NEW METHODOLOGY FOR MAPPING PRODUCTION OF THE SPANISH PROVINCE MAP 1:200.000 FROM A GIS

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Introduction

From its beginnings, mapping has been a multipurpose science. Handling locations and directions has been its main application: either on foot, or using any means of terrestrial locomotion, the human being has been able to move all over the terrestrial surface with no need to know the destination or the directions. Mapping has been used as well for navigation or aerial purposes. Another substantial application of Cartography is "Land Use Planning" as a mean to monitor and plan the different transformations that the man does of his surrounding environment. Due to the increasing technical development, territory is in continuous change and that makes updated maps even more necessary.

Until the arrival of computer science, and therefore of the Computer Aided Design (CAD), traditional Cartography could be considered as an art, given to its characteristics, methodologies used and scarce technical means. And as an art, it required time to carry out its work of art. But this necessity of time is incompatible with the requirement of immediate updated cartography. The arrival of the CAD systems triggered the first revolution in cartographic production because the time was reduced considerably, although part of this art spirit was lost in the process, and lot of work needed to be done to check all the quality required as far as CAD systems con not handle topology. It is now, with the application of the GIS systems to the Cartographic Production Workflow, when the second revolution takes place. Even though it means another loss in the cartographic art it may allow to have updated cartography with the speed and quality that the citizens demands.

Space capture on aerial or space ortoimages, spatial databases, automatic symbolization, the detection and automatic solution of cartographic design conflicts, automatic labeling and quality control systems are some of the processes that comprise the new semiautomatic system of cartographic production raised thanks to the development of the GIS and to the software development and improvement of the information technologies.

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IGNE. New challenges

National Geographic Institute of Spain - IGNE is Spain National Mapping Agency, providing not only official cartography but also geomatic applications of special interest for the citizens. Today, IGNE is witnessing the second revolution in cartographic production systems. Thanks to the National Topographic Databases (BTN in Spanish) based workflow we are able to automate most of the processes and provide a reliable quality control system. In this way, both cartographic production and GIS projects developed in the IGNE have a common origin in the BTN. Starting off of this premise, and based on the cartographic and geomatic necessities of the Spanish government, two basic scales have settled down from which the rest is obtained. . Therefore, two BTN on these scales (BTN25K and BCN200K) will be necessary to set up the job stream of any cartographic or GIS project.

On one hand, we have the 25k database, from which the National Topographic Map 1:25,000 (MTN25) and its derived at 1:50.000 scale (MTN50) are obtained. It is also the basis to produce GIS projects of national character, such as "Cartociudad Street Map".

On the other hand, we have the 1:200.000 scale. From this scale Province Maps and Cartoimages at 200k scale are obtained. It is also the basis to produce national GIS projects, such as SIGNA (National Geographic Information System 200k) or the IDEE (Spanish Spatial Data Infrastructure), as well as international ones, such as ERM (EuroRegionalMap). The 200k scale also provides a set of derived scales products e.g. regional maps at different scales between 1:200,000 and 1:400,000, the Map of Spain at 1:500.000 scale (ME500), etc.
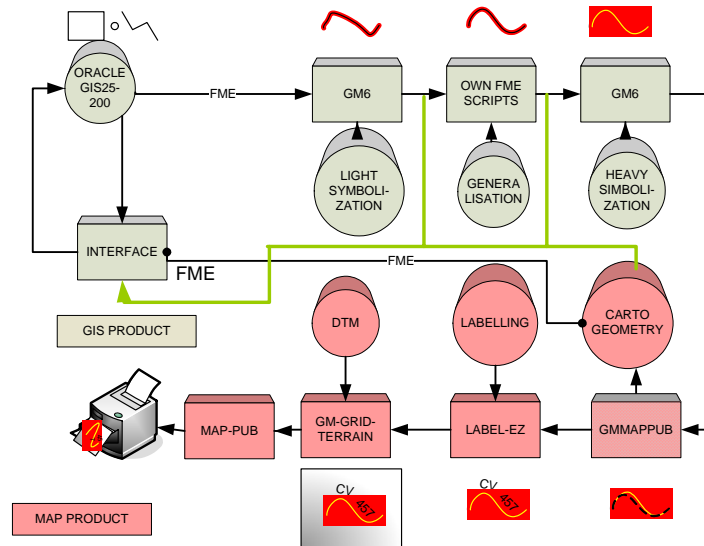

Figure 1. - Workflow for main SIG and mapping processes in the IGNE production

The minor the scale is, the simpler and faster the updating and implantation of new workflows is. In addition, when deficiencies appear, any readjustments in the methodology will be easier. Those are the reasons why the 200.000 scale has been set up as the core scale for SIG and cartographic projects in the IGNE. Once the 200k scale was chosen the Province Map (MP200) would be the associated Pilot Project to test all the amazing new GIS driven procedures.

