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Legalization Applications Integration

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Abstract

In Croatia, the voluminous project of legalization (of the illegally constructed buildings) has resulted-over the five years of implementation- in various dynamic processes in designing as such, in the surveying companies and in the state institutions when the surveying of the status quo situations in the cadastral land plots within the state is concerned.The above mentioned business entities are supported by software applications but they cooperate on the basis of their separate results. The only communication among them goes via the AutoCAD application.

However, the software applications are as well developed separately since each technology has its peculiarities and even its scientific qualities thus being inaccessible for everymen in all its segments. For the purpose of integration, it is inevitable to set up the combined sciences teams to cover for all applications and to set up a networked unit.

There is a series of integrating methods – such as MEP modeler, BREP, IFC and BIM – that, when supported by scientific procedures, are to contribute to enhancing of the data flow in the range from the data obtained in the field via the design data up to the databases in the respective state and business institutions.

These indices of the economic quality of not only companies but the state institutions as well can be significantly improved. In other words, these integrative processes offer an opportunity as well for further scientific investigations and the development of the society in terms of automating it at the levels ranging from one single application to all respective projects.

1. Legalization in the realm of partakers

For the purpose of collecting position data, various methods and surveying instruments are used today. If the polar surveying method is used, which comprises monitoring the horizontal and the vertical lines and the horizontal lengths in relation to the observed points (based on which their spatial coordinates are calculated in turn), generally total stations are used. Besides total stations, terrestrial laser scanners can be used as well and their employment reduces the field surveying time. In some cases, terrestrial laser scanners increase the preciseness of the volume of the obtained data, which results in a more precise surveying of a building or an area.

Besides total stations and terrestrial laser scanners,the GPS surveying methods are used by means of a GPS receiver. There is a wide scope of the manufacturers of the survey instruments and equipment in the market and they do not only sell the equipment but offer the support to the customers as well. Some of more widely known brands in the market are Topcon, Sokkia, Trimble, Leica, Nikon and others. Each instrument is delivered with appropriate software that enables the user to transfer the data to a computer and to process it.

In the passage that follows, a detailed description is given of the data transfer procedures for the total stations and GPS receivers manufactured by Topcon. Topcon is a Japanese company established in 1932 and besides the production of survey instruments it also produces and sells various medical and industrial instruments and optical systems. In 2008, Topcon bought the Japanese company Sokkia and thus additionally strengthened its position in the survey instruments and positioning equipment market. After the data has been collected either by a total station or a GPS receiver, the data should be transferred to a computer. Topcon offers several software packages that provide for transferring data from instruments. Topcon Link and Topcon Tools were once used for transferring and post-processing the data whereas they are nowadays replaced by a new one, Magnet Field. The purpose of the software support is to enable the user to transfer the data to a computer or vice versa, to post-process the obtained data, to export data into some of the supported formats, to chart, to make models, to calculate volumes etc.At transferring the data from an instrument to a computer, the device offers a choice of several formats into which the data will be transferred. The final product of each survey in geodesy is the positions of the surveyed points. Of course, the coded recording or the coded tachymetry can be used as well, which significantly facilitates the post-processing of the data because a sort of charting of the surveyed objects is performed simultaneously with collecting the data in the field.

Architects or civil engineerssurvey the buildingsin a plot of landboth photographically and technicallywith all the details of the building. For the purpose of the remote surveying of the changes in elevations, besides the classical tape measures, the laser ones are most frequently used.The outer elevations of a building are obtained from geodetic surveying maps whereas the further workout is done in CAD applications. There are several variants of CAD software like Auto,Inteli, Pro and Archi. Although ArxhiCADis the most feasible one, almost all partakers use the basic AutoCADapplication.

IT scientists do their best on daily basis to integrate various data formats and various databases. The wide range of data is however being compressed into an original link of XML data which dominates over the development of the internet technologies.

