Topographic Data Production as Basis for NSDI - Croatian Example

Stipica PAVIČIĆ, Mladen RAPAIĆ and Slavko LEMAJIĆ, Croatia

Key words: NSDI, geoinformation, topographic database, quality control, ISO

SUMMARY

The establishment of the Croatian National Spatial Data Infrastructure have started at the beginning of the 1990's. At the front of the activities was the State Geodetic Administration that gathered surveying and geodetic experts from geodetic companies, science and educational organizations. They built the basic documentation that designates vision and goals, while through studies and pilot projects they developed procedures and exact steps for realization of the goals. SGA by definition and it's internal structure does not have production capacities, so all production phases are commended to the private geodetic companies in public and open tenders.

One of the basic tasks in creation of NSDI is establishment of the Topographic Database, detailed and accurate spatial and seamless database of Croatia that has to serve for wide spectrum of users, from state and local administration, public institutions and state companies to the private companies. The main source for Topographic Database are topographic data collected in systematic and coordinated process by private geodetic companies. By establishment of the Croatian Geodetic Institute the process of Quality controlling ensures the homogeneity and alignment of the data to the Product Specifications that serves as a standard in production processes.

In front of the geodetic community in Croatia are some important and inevitable steps that will allow integration into the European geospatial system. First of all, the change of geodetic datum and cartographic projection which have to be accommodated regarding new technologies and users' needs and secondly, adoption of the ISO standards, the process that already started in State Office for Standardization and Metrology.

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1. INTRODUCTION

It is considered nowadays that one of the prerequisites for a country development is the establishment of the National Spatial Data Infrastructure (NSDI). According to Federal Geographic Data Consortium, NSDI implicates: technology, polices, standards and human recourses necessary to acquire, process, store, distribute and improve utilization of geographic data. Republic of Croatia started to build its infrastructure soon after proclaiming independency, with the State Geodetic Administration (SGA) in the forefront of activities, but structured and organized without own production and development facilities. By the law and by the status, the SGA has that authority and responsibility and also acts as the National Mapping Organization. In production of topographic data, the specific "Croatian model" (Rožić, 2003; Bačić, 2003) can be recognized, the model that consists of triangle formed by SGA, the Croatian Geodetic Institute and private geodetic companies who actually perform production. The aspect of this paper is concentrated in description of the production process and quality control of topographic data that are used for the Topographic Database uploading.

2. PREPARATORY ACTIVITIES

In the middle of the 1990's, the State Geodetic Administration established some of the fundamentals for successful building of infrastructure needed for creation of geodetic products: legal frame, reorganization of geodetic administration and delivery of *Program of State Survey and Real Estate Cadastre for the period 2001-2005* that was adopted by the Croatian Parliament and is financed mainly through the State and local administrations' budgets. Fundamental guidelines have been created in cooperation with the experts from the major private companies and from the Faculty of Geodesy (Bačić, 2003). The project STOKIS (*Official Topographic and Cartographic Information System of the Republic of Croatia*) from 1992 was the basic, general document for creation of digital topographic data. The following project CROTIS (*Croatian Topographic Information System*) gave more specific, implementable instructions for production and processing.

The fundamental geodetic legislative document, *Law on State Survey and Real Estate Cadastre*, delivered by the Croatian parliament in 1999 became fundament for the set of law's and bylaw's regulations, such as *Ordinance on Topographic Survey Methods and State Map Production*, *Guidelines for Orthophoto Production*, *Mapping Catalogue*, *Cartographic Key*, *Guidelines for Aerial Photography*, *Cartographic Generalization with Standardization for State Maps* and others.

The first projects were started with the basic scope to overcome technology challenges and to proof the ideas written in previously made documentation. The first products have been very often analogue, but the production processes were more and more managed with the modern, digital equipment. One of the first realized projects that had and still has great influence in further development was cyclic aerial photographing of the whole country (56000 sq km) in scale 1:20000 (Figure 1). Scanning those films with photogrammetric scanner, State Geodetic Administration built the basic source for products such as Digital Orthophoto, Digital Terrain Model and Topographic Data.

The crucial support and push in the same time, SGA received from the Croatian parliament in the form of Program of State Survey and Real Estate Cadastre. Some of the tasks that Croatian geodesists have to achieve in the field of topography, are (Official Gazette, 2001):

- production of all 603 map sheets of Topographic map 1:25000 (TK25)
- maintaining the cyclic aerial photographing of the country in five years time-frame (20% per year)
- finishing the project of Croatian Base Map 1:5000 (HOK) that started more than 30 years ago
- conversion of all map sheets (approx. 10000) of HOK into digital format
- creation of 5000 (50%) map sheets of Digital Orthophoto 1:5000 (DOF)
- foundation of digital Registry of Administrative and Spatial Units and
- establishment of multipurpose spatial information system for supporting the state and the local administration and public institutions in land management.

