given should only reference a three-dimensional IfcDirection.
WR4 : The Axis and RefDirection shall not be parallel or anti-parallel.
WR5 : Either both (Axis and RefDirection) are not given and therefore defaulted, or both shall be given. This is a further constraint in IFC Release 1.5.

References (4):

Name	Type	Referred through	Express-G
IfcAxis2Placement	Select	Select relation	Diagram 3
IfcElementarySurface	Entity	Attribute 'Position'	Diagram 7
IfcPlacement	Entity	Subtype	Diagram 3
IfcSweptSurface	Entity	Attribute 'Position'	Diagram 8

Inheritance graph

```
ENTITY IfcAxis2Placement3D;
  ENTITY IfcPlacement;
    Location                  : IfcCartesianPoint;
  DERIVE
    Dim                       : IfcDimensionCount :=  Location.Dim;
  ENTITY IfcAxis2Placement3D;
    Axis                      : OPTIONAL IfcDirection;
    RefDirection              : OPTIONAL IfcDirection;
  DERIVE
    P                         : LIST [3:3] OF IfcDirection :=
                                IfcBuildAxes(Axis, RefDirection);
END_ENTITY;
```