Towards 3D Land Registry in Hungary

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SUMMARY

New Act on Surveying and Mapping Activities, accepted by the Hungarian Parliament in May 2012, introduced 3D Land Registry. 3D Land Registry will work in unified environment, in the Unified Land Registry of Hungary, which was established in 1972. New legislation introduced the definition of 3D properties, the different rules for managing rights, restrictions and responsibilities in 3D space. Institute of Geodesy Cartography and Remote Sensing (FOMI) has a key role in this development. Development contains not only the legislative, but the geometric, GIS aspects as well. The paper deals with the current development issues both in legal and cadastral mapping field as well.

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1. INTRODUCTION

Hungary has a long tradition in cadastral surveying and land registration. The first cadastral survey of the country started at the mid of the XIX. Century, in the ages of the former Austro-Hungary. Surveying and registration of lands finished at the end of the Century. It means all the lands in Hungary have been surveyed and registered since the end of the XIX. Century.

At this time, the main goal of the Cadastre was the taxation of land. Cadastral surveying and land registry were separated. Registration of Condominium Units (CUs) has started in the 1930's.

Developed registration process was quasi 3D registration of CUs. Identification of CUs linked to the cadastral parcel number and the building in where the unit was. Each floor of the building had a layout plan, on which the CUs were delineated. This process remained the same until now. Registration of cadastral parcels based on a typical 2D registration method, no 3D aspects had been taken into consideration.

Operation of Land Registry and Cadastral Mapping was persistent during the socialist ages, because private ownership on land and real properties was existed.

In 1972, because of the large number of discrepancies between the Land Registry and Cadastral Map, Hungary introduced a new, Unified Land Registry, in which Land Registration and Cadastral Mapping, is the responsibility of the same organization the Land Office Network. Land Offices have to update Land Registry and Cadastral Maps together, on an integrated way. Land Offices' tasks are also Agricultural Land Valuation, Land Protection, Land Consolidation and Land Lease Registration altogether.

Institute of Geodesy Cartography and Remote Sensing (FÖMI) developed a standard (MSZ 7772:1-1996, Digital Base Map, Conceptual Model, DAT Standard) on Cadastral Map Database. DAT Standard is an object-oriented data model for cadastral map database. Based on DAT Standard new (mandatory) instructions have been developed for cadastral surveying and mapping activities in Hungary, which was introduced in 1997. DAT Standard was approved by the Hungarian Standards Institution in 1996 (IVÁN et. al. 2004).

New standard and instructions totally reformed the Hungarian Unified Land Registry. Object-oriented database view of Cadastre inspired many software and IT system developments. IT developments of Hungarian Land Administration are the responsibility of FÖMI. Until now FÖMI developed many IT systems for Land Office Network:

- TAKAROS (IT system for the management of Land Records and Legal Data, Application management, Statistics, Reporting, finished in 2000),
- FÖNYIR (IT system for Land Lease Register, finished in 2000),
- TAKARNET (Network of Hungarian Land Administration, Unified Land Registry Services for the users, finished in 2003),
- DATR (Integrated Unified Land Registry Management IT system, Management of Land Records and Cadastral Map by integrated way, finished in 2010),
- MENYÉT (IT system for Farmer's Registry, finished in 2014).

Development of an IT system has never finished. Continuous update, customization of the systems for the changing technical and legal environment is a very strict requirement. Since all the codes were developed by FÖMI en-bloc, this development task is a permanent duty of our institute.

All these IT systems are based on the DAT Standard. Reliable operation of the systems shows the success of our developments. Core data model of DATR system acts as a country profile in Land Administration Domain Model (ISO 19152:2012) Standard.

After the political changes at the beginning of the 90's the newly established local governments had not enough financial resources, therefore they sold out the flats and other properties for the citizens. This action caused a huge increase of the number of condominiums and registration of them.

