

A Taxonomy of Spatial Units in a Mixed 2D and 3D Cadastral Database

Rod Thompson, Peter van Oosterom, Sudarshan Karki, Ben Cowie

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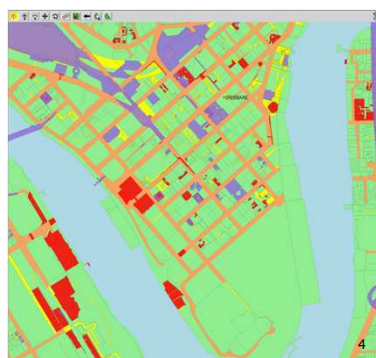
Introduction

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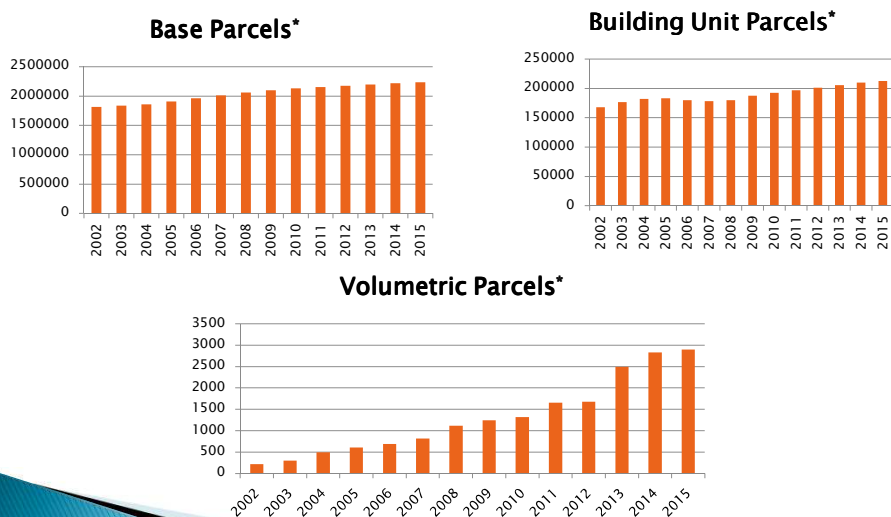
Existing Cadastres...

- ▶ 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



* Parcels counts as at 1st Jan each year ⁵

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

1. Text - Based
2. Point - Based
3. Line - Based
4. Polygon - Based
5. Topology - Based

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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

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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

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This presentation...

- ▶ Identifies issues in 2D/3D
- ▶ Discusses categorisation of real-world spatial units
- ▶ Categorises geometry of spatial units
- ▶ Discusses completeness of categorisation

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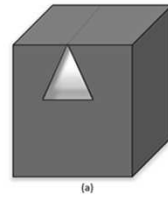
Issues in 2D/3D Spatial Units

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Real-world and Database representation...

▶ Valid cadastral parcels can be invalid DB objects

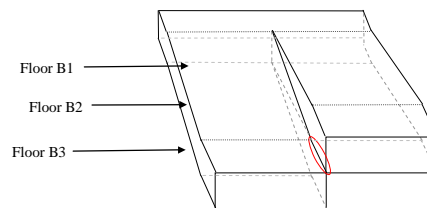
- According to standards - e.g. ISO19107
- According to database implementations e.g.:
 - Each face must be a simple planar polygon
 - The boundary must be a 2-manifold



(a)



(b)

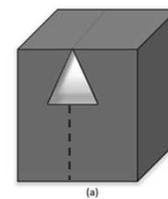


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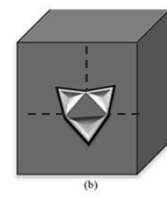
Real-world and Database representation...

▶ 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.



(a)



(b)

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Categorising Real-world Spatial Units

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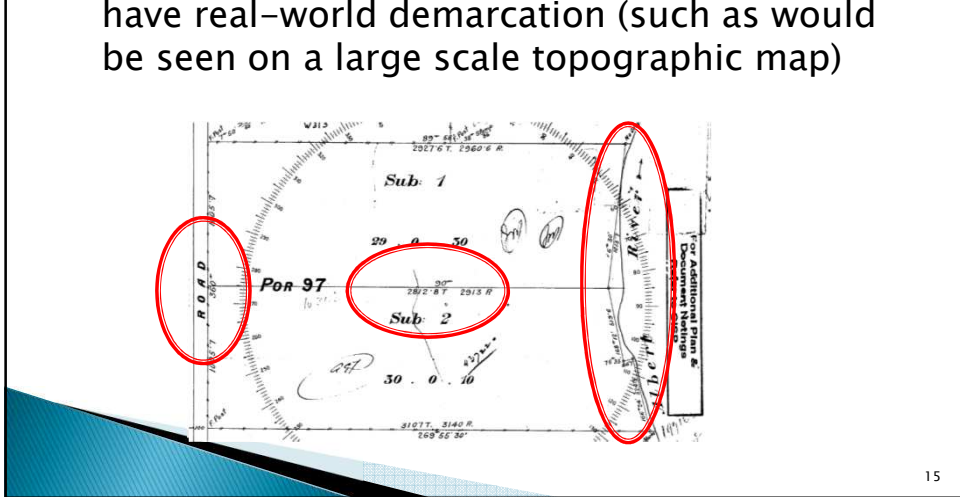
2D definitions

