Section 14

History and Thought
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Resurgence in Cartography: Getting Back to Basics

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Abstract

Advances in technology throughout history usually have occurred at a pace in which cartographers were able to adapt and embrace change at a reasonable pace - that is - until the end of the 20th Century. Traditional cartography was a labor-intensive process that resulted in divisions of labor, particularly in large mapping organizations. Early automation attempted to replicate the traditional mapping process as a means of reducing labor, decreasing production time, and increasing products and throughput.

In their early stages, commercial mapping systems "solutions" were developed as turn-key, all-inclusive hardware and software systems. This approach was the antithesis of today's purported open systems architecture, a basic imperceptible requirement of users. Interaction and exchange of data, hardware, and software was prohibited by the proprietary approach, which compelled many large mapping organizations to develop their own versions of computer mapping systems.

Home-grown systems transformed cartographers' roles. Determining map requirements gave way to specifying mapping system functionality. Defining map content was displaced by creating cartographic databases. The art of designing maps was relegated to writing computer software subroutines.

Commercial and home-grown systems ultimately required some level of interaction. The need for standards followed automated mapping revolutions. Interchange standards created a framework for spatial data to move from one system to another. The need to know information about spatial data led to development of metadata standards. The condition and value of the data in the form of data quality was the next logical progression.

A resurgence in cartography began with the convergence of technology, data, and user access. Geographic Information Systems (GIS) evolved to include mapping capabilities that began to address cartographic challenges such as text placement and generalization. Availability of spatial and non-spatial data served as an impetus for competitive commercial hardware and software development. The profusion of data themes complemented improved tools to access, process, and display data elements, and output maps.

Commercial competition put GIS products on store shelves. In addition, the Internet offered an outlet for emulating GIS and displaying maps. Technology, data, and mapping opened new opportunities for everyone. The results are mixed. GIS software, while simplistic in its advertising, is a commitment not equally shared. Users want results but are not necessarily willing to invest in learning and performing what can be complex functions. Earnest efforts oftentimes end in ineffective and poorly designed maps.

Commercial GIS has reduced the need for cartographers to design and build complex mapping systems. Flexible tools have freed cartographers to perform tasks such as communicating an effective message through creative map design and production, skills for which they were ultimately educated. Standards allowed improved data access and documentation. While users understand the value of data associated with visualizing its effect through maps, there is an appreciation of the professional talent imparted by the cartographic profession. It is an opportune time for cartographers to accept the innumerable challenges to advance their profession.

Introduction

Advances in technology throughout history usually have occurred at a rate in which cartographers were able to adapt and embrace change at a reasonable pace - that is - until the end of the 20th Century. In earlier times, the process of making maps evolved with new and different tools to etch or deposit an image on a surface. The implement and the object to which the image was etched or deposited evolved through time.

Cartographic images in olden times were transformed by early cartographers onto clay tablets or chiseled into stone. The creativity of these early cartographers generally included more art than geography, but as awareness of worldly events grew, the map helped to stimulate interest in geography. Map creation evolved to where drawing instruments were used by depositing an image via ink or lead. Reproducing maps in preprinting times was accomplished by copying an original work, usually by apprentices to the cartographic trade.

Mass reproduction became possible with the introduction of the printing press. The time required to make a map available for a user shifted from the time needed by the “copier” and reverted back to the time it took the cartographer who drafted the original work. Many more copies of maps were disseminated into the hands of more users in much shorter periods of time. The printing press has been identified as one of the most significant technological advances in history, and one from which cartography also benefited.

With time, aspects of map design changed to accommodate increasingly functional uses of maps. Some of the decorative aspects of map content lessened, however, the aesthetic aspects of map design continued. Cartography as a formal educational discipline entered the academic realm in the early 20th century. With increasing demands for maps and map production, improvements in the technical aspects of mapmaking were developed. As the discipline of cartography evolved in the 1960s and 1970s, scientific research grew particularly as it related to divisions between base mapping and thematic cartography.

Early Impact of Computers on Mapping Organizations

The arrival of computers forced the map production line to investigate, evaluate and determine if automation could increase map production throughput, reduce the amount of time required in making maps, and ultimately reduce the cost of the mapping process. The artistic and scientific needs for automating mapping were unique compared to the programming of accounting principles or matrix models for relational database management systems and their applications.

The initial thinking in automation was to replicate the conventional mapping process. Since large government mapping organizations were the only likely candidates to engage in the costly overheads required to embark on such an endeavor, early developments were closely modeled after their needs, usually by automating standard-scaled quadrangles with predefined content and symbolization. An anticipated auxiliary benefit was the reduction in the amount of labor required to make so many maps.

Early geographic database models were cartographic rather than geographic. Cartographic design and decision making were implicit in the database design and functionality. Just as changes to the mapping base artwork were laborious, time consuming, and in some cases requiring complete replacement, so, too, were the databases built on early cartographic models. Generally, rather than saving time, resources, and costs, the early attempts at cartographic automation usually resulted with the opposite effect. Beyond the resources, another effect of this approach was the introduction of large and costly hardware with systems-specific software to support this new approach to mapping.

Single Solutions to Automating Mapping and Their Impact on Cartographers

Computers and automation demanded expertise not typically associated with the education and training of cartographers. The requirements to meet the technology development exceeded the capabilities demanded of large mapping organizations. Private sector companies developed and offered their services to accommodate specific agency needs. Computer mapping systems in the early days of automated cartography were turn-key systems that included both hardware and software. Even though these services were provided by vendors, agencies began to realize a need to understand and evaluate the work of the vendors. Cartographers then began to train in various aspects of computer science and engineering.

As these systems were designed to copy the traditional mapping process, there was little need to "communicate" with other systems. Even within organizations that used a single mapping system, the fallacy of this premise was realized early, but choices for solutions were not possible. Slight differences in functional requirements often developed into multiple mapping systems with different purposes within the same organization. This was particularly true when multiple vendors serviced the same organization.

It is not clear if the replication of traditional mapping processes was effective with regard to the original goals. This question is valid when evaluating the move to automation by large government mapping organizations versus the reluctance of private mapping enterprises to do the same, including the largest mapping companies. Early automation efforts clearly raised issues that required redirection and further study, the effects which we continue to evaluate today. Turn-key systems clearly were not the solution for long-term mapping needs. Organizations found themselves restricted in relationships with specific vendors, principally because of the investment in hardware and software. The turn-key systems unintentionally became part of an organization's infrastructure and constrained development.

Changing and evolving map requirements of organizations played havoc with turn-key systems. Even the simplest changes were problematic and costly to implement. Complex changes were rarely done. Open, modular systems design had not entered the mapping system realm until users' demands, reflected through business relationships and standards, forced change in the transition in technology. Once open, universal file formats and file transfer utilities were recognized across vendors' software, frequently by third-party providers, then organizations were able to select the software of choice for particular mapping and GIS needs.

The changes that automation brought about to cartography were significant. Cartographers no longer designed a single map. Rather, they wrote map requirements and detailed map specifications for translation by computer programmers and computer systems engineers. Control over the mapping process was diminished from one of conceptualizer, designer, producer and author to a distant contender and observer with little or no control over the development process, and more importantly, the final results. Cartographers were at the mercy of a discipline which spoke a language different from all others. Not only did they feel the frustration of answers that did not provide resolution to problems they identified, but the most difficult aspect was one of helplessness, where it was nearly impossible to communicate suggestions for solutions due to their own technical ignorance and apparent unwillingness of programmers to appreciate cartographic subtleties.

The Fundamentals of Early Automated Mapping Systems

Mapping systems required basic components similar to early models of geographic information systems. A central processing unit (computer), some mechanism for data input (digitizer), software (systems and applications) and a mechanism for map output (screens and plotters) were the minimum components. Firmware allowed each of the components to function as a separate device and communications joined the components as a system.

Beyond the turn-key mapping systems, automating the mapping process required cartographic data in digital form. Since the model was a cartographic data base structure, the characteristics of the data were defined according to how it was used on the map. Because these early systems were map-based with plans to replicate the information in the same way, scanning technology previously developed for the fabric industry was exploited by mapping organizations. Another, more common option, was manual digitizing, the tracing of map data while assigning attributes for the data category and storing the coordinates of the feature.

The greatest problem initially, was a complete absence of digital cartographic data. The source for map digits was the map itself, at the designated scale, at the mapped datum and projection, with the designated symbolization (e.g. double-line roads, or roads with casings), with the mapsheet coordinates as well as marginal information predefined in the digital map detail. These electronic copies of paper maps served a limited usefulness. Any requested change that altered map characteristics such as content, scale, size, and design was not manipulated with ease. Frequently, these types of changes were not workable.

The Cartographer’s Dilemma: What Happened to My Profession?

The job descriptions of cartographers, and cartographic technicians and drafting staff changed as these systems replaced the conventional approaches. Technicians and drafting staff were becoming obsolete, partly because their functions were significantly reduced and partly because automation allowed cartographers to take over additional responsibility within the mapping process. Large organizations were placed in an unusual predicament where the move to computer technology was interpreted by political and management decision makers to require a highly qualified professional staff to accomplish the various mapping tasks, no matter how mundane.

The reality was that many of the tasks in automated mapping were ordinary and did not require the training nor the technical skills typically evident in the education and training of professional cartographers. These unfortunate decisions added to the cost of transitions in cartography during the initial technical stage. Many cartographers found themselves taking training in computer science, computer programming and related fields to shift their emphasis in work based on the demands of the industry. Cartographers found themselves building hardware and writing FORTRAN code rather than applying the fine art and technical skills of a mapping science career.

This trend in redefining the job description for cartographers was strengthened due to organizations’ frustration with the many limitations of turn-key systems. It was not long before agencies found themselves developing their own automated mapping systems by training and encouraging cartographers to acquire the skills necessary to develop and implement each of the mapping system components. Automation was viewed by some as a means to an end, rather than the end itself. For that reason, selected organizations capitalized on the expertise of cartographers in identifying, designing, and implementing cartographic systems while employing their new skills. System efficiency (which in time improved dramatically via technology) gave way to accurate results.

Initially, early attempts replicated turn-key approaches. With time and expertise, cartographers realized the need for a procedure that paralleled systems development trends in other technological fields, where flexible operation and modular design resulted in an open systems architecture. The result usually was a hybrid of the two approaches.

Cartographers took on a more active role in writing software. They became digitizers of cartographic data at resolutions governed by the scale and content of a specific map type. They continued their role as cartographic editors but they had little say in the procedures and outcome for correcting unacceptable consequences of the automated processes.

Other cartographers were involved in map production processes where the choices of interacting with the map were restricted to the functions programmed in the software. The only choices were limited by the number and function of the button or command. More often than not, visualization of a map image in various production stages was not possible following interaction with the data. The cartographer had to wait until the final production of the map to view any changes made. In some cases, cartographic data was the product without the possibility of seeing a map. The art of map design did not matter.

Traditional cartography was a labor-intensive process that resulted in divisions of labor, particularly in large mapping organizations. Early automation attempted to replicate the traditional mapping process as a means of reducing labor, decreasing production time, and increasing products and throughput. The effect minimized roles and opportunities for professional cartographers.

Cartographers sensed the limitations of early cartographic systems. It was not long before managers learned the importance of those concerns and realized the significant deficiencies of their agencies' huge financial and organizational investment. Selected organizations devoted resources to develop in-house mapping systems to ensure their needs were met. Many organizations had both commercial and in-house capabilities, neither of which "talked" to one another. Commercial and home-grown systems ultimately required some level of interaction.

Standards: An Unwitting Ally to Cartographers

The need for standards in digital cartography normally followed automated mapping revolutions. Closed proprietary commercial systems forced the issue of spatial data transfer standards (SDTS). The process for developing standards that provided a framework for interacting and moving cartographic data began to point out the inadequacies in the cartographic database model. For example, was it the symbolized graphic element that moved from one system to another or was it the geographic phenomenon that was of primary interest? The graphic representation, in many ways, imposed constraints on the transfer and use of information. Debates about the meaning of cartographic, geographic and spatial types of data and databases were common in conference proceedings. Even though the current favorite (spatial databases) persists, it implies an unstated qualification of geo-spatial, as the term spatial is not limited to cartographic and geographic data.

The SDTS was a mandate that forced vendors to "open-up" their data, thus allowing the movement of spatial data from one system to another. The standard, however, proved ineffective from a data provider and data user perspective. Data providers did not experience the same predicament, as vendor software easily imported and exported data in a variety of formats, thus reducing the need for the standard. In addition, the standard was not clear in describing and defining data and raised important questions about the data itself. These accessories were not required nor were they addressed in the SDTS.

Once the function of transferring data was accomplished, the need to know information about the data raised questions for the next set of standards. Simply having access to data was insufficient to make decisions on what to do with it in a geographic and cartographic context. Thus, metadata standards followed in the U.S., then they were mandated for federal use through a Presidential Executive Order promulgated under the auspices of the Federal Geographic Data Committee, and then were subsumed under the International Organization for Standardization (ISO). Metadata, the information about data, can be as simplistic or as complex as standards and users choose. Efforts at collecting metadata in some organizations make the onerous task of digitizing spatial data in the early days seem simplistic.

Metadata is the result of a documenting and reporting process. It is possible to use this information in its simplest form, for example, as user notes and data descriptions. At another, more progressive level, this information is used in mapping and information systems that "drive" software to perform functions and make decisions based on the metadata fields of information.

The need to know information about spatial data led to development of metadata standards. The condition and value of the data in the form of data quality is the next logical progression. Knowing the nature of the data and its format are not enough to make decisions about the appropriateness of its use in a given task. For some applications, statements about the quality of the data are required to assure its correct use or guard against its limitations.

It is not yet clear whether the metadata and data quality standards will prove effective or ineffective in their implementations. Minimally, such standards raise important questions that require examination, research, and practice. Implementation is the true testing ground for standards. Mandated standards have impediments in applications, where testing in real-world scenarios measures their effectiveness in the user community. De facto standards usually result from substantive utilization and user affiliation.

Geographic database structures and the standards that affect their use opened an entirely new set of challenges for cartographers. Past mapping practices required cartographers to learn as much about the content they were mapping as was required to effectively communicate the intended message. Spatial data standards expanded that practice by calling on the geographic knowledge and training of cartographers to define mapped geographic phenomena. The interpretation of derived data as it was represented through cartographic symbolization rarely equaled the full spectrum of meaning associated with the nature of the geographic phenomenon.

The Resurgence in Cartography is Underway

A resurgence in cartography began with the convergence of technology, data, and user access. One might argue that these elements existed before the technological revolution. The tools, skills, information, and needs of customers of the masters were combined to craft the map. Time and technology have improved the tools, demanded new skills (along with the old ones), made more information available more quickly, and given access to the map-making process to everyone.

The integration of mapping and GIS technology freed cartographers to apply their skills and knowledge in effective map design and production. Geographic information systems, originally devised as analytical tools, offered mapping as one of the options for viewing data and visualizing results. It was not long before GIS technology was viewed primarily as a means of fulfilling automated mapping needs. GIS software has evolved to include mapping capabilities that began to address automated cartographic challenges such as placement of text and generalization.

The increase in volume of available spatial and non-spatial data served as an impetus for competitive commercial hardware and software development. Cartographically unseasoned businesses emerged to offer a bevy of geographic and cartographic functions, several of which violated the most basic rules of cartography. Other companies continued to emerge to serve specific niches of services for which the geographic information has proved so valuable. Even traditional data base management systems added mapping functions to their suite of options for their traditional relational-based data. The profusion of data themes complemented improved tools to access, process, and display data elements and output maps.

Commercial competition and an increase in public awareness of maps and mapping techniques helped place GIS products on store shelves. Boxes of GIS software found their place alongside nearly every activity with the potential for geographic analysis and/or comparison in the real and virtual aisles of general and specialty merchants. With the technological revolution, the Internet understandably offered an outlet for emulating GIS and limited mapping capabilities. The combination of technology, data, and mapping functions opened new opportunities for everyone.

Cartographers and Their Response to the Call

A good cook knows that ingredients combined from a recipe do not guarantee good results. All have equal opportunities to use the same tools, but may not use them in the same way or an effective manner. Likewise, a professional chef, even with the best training, realizes that practice is critical in satisfying customers. The results of mapping functionality with concomitant data are mixed. GIS software, while simplistic in its advertising, is a commitment not equally shared. Users want results but are not necessarily willing to invest in learning and performing what can be complex functions. As a result, earnest efforts oftentimes end in ineffective and poorly designed maps.

Over the past few decades, cartographers have been diverted from the core of their professional calling. They had no choice but to work the periphery of the art and science of cartography. The essence of their training and skill were left to the smallest morsels within large projects. The profession was minimized by the artlessness of machines and ineffective translation of cartographic principles from empty lines of computer code. The new era of automated cartography challenged the best of the past with the promises of the future. Neither were realized in the development phase of automated mapping.

Commercial GIS improved and reduced the need for cartographers to design and build complex mapping systems. Availability of spatial data and the advances and investment in data collection methods provided mapmakers with sources for deriving well-executed results. Flexible tools have freed cartographers to perform tasks such as communicating an effective message through creative map design and production.

Improvements in automated cartography have occurred at varying rates. The components for fully automated mapping systems for customized, on-demand mapping continue their development. It is conceivable that, as diverse customer expectations and user demands grow in complexity, that automated solutions to these requirements might be possible through development of cartographic expert systems. Rather than an "all-encompassing" solution, cartographers will assume the task of guiding users through choices for designing and compiling the map.

Availability of volumes of data has stimulated interest in portraying its effects geographically. Interest in comparisons of data through time also is on the rise which lends itself to animated cartographic techniques. The visualization of change of data through time will assist data users in better understanding those effects. This approach will help to quantify and qualify the data.

The Cartographer of Tomorrow

The future for cartographers is bright, but they need to be prepared with the knowledge and skills to meet the common challenges of maps and mapping. The overall, general education of cartographers is helping to foster the resurgence in the discipline. This is particularly true for those with a "renaissance" approach to their learning combined with exploitation of innumerable resources about and from technologies such as the Internet. Cartographic education, however, must return to basic fundamentals of map design. The interaction of basic design elements within the map determine the impact of its effectiveness for communicating a cartographic message. Other current themes include new capabilities and limitations of the media in controlled environments (printed maps) and uncontrolled environments (map files disseminated electronically) as well as processes for evaluating data (as part of datasets) for use in mapping.

Cartographic production oftentimes includes problem solving and critical thinking. While digital cartographic systems and geographic information systems technology are tools with which to serve the requirements of its users, the most effective application of these tools is made possible through planning and implementation by the savvy cartographer. As services continue toward increasingly customized applications, the knowledgeable and experienced cartographer is poised for designing and creating cartographic and geographic solutions.

Cartography, as art and science, is once again taking its useful place in society. Sophisticated computer mapping tools, data availability, data standards, geographic information systems technology, revolutions in communications industry and other technological advances all contribute to the increased interest in maps and mapping. The cartographer, as a generalist, need not fear the disappearance of the discipline nor the profession. Rather, the cartographer brings together a broad range of others' ideas with the various tools and technologies necessary to design, compile, and produce an effective cartographic product to meet a user's requirements. The cartographer's knowledge, skill, and expertise are in demand to realize the convergence of technology, data, and user access. This is an opportune time for cartographers to accept the innumerable challenges and opportunities to advance their profession.

Session / Séance 35-A

What is a Map?

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Abstract

A recent Cartographica article posed the question "What Was a Map?" and reported on a survey of over three hundred definitions of the term 'map' found in dictionaries, encyclopaedias, geographical and cartographic texts over the last three hundred years. In contrast, this study poses the question 'what is a map?' and reports on initial investigations into what spatial images various groups currently consider to be maps and those that they do not. As part of the presentation a series of images will be shown and the audience asked to give their opinion. The responses will be included in subsequent analysis.

Introduction

In a recently published article, Andrews [1996] posed the question 'What Was a Map?' This examined the definition of the term 'map' from a lexicographers point of view, studying 321 definitions of the term found in dictionaries, glossaries, encyclopaedias, textbooks, monographs and learned journals published between 1649 and 1996. He found one group of definitions (or at least parts of definitions) that were very similar in there meaning, even if using different words, and that this group was so much larger than any other that it provides a 'standard' definition. From this analysis the key elements of the definition of the term map are:

- It is a representation (205/321);
- It is in a plane (150/321);
- It shows all or part of the Earth's surface (144/321).

Moreover, these elements of the definition are to be found consistently from the seventeenth to the late twentieth century.

Andrews continues to analyse the specific terms found in the definitions and then catagories the field by looking at The Scientific Map, The Popular Map, The Cartographer's Map and the Philosopher's Map. An appendix cites some of the more popular definitions that have been used in the latter part of the twentieth century, including those developed and/or adopted by the International Cartographic Association (ICA). Andrews does not try to produce a new definition for 'map'. Rather his purpose was to 'acknowledge the lexicographical record as a new window on the history of maps' [1996, p.7]. He notes that many otherwise authoritative works on cartography have left their subject undefined. This may be for two reasons. First, as Andrew's points out, we all know what 'map' means and therefore giving a definition would seem superfluous. On the other hand, by not giving a definition authors do not set boundaries on what they might discuss at the margins of what is and is not a map.

At the 10th General Assembly of the International Cartographic Association a working definition of the term ‘map’ was adopted: “A map is a symbolised image of geographical reality, representing selected features or characteristics, resulting from the creative effort of its author’s execution of choices, and is designed for use when spatial relationships are of primary relevance” [ICA, 1996]. This is a definition developed by cartographers (mainly academics) and was developed in conjunction with definitions of cartography and what a cartographer is (or does). (Earlier ICA definitions of cartography had not defined the term ‘map’.)

The user community and its view

Given the increasingly widespread exposure of an extensive range of geospatial images to scientists and the public at large, does the ICA definition match the perception of the broader community? Are aerial photographs, satellite images, etc., considered to be maps, and if so by whom? Do people recognise the difference between an aerial photograph and a photomap? Is a block diagram or panoramic view a map? How diagrammatic can a map become and still be considered to be map? The intention of the research reported on here is to address these questions by carrying out a survey of opinions of a variety of groups. How differences in age, gender, background and use of maps influence what is perceived as a map will ultimately be included in the analysis.

The initial major test group were first year Geography students at the University of Glasgow and the results of this survey are reported on briefly below. The test has also been carried out with postgraduate students on cartography, GIS and surveying courses at Glasgow. It is intended to test a group of Geography teachers - clearly an influential group in developing young people’s perception of what is and what is not a map. It would be interesting to test the ‘general public’ but difficulties in capturing such an audience make this problematic.

In order to give the study an international perspective and to assess how the cartographic community’s view compares with the predominantly Scottish one tested, the opportunity of the International Cartographic Conference will be taken to test cartographers and geomaticians from around the world to investigate the effect of national and regional differences in the perception of ‘what is a map’. As the audience are also to form part of the testing only a limited overview of previous results are given to prevent any risk significant bias being introduced into the testing.

The Test

The test is carried out by showing twenty-six slides of various map-like images to the audience. Some are quite clearly maps (by any definition of the term), some are not (in the author’s opinion at least). Many are images that are likely to be controversial in some respect. Apart from the first image, which is a conventional atlas map of the United Kingdom, the slides were ordered randomly.

The audience fills in a questionnaire giving some brief details of their background, age, gender, nationality, etc. The 26 slides are then each displayed for approximately five seconds. The question to be answered is ‘Is this a map?’ Subjects tick a box on the questionnaire indicating yes or no. Consideration was given to allowing a range of answers on a five or ten point scale to give some indication of how ‘map-like’ subjects thought an image was, but it was decided that this may lead to confusion or candidates finding it difficult to make this kind of decision in the short time available. By using a large number of subjects some overall indication of how map-like each image is should emerge.

In all, including giving a brief explanation, the filling in of personal details and carrying out the test takes about ten minutes.

The Glasgow test

286 first year Geography students were tested in their first week at university. This group was selected as the majority of them represent the late teen-age population, and by testing them during only their second Geography lecture they had not been influenced by the any teaching about cartography. Geography at Glasgow has the advantage that has students in the Arts, Social Science and Science faculties and only about one third of the students planning to proceed to Geography degrees.

For the 286 subjects, the average number of *yes* responses was 15.0 with a standard deviation of 3.6. Two said *yes* to all 26 images. The minimum number of *yes* scores was 4. Only eight said *yes* to less than ten images, and 19 said *yes* to more than 20.

The number of *yes* scores and percentage *yes* votes per image are summarised in table 1. The average number of *yes* scores per slide was 165 which represents 58%. Slide 1 and slide 15 were each given a *yes* response by all but one subject. The student who said *no* to map one did respond *yes* to slide 15 and responded positively to 15 slides, the overall average response. The one student who did say *no* to slide 15 did say *yes* to slide 1 and 12 others, only slightly below average. Of those responding *yes* to slide 11, the slide with the lowest score, six of the eight said *yes* to 20 or more images, one to 16 and one to 12.

Examining table 1, some natural breaks can be identified. There is a low scoring group of two, both of which are photographic images, rather than line images. The second low scoring group of three slides consists of two advertising images and it is not surprising that these achieved such scores. The third in this group is a manuscript plot of a hydrographic survey, dominated by soundings, but also showing some contours and point symbols, and it is perhaps slight surprising that so few students thought that this is a map.

At the other end of the spectrum, seven slides all achieved over 80 percent yes responses. The top scoring four are uncontroversial. The other three in this top group, all scoring in the eighty percent range are route planning guides to railway networks where space is significantly distorted, particularly in slides 4 and 7.