Development in urban infrastructures (e.g. roads, railways etc.), privatization of infrastructure companies (e.g. utilities, water supply, sewerage, electricity etc.) increased the value of properties and the number of privately owned infrastructure elements as well. Fast development leaded to intersecting, overlapping objects, which could not be registered in a traditional 2D Land Registry. Utility networks, which owned by different companies, also rose registration problems. Hungary has 22 wine-growing regions with a lot of cellars in the hills. Under the traditional 2D Cadastre regulations registration of cellars as individual properties within a cadastral parcel cannot be executed, because it is a part of the cadastral parcel. In the case of cellars registration of them is a very important issue for wine-makers. Samples can be counted, but these were the reasons, why Hungary changed Act on Surveying and Mapping Activities and Act on Land Registry introducing 3D Land Registry in 2012.

2. NEW ACT ON SURVEYING AND MAPPING ACTIVITIES

The goal of Act on Surveying and Mapping Activities is to determine the tasks of the State in Surveying and Mapping and to establish a condition system, which provides map databases in a cost-effective way for the whole economy and society.

The main issues, which are handled in this Act are the following:

- State works and State Data
  - State Databases
  - Data Services,
  - Control Networks

- State Databases
  - Database of State Boundary
  - Database of Control Points,
  - State Cadastral Map Databases,
  - State Topographic Databases,
  - State Remote Sensing Databases,
  - Databases for State Defence,
  - National Gazetteer,
  - Archive Databases.

- Surveying and Mapping Activities
  - Mounting and measuring surveying marks
  - Ownership of surveying marks,
  - Protection of Surveying Marks

- Ownership of Surveyed Data
- Institutional Issues in Surveying.

New concept on Surveying and Mapping activities changed from the old, map-based regulation to database fundament. State Cadastral Map Database is the geometric part of the Unified Land Registry Database, which is defined in the Act on Land Registry. Unified Land Registry Database contains two main parts, Cadastral Map Database and the Database of Land Records, which must be integrated.

Topographic mapping activities are shared between the public (FÖMI) and military mapping agencies. Large scale (1:10 000) topographic mapping is the responsibility of public (FÖMI), while smaller scale topographic mapping belongs to the military mapping agency.

State Remote Sensing Databases are Orthophotos, Satellite Images, LIDAR (including Terrestrial LIDAR technics), Photogrammetric products, which production is financed by the State are also regulated. There is a very strict statement in the new Act, which really helps the renewal, updating and production of State Map Databases:" A copy of any map database product, of which production is fully or partly financed by public funds, must be provided for FÖMI, without any financial and natural compensation." This means that every map database, produced in Hungary, of which production financed by public money, can be used for State level map database renewing, establishment. It is very important, if the financial resources in State Budget are generally low or not existed (like in Hungary). This statement really helps the Hungarian Mapping Agencies in their work.

New concept also includes 3D Cadastral issues, which determine that 3D parcels, related to Land Registry, should be stored in State Cadastral Map Databases. Because of the importance of 3D Cadastre solution (e.g. Condominiums in Hungarian Land Registry are registered since 1930's as quasi 3D parcels), Hungarian Land Administration Sector now is elaborating the legal restrictions of 3D Cadastre.

Act on Land Registry defines a Unified Land Registry, which means the legal and geometric (cadastral map) part of the Unified Land Registry compose one system. All geometric characteristics of Land Registry components (parcel boundary, area etc.) are derived from the State Cadastral Map Database. The Database of Land Records and State Cadastral Map Database compose one Database, Unified Land Registry Database.

This Act defines cadastral parcel, which is a continuous part of the Earth's surface, on which the ownership relationships are homogenous. There are other types of real properties beside cadastral parcels, which are the components of Land Registry (e.g. buildings, condominiums, flats, shops etc.).

Former Act defined some 3D Cadastre issues. These are the registering of condominiums, flats, shops, other areas within the condominium, cellars with access to public domain etc. Registering of these 3D situations, based on the 2D cadastral map. For example flats, shops are not the part of Cadastral Map Database, these are described by the floor layout plans, which act as Cadastral Map of Condominium Units. Change management of them is a very hard work. Cellars are described only by the line of access of them in the Cadastral Map Database.

Because of the above situation, and introducing a real 3D Cadastre in legislation, the renewed Act on Land Registry defines a new type of property, which open the doors to 3D Cadastre.