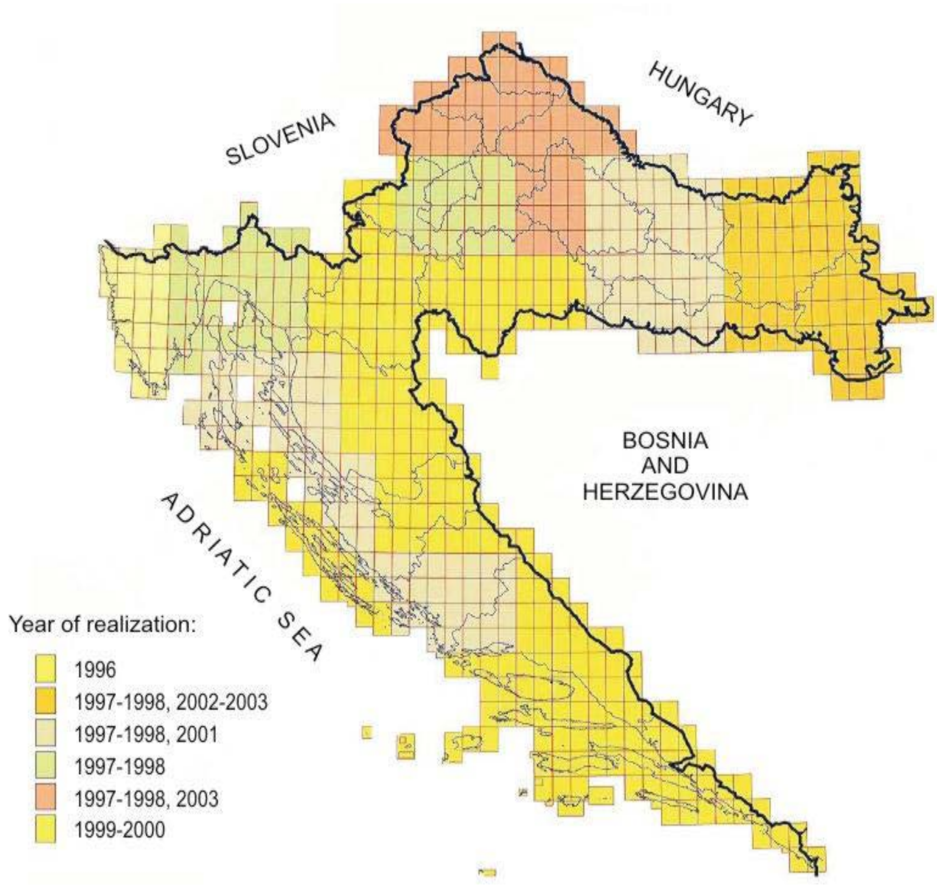

Figure 1 Overview map of realization of cyclic aerial photographing project (State Geodetic Administration, 2003c)

Finally, by establishing the Croatian Geodetic Institute (CGI), the new public and professional institution, the State Geodetic Administration acquired the partner (and the tool) for developing and conducting quality control processes of the geodetic products as well as scientific and professional support. The CGI enabled the processing circle of production of geodetic products to be fully closed. The CGI defines the "Croatian model" (Rožić, 2003; Bačić, 2003), the framework for clear and undoubtfull duties and responsibilities in the production of national topographic, cartographic and other geodetic products which, besides SGA and CGI, consists of private geodetic companies to whom the whole production is commended. The first tasks of the Institute have been design and execution of the Quality System for newly created Topographic maps 1:25000. In continuation, the work expands on design and execution of quality controls for other geodetic products such as Topographic Data, Orthophoto, Aerial Photographs, etc.

3. PRODUCTION OF TOPOGRAPHIC DATA

Previous activities, for the first time after the independence, enabled the geodetic community in Croatia to be in the position to launch the national project that will methodically cover whole country territory in homogenous, standardized way. After establishing the basic prerequisites, general plan was made that promotes topographic data production. Figure 2 shows basic responsibilities and steps and Figure 4 shows details of work that is done during data collection phase within geodetic companies.

