

# Parcel Fabric – A Good Possibility for Management of Geospatial Cadastral Data

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**Abstract**— Parcel Fabric represents an ArcGIS extension to manage cadastral data. One of the main advantages is those of retrieving historical parcels. So, we can see in any moment the situation of a cadastral parcel with all the processes of changing in shape. In this paper are highlighted the main possibilities to link and use with applications from another areas like urban development, environmental analysis, demography, waste management, etc.

**Keywords**— cadastre, geospatial data, Model Builder, Parcel Fabric

## I. INTRODUCTION

THIS approach is about ArcGIS Parcel Fabric. This is a very useful tool which is adapted to the current trends regarding the systematic recording of real estate at local/national level. Effective and efficient management of limited resources (land being a part of this category) became quite important locally for our country and for all countries at the EU regional and global level.

Parcel Fabric is one of the effective ways and dedicated management of geospatial data relating to real estates is the use Parcel Fabric.

Taking account that Romania has a unitary recording system of real estate throughout the country, there are quite a few administrative units that received a registration of technical, economic and legal status of all real estates.

Therefore, the system will contain a complete record of the reale estates at the whole country level just in a few years. For proper management of the real estate there are several software options and ParcelFabric from ESRI is an appropriate option.

Theoretical and practical aspects described in the paper, and the conclusions drawn from the case study approach aimed at efficiency, automation, reduction of working time and costs in the systematic recording projects.

## II. DEFINING ATTRIBUTES

Parcel Fabric is an ESRI dataset, configured to allow the storage, maintenance and editing geospatial data on real estates. Is created within a feature dataset taking spatial reference from the feature dataset (which may contain other

spatial objects connected together).

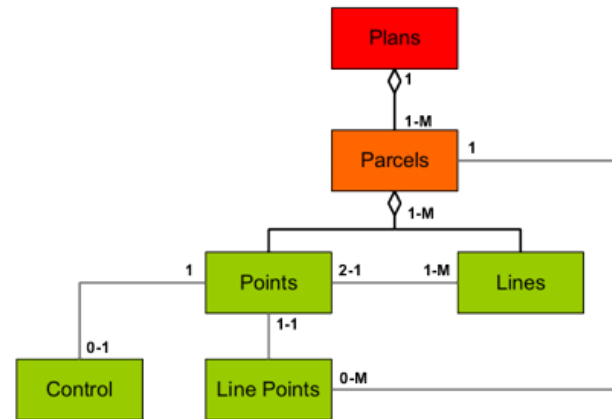


Figure 1 – Parcel data model in Parcel Fabric ([9], [17])

The information associated to the parcel contains documents, plans and textual information describing the configuration of the rights and limitations with regard to the land itself.

For example, could be information like the following: titles in that can be found the owner, legal description of the real estate and any other rights and duties.

Also are included information about the buildings, the values of the land and its improvements, address and tax related.

If a person owns a real estate, parcel information is describing documents, shape and configuration of the building and improvements value. If a person rents or leases a building, in the parcel information will be included the time period that ended the contract and the rights they have tenant or lessee. Information parcel includes all the limitations and burdens.

Value and improvements made to the building are determined through the real estate valuation process, the value of land, construction.

Real estate tax depends on the area, utilities and includes the estimated value of buildings, land and their area. This information is determined by the evaluators, and is based on valuation rules provided in norms and specific standards. When the land is sold or mortgaged, the owner could be required to evaluate the above.

Description of legal situation contains official information about a real estate and concerns about neighborhood

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boundaries, dimensions and the area determined from the coordinates located on the contour, calculated in national projection system, relation to other parcels, gaps and overlaps between parcels, all of which are necessary for accurate site maps.

These contains geometry, land use, often postal number and cadastral number, real estate area from measurements and from title, performer, date, signature and stamp. Description of legally is related from geospatial viewpoint with parcel boundaries and corners.

Basic Parcel Fabric editing is composed by:

- Parcel Traverse
- Cogo
- Line strings (natural boundaries)
- Parcel Construction
- Traversed, pasted or cogo tools
- Parcel Division
- Parcel Merge
- Remainder Parcel

### III. CASE STUDY

#### A. Reasons to Choose the Case Study Area

The main reasons to choose this study area are: urban limits have not been updated for about 25 years and does not reflect reality from the field; administrative units areas are not set clear limits; many buildings were returned to the owners in urban and rural areas; a lot of sporadic cadastral works across administrative units were made using the sheet into possession and their positioning is not properly carried out; existing land books within administrative units were not converted and included in the database of the e-Terra (Romanian informational system for the real estate registration), so is not possible to retrieve cgxml files; due to lack of modern equipment, GNSS systems, in the '90s following period a lot of sporadic cadastral works were made using a local system and their integration in the geometry and position of master plan has become very difficult.

