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FACULTY OF INFORMATICS  
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# THE USE OF AUTOMATION IN THEMATIC CARTOGRAPHY

Theses of Doctoral Dissertation

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# 1. Introduction

Thematic cartography is my chosen subject for this dissertation. I have been making various thematic maps as my primary task at my workplace, Hungarian Academy of Sciences, Research Center for Astronomy and Earth Sciences, Geographical Institute. (MTA Csillagászati és Földtudományi Kutatóközpont, Földrajztudományi Intézet). The urgency to get the maps ready for offset printing and distribution is quite common at work. To effectively prepare the best outcome it is essential to use the proper software (without depending on them entirely) and programming method.

In my work the automation of cartographic processes plays an exceptional role. Besides, vectorial geoinformatics, and the creation of the thematic maps based on this science are other outstanding features. My intention that motivated me was to automate the monotonous and time-consuming labor to a greatest possible extent so all the more time could be left for the enhancement of the visual appearance of the maps.

Fortunately public interest for thematic map designs has not decreased as a contrast to conventional maps of terrain orientation. Thematic maps are now actually in demand as the New Hungarian National Atlas, a major project, is being undertaken for publication. This project indeed could be a milestone in the historic development of thematic cartography in Hungary.

Can we again meet the high standards of the early age of Hungarian cartography? Can thematic cartography introduce a significantly new approach at all to the public with the new, modern technologies applied in it?

## 2. The Objectives

The foremost objective of my dissertation has been to lay the grounds for the upcoming work, and that this foundation in turn in the form of a major database be suitable to carry out all the tasks presented in my writing. Building a database has become an important subject to deal with in detail in regard to the automated procedures used. The quality of the database in fact determines the forthcoming possibilities. Even in the process of assembling the database automation related issues may emerge. To set an example, I have developed a unique database for the Austro-Hungarian Monarchy in 1910, a work inspired by my own interest, my workplace, and my early endeavors.

The next step of my objectives for my dissertation has been to shed light upon the problems of designing thematic maps and preparing visual effects in them. It was essential for this to examine the effects of geoinformatics on the study of thematic cartography. As a solution to these problems I felt responsible to show the way how to use, and take best advantage of the computer programs of geoinformatics, and the commonly used graphic arts software in order to promote a more effective way of constructing thematic maps. Data transmission between these two software families had to be sorted out. Eventually through my own computer programming I have managed to actually step beyond the limits of possibilities offered by either of these program families. To achieve my goal I have examined how automated certain thematic methods are and how to improve them. In particular I focused on individual methods, like dot distribution map, applied my written out principals to improve on them until

finally I have successfully automated a rather complex graphical method of exquisite quality for Jenő Cholnoky's ethnographic map of year 1900.

Beside these I had another objective. This was to examine other areas of cartography to find examples for the ones that could be enhanced by automation through computer programming without an attempt to be comprehensive.

My ultimate objective has been to implement the theoretical problems presented in my work in actual practice so that using the discussed thematic methods I can create the maps through automation.

### **3. The Applied Method**

I started off my approach with a specific statement quoted from the academic inaugural speech of Gyula Pápay in 2011. He pointed out that putting the principal ideas of cartography into practice required complex software applications and computer programming.

This was that I accomplished through the combined use of the general graphic arts software and geoinformatical programs. I entered and stored the data in the GIS (Geographic Information System) software, transformed chart projections, and quickly made thematic maps. At the same time I finalized the graphical appearance in the general graphic arts programs, and adjusted the settings for printing. Thus I had taken advantage of the favorable properties of both software families. But then I took another step forward to work out the solutions to certain problems still left.

In the course of the data transfer between the two software families I was executing numerous cartographic tasks (e.g. drawing of the thematic charts or running miscellaneous procedures like inscribing names of

settlements fitted to projection coordinate lines), and was putting various thematic methods under scrutiny where human labor could be spared through the implementation of automation.