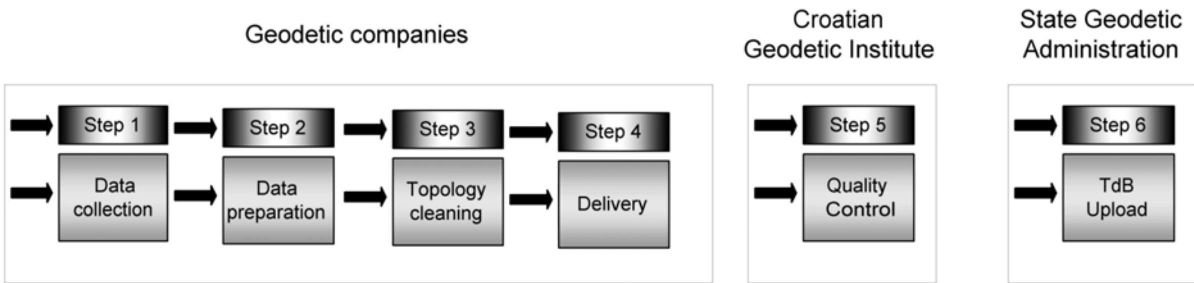

Figure 2: Production of topographic data

The objective of the program of topographic data production is the seamless Topographic Database (TdB) with positional accuracy of +/-1m on well defined details and +/-3m on other details (State Geodetic Administration, 2001b). By its content and accuracy, the database will be more than appropriate for production of Topographic map 1:25000. Although the data could be used for map production of larger scales (e.g. 1:10000), it is not considered because of the SGA's policy of creation and maintaining the serials of maps in scales 1:5000, 1:25000, 1:50000, 1:100000 and 1:200000. The data should fulfill the wide needs of a different users, from infrastructure object designers and urban planners to the professionals in a local community administration. Data should enable presentation of topographic objects in three dimensions, should be structured logically for the simplicity of acquisition, and the aerial images produced in the on-going project of cyclic aerial photographing have to be used as the main source. The complete production process was put in the hands of several largest private geodetic companies and for assuring the homogeneity of quality and for enabling the automated procedures in certain production steps, it was inevitable to prepare very detailed standards and directions for all production phases.

The standardization of the production process was accomplished in the frame of the Croatian-Norwegian Geoinformation project (CRONO-GIP) which goal was "development and implementation of a database within SGA for storage and use of data resulting from the on-going production of new topographic maps in the scale 1:25000" (Rožić et al, 2003). The project was conducted by SGA and CGI and realized in cooperation with Norwegian consulting company Program Management & Mapping along with Croatian geodetic professionals gathered around the Geofoto company. The existing production process was separated into fundamental phases and the result of each phase can be treated as stand-alone geodetic product: (1) Aerial Photography and Ground Control, (2) Scanned Photo, (3) Aerial Triangulation, (4) Digital Terrain Model, (5) Orthophoto, (6) Topographic Data and (7) Topographic Map 1:25000.

In the same time, each of the Products serves as the predecessor for the following production phase (Figure 3) so that each company can be in state to undertake and proceed the job from any other company. Two "main" products are needed for creation of Topographic Database: Topographic Data (TD) and Digital Terrain Model (DTM) and for their production, the Aerial Triangulation is the predecessor. It is planned that each production step in form of the Product will have to be quality controlled and approved before further usage.

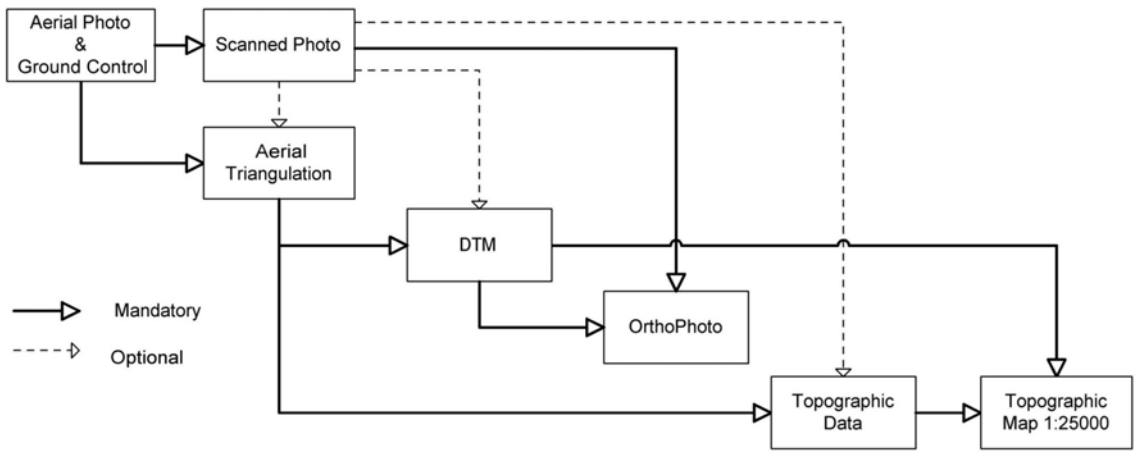

Figure 3: Products and products' predecessors

Although "main", only those Products are not foreseen to be on the market. Instead, the "export" from Topographic Database will be offered. The Product Topographic map 1:25000 is at the end of the process line and it represents "derived" product from TdB which may, in the future, become optional as soon as all 594 map sheets are done in the first edition.
Standardization of the Products is coming out of the Product Specifications that exist in the form of documentation and appropriate analogue and digital appendices. Specifications are designated with the exact version number and, generally, contain following information and instructions:

- description and purpose of the Product
- common set of terms (Terminology)
- data sources, including obligatory predecessors
- geographic coverage
- coordinate reference systems (horizontal and height)
- description of delivery which at least has to have (1) delivery list, (2) Product itself and (3) Technical Report
- required content of Technical Report
- Products in digital format has to be defined for file format and file arrangement and naming
- technical characteristics of the Product
- technical characteristic of the equipment to be used in production process
- technical description of the production process
- parameters for evaluation of Product's quality
- all other relevant information and instructions needed for production (for example, in Technical Specification for Topographic map 1:25000, the appendices (1) Generalization, (2) Cartographic Key and (3) Map Nomenclature and Names are added).

The greatest efforts have been embedded in creation of the specifications for Topographic Data and Topographic Map because the subjective factor has greatest influence during photogrammetric mapping, field data collection, generalization and cartographic design processes. Specifications are constituent part of the Contract between the State Geodetic Administration and the Producer (private geodetic company).

The structure of topographic data is defined by the project *Croatian Topographic Information System* (CROTIS). Taking into consideration that almost all companies use CAD tools for the photogrammetric data collection, the *Mapping Catalogue* was created that uniquely defines each feature class by the unique combination of graphic attributes Level, Color, Line Style and Weight, as shown in Table 1 (State Geodetic Administration, 2001a). The Catalogue also defines type of the geometry for feature representation, symbol name for point features and name of the table in the Access database that contains related metadata and attributes. The Mapping Catalogue is constitutional part of the Topographic Data (TD) specification.

For undoubtful, unique and homogeneous way of transforming topographic objects in stereo-model to the primitive geometric elements in CAD software and for unique attributisation, TD specification contains very detailed instructions called *Data Capture Object Selection Criteria* that explains topographic objects' definitions, presentation manners and priorities with examples.

Table 1: Excerpt form Mapping Catalogue that defines unique definition of certain features in Feature group Electric Power System

3100 ELECTRIC POWER SYSTEM						
		DATABASE TABLE				
UTILITY LINES		U_META				
UTILITY LINES SINGLE ELEMENTS		U_META				
		LV	**CO**	**ST**	**WT**	
3101	**ELECTRIC POWER SUPPLY LINES**	LINE				
AERIAL LINE		11	0	0	0	
UNDERWATER LINE		11	16	2	0	
		LV	**CO**	**ST**	**WT**	**CELL**
3102	**SINGLE POWER SUPPLY LINE ELEMENTS**	POINT				
METAL POLE		17	0	0	0	3102B
CONCRETE POLE		17	0	0	0	3102C

The result of photogrammetric measurement is completed with the data from other sources as well as information (mostly attributes) collected on the field. In the next step, those "raw" data are separated into several files for further compilation. Geometry is connected with the appropriate rows in the appropriate Access tables. Buildings and land cover are layers that must be topologically correct before uploading into the Topographic Database. To accomplish that requirement, two sets of data must be created: (1) building data compiled from building lines and classification codes related to buildings and (2) land cover data compiled from land cover lines and classification codes related to land cover. Companies must clean linear networks in those datasets and establish topology relationship of classification codes to polygon areas.

The Digital Elevation Model (DEM) must be interpolated and delivered in the form of regular grid. The input data are height points, formlines and natural break lines merged with break lines from the land cover data set (road edges, river banks, etc.) (State Geodetic Administration, 2003b).

Final data must be delivered, according to the specifications for Topographic Data and Digital Terrain Model in five MicroStation design files, one Access database and one text file (Figure 4).