Given these premises, it could be considered optimal choice using the Parcel Fabric data management.

The Parcel Fabric offers in workflow:

- Dataset for storage, maintenance and editing of parcels
- Historical parcels
- Linework adjustment
- Coincident geometry
- Topology shared across
- Production vs publication
- Tax Parcels
- Public access to data

#### B. Creating topology from CAD

First of all we created a topology from CAD [26], using Model Builder. There are many different methods for loading data from a CAD file into a geodatabase. The used approach may vary depending on the schema of the CAD files (whether they have just parcel data or there are many other feature

types. [1]

For the study area (Făurei, Romania) was created a model which converts a CAD data in a GDB topology. (Figure 3) This model is useful and it is the beginning of the data migration for the ParcelFabric organizing data in cadastral purposes. [11]

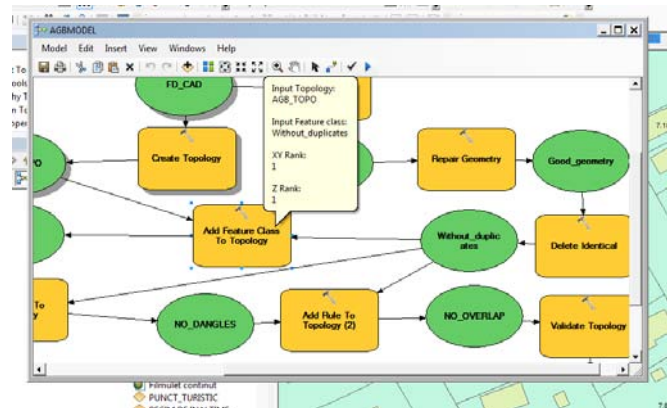


Fig. 1 - Running the model (adapted from [2], [8], [24])

#### C. Topology in Parcel Fabric

The difference between the topology (figure 2) and Parcel Fabric (figure 3) is the relationship between data. It must be created a topology of the data to make sure it meets the criteria for the fabric, but once loaded it is easy to manage parcels. [2]

Before the data migration in Parcel Fabric we cleaned up the topology errors. (Figure 2)

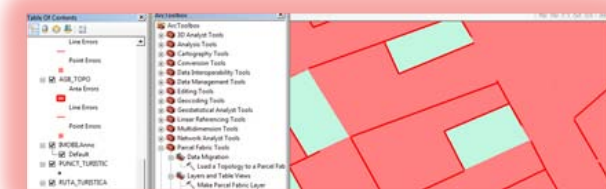


Fig. 2 – Topological errors

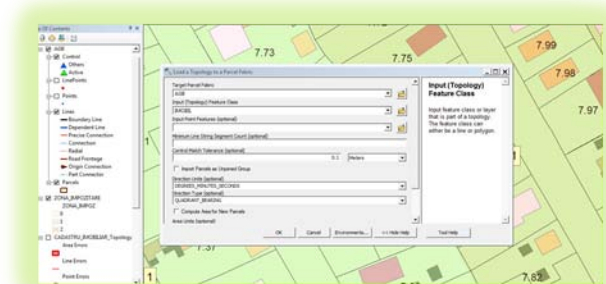


Fig. 3 - Loading a topology to Parcel Fabric

Once the topology errors [25] were fixed we loaded the data into the fabric and edited it. As for editing when is edited one parcel it edits all of the surrounding parcels whether it be a

Section, Township or other tax parcels or whatever is loaded into the fabric. Editing the neighboring parcels together is a strong reason to justify a much easier way to manage land records. In cadastral works, over the big areas, this is a very useful and complex method. [25]

#### D. Modeling relationships between parcels in Parcel Fabric

The Parcel Fabric relations exist between parcels, lines and points, and relationships between the characteristics of parcels and some other data from other maps managed by the same means.

In the following we are presenting the rules and relationships between characteristics of parcels and between parcel characteristics and other entities:

- a parcel polygon is in relation with several lines;
- a parcel line has two end points;
- a parcel line is in relation to a single parcel, resulting two lines in a common boundary which are representing the two parcels;
- a parcel point is in relation with a single point of control;
- a parcel point is located in relation to one or more lines;
- a point on the line is in relation to one or more parcel polygons;
- a point on the line is in relation with a line parcel;
- a parcel point is in relation to a point on the line;
- a parcel polygon can have many points of the line;
- a parcel polygon are compared with a single map;
- a parcel may have one or more historical parcels;
- a parcel point may have one or more vectors of adjustment.