## **4. Theses**

**I. I have developed the executive, ethnographic, and religious database for the Austro-Hungarian Monarchy of 1910 that I made available in a wide-scale projection chart. I have collected all researchable and accessible evidence for this project, and organized the data.**

At first building up this database for the Austro-Hungarian Monarchy of 1910 constituted my thesis work for my undergraduate degree. Later this turned however into an extensive doctoral research. I have completed processing all thematic and cartographic data for portraying the Historical Hungary comprising every township settlement in it. (For the Austrian territory thematic data has fully been processed as well, its cartographic content however still requires some work.) The outcome had become a flexibly adaptable database that I could adapt since then to various other tasks: e.g. I could run other automation procedures, or design new maps using this database without the hassle of searching for a suitable external database. My accomplished database thus provides an outstanding source for widespread demonstrations of thematic methods.

**II. Geoinformatics introduced some serious changes into the realm of thematic cartography. The creation of thematic maps has grown significantly faster since then. On the contrary the diversity of**

**graphical artwork used in conventional thematic map designs has considerably decreased. While other thematic methods (e.g. dot density map) can noticeably diverge from the appearance of traditional cartography.**

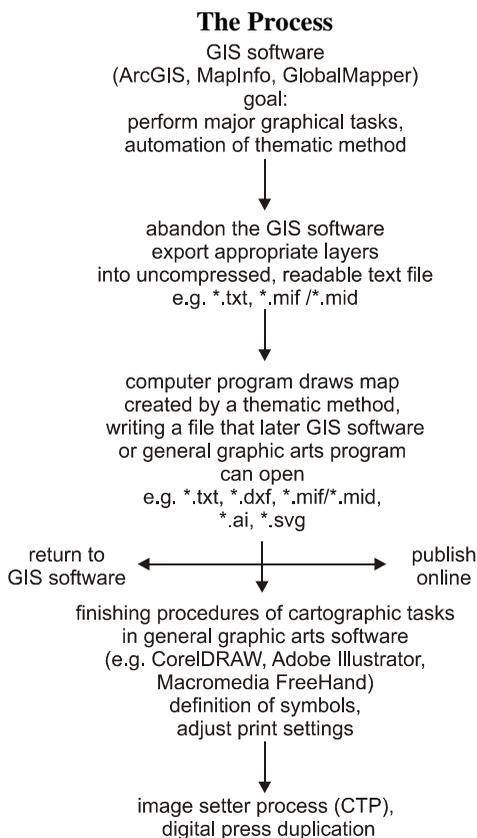
I have made studies on three different thematic atlases each significant in its time of publishing. The first one was *Atlas of Central-Europe* from 1945 (*Közép-Európa Atlasz*), the other was *National Atlas of Hungary* from 1989 (*Magyarország Nemzeti Atlasza*), and finally *Hungary in Maps* from 2011 (*Magyarország Térképekben*). I counted the number of occurrences of the various thematic methods involved in them. The frequency of the methods of thematic cartography clearly shows some changes in them, e.g. as a negative effect one can find less of the individual thematic methods depicted respectively in the volumes.

**III. While designing the maps I could take advantage of the combined benefits of the geoinformatical, and general graphic arts programs. As a result of my own programming method I could step way beyond the possibilities offered by either of these program types as I had to trespass between these two program families, e.g. I imposed automation on an existing, and also on a new thematic method. This approach furthermore provided opportunities for reusing the old methods but placing them at the same time into a more elaborate graphical environment.**

My technique has improved by this on the effectiveness of the creation of thematic maps. In the course of transferring data between the software families I was performing numerous cartographic tasks (e.g. the drawing of thematic chart, or running miscellaneous procedures like

inscribing names of settlements fitted to projection coordinate lines), and was putting various thematic methods under scrutiny at which human labor could be spared through the implementation of automation.

As defined in my thesis I have been dealing with the automation of rather complex graphical illustrations, and individual methods that would otherwise require time consuming labor. The old methods that my newly introduced procedure has brought back to life increase visual complexity, and the thematic maps based on the revived old models enrich modern thematic cartography.



**IV. I have improved the point density performance of geoinformatical programs, by automating the thematic method for creating dot distribution maps.**

Till present day no algorithm has been invented for the automation of the thematic method for making dot distribution maps that actually returns the time invested in its creation. My objective was neither to carry it out perfectly but rather just an optimal approach, involving the subsequent correction of errors with the general graphic arts software. I considered the fact that dot distribution is eventually a way of reflecting the imagination of the human brain, so adequate presentation of this method would encounter serious programming difficulties. Therefore the best approach toward a satisfactory graphic image was my primary purpose. The result of my programming procedure met this expectation. The accumulated small errors could easily and quickly be processed afterward.

