

Design Models

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This tutorial makes a quick examination of a simple design model.

The top level instantiated Entity in a Design Model is an `assembly_design`. It may inherit different optional attributes from `assembly`: an `assembly_sequence_number` (for when there are several), a `complexity_level` flag, and optionally a `shape_representation` for the overall assembly (for special cases). `Assembly_designs` may be defined hierarchically, with child design assemblies. Each `assembly_design` has flags whether it has been `designed` or `checked`, its `functional_role` and a set of `design_criteria`. `Assembly_design` is a high level entity usually inherited into one of three children, a structural frame, a structural member, or a connection. Frames are assemblies, made up of members and connections. Frames, defined as `assembly_design_structural_frame`, has a variety of descriptors, as do structural members and connections. An important reference to `assembly_design` is `design_part`. The is a `design_part` for each part that makes up the assembly.

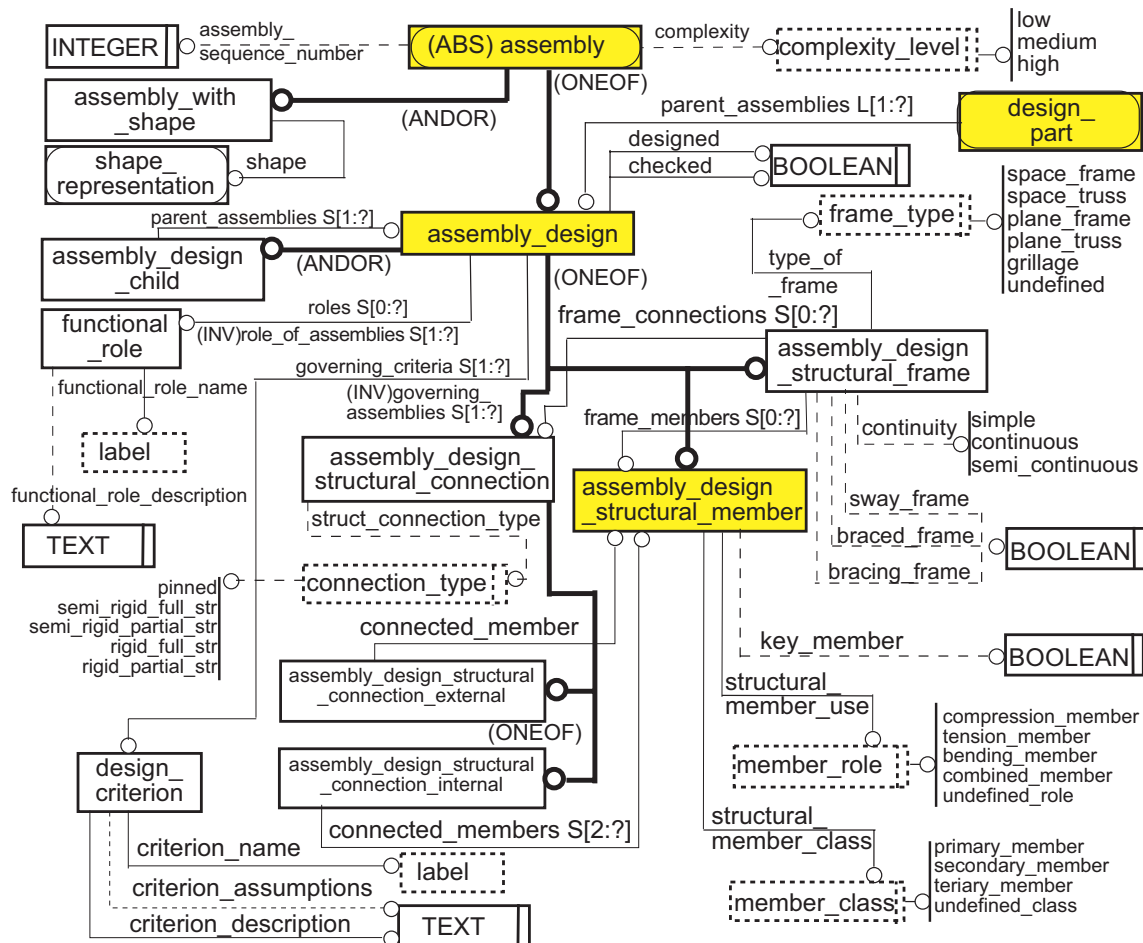


Figure One: the high level representation of an `assembly_design`.