This new type of property is defined by the follows:

"Under-ground and above-ground passes, objects, structures, which has homogenous ownership relationships should be taken into account as property, which must be registered in Land Registry."

With the help of this definition utilities, over-crossings and other objects (e.g. cellars) should be registered as property and 3D legal relationships should be modeled in Hungarian Unified Land Registry. Versus with some 3D Cadastre solution, the Hungarian concept registers 3D object in space. Connecting legal space of 3D object should be derived from the geometry of the objects itself and other regulations (e.g. spatial planning regulations).

Legal space required for 3D Cadastre object is defined in different Laws, Regulations related to Land Use and Land Development in Hungary. This means if 3D objects and their legal space should be registered in Land Registry, the required legal space must be modeled based on regulations.

The Act authorizes FÖMI to elaborate the required legal and technical regulations for the implementation of 3D Cadastre in Hungarian Unified Land Registry. Therefore 3D elements of the Act will not come into force immediately, only after these regulations and technical conditions are ready.

3. LEGAL ISSUES

Civil Code of Hungary defines the extension of ownership on real-property as follows: ”Ownership right on a real-property extends to the air-space above and to the subsurface below it until utilization is possible”. It is a typical ”from-heaven-to-hell” situation as in many countries all over the world.

Fortunately the word ”utilization” can limit the infinite extension of property rights. The main legal problem in the introduction of 3D Land Registry is the legal handling of 3D situations, for example on Figure 1:

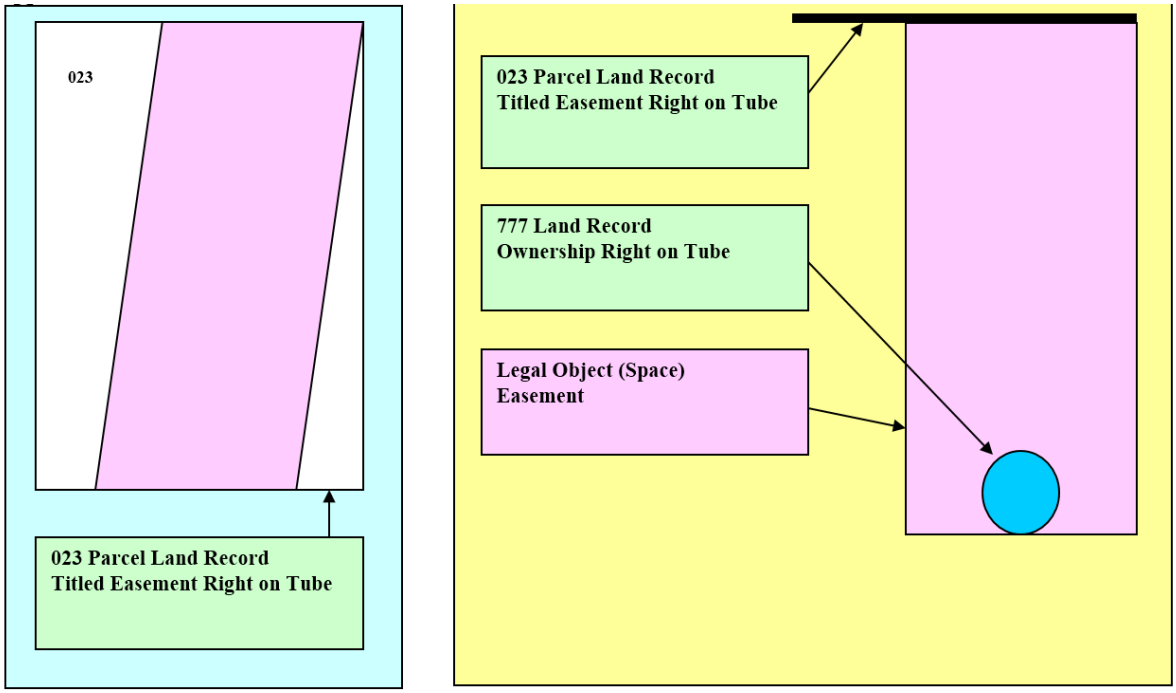

Figure 1: 2D and 3D Land Registry situation

On Figure 1 a typical situation is shown. There is a cadastral parcel (number: 023), and under the parcel there is a tube, of which owner is different from the cadastral parcel’s owner. Based on the regulations on tubes, a tube must have safety zone, which is defined by the certain distance from the axis of the tube.