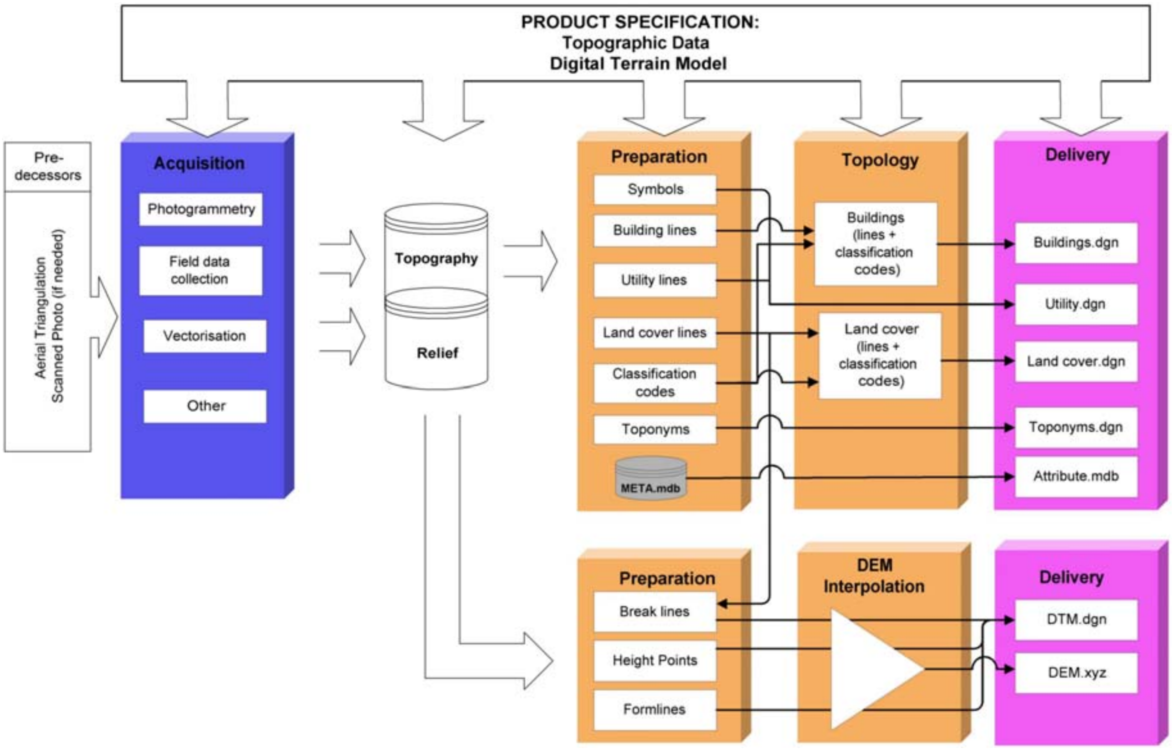

Figure 4: Production of topographic data – acquisition, processing and delivery

4. QUALITY CONTROL SYSTEM

After Topographic Data and Digital Terrain Model delivery (Figure 4) the process of Quality Control in Croatian Geodetic Institute starts (Figure 5).

According to definitions of ISO quality elements, subelements, descriptors, evaluation methods and selected tolerances (ISO, 2001) the Quality Plan is developed. Execution of the Quality Plan on Topographic Data and DTM results with the Quality Evaluation Reports.

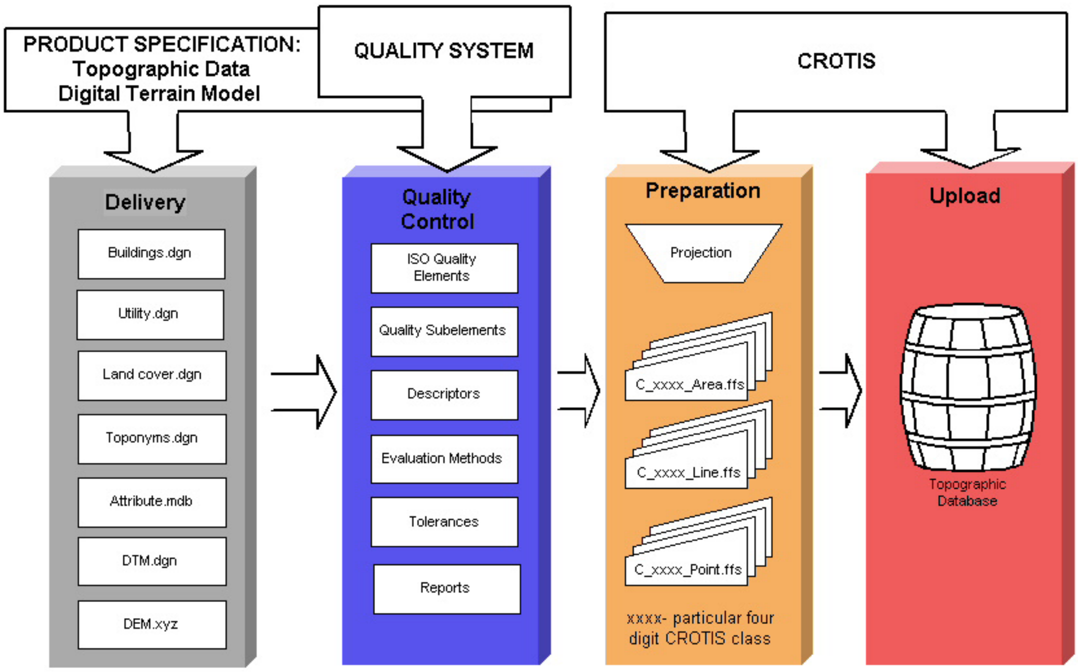

Figure 5: Controlling and database uploading procedure

Short simplified overview of Topographic Data quality control elements and subelements is presented in Table 2.