The main corresponding EXPRESS code for these Entities is:

```
ENTITY assembly
ABSTRACT SUPERTYPE OF (ONEOF
    (assembly_design,
    assembly_manufacturing) ANDOR
    assembly_with_shape)
SUBTYPE OF (structural_frame_product);
    assembly_sequence_number : OPTIONAL INTEGER;
    complexity : OPTIONAL complexity_level;
END_ENTITY;
```

```
ENTITY assembly_design
SUPERTYPE OF (ONEOF
    (assembly_design_structural_frame,
    assembly_design_structural_member,
    assembly_design_structural_connection) ANDOR
    assembly_design_child)
SUBTYPE OF (assembly);
    designed : BOOLEAN;
    checked : BOOLEAN;
    roles : SET [0:?] OF functional_role;
    governing_criteria : SET [0:?] OF design_criterion;
END_ENTITY;
```

```
ENTITY assembly_design_child
SUBTYPE OF (assembly_design);
    parent_assemblies : SET [1:?] OF assembly_design;
WHERE
    WRA27 : SIZEOF(QUERY(assembly <* parent_assemblies | assembly := (SELF)) ) = 0;
END_ENTITY;
```

```
ENTITY assembly_design_structural_connection
SUPERTYPE OF (ONEOF
    (assembly_design_structural_connection_internal,
    assembly_design_structural_connection_external))
SUBTYPE OF (assembly_design);
    struc_connection_type : OPTIONAL connection_type;
END_ENTITY;
```

```
ENTITY assembly_design_structural_frame
SUBTYPE OF (assembly_design);
    type_of_frame : frame_type;
    continuity : OPTIONAL frame_continuity;
    sway_frame : OPTIONAL BOOLEAN;
    braced_frame : OPTIONAL BOOLEAN;
    bracing_frame : OPTIONAL BOOLEAN;
    frame_members : SET [0:?] OF assembly_design_structural_member;
    frame_connections : SET [0:?] OF assembly_design_structural_connection;
END_ENTITY;
```

```
ENTITY assembly_design_structural_member
SUPERTYPE OF (ONEOF
    (assembly_design_structural_member_cubic,
    assembly_design_structural_member_linear,
    assembly_design_structural_member_planar))
SUBTYPE OF (assembly_design);
```

```

    key_member : OPTIONAL BOOLEAN;
    structural_member_use : member_role;
    structural_member_class : member_class;
END_ENTITY;

```

```

ENTITY assembly_design_structural_connection_external
SUBTYPE OF (assembly_design_structural_connection);
    connected_member : assembly_design_structural_member;
END_ENTITY;

```

```

ENTITY assembly_design_structural_connection_internal
SUBTYPE OF (assembly_design_structural_connection);
    connected_members : SET [2:?] OF assembly_design_structural_member;
END_ENTITY;

```

```

ENTITY functional_role
SUPERTYPE OF (functional_role_documented);
    functional_role_name : label;
    functional_role_description : text;
INVERSE
    role_for_assemblies : SET [1:?] OF assembly_design FOR roles;
END_ENTITY;

```

```

ENTITY design_criterion
SUPERTYPE OF (design_criterion_documented);
    criterion_name : label;
    criterion_description : text;
    design_assumptions : OPTIONAL text;
INVERSE
    governed_assemblies : SET [1:?] OF assembly_design FOR governing_criteria;
END_ENTITY;