BCN200 background

BCN200 is the National Cartographic DataBase at 1: 200,000 scale, which provides the core geometric and thematic information for cartographic products and GIS at 200,000 and derivatives. Its model has been established with the aim of making the development of semiautomatic tasks in production processes easier.

Its main features are a :
- Entity-relationship model
- One feature in each GIS feature class
- Seamless GIS
- Simple geometry: point, line and area

While designing the model semantic control measures were taken to enhance quality and accuracy, such as the stablishment of relationships between tables to restrict the input of feature classes and attributes, or the introduction of listed values and picklists in the attribute fields to control the input data. Everything runs on Geomedia Professional.

Spot images are used for the elements capture and updating, as well as other complementary official sources of data. The Official road map (PublicWorks Ministry) , the Nomenclátor (Gazetteer from the National Institute of Statistic and Ministry of Public Administrations), the CORINE Land Cover or The Geodetic Data Server are some of these sources and organisms.

The initial data format is a Geomedia Access Warehouse usual and day by day working format but it´s just a copy of the Oracle database in order not to corrupt the master database in case of fail. BCN200 is available, in most of the common GIS formats, always trying to fulfill the greater number of customer requirements.

Project pilot: MP200
Simbology
The first task consisted in the definition of a Style and Symbols Library with the purpose of establishing the necessary simbology for the cartographic elements.
The generation of the simbology fulfills a double objective: to provide the own BCN200 with a simbology that allows a greater understanding at the time of visualizing it and establishing the simbology of map for the Provincial Map 1:200.000 (MP200)
All BCN200 elements were assigned a corresponding style. Depending on whether it was a point, linear or areal feature, a different set of parameters were assigned (line style, line thickness, RGB color, RGB fill color, point size, etc.).
Although the primary library was made with Geomedia Libraries (fsm) there are also other library formats available (style, svg, ttf, bmp). Again, we try to fulfill the maximum number of customer requirements.

MP200 Map Model

Once the symbology is defined it is necessary to design the "MP200 Model Map" that comprises not only the BCN200 elements, but also other features that weren´t included and are essential for the cartographic production of the MP200. Most of the BCN200 feature classes were included in the model. Moreover, new feature classes were added such as sheet frames, streets, blocks or isolated buildings. Again, measures were taken to ensure the quality: constraints with referential integrity between tables, restricted entities and attributes, picklists tables, etc.

Semiautomatic Edition

The mapping edition Methodology is significantly modified when it comes to produce a map by means of a Geographic Information System. All this is done under a basic premise: The dual geometry. This means that we would be able to edit and obtain map geometry without thereby losing the original geometry, in this case BCN200.

The first problem that arises is the absence of elements, meaning new features classes that did not exist in the BCN200 and therefore will be stored in the new feature classes generated by defining the "MP200 Map Model." The solution to this problem required the capture of these new elements, using the basic Geomedia Professional editing tools on the BCN200 and SPOT5 orthoimages for the study area. The main difference between the MP200 and BCN200 is the settlements definition, which need a more exhaustive depiction according to cartographic requirements.

Once all the elements are captured, the following problem is given by the conflicts in cartographic drafting. To start by, we will define "conflict": *"The circumstance in which two or more mapping elements share the same geometric position (either by coincidence of their vertexes or part of their symbols) making the map less readable"*. Based on this   definition, conflicts can be classified into three different categories:

Overlap: If   two   or   more   elements   have   coincident   vertexes.
Coalescence: When two items without overlapping vertices share position as a result of the size of its symbol.
Contained in: When a linear or surface element is contained in a surface element.