The responses appear to indicate that the students do not expect a map to have a photographic appearance. The result for the oblique air photo is not unexpected, but the orthophotomap (slide 9) which includes contours, names and other symbols must be classified as being a map by any reasonable criteria, despite 60 percent not considering it to be so. Of the ‘image maps’ only the urban pictomap (23) scored highly (67% *yes*). In this case the photographic image has been significantly enhanced and the dominant part of the image is conventional symbols and names rather than the photographic aspect of the image.

Conclusions

Further analyses is not presented here to avoid influencing the test to be carried out during the conference, but clearly even this overview indicates that many images which are not ‘traditional’ maps are generally considered to be maps by the younger generation in Britain, but some images which do conform to ‘scientific’ definitions of a map are not considered to be maps by many.

The intention is to provide a summary of the ICA testing on the author’s web site at www.geog.gla.ac.uk/~dforrest soon after the conference.

Table 1. Summary of responses per slide.

Slide number	*Description*	*Total 'yes'*	*Perc 'yes'*
11	oblique air photo	8	3
2	colour vertical air photo	21	7
26	London underg'nd / Tate Gallery	59	21
5	Campus Travel brocure	61	21
24	hydrographic survey plot	76	27
9	orthophoto map	117	41
25	3D fishnet plot	121	42
12	motorway strip diagram	123	43
10	3D fishnet with colour layers	131	46
8	screen contour plot	142	50
16	British Isles satellite image	150	52
13	Central Scotland panorama	153	53
14	Arc/INFO soils coverage	157	55
22	mental sketch map of UK	161	56
3	colour block diagram	166	58
18	Montreal bird's eye view	184	64
23	Urban pictomap	192	67
17	UK Social atlas cartogram	205	72
6	Scotland perspective view	206	72
4	North Clyde rail diagram	236	83
7	London underground planner	248	87
19	Brit. Rail routeplanner diagram	252	88
21	Manhattan map guide	271	95
20	Basedata GB plot	275	96
1	British Isles atlas map	285	100
15	Central London map	285	100
	Average 'yes'	165	58

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Towards a New Understanding of Maps – Concerning the Concepts of Quality used in Cartography

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Abstract

Maps have proven to be useful tools in transmitting spatial information and helping getting knowledge about the arrangement and distribution of spatial objects. The Internet and innovations like multimedia, computer-animation and virtual reality increase and change the possibilities for individuals to use geographical information as well as to link geographical information with various other information. These additional forms of information transmission and -access determine fundamental questions, concerning the goals of cartography.

In pursuing the goal of cartography to make "better" maps, it is important to understand and comprehend what "better" means. By examining the meaning of "quality" in cartography some consequences of innovations and new technologies for cartography can be better understood and judged. To answer the question "What is a good map", different meanings have been examined. This paper deals with selected relevant concepts concerning the meaning of "quality" including philosophical ideas as well as cartographic understandings. To answer the question of what a quality map is, cartographers have attempted to define the map's function. These attempts include esthetical functions as well as aspects of communication or cognitive aspects, which will be addressed at this paper.

As a precondition, the paper analyses some selected aspects and consequences of recent developments in cartography, driven by technological innovations. The need of developing a new understanding of cartography, in terms of redefining tasks and theories is argued. The task of modern cartography, to visualize, distribute and transmit geographic information with a variety of tools can only be achieved with a modernisation of theories in order to meet the current challenges.

1. The Challenge of Brains

It is obvious, that we are witnesses of an information revolution. Everything changes: how we live; communicate; teach; learn; access information; and send information. Even how we act and speak and think has been changed by technologies, thrust into our daily life (think for instance of mobile phones, the Internet, Television or traffic and transport–innovations like cars or planes). Almost at the turn of a millennium the speed and the consistency at which technologies are being invented, developed and used has become breathlessly fast.

A major part of this technological revolution are communication and information technology innovations. Cartography is directly connected to these innovations as it can be seen as a branch that is concerned about the transfer and communication of geographical information and deals with all parts of this phenomena. This involves three main areas: the object (geographical information); the transfer (maps and other cartographic products); and the users. Every part can be seen as related to the major aspects of the development of communication and information technologies.

Figure 1 depicts how the main challenges of modern communication and information technologies are related to the main tasks of cartography. By understanding cartography as a system, where information has to be stored, coded, transferred and decoded in order to help a person to process and use geographic information, the development of a global information storage tool (the Internet), the possibility of accessing the global information storage unlimited from location and time (the mobile information and communication machine like a mobile phone) and the analysis of the human brains processing methods can all have impacts on how cartography will try to cope their tasks in the next millennium.

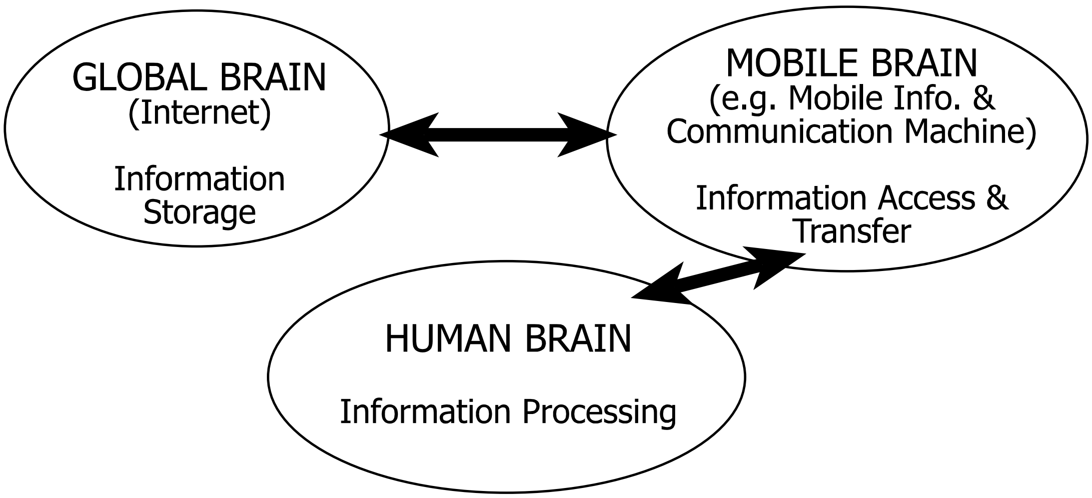

Figure 1. Research tasks having impacts on the future directions of cartography

The global brain

The Internet has linked computers and provides a communication standard. This has been seen by many as the development of a global brain. It is not the information that is new, but the system of providing that information and links (like stored information in our brain that is only helpful when links and 'access' to that information exist). As authors like Peterson (1997), Crampton (1997), Gartner (1996) have stated, it has never before been possible to have such direct and fast access to such an enormous amount of information. It is also been argued, that the access to the Internet could become a tool for democracy and prosperity (Hansen 1996).

As a result of these advances, the fiction of an ideal cartographic application like an user-oriented Tourist Information System of a city is now plausible. Such a system could have various shared databases, and, if a user wanted access to the system, a social security number would be entered, allowing the system to get basic information about the user. The system would then design and deliver, via a 'best practice' interface, the requested information, such as maps, in such a way that it is 'made-to-measure'. In technical terms this would provide a usable 'dream' of cartography, giving a user exactly the information wanted in the way it is needed and understood. On the other hand, the control of the information could become very divisive. If access to an information system can be 'individually-tailored', the user could be provided with wrong or manipulative information or misinformation.

The mobile brain

While the development of a global brain, where all kind of information is and can be stored, offers enormous possibilities, the access conditions and possibilities become crucial. The full "power" of an information society could only be achieved, if all this stored information, hold ready for users, is accessible independently from any location and time. By extending the functionalities of mobile phones to a ‘mobile communication and information machine’, as promoted as a new future product by major mobile phone and computer vendors, a ‘mobile brain’ could be created. Then, a user who needs geographical information, say to solve an orientation problem, could then make a request to the information system via a mobile phone, deliver the current location with an integrated GPS, and receive results. Cartography would then have to develop and use different strategies of delivering this information.

Typical of the developments in the use of mobile telephones for information provision is the Symbian company, owned by Ericsson, Nokia, Motorola and Psion (Symbian 1999a). Sun Microsystems has also shown some interest in being involved in the company (PDACentral 1999). This company developed the EPOC operating system, designed for Wireless Information devices like mobile telephones. This operating system also powers the Psion palmtop computer. Development partner Tegic Communications launched its Intelligent Text input for EPOC in 1998 that allows for text entry on devices with limited keyboards (Symbian 1999b). If microprocessors like Digital’s Mic SA-1100 are installed, then information can be sent and received from Internet providers, including providers of geographical information. Things are moving quite quickly in this area and in January 1999 - Symbian licensed WWW technology from STNC Ltd., enabling the addition of Internet options for their wireless products (Symbian 1999c). The products being developed have been given the generic title of ‘Smartphones‘ (and thus cartographers could use them to produce and deliver ‘Smart Maps’ (as discussed in Cartwright et al. 1998)). Development in this area is centered around the use of Wireless Application Protocol (WAP) and the WAP Forum Ltd was established by Ericsson, Motorola, Nokia and Unwired Planet for Wireless Information and the Internet. The Protocol has been published for comment (WAP Forum Ltd 1999).

The human brain

One of the last main ‘unknown territories’ for science is the research of the human brain. By analysing questions like: how the brain works; and how it processes, stores and links information, impacts on all sciences, technologies related to these sciences and also our daily life can be expected. The primary goal can be seen in knowing, how we know, in terms of what and how we perceive, process and link all kinds of information. By analysing the methods of perception and mental information processing and storage, important knowledge for the development of the mobile and global brain can be created.

Research projects like linking a protease to the nerves of an arm, giving the patient a control over the protease which is nearly similar to the way an arm is controlled (Format 1998) and linking brain functions of a person unable to communicate or move to a sender that controls the movements of a computer mouse (APA Science Week 1998) show that the ‘unknown territories’ are contracting. It is obvious, that knowledge of the human brain regarding how geographical information is processed and stored will have a major role for the science and technology applied to the depiction of geographical information.

2. The Challenge of Quality

The definition of what a ‘good map’ mean will obviously change with developments concerning the challenge of brains. The understanding of the quality of a map distributed via the Web can be seen as a good example for the confusion about the value of maps in context with a new technology.

The distribution of maps using the Web has developed very quickly. But the quantitative increase of maps published and distributed on the Internet has been accompanied by concerns about the missing quality of the distributed maps (Crampton 1997, Dickmann 1997, Silwester 1998). Therefore, methodical and theoretical considerations of increasing and optimising the quality of maps and visualized geographic information at the web are claimed (Kelnhofer 1996, Peterson 1997, Buziek 1997). This includes technical concepts (concerning the architecture of application and format), graphical design and symbolisation principles, concepts of applications using interactivity, multimedia, animation or VR and finding rules for the formalisation of cartographic issues (for instance, generalisation). It seems essential to analyse the meaning of 'quality', in order to better understand what a 'good map' means.

The meaning of quality has been and is examined, in general terms, by philosophers. Some of these concepts can be seen as relevant to the question of the 'quality of maps'. Axiology, for instance, is concerned with quality in terms of value. The value of 'goodness' and the worth of 'beauty' is interpreted by ethics and aesthetics. Ethical/aesthetical – oriented distinctions include the understanding of quality as a 'value' not only when describing parameters of an object, but also the background of the judging subject and the sensory and non-sensory perception. Due to axiology it is necessary to analyse the relationships between 'internal' and 'external' aspects of an object in order to understand the meaning of 'quality' of a particular object.

Beneath axiology, there are more plausible value-oriented distinctions of quality. From a more idealistic viewpoint, an absolute value exists (for instance "THE" good map, "THE" beautiful map), and every object (the map) has to be judged by that value. Such absolute values are used often by cartographers, but are not explicitly stated. In contrast to the idealistic understanding of quality, the proponents of the pragmatic / realistic understanding do not believe that an absolute value exists. Rather, they assume that the quality of the object can only be judged in its relationship to an individual perception.

As well as such philosophical concepts as at concepts of quality in economics it can be noted, that to understand the 'value' or the 'quality' of an object, the relationships and the context of the whole system have to be considered. Therefore, the quality of maps, distributed via the Internet or as a part of a Web-based GIS, should only be judged in their context and within their system relationships, rather than comparing graphical details to objects in different contexts (analogue maps).

Among cartographers similar idealistic and realistic–oriented perspectives related to the meaning of 'quality' in the context with maps are used. These have been described by Gartner (1998).

Maps as pleasing to the eye: Aesthetics and Pleasure

According to this view (Spiess 1996, Kelnhofer 1996), a major function of maps is their ability to stimulate a form of pleasure. Pleasure, in this sense, has to be seen as the esthetical form of sensory and non-sensory quality, whether on the level of perceptions, feelings or thoughts. The graphic variables used in cartography (Bertin 1967) are not only important because of their role as a transmitter of quantitative / qualitative information but also because of their role in transporting esthetical aspects (Tufte 1983, Spiess 1996). Therefore, graphics have to be seen as the tool for stimulating a form of pleasure. If the map fails in this role, it will be judged as "ugly" or of "low quality."

The statement that an Internet-map has "low quality" often arises from this point of view and means that the map does not meet some sort of esthetical standards. The concern is, therefore, focused on the graphical design and potential of the map. Judgements like this, referring to the poor or missing esthetical aspects of maps, do not take into consideration the other functions of the map.

Esthetical aspects are only a part of cartographic quality. The graphics developed by cartographers may be viewed as a continuous improvement to meet the esthetical and perceptive demands of the map users. Cartographers throughout time have tried to improve their maps, with a major part of these improvements focusing on the esthetical functions. Research on perception, graphic variables and map design supports this concern (MacEachren 1995).

Maps as a Communication Device

By defining a map as a communication device (Robinson 1952, Robinson & Petchenik 1976), the meaning of quality changes. In this view, the map has *high quality* when the map transfers information and the user receives the message clearly, i.e., the user receives the message the cartographer has in mind. Therefore, a cartographer would judge a map as good if the user receives the intended information without interference. The graphical-esthetical aspects are important here as well because of their ability to enhance or interfere with the communication process. For those who view the quality of a map as a communication device, it is, nevertheless, possible to speak of a good map, even if the map is "graphically poorly designed," as long as the information has reached the receiver correctly (Morrison 1978).

If the concept of quality considers source, object and subject, as do the theories of Deming [1986] and Pirsig [1974], then the quality of a map can not only be judged by its graphical-esthetical design. By defining graphical design, it becomes a suitable means to reach improved quality.

Processing Maps in the Mind: Cognitive Quality

The quality of a map, in terms of cognitive quality (Peterson 1994), has to be judged by its ability to conform to the way maps are mentally processed. In Peterson's opinion, maps are internalised in some way and are connected to former and future knowledge. At a later time, the stored mental image or information stored in non-image form can be used. The mental processing of maps is described as interactive, dynamic, multimedia, and multi-dimensional, consequently, Peterson rates the quality of maps in terms of their similarity to these attributes. The recent technological innovations like interactivity, multimedia and animation are, therefore, helpful steps in improving the quality of maps because of their greater similarity to the mental processing of maps.

According to this view, a map can be judged as good if it moves into the receiver's mind in such a way that it can be connected with stored knowledge (mental maps) or is stored for future use. The map's primary function, then, is not to be found in the production, presentation or immediate reception, but in how it helps our mental processing of spatial information. Therefore, it is possible that *graphically poorly designed* maps can be seen as having *high quality*. In fact, the quality of a map cannot be determined until long after it has been used.

Furthermore, proponents of this view extend the meaning of quality from beyond the actual communication process to the impacts and consequences that the map's information has for the mental processing of spatial information. This could help to overcome one of the weaknesses of information theory associated with cartographic communication, by explaining how knowledge can be acquired by the receiver that the sender had not intended.

Using this definition, the meaning of quality is not only expanded, but an adequate explanation of the new cartographic products that have resulted from the use of technologies such as interactive maps, multimedia, computer-animation or hypermedia can be given. Earlier concepts of quality in cartography often cannot judge the quality of these new cartographic expressions. By using the concept of "cognitive quality," a more adequate evaluation of these new cartographic expressions becomes possible.

The GIS Approach

Cartography has been intensely influenced by the development and use of geographic information systems (GIS). With such a powerful influence on the cartographic community, the development of GIS has lead to different ways of viewing the meaning of "quality" and enhancing the analytical potential and usage of maps.

For GIS, a map is a derivation of an abstract and scale-less ("primary") model of a part of the world (Bartelme 1995, Maguire & Dangermond 1991). Therefore, the quality of a map has to be seen not only in its ability to meet the *esthetical* and *informational* demands of the user but also in its ability to meet the *technological* needs of the GIS-system. As a consequence, quality, according to this view, is a measure of how well the map ("secondary model") is derived from the model and how well it meets the demands of the system in terms of supporting the presentation and visualization tasks (Bill 1994, Mark & Frank 1995).

The secondary model requires the use of generalisation methods. Many doubt that general formalisation algorithms for an automatic derivation of maps from a primary model can be found (Kelnhofer 1996). Therefore, this major aspect of the understanding of "the quality of a map" in context with GIS, the *quality of derivation*, can be seen as using absolute concepts by defining a highest goal ("formalised and automated derivation"), to which we should aspire.

The Visualization Approach

Geographic visualization (Gvis), as formulated by DiBiase (1990) and MacEachren (1994), has to be seen in close relationship to the development of computer graphic data processing. In this approach, the functions of a map can be divided into presenting, communicating, analysing and exploring spatial data. The definition of quality is, therefore, extended to the ability and capacity of a map to lead to more questions. By extending the definition to include the ability to interact with a map (as a result of technological development), maps have not only the function to present something known but also to make something unknown perceivable and knowable.

Understanding quality according to this approach has to be seen as technology-oriented and usage-oriented. Technology-oriented because geographic visualization demands that maps have specific abilities and characteristics such as interactivity and dynamic processing, and usage-oriented because the quality of a map is judged by its ability to enable "visual thinking" and to meet the needs (explanation, confirmation, synthesis and presentation) and interests of the user, whether private or public.

This usage-orientation of geographic visualization implies "some connotations" (MacEachren 1995, p. 452). MacEachren has noted that by trying to define the goal of visualization as making presentations as pictorial as possible ("moving toward realism"), implications for the interaction between scientists and the society can be expected. The potential of "scientific representations more like the real world" (p.452) at the societal level, in terms of becoming public, can be seen as another approach to the meaning of quality in the context of cartography.

3. Conclusion

Geographical information will have an increasing role in the future. The uniqueness of the information and the need for information on 'space' in nearly every part of life, society and business is becoming more and more important. For all related applications cartographic visualization is necessary, thus increasing the importance of cartography, as geographical information will play a decisive role in the future. Cartographers control how and what information is presented and transferred. Therefore, cartography in the next millennium can be considered to be a major player in the provision of global information. This fact, and the increasing number of applications, tools and alliances that have already been linked to cartography have led to both internal and external developments. Internal developments can be seen in the change about what and how cartography actually is – theoretical, methodical and practical. Cartography in the next millennium will probably not only be considered as the information branch focused on 'the technology of how to make maps', but on 'the science of how to efficiently transfer geographical information'. This includes not only knowledge of map making, but also about efficiencies and how geographical information is transferred by different media, as well as knowledge of perception processes and the way we mentally store, process and use spatial information.

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Session / Séance 15-C

La démocratisation des cartes ou les cartes pour tous et chacun / Maps liberation or maps for everyone

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Résumé / Abstract

La communication a pour objectif de présenter une réflexion sur les nouveaux utilisateurs et les nouveaux fabriquants de cartes. Deux mouvements s'additionnent pour créer une prolifération de cartes: la population est en quête d'information tandis que la démocratisation des données et la généralisation des outils engendre un brassage de cartes jamais égalé jusqu'à ce jour. Cette présentation brosse un tableau de la situation. On y expose le concept de démocratisation, on traite de l'accessibilité aux données, de la disponibilité des outils, des formes de besoins et d'utilisation des cartes. On termine par un regard critique sur le design et la qualité des cartes.

The paper aims to present reflections on new users and new map makers. Two trends combine to create the proliferation of maps: the population is looking for geo-information while the democratization of data (data liberation) and the spreading of cartographic tools generate numbers of maps never equalled before. This presentation makes an overview of the situation, exposes the concept of democratization and deals with the accessibility of data and the availability of tools. The questions of needs and uses of maps are tackled. The paper finishes with a critical glance at the design and the quality of the maps.

Introduction

L'utilisation des cartes prend des orientations nouvelles. De plus en plus, la population en général en demande et de plus en plus des outils et des produits sont offerts sur le marché. Traditionnellement, on produisait des cartes de localisation, des cartes dans les atlas et des cartes routières par exemples. Maintenant apparaît une variété de produits cartographiques qui répondent à des besoins nouveaux et qui sont disponibles à travers des moyens techniques divers.

Les thèmes exploités dans la cartographie dans les médias par exemple ont beaucoup évolué. Si dans un premier temps cela concernait davantage les questions politiques, économiques, maintenant se sont les questions environnementales, des questions de dangers et de risques, des questions de plus en plus proches des personnes qui peuvent être affectées. On parle alors de cartes souvent pleines d'informations et à partir desquelles les gens peuvent prendre des décisions. Donnons comme exemples les routes à éviter à cause de constructions ou de chaussées enneigées, les tempêtes, les feux, les inondations; il y a aussi la diffusion de schémas municipaux d'aménagement, la promotion de projets de développement. Dans le domaine des médias, certains journaux ont tellement créé d'attentes auprès des lecteurs que certains d'entre eux font des pressions pour que des cartes sur des sujets particuliers d'actualité y soient présentées.

Le domaine de la promotion touristique et de la publicité ne sont pas du reste. D'une part, les publications touristiques font preuve de beaucoup de créativité et d'intelligence pour vendre leur petit coin de soleil, de culture, de dépaysement. D'autre part, les entreprises, des plus grandes aux plus petites, ne manquent pas l'occasion de fournir non seulement de l'information sur leurs produits ou sur les services qu'elles rendent, mais aussi sur les moyens de les atteindre, notamment à l'aide de cartes souvent efficaces.

Internet met également à la disposition des utilisateurs de cartes des moyens extraordinaires de s'informer et de comprendre des situations souvent simples et parfois complexes. Puis, la mise sur le marché de cédéroms bien faits, faciles d'utilisation et utiles ne fait que commencer.

Cette présentation brosse un tableau de la situation. On y expose le concept de démocratisation, on traite de l'accessibilité aux données, de la disponibilité des outils, des formes de besoins et d'utilisation des cartes. On termine par un regard critique sur le design et la qualité des cartes.

1. Démocratisation

Regardons d'abord ce que signifie démocratisation. Si l'on se base sur les définitions officielles, démocratisation signifie l'«action de démocratiser». Par ailleurs, démocratiser veut dire entre autres «mettre à la portée de toutes les classes de la société» [Petit Larousse en couleur, 1980].

Dans le cas de la cartographie et des sciences touchant le territoire, la démocratisation signifie une plus grande accessibilité à la fois aux données, aux outils et aux moyens de diffusion de l'information. En général, ce sont les gouvernements ou les États qui sont producteurs et fournisseurs d'information. Et, c'est le public qui en bout de ligne devrait profiter de leur utilisation; c'est lui aussi, qui dans une certaine mesure, veut s'approprier cette information..

2. Des données plus accessibles

Fournir l'accès aux données est une question primordiale pour les organisations qui ont une mission de développent économique et social ainsi que pour le public qui devrait en profiter en bout de ligne. Ce ne sont pas uniquement les gouvernements qui sont les producteurs de données mais ils occupent une part importante dans le domaine. Les données produites par ceux-ci sont diversifiées et peuvent être utilisées dans une variété de secteurs. Le schéma mis au point par Paul Bernard [1996], relatif à l'IDD (Initiative de la Démocratisation des Données) au Canada, constitue un bel exemple de ce que pourrait être la diffusion des données dans un contexte de «Culture des données et de ses publics» (voir la figure 1). Il y présente six secteurs d'activité subdivisés en quatre couronnes concentriques dont le foyer est constitué du groupe d'utilisateurs ayant le plus d'expertise dans le domaine des données (les chercheurs professionnels, avec le chiffre 1); les autres ayant des niveaux d'expertise décroissant allant jusqu'à dix pour les usagers de services dans le secteur public.

Il semble que les États-Unis d'Amérique soient actuellement, parmi les pays du monde, les plus ouverts à l'utilisation gratuite des données. «La politique américaine en matière de données spatiales est établie dans deux circulaires de l'Office of Management and Budget (OMB A16 et OMB A130) et dans l'Executive Order 12906. Le gouvernement fédéral offrira gratuitement ses données ou n'exigera que le coût de la reproduction. Tout ce qui limite l'accès aux données est considéré comme mauvais. Pour la plupart des agences, les données spatiales sont gratuites à moins que la quantité à livrer en un même moment soit considérable (p. ex., > 50 Mb). Ceux qui reçoivent des données spatiales des agences américaines peuvent en faire des copies, les redistribuer ou les utiliser dans des produits commerciaux» [Goodenough 1997].

Actuellement le gouvernement canadien met à la disposition de la population des données que l'on doit payer; elles sont sur Internet ou sur cédéroms. Il y a eu une volonté de démocratiser les données, avec un accès gratuit, notamment pour les universités dans l'entente de 1996 de l'IDD, [Watkins and Boyko 1996], mais ce n'est pas disponible pour l'ensemble de la population. L'Atlas national du Canada a pris la liberté de mettre à la disposition de la population via Internet les données qu'il a lui-même produites ou aménagées; la décision fut ainsi prise surtout en raison des coûts qu'entraînait le soutien après vente. C'est un site Web couplé à un site FTP permettant la distribution de données géospatiales canadiennes. Les données sont disponibles pour téléchargement sans frais. Des cartographiques sont offertes à des échelles variant entre 1: 250 000 et 1: 30 000 000 et ce, dans une variété de formats. De plus, plusieurs types d'images satellitaires à pleine résolution sont disponibles en ligne [Canada 1999].

