Flow of Events for Use Case – Show Terrain

Change Log	
19/06/2004	Changed Title changed from UC-ShowTerrain to lower case uc_show_terrain. Grid based terrains added.
31/10/2004	Finalized for pre-integrated model

Overview

Describes the surface shape of the terrain within an area based on survey information that identifies the elevation of the ground at a set of points.

Process

Preconditions

Area within which the terrain is to be shown is defined and located.
Survey has been carried over the area so that elevations at specified points within the survey grid are known.

Actors

Authority (for base map)
Applicant (for situation map/situation plan)

Main Flow

1. A terrain may be specified using existing approaches based on provisions for the representation of IfcSite. Two approaches may be defined namely a TIN approach and a Grid approach

   a) TIN Representation
   The TIN representation can be seen as part of existing representation of IfcSite using the facetation representation. A TIN is a topological representation as
   - a (minimum) connected face set
   - or (by fulfilling additional topological constraints) as an open shell.

   This is already covered by IfcSite with IfcShapeRepresentation.RepresentationIdentifier = "Facetation", since the RepresentationType "SurfaceModel" allows for either IfcFaceBasedSurfaceModel (i.e. connected face sets), or IfcShellBasedSurfaceModel (i.e. open shell).

   Usually the representation of a terrain model is either given by
   - a set of survey points (and optionally break lines) where the triangulation is left to the receiving system (provided by current IfcShapeRepresentation.RepresentationIdentifier = "SurveyPoints"),
   - or the triangulation is explicitly exchanged (the TIN model, or IfcShapeRepresentation.RepresentationIdentifier = "Facetation".

   If a more constrained representation for TIN is sought, a new RepresentationIdentifier "TIN Facetation" can be introduced, which would force the faceted representation to only contain polygons with three points.

   A different question should be discussed. Currently an IfcSite has the definition shape directly defined, i.e. a site is equal to an area as a feature. It also implies that the site fully covered by the area it defines. If a site should include different areas, like the buildabe area, or the distance (or set back) area, or any other area, a new concept (similar to IfcSpace) needs to be introduced to cover external areas and spaces. These areas would then form part of the site, like buildings form part of the site, using the same relationship IfcRelAggregates.

Note: as said above, a triangulated network is a faceted representation already covered by IfcSite. If a site should have several areas that represents different usages of the site, it should be dealt with by a new IFC object, potential naming candidates are IfcArea, or IfcRegion, or IfcSiteArea, etc. It would be used as part of the spatial structure and be assigned to IfcSite using IfcRelAggregates. In this case each of the individual areas are specified as:

b) Grid Representation

This is an alternative approach in which survey data gives point location and elevation at the point based on measurements along and across a conventional grid. Having acquired this information, the surface shape can be defined either by:

- Creating triangular shapes to define the surface much as for TIN representations above (but based on a more regular grid pattern)
- Creating shapes that define the shape of a surface between a selected set of grid points (probably using surface patches).

Note that a grid based approach using surface patches is not elaborated here since surface patches are not presently defined within the IFC model (but see new entity requirements).

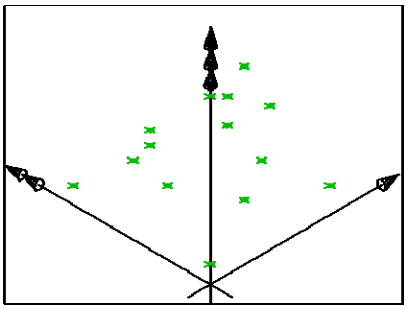
Subflows

S1: Use existing IfcSite approach

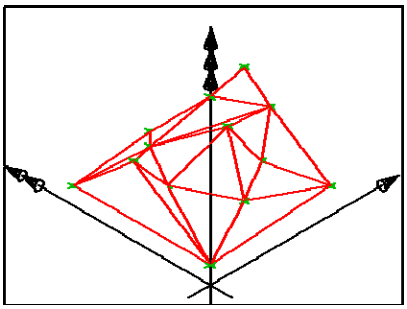
1. The **local placement** for the area of interest, specified as a type of IfcSpatialStructureElement, is defined in its supertype IfcProduct. It is defined by the IfcLocalPlacement, which defines the local coordinate system that is referenced by all geometric representations.
   - The PlacementRelTo relationship of IfcLocalPlacement shall point to the appropriate type of IfcSpatialStructureElement, if relative placement is used (e.g. to position an area relative an a area complex, or an area section to an area).
   - If the relative placement is not used, the absolute placement is defined within the world coordinate system. If there is only one area object, then this is the default situation.

