Contents

1. Introduction
2. Issues in 2D/3D Spatial Units
3. Categorising Real-world Spatial Units
4. Categorising Geometry of 3D Spatial Units
5. Completeness of the Categorisation
6. Conclusion
Introduction

Existing Cadastres...

- Have:
  - Different types of land parcels
  - Growing needs for 3D parcels
- Need to consider:
  - Required Functionalities
  - Cost of back capture

- Base Parcels: property, road, watercourse, Easements, Building format parcels, True volumetric parcels
Growth rate in Queensland

Land Administration Domain Model (LADM) provides...

- Different levels of encoding
- Framework for categorisation
- Range of coverage for registration
  - Can include Formal, Informal, Current or Planned
Spatial units in a Cadastre...

- Might be restricted to a single level of encoding, BUT,
  - In practice, mostly have multiple levels

- Need to have DCDB capable of accommodating all types in a jurisdiction

In developing a DCDB...

- Vital to have:
  - Complete range of possible objects
  - List of possible problem cases
  - Test data for acceptance testing

- Knowledge of:
  - Types of 3D objects allowed to be registered
  - Appropriate level of encoding
This presentation...

- Identifies issues in 2D/3D
- Discusses categorisation of real-world spatial units
- Categorises geometry of spatial units
- Discusses completeness of categorisation
Real-world and Database representation...

- Valid cadastral parcels can be invalid DB objects
  - According to standards – e.g. ISO19107
  - According to database implementations e.g.:
    - Each face must be a simple planar polygon
    - The boundary must be a 2-manifold

Real-world and Database representation...

- Workarounds to represent objects in DB:
  - Break up parcels into smaller, conforming units
  - Use construction lines to break up surfaces
  - Restrict to building format
  - Restrict to polygon slices
  - Define survey regulations to match database constraints
  - "Move" points apart.
2D definitions

- Majority of parcel boundaries do not exist independent of human cognitive acts (“fiat objects”)
- Some are defined by natural features
- Parcels well supported by polygon concept
2D Spatial Units...

- "Feature – abstraction of real-world phenomena", BUT, cadastral parcels may not have real-world demarcation (such as would be seen on a large scale topographic map)

3D Primary categories

- **Building format** – (or construction format) – defined variously (e.g. centre of wall, to the wall surface etc.)

- **Volume** – described geometrically with reference to a datum – can be freehold, lease, easement etc.

(There might not be any construction present)
Categorisation Issues (1)

- Real – world spatial units
  - unspecified top (to the depth of ...),
  - unspecified bottom (below the depth of),
  - two horizontal planes defining top and bottom (a “slice”),
  - two (potentially non-horizontal) surfaces defining top and bottom,
  - faces restricted to horizontal or vertical,

Categorisation Issues (2)

- Real – world spatial units
  - textually described face(s),
  - single valued (for any XY position, only one range of Z permitted),
  - presence of caves and/or tunnels,
  - moving face(s) (ambulatory),
  - non-planar (curved) faces,
  - non-contiguous volumes
Categorising Geometry of 3D Spatial Units

Why categorise?

- Different kinds of 3D shapes exist – most can be represented as a simple solid
  - (e.g. a polyhedron with a connected 2-manifold boundary, planar simple polygonal faces, and a connected interior)

- Some cannot be represented as solids

- Vast majority of 3D spatial units in a jurisdiction are not complex

Fit for purpose – avoid unnecessary effort in encoding simple objects into complex volumes (and avoid overestimating the problem).
Categorisation

- Contiguous/Non Contiguous volumes
  - Not very important issue in this context
  - For this discussion, any non-contiguous LA_BAUnit are divided into contiguous LA_SpatialUnit

Categorisation – (1)

- 2D Spatial Units
  - 2D spatial unit effectively special case of 3D
  - Simplest form of 3D spatial unit
  - Ring of LA_BoundaryFaceString objects delineating outer boundary
  - May have inner rings of LA_BoundaryFaceString objects
Categorisation – (2)

- Above/Below a Depth or Height
  - Volume created by restriction or exclusion
  - The volume is unbounded (above or below) – therefore infinite.

Defined by:
1. The extents of the 2D parcel
2. A definition of the bounding surface
3. Whether the spatial unit is above or below that surface

Three sub-categories:
1. Above/below an elevation (with respect to a height datum)
   e.g. "above 50m AHD" (Australian Height Datum)
2. Above/below surface parallel to the ground
   e.g. this plan
3. Above/below explicit single valued surface

Categorisation – (3)

- Polygonal Slice
  - Volume created as a slice delineated above and below.

Defined by:
1. Extents of the 2D parcel
2. Definition of the top bounding surface
3. Definition of the bottom bounding surface

Can also be defined textually – e.g. Floor 4 (a polygonal slice of the 4th Floor)

Special case is the Building Format – where the unit is defined by the building walls. (Not by dimensions).
Categorisation – (4)

- Single–valued Stepped Slice
  - Set of faces all horizontal or vertical
  - Volume single valued in Z
    That is at any X,Y location, there is only a single range of \([Z_{\text{min}}\text{-}Z_{\text{max}}]\).

Categorisation – (5)

- Multi–valued Stepped Slice
  - Set of faces all horizontal or vertical
  - No restriction for volume to be single valued in Z
  - Allows volumes with “caves” or “tunnels”
  - Can be constructed as union of number of slices
Categorisation – (6)

- General 3D Parcels
  - Not fitting any of the earlier categories
  - Criteria may include:
    - 2-manifold required or not,
    - Open/closed volume,
    - Planar/curved boundaries,
    - Single/multi-volume

Categorisation

- Balance of Parcels
  - The excised volume can be of any of the categories described before
  - Volume may be primary interest excised from 2D spatial unit
  - Volume may be secondary interest, thus leaving the base spatial unit as standard 2D parcel

Note the volume
Completeness of the Categorisation

Is the SU fully defined by a 2 dimensional shape? That is to say, the spatial unit can be defined entirely by face strings

- yes → 2D Spatial Unit
- no → Is the SU defined by the extents of a structure?

- yes → Building Form Spatial Unit
- no → Is the SU defined by a 2D parcel above/below a single-valued surface?

- yes → Above/Below Depth or Height
- no → Is the SU defined by a 2D parcel and a pair of single-valued non-intersecting surfaces defining the top and bottom?

- yes → Polygonal Slice
- no → Is the SU defined entirely by horizontal or vertical faces

- yes → General 3D Parcel
- no → Is the SU single valued in Z?

- yes → Single-Valued Stepped Slice
- no → Multi-Valued Stepped Slice
Completeness of Categories

- By following the decision tree a unique classification is guaranteed
- Further sub-categories are possible (e.g. of the “General 3D Parcel”)

Counts of Categories

- Brisbane CBD
- Approximately 600 2D plans, 97 3D plans.
  - Plans inspected to determine category
  - Possibility of miss-categorisation
Counts of Categories

- Full database for Queensland queried using SQL – determined number of:
  - Building Format Lots
  - Easements

- Not a statistically valid result – just an indication.

Frequency of Categories

Not a statistically correct survey, just an inspection of the Brisbane CBD area extrapolated to the whole of Queensland.
Conclusion

Usefulness...

- Potentially useful in discussing DCDB 3D needs/practicality (e.g. cost of capture)
- Decision on types of 3D available and allowed
- Design of a database schema
- Decision on software requirements
- Standardised categories and terminology

- Further refinement of categories to suit
A Taxonomy of Spatial Units in a Mixed 2D and 3D Cadastral Database

Thank you

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