Figure 2. – Several conflicts in cartographic drafting

Once the conflict and the different categories are defined, we proceed to the detailed study of different types of possible conflicts. For this purpose, an example of BCN200 with map symbols was plotted and a visual identification of conflicts was done by means of identifying the different conflicts on paper. They were grouped according to common criteria, usually by the types of geometry of the elements in conflict (point with lines, lines with lines, lines with areas, etc.).

Finally, we filled up a record for each type of conflict (name, definition, graphic, detection tool, resolution tools and proposed improvements and solutions). For semiautomatic edition of conflicts, we used the Geomedia Map Publisher that runs on Geomedia Professional. The basic principle of this software is the dual geometry. We can do any editing on the element without losing the original geometry. First it is necessary to define where we will store the original geometry and where we will store the map geometry, although they can be stored in the same database.

Automatic detection of conflicts is based on the generation of queues that meet a set of previous requirements. It first defines the rule of the conflict with the parameters to analyze and then the rule is executed. We will explain the rule for the conflict "Hydrography versus National Roads", a very common problem for any project. It is quite usual finding a national road and a river (or reservoir) that runs parallel at a given sufficiently small distance so that coalescence of the symbolized line is produced. First it will be necessary to choose the feature class that we want to analyze. In this case it will be "National Roads". Then we will decide the conflict category to analyze which will be coalescence as we described before. On the other hand we have to specify the other feature classes that can come into conflict; Rivers, Reservoirs, artificial Channels, Ponds, Sea loch ... It is also possible to perform SQL queries that would filter for each selected feature class, with a considerable saving of time in the process. Then it just would be necessary to define the resolution tool. In this case, we have two: eliminating the feature or changing its style. Neither is satisfactory. The coalescence between a national road and a river will never be a reason for eliminating one of the two elements or to substituting the type of symbology used. This example will be very common in a cartographic project, therefore it is obvious the existing need to develop and improve the resolution tools.
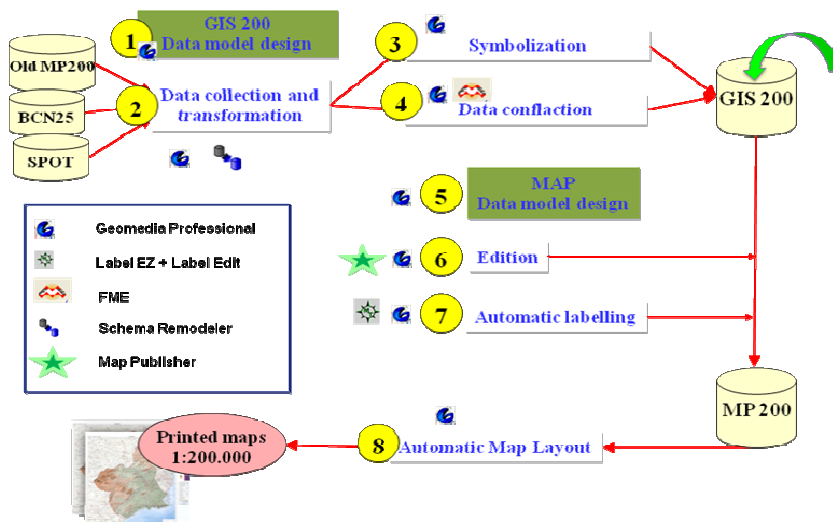

Figure 3. - Workflow for mapping production of the Spanish Province Map1:200.000

The implementation of the rules is shown in three windows. The first of them is the map window, to edit the queue, which focuses each case presenting the conflicting geometries with a high zoom level. On the other hand, there is a text box that specifies the type of conflict, the state (solved or not solved) and the description. Finally, there is the traditional map window in which a cursor indicates the position of the conflict. Then we will resolve the conflict.

The edition of the geometry of the elements has an essential and indispensable tool in order to fulfill the premise of the dual geometry. This is the "Create cartographic geometry" tool. This tool creates a "replica element". When a map element has been created, one can edit its geometry with any of the traditional editing tools of Geomedia Professional. Two other tools, 'delete' and 'restore geometry', allow these operations and in no case the original geometry will disappear from the original warehouse.

There is a tool that allows to visualize and to hide as well as to establish the location or to deactivate it of all those cartographic elements generated, or those who have been eliminated. Once the geometries have been edited for its optimal readability, automatic labeling can be done to avoid the traditional a tiring task of manual labeling.

