Joint 3D ATHENS CONFERENCE 2016, GREECE

Systematic Analysis of Functionalities for the Israeli 3D Cadastre

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Outline

01 Background

02 Primary requirements

03 3D cadastre system process

04 Functionalities

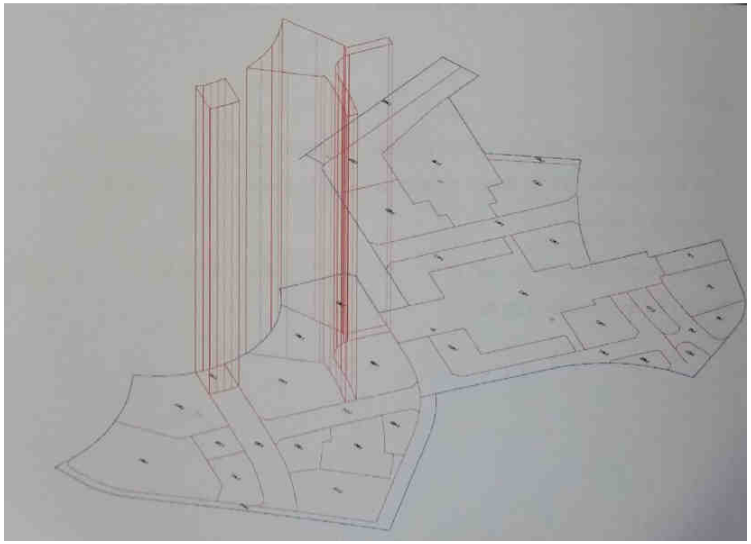
05 Summary & Future work

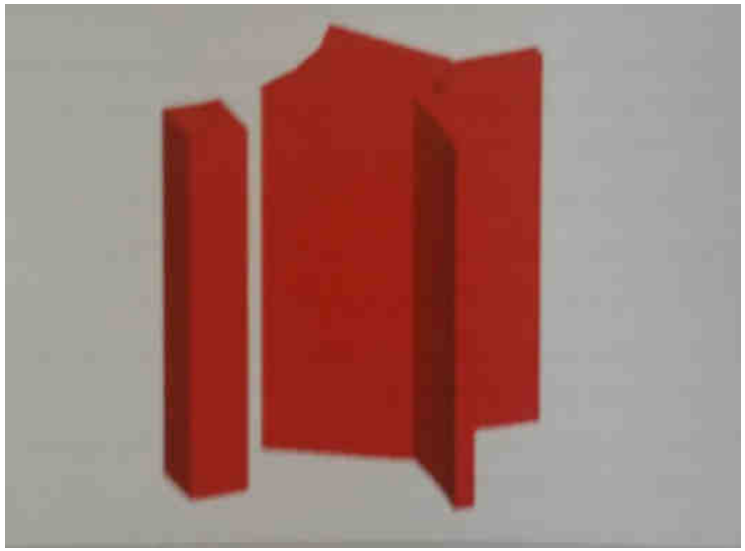
Background

- The Survey Of Israel (SOI) is advocating towards a solution related to 3D cadastre.

- Recommendations so far consisted mainly of two key aspects (Shoshani et al., 2005):
  1. Preparation of appropriate legislation and regulation;
  2. Placement of a technological base and implementing solutions for 3D cadastre.