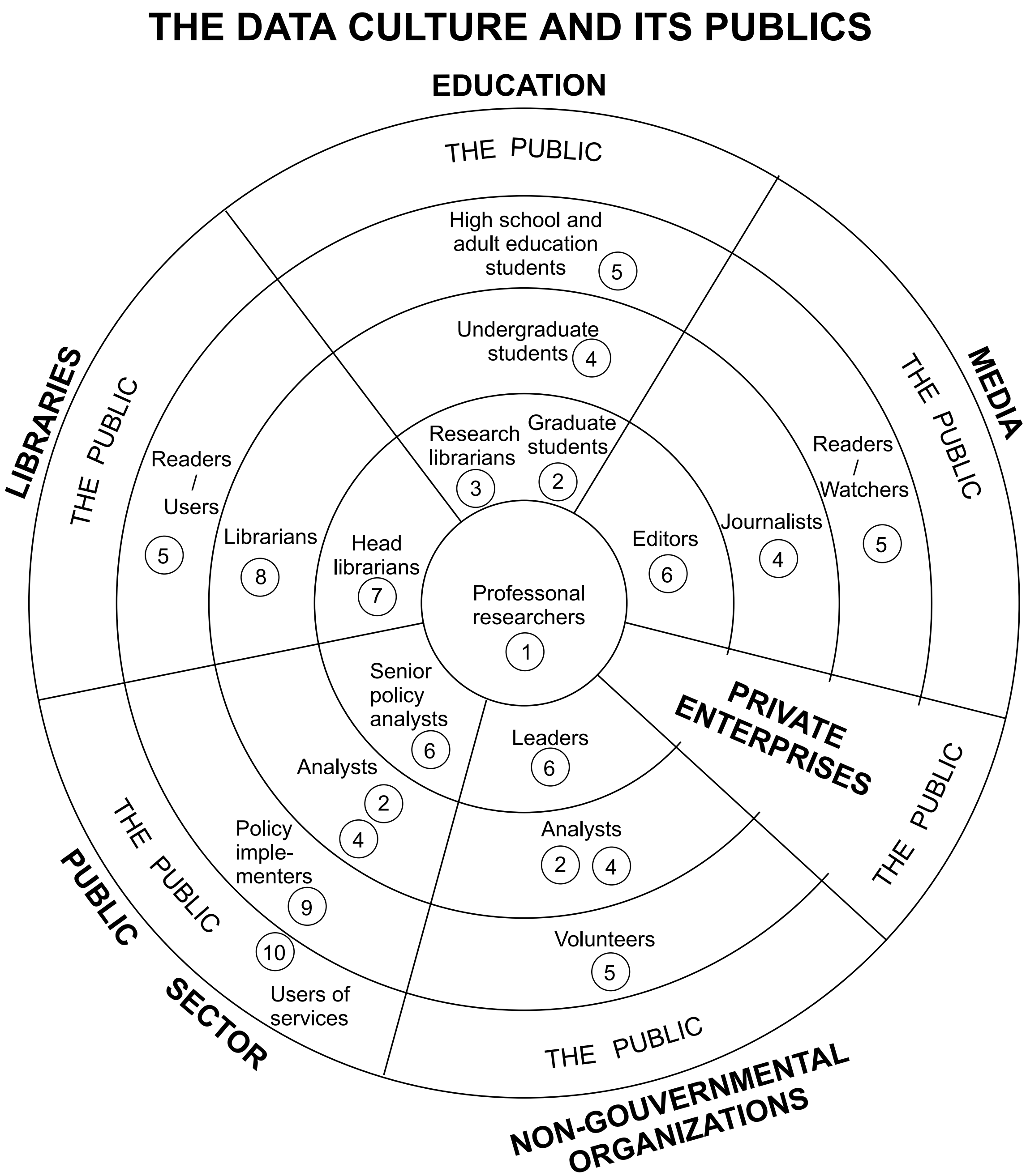

Figure 1. La culture des données et ses publics (selon Paul Bernard, 1996)

Dans le cas canadien, les données numériques, que cela soit des cartes de fond ou d Recencement du Canada ou les carte topographiques doivent être achetées par les utilisateurs (même à l'intérieur des différents ministères) [Goodenough 1997].

Somme toute, les données existent, mais il reste encore un bon bout de chemin à parcourir pour les rendre accessibles aux utilisateurs gratuitement ou à un coût minime. Des essais en cours peuvent ouvrir la voie à des développements intéressants.

3. Des outils plus disponibles

L'ordinateur est devenu un article de plus en plus répandu non seulement dans les organisations, les entreprises mais aussi sans les foyers. Par exemple si, 16% des foyers de France possédaient en 1998 un ordinateur et qu'aux États-Unis c'était 25% en 1995, au Canada pour la même année le taux s'élevait à 29% soit 3 fois plus qu'en 1986 [Dickinson 1996]. Jean-René Cazeneuve, cité dans un article du journal Le Monde, dit: «Mais la magie, c'est le volume»… … « Il se vend déjà plus de PC que de voitures et le chiffre d'affaire de l'informatique a dépassé celui de la télévision. En l'an 2.000, il se vendra plus de 100 millions d'ordinateurs dans le monde dont 50,% dans le grand public» [Alberganti 1998]. Les ordinateurs personnels sont de plus en plus performants; le seul problème c'est que les prix, bien qu'il soient à la baisse, ne sont pas la protée de toutes les bourses.

Les logiciels permettant d'utiliser les données, de les traiter et de les analyser sont plus nombreux et leur accès plus grand. En cartographie notamment, que l'on pense à ce qui est disponible gratuitement avec Office, que l'on pense aux logiciels de «desktop mapping» que chacun peut se procurer à des coûts relativement abordables, que l'on regarde les possibilités de faire appel à des logiciels «on-line» pour cartographier ses données. En infographie, les possibilités sont immenses pour illustrer de l'information géographique; habituellement on s'en sert pour fignoler les cartes. Il n'est pas inutile d'ajouter que les passerelles entre les logiciels s'avèrent utiles dans le transfert de données et de produits graphiques.

Les périphériques plus sophistiqués et à relativement bon marché se retrouvent même à la maison: «scanners», imprimantes de haute résolution par exemple. Les GPS prennent plus de place dans la confection des fonds cartographiques et pour les déplacements dans l'espace.

Il y a une politique, du moins aux États-Unis, pour s'entendre sur des normes en matière de métadonnées; d'autres pays comme le Canada devraient eux aussi mettre prochainement en oeuvre des communications grande vitesse MTA (155 Mb/s). À ce propos, les modems sont remplacés de plus en plus par le cable et la fibre optique.

4. Des besoins et des finalités plus exprimés

La consultation, l'analyse et la visualisation de données spatiales prennent plusieurs faciès. On a vu antérieurement que les secteurs Éducation, Médias, Bibliothèques, Secteur public, Organisations non-gouvernementales présentent une variété d'utilisateurs.

Il serait présomptueux de notre part de faire la liste de toutes les aires dans lesquelles les besoins d'informations spatiales s'expriment actuellement. Penchons-nous simplement sur certains cas qui semblent en plein changement.

Les médias sont de gros producteurs de cartes. Que ce soit dans la presse écrite, la presse télévisuelle ou sur Internet [Scharfe 1997]. Dans la presse écrite et à la télévision, les données diffusées sous formes de cartes couvrent des champs traditionnels comme la politique, l'économie, les sciences sociales, les voyages, etc. Ce qui a surtout changé au cours des dernières années, c'est la diffusion d'information proche des préoccupations des gens, celle qui leur permet de connaître la venue d'un événement particulier, de connaître les risques qui les guettent (les incendies et les meurtres en ville, les feux de forêt dans le voisinage, les détours routiers, les conditions de la chaussée en hiver, etc.) (voir la figure 2). Ceci est d'autant plus fréquent que les médias, même de taille modeste, ont maintenant du personnel qualifié et/ou font partie de réseaux capables de les alimenter [Gauthier 1997]. On a même vu un cas où ce sont les lecteurs du quotidien Le Soleil de Québec qui ont demandé au journal de publier une carte montrant la localisation d'un navigateur québécois en péril aux environs de la Terre de Feu.

Internet est sans doute le véhicule qui diffuse aujourd'hui la plus grande quantité de cartes. Les journaux, les magazines et les réseaux de télévision y ont souvent leur propre site où ils reprennent les cartes publiées dans leurs éditions de base. Internet a par ailleurs l'avantage de permettre l'observation d'événements en temps réel (météorologie) ou extrêmement collé au fil du temps; par exemple des sites Web polonais à Wroclaw ont permis de suivre le débordement de l'Odra d'une heure à l'autre. Comme pour la télévision, Internet offre la chance d'utiliser l'animation pour montrer l'évolution d'une situation.

Internet permet des échanges de données et de diffuser de l'information sous forme de cartes. Il s'agit de consulter le site Oddens's Bookmarks pour s'en convaincre. En plus de consulter des cartes mondiales et de milliers de coins de pays, on peut ouvrir des atlas électroniques comme l'Atlas du Québec et de ses régions [Carrière et autres 1997], et d'autres qui offrent la possibilité de créer ses propres cartes comme par exemple l'Atlas électronique du Massachussetts [Carnahan and others 199?].

Les cartes prennent une part des plus sensibles dans la promotion, la publicité et les affaires. Cela se produit surtout dans les domaines suivants: l'immobilier avec des plans de lotissement ou de localisation de projets domiciliaires; la restauration avec la répartition des établissements faisant partie d'un réseau; l'analyse de marché; ainsi que le commerce et les services où les représentants fournissent des cartes d'affaires avec la localisation de l'établissement au verso;

Les cédéroms occupent une place importante. Non seulement, sont-ils le support de banques de données diffusées par les producteurs de données mais aussi ils comprennent des systèmes d'information complets. Concernant ce dernier point, il faut souligner l'existence de systèmes de navigation qui permettent d'effectuer des interrogations de localisation, de trajet, des requêtes sur la durée des déplacements, leur longueur, et bien sûr, ils peuvent être couplés à un GPS [DeLorme Mapping 1997]. Ils contribuent par le fait même à la réalisation d'analyse de la part de l'utilisateur et à éclairer sa prise de décision notamment pour ses déplacements.

5. Tout n'est pas parfait.

L'arrivée de l'ordinateur personnel au début dans les années '80 a favorisé grandement l'éclosion de la production de cartes. Internet et les nouveaux supports de données comme les cécéroms ont par la suite pris la relève et donné un autre élan à l'utilisation des données spatiales et à leur cartographie. Tout n'est pas parfait. En effet, nombre de cartes pêchent par leur manque, de lisibilité, de clarté, de contraste. La symbolisation fait défaut, le traitement de l'information est trop simpliste ou trop complexe. Lors du Symposium tenu à Berlin en 1996, les participants ont même parlé d'«Infotainment» et de «Confugraphics».

Puisque tout et chacun produit des cartes, on peut se demander si toutes les règles liés à l'exactitude des données et à leur validité ont été respectées. Et, à ce propos, les cartes mises sur Internet en sont souvent des cas patents.

Conclusion

Les données géospatiales et les cartes sont de plus en plus accessibles pour toutes les couches de la société. Avec un minimum d'équipement, il est possible de consulter des données et des cartes. Aussi, il devient plus facile d'utiliser des données, de les exploiter, de les télécharger, voire même de les traiter, après coup, sur son propre ordinateur. Les moyens techniques s'améliorent, les logiciels sont plus variés et plus conciliables entre eux. Les besoins d'information géographique se font sentir à plusieurs niveaux; autant dans les organisations gouvernementales et municipales que dans les groupements sociaux, populaires pour qui les questions de développement social et économique sont importantes.

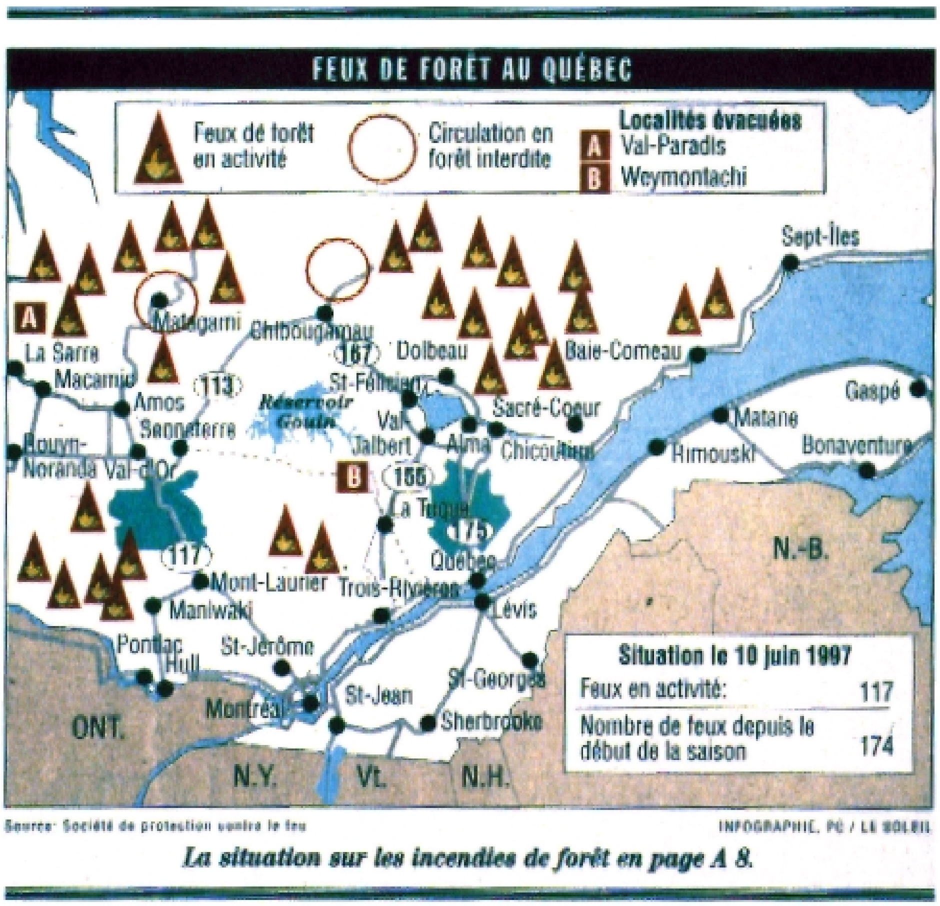

Figure 2. Feux de forêts au Québec (Le Soleil 1997). Carte publiée en couleur au moment où la province était la proie de plusieurs foyers d'incendie et où les dangers pour les populations étaient grands.

Il n'en reste pas moins qu'un danger nous guette. C'est celui d'être inondé par trop d'information et de picorer à tous azimuts. Les individus et les sociétés qui vont le mieux s'en tirer seront ceux et celles qui feront appel à la réflexion, à l'invention, au rêve, qui se fixeront des buts et qui passeront à l'action. C'est ce que Poole et Ethier [1998] appelle l'intelligence créative.

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The Field of Analytical Cartography: Scope, Contents and Prospects

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Abstract

Analytical Cartography offers a more conceptual, analytical, and mathematical approach to the field of cartography. Since its founding by Professor Waldo Tobler in the late 1960s, who defined the field as the "solving of cartographic problems", the specialization has continued to develop and mature during the last few decades. Analytical Cartography can be seen as the intersection of the fields of cartography, discrete mathematics, geography, computer science and image analysis. Two of the goals of the field are to extend the body of existing spatial theory, and to develop new conceptual theory. This paper will explore, and then proceed to provide a brief overview of the scope, contents, and prospects for Analytical Cartography.

Introduction

Analytical Cartography offers a more conceptual, analytical, and mathematical approach to the field of cartography. Since its founding by Professor Waldo Tobler in the late 1960s, who defined the field as the "solving of cartographic problems" [Tobler, 1966]. Of special note is Tobler's dissertation [1961] where he develops his concept of map transformations in geographic space. Later, Tobler [1979] extended this notion of cartographic transformations to explain the traditional cartographic map creation and reading process. At roughly the same time, the field of traditional cartography was in something of a quandary because the technological development of new cartographic products, mostly digital, such as spatial data bases, digital terrain models, and CRT display images, did not fit into the conventional definition of traditional hard copy cartography. This problem was clearly pointed out by Morrison[1974] in the premier article in the first issue of *The American Cartographer*, where he called for an expanded and extended definition of what constitutes a map. Moellering was confronted by a similar problem and began research on this problem pointed out by Morrison. Since then Analytical Cartography has continued to develop and mature during the last few decades. Analytical Cartography can be seen as the intersection of the fields of cartography, discrete mathematics, geography, computer science and image analysis as discussed by Nyerges[1980].

Two of the goals of the field are to extend the body of existing spatial theory, such as develop further uses and extensions of the sampling theorem, and other theory like it, and to develop new conceptual theory, such as Moellering's[1977] concept of real and virtual maps, and their applications. Several efforts in the field have begun to explicitly recognize these needs, such as Müller's [1991] book on the cartographic research agenda, some of which have touched on analytical cartography. Moellering [1991c, 1994] also recognized that the effort to develop spatial data standards identified a distinct need to expand analytical theory in an attempt to fill the huge conceptual gaps in it. An effort was begun by Moellering [1991a, 1991b] to fill in some of these gaps by organizing and editing a dedicated content issue of *Cartography and Geographic Information Systems* dedicated to Analytical Cartography. The realization that the field needs to make a major push to expand its theoretical base is well grounded in view of the theoretical limitations of computer horsepower to empirically or heuristically crunch numerical problems as has been initially articulated by Saalfeld [1999] in a presentation where he shows that problems of complexity and intractability of algorithms and computer processing are significant limitations to the solving of cartographic problems. Saalfeld shows that for problems that are NP complete and beyond, e.g. NP-hard, are not likely to be solved by more computer horsepower. Williams[1996] view of a "new era in cartography" in Australia, emphasizes expanding and adapting institutional changes in a similar context. It is clear that such changes are necessary to accompany the expanded need for further developing the cartographic and spatial theory discussed here.

Analytical cartography has a considerable overlap with Geographic Information Systems (GIS), with the primary differences arising in how the base of conceptual theory is directed and used. However, in the 1990s this situation was recognized by researchers in the area of GIS, and leaders such as Goodchild [1990] began to call for an expansion of the theoretical base of the field in what he called "Spatial Information Science." More recently Bergougnoux [1997] indirectly articulates this same need in the editor's opening statement in the premier issue of the new journal *GeoInformatica*. The limitations of expanded computer computational power as articulated by Saalfeld are perhaps more acute in GIS because much of the work there is more empirically based.

Fundamental Theoretical Concepts

The beginning point in the field of Analytical Cartography is Tobler's dissertation [1961] titled: "Map Transformations of Geographic Space", where he explores the concept of spatial coordinate transformations and how they can be used. In this novel and extremely creative research work, Tobler develops the concept of map, or spatial coordinate, transformations in a systematic way, and shows some of the ways such theory can be used. One outcome is the mathematical development of cartograms. He also shows that map projections are a special case of map, or spatial coordinate transformations. Later Tobler[1979] extended his ideas of cartographic transformations to conceptually explain the notion of the cartographic process as practiced by most conventional cartographers at that time. More recently, Palma and Benedetti [1998] have suggested this conceptual approach for use in GIS.

In the early 1970s Morrison recognized that the conventional definition of the map was clearly insufficient in light of the newer technological and computer developments in the field. In his article in the premier issue of the *American Cartographer*, Morrison [1974] calls for an expanded definition of what was at that time considered to be a map. Moellering took up Morrison's challenge by developing the concept of Real and Virtual maps [Moellering, 1976, 1980a, 1984]. This expanded concept of the fundamental nature of a map extended Tobler's original concept of map transformations to a new level, while at the same time answering Morrison's challenge for a new definition of a map that encompassed all of the new kinds of cartographic products being developed. In a nutshell, the concept of Real and Virtual maps is based on two crucial characteristics of maps and spatial data:

1) Whether it is directly viewable as a cartographic image; and

2) Whether it has a permanent tangible reality.

These two critical characteristics are then cross classified into a four class concept of Real and Virtual maps. They are defined as follows from Moellering (1980a):

Real Map - Any cartographic product which has a directly viewable cartographic image and has a permanent tangible reality (hard copy). There is no difference as to whether that real map was produced by mechanical, electronic, or manual means.

Virtual Map, Type I - Has a directly viewable cartographic image but only a transient reality as has a CRT map image. This is what Riffe called a temporary map. Given the direction of current scientific work, electrocognitive displays may be possible.

Virtual Map, Type II - Has a permanent tangible reality, but cannot be directly viewed as a cartographic image. These are all hard copy media, but in all cases these products must be further processed to be made viewable. It is interesting to note that the film animation adds a temporal dimension to the cartographic information.

Virtual Map, Type III - Has neither of the characteristics of the earlier classes, but can be converted into a real map as readily the other two classes of virtual maps. Computer based information in this form is usually very easily manipulated.

One can then extend Tobler's concept of cartographic transformation in a very real way to realize 16 Real/Virtual possible map transformations [Moellering, 1984]. The following seven examples can be easily recognized:

Real ==> Real - conventional cartographic processing

Real ==> Virtual 3 - digitizing spatial data and storing it into a digital data base

Virtual 1 ==> Real - making hard copy image of a CRT screen image

Virtual 3 ==> Real - digital cartographic plotting/drawing from spatial data base

Virtual 3 ==> Virtual 1 - CRT display of digital spatial data from computer hard disk to CRT

Virtual 1 ==> Virtual 3 - CRT screen editing spatial data stored on computer hard disk

Virtual 2 ==> Virtual 3 - reading digital data from CD-ROM and storing it on a computer hard disk

Virtual 3 ==> Virtual 3 - mathematical transformation of digital spatial data resident on computer hard disk. These are sometimes called Tobler's transformations.

The other eight transformations are defined [Moellering, 1984] and many have practical uses. Together, these 16 Real and Virtual map transformations define **all** of the cartographic and spatial data processing processes steps that exist in cartography, and the spatial data sciences. In fact, Virtual 1 and Virtual 3 transformations are the key to the understanding of the operation and running of cartographic data processing systems [Moellering, 1984].

A second major concept in Analytical Cartography is that of Deep and Surface Structure in cartography as developed by Nyerges [1980]. Here Nyerges takes the basic notions of Chomsky's[1965] structural linguistic syntactical relationships, adapts them over to cover spatial data relationships, and then relates them to Real and Virtual maps. Here surface structure in a cartographic setting becomes cartographically displayed spatial data (Real or Virtual 1 form), while deep structure becomes spatial data and relationships stored in a nongraphic (usually digital) Virtual 3 form on some kind of magnetic media. Now one can see cartography in a new conceptual light, and realize that 99 percent of cartographic work, since the Babylonians, has dealt with cartographic surface structure. Analytical Cartography deals primarily with spatial and cartographic information in the Deep Structure domain, usually in a Virtual 3 form. Hence, we can now realize that Analytical Cartography dealing with Deep Cartographic Structure is the "New Half" of the field that has been operating since its founding by Tobler in the early 1960s. Now one can see much more clearly the research opportunities offered by Analytical Cartography in terms of its conceptual definitions in Deep/Surface spatial structure, and in terms of Real and Virtual maps.

A third fundamental concept developed by Nyerges [1980] is the notion of cartographic data levels. He saw that when one is dealing with spatial data, that it exists at several levels of abstraction, now known as Nyerges' Data Levels. Nyerges clarified what up until then was a very confused situation in cartographic data, and in the spatial data sciences in general. This work has resulted in a six level definition of cartographic data structures defined by Nyerges [1980] as follows:

Data Reality - The data existing as ideas about geographical entities and their relationships which knowledgeable persons would communicate with each other using any medium for communication.

Information Structure - A formal model that specifies the information organization of a particular phenomenon. This structure acts as a skeleton to the canonical structure and includes entity sets plus the types of relationships which exist between those entity sets.

Canonical Structure - A model of data which represents the inherent structure of that data and hence is independent of individual applications of the data and also of the software or hardware mechanisms which are employed in representing and using the data.

Data Structure - A description elucidating the logical structure of data accessibility in the canonical structure. There are access paths which are dependent on explicit links..... Those access paths dependent on links would be based on tree or plex structures such as network models. Those access paths independent of links would be based on tables as in relational models.

Storage Structure - An explicit statement of the nature of links expressed in terms of diagrams which represent cells, linked, and contiguous lists, levels of storage medium, etc. It includes indexing how stored fields are represented and in what physical sequence the records are [sic] stored.

Machine Encoding - A machine representation of data including a specifications of addressing (absolute, relative or symbolic), data compression and machine code.

Although other general spatial data models with fewer levels have been discussed in the literature [Peuquet,1984], Nyerges' six level data model is still the best for both conceptual understanding, and for pedagogic purposes, because it provides for explicit specification of data levels as a spatial information system carries out its Real/ Virtual map transformations.

In order to store digital encodings of spatial objects that are digital representations of real world entities, these fundamental spatial primitives and objects must be defined and specified. This primitive and simple objects serve as fundamental digital building blocks of spatial data structures in Virtual 3 spatial databases. Although the basic spatial dimensionalities have been sorted out relatively early by Bunge [1962] and Nystuen [1963], the definition and specifications of digital primitive and simple objects remained illusive. In the U.S., systematic work to specify a unified set of spatial object primitives began in earnest with the founding of the U.S. National Committee for Digital Cartographic Data Standards in 1982 [Moellering, 1982], that after five years of detailed scientific work developed a full set of 0-, 1-, 2-D spatial primitive and simple objects which became the conceptual heart and soul of the American Spatial Data Transfer Standard [NCDCDS, 1988], now known as Federal Information Processing Standard (FIPS) 173-1. These 0-, 1-, and 2-D spatial primitive and simple objects can be used to construct almost any kind of digital spatial data objects from zero through three dimensions. However, more work is needed on the more exotic 3-D primitives and the relative topologies associated with them.