In 2D situation the tube is surveyed, and the safety zone is defined. If the safety zone intersects a privately owned cadastral parcel (023) the safety zone must be inserted into the cadastral map database and an easement right must be registered on this cadastral parcel in Land Registry.

In 3D situation the tube, oneself is a property. It has a land record in Land Registry. But the tube generates a legal space (safety zone) around it as well. A new, legal object must be introduced, which defines the safety right of the tube. This legal space intersects the legal space
of the cadastral parcel (023), the intersection of the two legal spaces generates an easement right on the cadastral parcel.

In the legal solution of 3D Land Registry such intersections, touching, overlapping of legal spaces and the arising rights must be modeled techically and legally as well.

Legal and technical issue is the identification of 3D properties. On Figure 2 a cadastral map is shown and there is a 3D object, which overlaps cadastral parcels:

Figure 2: 3D object overlaps cadastral parcels

Generally there are two solutions for the unique identification of such object:

- intersecting the object with the cadastral parcels, and split it into as many pieces as many cadastral parcels overlapped,
- no intersection, keep the 3D object as a whole, but some unique identifier should be assigned to it.

In Hungary the second solution is supported, because splitting dissolves the object and its registration and lose main meaning of it. The object, which overlaps parcels (under or below the surface of the earth) must connect to a physical object within a cadastral parcel (e.g. pillars of a bridge, transformer house of a electricity cable, gas distributor station of gas pipeline etc.). For the unique identification of 3D object these "starting" cadastral parcel identifier should be used with some other identifiers, which uniquely identify the 3D object. This identification can connect 3D object identifiers to the traditional 2D identification.

The whole concept of such “octopus” identification has not been finish yet.

4. GEOMETRIC MODEL

There are different recommendation, solutions for modeling legal spaces in 3D Cadastre. One of the most known was published in LADM, which was using boundary face concept for 3D representation of legal spaces. It has a great advantage, because mixed representation of 2D and 3D legal spaces is also available using boundary face string and boundary face solutions (ISO 2012).

The author recommended the usage of homogenous coordinates for managing unbounded legal spaces, or the tesselation of legal spaces by using tetrahedrons (IVÁN, 2012). This solution could be really flexible, but the management of homogenous coordinates could cause computational problems. Tesselation of space requires that all parts of the space should be tessellated, which requires a lot of computation and storage, and mixed 2D and 3D situations cannot be handled in this way. In the future, taking into account the development of ICT technology, this solution could be introduced.

The Hungarian Cadastral Map Standard and the IT system of the Unified Land Registry is using the concept described in DAT Standard. DAT Standard is using 3D points as default for the representation of geometry of the Cadastral Database. Until now only the 2D capacity of the model was used, generally the “Z” coordinate of a point was set to zero (except in the case of vertical ground control points, which require the “Z” coordinate). The sketch of DAT Standard geometry can be found on Figure 3.