3D Volumetric Parcel

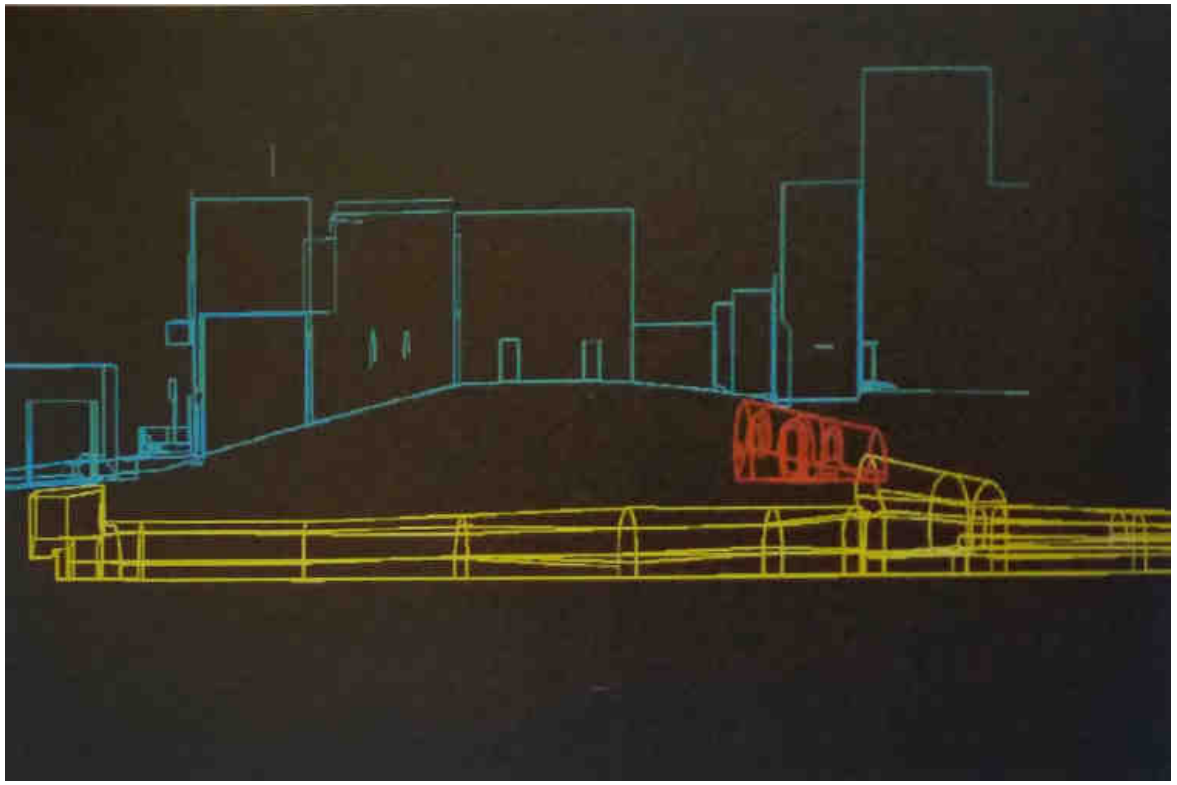




Survey of Israel, 2004

- 3D volumetric parcel is a spatial unit with the same right, responsibilities and restrictions.
- Above-terrain and below-terrain.
- 3D volumetric parcel can be a part of (subtracted from) a number of 2D parcels.