One of the simplest, most basic and most important pieces of fundamental spatial theory is the sampling theorem. This theorem specifies desired sampling intervals in one and two dimensions for sampling along a linear object such as a line, or an areal object such as a surface. The equation of Delta= ½ Lambda, where Delta is the resulting theoretical sampling interval, and Lambda is the finest assumed spatial wavelength in the 1-D or 2-D object being sampled. This seemingly simple equation is the theoretical key to all questions of resolution and spatial sampling. Proper use of this fundamental piece of spatial cartographic theory facilitates the proper use of sampling, interpolation, neighborhood operators, pixel resolution and a host of other applications. The sampling theorem was originally borrowed from mathematics, and the above equation is intended to be used in a regular segment or cellular setting. Later, Tobler[1984] showed how average resolution could be approximated in an irregular polygonal domain with the concept of resels.

Every entity exists in both space and time, but time is usually recorded as a single fixed temporal point. However, time moves on as one moves through the time/space continuum. Research work in recent decades has recognized that time is a continuum, and has tried to develop various strategies to record time that way in one dimension, in a manner analogous to the way we treat space in two or three dimensions. Early workers in dynamic cartography [Tobler 1970, Moellering, 1973] recognized this fundamental temporal characteristic of spatial data when they created their spatiotemporal [Moellering, 1973a, 1980b] computer animated displays. However a special animated spatiotemporal display is different from designing and building a Virtual 3 spatial database system that records and handles more than one point in time for specific entities encoded in that spatial database. Peuquet[1999] has researched temporal aspects of spatial data systems and is raising this challenge to the conceptual community. Most workers conceive of time as a linear thing, but Moellering[1973a] has realized that one can treat time as a circular variable when analyzing certain spatial variables such as traffic crashes. In that piece of research in analytical visualization time was treated as a circular variable based on the day of the week. The results of this time transformation was an extremely effective spatiotemporal display [Moellering, 1973b]. Other such temporal cycles are theoretically possible.

Specific Theory in Analytical Cartography

From the fundamental theoretical concepts presented and discussed above, one can see a host of more specific pieces of mathematical spatial theory flow from them. Many of these pieces of spatial theory were originally developed in mathematics, statistics or other systematic sciences, and have been brought over and adapted for uses in Analytical Cartography and the other neighboring spatial data sciences. In this following section an effort will be made to touch on the more important pieces of spatial analytical theory, while other items of lesser importance must be passed over. It should be recognized that much of this early adaptation work in Analytical Cartography has been done by Tobler himself.

One of the most general concepts is that of how one conceptualizes a spatial 2-D surface. If one takes the sampling theorem seriously, then one can conceptually view spatial surfaces from the point of view of spatial frequencies. Spatial surfaces can be conceived of being made up of many different spatial frequencies, each of which has its particular wavelength, magnitude, and orientation. Added together, any spatial surface is composed of perhaps hundreds of spatial frequencies. Each particular frequency contributes its part to the overall mathematical definition of the surface. Hence, any operation carried out on the surface, regardless whether it is quantitative or visual, has some effect on the surface by altering the spatial frequencies contained in it. This conceptual and theoretical view of spatial surfaces then serves as a conceptual foundation for many of the other pieces of spatial theory that are discussed below.

The first of these is spatial neighborhood operators that can be designed to operate on any kind of regular or irregular topologically well behaved set of polygons. Tobler brought the concept for the regular cellular domain in from Holloway[1961], which was the early bible of quantitative neighborhood operators to the early researchers in the field. Holloway showed clearly the relationship between the data domain and the spatial frequency domain, and how neighborhood filters could be designed and used on spatial surfaces. Although Holloway's work focused on regular cellular structures, both square and hexagonal, his work proved to be singularly instructive to the field as articulated by Tobler. Now, clearly, the effects of quantitative neighborhood weight field operators could be understood in terms of the theory of spatial frequencies. However, a big limitation to Holloway's work is that it does not work in the domain of irregular polygons. Guptill[1978] showed how such neighborhood filters could be designed and used on nominally scaled data using a weighted probability approach for the neighborhood operator.

Fourier theory is an explicitly mathematically defined piece of theory that can calculate the wavelength and magnitude of spatial frequencies in a regular cellular defined surface of Z values. Fourier theory is rigidly tied to the sampling theorem in terms of how it calculates, resolves and approximates the spatial frequencies, wavelengths, magnitudes, and orientations in a spatial surface. If a particular candidate surface in question meets the cellular, mathematical and continuity assumptions required, then the researcher can straightforwardly calculate the spatial frequencies and magnitudes resident in a spatial surface. Both Tobler[1967] and Rayner [1971] were early researchers in this area, and adapted much of the mathematical theory to Analytical Cartography and the spatial data sciences. Dougherty and Moellering [1996] have shown how Fourier analysis can be used to calculate signatures for numerical terrain types. However, the problem remains that generally Fourier frequencies and magnitudes cannot be calculated in an irregular polygonal cellular approximations of a surface. One exception to this problem is the work of Moellering and Tobler [1972] where the relative average magnitudes were approximated as increments of a variance spectrum in a hierarchically defined system of irregular polygons which has an a priori fixed hierarchical structure that meet some additional spatial constraints.

Information Theory is a concept that holds much promise for Analytical Cartography. The concept is usually employed as an entropy measure of some spatial distribution. Entropy is usually reckoned for a parameter H of some kind of spatial distribution that is being optimized. The great theoretical advantage of entropy measures is that they are what is distribution free statistics, whereas most least squares measures, such as those used in geography, surveying and geodesy are assumed to have a Gaussian parametric distribution. It can be shown that many spatial statistical quantitative Z distributions do not have a normal Gaussian parametric distribution, and if not corrected, can severely bias the results of the analysis. Entropy statistics are distribution free, meaning that there is NO underlying assumed base statistical distribution. Hence, the resulting entropy statistic, usually H, cannot be biased by a strange underlying statistical Z distribution. Wasilenko and Moellering [1977] showed how this approach could be used to calculate better choropleth map classes. The entropy statistic could also be used to approximate a range of how many data classes are suitable for a particular Z distribution. Other entropy models have been used in Analytical Cartography.

Fractional Dimensions, known as fractals, play an important role in Analytical Cartography. Fractals, a spatial adaptation of the mathematical definition of the Hausdorff-Besicovitch measure of spatial dimension. Most cartographers and spatial scientists conceive of things in the real world as having integer 0-, 1-, 2-, 3-, etc. fixed physical dimensions. Hausdorff-Besicovitch have shown that spatial phenomena in the linear and areal domains can be conceived of having dimensionalities that are decimal numbers. This spatial work with fractals was initiated by Mandelbrot [1967], a mathematician, with an article titled “How Long is the Coastline of Britain?”. This insight stimulated several researchers to become interested in the potential for fractal theory in Analytical Cartography. Goodchild [1980] looked at the use of fractals for the analysis of physiographic surfaces. Shortly thereafter Shelberg, Moellering and Lam[1982] presented what has become known as the “Shelberg Algorithm” to the discipline, which can be used to measure the fractional dimension of lines analytically. Later Quie[1988] utilized this theory on the coastline of Louisiana, while Outcalt[1994] more recently analyzed some landscape physiography. Fractals can be measured for both regular and irregularly partitioned lines and surfaces.

One of the more interesting ways of analyzing surfaces is to determine the mathematically critical points and lines on the surface where the first and second spatial derivatives are zero. A careful determination of these critical points and lines can then be used to collect them together in a topologically systematic way to construct the topological skeleton of the surface. The formal name of this topological skeleton of a surface is called a Warntz Network, after William Warntz [1966], who proposed the concept. Warntz Networks provide those in Analytical Cartography with a powerful tool to analyze such surfaces, and with this tool such things as visibility, line-of-sight and slope/gradient can be straightforwardly estimated. Peucker and Douglas [1975] and Toriwaki and Fukumura[1978] developed and tested pass location algorithms to assist the building of Warntz Networks. More recently Wilcox and Moellering [1995] have presented a new and more efficient Wilcox algorithm which more effectively assists in the building of Warntz Networks. It should be noted that the basic topological theory still appears to have some gaps in it, and needs more deeply theoretical work before such approaches are complete.

Polygon analysis is a very broad and wide ranging area of research in the field. Most of the early work in the spatial sciences on irregular cellular data was accomplished by interpolating back to regular square cellular systems where the standard mathematical theory usually worked. See for example Lam[1983]. However, in recent years research has been carried out to extend the theory from regular cellular analysis into what is known as the irregular domain. This thrust has resulted in the development of some spatial neighborhood operations that work in the irregular domain. Early work by Tobler[1973, 1984], and Chen[1986], Rhynsburger[1972] and later Gold[1999] for Thiessen and Delunay polygons. Wagner[1988] analyzed the polygon overlay process and found that there are at least 34 different cases of how irregular 2-D polygons could overlay each other. This finding lead to the realization that several of the leading polygon overlay algorithms, Goodchild[1979] and Miyashita, et.al[1985] were theoretically insufficient because they did not take into account all of the topologically possible cases of polygon overlay. This could produce errors in output and empirical results.

Shape analysis has always been an illusive analytical challenge to the field. Early work to develop single parameter measures of shape, usually the compactness characteristic, were theoretically deficient because their units of measure do not cancel. Good measures are dimensionless and have a numerical range from 0.0 to 1.0 (and sometimes -1.0). Moellering and Rayner[1979] reviewed these measures and found most of them wanting. They then went ahead and developed an analytical measure of shape based on Fourier Analysis in the complex domain that is mathematically robust. This measure called Dual Axis Fourier Shape Analysis (DAFSA) developed by them [Moellering and Rayner, 1982], is independent of location, orientation, scale, number of points and the beginning of the string of points in the outline. With this DAFSA analytical approach to shape analysis, they showed how to calculate a variance spectrum of any closed shape. These frequencies and magnitudes could then be used to interpret the mix of spatial frequencies that make up the outline of the shape, this time in the complex 2-D domain. Their paper, presented at the Tokyo ICA Congress in 1980, analyzed the outline of the island of Hokkaido, for example. Shortly thereafter they developed an analytical approach to measure the shape correlation between two closed outlines. This measure, known as DAFSA harmonic correlation, and coefficient of determination, is analogous to the Pearson correlation coefficient and coefficient of determination in statistics. The DAFSA shape correlation coefficients range from 0.0 to 1.0 and are interpreted in the same way that the Personian coefficients are.

The challenge of cartographic map generalization has existed in the field of cartography for centuries. In recent centuries more systematic graphic approaches were developed in the form of graphic rules for the production of Real maps. With the development of digital computer systems in the last five decades, more work has been devoted to developing numerical approaches to map generalization. It should be said that this is a very complex cartographic problem worthy of the attention of some of the best minds in the field. Most of the work so far has resulted in the development of numerical algorithms and some numerical measures which have a rather shallow base in the theory. This is primarily because most of the work in cartographic generalization has taken place in the surface structure realizations of the cartographic imagery, rather than down in the deep structure where most of the mathematical analytical theory probably resides. Several numerical algorithms have been developed that are widely utilized, such as that by Douglas and Peucker [1973]. Peucker's [1976] paper to describe the underlying concepts are based on geometric surface structure properties. However, a more conceptual approach is slowly developing for this very complex and vexing problem. Brassel and Weibel[1988] have begun to specify a more conceptual base for this work, although much of it is still in the surface structure domain. Weibel [1992] has begun to make some real theoretical progress with the generalization of terrain surfaces by building an approximation to the local Warntz Network of the surface, and then making analytical modifications to it and the resulting skeletal structure of the surface. This approach shows some real analytical promise. Müller, Weibel, LaGrange, and Salgé [1995] have reviewed the state of the art in cartographic generalization, and have provided some interesting insights. This work is the first of a book [Müller, LaGrange, and Weibel, 1995] on generalization that illustrates the general state of the art in the area. It is clear that progress is being made on this problem that has challenged cartographers for centuries.

Analytical visualization is an area that most people would view as an oxymoron of a scientific term. In the area of analytical visualization, technology from the surface structure is combined with some sort of analytical concepts or theory from the deep structure, that result in a visualization process that is an advance over what existed before. The seminal article by Horn[1982] describes the progress in visualization since the early days in both cartography and in computer graphics, a unique appraisal of two sets of literature from two separate disciplines. It turns out that one of the earliest pieces of research on cartographic visualization is Wiegel[1878], who provides the mathematical equations for calculating gray level reflectance on spatial surfaces at a point. Much later, work by Brassel[1974] continued this line of work on gray level relief shading of terrain surfaces, which even began to develop some equations that took into account atmospheric variations in mountain areas. More recently Moellering and Kimerling[1990, and Moellering, 1993] have developed a mathematical approach to terrain illumination utilizing color hues that preserve the perceptual relief effect, and eliminate the well known directional bias of gray shading. For their ground breaking work they were awarded two patents by the U.S. Patent Office (Nos. 5,067,098 and 5,283,858) for a process now officially known as the MKS-ASPECT™ SLOPE-ASPECT COLOR SURFACE RENDERING PROCESS. Another example of analytical visualization is work going on in true 3-D digital stereoscopic display [e.g. Moellering, 1989, 1990a, 1990b, 1991d].

Summary and Conclusions

Unfortunately there is not room to discuss many other topics that are important to Analytical Cartography. They include spatial data schema design, spatial data models and structures, and spatial query languages, to name a few. These have been left to a future discussion because these areas have seen much development in the fields of GIS and computer science, perhaps more than in Analytical Cartography.

However, one can clearly see that the breadth and depth of Analytical Cartography is substantial, associated with the opening up of the potential of the deep structure of cartography. This has greatly contributed to the theoretical and conceptual growth and development in the field of Analytical Cartography. Although much progress has been made in the last four decades, one can clearly perceive the opportunities for theoretical and analytical research in the coming years.

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What definitions are needed in cartography?

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Abstract

Present state of defining in cartography is characterized by a stagnation caused by shaking of some hitherto existing notions through development of map elaboration technology. In practice, traditional understanding of notions including map notion is still in use. Author, on example of map mostly, shows the need of their redefining and formation of definitions creating a certain system with global map definition.

Introduction

Among cartographers an aversion to more precise defining of used terms is lately seen, especially with reference to maps.We can say, that modern cartographer is more interested in answer to question „how to make a good map" and „how to use a map" than „what is a map". This empirical and practical orientation of cartographic thinking is rather justified. Development of cartography during last three decades has been executed thanks to application of new technologies mainly. Technological problems attracted the attention of research workers and overshadowed other aspects of cartography. New technology blew up also old map forms. Cartographers are convinced, that this process did not reach its end and therefore the moment of notions codification did not appear. It seems, that some cartographers have lost certitude, what is a map and they prefer not to take up this problem.

Independently from the above, language specification is hampered by opinion, that readers understand the text like its authors. Some think groundlessly, that they themselves understand completely created and used terms and that an ostensive definition is sufficient: map, as it is, everybody sees. This condition was perceived by some cartographers, what is testified by publications, among others, of A. M. Berlyant (1995), Y. Chen (1997), A. Makowski (1997) and H. Schlichtmann et al. (1995). Here is to be mentioned formation of working group for definitions at International Cartographic Association and the advanced research on dictionnary of cartographic terminology in Germany [W. G. Koch, 1997].

Meanwhile during attempts of defining we get to know helpfulness of created and used notions, namely if these notions are adequate with defined objects, if they determine sharply objects extension, if they are compatible with other notions and if they form together a system. Briefly, if they are suitable for communication and construction of science language. Importance of defining refers also to object itself, because during defining we can ascertain, to what a degree this object may be separated from surroundings.

General principles and types of defining

Looking for answer the question „what definitions cartographers need" we ought to notice the external conditions of defining process itself. Here belongs language, in which definition is created. I mean on the first place ethnic languages, in which corresponding terms may have somewhat different meaning. It is felt during translation from one language into another and at comparison of definitions of the same object expressed in different languages.

Within an ethnic language, a language of a given branch is also involved, e. g. language of cartography, psychology or linguistics. On one hand, these languages are characterized by semantic differences: the same terms may have different meaning. On the other hand, between languages of related branches exists an interaction: language of branches more advanced methodically and theoretically influences language of less advanced ones, what is visible, among others, in borrowing of terms. Hence, we must remember, that every branch has formed its own terminology of determined meaning. Hence, there is a need to take care in transfering more detailed terms from one branch into another.

To external conditions of defining belongs also the way of object being. As it was mentioned, some of objects may have not sharp enough extension and their defining faces difficulties. Moreover, the influence of object knowledge and the way of interest in this object is to be noticed, e. g. historian of cartography will define the map differently than user of geographic information system.

As is well known from literature, there are many definition types of different extensions and aiming to different goals. In this simplified review of these definitions one should mention on the first place real definitions concerning existing objects. These definitions in their classic form designate object extension (definiendum) by indication of one or a set of features (definiens), separating this object from a larger extension (genus proximum). Classic definitions are formed by features analysis of these objects, which we plan to define. They create language of science branch interested in these objects and have truth or falseness property. We admit, that a definition is true, if in its extension are objects having given features only and solely.

The most valuable definitions indicate object by determining a feature characteristic for this object only, i. e. feature creating this object. From constituting features one may deduce secondary features of object. However, object often is defined by mentioning its several features. It happens, that some of these features belong not only to the interesting object and because of that they determine it together with other features only. Such a way of defining leads to lengthening of feature list, more or less accidental. Consequently that definition becomes less readable and acquires the character of external description. These definitions have smaller cognitive value.

In case of object divided into parts, real definitions may have global or subordinated character, i. e. concerning particular object units. Subordinated definitions together with global ones form a system of definitions more or less developed, according to multibasic division and multigradual classification. Regarding the extension, real definitions may have more or less distinct limits. In this case we admit existence of elements, about which it is difficult to decide, if they belong to defined object or if they are beyond its extension. This case is illustrated by Figure 1.

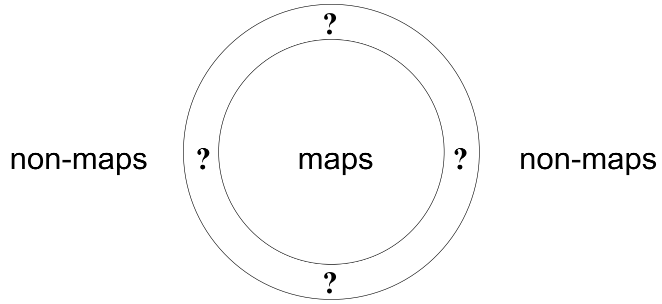

Figure 1. Map as object with indistinct limits.

Besides real definitions of reporting character one creates projecting definitions, which aim at determining features of objects newly formed or modified. Here belong also regulating definitions which set up standards for objects. They are used in technical instructions and in law documents. Their translation into real definitions is not always full and requires examination of new object features.

The real definitions are completed by nominal definitions. While the first ones have form „map is ...", the second ones sound „under the term map one understands ...". The nominal definitions refer immediately not to object examined by a branch, but to signs of natural language. Hence they belong to metalanguage of this branch. It occurs, that these definitions are used to determine objects and then their function does not differ from real definitions. We speak then about nominal stylization of real definition.

Nominal definitions play a great role in language formation both in practical and scientific activity. They are formed, if there is a need to state precisely the hitherto used terms or a need of new terms introduction. It takes place, if during research we come to the conviction, that a new notion creation is necessary. For this notion we make inquires about new sign, generally in a shape of a noun. Then we define this noun by designating its features and extension.At the end one ascertains, if the formed definition is compactible with definitions accepted already in the branch.

Present state of map defining.

In light of the above principles let us try to present and estimate the way of map defining predominant in manuals of cartography. Generally, map is defined here as representation or image of object situation on the Earth surface or other celestial body, in a graphic way, diminished and mathematically determined. On stresses as well symbolic and generalized character of this representation. Similarly the map definitions sound in cartographic literature before informatic revolution, as well as working definition accepted during 10th General Assembly of International Cartographic Association in Barcelona, 1995 [International Cartographic Association 1996]. Preservation of this form during such a long time shows a superiority of map pattern perceived visually in cartographer's consciousness and conviction, that this is a typical map form.

On the other hand one mentions in cartographic literature new kinds of maps, such as numeric-, mental-, hiper-, tactile-, sonoric-, electronic-, virtual-, interactive-, dynamic-, animated map etc. These new kinds of maps are not always defined precisely. Their authors are satisfied with descriptions, which sometimes differ one from another. Estimation of these definitions faces difficulties, because authors of definitions do not mention, what kind of definition they had in the mind. No doubt, that they aim at subordinated definitions, however without reference to global map definition.

In case of definitions in cartographic manual one should expect, that they concern definition including all maps. This supposition proved however not to be entirely true, because map defined in such a way does not embrace object called commonly as maps, among others old primitive maps using inscriptions only, and at present – maps recognized by touch and ear, as well as topographic data bases registered on disc, acknowledged sometimes as new map form. Hence, it seems, that present state of map defining is characterized by lack of compact map conception, what is presented with simplification in relation to map type „representation" on Figure 2.

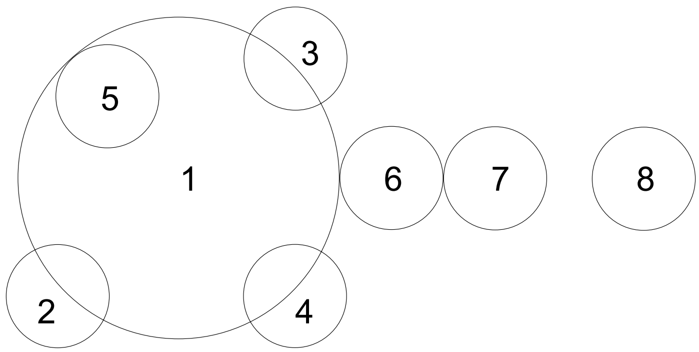

Figure 2. Simplified image of present map defining state.

Extensions of some topographic information means called „maps" in cartographic literature: 1 – representations (symbolized images), 2 – primitive maps, 3 – tactile-, 4 – electronic-, 5 – anamorphic-, 6 – numeric (digital) maps, 7 – topographic data bases, 8 – mental maps.

Which definitions are needed in cartography ?

Remarques as above make base for answer the introductory question concerning defining in cartography. In creation of definition one should, before all, take care to express this definition in language of cartography. Borrowing from related branches is inevitable and undobtedly contributes in development of our branch language. However borrowed terms must be defined anew on the ground of cartography. For instance, one should define what means „grammar" or „syntax" in application to map. If this attempt is not succesful, usefulness of these borrowings in cartography will be insignificant. Here one ought to notice, that cartographic terms transfered on the ground of other branch change their meaning too, e. g. terms „map" and „mapping" in mathematics and in psychology.

It is selfevident, that for creation of our branch language we want many types of definitions, that compose, as the need arises, less or more extended systems. There are necessary both real definitions concerning produced and examined in cartography objects , and nominal definitions concerning expressions of cartographic language. Purposeful application of these definitions is also indispensable.

Global map definition ought to be completed by definitions of maps in a given place and time. Real and nominal definitions, which reported respectively about object features or about way of term understanding should be accompanied by projecting and regulating definitions. They suggest or impose conditions, which must be fulfiled by defined object or they establish meaning of the terms used by authors. Elaborated map may not correspond entirely to project principles, however projecting and regulating definition gives a reference to estimation of this elaboration. We may not agree to arbitraryly projected meaning of term, but its definition is necessary for understanding the author's reasoning. Hence nominal definitions are inseparable part of each cartographic research work and practice. This way one introduces new notions into our branch language.

The greatest importance for cartography itself and for its contacts with other branches have real definitions of maps with global map definition - concerning the concept of map - at the top. Cartographers need such a global definition, which comprises all maps produced in any place and time and which is opened, in a measure, on map in future. Meanwhile determining this definition faces difficulties presented visually on Fig. 2.

Searching after this definition we start from mentioned above classic principles of defining. At first let us try to find an object having wider extension and comprising all objects called at present „map". Because of great differentiation of these objects one must take „means of information" as „genus proximum". Similarly as „differentia specifica" an equally large separating feature is found, namely „comprising information on objects situation on the Earth's surface". Consequently global map definition reads as follows: „map is a medium of information about objects situation on the Earth's surface".

It is easy to notice, that according to this definition one would find between maps not only means considered nowadays to be maps, but also descriptions of objects situation in natural language, as well as pictures representing terrain view. Meanwhile these means were never counted among maps. What is more, maps came into being and were formed in opposition to these means. Hence in this definition inhere some internal discrepancies. Therefore description and picture can be used as negative criterion to test every newly suggested global definition. Namely, each global map definition, in extension of which was description in natural language or picture would be false.

Comparative analysis of features of map, description and picture leads to detection of an essential difference between these means. Namely, this difference depends neither on kind of signs, nor on way of their transmission, but on structure of sign set. This structure may be therefore the feature sought for separating maps from other means of information and specifying the map extension. Constructed on this base global map definition reads as follows. Map is a set of signs, which informs about objects position on the Earth's surface only and solely by means of disposition on plane of signs denoting these objects. Global map definition and subordinated definitions should form a system based on principle of containing subordinated definitions into superior ones.

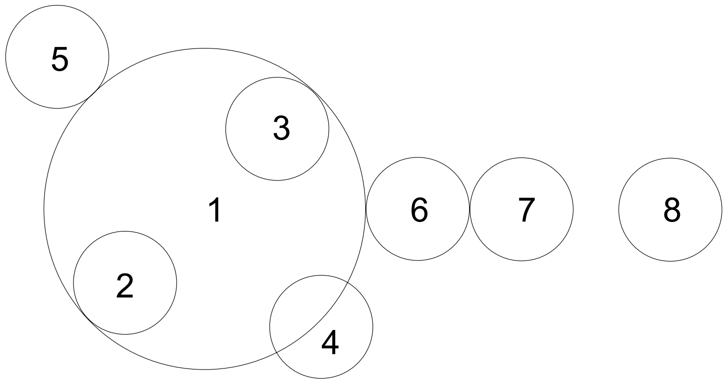

Figure 3. Map extension according to structural conception.