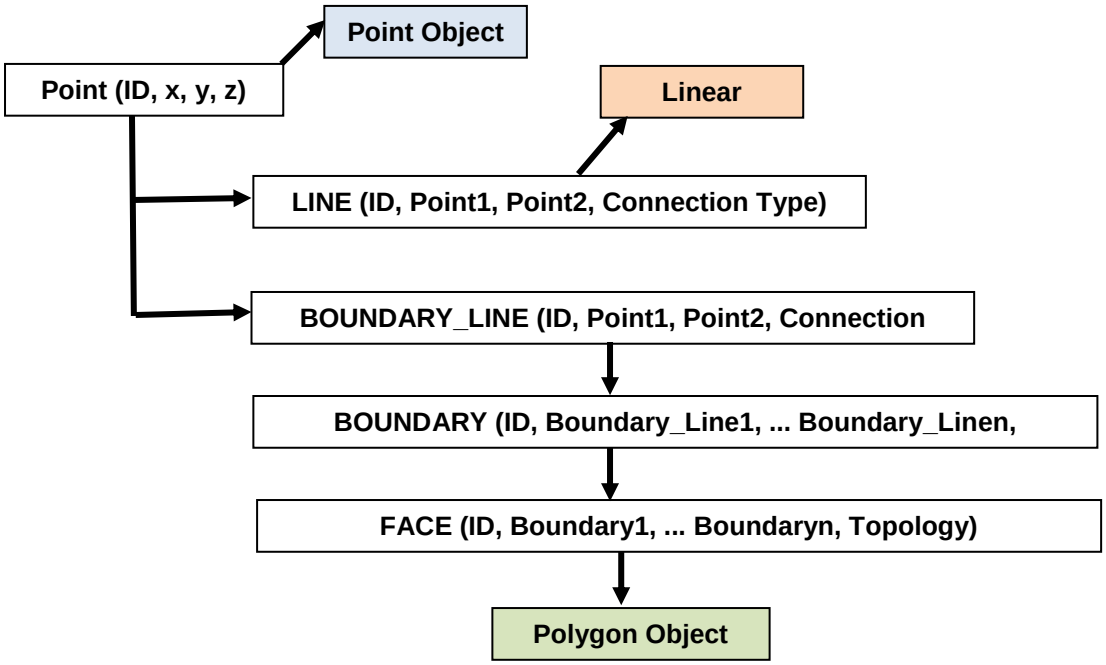

Figure 3: Geometric Concept of DAT Standard

The base is the class Point, which describe the positions (3D as default). If an object is a point type object, it is directly linked to Point class. Line is a class, which stores Points describing a line. Connection type is line as default, but curved connection is also available. If an object is a linear object, it linked to class Line. Boundary_Line class is similar to Line, except it must be a part of a boundary. Boundary is a set of connected Boundary_Lines and it must be closed. Face is a composition of boundaries. Face must have only one outer and zero or more inner boundaries. Polygon type objects are directly linked to Face, describing their geometry. This concept is very similar to any GIS systems concept is it is a 2D situation.

DAT Standard based solution for modeling 3D legal spaces is based on the condition that the legal spaces are not unbounded or can be closed in the finite. Boundaries of legal spaces are represented by planes (no curved surfaces are allowed, Figure 4).

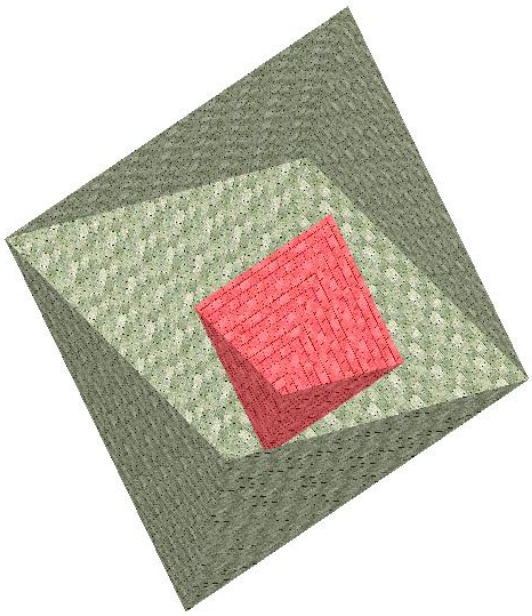

Figure 4: Legal spaces delineated by planes

On Figure 4 two legal spaces are shown delineated by planes. The outer (green) legal space contains an inner legal space (red), which is not a part of the green one (hole in the space).