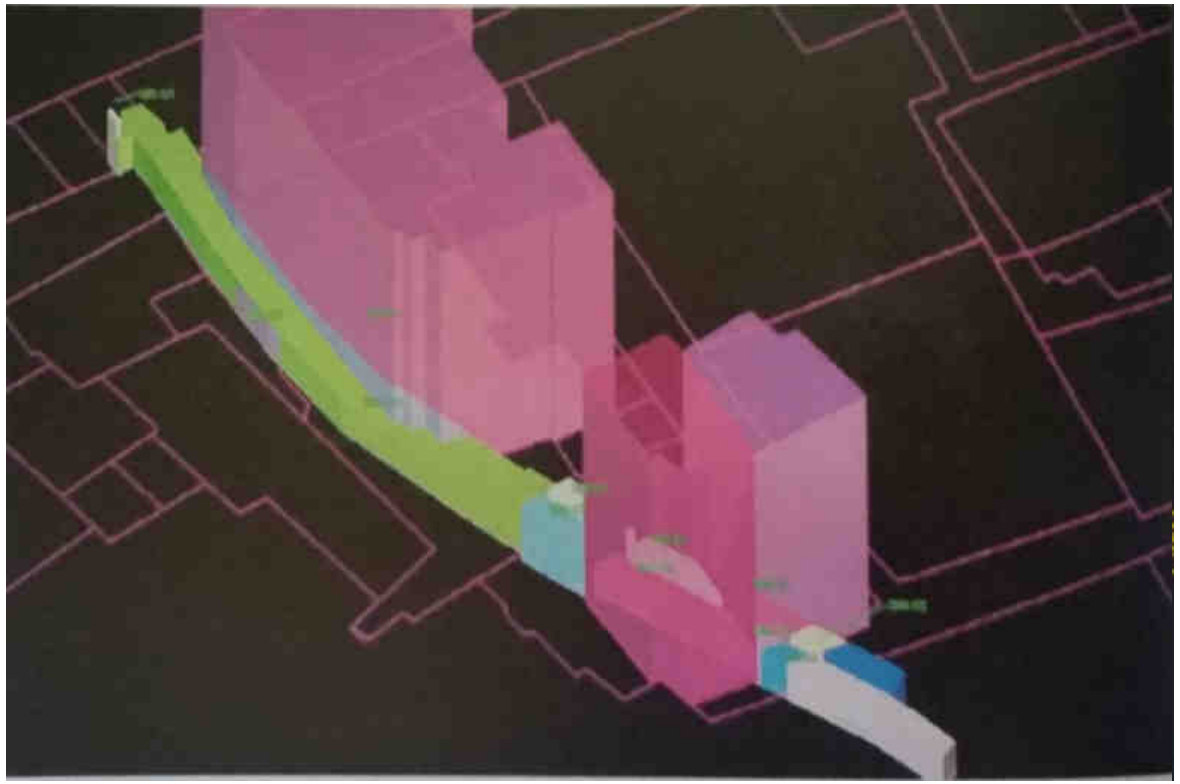
Templar Tunnel - Acre



Perspective View

Survey of Israel, 2004

Templar Tunnel - Acre



3D Model

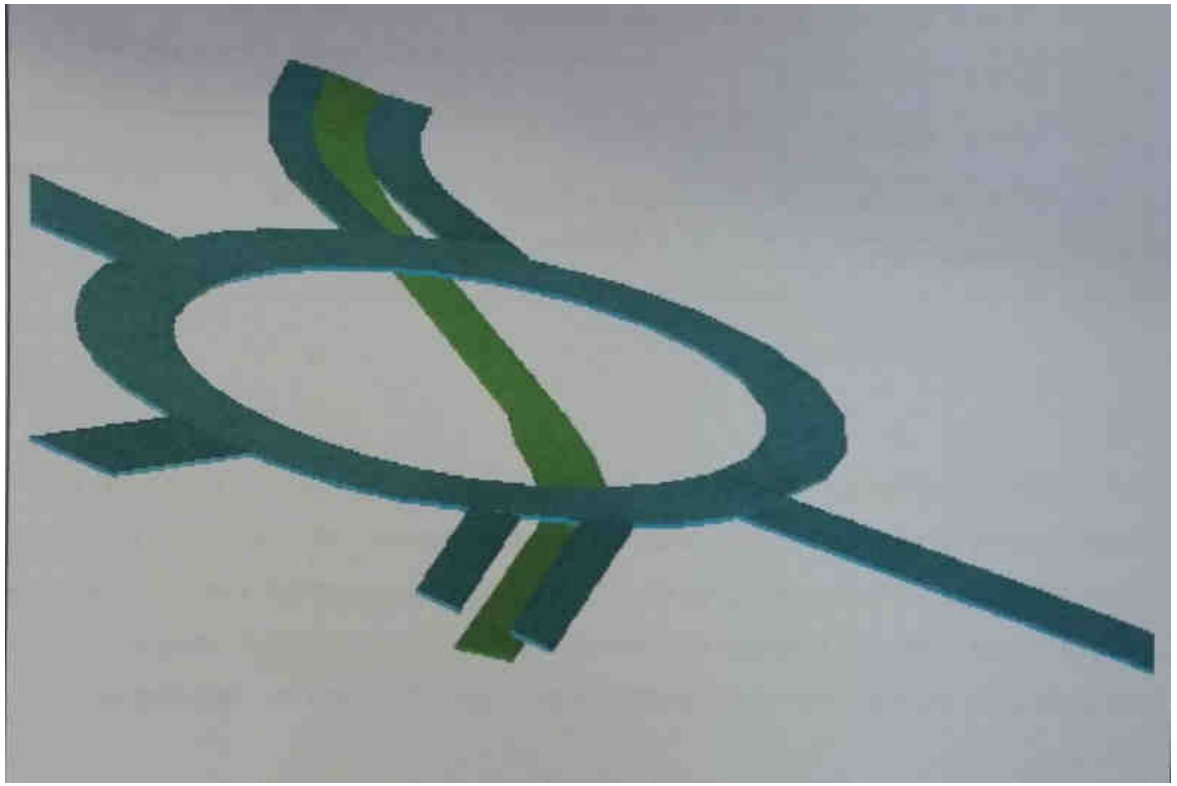
Survey of Israel, 2004

Modi'in - Downtown

Downtown Model

Survey of Israel, 2004

Modi'in - Downtown



3D Model

Survey of Israel, 2004

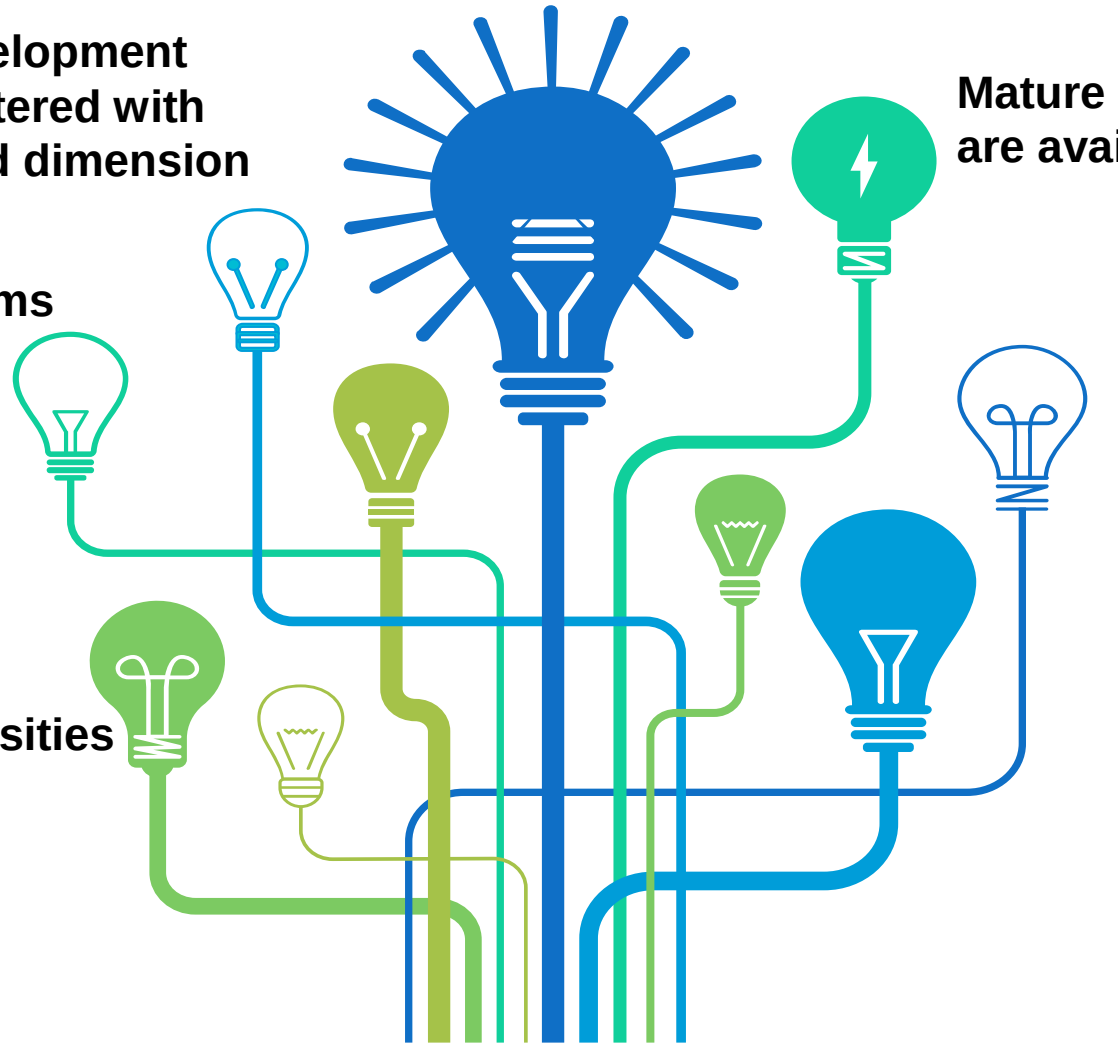
Expansion of 2D Cadastral Systems

Utilization of land/space for complex projects

Infrastructure development that must be registered with respect to the third dimension

2D cadastral systems are limited in their ability to manage modern urban and complex areas

Modern urban planning necessities



Mature technologies are available

Three-dimensional systems are currently having their focus on 3D topography

Geometric and Topologic Requirements

- Descriptive data of a plot as defined in the registry (titles) and obtained from survey:
  - 3D coordinate values of parcel's borders;
  - 2D and 3D mutation plans;
  - Describing measurable plots' boundaries in 3D and noticeable objects located nearby (bounds);
  - Partitions and deals that have occurred previously (historical documentation).