- ▶ 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

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2D Spatial Units...

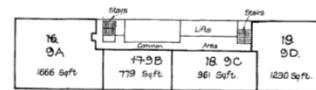
- ▶ “Feature – abstraction of real-world phenomena”, BUT, cadastral parcels may not have real-world demarcation (such as would be seen on a large scale topographic map)



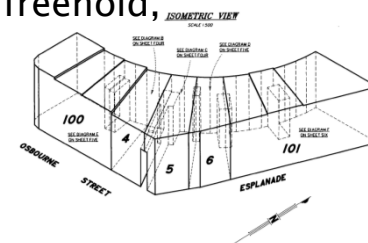
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3D Primary categories

- ▶ **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)



Scale:- 30 feet to an inch
Floor Areas are Approximate Only.



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,

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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

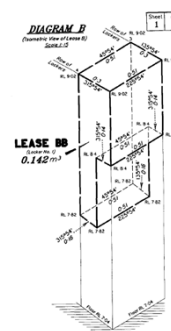
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Categorising Geometry of 3D Spatial Units

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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).

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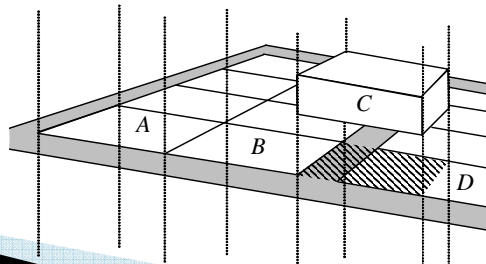
Categorisation

- ▶ 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

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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



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Categorisation – (2)

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

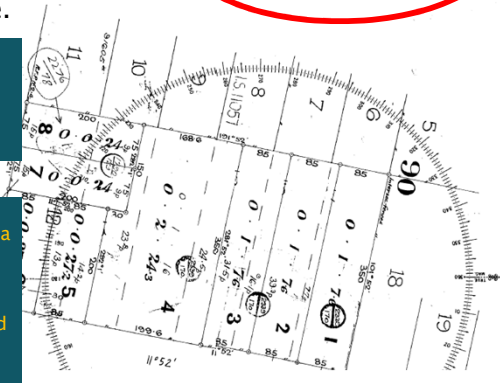
LOT 3 IS TO THE DEPTH OF 30.48 M
 LOT 5 " " " " " " " " " " " " " " 21.336 M
 LOT 6 " " " " " " " " " " " " " " 15.24 M
 LOTS 3, 5 & 6 ARE BELOW LOTS 5, 5 & 6
 RESPECTIVELY AND ARE BELOW THE DEPTHS OF
 30.48M, 21.336M AND 15.24 M RESPECTIVELY.

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



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Categorisation – (3)

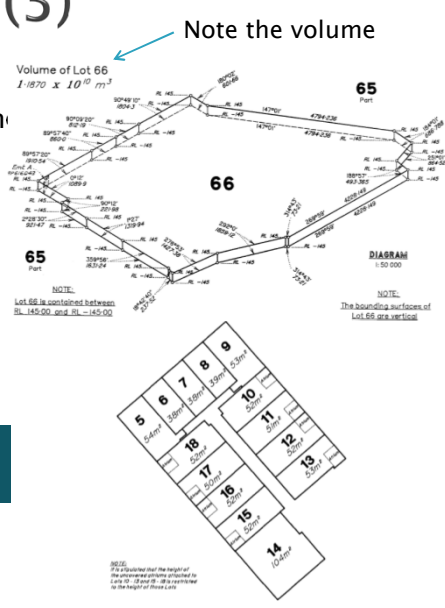
- ▶ Polygonal Slice
 - Volume created as a slice defined above and below.