Parcels are defined by a series of boundary lines that store measurements as attributes of lines.

When we are introducing parcels lines, they will be preserved, regardless of the changes that are made to the parcel geometry to assemble a continuous dataset of parcel.

By working with Parcel Fabric we are sure that the parcel lines of adjacent parcels are not broken. In this regard, we maintained a continuous series of lines for each parcel and these lines do not intersect each other when the adjacent parcels meet at corners. [18]

The data importing was made by scheme-only layer package containing schema and data which can be used as a template. Local Government Information Model is shared as a package scheme as a way to distribute design of a geodatabase.

The control points are defining the accuracy of the X, Y, Z for the physical characteristics of the Earth surface. Control points are added to the Parcel Fabric so that parcels can be constrained by network control points using the method of least squares.

While parcel size limits are precisely defining the parcels in relation to themselves, control points help us to obtain precisely defined spatial locations of the corner parcel points when they are used in an adjustment using the least squares method.

The checkpoints coordinate values are maintained "fixed"

while the coordinate system of checkpoints is transferred in Parcel Fabric. (figure 4)

One of the biggest advantages using the processing method of least squares is that all measurements can be analyzed simultaneously.

Each parcel size and thus each parcel of Parcel Fabric has an associated accuracy. This is due to the fact that the size of parcels are derived from the processing of the raw data associated with precision. By default, the accuracy of the Parcel Fabric data is defined by the data because currently surveying instruments are more accurate than in the past.

Before applying constraints using the method of least squares was made the checking of control points ("check fit"), which calculates the transformation between the old coordinates and the coordinates of the control points by Helmert transformation.

Calculated parameters (rotation, translation in X, translation in Y and scale) were applied to the old coordinates of the points related to temporary values to calculate new coordinates of the Parcel Fabric points.

The differences between the new values of the calculated points and control points are reported as residual values (dx, dy) for each active control point. High residual values may indicate a problem and should be investigated further.

The residual values are within acceptable limits (differences between the two sets of values) and processing parameters can thus be applied to all coordinates of the Parcel Fabric points to process them into the coordinates of the control system. Before starting the processing of the coordinates, we specified the tolerances to be met. In general, if is determined more accurate data, then the offset will be less, and correction will therefore be lower.

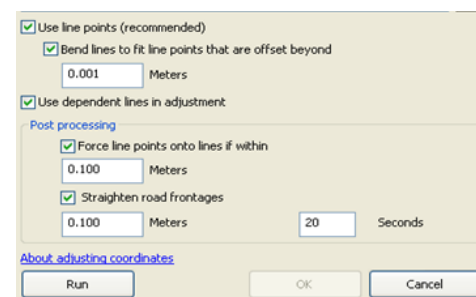


Fig. 4 – Required tolerances

Manufacturing process was iteratively repeated until the average and maximum coordinates is 0.0 or as close to this value, and when this was accomplished, it could be concluded that the adjustment was constrained to an optimal solution. [18]

In the attributes of Parcel Fabric tables were generated automatically all the processing elements. Later we added coordinates and distances between them on the obtained map. [24]

In conclusion, through the Least Squares Adjustment we can obtain:

- 1st run check on control points

□all are included in best fit: stored bearings, distances on parcel lines, control points

□can be repeated until maximum displacement in northings and eastings close to zero

□original COGO is not altered

#### E. Using historical parcel information

One of the major advantages of this workflow consists in using of historical information. Real estate, adjoining, detachment are continuously influencing the shape and size of parcels. Some authorities in the field of cadastre can have a record of the current state of the real estate on digital media, but are not knowing the representations of their past situation.[21]

There are three ways of tracing the parcel history, as shown in figure 5.

Archive - This type of tracking historical information is a snapshot of the entire geodatabase at a moment in time.

Periodically, preferably annually, we must archive the fiscal role and taxation.

The advantage is that these archives can be analyzed if changes have occurred in the assessment and can be used to document the data condition or state at a time. This mode can be traced the intermediary changes that occur between archive periods. For example, a property can have several different owners over several transactions during the year and only the first and the last owner would be included in this archive.