**V. I have implemented automation in the thematic technique of Jenő Cholnoky's ethnographic map from year 1900. I have worked out a method through its adjustable display resolution so that it is available in wide-scale projection chart.**

While working on the automation of this thematic method I laid a great store on evading the limitations of the available programs, and rather inventing my own programming script that could overcome difficulties and accomplish things the present software could not.

This example reveals that other thematic techniques can likewise be automated. In the light of these experiences it is worth to supplement the opportunities related to geoinformatics with new strategies, on occasion step beyond those, and try to emulate the versatility of representation of our old historic maps with the new technology.

## 5. Summary

For a preliminary example, I have developed a unique database for the Austro-Hungarian Monarchy in 1910 assembling its executive, ethnographic, and religious aspects. With this project I have established an essential resource for the execution of subsequent automation procedures.

I have examined the effect of geoinformatics on thematic cartography. I have determined that geoinformatics brought significant changes in particular how much faster thematic maps are being created. The diversity of graphic artwork that was a well-known characteristic of thematic map designs however decreased. And we sometimes come across examples of thematic techniques that noticeably diverge from the appearance of traditional cartography.

Keeping these facts in mind I had been rethinking the effectiveness of thematic map designs. I combined the benefits of the computer programs of both geoinformatics and the commonly used graphic arts software. Due to my own computer programming however I eventually have stepped way beyond the limits of the possibilities offered by these two program families as I had to trespass between them.

Building on my strategies then I automated the dot density method, and improved on the dispersive capabilities of geoinformatics programs. I also implemented automation in the thematic technique of Jenő Cholnoky's ethnographic map, through which I could demonstrate how to reinstate old methods or construct algorithm for more complex graphic designs.

My discussed topics clearly exhibit that they are not just technical questions but also they are meant to preserve the emphasis on cartographic approach. Bearing this in mind I have successfully developed higher quality products using present technology, and could set a greater store on presenting the diverse aspects of thematic cartography.

## 7. Publications, lectures

### Current publications in media on the subject:

Agárdi, N.: Pontszórásos térképek készítésének automatizálása  
*Geodézia és Kartográfia, 2013/7–8, LXV. évfolyam, 21–24. oldal*

Agárdi, N.–Ungvári, Zs.–Zentai, L.: Domborzatmodellből nyert szintvonalak automatizált generalizálása  
*Térinformatikai konferencia és szakkiállítás konferencia kiadványa, Debrecen, 2013, 37–44. oldal*

Agárdi, N.: Programozással segített tematikus térképezés  
*Térinformatikai konferencia és szakkiállítás konferencia kiadványa, Debrecen, 2012, 19–26. oldal*

Agárdi, N.: Automation of Compiling Dot Density Maps  
*Kartographische Nachrichten, 2012/2, 71–74 . oldal*

Agárdi, N.: Geoinformatikai problémák térképész szemmel  
*Térinformatikai konferencia és szakkiállítás konferencia kiadványa, Debrecen, 2011, 151–157. oldal*

### Lecture presentations, speeches on the subject:

Ungvári, Zs.–Agárdi, N.–Zentai, L.: A comparison of methods for automatic generalization of contour lines generated from digital elevation models  
*16th ICA Generalisation Workshop, Drezda, 2013*

Agárdi, N.–Ungvári, Zs.–Zentai, L.: Domborzatmodellből nyert szintvonalak automatizált generalizálása  
*Térinformatikai konferencia és szakkiállítás, Debrecen, 2013*

Agárdi, N.: Programozással segített tematikus térképezés  
*Térinformatikai konferencia és szakkiállítás, Debrecen, 2012*

Agárdi, N.: Geoinformatikai problémák térképész szemmel  
*Térinformatikai konferencia és szakkiállítás, Debrecen, 2011*

Agárdi, N.: Geoinformatikai megoldások az etnikai térképezésben  
*Magyar Földmérési Térképészeti és Távérzékelési Társaság, Budapest, 2011*