- Defining the quality of boundaries and presenting their topology;

3D Requirements

- Providing basic elements for representing 3D volumetric parcels, such as: node, edge, face and body. Or, differently: points, line segments, triangles, tetrahedrons and collections hereof to represent geometry objects.

- Archiving, visualization, queries and analysis of three-dimensional characteristics and structures on different temporal time-stamps.

- Linking 3D volumetric parcels to their associated 2D objects (e.g. 2D parcels, 2D cadastral plans, etc.) - and vice versa;

3D Requirements

- Enabling search, selection and visualization of 3D volumetric parcels that fall inside a volumetric extend.
- Offering 3D spatial parcel numbering approach (a 3D volumetric parcel sequence associated with block).
- Enforcing 3D geometric and cadastral constraints (e.g. minimal 3D volumetric parcel volume, minimal area of faces, parallelism or perpendicularity between faces of the 3D parcels, etc.).

General Requirements

- Property tax registrations to support claim to land and organization of records and ledgers and land values analytical calculations of boundaries;
- Description of the spatial framework of a parcel, which is datum, coordinate system, reference points, etc...
- Data quality check:
  - Accuracy requirements designed for a variety of applications;
  - Data quality and reliability and propagation of errors must be appropriate.

3D Cadastre System Process: Main Workflows

Insertion of 3D volumetric parcel

Several geometric and topologic functions and validations are needed.

Visualization of 3D volumetric parcel

Mostly it will be carried out via a geometric search (extent) criteria.

Area analysis for plan/design

For a preliminary assessment of a certain area.

Insertion of 2D cadastral plan

Details the insertion of a digital 2D cadastral plan into the system.

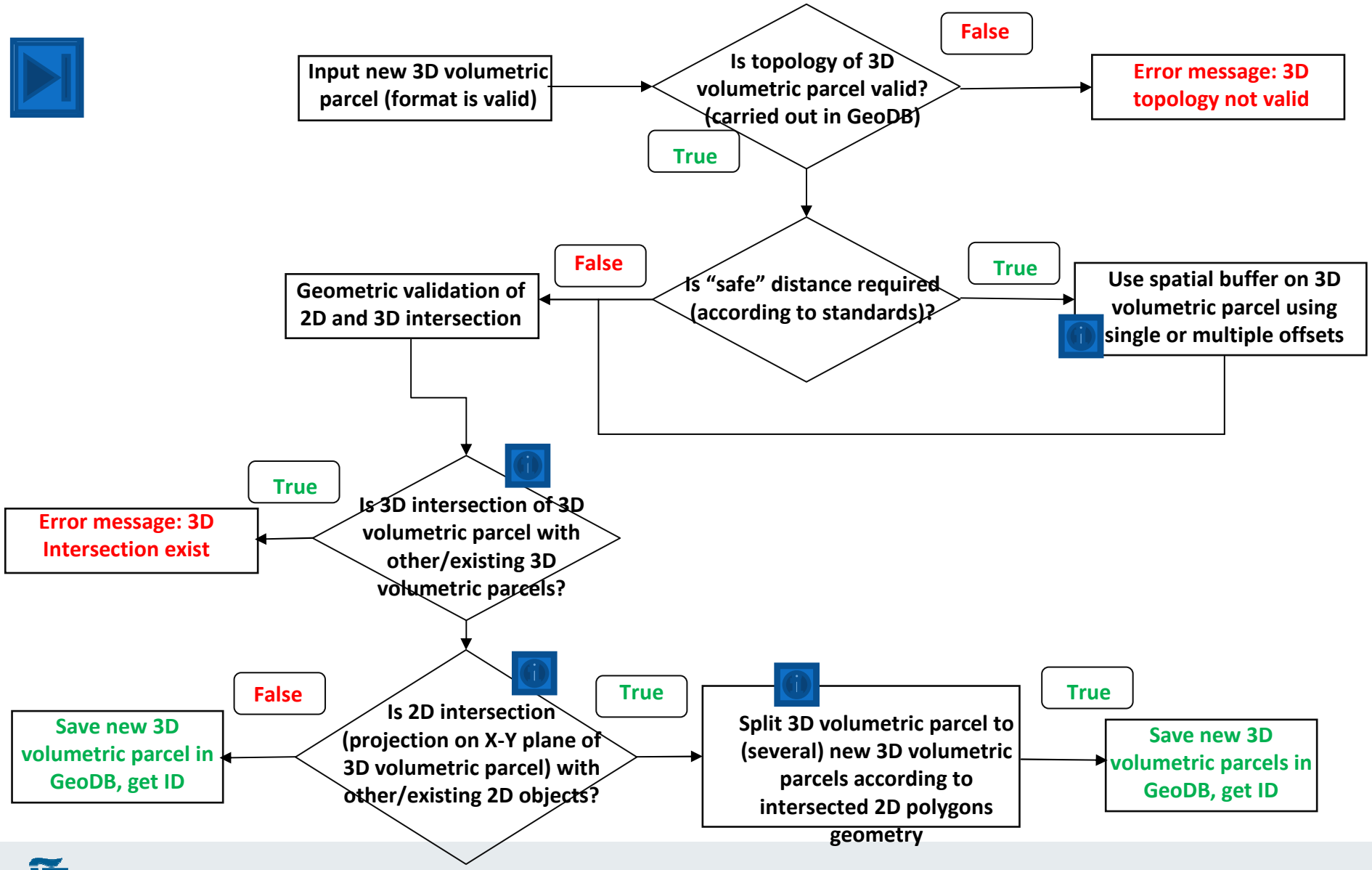
4 steps Computerized Process

Functionalities

Topologic and geometric functionalities integrated in the system:

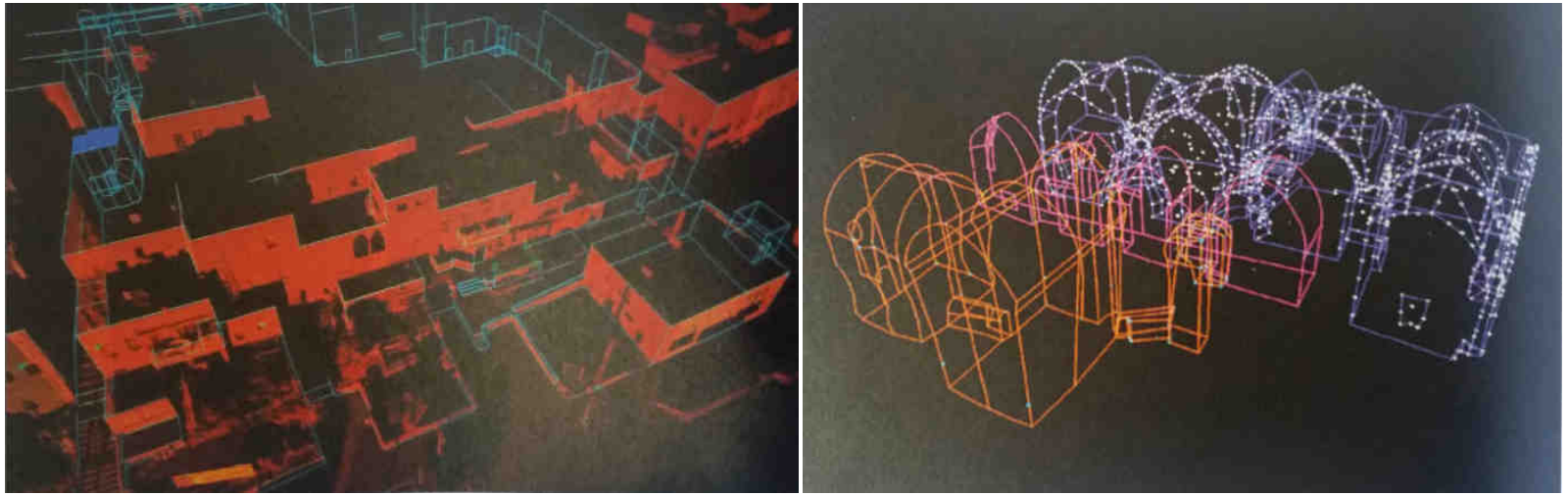
- Spatial intersection
- Spatial overlap / overlay
- Spatial buffer / extrusion
- Spatial union / merge
- Spatial clip / extract / select
- Spatial Split
- Spatial delete / erase
- Distance calculation
- Area / projection calculation
- Volume calculation

Insertion of a New 3D volumetric parcel



Spatial Buffer

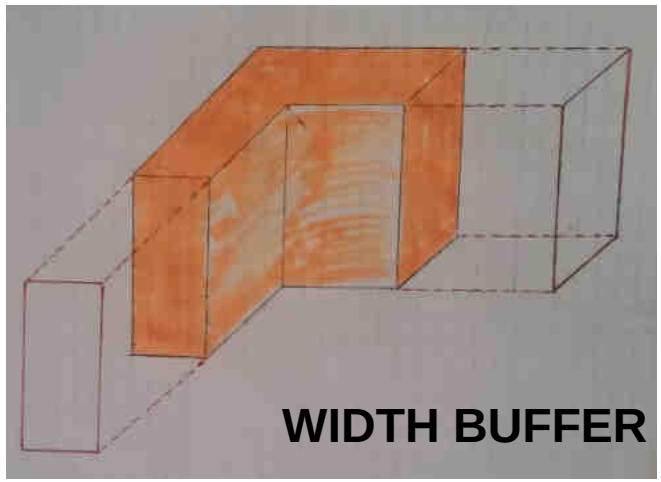
- Eexamining the proximity to neighbouring 2D/3D parcels
- Ensuring safe distance
- Joining two neighbouring 3D volumetric parcels into a single 3D parcel

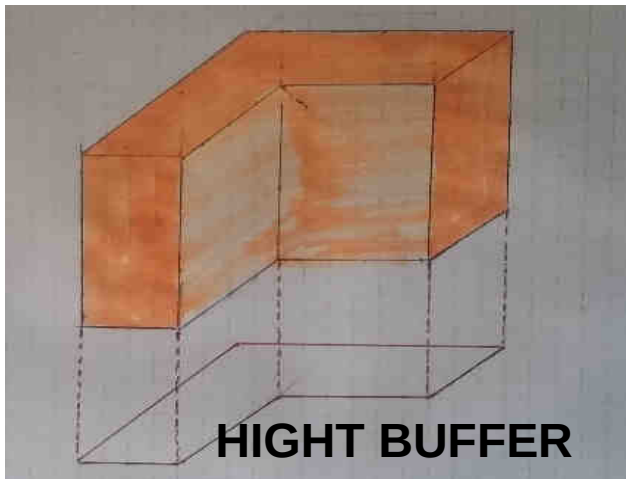


Survey of Israel, 2004

Spatial Buffer

- Enlargement (positive buffer sign) and reduction (negative buffer sign)
- Multiple offsets: choosing vertical and horizontal buffers separately
- Single offset: enlarges a 3D volumetric parcel both vertically and horizontally by the same factor