1 – maps, 2 – primitive maps, 3 – tactile maps, 4 – electronic means of topographic information, 5 – anamorphoses, 6 – numeric (digital) means of topographic information, 7 – topographic data bases, 8 – mental topographic representations.

Structural concept of map has been presented comprehesively in book „Polish Cartography", published on the occasion of the XIXth International Conference in Ottawa 1999. According to this conception (Fig. 3) among new kinds of means called maps in map extension come tactile maps, whereas besides this extension are mental and anamorphic maps, as well as numeric maps understood as topographic data written on disc. As concerns „mental maps" I suppose, that this term understood as „a set of representations of spatial relation in mind" does not belon to language of cartography, but to that of psychology.

Facing the persisting map development one should expect, that also in future may appear new forms of information media claiming to name „map". Veryfying procedure would consist on test, if these forms are contained in the extension of the global definition. If test is negative, one should try to enlargen the extension of the global definition, according to the rules of definition construction. If this trial fails, one has to resign calling this form „map", at least on the ground of cartography.

Defining in cartography is therefore a process, whereas arrangement of definitions is a part of arrangement of cartography language. By means of this language we acquaint examined reality and we construct theoretic base of our branch. This process should accompany constantly technology development in order not to lose control on cartography langugage. Improvement of this language should go together with map language improvement, which is already object of cartographers' care.

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Session / Séance 16-A

Revitalising interest on History of Cartography

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Abstract

It is more or less evident these days that the interest about History of Cartography (HoC) is focused either on its pure historic domain or on issues related with old map collection, and care. The traditional richness in treating issues of HoC from a manifold of points of view with origins in the generating disciplines of map-making (e.g., geography, geometry, astronomy, geodesy, navigation and their modern counterparts and machinery) seems to decline in front of the vitality and stress put into this field by historians, map collectors, map curators and distinguished well prepared amateurs and merchants. A consequence of this, is the image which is developing, that HoC does not more concern cartographers or scientists from affine fields of mapping sciences; in a less pessimistic case, their involvement is considered as a minor or supporting contribution. But can this image be true in the substance of the matter or is a false reflection of cartographers' massive devotion to new technologies and skills? Is contemporary cartography interested to conserve its cultural roots and heritage which was for centuries a well preserved privilege? In this paper, some ideas and examples are given in how contemporary cartography could re-organise and revitalise actions in the field of HoC refreshing interests in this traditional area of cartographic thinking and analysis by using some of the available new tools and practices. An action plan for this is presented. As examples some cases are treated in order to illustrate

how it is possible to use efficiently the digital documentation and visualisation techniques, mainly through multimedia, in order to spread cartographic heritage to larger audiences, network map libraries, take full advantage of the internet etc. Or how it is possible to classify and use concrete and well defined analytical methods in discovering the many times hidden geometry background of historic maps and significant patterns which allow the extraction of 'signature'-type features helping the interpretation and evaluation of cases with ambiguities in historic map classification. In addition, a proposal is made for proper reform in cartographic curricula as far as the teaching of HoC is concerned in order to unveil and revisit the intrinsic relation which exists between the generating sources of map making with the map per-se. This relation offers always integrated insights in studying HoC in association with factors which strictly interest History namely the social, economic, political and ethical ones.

The Current Interest in History

There is a general feeling, in our days, that the current interest about History, as part of the human cultural heritage, is not in a highest level. It looks that this is the case especially in societies with an 'advanced' standard of life. This lack of interest about History is much more evident among younger population. Young people not only ignore the fundamentals but are also indifferent in continuing and enriching the basic historical education offered in school in a traditional faschion. A similar situation is observed in Geography, a field that is strongly related to History and some times in an intrinsic way. A relatively stronger interest about History, but with the same trends as above, is registered in economically 'less-advanced' societies passing their emerging phase of development, where, on the other hand, such interest is sometimes manipulated for political reasons which are not always clearly defined or documented. This last evidence is occasionally strong and the effects are rather disturbing so that the pure interest on History becomes a rather uneasy occupation and is faced almost negatively by decision-makers. A result of this is, that History becomes today a rather elite occupation addressed to a less numerous audience. It becomes a field where small groups of specialists are involved and interact; many times they are introvert and self-sufficient. This phenomenon around History is not an isolated event within the broader domain of Culture and the same tendencies are observed in other fields of cultural heritage as well. We mention here an indeed characteristic fact on how the advanced states from the north, in European Union, are strongly opposing the Union's budget arrangements for the financing of Culture and cultural heritage, as basic component of European unity and development. On the contrary, the states of the European south are much more sensitive in directing funds and resources to Culture. It looks that the 'compromise' in this controversy is achieved (in a way) by introducing in almost all projects dealing with cultural heritage the demand for the involvement of 'new technologies' especially those dealing with information and communication. This demand sounds like the necessity for a magic-wand that is now indispensable for modern treatment of cultural issues. Another pre-assumption in promoting and supporting cultural projects today is that they should be addressed to the broad public and especially the young generation emphasising also the relevant care for disable people. It is obvious that in this trend, new information and communication technologies (especially the audio-visual) are of key importance. The consequence seems to be that, as soon as all these technologies are involved in the fields of cultural heritage, the interest from the 'market' is much more than evident!

The History of Cartography Case

The above remarks hold also for the domain of the History of Cartography (HoC) which traditionally indeed interested cartographers and related scientists coming from 'generating disciplines' of map-making (e.g., geography, geometry, astronomy, geodesy, surveying, navigation, with their modern counterparts and metrology). The massive application of modern technology in data-collection, processing and visualisation as well as the general decline of the interest in History make modern cartographers more and more indifferent for their cartographic heritage. The interest is mainly focused either on its pure historic domain or on issues related to old map collection, and care. This growing lack of interest for HoC among younger cartographers, left almost all space to pure historians, map-collectors, map curators and distinguished well-prepared amateurs and map-merchants. But can this be the solution in filling the gap? In other words, is it a sufficient and necessary condition for the proper treatment of HoC (a privileged domain of cartographers' tradition) the almost exclusive involvement of historians, map-collectors and map-fans in general? The same questions are posed in other scientific disciples as well, e.g., physics, mathematics, medicine, law etc. But in all these cases it is rather difficult to claim, e.g., that the history of medicine, or mathematics is not a subject for doctors or mathematicians. Of course the case of cartography is somewhat diverse when its artistic component is concerned [Woodward, 1987]. But in general, it is indeed a scientific and technological multidisciplinary field, since map-making and even simple map-drawing (as a result of a memory-experience process) was ever a purely 'technical' elaboration in the core of its substance.

A new interest on History of Cartography

A challenging problem today is how to treat the history and the heritage of a scientific, technological or artistic field of human intellect in a modern, efficient, productive and attractive way. The real point here, recalling the general decline of people's interest about History and historical matters, is how do define and apply modern approaches in treating historical cartographic issues. How to make cartographic heritage a part of the overall cultural heritage. This should be seen as a tool for a manifold of initiatives and activities to be taken in order to raise and enrich the interest of the wide public, the young generation, the mass media and the decision makers for Cartography. Without such approaches, Cartography will soon loose its traditional appeal to the broad public becoming simply an impersonal hi-tech application. On the other hand, one has to observe that, the trend followed by modern cartography to become a high-tech application, can be the strong comparative advantage for Cartography when viewed in a general cultural context. This can be only achieved if HoC and cartographic heritage become a solid integrating factor in the formation of young cartographers. To our understanding HoC, seen in a modern context, should be revisited in order to satisfy the above mentioned ideas: To become an efficient and attractive tool in improving the general and overall image of Cartography in modern societies. This public image, can not be justified by offering high-tech services and products only. It is necessary to offer a cultural reasoning according to the long traditions of Cartography in the people's collective memory concerning maps and their role in human progress.

A model-proposal for a new concept

A new concept concerning the cultural value of Cartography within the context of its modern face and trend could be designed around the term 'cartographic heritage' rather than around the traditional term 'history of cartography'. This new term allows for new insights being more general and giving space for broader initiatives and activities. On the other hand there will be no conceptual overlapping or 'conflict' with other structures dealing with the 'history of cartography' as a subject in overall historic dialectics. In this way antagonisms and misunderstandings can be avoided. This new concept, in dealing with matters of cartographic heritage, requires proper definition of the term 'cartographic heritage' and the inclusion of cartographic heritage in the ensemble of the world cultural heritage, considering twentieth century too. The agreement on a common language and terminology in this field is also necessary. Other points to be treated could be:

(a) The rigorous classification of cartographic evolution, in relation to the generating methodological and technological factors of mapmaking. Here, a relevant dialogue with other disciplines in mapping sciences and geography could offer common grounds for actions.

(b) The promotion of cartographic heritage in the educational and cultural systems internationally and the development of a new understanding of cartographic heritage as a crossing boarder-concept with the aim to bring closer various cultures, through maps.

(c) The collaboration with the mass media in order to reveal the value of maps and cartography as a common cultural good throughout the ages.

(d) The establishment of a network between interested institutes willing to develop joint activities in promoting the concept of cartographic heritage and the classification of existing relevant initiatives offering co-ordination and support.

(e) The study on how new technologies could contribute in spreading the concept of cartographic heritage. In this study the determination of the modern tools which can be used for this purpose, are included. They could be e.g. the multimedia map-archives and means for the electronic management and communication; norms for the production and diffusion of electronic platforms for the documentation of historic map collections, other important map series and affine cartographic material).

(f) The elaboration of models for modern 'museums of cartographic heritage' using what is offered from digital multi-visual and audio technologies.

(g) The full use of the Internet as an integrating factor of the above actions.

All above points are relevant to the terms of reference of many high-tech activities within our modern cartographic community. This allows for collaboration, coupling and mutual influence.

An example

As an example of such a new concept, one can think of the CartoTech project [CartoTech, 1998], designed by the 'Hellenic Centre for maps and cartographic heritage – National map library', a new public institution under private law established recently in Greece. The project in partnership with the 'Centro interdipartimentale, rilievo, cartografia, elaborazione', University Institute of Architecture in Venice, the 'Faculty of geography', Utrecht University and the 'Institute of geoinformatics and cartography', Helsinki University of Technology, was sponsored by the European Commission General Directorate X, for Cultural Heritage. Among the main objective of the project are:

(a) The introduction of the large public and especially of a young audience in the culture of the European cartographic heritage with the use of new technologies and the media.

(b) The study for the development of processes, techniques and patterns for the realisation of standard electronic map archives and tools for the electronic management and communication, the production and diffusion of electronic means for the documentation of historic map collections and other important map series and affine cartographic material, the creation of historic mapping instruments Museum using virtual techniques, the use of the Internet

(c) The determination of the main issues possibly defining a new profile in the professional occupation of the map-keeper.

(d) A pilot project for the setting up of a modern historic map-library in the city of Kozani (NW Greece).

(e) The development of a laboratory for high-tech cartographic application for the training of young European cartographers, encouraging the interregional co-operation.

(f) The research on the possibilities offered by new technologies in production of historic maps and related material for the blind.

The support from analytical domain

In the previous paragraphs, hints are given on how new information and communication technology (digital documentation, audio-visual techniques, multimedia), can be used in order to spread cartographic heritage to larger audiences, network map libraries, take full advantage of the Web etc. Here, using two examples from the domain of the rigorous analytical methodologies, that can be used in the study of historical cartographic documents, we extend the discussion on some possible ways to revitalise interest on cartographic heritage. The examples deal with,

(a) how to discover the, many times, hidden geometry background of historic maps and archives and

(b) how to analyse the significant patterns which allow the extraction of 'signature'-type features helping the interpretation and evaluation of cases with ambiguities in historic map classification.

Both applications are jointly carried out by the Depts. of Cadastre, Photogrammetry and Cartography and of Geodesy and Surveying, Aristotle University of Thessaloniki.

The fitting process

The first application concerns a 'revisiting' of the numerical analyses of Ptolemy's Geography coordinates, using modern best-fitting techniques. Systematic differences in positioning can be modelled, with respect to scale differences and shift parameters using simple linear regression. It proved to be sufficient in the Ptolemy-case, provided that geographic coordinates are reduced on datum meridians and parallels. The implementation of such analysis for the area of the Mediterranean or parts of it, shows that the model absorbs a great part of systematic differences and it is compatible with the character of the measurement methodologies in the era of Ptolemy. Constant values for the scale parameters have been found but the shifts are varying since they are influenced by the coordinate uncertainties of Ptolemy's positioning. From the analysis new interpretations can be given on the metrological assumptions used at that time. For example, a 5/7 constant scale parameter, found from a regression model applied in the area of Mediterranean, corresponds to the ratio 500/700, where 500 are the stadia for the length of one degree on the equator. This value seems to be used by Ptolemy instead of the exact value of 700 stadia and explains also the extended length of Ptolemy's Mediterranean since distances in stadia were divided by 500 in order to be transformed in degrees. .

The spectral process

The second application deals with the use of spectral analysis techniques in studying the coast-line 'signature' of old maps, thus their shape pattern, in order to unveil, in quantitative terms, possible similarities, correlation and coherence between maps. The problem of using such processing techniques apart of its theoretical interest, it presents important new ways in map classification, according to the 'spectral-signature' and also helps the research on the comparison of given old maps with those that eventually were used as originals. This is a typical case for the identification of the maps that were used for the preparation of the monumental "Charta of Righas", a map related to Greek Enlightment in the late eighteenth century, published in Vienna (1797). A long discussion about this map concerns, among other important issues, the variety of map-sources which seems that were used by Righas. The development of a processing package using digital coast-line coordinates, includes comparisons in the spectral domain; filtering in order to absorb systematic effects; trend patterns and transfer-funtion modules which give the 'signature-pattern' semantics of the map, with respect to a reference map or maps, used as pattern-guides.

Reflections on the curricula

From the above, one could think of a possible 'transfusion' of a manifold of issues related to cartographic heritage, into courses dealing with 'new information technology' and 'analytical methods of data analysis'. This is a challenge since both fields apply in many modern fields of geography and engineering curricula, where cartography is implemented, both in undergraduate and in graduate levels. For example, the application of the best fitting of data in Ptolemy's cartography could be used in geography, geodesy and surveying courses of statistical data analysis and adjustment theory. The application of the coast-line analysis of old maps can be included in courses of spectral analysis in geosciences, in pattern recognition and digital data processing which are also available in geography, geodesy, surveying and geoinformatics curricula. These examples from cartographic heritage applied in modern fields of data-processing and interpretation using quantitative techniques will refresh and strengthen the students' interested for their own history so nicely depicted in old maps. Needless to say that, in the domain of spatial information systems, multimedia and many other fields of new information technology (involved in geography and geoinformatics curricula), cartographic heritage could be of extreme interest for the student body due to the fascination-effect which is always emerging when coupling high-tech with culture, through historic maps. The real problem here is the profile of the teacher and the preparation required for such couplings. But this is the indeed interesting and challenging problem which could influence a revitalisation of HoC per-se and not as a small part of History only.

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Twentieth Century American Academic Cartography

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Abstract

Earlier papers and projects on the history of U.S. academic cartography have focused more on the individuals and curricula, and less on the growth of the discipline within the academic field of geography [McMaster and Thrower, 1987; McMaster, 1991]. Yet it is academic geography that provided cartographers with a disciplinary home and, ultimately, allowed rapid growth through the 1960s and 1970s. This paper first reviews developments in the history of U.S. academic cartography, identifying four major periods. The incipient period, spanning from the early part of the century to the 1940s, represents what might be called nodal activity, where academic cartography was centered at only two to three institutions with individuals who were not necessarily educated in cartography. An example is J. Paul Goode at the University of Chicago. A second period, from the 1940s to the 1960s, saw the building of core programs. Three core programs stand out—the Universities of Wisconsin, Kansas, and Washington. Other universities developed cartographic programs in this third period, including those at UCLA, Michigan, and Syracuse. This third period, from the 1960s to the 1980s, also witnessed rapid growth in academic cartography in terms of faculty hired, students trained, journals started, and development within professional societies. It is in this period where cartography emerges as a true academic "sub" discipline, nurtured within academic geography departments with strong research programs and well-established graduate education. Finally, a fourth period is one of transition, where cartography becomes increasingly integrated within a geographic information system (GIS) curricula. The result has been fewer academic positions in cartography, fewer students educated as thoroughly in thematic cartography, and a growth in what is now called geovisualization.

The second part of this paper, which documents the trends in cartography through a survey of selected Association of American Geographers' Guides to Departments of Geography in the United States and Canada, helps to identify some of these trends from 1956 onward. From the perspective of academic geography, as we leave the 20th century, cartography has witnessed remarkable growth from the 1940s to the 1980s, but has, in the past decade, seen a decline as a direct result of the rapid rise of the new related discipline, geographic information science. However, as we approach the next millenium, it appears that a synthesis of the two is slowly emerging with the development of the integrated cartography-GIS curricula.

Introduction

As pointed out by McMaster and Thrower in an International Cartographic Association proceedings paper over ten years ago, "Academic cartography in the United States is a largely a twentieth century phenomenon, although it builds on an earlier foundation of governmental and private map making" [McMaster and Thrower, 1987, p. 345]. In that paper the authors attempted to trace the evolution of academic cartography throughout this century, detailing specific individuals and departments. Since that effort, there has been little progress in discovering, more specifically, how our discipline grew from a single individual, J. Paul Goode at the University of Chicago, to one of the more significant influences in academic geography. One exception is the United States National Report to the International Cartographic Association, published in 1991, entitled, "History and Development of Academic Cartography in the United States" and published in the journal, *Cartography and Geographic Information Systems (CaGIS)*. This particular issue of CaGIS details the earlier programs at Wisconsin, Kansas, and Washington, as well as those at the universities of South Carolina, Northern Illinois, Southwest Texas State, Michigan State, Oregon State, Penn State, SUNY at Buffalo, Ohio State, Syracuse, and Minnesota. Histories of other significant programs, including the University of California, Los Angeles, U.C. Santa Barbara, Clark University, University of Georgia, San Diego State University, and George Mason University, remain to be told.

In this paper we continue to document the very rich history of Twentieth Century academic cartography. We focus on the education of scholars who have taught and conducted research in cartography primarily in American geography departments in universities and colleges and on the key programs associated with producing Ph.D.s. We assert there are four major periods of activity during the century, including: (1) the emergence of academic cartography at the University of Chicago during the early part of the century, as well as the development of several pre-World War II nodes of activity with single individuals, including Erwin Raisz at Harvard, Guy Harold Smith at Ohio State University, and Richard Edes Harrison at Syracuse University, (2) the creation of post World War II centers of excellence for graduate education, including those at Wisconsin, Kansas, and Washington, (3) the diffusion of cartographic programs in geography departments, including Michigan, UCLA, Syracuse, Buffalo, and South Carolina, and (4) the transition period, where cartography is increasingly integrated with GIS programs during the late 1980s and 1990s. We also provide an assessment, based on Association of American Geographers (AAG) data from their yearly *Guide to Departments of Geography in the United States and Canada*, on the growth of academic cartographers from the 1950s to the 1990s.

Four Major Periods of U.S. Academic Cartography

Dividing a history into categories is problematic and subjective. However, we feel that several logical "dividing" lines may be identified in the history of United States academic cartography. One clear line is pre- and post- World War II. From a rather sporadic set of institutions offering one or at most two courses in cartography, the Post World War II era witnessed the creation of well-established centers of excellence. A second line may be found when, upon maturation of these graduate program, the centers began sending out Ph.D.s educated in cartography to establish other programs—a second generation of centers with intellectual children from the initial set. Finally, the discipline has witnessed significant changes in the late-1980s and 1990s as cartography has increasingly become a component—often a smaller component—of expanding programs in geographic information science and systems.

Period 1. J. Paul Goode and the University of Chicago, Guy-Harold Smith at Ohio State, and Richard Edes Harrison.

John Paul Goode at the University of Chicago

According to McMaster and Thrower [McMaster and Throiwer, 1987] although basic training in cartography started as early as 1900 in the United States, "It could be argued that the first genuine American academic cartographer was John Paul Goode at the University of Chicago" [McMaster and Thrower, 1987, 346]. Goode, who graduated from the University of Minnesota in 1889, taught at Minnesota State Normal School at Moorhead until 1898, and received the Ph.D. in economic geography from the University of Pennsylvania in 1903, was one of the most professionally active geographers of his time. During the early part of the century, Goode became a charter member of the Association of American Geographers (AAG), served as co-editor of the *Journal of Geography* from 1901-1904, helped organize the Geographic Society of Chicago, and was appointed by President Taft to assist in leading a U.S. tour for a distinguished group of Japanese financiers. However, Goode is best known for the development of Goode's Homolosine Projection, first presented at the Association of American Geographer's meetings in 1923 and the development of Goode's School Atlas, also published in 1923. Goode's AAG presidential address , "The Map as a Record of Progress in Geography," given at the 1926 meetings, illustrated the importance of maps to Goode's philosophy of geography. Two of Goode's students at the University of Chicago, Henry Leppard (University of Chicago, Washington, and UCLA) and Edward Espenshade (Northwestern University) devoted their careers to cartographic education, and continued Goode's work with both base map development and the many generations of the *Goode's School and World Atlas*, published by Rand McNally.

Guy-Harold Smith at Ohio State

Cartography at The Ohio State University was taught as early as 1925—a class in Map Construction and Interpretation offered by Fred Carlson—making this one of the oldest courses in the country. In 1927 Guy-Harold Smith, a recent Ph.D. from the University of Wisconsin (A.K. Lobeck was his advisor) took over the cartography program at OSU, where he taught for nearly 40 years until his retirement in 1965. Although chair of the department for twenty nine years, Smith was a prolific thematic cartographer, producing his famous "Relative Relief Map of Ohio" and Population Map of Ohio" using graduated spheres. A talented teacher, his best known student was Arthur Robinson, who created the influential program in cartography at The University of Wisconsin.

Richard Edes Harrison

Richard Edes Harrison, born in Baltimore in 1901, was the son of Ross Granville Harrison—one of the most distinguished biologists of his time. Although Harrison graduated with a degree in architecture from Yale University in 1930, his interests soon turned to scientific illustration where, in the years after completing his degree, he eventually was attracted to cartography. He drew his first map for *Time Magazine* in 1932. This initial exposure to mapping piqued his curiosity, and he soon became a free-lance cartographer for *Time* and *Fortune* magazine, and from 1936 to 1938 was on the staff of *Fortune*. During the 1940s and 50s he was a map consultant to the Geographer of the State Department, to the Office of Strategic Services, to *Life* and *Fortune*, and to the museum of Modern Art. He was also a Fellow of the American and the Royal Geographical Societies. In the late 1940s, Harrison would fly to Syracuse University once per week to teach the course in cartography (George Jenks was one of his students), and he also lectured at Clark, Trinity, and Columbia Universities. Although not formally an educator, Harrison nonetheless influenced the discipline of cartography through his specific technique and intrinsic cartographic abilities. He might also be considered one of the first "popular" cartographers for his work in media mapping.

Period 2. Post-World War II graduate education centers of excellence

The period following World War II is associated with a great expansion of geography departments in many U.S. university and colleges, especially Wisconsin, Kansas and Washington, as well as a decline at others such as Harvard that dissolved its geography program in 1947 [Smith, 1987].

Table 1. American Departments of Geography offering three or more courses in cartography during 1950-1951 (from Kish, 1950)

Geography Department	*Number of Cartography Courses*
University of California, Berkeley	4
University of Chicago	7
University of Georgia	5
University of Kansas	3
University of Maryland	6
McMaster University (Canada)	6
University of Michigan	3
Michigan State College (now University)	5
Northwestern University	6
Oregon State College	3
Pennsylvania State College (now University)	4
Syracuse University	6
University of Washington	3
University of Wisconsin	5

Also according to Kish, there were seven geography departments offering graduate work in cartography in 1950 including UCLA, University of Chicago, The John Hopkins University, Kent State University, Northwestern University, Pennsylvania State College (now University), and University of Wisconsin.

University of Wisconsin

Upon the return to the University of Wisconsin of the influential geographer Richard Hartshorne in 1945 from his appointment to establish the Geography Division in the Office of Strategic Affairs, the department decided to develop its cartography program through a new faculty position. This position included the responsibility of establishing a cartography and map use instructional/curricular program which at the outset included two basic cartography courses (i.e., introductory and intermediate cartography) as well as an aerial photo interpretation course. The key figure attracted to the program was Arthur H. Robinson. Robinson was hired in 1945 after concluding his position as Chief of the Map Division of the Office of Strategic Services and completed his Ph.D. in 1947 at Ohio State University under the direction of Guy-Harold Smith and Roderick Peattie. Robinson exerted an important influence in the area of analytical cartography in general and in the development of undergraduate and graduate degree programs at the university. As described by Arthur Robinson [1991, p. 156], the program at The University of Wisconsin started in the late 1930s with a single course covering map projections and statistical mapping. He credits Richard Hartshorne with much of the post World War II development in cartography at Wisconsin. Later, other courses were added, including Seminar in Cartography, Cartographic Production, and Use and Evaluation of Maps. These were followed by another series of courses in Map Projections and Coordinate Systems, Problems in Cartography, Computer Cartography, History of Map Making, and Cartographic Design. In the late 1960s, the staff in cartography was increased when Randall Sale became associate director of the University of Wisconsin Cartographic Laboratory.