2. Communicationamongsoftwaretechnologiesinlegalization

The communication with engineers is enabled via computers that operate with various formats of records. For a surveyor, the most popular formats to be used at the transfer of data are plain textual txt files and CSV (CommaSeparatedValues) where the data on the surveyed points are written and separated mostly only by commas or single spaces (point number, y-axis position of the point, x-axis position of the point , point height, code, description). Besides the textual records, the graphic vector format DXF (Data Exchange File) is widely used; it was developed byAutoDeskwhich is in turn supported by almost all CAD (ComputerAidedDesign) applications.
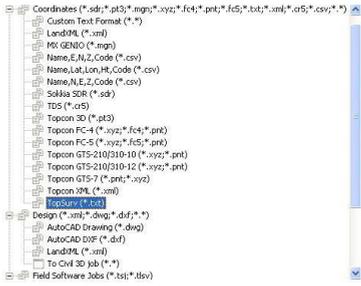
Fig. 1.An overview ofthe formats supported by Topcon Link

Besides the coordinates of points, users sometime need the tachymetry logcontaining raw findings in accordance with the points having been observed (fig.2) (the height of the instrument at the standpoint, the height of the reflectorrelated to each of the observed points, angledor horizontal distance, horizontal and verticalanglesetc.).This is how the vector record of the data obtained in the field is defined (1).
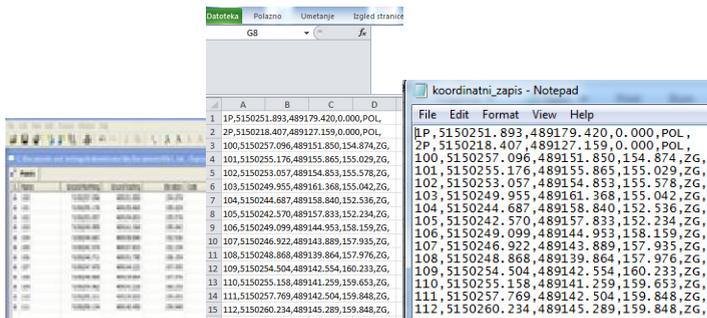
$$\vec{r} = [\overrightarrow{aij}] \tag{1}$$

Fig. 2.The list of points and their coordinates in Topcon Link

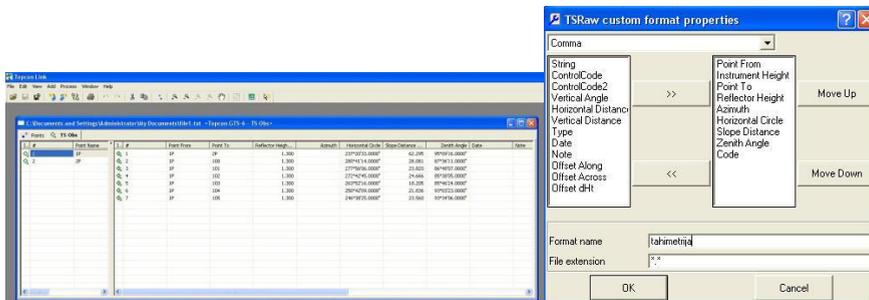Fig. 3. (a)Tachymetry log inTopcon Link   (b) Defining tachymetry log

When a tachymetry log is being created, the user can define parameters to be displayed.
From Topcon Link or Magnet Field,the user can convert the surveyed situation into some of the graphic vector formats (DXF or DGN) for processing the situation.When a DXF file is being created,each of the charted points is assigned the detail point number, the absolute point height and the angle at which the point was surveyed for the purpose of making the situation setup as easy as possible and to link the characteristic points of the building.
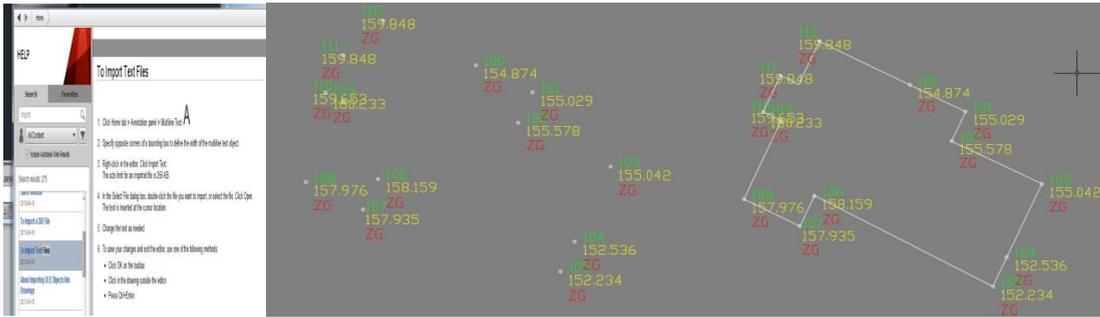
Fig. 4.(a) Importing the data with (b) charting the points in AutoCad MAP 2016 and(c) building ground plan

An architect thus automatically continues to work on a survey map. Architects have their own maps but nevertheless transfer them into their AutoCADs that can, besides in the templates, differ in variants as well. Presently, there are only a few architects working in ArchiCAD. As it is faster and of a better quality, the transfer of data into ArchiCAD is obligatory.The applications developers have already taken care of that problemas shown in (Fig. 5).