2. The **foot print representation** of the type of IfcSpatialStructureElement is given by either a single 2D curve (such as IfcPolyline or IfcCompositeCurve), or by a list of 2D curves (in case of inner boundaries). The representation identifier and type of this geometric representation is:
   - IfcShapeRepresentation.RepresentationIdentifier = 'FootPrint'
   - IfcShapeRepresentation.RepresentationType = 'Curve2D' or 'GeometricCurveSet'

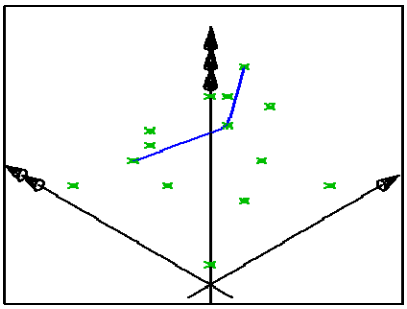
3. The **survey point representation** of the type of IfcSpatialStructureElement is defined using a set of survey points and optionally breaklines (see also use case ‘Define Survey Points’). The breaklines are restricted to only connect points given in the set of survey points. Breaklines, if given, are used to constrain the triangulation. The representation identifier and type of this geometric representation is:
   - IfcShapeRepresentation.RepresentationIdentifier = 'SurveyPoints'
   - IfcShapeRepresentation.RepresentationType = 'GeometricSet'



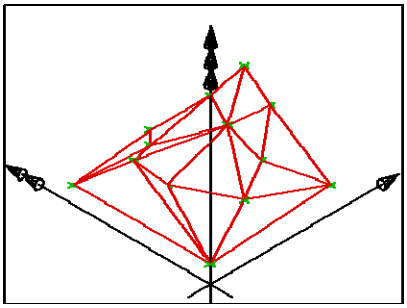
A set of survey points, given as 3D Cartesian points within the object coordinate system of the site.
The set of IfcCartesianPoint is included in the set of IfcGeometricSet.Elements.



result after facetation



A set of survey points, given as 3D Cartesian points, and a set of break points, given as a set of lines, connecting some survey points, within the object coordinate system of the site.
The set of IfcCartesianPoint and the set of IfcPolyline are included in the set of IfcGeometricSet.Elements.



result after facetation taking the breaklines into account.

4. The **facetation representation** of the type of IfcSpatialStructureElement is defined using a surface model, based on the IfcFaceBasedSurfaceModel or on the IfcShellBasedSurfaceModel. Normally the surface model is the result after triangulation of the site survey points. The representation identifier and type of this representation is:
   - IfcShapeRepresentation.RepresentationIdentifier = 'Facetation'
   - IfcShapeRepresentation.RepresentationType = 'SurfaceModel'

5. If a more constraint representation of the facetation is needed to ensure that each facet only contains three points (the polyloop representing the outer bound) and that no face should have inner bounds, the identifier “TIN Facetation” should be used.

6. The **body (or solid model) representation** of the type of IfcSpatialStructureElement is defined using a faceted boundary representation based on the IfcFacetedBrep or on the IfcFacetedBrepWithVoids. The representation identifier and type of this representation is:
   - IfcShapeRepresentation.RepresentationIdentifier = 'Body'
   - IfcShapeRepresentation.RepresentationType = 'Brep'