Table 2: Quality elements and subelements used for Topographic Data quality control (State Geodetic Administration, 2003a)

ISO Quality Element	Quality Subelement	Check …
Overview	Configuration	- That all items are delivered - Readability of digital media
	History	Approval of predecessors
	HW and SW description	Producer's information about hardware/software, calibrations, certificates, licenses, etc.
Spatial Characteristics	Model Configuration	Check interior orientation number of fiducial marks used
		For analytical plotters, check number of control points/passpoints used for model orientation and their distribution in the model
		Model orientation error
		Model orientation gross errors > 3 SD
Completeness	Commission	Excessive objects
	Omission	Buildings
		Utility lines
		Transportation
		Hydrography
		Vegetation and land use
		Toponyms
Logical Consistency	Domain Consistency	Feature classes, attributes and values

ISO Quality Element	Quality Subelement	Check …
	Format Consistency	- That correct file-naming conventions are used That MicroStation v7 format is used and with parameters according to product specification - That MS Access v2000 is used
	Geometric fidelity	That data contains only points, linestrings and text objects
	Topological Consistency	That dataset has correct topology
Thematic Accuracy	Classification Correctness	Dataset
Positional Accuracy	Absolute Accuracy	Well defined details
		Not well defined details
		Gross errors > 3* SD

The process of quality control procedures can be divided in four classes depending of the control type used: manual full (MF), automatic full (AF), manual sample (MS) and automatic sample (AS).

Automatic sample control is not included in the CGI quality system procedure. In following chapters the applications of full manual, full automatic and sample manual quality control procedures used in control of Topographic Data are described.

4.1 Full Manual Quality Control Procedures

Full manual controls are used to check all items identified for the Overview quality element. It has to be manually checked that all expected documents and files are delivered, that the CD media is usable and the files are named according to the Specification (subelement Configuration).
The subelement History assures that all predecessors (Figure 3) have been approved. For Topographic Data it has to be checked that product Aerial Triangulation is approved and if the data were produced using scanned photos, the Scanned Photo have to be approved first. To execute this step of control process the contractor have to identify the SGA/CGI's project number and the name of predecessor products, as well as the date for submission of these products to CGI for quality control.

Last identified subelement of the Overview quality element is HW and SW description. This subelement requires brief and concise description of hardware and software used in the production. The criteria for acceptance is that the instrument calibration Report is according to the Specification and the vendor name, version number, main purpose of the SW/HW and the technical capabilities for the job are provided.

Manual control is also used to check some of the items belonging to quality elements Completeness and Logical consistency. It has to be checked that there is no objects (data) outside of the production area and that the landcover polygons are closed to the production area boundary (subelement Commission). Omission of special objects and omission of the settlement names have to be checked with zero tolerance, but the toponyms of significant hydorographic objects are checked with the different specified tolerance.

Domain consistency and the Format consistency are the last two subelements belonging to the quality element Logical consistency that have to be checked in full manual manner, both with zero tolerances. Checking domain, controller have to verify that there is no new, undefined attribute values in Access database and checking format, controller have to verify that all *dgn* files are version 7 and are readable in MicroStation and that Access *mdb* file is version 2000 and is readable in MS Access.

4.2. Full Automatic Quality Control Procedures

Full Automatic method in quality control procedure is done with the use of FME (Safe Software Inc.) Workbench files developed firstly under the CRONO GIP project and later in the Croatian Geodetic Institute. A number of quality elements are checked in this way all with zero tolerances. Automatic control is performed after manual control of all items belonging to the Overview quality element.

FME Workbench files are designed to detect anomalies in delivered *dgn* files relating to Product Specification. Following simple procedure, the controller can detect variety of errors. It can be detected if the object is below minimum size (subelement Minimum Size). Minimum size is defined in Product Specification for buildings (20 m^2), landuse (500 m^2) and utility lines (10 m). Checking Domain Consistency it can be detected if the features are encoded according to the Product Specification. The allowed combinations of level, color, style and weight (example in Table 1) are checked in all *dgn* files. It can also be detected if the classification text codes for future polygon construction (buildings, landuse areas and elevated areas) are legal according to the Mapping Catalog.

Geometric representation in *dgn* files is also restricted by the Product Specification. Subelement Geometric fidelity is checked for presence of undefined geometry. The only allowed geometry elements are: text, point (cell) and the line string.

Except of described subelements, the automatic control procedure is applied to check the topological consistency. No features are allowed to intersect themselves in Utility, Buildings and Landcover *dgn* files. Buildings and landcover boundaries are not allowed to cross each other, building boundaries also should not cross landuse boundaries but elevated objects boundaries are allowed to cross other boundaries. Each building, landuse and elevated object polygon must have just one classification point. Automatic control reports if the classification points are multiple or missing. After construction of closed polygons all dangling lines are detected for landuse, buildings and elevated areas. If the automatic control procedure does not fail controller can go ahead with the rest of controlling procedure. One small part of that procedure is presented in the Chapter 4.1. and the rest belongs to the sample manual controlling procedure.