Wisconsin is recognized as one of only a few institutions to have separate cartography degree programs at the bachelors and masters level. It has produced over 100 students with master's degrees and 20 students with doctoral degrees. The first master's degree with a cartography specialization was awarded in 1949 and doctoral degree in 1956. In the late 1960s the department embarked on the development of bachelor of science and master of science degree programs in cartography with the first students entering these programs in the early 1970s (1972-1973). [This was an innovative idea at the time and an important formative period for the program.] Along with the establishment of these degree programs in cartography, in the early 1970s the department added two more faculty positions in cartography with the hiring of Joel Morrison and Phillip Muehrcke. Another important factor in the development of cartographic instruction at Wisconsin was associated with the awarding of several National Defense Education Act Fellowships in the 1960s to support graduate work in cartography. Each fellowship included a generous three-year stipend and a grant to support the development of the cartography instructional program.

With the retirement of Robinson in 1979, David Woodward, a former Robinson student who specialized in the history of the discipline, was hired. Sale retired in 1981 and Morrison, also a Robinson Ph.D. left in 1983 for the United States Geological Survey. In the early 1980s, James Burt, a climatologist out of UCLA who specialized in computer graphics, and Barbara Buttenfield, a John Sherman Ph.D. out of Washington, were hired. Buttenfield left in 1987 for SUNY Buffalo, and Lynn Usery replaced her in 1988. Phillip Muehrcke, the last of the four core cartographers at Wisconsin—Robinson, Sale, Morrison, and Muehrcke—retired recently in 1998.

University of Kansas

The cartography program at the University of Kansas was started, and nurtured for over 35 years, by George Jenks. Jenks, who had received his Ph.D. in agricultural geography at Syracuse University, had also studied with Richard Edes Harrison, the cartographer for *Time* and *Fortune* magazines, at Syracuse. As Jenks discussed in a 1991 paper, “I attended Harrison’s courses in cartography during 1946 and 1947. They were a mixture of lectures, demonstrations, drafting, and hand lettering. In the spring of 1946 there were five of us in his class, but attendance grew rapidly the following years. While his courses were interesting, I recall his demonstrations with fondness” (Jenks, 1991, p. 162). In 1949 Jenks arrived at a small, but talent-laden department, at Kansas and started building the cartography program. A significant event in Jenks’ career, and for the program itself, was his award, granted through the Fund for the Advancement of Science, that allowed him to visit all major mapmaking establishments of the federal government as well as a number of quasi-public laboratories in 1951-52. The information collected during this grant year was incorporated into an Annals of the Association of American Geographers paper, and adopted in the cartography program at Kansas. Another significant influence on Jenk’s early career was his relationship with John Sherman of the University of Washington. In the summer of 1956 Sherman came to Kansas to teach, and later Jenks was in residence at Washington. Despite faculty at Kansas with interests closely related to cartography—in particular statistics and remote sensing—at the end of the 1960s Jenks was still the only cartographer on staff. Robert Aangeenbrug, with strong interests in computer cartography and urban cartography and the director of two of the International Symposium on Computer-Assisted Cartography (Auto-Carto) conferences joined the Kansas faculty in the 1960s. Thomas Smith, who had arrived in the department as its second hire in 1947, established coursework in the history of cartography during the 1970s and 1980s.

The Kansas program experienced rapid growth in the 1970s. As explained by Jenks, “George McCleary joined the staff, and with his help we renovated and broadened the offerings in cartography. More emphasis was placed on map design and map production, and new courses at the freshman and sophomore level were added. Greater numbers of students with undergraduate training in other departments enrolled in our M.A. and Ph.D. programs in cartography” [Jenks, 1991, p. 164]. During this period, Jenks initiated research projects on three-dimensional maps, eye-movement research, thematic map communication, and geostatistics. By the end of the 1970s, Jenks’ had turned his attention to cartographic line generalization. Also during this period, he supervised 10 Ph.Ds, 15 MA candidates, and four postdoctoral cartographers. Many of these individuals accepted academic appointments and continued the “Jenks’ school.”

Jenks continued to teach and be engaged in research until his retirement at Kansas in 1986. It should be noted that a constant influence on Jenks’ academic career at Kansas, and thus most of his students also, was his continual interaction with colleagues both from within, and outside of the, department. These interactions included those with Walter Kollmorgan (suitcase farming in the plains), Charles Colby (wall-map preparation), Waldo Tobler (statistical mapping), John Davis (spatial statistics), Robert Bachi (geostatistics), Robert Sokal (numerical taxonomy), and of course John Sherman. Terry Slocum, one of Jenks's Ph.D.s who joined the faculty in 1982, still is on the faculty along with George McCleary.

University of Washington

Although the first formally-identified "cartography" course at the University of Washington was offered by William Pierson in the geography department during the 1937-38 academic year, it was John C. Sherman who is the person primarily associated with developing the cartography program at the University of Washington, Seattle. Sherman received his B.A. degree from the University of Michigan in 1937, his M.A. from Clark University in 1941 and was awarded the Ph.D. at Washington in 1947. In 1950 Sherman was appointed to the faculty at Washington, and was joined by Henry Leppard in 1951. Leppard, who had studied under J. Paul Goode at the University of Chicago, had remained at Chicago after Goode's death. As explained by Sherman, "By 1953 six cartography courses were in place, including Maps and Map Reading, Introductory Cartography, Intermediate Cartography, Techniques in the Social Sciences, Map Reproduction, and Map Intelligence. In 1954 Leppard left for UCLA and in 1958 Willis Heath, having completed his Ph.D. in the department, joined Sherman in carrying on the cartography program." [Sherman, 1991, p. 169]. One seminal event in the early history of the program was Heath and Sherman's participation in the Rand McNally-sponsored Second International Cartographic Conference at Northwestern University, held in June 1958. According to Sherman, a group of some 50 international cartographers were able to discuss "the graphic philosophy, functional analysis, and technological developments that were then influencing the field" [Sherman, 1991, p. 169]. Based on discussions at the conference, changes and additions were made to the cartography program at Washington. Another event influencing Sherman, and the program in cartography at Washington, was the first Summer Institute for College Teachers in Cartography funded by the National Science Foundation. The goal of the Institute, held in Seattle in 1963 and again in 1966 under the direction of Jenks and Sherman, was to prepare young geography professors, who had little or no training, to teach cartography. Later, in 1968, Sherman developed a proposal to establish a National Institute of Cartography, which had been requested by the National Academy of Sciences/National Research Council (NAS/NRC) Committee on Geography. Sherman was assisted by a panel of prestigious cartographers, including Arch Gerlach, Norman Thrower, Richard Dahlberg, Waldo Tobler, George McCleary, George Jenks, and Arthur Robinson. Unfortunately, the proposed institute was never created.

In more modern times, Washington has seen a series of cartographers come to and leave the department. Phillip Muehrcke, a student of Waldo Tobler's at the University of Michigan, joined the faculty in 1969, but soon left the department for the University of Wisconsin in 1972. While at Washington, however, "he offered our first course in computer cartography, expanded the seminar offerings, and amplified our interdisciplinary activities with computer scientists on campus and cartography-oriented computer users in state government agencies in Olympia" [Sherman, 1991, p. 169]. Heath became ill in the early 1970s and was replace by Carl Youngmann, a Jenk's educated University of Kansas Ph.D. Youngmann stayed at Washington for 10 years, and , after his resignation in 1983, was replaced in 1985 by Timothy Nyerges, an Ohio State Ph.D. In 1987 Nyerges was joined by Nicholas Chrisman, who had spent many years at the Harvard Laboratory for Spatial Analysis and Computer Graphics.

Period 3. Diffusion of Cartographic Programs in Geography Departments

During the 1970s and 1980s a series of what might be called secondary programs, many established by Ph.D.s from Wisconsin, Kansas, and Washington, were created in the United States. Although not exhaustive, one can point to programs at UCLA with Norman J.W. Thrower (a Wisconsin Ph.D.), Michigan with Waldo Tobler (a Washington Ph.D.), South Carolina with Ted Steinke and Patricia Gilmartin (Kansas Ph.Ds), SUNY Buffalo with Kurt Brassel (a Zurich Ph.D.), Michigan State with Richard Groop (a Kansas Ph.D.) and Judy Olson (a Wisconsin Ph.D.), Northern Illinois University with Richard Dahlberg (a Wisconsin Ph.D.), Oregon State University with A. Jon Kimerling (a Wisconsin Ph.D.), Syracuse with Mark Monmonier (a Penn State Ph.D.), Penn State University with Alan MacEachren (a Kansas Ph.D.), and Ohio State with Harold Moellering (a Michigan Ph.D.). Although not possible in this short paper, one can point to several key activities in these departments, including the development of analytical cartography by Tobler, Thrower's expertise in the history of cartography and remote sensing, Moellering's animated cartography, Monmonier's statistical mapping, and the work of Judy Olson in cognitive research. Each of the institutions developed its own area of expertise where, unlike the earlier days when students would purse a general graduate program in cartography, individual graduate programs were identified for their particular research specialty such as cognitive or analytical cartography.

Period 4. The Transition Period

The intellectual landscape of cartography has changed significantly over the past ten years, in large part due to the rapid growth of geographic information science and systems. Fifteen years ago, the prognosis for a Ph.D. in cartography acquiring an academic position was excellent whereas today's job market seeks out the geographic information scientist. One can certainly still study cartography at most major institutions, but the number of courses has decreased as the number of GIS-related courses has increased. Additionally, the term geographic visualization, increasingly used by many departments instead of cartography, has caused a further erosion of the professional base of cartography. However, one hope for the discipline is that as GISs become almost ubiquitous in our society, there seems to be the realization that a deeper knowledge of maps, cartography, and map symbolization and design is still a crucial and necessary skill.

Trends in the Education of Academic Cartographers, 1950s-1990s

This section summarizes the findings of a survey of a sample of AAG handbook-directory and guide to programs publications that help to reveal the primary cartographic programs and cartographers (i.e., those who ranked the field first in their list of specialties) in the U.S. from the 1950s to the 1990s [AAG, 1956; AAG, 1960;, AAG 1969; AAG 1988; AAG, 1990; AAG, 1995; AAG, 1998]. This discussion compliments the section on major programs and periods of academic cartography above. Our decision to use these sources in deriving data to study trends in academic cartography is very dependent on the way individuals and departments classify themselves. For example, depending on the teaching responsibilities of an individual or because of changing research interests, their definition of themselves as a cartographer can change. This also applies to any programmatic changes in departments over time. Finally, the earlier data were collected from Handbook-Directory sources while data for later years were primarily gathered from the guide to programs.

Table 2. Growth of Academic Cartography in U.S. Geography Departments, 1956-1990

Survey Year	*Geography Ph.D.s with primary interest in cartography*	*Geography Departments with a primary cartographer*	*Total Departments in the AAG Directories*
1956	9	9	Not available
1960	16	14	Not available
1969	48	42	107
1990	102	81	209

Table 2 shows the growth in academic cartography between 1956 and 1990. In 1956, nine geography Ph.D's had a primary interest in cartography at nine universities. There was almost a doubling in the number of geography Ph.D.s with a cartographic specialization between 1956 and 1960. Table 3 lists the nine cartographers found in the 1956 Handbook-Directory along with their institutional affiliation and Ph.D. granting institution. Key figures in the post-World War II period such as George Jenks, Arthur Robinson, and John Sherman are found in this listing. Table 4 shows the 16 geographers that specialized in cartography in the 1960 directory, including other important individuals such as Norman J. W. Thrower and Richard Dahlberg (John Sherman was obviously an important figure in the field that was not listed in this source). Within a nine-year period between 1960 and 1969, Ph.D.s specializing in cartography tripled. In 1969, there were 48 geography Ph.D.s with a primary interest in cartography at 42 universities. Between 1969 and 1990 (a 21-year period), Ph.D.s specializing in cartography doubled and, although this indicates an increase, it also shows a slowing trend as GIS begins to emerge.

Table 3. Geographers with Ph.D.s indicating a primary interest in cartography in 1956 AAG Directory

Name	*Institutional Affiliation in 1956 Directory*	*Ph.D. Granting Institution*
Van H. English	Dartmouth	Clark
Edward B. Espenshade	Northwestern	Chicago
George Jenks	Kansas	Syracuse
Ying Cheng Kiang	San Francisco State	Columbia
Henry M. Leppard	UCLA	Chicago
Erwin Raisz	Clark	Columbia
Arthur Robinson	Wisconsin	Ohio State
John Sherman	Washington	Washington
Floyd A. Stilgenbauer	Wayne	Michigan

Table 4. Geographers with Ph.D.s indicating a primary interest in cartography in 1960 AAG Directory

Name	*Institutional Affiliation in 1960 Directory*	*Ph.D. Granting Institution*
Robert Cramer	East Carolina College	Ohio State
Richard Dahlberg	UCLA	Wisconsin
Van H. English	Dartmouth	Clark
Edward B. Espenshade	Northwestern	Chicago
James John Flannery	Pennsylvania State	Wisconsin
Fred W. Foster	Illinois	Michigan
William N. Harris	Ohio Wesleyan	Ohio State
Willis R. Heath	Washington	Washington
George Jenks	Kansas	Syracuse
Arhur Karinen	Chico State	Maryland
Henry Leppard	UCLA	Chicago
Philip Porter	Minnesota	University of London
Erwin Raisz	Clark	Columbia
Arthur Robinson	Wisconsin	Ohio State
Norman J. W. Thrower	UCLA	Wisconsin
Joseph E. Williams	Stanford	University of Vienna

Table 5. Comparison of Cartography and GIS Speciaties in U.S. Geography Departments

Survey Year	*Cartographic Specialty**	*GIS Specialty*	*U.S. Departments in Directory*
1988	149	93	204
1990	131	131	210
1995	153	176	220
1998	144	184	217

Summary

Table 5 was constructed from the surveys of U.S. geography department specialties found in the 1988-89, 1990-91, 1995-96 and 1998-99 *Guides to Geography Programs in the United States and Canada*. Overall this table illustrates the transition period discussed earlier in which GIS becomes increasingly prominent in geography programs. It should be noted that these figures reflect how a department classified its specialties. As a test, a detailed assessment of the 1990 data was undertaken by examining each listed program and tabulating the number of departments that had a Ph.D. faculty member with a primary interest in cartography. For example, the program specialty information in the 1990 handbook indicated 131 departments had identified a cartography specialization, while the detailed examination of each program indicated 186 of these had Ph.D.-level faculty who indicated a primary cartographic specialization. Despite this difference, the program specialty data still provides an accurate representation of the overall trends in academic cartography from the late 1980s through the 1990s.

Another trend, as indicated in these sources, illustrates the transitional period relating to differences in the actual labeling of specializations, or put differently the “fashions” in professional labeling (e.g., computer-assisted cartography, GIS, digital cartography). In the 1984-85 directory a sample of major programs in cartography such as Clark, Colorado, Kansas, Minnesota, and SUNY Buffalo actually use the term “GIS”. Some 1984-85 terms in addition, and related to, GIS include computer-assisted cartography, digital cartography, computer graphics, artificial intelligence, and graphics communication.

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Session / Séance 16-B

Twentieth-Century European and American Studies on the History of Chinese Cartography

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Abstract

French sinologist Edouard Chavannes' publication of "Les Deux Plus Anciens Specimens de la Cartographie Chinoise" in Bulletin de l'Ecole Francaise de l'Extreme Orient in 1903 marked the commencement of the study of the history of Chinese cartography in the West. A number of characteristics of the twentieth-century European and American studies on the history of Chinese cartography can be generalized. In terms of contents, seven topics have been more prevalent than others: (1) a general history of Chinese cartography, (2) studies of individual old maps, (3) methodological studies, (4) studies on sea charts and coastal defense maps, (5) studies of old atlases, (6) studies on missionary cartography, and (7) studies on foreign geographical materials found in old Chinese maps. In comparison with studies by Chinese scholars, five features are worthy of note. Firstly, European and American studies are of a relatively more analytic nature. Secondly, there are more studies of international contrast. Thirdly, there are more studies on a worldwide framework. Fourthly, old Chinese maps are examined from the cultural, artistic, political, and psychological perspectives while Chinese scholars do not approach the subject from these viewpoints. Finally, in the study of the history of Chinese cartography, European and American scholars are more or less influenced by the general trend of Western Sinology.

Introduction

French sinologist Edouard Chavannes' publication of "Les Deux Plus Anciens Specimens de la Cartographie Chinoise" in Bulletin de l'Ecole Francaise de l'Extreme Orient in 1903 marked the commencement of the study of the history of Chinese cartography in the West. In the 20th century, currently European and American scholars have completed about eighty pieces, nearly all in English, on the subject. On average, there is less than one work per year. In the first half of this century, there were only less than twenty pieces of works. In the following two decades, there were more, about one every year. In l959, Joseph Needham's Science and Civilisation in China, Volume 3, was published. Its Chapter 22, entitled "Geography and Cartography" contains six sections dealing with the history of Chinese cartography. This has stimulated new interest in the studies of the history of Chinese cartography in the West. During the three decades following 1968, more than fifty pieces were completed. A high point was reached in 1994 when Cartography in the Traditional East and Southeast Asian Societies, the Second Volume, Book two of The History of Cartography was published. Over four tenths of its 970 pages is devoted to the history of Chinese cartography.

Early Studies: the Sinological Tradition

Before the end of World War II, few scholars were interested in Chinese old maps. They were mainly Europeans. Chavannes' article analyzed two ancient Chinese maps and briefly described the history of Chinese cartography. Other scholars were J. F. Baddeley, E. Heawood, L. Giles, W. E. Soothill, W. Z. Mulder, and H. B. Hulbert. In 1917, Baddeley published an article entitled "Father Matteo Ricci's Chinese World-Maps", while Headwood published one on the relations of the Ricci maps. Both of these were centered around Ricci's Chinese World Maps. Giles translated the notes on the Chinese World Map of Father Ricci in 1918. Soothill discussed the contents, publication dates, purposes, and authors in detail for two old Chinese maps. Mulder wrote on China's coastal charts. In 1904, Hulbert introduced a Chinese wheel-map of the world.

Post-World War II Studies

In the decade following World War II, few scholars worked on the subject. Two noteworthy European scholars were J.V. Mills and M.J. Meijer. Mills examined three Chinese manuscript maps in 1953. The next year, he published an article entitled "Chinese Coastal Maps" in Imago Mundi. Acquisition, map contents, authorship, completion dates, scales, orientation, format, symbols inter alia were examined for 11 Chinese coastal charts and Zheng He's sea chart. In 1954, Meijer discussed the contents of a map of the Great Wall of China.

Needham's Contributions

In 1959, Joseph Needham published with the collaboration of Ling Wang "Quantitative cartography in East and West", a chapter in Science and Civilisation in China. It discussed in detail the history of Chinese cartography in comparison with that of Western cartography. For the first time, the history of Chinese cartography was treated as an integrated part of the history of science and technology in China. They innovatively compared Chinese cartography with that of the West from a much wider perspective than the Chinese scholars. Before the publication of Cartography in the Traditional East and Southest Asian Societies, ed. by J. B. Harley et al. in 1994, this treatment was the most comprehensive study for more than three decades. It stimulated interest in studying the history of Chinese cartography and had a profound impact on later studies.

Studies of Wallis and Others

Helen Wallis published several articles dealing with aspects of the history of Chinese cartography. In an article entitled "The influence of Father Ricci on Far Eastern cartography" published in Imago Mundi, she examined a globe made by Manuel Dias and Nicola Longobardi to analyze Ricci's influence on Chinese cartography. In 1975, she reviewed the mapping activities of Matteo Ricci, Michael Boym, Ferdinand Verbiest, and Nicola Longobardi in China and their contributions to the mapping of China. She contributed a chapter describing Chinese maps and globes in the British Library and the Phillips Collection in Chinese Studies edited by Frances Wood in l988.

In addition, there were other scholars who published on the history of Chinese cartography in the sixties. P. M. D'Elia published an article entitled "Recent discoveries and new studies (1938-1960) on the world map in Chinese of Father Matteo Ricci" in Monumenta Serica. H. J. Wiens contributed a chapter entitled "Development of geographical science, 1949-1960" in Sciences in Communist China edited by Sidney H. Gould in 1961. In that chapter, he briefly discussed China's mapping activities.

Studies of Chang and Others

During the seventies Western scholars were fairly productive. Four were Chinese-Americans. Hsu, whose contributions is dealt in the next section, was the most productive. The others were Kuei-sheng Chang, Sen-dou Chang, and Gregory Hoi-yuen Chu. In 1970, Kuei-sheng Chang published an article entitled "Africa and the Indian Ocean in Chinese maps of the fourteenth and fifteenth centuries" in Imago Mundi. He discussed the degree of understanding the Chinese had of Africa and the Indian Ocean during the fourteenth and fifteenth centuries by examining what was portrayed on Chinese maps. In 1979, he published another article in Imago Mundi entitled "The Han maps: new light on cartography in Classical China." He discussed the discovery of the Mawangdui Han maps and the achievements of ancient Chinese cartographers. In 1974, Sen-dou Chang discussed features of the Qing manuscript maps kept at the Library of Congress and the British Library, and evaluated their position in the history of cartography. In the same year, Gregory Hoi-yuen Chu submitted an M.S. thesis entitled "The rectangular grid in Chinese cartography" to the University of Wisconsin at Madison. He concluded that the rectangular grid was invented by Pei Xiu. The system was introduced to Europe in the thirteenth century. It fulfilled two important functions by showing map scale and working as a coordinate system to define the position of an object on the map or in the real world.

Among non-Chinese scholars, D. J. Marion submitted his M.A. thesis entitled "Partial Translation of Chung-kuo ti-t'u shih kang by Wang Yung: A Study of Early Chinese Cartography with Added Notes, an Introduction, and a Bibliography" to the University of Chicago in 1971. His contribution is making Wang's work more accessible to Western scholars not versed in Chinese.

An exhibition of Chinese and Japanese maps was organized by the British Library at the British Museum in London, 1 February - 31 December 1974. Y. Jones, H. Nelson and H. Wallis prepared a pamphlet. In addition to descriptions of these maps, there was a brief introduction of the history of Chinese cartography.

H. Nelson published "Maps from old Cathay" in 1975. He very briefly discussed the history of mapping of China from the 3rd century B.C. to the 19th century A.D. A year later, E. Marchand published "The Panorama of Wu-t'ai Shan as an example of tenth century cartography." He examined contents of the renowned Panorama of Wu-t'ai Shan, a mural in the Cave of the Thousand Buddhas and its cartographical features. Marchand concluded that the mural presented the origin of Chinese maps that were prepared using landscape painting techniques.

Hsu's Contributions

From 1978 to 1997, Hsu published at least eight items on the history of Chinese cartography. She is not only one of the most productive scholars, but also made valuable contribution to the History of Cartography Project in its initial stage. She presented a paper entitled "The Han maps of the second century B.C.: their quality and historical importance" at The 7th International Conference on the History of Cartography in l977. The paper, re-entitled "The Han maps and early Chinese cartography", was subsequently published in the Annals of the Association of American Geographers. She analyzed the Han maps and concluded that the maps were not only the records of the political and military activities of the Former Han, but also more importantly they were solid evidence of the high achievements of the ancient Chinese cartographers. Due to the discovery of these maps, we now know that the descriptive and quantitative traditions both co-existed since very early times. In a paper published in ACSM Technical Papers in 1984, she discussed the mathematical and surveying backgrounds of the early Chinese cartography. Four years later, in an article published in Imago Mundi, she discussed the contents, technical aspects and cartographical achievements of Zheng He's sea charts.

In “The Qin maps: a clue to later Chinese cartographic development”, published in Imago Mundi in 1993, she discussed the significance of the Qin maps in the development of Chinese cartography. Four years later, she contributed a chapter to Images of the World: The Atlas through History, edited by John A. Wolter and Ronald E. Grim. She discussed three ancient Chinese atlases, namely Maps of Regions in the Tribute to Yu, Geographical Maps of Successive Dynasties, and Enlarged Terrestrial Atlas. She pointed out that the last was the most important. It was in an atlas format and summarized the geographical information known in China up to the time of its publication in the mid-sixteenth century. Both the maps and their texts provided the major source of reference for a large number of cartographic works produced subsequently in China. Furthermore, the atlas is not only a major source for Matteo Ricci’s mapping activities, but it also provided the foundation for the Novus Atlas Sinensis by Martin Martini in 1655.

Studies of de Crespigny and Others in the Eighties

In 1980, R. R. C. de Crespigny published an article in Cartography, describing two Mawangdui Han maps and discussing their significance in the history of Chinese cartography. Another Chinese-American scholar David Woo completed an M.A. thesis entitled Map as Expression: A Study of Traditional Chinese Cartographic Style at the University of Washington, Seattle, in 1981, where he discussed map design and symbols in traditional Chinese cartography from the cultural and social viewpoints. He claimed that traditional Chinese maps were art works which were deeply affected by the personality, general knowledge, artistic ability, and the cartographical knowledge of the individual map maker.

In 1987, C. Semans submitted her Ph.D. dissertation entitled Mapping the Unknown: Jesuit Cartography in China, 1583-1773 to the University of California, Berkeley. She analyzed several Jesuit maps and atlases and concluded that in the early 18th century the West acquired fairly accurate geographical knowledge about China and this knowledge was accepted by the Europeans even as late as the early 20th century. In the same year, C. Vertente presented a paper entitled “Nan Huai-ren’s maps of the world” at a conference held in Taipei. She described three different maps bearing Ferdinand Verbiest’s name: the Kunyu Quan Tu in 8 scrolls, the Kunyu Quan Tu on one sheet, and Kunyu Quan Tu also on one sheet. All three were dated 1674. She pointed out evidences indicating that Johannes Blaeu’s Nova Totius Terarum Orbis Tabula, Amsterdam, 1648, was the main source of Verviest’s world maps. In 1987, D. R. F. Taylor published a substantial article entitled “Recent developments in cartography in the People’s Republic of China” in Cartographica. He began by setting the context for a consideration of recent developments by referring briefly to some of the landmarks in the development of cartography in China since earliest times. This is followed by a description of the cartographic agencies and organizations nationwide, and an assessment of the recent achievements and the major challenges facing cartography in China. Taylor asserts that China is one of the most active countries in the development of cartography especially as it applies to the challenge of socio-economic progress.