Fig. 5.Format exporting – Revitsoftware

The export into DWF, TSP orDWFx, ODBC,into HTML, IFC, gbXML, XML into 3D viewand into DWG format is possible. Besides these graphic applications formats, the export is possible as well into 3ds Max design for the production of high-end visualizations and there is a possibility of adding the final details. Architects can design buildings in various software applications and then export the design into the appropriate 3D model for civil engineers' applications that accept Autodesk Exchange (ADSK) files such as the structural interoperability with the tools like AutoCADArchitecture 3D® and AutoCAD MEP.

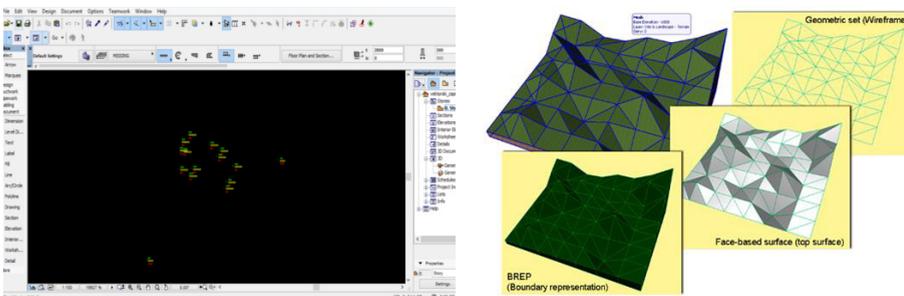The import fromthe surveying software dxf format into the Archicad16application is shown in (fig. 6.),

Fig. 6. (a)Importing the charted points data into Arhicadsoftware,   (b) IFC site geometry

The disadvantages of that method are that ArchiCAD application processes the elements of construction, not the points of the constructions (2,3) and that the system has not been fully developed.

$$Autocad = f(lines(points))$$ (2)

$$Archicad = f(elements - construction)$$ (3)

And besides, AutoCADhas imported coordinates correctlywhereas archicad16 has not imported the dimensions correctly. The problem lies in the Work Enironment variant whose data is not well-defined and itpops-upa wait or bugwarning.

GRAPHISOFT has played an active role in the IAI organization since 1996. It supports the IFC standards that enable ArchiCAD to communicate with other disciplines within the model building and to fully coordinate the design of the building in 3D.IFC - Industry FoundationClasses - , which is a neutral file format that provides for the exchange of the information among various CAD systemsand other systems in a buildingand provides as well for managing the sector object. IFC format can by means of the ISO certificatebe integrated into any existing quality ensuring policy.

BIM, or "Building InformationModeling", has presented one of the major advances in the construction industry methods of work ever since the CAD software was introduced. BIM is not synonymous with 3D projects. Three-dimensional geometryview is only one of digitally delivered views. The projectincludesnon-graphic informationsuch as the calculations performed in surveys, building managementand the energy balance. A prerequisite for a successful BIM projectis that intelligent information can be exchanged among various software and even among various operating systems in the course of the construction of a building. The interoperability thus requires a neutral data format with an open standard that supports various systems.

3. Integration of desktop applications into web application format in legalization process

The way of integrating applications (and/or data) is possible, naturally, at the software solutions level and at the secondary level, which presumes the use of web applications for the conversion of file formats (i.e. *.dxf format into generally known *.gml formatfor displaying spatial data). In order for a particular building or some points belonging to the coordinate system (3D)to be shown within web applications (and in them as well),the file has to be converted into generally known *.gml format (Fig 8).or displaying

The full name of theGML(Geography Markup Language,the geographic descriptive language)format is Geography Markup Language Encoding Standard (GML). The Geography Markup Language (GML) is an XML grammar for expressing geographical features. GML serves as a modeling language for geographic systems as well as an open interchange format for geographic transactions on the Internet [1].

GML is as well an international ISO norm: ISO 19136:2007 Geographic information - Geography Markup Language (version OGC-a GML 3.2.1). [1] GMLrepresents a smaller part of XML and it may differ from the standard XML by the names of the written tags (Fig 8).As for the GML language, the tags (written on the attribute basis)frequently relate to, for example, names, areas, geometry, polygons, location etc. GML is not a descriptive language for displaying the visual geo-spatial data and the visualization is thus performed through a transformation,i.e.by means of XSLT and SVG (Scalable Vector Graphics) formats(vector graphics records intended for use on web).It is to be mentioned as well that the SVG(Scalable Vector Graphics) format is still under development and its developmental advantage is the quality of being based so that it can combine with almost all XML contents.