```

This large graph of Entities can be flattened to define several types of design members. Assembly_design_structural_member inherits attributes from assembly and assembly_design. It has the form:

```

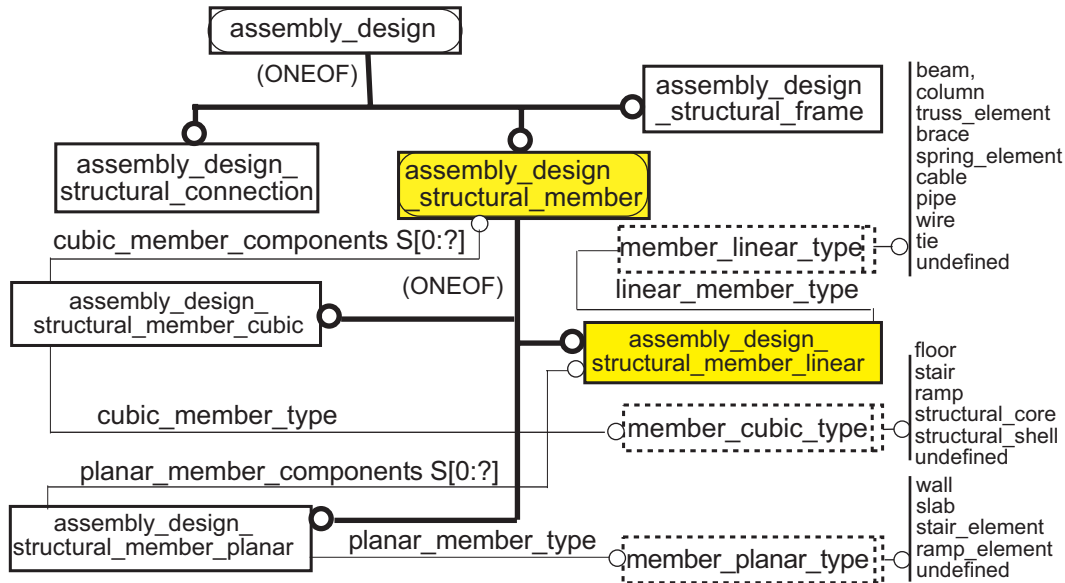
ENTITY assembly_design_structural_member
SUPERTYPE OF (ONEOF
    (assembly_design_structural_member_cubic,
    assembly_design_structural_member_linear,
    assembly_design_structural_member_planar))
(assembly_design:
(assembly:
    assembly_sequence_number : OPTIONAL INTEGER;
    complexity : OPTIONAL complexity_level;
    );
    designed : BOOLEAN;
    checked : BOOLEAN;
    roles : SET [0:?] OF functional_role;
    governing_criteria : SET [0:?] OF design_criterion;
    );
    key_member : OPTIONAL BOOLEAN;
    structural_member_use : member_role;
    structural_member_class : member_class;
END_ENTITY;

```

If we then use this to define an `assembly_design_structural_member_liner`, used to represent a beam, we might have:

```
#106=ASSEMBLY DESIGN STRUCTURAL MEMBER (1,.LOW...F...F.,(),(),$,
.UNDEFINED_ROLE.,.UNDEFINED_CLASS.);
```

There are three kinds of structural members for use in design: linear, cubic and planar. Each is classified with creation type. The most common type of structural member is linear. It and the other types are shown in Figure Two. These types are used to classify the structural member type.



The EXPRESS code for these Entities are:

```
ENTITY assembly_design_structural_member_cubic
SUBTYPE OF (assembly_design_structural_member);
    cubic_member_type : member_cubic_type;
    cubic_member_components : SET [0:?] OF assembly_design_structural_member;
WHERE
    WRA28 : SIZEOF(QUERY(member <* cubic_member_components | member :=:
        (SELF))) = 0;
END_ENTITY;
```

```
ENTITY assembly_design_structural_member_linear
SUBTYPE OF (assembly_design_structural_member);
    linear_member_type : member_linear_type;
END_ENTITY;
```

```
ENTITY assembly_design_structural_member_planar
SUBTYPE OF (assembly_design_structural_member);
    planar_member_type : member_planar_type;
    planar_member_components : SET [0:?] OF
assembly_design_structural_member_linear;
END_ENTITY;
```

If we create an `assembly_design_structural_member_linear`, it adds its use to `assembly_design_structural_member`, such as `.beam.` or `.column.` Planar and cubic members may have components.