4.3. Sample Manual Quality Control Procedures

Manual control is the most demanding part of quality control procedure. Majority of manual control is done with sampling.

Some items belonging to the quality element Spatial Characteristics are checked during automatic control procedure with the FME Workbench files (subelement Minimum Size) but the rest are checked manually with sampling. Sample is used for Model Configuration sublement. Items belonging to that quality subelement have to confirm that the minimum four fiducal marks have been used, that the minimum six points are in Gruber positions and that at least four points are used for absolute orientation of the photogrammetric model. The last item, dealing with Model Configuration that has to be checked is Model Orientation Error. Maximum allowed standard deviation (SD) for model orientation error is set to 0.3 m. Gross errors, which are defined as values greater then 3 SD are not allowed.

Table 2. is simplified version of real quality control plan that has to be applied. For example, tolerances for checking omission of buildings may not be universally set to some value because some buildings can be treated more important then others. That is the reason why the item Buildings is further divided into few sub-items with different tolerances: residential, not residential, point objects and other objects. Besides omission of buildings, with sampling procedure, the omission of utility lines, transportation, hydrography, the rest of landuse and the rest of toponyms are checked.

Most items belonging to the quality element Logical Consistency are checked without sampling. Sampling procedure is applied to check correct spelling of toponyms (subelement Domain consistency) and the proper snapping of road centerline network (subelement Topological consistency).

Thematic accuracy quality element is fully checked manually with sampling. This quality element is in the Table 2 roughly presented using the only one quality subelement, Classification Correctness. The real situation is that the dataset is checked with different tolerances dividing the whole dataset into several items belonging to the Buildings, Utility lines and point features, Landuse, Transportation and the Hydrography. Depending of the object significance different tolerances may be used. The main tool in controlling is Digital Photogrammetric Workstation using the original photogrammetric material.

The rest of items that has to be checked belong to the quality element Positional accuracy and the quality subelement Absolute accuracy. For well defined details the tolerance is defined using standard deviation of 1m and for not well defined details the tolerance is 2m.

Determination of number of objects in a sample is based on 95% confidence level. To help controller in determination of number of objects in a sample, two statistical tables are made (Table 3). Left table is used for sample based control of errors and missing objects and the right table is used for sample based control of standard deviation. Values presented in table 3. are in conformance with ISO 2859 and ISO 3951.

Table 3: Statistical tables for sample size determination based on 95% confidence interval

For sample based control of errors and missing objects						
Number of objects		Po (%) =	1.0	2.0	3.0	5.0
From	*To*	*Sample size*				
1	8	all	1	1	1	1
9	50	8	1	1	1	1
51	90	13	1	2	2	3
91	150	20	2	2	3	4
151	280	32	2	3	3	4
281	400	50	3	3	4	6
401	500	60	3	4	5	7
Po – tolerance from the Product Specification						

For sample based control of standard deviation			
Number of objects		Sample size	F-distribution
From	To		
1	26	all	1
26	50	5	1.54
51	90	7	1.45
91	150	10	1.37
151	280	15	1.30
281	400	20	1.26
401	500	25	1.23

4.4. Reporting Quality Control Results

In the addition are presented excerpts from typical CGI tables planed for performing and reporting quality control. Those tables as templates are developed with the use of Microsoft Excel. They are intended to guide the controller in controlling and reporting the quality of dataset. Abbreviations used in following tables are: MF – manual full, MS - manual sample, AF – automatic full, AS – automatic sample, E – Exclusive, Q – Quantitative, SD – standard deviation.

Table 4: Excerpt from CGI control items

ID	ISO Element	ISO Subelement	Item	Eval Type	Ctrl type	Tol%/ SD	Details about control item
Sc2	*Spatial characteristics*	*Model configuration*	*Distr. of points*	*E*	MS	n/a	- minimum 6 in Gruber positions, minimum 4 used for abs. orient.
Sc3	*Spatial characteristics*	*Model configuration*	*Model orientation error*	*E*	MS	0.3	meter SD
…							

Table 5: Excerpt from CGI quality control results

ID	Control Item	Eval Typ	Ctrl type	No Of Obj	Obj In Samp	Failed objects	Fail %	Tol %/ SD	95% tol	Result
Sc2	*Distribution of points*	*E*	*MS*				n/a	n/a	n/a	n/a
Sc3	*Model orientation error*	*E*	*MS*				n/a	0.3	n/a	n/a
…										

Table 6: Example of control details: Number of fiducial marks

CONTROL DETAILS				
Quality control ID	**ISO Subelement**	**Control Item**	**Control type**	**Result**
Sc1	*Model configuration*	Number of fiducial marks	Manual-Sample	n/a
Remarks to control result / Additional documentation / screenshots / listings / co-ordinates / …				

Table 6 contains details of one particular control item. Typically there will be one similar table for each failed control item in the quality control.
Reporting of Data Quality Evaluation can be done in different stiles (Lemajić et al, 2003) and for the future reports CGI is planning to use presented tables (table 4, table 5 and table 6) with some additional information (dates of delivery and quality control, controller names, etc.).