XML is a simple textual format and the abbreviation XML stands foreXtensibleMarkupLanguage and it is originally used in web development.. XML is a transfer-friendly data formatand it is widely used for that reason.

As with most XML based grammars, there are two parts to the grammar – the schema that describes the document and the instance document that contains the actual data. A GML document is described using a GML Schema (Fig 7). This allows users and developers to describe generic geographic data sets that contain points, lines and polygons. [1]

Fig. 7.GML format (as an XML format branch) use overview based on an actual *.dxffile

The divergence that has marked the surveying, architecture and construction-related and web applications up to now causes errors in transferring the lengths related to buildings.The automatic data download and so-called "pure" conversion into various other tool-compatible data formats would eliminate the above mentioned disadvantage. The purpose of applying the conversion of *.dxf format into the *.xml format, or more precisely, into *.gml format (that originally developed from *.xml format) lies in its direct applicability via the Internet, a wide scope of use, its compatibility with XHTML and the simplicity of creating *.xml documents.XHTML integrates XML format for displaying databases on web and HTML descriptive language for web pages developmentinto one technology. HTML5 is a web page development and web programming descriptive language based on the latest tags. HTML 5 descriptive language is used exclusively for the development of dynamic web applications and it is currently the latest HTML version.

TheCityGML data model is also worth mentioning. It is an open, XML-based semantic data model used for the storage and exchange of virtual 3D city models. It is an application schema for the Geography Markup Language version 3.1.1 (GML3), the extendible international standard for spatial data exchange issued by the Open Geospatial Consortium (OGC) and the ISO TC211. The aim of the development of CityGML is to reach a common definition of the basic entities, attributes, and relations of a 3D city model. This is especially important with respect to the cost-effective sustainable maintenance of 3D city models, allowing the reuse of the same data in different application fields. [2]

4. Automating Legalization

Besides integrating the engineers in practice (in the field), the engineers in institutions should be integrated too. All of the mentioned integrations request a new qualification structure, a new organizational structure and a new way of regulation for the legalization process. This is how the vector data recording leads to vector organizations [3,4](fig.8).
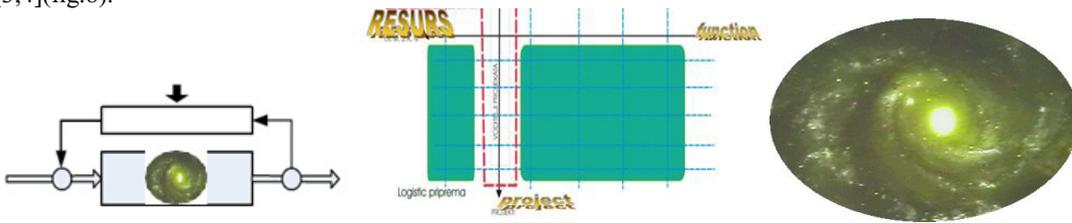

Fig8.System regulation, b Vector structure., c   Vector pyramid-star map organization path PS

Designing the PUPS-maris[5] data in the relational database and connecting with the SuperProject application (for the purpose of relating with planning within the database, XML technology was used fig(9).
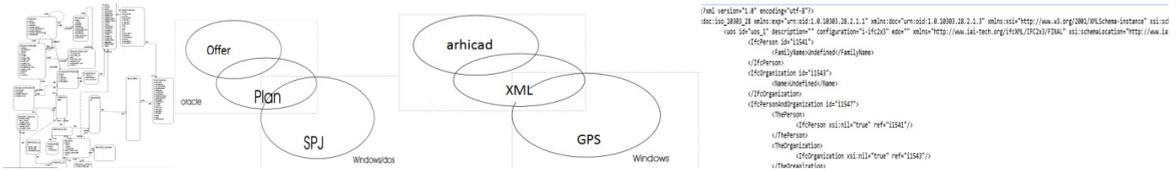
Fig 9.IIS data planning model by SPJ,   b transfer of XML data by IFC technology for the plan and ArchiCad arhicad