Input

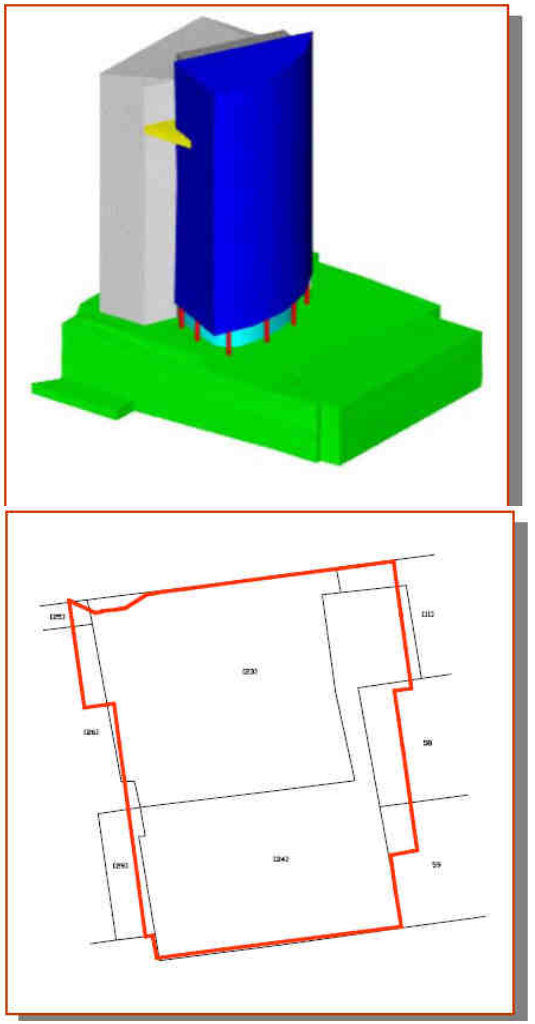
- 3D volumetric parcels
- Height/Width size
- Reference point/plan

Output

- Enlarged or reduced 3D volumetric parcels with facades (vertical, horizontal, diagonal)

Intersection and Overlay

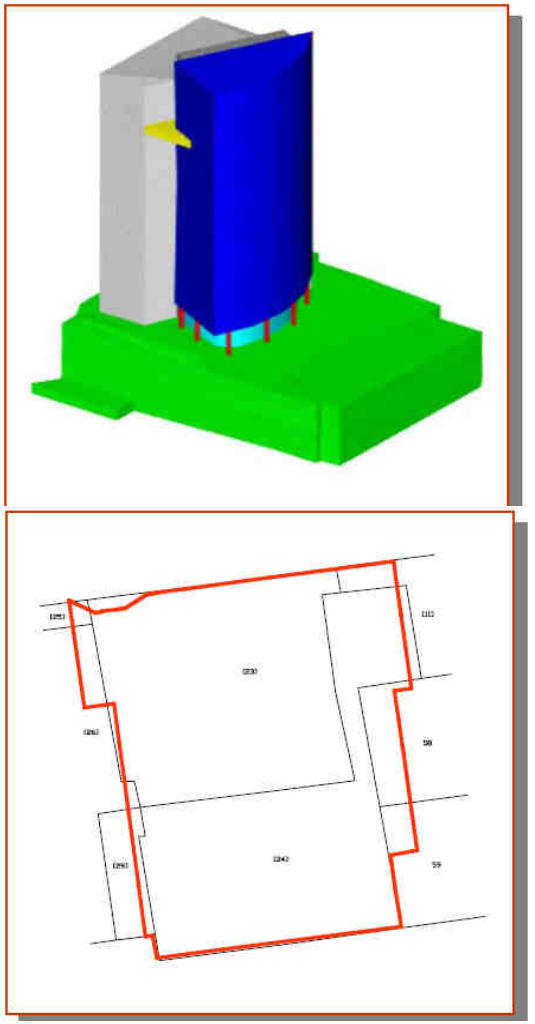
- Detecting whether a 3D volumetric parcel covers in-full or in-part other 3D volumetric parcel/s in horizontal plane and vertical plane
- Overlay function as an alternative to full intersection



Survey of Israel, 2004

Intersection and Overlay

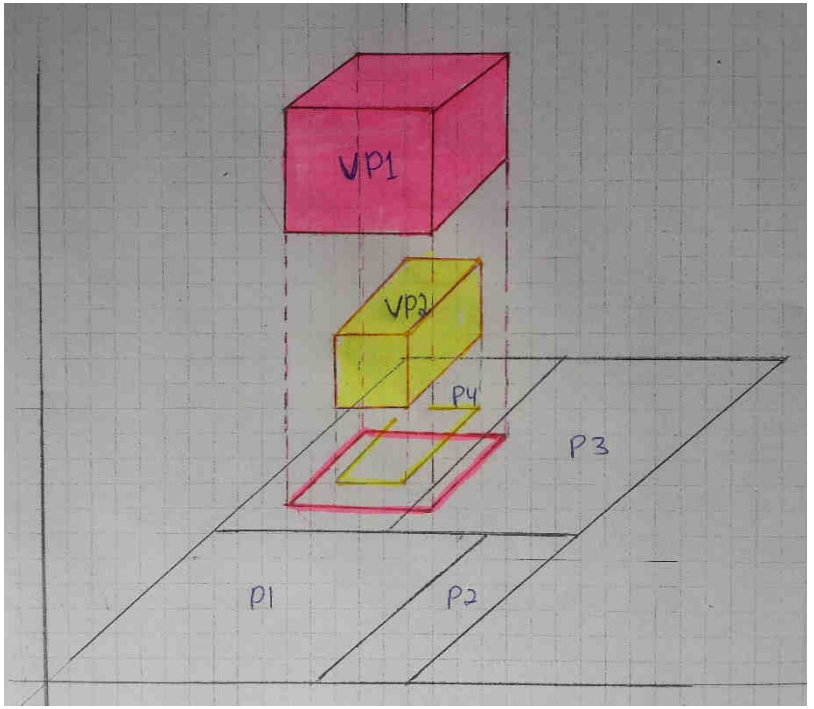
- Finding the spatial correspondence (condition, state) between two 3D volumetric parcels in various geometric perspectives ('directions') without the need for full spatial intersection computation.
- The required various perspectives are mostly the vertical and horizontal ones
- This examination is necessary when considering whether a 3D parcel obscures in-full or in-part other 3D parcel/s.