In the case of positive quality control result all of *dgn* files are converted in common coordinate system and at the same time translated in FME format files (*ffs*). Features belonging to the same CROTIS class and geometry type (area, line or point) form one *ffs* file. Each topographic feature gets in this stage a "stamp" in form of attributes that denote the contract number (CONTRACT_ID) and quality control identificator (QCID) and gives credit to the future users of Topographic Database that the received data is quality controlled. At the end of procedure all of the *ffs* files are uploaded into the SGA's Topographic Database.

Working with real data and inspecting possibility of reaching certain level of quality will help CGI experts to develop and implement more reliable quality system. Besides development of quality system, performing quality control can emphasize weakness of the product specifications and help to make it superior. Errors common to all producers points that something might be incorrectly described or be impossible to achieve. In this early stage of developing the whole production process, it is extremely important to act fast and coordinated between SGA, CGI and production companies in correcting and upgrading product and quality documentations. The particular cases appeared at the first deliveries e.g. the Specification did not foreseen that buildings can form closed polygon, which caused error in automatic control processes. Such examples were solved in direct consultation with SGA and producers and were noticed for change in future versions of Specification.

5. CONCLUSION

Republic of Croatia started many processes with the goal to create national spatial data infrastructure. From the technical, technological, organizational, financial and implementable side those processes are carried by experts from geodetic companies, science and educational organizations and state bodies guided by the State Geodetic Administration.

Production of spatial data have started, first experiences enabled geodesists to improve implemented documents and technology procedures. Very important part in the cycle of improvement lies on the Croatian Geodetic Institute that controls most of the geodetic Products and is in position to objectively evaluate the Products and its Specification in the same time. It has to be pointed out that the Quality Control System according to ISO norms is in process of development and implementation and still not routine. In spite of that, all of the Products are national official standardized products with State warranty.

Geodetic community in Croatia still have the obligation to perform several important and inevitable steps that will allow integration into the European spatial system. First of all, it is change of geodetic datum and cartographic projection which have to be accommodated to new technologies and users' needs and adoption of the ISO standards, the process that already started in State Office for Standardization and Metrology.

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BIOGRAPHICAL NOTES

Slavko Lemajić was born in Zagreb, Croatia in 1968. He graduated on Geodetic Faculty in 1994. Same year he starts to work in private geodetic company Zavod za fotogrametriju d.d. and works on various projects in the area of GIS, cartography and cadastre. From 1997. he constitutes and manages production of new Topographic map based on modern technology. From 2002 he works in the Croatian Geodetic Institute as Head of Department for Topographic Survey and Supervising where actively participates and runs process of controlling the quality of geodetic products and participates in works related to the national topographic database.

Stipica Pavičić was born 1974 in Split, Croatia. He graduated in 1998 on Geodetic faculty in Zagreb. Same year he starts to work on faculty as assistant in Department for Geomatics where he starts postgraduate scientific study and finishes it in 2003. During work he participates in conducting the education and cooperates in various scientific and professional projects. In 2003 he starts to work in Croatian Geodetic Institute as professional collaborator in Department for Geoinformation Systems and Databases.

Mladen Rapaić was born 1960 in Zagreb, Croatia where he graduated on Geodetic faculty. At the beginning, he worked in private geodetic company Zavod za fotogrametriju d.d. on IT implementation in all surveying processes. After transferring to company Gisdata d.o.o. in 1996, he establishes and manages production of geographic data needed for running the GIS projects in Southeastern Europe area. From the year 2002 he works in the Croatian Geodetic Institute as Head of Department for GIS and Databases where he participates in projects of the national topographic database and processes of quality control implementation.

CONTACTS

BS Slavko Lemajić
MSc Stipica Pavičić
BS Mladen Rapaić

Croatian Geodetic Institute
Savska 41/XVI, p.p.19
10144 Zagreb
CROATIA
Tel. + 385 1 6312 400
Fax + 385 1 6312 410
Email: slavko.lemajic@hgi.htnet.hr
stipica.pavicic@hgi.htnet.hr
mladen.rapaic@hgi.htnet.hr
Web site: http://www.hinet.hr/hgi