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)

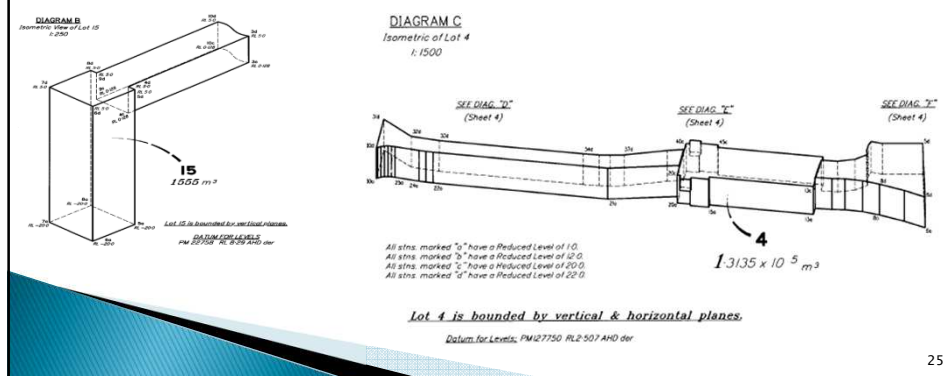
Special case is the Building Format – where the unit is defined by the building walls. (Not by dimensions).



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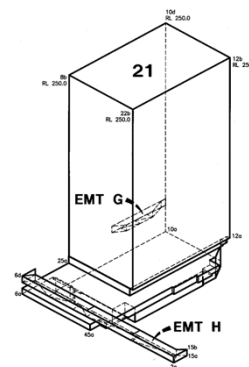
Categorisation – (4)

- ▶ 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 $[Z_{\min}:Z_{\max}]$.



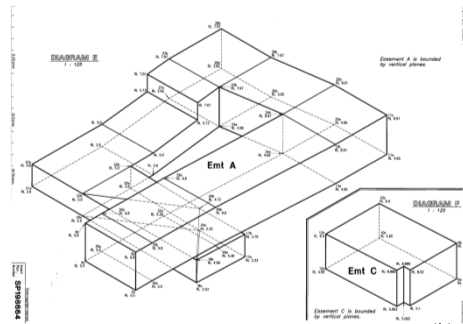
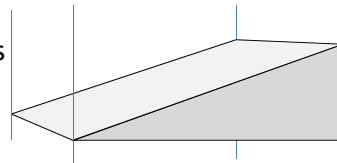
Categorisation – (5)

- ▶ 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



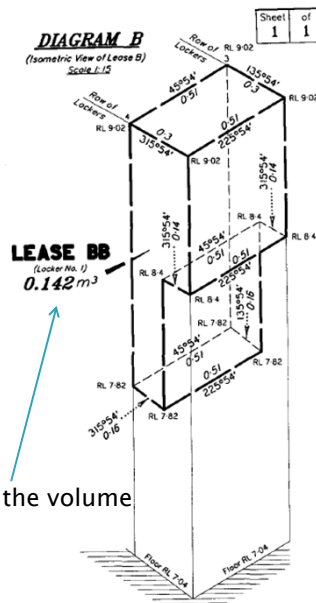
Categorisation – (6)