Studies in the Nineties

In the nineties, in addition to Hsu’s two papers mentioned above and the History of Cartography Project to be noted below, there were six other studies worthy of note. In 1991, H. Walravens published “Father Verbiest’s Chinese World Map” in Imago Mundi. He examined Father Verbiest’s Kunyu Quan Tu and Kunyu Tu Shuo. He listed Chinese transliterations of 237 foreign place names on these two maps.

“A cartography of introspection: Chinese maps as other than European” by Cordell D. K. Yee appeared in Asian Art in 1992. Yee pointed out that traditional Chinese maps were dissimilar to European ones. On traditional Chinese maps, pictures play a more important functional role than on European maps. Traditional Chinese map-makers considered art very critical to map-making, whereby art refers to poetry, calligraphy, and landscape painting, and the map is a fusion of image and text, of the denotative and the expressive, and of the useful and the beautiful. Maps served to indicate and to express. In the 20th century, modern mathematical cartogaphy displaced traditional cartography. Whether this is progress remains an open question. In the same year, H. K. Yoon published an article entitled "The expression of landforms in Chinese geomantic maps" in The Cartographical Journal. He concluded that the landform presentation on the geomantic topographic map is perhaps more sophisticated than any other technique in traditional China before the introduction of the modern Western topographic map with contours. An important reason why these geomantic maps were ignored by East Asian scholars may be that they were not proud of the practice of geomancy, which is generally considered a superstition not worthy of note. Nevertheless, their contribution to Chinese cartography needs to be re-evaluated. F. Blanchon briefly described the Qin maps from Fangmatan and Han maps from Mawangdui in a French article entitled "La cartographie chinoise: nouvelles decouvertes de cartes au Gansu et au Hunan" published in ACTA Geographica also in 1992.

In 1995, J. D. Day compared different versions of Ricci's world maps in his article published in Imago Mundi and concluded that the map printed in 1602 is the original. Today, there are only eight copies of the map worldwide.

The History of Cartography Project

The History of Cartography Project was initiated by J. B. Harley and David Woodward in the seventies and later they served as its editors. It is a multivolume publication from the University of Chicago Press. Volume 2, Book 2, Cartography in the Traditional East and Southeast Asian Societies was published in l994. More than three fourths of it is devoted to East Asia, including China, Japan, Korea, and Vietnam. The part on China accounts for nearly half of the volume. There are seven chapters. They are Chapter 3, Reinterpreting Traditional Chinese Geographical Maps; Chapter 4, Chinese Maps in Political Culture; Chapter 5, Taking the World's Measure: Chinese Maps between Observation and Text; Chapter 6, Chinese Cartography among the Arts: Objectivity, Subjectivity, and Representation; Chapter 7, Traditional Chinese Cartography and the Myth of Westernization; Chapter 8, Chinese Cosmographical Thought: The High Intellectual Tradition; and Chapter 9, Concluding Remarks: Foundations for a Future History of Chinese Mapping. The author of Chapter 8 is John B. Henderson while the author of the other six is Cordell D. K. Yee. Several other chapters only partially deal with China. As mentioned previously, before the publication of this volume, Needham's work was the most comprehensive treatment of the history of Chinese cartography in European languages. Yee and Henderson cited a prodigious amount of references. They corrected some of the errors in Needham's work. A wider perspective was taken to view the history of Chinese cartography. Yee's view on Chinese cartography is quite different from that of Chinese scholars. Yee discusses the relations between Chinese maps and political culture, relations between map measurement and textual research, relations between maps and literature and art, and the Westernization of Chinese cartography. Some questions remain unanswered. For example, what were the impacts of Taoism and Buddhism on Chinese cartography? Why are there so few maps before the Song dynasty still in existence? Yee admits that his story in these chapters is still incomplete. His aim has been more suggestive than definitive. Nonetheless, as the heading of his concluding chapter suggests, Yee has provided a good foundation for future study of the history of Chinese mapping.

Conclusions

In summary, a number of characteristic features of the twentieth-century European and American studies on the history of Chinese cartography can be generalized. In terms of contents, there are seven topics more prevalent than others: (1) a general history of Chinese cartography, (2) studies of individual old maps, (3) methodological studies, (4) studies on sea charts and coastal defense maps, (5) studies of old atlases, (6) studies on missionary cartography, and (7) studies on foreign geographical materials found in old Chinese maps.

Some ancient maps, such as the Fangmatan Qin maps, Mawangdui Han maps, Zheng He's sea charts, Huai Tu, Yuji Tu, Guangyu Tu, and Ricci's world maps, received more attention than others. European and American scholars have paid more attention to Ricci's maps than any other maps. There are two possible reasons. First, Ricci himself was an European missionary. Second, there are probably more literature on Ricci and his maps in the European languages. Among the European and American scholars, five have contributed more than the rest: Edouard Chavannes, Joseph Needham, Ling Wang, Mei-ling Hsu, and Cordell D. K. Lee. Chavannes was a pioneer in the field. Needham and Wang built the primary foundation while Hsu and Yee have been more productive in the closing decades of the 20th century. Hsu is a geographer while Yee has a background in Chinese literature and art history. Both have cultivated new directions of research in the history of Chinese cartography.

In comparison with studies done by Chinese scholars, it is worthy to note the following features. Firstly, European and American studies are of a relatively more analytic nature. Secondly, there are more studies of international contrast. Thirdly, there are more studies on a world wide framework. Fourthly, old Chinese maps are examined from the cultural, artistic, political, and psychological perspectives while Chinese scholars do not approach the subject from these viewpoints. Finally, in the study of the history of Chinese cartography, European and American scholars are more or less influenced by the general trend of Western Sinology. The history of Chinese cartography is finally coming of age because of the efforts by generations of scholars, European and American as well as Chinese and Japanese. (A list of references can be obtained upon request.)

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The probe of the origins of the most primitive maps in China

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Abstract

It is still difficult to say anything conclusive about the most primitive maps in China. The author of the paper suggests that in China the early development of the most primitive society had laid foundation for the mapping or the base of the mapping. Then in Xia and Shang Dynasties with the development of the painting skills, the hieroglyph appeared. It was followed by the beginning of the embryonic maps of integrated picture with hieroglyph. Finally, in Zhou Dynasty, maps emerged in China. There were the maps of the whole nation, the land allocation maps, the battle maps and the mine maps.

Probing the Origins of China's Most Primitive Maps Few probes have been made into the origins of China's most primitive maps, even by cartographic historians. Until now the question of how the earliest Chinese maps came into being has remained unanswered. The purpose of this essay is to attempt to fill this gap in the history of map-making.

1. Drawing appeared earlier than pictograph.

In the early days, primitive men had to fish, hunt and farm to survive. The hard living conditions forced them to keep a close observation of everything around them. Gradually, they started to draw the things that they thought important in their life as the guidance in their future activities. Accordingly, drawings began to emerge in the primitive societies.

Primitive man's survival depended upon fishing, hunting and farming. Difficult living conditions forced them to observe closely everything around them. Gradually they began to draw the things they deemed important to guide them into the future. The earliest drawings probably appeared in the late Paleolithic Period. Drawings were discovered among the artifacts left by the Upper Cave Man at Zhoukoudian near Beijing and in the ancient stone caves where primitive man lived in France and Spain. Their skills in drawing and sculpture developed extensively during the Neolithic Period, about 10000-4000 years ago. Chinese ancestors not only invented pottery but also were able to draw various pictures on it such as plants, rising and falling water, animal or human figures, and daily utensils. Archeologists found a portrait of a head on a piece of painted pottery among the ruins of ancient Banpo Village on the eastern outskirts of Xian. This village existed about 6080-5600 years ago and belonged to the Yang-shao culture. The painted figure can best be described as having a round head topped with a cone hat, two narrowed eyes, a nose in an upside-down shape, and a large mouth. (See Figure 1). Painted pottery from the same period was also found in Shandong, on which there are abstract pictures of mountains, the moon and the sun. (See Figure 2).

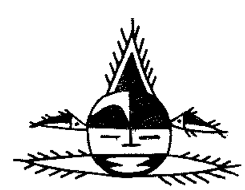


Figure 1

Figure2

All these indicate that the ancestors of Chinese observed closely everything around them in their fishing, hunting and farming activities and gradually developed an ability to pick out features representing different objects, including those of a landscape. When they had learned how to draw simple pictures, maps gradually emerged on the basis of practice. Actually, figure 2 is a very simple heaven-and-earth map of that time. The symbol of mountain in the later maps has developed from this mountain picture.

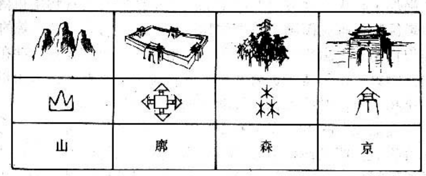
The archaeological finds prove that men had already had the basic skills of drawing in the late period of primitive society. Is there any record showing that any map appeared during that period? According to *Shibengbazhong*, Huangdi who is the chief of a tribe living in the middle and lower reaches of the Yellow River 4000 years ago ever used maps in the conflicts with other tribes.

To sum up: although Chinese characters had not come into being by that time, many beautiful pictures already emerged and various materials for making maps also existed, such as pottery bits, wooden boards, stone walls, bones and tortoise shells. Because of this, as well as the productivity development and war demands, making primitive maps became possible. Although these simple primitive maps were no more than drawings combining pictorial symbols with pictures, it is the foundation of the forthcoming ancient Chinese maps.

2. Maps began to take shape during the period when drawings were composed of pictorial symbols and pictographs.

With the development of the primitive society, man's understanding of natural phenomena improved. Men began to simplify the outlines of some objects and use symbols to stand for them, so the earliest pictographs emerged. (See figure 3.) For example, forest was simplified as three abstract trees. In this way, the pictures of objects gradually developed into abstract symbols — the earliest character, pictograph.

In the initial stage, pictures, pictorial symbols and pictographs had no obvious difference. They composed a map together. The Nine-Pot Drawing, an ancient Chinese map, is a good example. When the production and war needed concise and explicit maps, men began to abandon the pictures in the maps instead of those picture-like pictographs with the accurate positions of the actual objects; therefore, the maps mainly consisting of symbols emerged.



Mountain City Forest Capital

Figure3

3.Practical maps appeared in the Zhou Dynasty.

The primitive society of China disintegrated in the Xia Dynasty. Shang, a tribe prospered in the east of China, defeated Xia and established a slavery state. The splendid ancient Chinese civilization further developed. To meet the needs of administrative rule and war, the ruling class accordingly increased their knowledge of geography. Then in the Zhou Dynasty, maps with definite theme and of practical use began to spring up.

The earliest city planning maps

After Emperor Zhou Wuwang had defeated Shang in 1020 BC, he planned to move the capital to the Yi & Luo valley but didn't realized it. Emperor Zhou Wenwang succeeded him. He sent people to survey the Yi & Luo valley and observe the stars and the geographical conditions there. They decided on the place where the Jian River and the Luo River converged, made the Royal Area Planning map and submitted it to Emperor Zhou Wenwang. According to *Shangshu Luogao*, two cities would be built there at that time. One was an imperial city to the east of the Jian River and to the west of the Chan River, where the emperor and his officials would live; the other was a city for civilians. There is no proof to prove it, but anyway this is the first practical city-planning map recorded in the Chinese historical records.

The Land Maps of the World

Zhouli Diguansitu recorded that the land maps of the world were in the charge of the Royal Land Ministry. Maps of this kind recorded territories, mountains, rivers, interesting spots, mausoleums, and the landscapes of neighboring countries. The uses of the land maps were as follows: first, state construction planning and the divisions of land; second the proof to settle the dispute over territories; third, marking the important state mineral fields and preventing civilians from exploiting them.

The Omen Field Maps

Maps were used not only to plan the construction of cities, but to design the building of mausoleums in the Zhou Dynasty. It is recorded in *Zhoushu* that when the emperors and dukes were alive, they would order many people to build grand coffin pits and mourning halls for them. To make sure that the project would go on smoothly, they would have the tomb fields surveyed, then the engineering drawings of the coffin pits would be made in advance. The official who was in charge of the project was called Tomb Minister and was one of the Spring Officials of the royalty. It is recorded in *Zhouli Chunguan Zhongren* that the Tomb Minister was " in charge of mausoleums," and should "find omen fields and make maps of them." The above-mentioned omen fields were actually the coffin pit fields and the mourning hall fields. Omen field maps were actually the maps of the coffin pits and the mourning halls. The existing omen field map is not one made in the Zhou Dynasty, but a map of Zhongshan Mausoleum engraved on a bronze board in about 300 BC. On the map, the distances between different constructions are marked. The building size was marked on the map. Comparing with the actual objects, we can see the map scale is about 1:500. The find of this map is of great significance. Firstly, this is the earliest construction map of actual objects found in China up to now. Secondly, it proves that the record of the Tomb Minister in charge of omen field maps in *Zhouli* is reliable. Which further proves that the Heaven Ministry was in charge of the state maps, the Earth Ministry was in charge of land maps of states and the Summer Minister was in charge of the maps of the world. Thirdly, the map of Zhongshan Mausoleum is made on a certain scale, so the record of the scale-maps is shifted to a date 500 years earlier. According to the original record, it was believed that scale-maps first appeared in the time of Pei Xiu in the West Jin Dynasty.

Military Maps

It is recorded in *Zhouguan* that the Summer Ministry should administer the state, command the army forces, put down rebellions at home and resist invasion from abroad. In the Summer Ministry there was a special officer who was in charge of the military maps. The officer was called Zhefangshi, and was in charge of the maps of the world. According to *Summerguan Zhefangpian*, the maps administered by Zhefangshi called nine states maps. Exactly they were the maps of the whole ancient China. The maps show all of the things in nine states, for example, mountains, rivers, lakes, productions, and so on. With such detailed maps, the Summer Ministry would know the advantages and disadvantages of each state and then was able to control them. It could also use the maps to command a battle.

Mineral Distribution Maps

It is recorded in *Zhouguan Earthguan* that there was a special kind of maps — the mineral distribution maps. The Mine Minister in the Zhou Dynaty was the official who controlled the mines and whose assignment was to explore the distribution of metal mines. When a mine was found, Mine Minister would send people there to guard it and make a map of it. If the mine were to be exploited, the map of it would be handed over to miners.

From the above analyses, we can see that the development of ancient Chinese maps had three stages. The first stage was in the Paleolithic Period, when maps reflected only some simple natural elements by means of picture and carving. Actually they were not generalized maps but the beginning of a map at most. The second stage was in the Xia Dynasty, when maps consisted of both pictures and pictographs, and began to take shape. The third stage was in the Shang Dynasty and the Zhou Dynasty, when practical maps came into being. Then maps began to become scientific and practical.

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Session / Séance 16-C

The use of maps and the attendant materials with historical and ethographic view and while study population (an example of Bashkiria)

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Maps represent the basis of cartographical method in historical and geographical researches. Today the cartographical materials of the past are mainly used to find out natural and antropogenic changes of various components of the natural environment. But at the same time cartographical materials are not sufficiently used white study population, ethnic history and history of peoples' setting. Old maps and the attendant materials along with the data on historical geography, archaeology, ethnography and other adjacent sciences may be useful for the solution of some problems of ethnogenesis and ethnic history of people. The peoples of the Volga-Urals region began to appear on the eastern and westeuropean maps since the XI-XII-th centuries (though some geographical denominations and objects of the region we can find on earlies maps). Let us examine some medieval maps from the point of view of their use in ethnographic and ethnogenetic reconstructions.

The round map of the world of Makhmud-al-Kashgari represents great historical and ethnographic value for the reconstruction of ethnic history of the Bashkirs. It is enclosed to his work "The code of Turkic vocabulary" ("Divan lugat at-turk") compiled in 1072-1074. This code (dictionary) represents a capital work, in wich there are represented: vocabulary with the indication of tribal belonging; data on settling of Turkic tribes; classification of Turkic languages; data on history, geography and ethnography of Turks. Makhmud Kashgari distinguished twenty Turkic tribes and noted: "… I have described only tribes, and have not taken into account tribal devisions… Besides, I've pointed out, beginning with the east, all the places, where each tribe lived. The nearest tribe to Rum is pechenegi, then follow kypchak, oguz, iemek, *bashkir*, basmyl, kai, iabaku, tatar, kirgis; all these tribes inhabit to the east of Rum (Bizantiya). Then follow chigil', tukhsi, iagma, ugrak, djharuk, chumul, uigur, tangut, khytai, tavgach. These tribes inhabit between the south and nort. All them I've separately shown on the round map… Kirgiz, kypchak, oguz, tukhsi, iagma, chigil', ugrak, djharuk speak Turkic, but have their own dialects. Languages of iemeks and *bashkirs* are close to them" [Makhmud Kashgari, 1960].

The most valuable source for geographers is the round map of the world, enclosed to the dictionary. The map is oriented to the east, and in spite of Arabian cartographical tradition, in the centre there are represented Kashgar and Semirechie with the town of Balasagun instead of Mecca. There are more than one hundred denominations on the map. However, it must be noted, that there are some denominations which are not represented in the text, and vice versa, not all geographical denominations represented in the text, are not shown on the map. The Bashkirs are shown between the upper Irtysh (Artysh) and the Ili (Ila) rivers (see Figure 1).

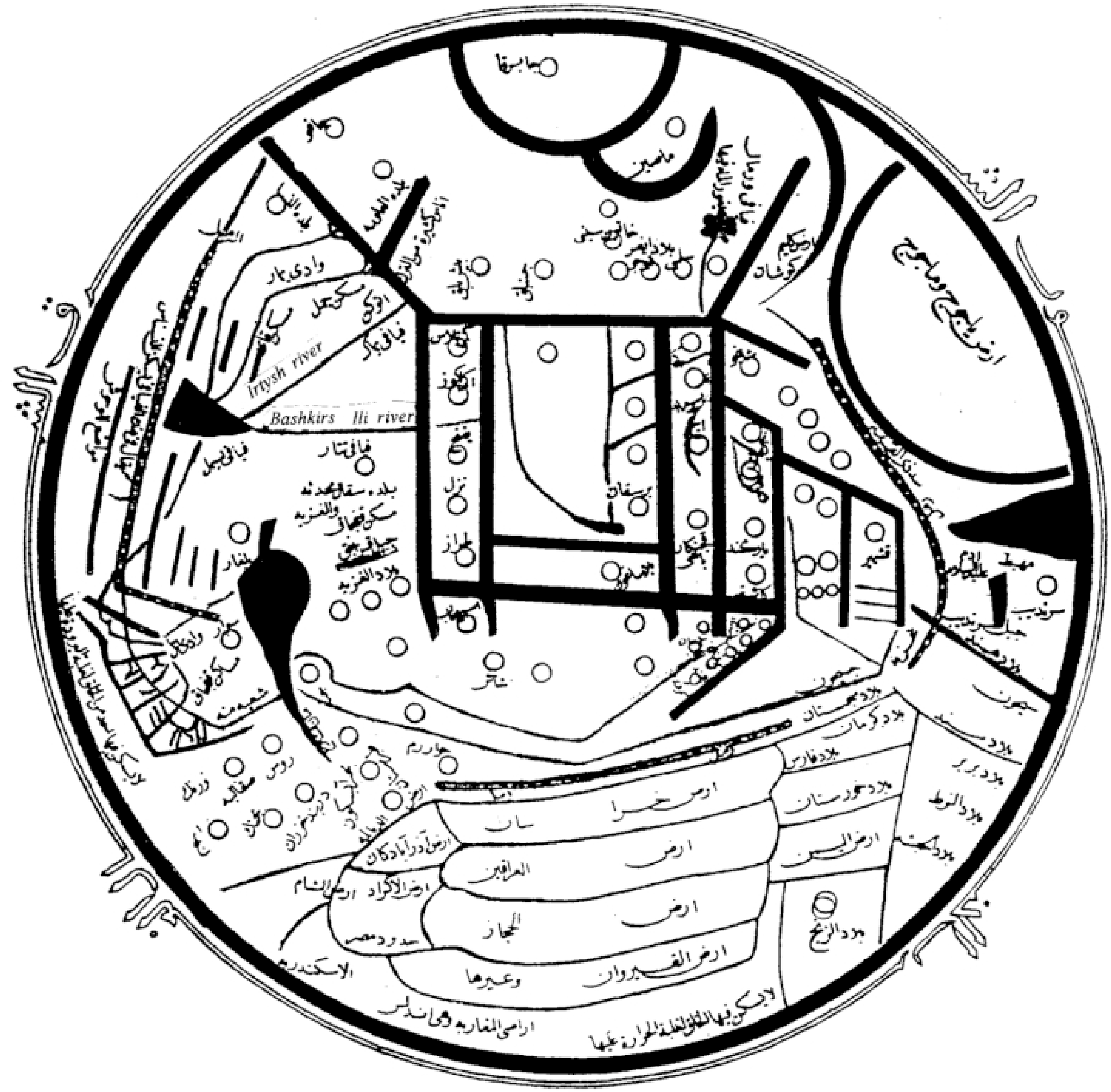

Figure 1. The round map of the world of Makhmud-al-Kashgari

The researcher of the map, I.I. Umnyakov, considered that not only the text, but also the map was subjected to changes; something from the first variant was removed, and something was added. He also noted that there was one more map, older than existed one, which coresponded to the primary editing of the dictionary of Makhmud Kashgari [Umnyakov, 1940]. I.Yu.Krachkovskii thought that the map went back to the round map of the world in "The atlas of the world" of the X-th century and it was planned as regional, but later Makhmud Kashgari filled the blank places with the denominations known to him, as a result of which it became the map of the world [Krachkovskii, 1957].

Really, the Turkic tradition to orientate to the east goes back to the Orkhon monuments of ancient Turkic language of the VIII-th century. Thus, in small inscription of "the monument in honour of Kyul'-Tegin" there is told: "… People and beks of toguz-oguzes, listen to my speech well and go deep into it! Onward, up to the *sunrise* (the east – A.P.), to the right, up to the *midday* (the north – A.P.), backwards, up to the *sunset* (the west – A.P.), to the left, up to the *midnight* (the south – A.P.) – in these bounds everybody belongs to my realm. Many peoples – all I have settled!" [Aidarov, 1971].

The illustration of different ages of the text and the map is the fact that the term "*bashkir*" can be found in the text in a form "*bashgyrt*", i.e. it's written with "*gain*", but on the map we see - "*bashkyrt*", i.e. it's written with "*kaf*" [Garipov, 1972].

Summing up the aforesaid, we can say, that the map represnts the settling of peoples of the earlier period, that is of the IX-X-th centuries. It must be noted, that according to R.G.Kuzeev, the bashkirs came to Prearalie and then to Urals from the east [Kuzeev, 1974]. Thus, we can conclude that a part of the Bashkirs inhabit the territory between the Irtysh and the Ili rivers in the IX-X-th centuries.

It should be noted that medieval maps are both geographical and ethnographical, they clearly reflected the spatial relations of the peoples. Among these maps the most prominent from the point of view of the demonstration of the population, are the maps of Al-Idrisi (1154), Pizigano brothers (1367), Fra-Mauro (1459), Martin Waldseemuller (1516), and the atlases of Abraham Ortelius (1570), Gerard Mercator (1595) and others.

"Chertezh i skhodstvo nalichie zemel' vsei Sibiri Tobol'skogo goroda i vsekh raznukh gradov i zhilisch i stepei" ("The draught and likeness of the lands of all Siberia Tobol town and all various towns and settlements and steppes") of Semen Remezov of 1701 has great importance for the study of the population of the region. It practically represents the first Russian ethnographic map [Chertezhnaya kniga Sibiri, 1882]. There are shown the areas of settling of the Bashkirs< the Chuvashes are shown to the west of them, the Teptyars land is shown to the north-east, and the Votyak (the Udmurts) land is shown to the north and so on. There are also represented the Karakalpaks, the Nogais, the Kirghizes, the Mari, the Kalmyks and others. On the maps of "Chertezhnaya kniga Sibiri" there is also shown the settling of aborigines and Russian, places of nomads' camps, data on yasak and so on.

While examining the maps, the analysis of cartographical toponimics represents great interest. Thus, while study toponimics we can find out not only the developing of the territory, but also how the migrants inhabited the region. For example, the settlements of the indigenous inhabitants have in their names word "iske" – old, "tamakh" – mouth, "tubenge" - lower, but in the names of the settlements of the settlers there are the definitions "yany" – new, "urge" – upper, "bash" – source.

In the 1870's in the Orenburg and Ufa provinces (guberniya) there were executed the recognitions in the uezds (districts). Using the data of these recognitions we can retrace the change in the number of settlements. According to these data we have compiled a diagramm, wich reflected the change in number of villages and farmsteads in 3 districts (see Figure 2). We can see in this diagram that in two agricultural districts (the Belebei and the Ufa) the number of settlements has grown as a result of migrants' movement. But in the mining and metallurgical Upper-Ural district the number of settlements has diminished as a result of the recession in mining and metallurgical industry.