The design of fiules can be presented in the form of matrix (4), as well as through software mathematicas and by means of the XML technology. The database is thus the sum of files and a file is the sum of records, i.e. the sum of data fields within a record,

$$B = \sum_{i=1}^{max} D \quad ; \quad B = \quad [D_{ij}] \tag{4}$$

$$B = U \begin{bmatrix} d_1 \rightarrow s_1 \\ s_{j\,max} \hookleftarrow \end{bmatrix} U \begin{bmatrix} d_i \rightarrow s_1 \\ s_{j\,max} \hookleftarrow \end{bmatrix} U \begin{bmatrix} d_{max} \rightarrow s_1 \\ s_{j\,max} \hookleftarrow \end{bmatrix} \tag{5}$$

whereas the XML presents it all as the sum of strings(6) (begin, value, end) . In other words, the database is the sum of strings with the defined sequence of the files scheme with their records and fields (7).

$$B = \sum_{j=1}^{max} S \quad ; \quad B = \quad [S_j] \tag{6}$$

$$B = U \begin{bmatrix} b_1 \rightarrow V_1 & \rightarrow e_1 \\ b_j \rightarrow V_{j\,max} & \rightarrow e_j \hookleftarrow \end{bmatrix} \tag{7}$$

For the purpose of a full automation, combining the system regulation with the GPS technology (Fig.9) provides the resources for further investigation.

Fig. 9. GPS system and a drone

The above mentioned systems should be integrated through the Internet technologies. It has been recommended that the desktop applications formats, web formats and the descriptive languages (i.e. web technologies) should be integrated in a technology under one name, XGKHTML5 technology based on AJAX,which is to provide for a precise input and overview of the surveying, architectural, constructional and spatial data on web (without variations).

AJAX technology enabled access to web applications at a rate that is present when accessing common desktop

applications. This improvement in speed of access to web applications is achieved by placing the JavaScript technology and the XMLHttpRequest object between webs forms (module web applications) and web servers.

An example follows of conversion from *.dxf format into *.xml format, or precisely, into *.gml format based on the data collected in the field:

```
<gml:featureMember>
<ogr:entities fid="entities.2">
<ogr:geometryProperty><gml:Point
srsName="EPSG:4326"><gml:coordinates>489180.063916,5150250.05324,0</gml:coordinates></gml:Point></ogr:geometryProperty>
<ogr:Layer>PNTDESC</ogr:Layer>
<ogr:SubClasses>AcDbEntity:AcDbText:AcDbText</ogr:SubClasses>
<ogr:EntityHandle>82</ogr:EntityHandle>
<ogr:Text></ogr:Text>
</ogr:entities>
</gml:featureMember>
<gml:featureMember>
<ogr:entities fid="entities.3">
<ogr:geometryProperty><gml:Point
srsName="EPSG:4326"><gml:coordinates>489180.063916,5150249.1333599993959,0</gml:coordinates></gml:Point></ogr:geometryProperty>
<ogr:Layer>PNTATTRS</ogr:Layer>
<ogr:SubClasses>AcDbEntity:AcDbText:AcDbText</ogr:SubClasses>
<ogr:EntityHandle>83</ogr:EntityHandle>
<ogr:Text></ogr:Text>
</ogr:entities>
</gml:featureMember>
```

Besides the fact that a file in *.dxfcan be converted into XML, it can as well be convertedinto KML format which is also based on XML. The acronym KML stands for Keyhole Markup Language. KML (Fig. 11) is the geographic data record format.

An example follows of conversion from *.dxf format into *.xml format, or precisely, into *.kml format based on the data collected in the field:

```
<Placemark>
        <ExtendedData><SchemaData schemaUrl="#entities">
                <SimpleData name="Layer">PNTDESC</SimpleData>
                <SimpleData name="SubClasses">AcDbEntity:AcDbText:AcDbText</SimpleData>
                <SimpleData name="EntityHandle">82</SimpleData>
                <SimpleData name="Text"></SimpleData>
        </SchemaData></ExtendedData>
<Point><coordinates>-59.936083999986295,5150250.05324,0</coordinates></Point>
</Placemark>
<Placemark>
        <ExtendedData><SchemaData schemaUrl="#entities">
                <SimpleData name="Layer">PNTATTRS</SimpleData>
                <SimpleData name="SubClasses">AcDbEntity:AcDbText:AcDbText</SimpleData>
                <SimpleData name="EntityHandle">83</SimpleData>
                <SimpleData name="Text"></SimpleData>
        </SchemaData></ExtendedData>
<Point><coordinates>-59.936083999986295,5150249.1333599993959,0</coordinates></Point>
</Placemark>
<Placemark>
        <ExtendedData><SchemaData schemaUrl="#entities">
                <SimpleData name="Layer">0</SimpleData>
                <SimpleData name="SubClasses">AcDbEntity:AcDbPoint</SimpleData>
                <SimpleData name="EntityHandle">84</SimpleData>
        </SchemaData></ExtendedData>
<Point><coordinates>-60.580000000016298,5150251.893,0</coordinates></Point>
</Placemark>
```