Survey of Israel, 2004

Intersection and Overlay

- VP1 and VP2 are 3D volumetric parcels with no intersection between them.
- P1, P2,P3 and P4 are 2D polygon parcels with no intersection.
- The projections of VP1 and VP2 (2D polygons) partially intersect.
- VP2 is fully contained in P4 (2D polygon).
- VP1 partially intersects P4.



Input

- 3D volumetric parcels
- 2D polygon parcels
- 2D polygon and 3D vol. parcels

Output

- No intersection
- Fully contained
- Partial Intersection

Three Intersection Types:

Intersection of 2D parcel

- Adding a 2D mutation plan patch
- Adding land parcel
- Examination of possible discrepancies existing between adjacent cadastral map blocks

Intersection of 3D volumetric parcel

- Examine the corresponding condition/state between two 3D volumetric parcels

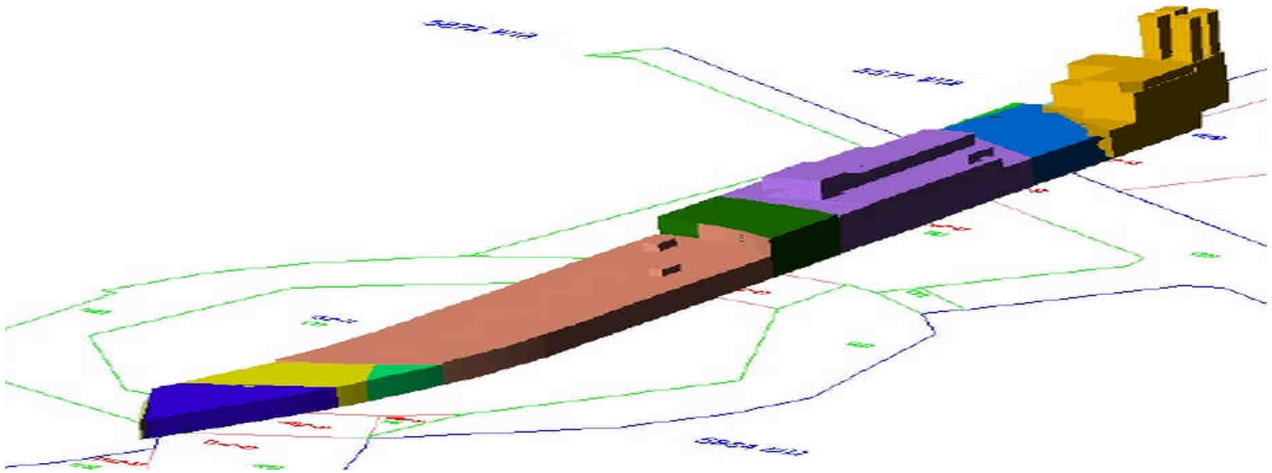
Intersection of 2D and 3D volumetric parcel

- Examination of the spatial condition/ position of a 3D and a 2D cadastral parcels

Split

Split of 3D volumetric parcel as function of geometric/cadastral constraints

- Geometric constraints: splitting a 3D cadastral volumetric parcel on a horizontal or vertical plane; parallelism or perpendicularity between faces of the 3D object, etc.
- Cadastral constraints: minimal 3D volumetric parcel volume, minimal area of faces etc.