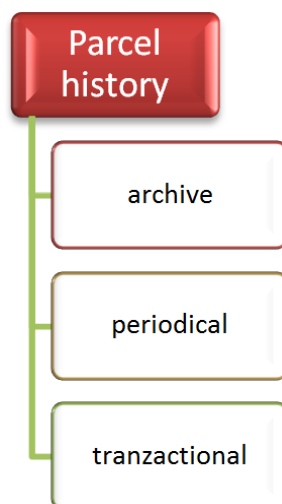


Fig. 5 - Parcel histoy tracking methods

Periodical - Periodic tracking historical information documenting changes at some known point in time. These are the only versions that contain changes. If periodic changes are kept as a separate file, there is a record of intermediary updates and changes during the year.

Transactional - This historical information monitors and keeps all transactions and all historical parcel information databases and parcel maps. [20]

All changes are kept in a temporal sequence and all changes

are maintained and preserved. Historical transactional information retains flow change of the ownership titles and geometrical changes.

Parcel history is important for legal status and for the value in the process of adjustment. [1]

Parcel history contains the correct size that offers an increased measurement redundancy in an adjustment using the method of least squares. Coordinate points will have to be changed over time.

To follow the evolution over time must be kept current and the spatial relationship between the historical parcels. [15]

Therefore, all parcels, both current and those from history, will be part of any adjustment by the method of least squares. [3]

Historic boundaries of parcels will be adjusted together with the current parcel boundaries.[19]

For example, we considered if the owner of a parcel is purchasing a new neighboring parcel and wishes to make an adjoining. (figure 6)

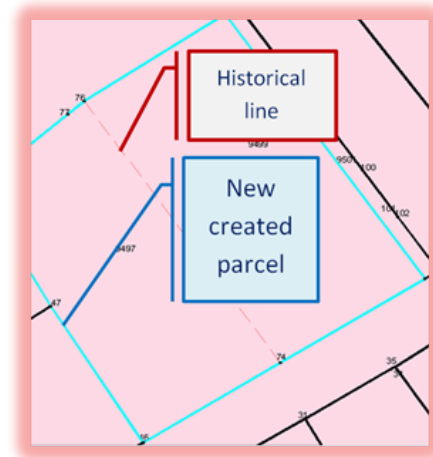


Fig. 6 – The adjoining result

Properties of the new parcel are including the legal start date of parcel creation that was automatically updated.

New parcel contains the date on which they were annexed the two parcels and this is done automatically. (figure 7)

If it is desired to achieve a detachment [13] of a real estate using some measurements, the data model of the Parcel Fabric application provides the possibility to enter values of the angles and distances measured by the user to create a new parcel and the old parcel is marked as historical.

It is important that a new detached parcel to inherit all the attributes from the parcel parent. [14]

The data model of the application parcel fabric provides the ability to enter values of the angles and distances measured by the user to create a new parcel or a new building, the old building being marked as historical.

First of all must be marked the building in which it is desired to make detachment.[23]

Then proceed to the interruption of the property lines between two initially selected vertices at the desired distance.



It can be seen scroll direction from one vertex to another in ascending order. It will be placed at the distance specified by the user and will be considered in advance as vertex of the new parcel.

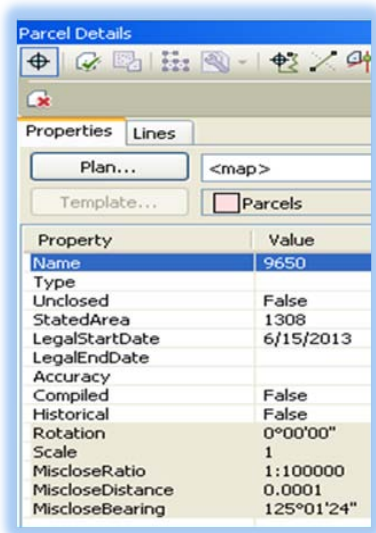


Fig. 7 -The history of new parcel

Then proceed to the start of construction of the new parcels from the last created point, the values for the angle and distance can be entered in the fields on the plot details. (figure 8)

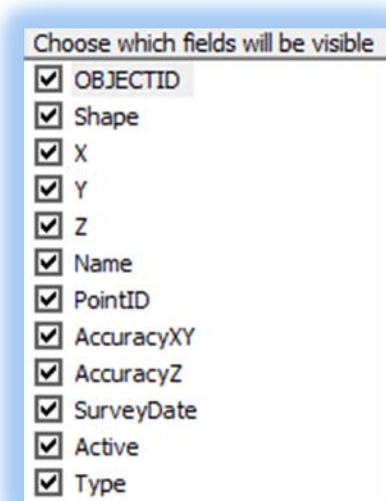


Fig. 8 – Choosing of visible fields

In this way results a new created parcel, to which we assign a new cadastral number, which have been automatically linked the same properties that those linked with the old parcel, which offer information about the legal date of parcel creation, about angles and distances between the points of inflection, etc..[13]