- ▶ 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

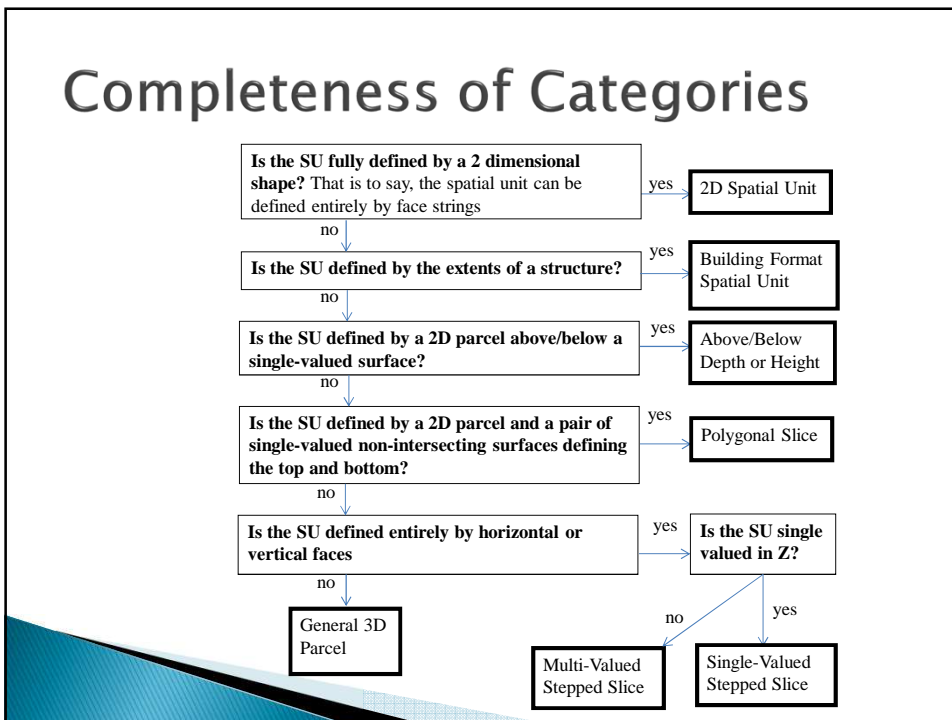


Categorisation

- ▶ 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

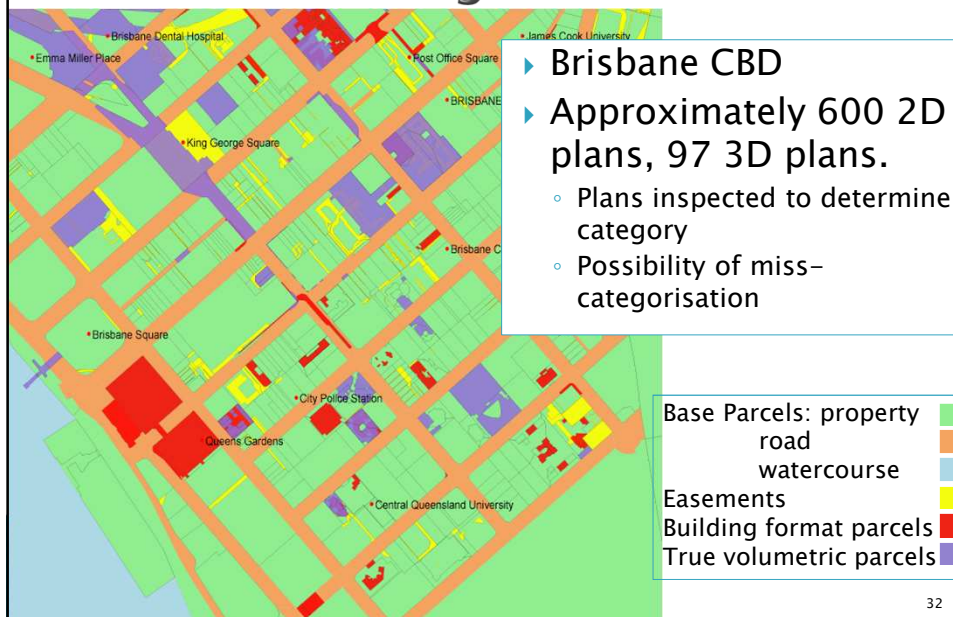


Completeness of Categories

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

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Counts of Categories



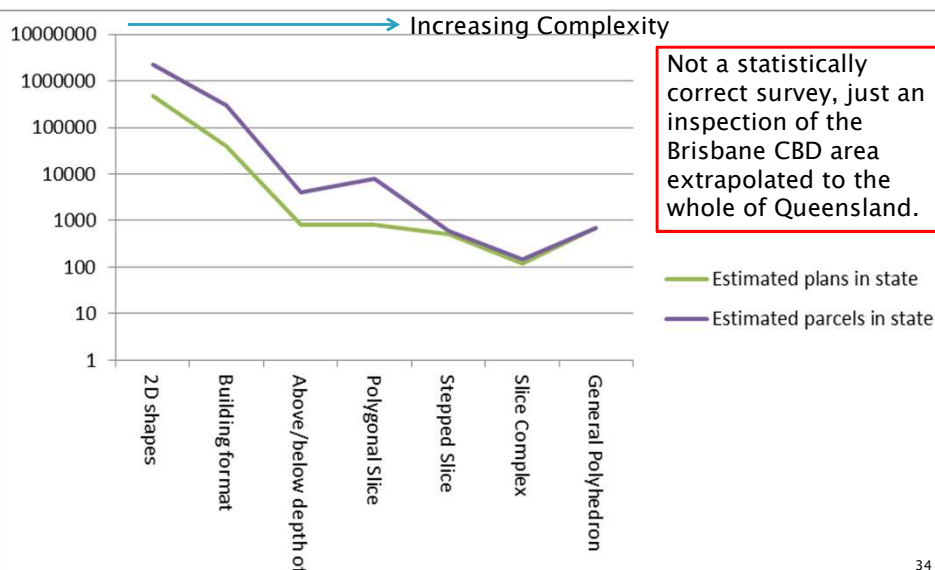
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Counts of Categories

- ▶ Full database for Queensland queried using SQL – determined number of:
 - Building Format Lots
 - Easements
- ▶ Not a statistically valid result – just an indication.

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Frequency of Categories



Conclusion

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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

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Thank you

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