From (Fig. 10) showing KML format converted by means of a *.dxf file, the links, elements, attributes and the hierarchy can be seen. KML format is used for displaying 2D and 3D maps, locations, polygons, 3D modelsand the animation of the relations among data.

Fig. 10.KML format (as an XML format branch) use overview based on an actual *.dxffile – an example of encoding geometry in GML

KML provides for a direct connection to GPS. KML formathas been mentioned in this paperbecause it encourages a more intense and wider interoperability and it is complementary to the majority of the existing standards (i.e. OGCthat originated as far back as in 1994 for the purpose of defining open systems for the geographic information). OGC was inspired by XML and the incentive resulted in inventing GML. XML formats GML and KML belong to the WFS (Web Feature Service) domain of the OGC Web services.
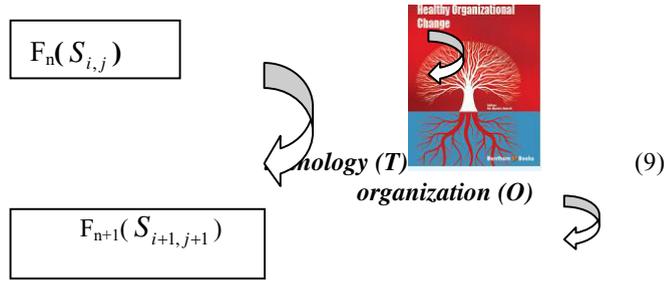
5. Conclusion

The purpose of this paper is to recommend for web formats and the descriptive languages (i.e. web technologies) to be integrated into a technology under one name, the XGKHTML5 technology based on AJAX, which is to provide for input and a precise overview of surveying, architectural, construction industry and spatial data on web and provide as well for the smallest mobile devices (for example, a wristwatch with an access to the Internet) to be able to access some particular e-information on land sites and buildings. The integration of web system of displaying surveying, architectural, construction industry and spatial data into one unit and desktop applications is still being developed. Namely, achieving a further structural interoperability of AutoCAD Architecture 3D® and AutoCAD MEP tools is expected.

In order to facilitate the communication among engineers and ICT experts, it is obligatory for the software mathematics to be deployed.

In other words, combinatorics penetrates every branch of science including the collection(8).

$$K = U\begin{bmatrix} n_1 \to k_{\max} \\ n_{1\max} \hookleftarrow \end{bmatrix} U \begin{bmatrix} n_2 \to 1 \\ n_{i\max} - k_i \hookleftarrow \end{bmatrix} U \begin{bmatrix} n_i \to n_i + 1 \hookleftarrow n_k - 1 \\ n_1 - k_i \hookleftarrow \end{bmatrix} U \begin{bmatrix} n_k \to n_1 + 1 \\ n_{\max} \hookleftarrow \end{bmatrix} \quad (8)$$

Furthermore, all records can be sown by software formulas (9), i.e. by the similar iteration XML formulas.

$$F_n(S_{i,j})$$

$$F_{n+1}(S_{i+1,j+1})$$

hology (T)

organization (O)

(9)

In turn, the DSP method as a recurrent form (10) can be increasingly used in the data transfer and recording projectsincluding legalization, which is the largest project in the Republic of Croatia after the famous spatial status quo defining surveying endeavor once performed by the Austro-Hungarian Empire.

$$f_n(T_n, O_n) = f_{n+1}(T_{n+1}, O_{n+1})$$ (10)

By means of defining the model standardization of the construction industry production, the DSP formula is obtained (11

$$[A_{tn}[R_{tn}[D_{tn}[A_{on}[R_{on}[D_{on}]]]]]] = [A_{tn+1}[R_{tn+1}[D_{tn+1}[A_{on+1}[R_{on+1}[D_{on+1}]]]]]]$$ (11)

as a by-product of the mathematic fields of sciences and technologies of the dynamic structural dimensioning of the construction industry productionthat can lead to defining the organization differential calculus to be used in all fields.

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