The main elements making up an `assembly_design` are parts. Parts inherit a variety of attributes, shown in Figure Three. `Part` is a supertype of `part_prismatic`, `part_sheet` and `part_complex`. Parts can optionally inherit (through the ANDOR inheritance constraint) `structural_frame_product_with_material`, which adds material properties. A part may be one of three types: a `part_prismatic` (for extruded elements) a `part_sheet` (for flat or bent sheets) and `part_complex` for irregular parts, such as those that are cast. Each part has two ways to define its geometry, through explicit parameters and implicitly by a reference to an existing standard or library. `Item_reference_assigned` is the link between a `part` and an `item_reference` (described more fully in the tutorial on Section Profiles). The subtypes of `part` have explicit parameters.

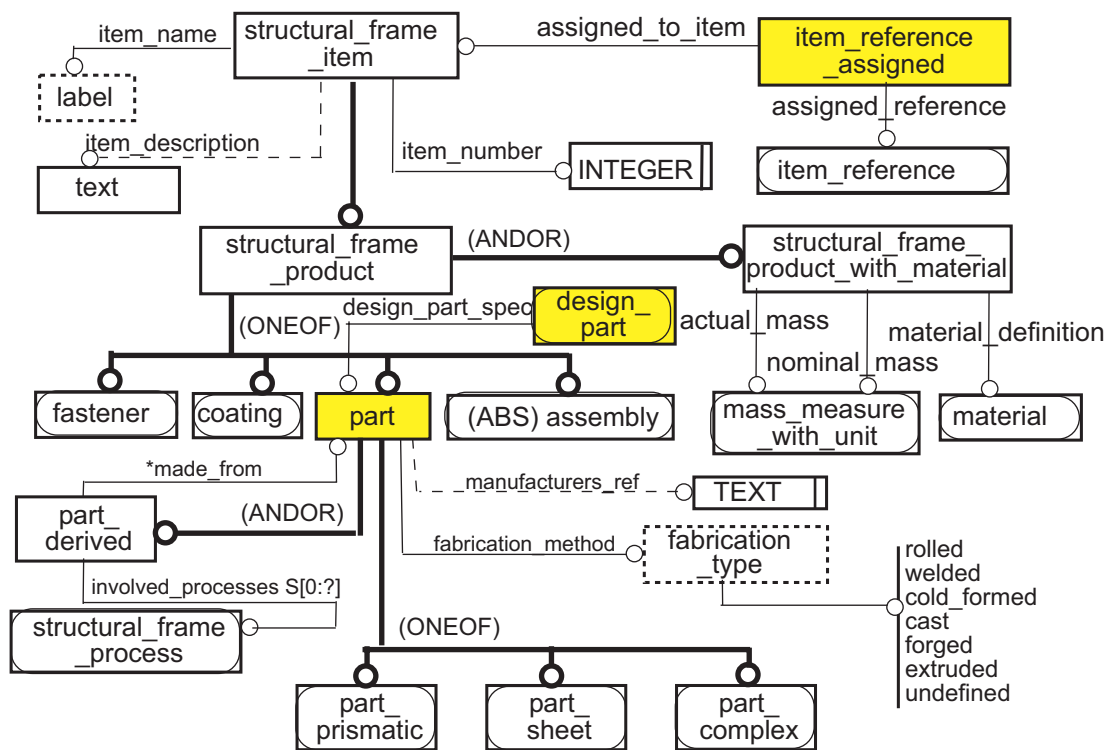


Figure Three: The main element of an `assembly_design`, the part, and the Entities inherited into it.