Labeling
Automatic maps labeling is one of the main GIS challenges. In order to get readable maps, labels have to be fitted to cartographic elements. In this sense, text overlaps or ambiguities have to be solved by programming different solutions to get an automatic text placement as better as possible in a global backtracking process. This consists in a set of rules for text placement and specifications for each feature class and a global configuration for settings and priorities definition in order to solve automatically and dynamically all conflict situations. The goal is to obtain configured software to make accurate and readable maps in full conformance with cartographic labelling rules.

In order to generate the labels additional software to the GIS is needed. This specific software accesses the geospatial database, runs an execution sequence considering the specified requirements and stores the results as part of the GIS. In this case the labeling software accesses the GeoMedia Warehouses and GeoWorkspaces directly and generates a new feature class to store the labels and displays the result in the GeoWorkspace.

The automatic labeling job needs two different files: The specification File and the Configuration File.

The Configuration file manages the exact sequence in which the text will be placed for each feature class in the map. This file contains a set of rules and parameters for each feature class. Therefore, every feature in the same feature class will be placed following the same set of rules and parameters. The most important part of the file is the execution sequence, which will guide the way the label placement. It is composed by a list of conditional clauses that define placement, position, persistence and failure. A clause will only be run if the previous placement clause does not work for that label. As soon as a sentence manages to correctly place the label, the sequence is automatically interrupted. If, when arriving to the end of the sequence, none of the clauses provides a satisfactory placement then the label will be either suppressed or forced. As well,

general map specifications are defined with the aim of providing default parameters. The Specification file indicates the paths for the different databases, workspaces and files and defines the general input and output parameters.

These Configuration and Specification files need to be executed in a global process for all the feature classes in the map at a single time, since one of the benefits of automatic labeling is that conflicts between different feature class texts are solved. Once the files are processed a new txt type feature class will be created and it will be displayable within the Workspace and editable with the typical GIS tools or special software.

The result is software that is able to efficiently generate the labels avoiding any overlapping conflict and dynamically solving the problems that may occur. At the same time it provides a readable and precise map fulfilling the cartographic labeling rules.

Figure 4. - Labeling without and with automatic placement rules.

Shading
Shading in MP200 complements the information given by the contours and provides a better comprehension of the relief. Shaded relief has been generated automatically. Geomedia Grid module of Geomedia Professional has been used for this purpose. This module is based on the management of raster images. From NTDB25 contours, a raster DTM was generated using FME software. This DTM was imported into a GeoMedia GRID Study Area on the required projection. From this image we produce the shaded relief. The parameters were an illumination azimuth of 315º, a solar inclination of 45º and an average degree of smoothing. A preview of the result was shown to modify the parameters if it necessary.

Composition

The output layout is the last task of this project. It comprises the generation of printed cartography from the GIS starting off the design of the cartographic space and automating the process. This has been made by means of the GeoMedia Professional BatchPlot utility.

The result will be a tool that allows the user to select the geographic window and to send to plot any sheet of the MP200.

Conclusions

New GIS methodologies can be to applied cartographic production in order to save time and workload in a near future. This is pretty clear and probably most of the cartographic agencies have not doubt at all. There are only a few drawbacks about complex or well established workflows; one cannot resist the temptation to start it all from scratch when taking a look to all the requirements the input data needs: clean data, topology consistency, semantic rules over a well defined data model for instance. Secondly, if the life cycle of a product is short enough, then it is possible to see what was wrong in the initial phases (eg design stage) with time enough to react, and obviously get all the benefits from technology as quick as possible.

One great benefit of a well structured data is the semiautomatic tools applied to ~~the~~ cartographic production reducing considerably the time of production. The conflict detection tools provide~~s~~ optimal results and cartographic editing can be made, without losing the original geometry thanks to the multiple geometry and the results obtained with the automatic labeling are highly satisfactory. The 76% of the labels of the map are automatically placed with the programmed execution sequences and respecting the defined configuration parameters. However it is still necessary to manually edit the texts due to the subjective component.

On the other hand, there are compatibility problems with the different symbol library formats from different manufacturers, a standard on this matter would be really appreciated. Besides _ good developers, API documentation is required to customize the product that allows a "Taylor's made" environment to increase productivity and reduce annoying "clicks" in common operations.

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