#### IV. CONCLUSIONS

As advantages of using Parcel Fabric application we can include the following:

- is part of a dedicated GIS system;
- is defined by a simple geometry to create and manage a precise spatial cadastral GIS;
- is built as an extensible platform for real estate cadastre and registration;
- is possible to achieve adjustments on feature class sites based on control points;
- is an easily expandable and customizable system;
- gives to the user a wide range of functions for editing parcels, which gives unity to the work in which it is applied;
- can be scaled to any highly comprehensive datasets;
- parcels updated with new information are not deleted from the system, they will be marked as a historian;
- control points are designed to help coordinates adjustments of the parcel corners;
- has an explicit topology defined by common corners of adjacent parcels;
- topology is required in the model and is defined and executed during import of the necessary data;
- has standardized procedures;
- eliminates duplicate data.

Land management using the Parcel Fabric provides opportunities for providing better services, increase customer satisfaction and reduce of operating costs is increasingly.

The concept of "Parcel Fabric" offers a comprehensive database in which parcel information can be easily managed, on this basis it can easily maintain the details previously used like a a part of the control points network.

In table 1 are highlighted the main advantages of this workflow.

Table 1 – The advantages of Parcel Fabric workflow [16], [17],[24]

Nr.	Benefits	Characteristics
1	Data Integrity	The topological relationships between the parcel, lines and point are persisted as an inherit part of the data (not available in simple features and topologies, in which a user might perform an edit that breaks a rule and the operator must validate and fix the error to persist data integrity).
2	Historical Parcels	parcel history, or lineage - any transaction, such

Nr.	Benefits	Characteristics
		as a split or a merge, retires the parent parcel(s), and the historic parcels are not deleted but marked historic automatically and can be viewed in any time.
3	Legal Start/End Dates	Each parcel has a legal start and legal end date that allows the operator to track the legal creation of that parcel.
4	Record Measurements(COGO)	The record values or measurements on a line are never changed, even if the line geometry changes in the parcel fabric. Records values are used to calculate misclosures, legal area and other processes. Each parcel has its own set of lines, and 2 lines can be connected to the same start and end points, even if have different records measurement.
5	Stacked Parcel Types	The fabric support stacked parcels that can connect to the same points. A subdivision, lot, and tax parcel all use the same points on the subdivision boundary. If those points move, all the parcel types move.
6	Associated Feature Classes	Any adjustment or movements the operator makes to the parcels can be applied to other simple feature classes (e.g. tax districts, utilities, zoning,etc.) that are associated to the fabric.
7	Backlots	The parcel fabric manages line points that connect a line to another line without breaking

Nr.	Benefits	Characteristics
		the other line. This helps users persist the record measurements of each parcel uniquely.
8	Plans	A group of parcels can be managed together and can specify the accuracy level, unit of measure, how the curves are defined and other properties.
9	Accuracy	Each measurement has an associated accuracy. Survey control points can be improved over time and used to run an adjustment in order to improve overall accuracy and identify blunders.
10	Parcel Editor Toolbar	The parcel editor contain tools that are specific for parcel maintenance: merge, metes & bounds, area calculation based on records measurements,construct from parent.

After the cadastre was implemented it can be improved over time and obviously can be associated with a number of new elements needed for other activities or changing some predefined elements of the database.[22]

With this concept, the benefits of correcting the data are innovative and numerous [12], so it can improve the systematic recording, working time, execution cost, so the concept can easily be applied to other projects. [10]

In purposes of taxation or record management, many governmental entities are charged with the task of managing all parcels and survey measurements within their jurisdiction. Usually, most of agencies store only the information for reference proposes inside a GIS or CAD program.

Parcel Fabric can manage a small group of parcels or hundreds of thousands of parcels and process a few COGO values or thousands of values through the least squares adjustment engine. A surveying company which use it can build their own project-specific fabric from existing survey maps in the area.

As application domains, managing spatial data in a cadastral unit has the advantage of using the Parcel Fabric in many fields, such those from figure 9.

#	Cadastr
	Urban and Regional Planning
	Civil Engineering
	Emergency Interventions
	Environmental Analysis
	Urban Development
	Zonal Administration
	Environment
	History
	Census
	Demography
	Real estate industry
	Waste management
	Registration of property documents
	Insurance
	Develop thematic maps for NACLR
	Real estate evaluation
	Statistics
	Parks and recreation activities
	Railways
	Agriculture / land use
	Epidemiology
	Designing the risk and hazard maps

Fig. 9 – Advantages of use Parcel Fabric

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