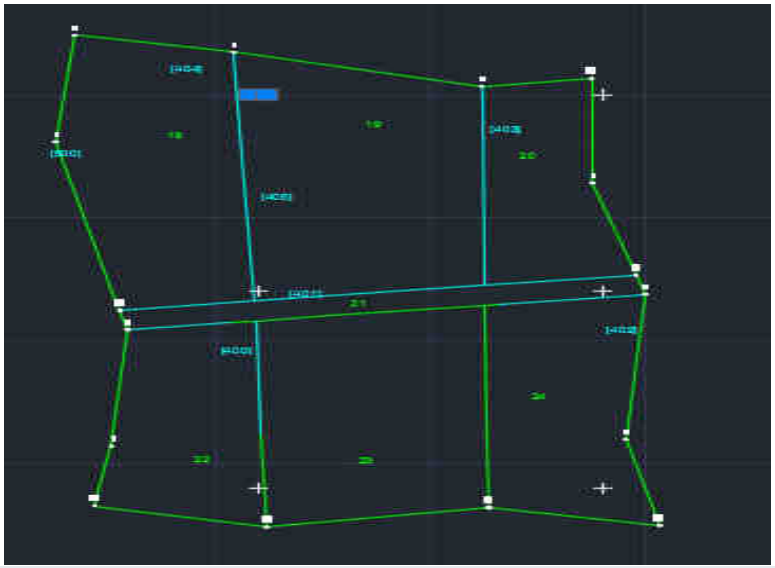


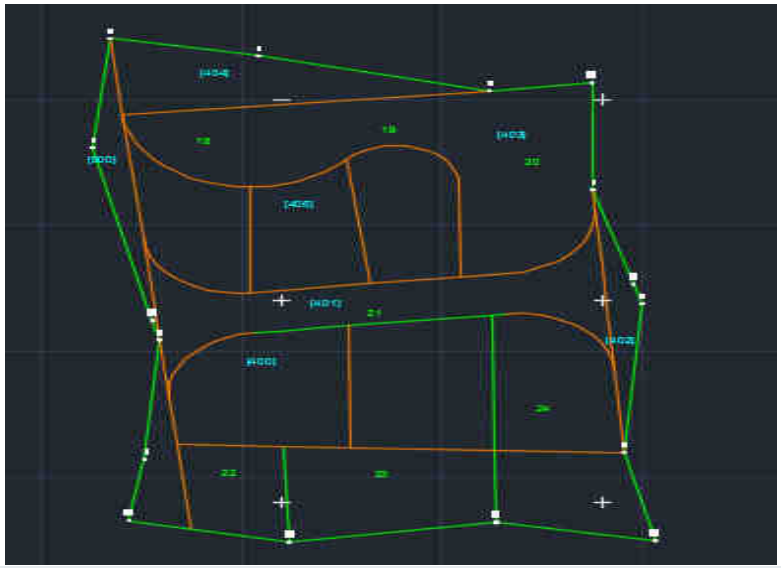
Survey of Israel, 2004

Split

Split of 2D volumetric parcel as function of geometric/cadastral constraints

- Geometric constraints: required width of a parcel/lot, parallel or perpendicular segments of the polygon, etc.
- Cadastral constraints: minimal area, length of minimal facades, etc.



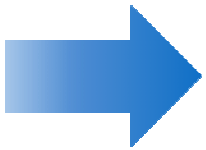


Split

3D Split

Input

- 3D volumetric parcels
- Geometric constraints
- Cadastral threshold



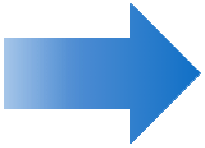
Output

- Two - or more - 3D volumetric parcels derived from splitting of the original 3D volumetric parcels

2D Split

Input

- Parcel/lot
- Geometric constraints
- Cadastral threshold

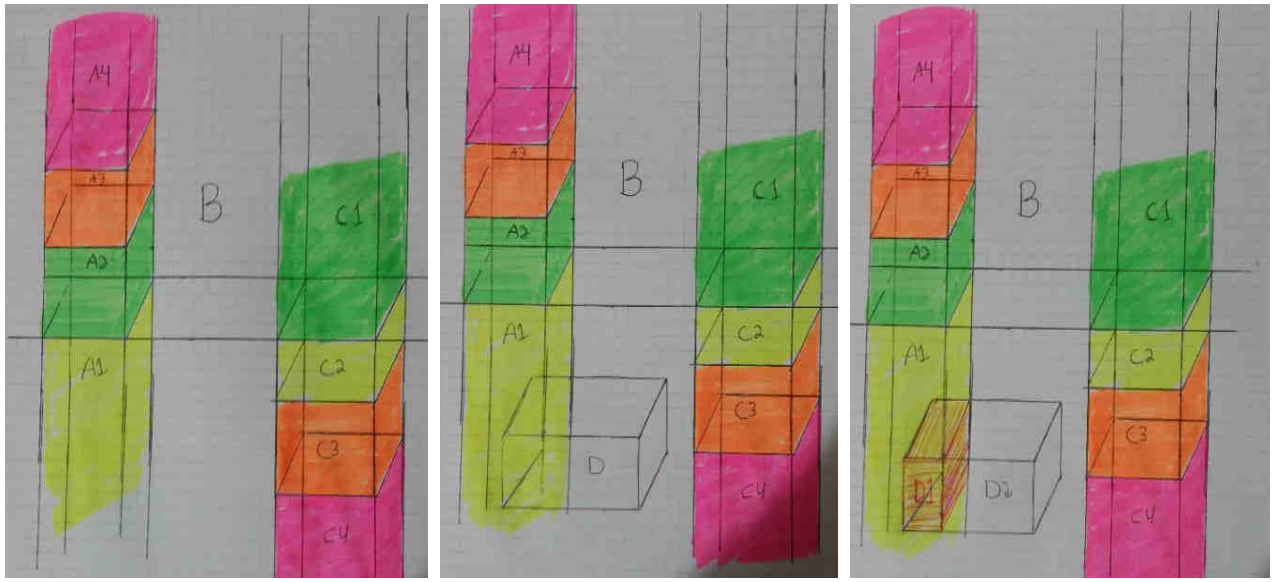


Output

- Two - or more – 2D polygon parcels derived from splitting of the original 2D parcels

Split

Split of 2D/3D objects in relation to existing/neighboring 3D objects



Input

- 3D volumetric parcels
- One (or more) 2D objects

Output

- Two - or more - 3D volumetric parcels created by splitting of the original 3D volumetric parcels

Summary

- Definition of complete and computerized set of functionalities required for the 3D management and handling of objects in a 3D cadastre system.
- Functionalities' input, output and the way they perform have been defined.
- Functionalities were presented from physical and jurisdictional point of view in respect to the configuration and guidelines made by the Survey of Israel.
- Several primary processes presented to form an effective cadastre system, outlying all the steps required and functions handled.

Future work

- Our next step is to construct a 3D geo-database and data-structure required for handling 2D and 3D objects, and integrate the functionalities.

- Implementing the different processes into a 3D cadastral system in a manner that enables good governance, in accordance with the definitions and guidelines made by the SOI.

- Validating the functionalities and examining their workflow in various conditions and different situations within a system.

Thank You !

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