If the original geometric construction of DAT Standard is used, Face class should describe the planes, which delineate the legal space. In Face class holes within a face are also allowed. For the usage of Face in 3D a co-planarity constrain is required as defined in the following formula:

$$\text{Det}\begin{bmatrix} X_1 & Y_1 & Z_1 & 1 \\ X_2 & Y_2 & Z_2 & 1 \\ X_3 & Y_3 & Z_3 & 1 \\ X_i & Y_i & Z_i & 1 \end{bmatrix} = 0$$

where:

- X_1,Y_1,Z_1 – are the coordinates of point 1 on the face, which cannot be collinear with point 2 and 3,
- X_2,Y_2,Z_2 – are the coordinates of point 2 on the face, which cannot be collinear with point 1 and 3,
- X_3,Y_3,Z_3 – are the coordinates of point 3 on the face, which cannot be collinear with point 1 and 2,
- X_i,Y_i,Z_i – are the coordinates of point i on the face, i = 4..n, n is the number of vertices of the face.

Constrain: Faces should have only one outer boundary, no multiple faces are allowed.

DAT Standard geometry has been expanded with two geometric primitive: shell and legal space. Shell is the polyhedron, which bounds a legal space. Legal space is a set of shells (or one shell), which describes the 3D land registry entity. The following definitions and constrains were defined (IVÁN, 2014):

- Outer shell of legal space is the shell, which bounds the legal space. There is no same legal space (regarding to Land Registry) outside this shell,
- An edge of a shell is the intersection of only two, and only two Faces[1],
- Legal space has only one outer shell,
- Outer shell cannot intersect or touch oneself,
- Inner shell of legal space is a shell, which is entirely within the outer shell of the legal space, and bounds a legal space, which is different from the legal space is bounded by outer shell (regarding to Land Registry (see Figure 4, red space),
- Inner shell cannot intersect or touch outer shell,
- Inner shell cannot intersect or touch oneself.

An example of the usage of these rules is shown on Figure 5:

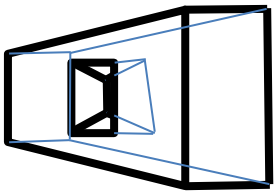

Figure 5: Legal space description by shells

[1] This constrain is nearly the similar to Euler's Polyhedron Formula V-E+F=2, where V is the number of vertices, E of the edges and F os the Faces, but not the same, because holes are allowed ont he Faces

By the usage of above expansion of DAT Standard geometry model 3D legal situations can be modeled in the existing Hungarian Land Administration IT environment. It is a flexible solution, because 3D Land Registry is required anywhere. At that places the original 2D model can be used and mixed use of 2D and 3D geometry also available, because 3D solution is based on the 2D primitives.

5. CONCLUSION

Hungarian Unified Land Registry has enough resources for the introduction of 3D Land Registry in Hungary. Introduction must be very careful, an agenda should be planned, because not only human and IT resources are needed, but a huge financial and surveying capacity are required as well. FÖMI is working on the implementation of the system both on legal and technical level as well.

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BIOGRAPHICAL NOTES

Gyula IVÁN (50): has a master degree in civil engineering (faculty of surveying and geodesy) from Technical University of Budapest, HUNGARY. He is currently the Chief Adviser of Director General of FÖMI. He was the vice-chair of administration in FIG Commission 7 (Cadastre & Land Management) between 2006-2010. He is a member of Hungarian Association of Surveying, Mapping and Remote Sensing, member of FIG.

András OSSKÓ (73): has a master degree in surveying and geodesy from Technical University of Budapest, HUNGARY.He is currently advisor at FÖMI. He was an international expert in the field of surveying in Nigeria between 1977-79 and 1982-86. Project advisor in Swiss supported Budapest INFOCAM Digital Cadastral Mapping project between 1993-95. Advisor and consultant in PHARE supported international projects. Member of Advisory Committee at Central European Land Knowledge Center (2002-2005). Consultant in Moldova First Cadastral Project (2007-2009). He is a member of Hungarian Association of Surveying, Mapping and Remote Sensing, member of FIG from 1971. He is a Member of Chamber of Judicial Experts from 1988.
He has been the Hungarian delegate to FIG Commission 7 since 1995. Chairman of Working Group of Commission 7 1998-2002. Vice chair of Commission 7 2002-2006. Chair FIG Commission 7 2007-2010.

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