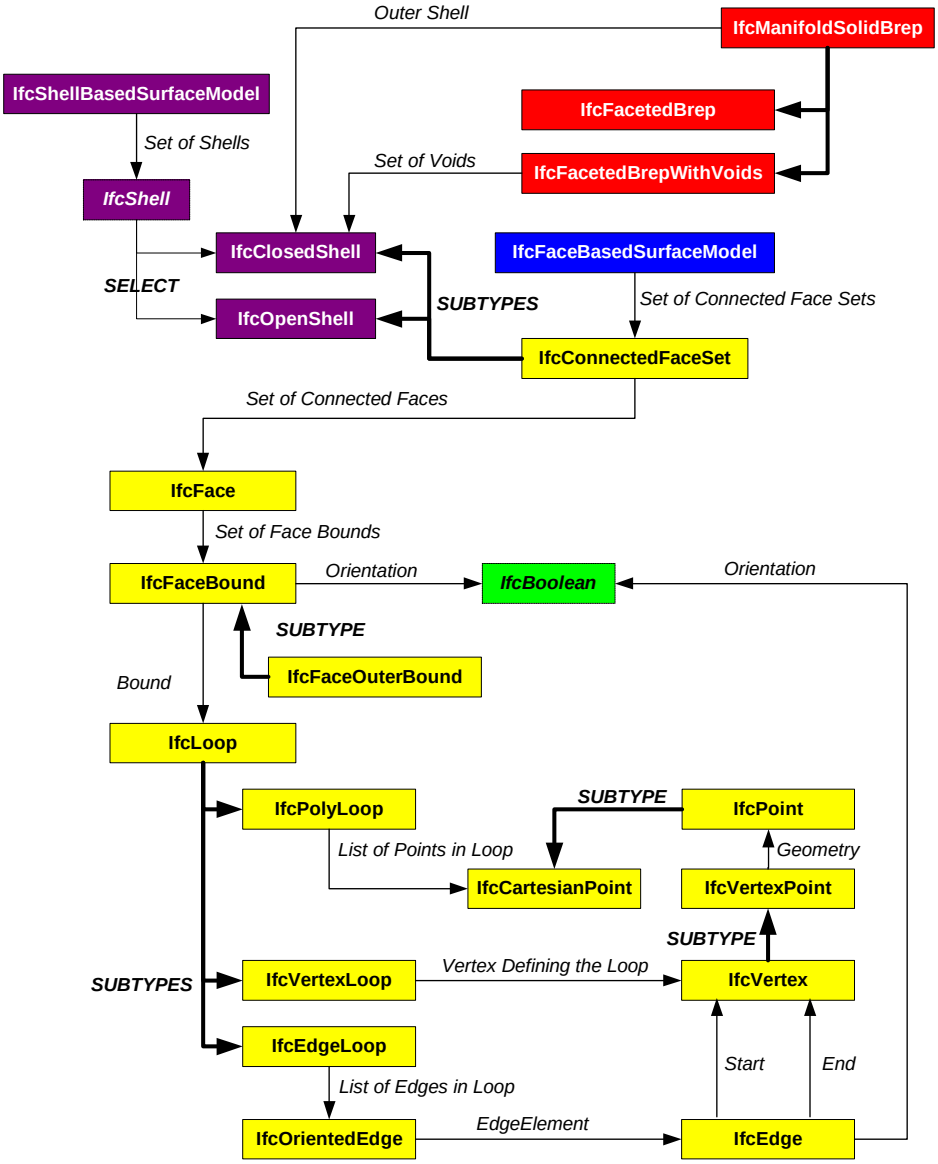


Figure 1: Surface Model and Brep in IFC showing common use of Faces

1. A triangulated irregular network (TIN) enables a model of a surface to be defined. It comprises a set of points (or nodes) that have positional information including elevation, edges that connect the points and faces that are defined by the edges.
2. The nodes describing the points of the TIN may need to be interpolated from the survey information available. A more rapidly varying landscape of a feature will require more points to be determined.
3. A TIN may be represented using topology/geometry capabilities from the IFC model as shown above.
4. A TIN should be identified as an entity so that it is semantically understood. The shape representation of a TIN should be a connected face set with a shape representation identifier = 'TIN Facetation'. The semantic entity of which a TIN is the shape representation could be either IfcSite, or IfcSiteArea.
5. A face within a TIN should be constrained to have only one bound, being the outer bound.
6. Each bound is represented by an IfcPolyloop (to represent the facetation)
7. Each IfcPolyLoop used within a TIN requires a proposition (rule) such that the attribute 'Polygon' is constrained to have a cardinality of LIST [3:3] OF IfcCartesianPoint.
8. The network aspect of a TIN is completed by the Euler formula for shells.

Note: A TIN is a faceted representation and should thereby use the topological elements for faceted representation (similar to faceted brep). These are:

- IfcOpenShell (or IfcConnectedFaceSet), having 1:N IfcFace, having 1:1 IfcFaceOuterBound being IfcPolyloop of 3:3 IfcCartesianPoint.

Post Conditions

Terrain model is defined and shown.

IFC Usage and Extension Requirements

Existing Entity/Class Usage

Entity Class Name	*Usage*
IfcSpace	Used for identification of the external space within whose boundary the terrain is defined.
IfcFaceBasedSurfaceModel	A surface model described by a set of connected face sets of dimensionality 2
IfcShellBasedSurfaceModel	A surface model described by a set of open or closed shells of dimensionality 2
IfcConnectedFaceSet	A set of faces such that the domain of faces together with their bounding edges and vertices is connected
IfcFace	A topological entity of dimensionality 2 corresponding to the intuitive notion of a piece of surface bounded by loops. A face is represented by its bounding loops, which are defined as face bounds.
IfcFaceBound	A loop which is intended to be used for bounding a face
IfcPolyLoop	A poly loop is a loop with straight edges bounding a planar region in space.
IfcCartesianPoint	A location in some real Cartesian coordinate space

Existing Entity/Class with Proposed Modification

Entity Class Name	*Usage*
IfcFace	This should be constrained where used for a TIN so that it references only one face bound, being an outer bound.
IfcPolyLoop	This should be constrained where used for a TIN so that it references only three points.

ARM	*Attribute*	*Cardinality*	*Datatype*	*Definition*

Issue List

Question	*Answer*