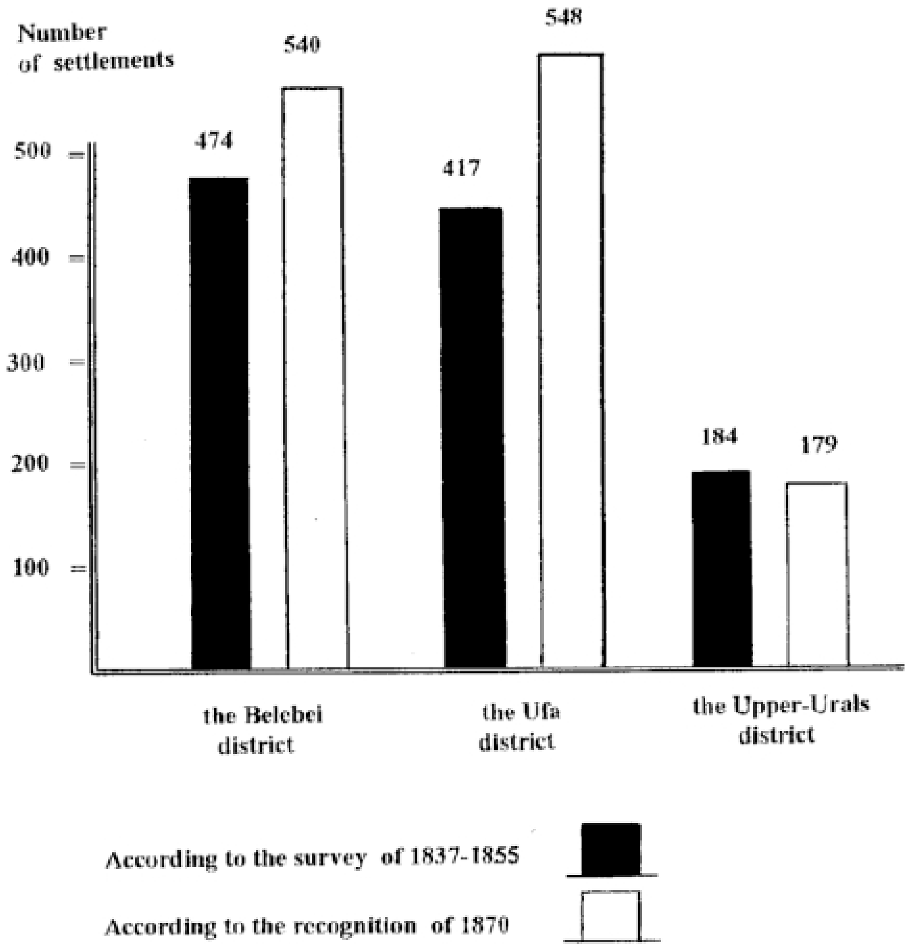

Figure 2

Thus we see that maps and adjiacent materials can be used in ethnographical researches, while defining the time of the emergence of one or another settlement and examining the ddnamics of the settling in a territory and so on. Examination of maps with historical and ethnographical view and with application of statistic, archaeological and other materials let us study the reculiarities of settling of peoples, intensity of ethnic processes and so on. Of course, maps should be used with adjacent materials (texts, economic notes and so on).

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Session / Séance 13-C

Materials of the Military-Scientific Archives' Fund, belonging to the Russian State Archives of the Military History (Moscow), and their importance for the Studies on the History of Cartography

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Abstract

From its founding in 1796 Military-Scientific Archives had become as the main Russian depository for documents on the History of Wars and Military Art of the Empire, so - the most prominent archives of materials, connected with the landscape studies, the substantial bulk of them being maps and plans. Notwithstanding intensive and fruitful investigations by Russian historians, fund VUA could not be looked upon as a wholly explored stock. Further studying of VUA's foreign files seems to be a very promising and fruitful field for those who are doing research on the genesis of the Russian National School of Field Cartography. While foreign methodical materials are very important as sources on the History of initial stage of Russian Surveys and Cartography, the actual results of regional surveys and descriptions, survived in the VUA, provide an outstanding corpus of sources for studying of the History of geographical exploration and mapping, as for the different parts of the Russian Empire, so for some foreign states. This study promises to be especially profitable in elucidating cases and methods of native sources' usage, as well as in founding new details of survey and cartography methods' development depending on regions' specific natural features. This direction of research ought to become an important part of future studies in the history of Russian topography and cartography. There is a great potential of future growth for studies in this direction. These investigations promise to be of great importance, especially in the lights of recent changes in Russia: cartographic stocks are now free to use, and quite recently they were complemented very much due to return into the Archives of the main bulk of genuine field survey materials of the nineteenth century from the "Archival Exile" in Siberia, where they had been kept from the late 1930th.

Military-Scientific Archives' Collection was founded during reorganization of *His Imperial Majesty's Own Drawing Room*, which had been decreed in 1796, into *His Imperial Majesty's Own Map Depot... with the sole purpose of it to serve not only as a Military, but as a whole State Archives of Maps and Plans*; besides, the Depot had to compile and publish new maps. Different organizations sent 766 plans and maps for the Map Depot during the first year of its life /Russian State Archives of the Military History (RGVIA), Fond of the Military Scientific Archives (VUA), # 306: *Bumagi, otnosyashchiesya do uchrezhdeniya po Vusochayshemu poveleniyu Sobstvennogo e.i.v. Depo kart v 1797 g*. [Papers, related to the founding by His Imperial Highness Decree of His Own Depot of Maps], Sheets 1-22/. So, from the beginning, Military-Scientific Archives had become as the main Russian depository for documents on the History of Wars and Military Art of the Empire, so - the most prominent archives of materials, connected with the landscape studies, the substantial bulk of these materials being maps and plans.

Plans, maps, and atlases stored in *His Imperial Majesty's Own Map Depot*, had been a nucleus of the Military-Scientific Archives' Collection, which is a case with other largest depositories of this kind in the world, Map Library of the British Library (London) and Department of Plans and Maps of the Bibliothèque Nationale (Paris) being two of the most prominent examples of the pattern. In origin, volume and impotence the Military-Scientific Archives' (VUA) Map Collection is very much similar to these British and French stocks, although it could not be compared with them in the degree of its fame and its materials' study. This lack of publicity is attributable primarily to the tight restrictions imposed on use and publication of cartographic materials by the Soviet authorities. Practically the same security procedure which applied to modern topographical and geographical maps of scale larger than 1:2,500,000 was enforced concerning Russian maps drawn in the eighteen and nineteenth centuries. This measure meant that those materials were either classified (maps with a scale of 1:1,1000,000 and bigger) or were documents intended for official use (scale between 1:1,000,000 and 1:2,500,000) and kept in the special vaults of Military-Scientific Archives. It does not mean that materials of VUA as a whole have not been used in the Soviet time. Many fundamental historical monographs and publication of documents on the history of wars, in which Russia had been involved during eighteenth - beginning of twentieth centuries, was published by Soviet historians on base of sources stored in VUA, which is up now the most intensively used fund of the Russian State Archives of the Military History.

Manuscript materials of the Military-Scientific Archives, connected with geographical exploration of the country, have begun to be studied especially thoroughly after the Second World War. These studies were centered mainly on the early period of the Russian Cartography's development, and the history of the so named Great Russian Geographical Discoveries of the late seventeenth - eighteenth centuries in Siberia, Far East, North Pacific and the Northwest Coast of America. Such prominent geographers and historians as A.I. Alexeev, A.I. Andreev, M.I. Belov, L.S. Berg, L.A. Goldenberg, V.I. Grekov, V.A. Esakov, A.V. Efimov, and D.M. Medushevskaya have demonstrated in their books a great potency of VUA's materials as sources for the history of geographical exploration and mapping of the said regions. Alexei V. Efimov's *Atlas of the Geographical Discoveries in Siberia and in the Northwest America, seventeenth - nineteenth centuries*, including 194 copies of the most interesting maps by Russian *zemleprokhodtcy* (path finders) and sailors, has been an outstanding example of such studies. Some eminent cartographic memorials, stored in the Military-Scientific Archives, have been printed as facsimile for the first time in that Atlas.

The above mentioned publications dealt with cartographic materials of the VUA, as with sources for study of step by step history of geographical exploration and mapping of the country. Besides this evident aspect of these materials' usage, documents of the fund as a whole are extremely important for those who are investigating history of Russian Cartography as a science and field of enterprise. One can find the beginning of a research of such kind as early as 1822, when Military Topographic Corps as a part of the Russian Army General Staff' Military-Topographic Depot was founded. The founder, and first Director of the Military Topographic Corps, outstanding surveyors and cartographer Fedor F. Shubert (1789-1865) had been the first to use the fund of the Military-Scientific Archives for his History of the initial stage of geodesy and cartography, as a field of the Russian General Staff's activity /Shubert, 1837/.[1] F.F. Shubert had initiated a tradition of an official historiography of the large scale cartography in Russia, which got a continuation in jubilee's publications of the General Staff (for the Centennial of the War Ministry) and Military Topographic Corps (for Fiftieth anniversary of the MTC), as well as in special historical assays by P.A. Tuchkov, D.M. Perevoshchikov, P.I. Ivanov, A.A. Bol'shov, A. Kartykov. /RGVIA, Fond VUA, # 18245: *Istoriya general'nogo shtaba* [A History of the General Staff] - Manuscript, compiled under the supervision of Adjutant-General Neidgardt. 1833; *Istoricheskii ocherk*...,1872; *Stoleyie voennogo ministerstva*...,1902; [Tuchkov],1847; Perevoshchikov. ,1854; Ivanov, 1872; Glinoitskii, 1883; Bol'shov,1900; Kartykov, 1910/. [1] Administrative and methodic aspects of these surveys and mapping projects, as well as their chronologies were the main themes of these publications.

Beginning from 1940s Russian cartographers and geographers in their history of sciences' studies are paying a thorough attention for the analysis of the development of Cartographic Science and Practice, and for the progress of ideas and technique in geodesy, topography, and cartography. The basis of this new, for that time, methodological approach to the history of the said sciences had been laid out by Professor Konstantin A. Salishchev (1905-1988) in his book on the general History of Cartography, which was published, as a historical part of his monograph textbook on the Basic Cartography (*Cartovedenie*) for universities /Salishchev, 1943/.[2] K.A. Salishchev studied the development of Cartography in close relationship with the achievements of related fields of Science and Technology, the geography being the most important of them. Those chapters of his book, which dealt with the history of large scale (field) Russian Cartography, were written by K.A. Salishchev mainly on base of his studies of stocks of the Military Scientific Archives, this author being the first to draw an attention of scientists and students to the outstanding monuments of the Russian Cartography, survived in this Archives, such as the *Atlas of the Military Topographic Map of the Russian Finland, surveyed and compiled by the His Majesty's Suite on the Quartermaster's Branch of the Finland's Division in 1798 and 1800* [3] /RGVIA, Fond 846 (VUA), opis' 16, # 19419/. and *Atlas of the Russian Imperial Army's Campaign in Switzerland...1799* /[3] RGVIA, Fond 846 (VUA), opis' 16, # 2738/. L.S. Abramov, F.A. Shibanov, Z.K. Novokshanova-Sokolovskaya, P.P. Papkovskii, and some other scientists, continued detailed studies on the History of Field Cartography and Geographical Explorations by Russian military topographers on base of the VUA's materials /Abramov, 1972; Novokshanova-Sokolovskaya", 1967; Shibanov, 1970; Papkovskii, 1983; Postnikov, 1989, 1996).[3]

Notwithstanding all these intensive and fruitful investigations, fund VUA could not be looked upon as a wholly explored stock, which capacities are exhausted. We could stress this fact as on base of our analyses VUA's Collection composition, so due to some peculiarities, which up to the recent time had been typical for the Russian studies on the History of Cartography. Speaking about the latter aspect, we might first of all point out that Russian historians were very reluctant to study and to accept any foreign influences on genesis and development of National Cartography, which approach had been very characteristic for the Russian Slavophile Tradition (in a way continued in the Soviet time). In Stalin's period even delicate inference about past possibilities of such an impact could be treated as an example of "unpatriotic cosmopolitanism" with very bad consequences for those authors who had made such supposition. Notwithstanding all recent positive changes, similar feelings are survived in Russia even now. While, even on base of the most general logic of the Humanity's and Science's Development, it is absolutely evident, that a progress in each field of the humans' activity could be achieved only as a result of joint experience of different countries and peoples.

Due to Peter's the Great reforms Russia has been included into the general process of the European Civilization's development, an intensive exchange of ideas and methods between European states in different branches of Science and Practice being one of arbitrary aspects of this process. It may be pointed out that this development was reflected especially clear in the progress of Russian Geography and Cartography in eighteenth - early nineteenth centuries. In this period Russia was leading many wars with countries well developed in Surveys and Cartography (such as Sweden and France). The surveys and map making, which accompanied these wars, had led to foundation of many geographic collections in funds of General Quarter Master's Department and Map Depot, with many Russian and foreign manuscript maps, charts, descriptions, survey manuals, instructions, tables of symbols, and other methodic materials. The majority of the materials created a core of the Military-Scientific Archives' Collection. Even a superficial study of the Military-Scientific Archives' Catalog, shows, that supervises of the General Staff (especially during first twenty years of the nineteenth century) paid a great attention to collecting such materials /see, for instance: GRVIA, Fund VUA, # 17813: *Aperçu sur les reconnaissances militaires*. (Par le comte Serriston); GRVIA, Fund VUA, # 17848: *Instruction pour lever à vue, à l'usage des élèves de l'ecole d'application du corps royal d'etat-major*; GRVIA, Fund VUA, # 17979: *Instruction für die topographischen Arbeiten des Königolich-preussischen General-stabes*. 1822. (V. Muffling); GRVIA, Fund VUA, # 18015: *Mémoire sur les reconnoissances militaires*. 1822 (par Burnod, capitaine de Génie); GRVIA, Fund VUA, # 18082: *Mémoire, concernant une collection des, livres, imprimés et manuscripts, des cartes et plans gravés et dessinés, et des modèles propres à servir d'éclaircissements à un cours de* *sciences militaires, aux quels on a joint une indication sommaire du nombre de volumes et des cartes*. [late eighteenth century]; GRVIA, Fund VUA, # 18085: *Zapiski, otnosyashchiesya do rossiyskoy geografii, sostavlennye bol'sheyu chastiyu professorom korolevskoi akademii nauk v Parizhe Demichem*. [Notes on the Russian Geography by Demich, Professor of the Paris Academy]. Manuscript. [late eughteenth century]; GRVIA, Fund VUA, # 18102: *Segni convenzionale per designare le carte di Topografia generale et particolare di Corografio, geografia ed idrografia*. GRVIA, Fund VUA, # 18117: *Teintes conventionelles pour la Topographie*; GRVIA, Fund VUA, # 18147: *Comparateir universel des èchelles géographiques*. 1808. (par. M. Bonne); GRVIA, Fund VUA, # 18153: *Coup d'oeil militaire topographique sur les frontières de la Russie*. 1811; GRVIA, Fund VUA, # 18154: *Instruktsiya dlya sostavleniya opisaniya Rossii*. [Instruction on compiling of Russia's discription]. [In French, by count Sanson, 1811]. Manuscript; GRVIA, Fund VUA, # 18193: *Pravila dlya chercheniya, s zapiskoyu (na frantsuzkom yazyke) o novom mernike dlya oznacheniya na topograficheskikh planakh i kartakh skloneniya ploskostey*. [Rules for drawing, with notes in French about a new way of showing declines on topographic plans and maps]. 1821/.

Studying these documents we found that they had been used profusely by the leading officers of the General Quarter Master's Department and Map Depot for compiling first Russian instructions, manuals, tables of maps' symbols and other methodic documents, especially in the period of the Military Topographic Corps's formation, and during first decade of its functioning. So, Russians actively and creatively were using foreign survey and mapping experience, as well as foreign professionals while surveying a newly annexed Finnish (1809) and Polish (1815) lands /details see in: Babicz, Postnikov, 1989,1997; Postnikov, 1989, 1993, 1995/.[4]

We would like to point out, that further studying of VUA's foreign files seems to be a very promising and fruitful field for those who are doing research on the genesis of the Russian National School of Field Cartography. In particular, we believe it to be of great interest to study materials connected with activities of French Royalists engineer-geographers, who were emigrating to Russia during the French Revolution 1789-95, and especially in period of Jacobinic purges in 1793-94. Published translations of works on the Military Topography by such French officers aristocrats as Dupen de Monteson /Information on life and activities of Dupen de Monteson sirvived in file: RGVIA, Fund 489, opis' 1, # 7071/, and baron Kalemberkh are well known, and an influence of the French School of Military Geography on the first stage of the Russian Military Topography's formation is a good confirmed and unquestionable fact. /A history of these projects see: Postnikov (1989): 83-86, 106-107/. Notwithstanding it, many lacunas are left to be studied in the history of lives and professional activities of French emigrant surveyors and cartographers as offices of the Russian General Quarter Master's Department and Map Depot. A detail research of such kind would help to elucidate a versatile role of French Topographic School as a whole so a personal impact of its different representatives on the development of the Russian Field Cartography's scientific and methodical basis. Nowadays historians of Science are showing some interest in the fates of French refugees and their influence on the spreading of contacts and interacting amidst different scientific and methodic traditions of European nations. A recent example of such interest is Dr. R.W. Bremner's paper presented for Seventeenth International Conference on the History of Cartography in Lisbon (1997), which deals with mapping in Portugal by French Royalists in the British Army during its actions against Napoleon, 1800-1801. /Bremner, 1997/.[5] Russian scientists should try in the future the same direction of research on base of VUA's documental materials.

While referred above foreign scientific and methodic materials are very important as sources on the History of initial stage of Russian Surveys and Cartography, the actual results of regional surveys and descriptions, survived in the VUA, provide an outstanding corpus of sources for studying of the History of geographical exploration and mapping, as for the different parts of the Russian Empire, so for some foreign states. Sometimes the Collection contains a whole complex of documents, which in their entity provide all necessary sources for recontracting an in depth history (Case Study) of some important Cartographic Projects. An outstanding example of such documental complex is the corps of sources on the History of surveys, descriptions, and mapping for compilation of "The Topographical Map of the Polish Kingdom," (scale: 1:126000) which had been produced in 1818-1843, and became one of the best topographic maps of its time. The corps includes the following groups of documents:

1. Official reports to the Russian General Staff by the Project's Supervisor Major General K.I. Richter (1793-1842)./GRVIA, Fund VUA, # 19455: *Otchet o rabotukh po c"emke Tsarstva Pol'skogo s 1831 po 1844 god*. [Report on the Survey of the Polish Kingdom, 1831-1844]/. Russian Emperor Nikolai I had looked through these reports and approved them. These reports incorporate a detail history of surveys and compilation of the map by Polish and Russian officers, an estimate of the quality and quantity of works, performed by Polish topographers - officers of the Polish Army General Quarter Master's Office in period of 1818-1831 (before the Warsaw Uprising /1831/). There are also same maps, showing a progress of the work by years, and some other materials.
2. Instructions, manuals and correspondence processed in the period of surveys and map's compilation. /See, for instance: RGVIA, Fund VUA, # 20446 [Map by Zotsmann, used a one of sources]; RGVIA, Fund VUA, # 21143: *Semitopograficheskaya karta Tsarstva Pol'skogo*. ["Half topografic map of the Polish Kingdom]. 1820; RGVIA, Fund VUA, # 21793: [Plan of Warsaw].1842./. This stock includes following files: correspondence on organizing and methods of the surveys; official letters and manuals on collecting of different data about the terrain, population, husbandry, industries, and so on, for compiling of geographical, economic, and military-statistic descriptions of the Polish Kingdom; different versions of Polish and Russian instructions on surveys, map making, and descriptions' compilation; monthly and yearly official reports and report-maps on progress of the Project.
3. Single survey originals of maps made by Polish and Russian surveyors, printed Russian and foreign maps used as sources for "Topographic Map of Polish Kingdom compilation; schemes of geodetic control, and other manuscript and printed drawings./See, for instance: RGVIA, Fund VUA, # 20446 [Map by Zotsmann, used a one of sources]; RGVIA, Fund VUA, # 21143: *Semitopograficheskaya karta Tsarstva Pol'skogo*. ["Half topografic map of the Polish Kingdom]. 1820; RGVIA, Fund VUA, # 21793: [Plan of Warsaw].1842./
4. Manuscript Geographical (Statistical) and Military-Topographyical descriptions of the Polish Kingdom in fifteen volumes /GRVIA, Fund VUA, # 18465, parts I - XV./, compiled in 1832-1843 by Polish and Russian officers, who fulfilled an instruction, which Polish military engineer Colonel Stanislav Dšngoff had compiled /RGVIA, Fund 846 [VUA], op. 16, No. 18467): "Rédactions topographiques, statistiques et militaires sur la Pologne formant pieces de complément, de travaux du Lévé et de la construction de la carte de ce pays..." (775 sheets)./. This huge and detailed corpus of historical-geographical sources includes more than 9000 sheets, and its fifteenth volume is "The Statistical Atlas of the Polish Kingdom, complementing the Statistic and Military Description." This Atlas shows on its maps the nature, economics, culture, religion, and other aspects of Polish lands, which were parts of the Russian Empire in 1840s. This manuscript cartographic composition has been in fact a first Russian Thematic atlas, which is very important as a historical-geographical source.
5. Sets of printed sheets of the Topographic Map of the Polish Kingdom, issued in different years /GRVIA, Fund VUA, # # 21154-21156/.

An outstanding feature of this and similar documental complexes is the fact, that critical analysis and estimation of quality of all sources included into these stocks could be fulfilled without consulting with any other additional authorities outside these documental collections. For instance, a reliability and accuracy of general, resulting official reports could be easily found and estimated on base of studying genuine monthly reports and correspondence. A completeness and quality of the fifteen volumes' Statistic and Military-Topographic descriptions of the Polish kingdom could be verified by using files with correspondence related to collecting data for such descriptions, related instructions, and so on. To the said we may add , that the files from such kind of collections are very dependable sources due to their implicit nature, as genuine materials, signed by the actual participants of surveys, descriptions and mapping. These materials had been strictly practical technical documents only for service use aimed at ensuring sound fulfillment of the mapping project, which fact helped to “clean” them from many blemishes typical for other historical testimonies.

Although the corpus of documents under discussion is an exceptionally full collection of materials on the history of The Topographic Map of the Polish Kingdom compilation, it does not mean that absolutely all documents, connected with the theme, have been survived. From the five singled out groups of sources, the third one (genuine field materials of surveys and map making) had suffered the most losses during their archival life. The majority of these materials had been returned to Poland in 1939-40, and then perished in flames of Fascists’ vandalism after a failure of the Warsaw’s Uprising, 1944. On the authority of the *Catalog for the Military-Scientific Archives of the General Staff*, the most part of these materials had been represented by originals of Polish surveys in the period between 1822 and 1831, but some of them were Russian topographic and geodetic materials of 1832-1839.

Notwithstanding these lacunas, the corpus of documents (survived as in VUA fund, so in some other funds of the Russian State Archives of the Military History), connected with the history of Topographic Map of the Polish Kingdom is probably unique in this Archives in the representativeness and completeness of survey, descriptive and compiling works in limits of a single cartographic project. On other territories, such as Finland, Moldavia and *Bessarabiya*, Crimea, Manchzhuriya, and some gubernias of the Russian Empire, the Russian State Archives of the Military History has gotten similar collections of less and different representativeness. We are sure that the future thorough study of such stocks would essentially improve our knowledge on the history of mapping of these countries and regions. This study promises to be especially profitable concerning elucidating cases and methods of native sources’ usage, as well as in founding new details of survey and cartography methods’ development depending on regions’ specific natural features. We believe that this direction of research ought to become an important part of future studies in the history of Russian topography and cartography.

At the beginning of our paper we pointed out, that fund VUA, as well as many other funds of RGVI are incomparably less studied and known than analogous documental-cartographic collections abroad. In conclusion of our presentation, we would like to discuss some perspectives of studies of the fund. The majority of foreign collections of this kind had been in some way singled out inside main libraries and archives long ago, and functioned as special Map Rooms, Departments of Plans and Maps, Map Libraries, and so on. Many of them with time have become an internationally renown research centers in the history of cartography. Such centers as the Map Library (former Map Room) of the British Library, Royal Geographical Society’s Map Department (London), Department of Plans and Maps of the National Library in Paris, Map Department in the Library of the Congress of the USA, Plans and Maps Department in the National Archives of Canada, Newberry Library Dunlop Smith Center on the history of Cartography, American Geographical Society Collection in the University of Wisconsin-Milwaukee comprise leading history of cartography institutions. Each of these centers have gotten more or less permanent staff of professionals devoted to the History of Cartography. Many of supervisors of these special collections were and are scientists who have become Classics of the History of Cartography. The Collection of the Military Scientific Archives, as well as closely connected with it other collections of geographical materials of the Russian State Archives of the Military History in this way are only in the beginning of their development. There is no special department on the History of Cartography there yet, but there is a great potential of future growth for studies in this direction. These investigations promise to be of great importance, especially in the lights of real changes in our country: cartographic stocks are now free to use, and quite recently they were complemented very much due to return into the Archives of the main bulk of genuine field survey materials of the nineteenth century from the “Archival Exile” in Siberia, where they had been kept from the late 1930th because of their large scale (1: 21000 - 1: 126000). This is fund # 386 of the Military Topography Administration of the Russian War Ministry, and it includes many thousands of Russian manuscript maps, as well as some rare foreign maps and atlases. The fund now is being checked, systematized and cataloged; in some two years’ scholars will get an opportunity to work with these precious materials.

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Session / Séance 13-D

Cartographie de la Nouvelle-France
Discours colonial sur l'Amérique et géographie autochtone

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La carte de la Nouvelle-France est conçue par et pour les Européens, et dans la mesure où la carte n'est pas seulement un outil technique, scientifique et objectif de représentation de la réalité, mais bien une image subjective et discursive de l'espace référent, elle ne peut pas éviter d'être le reflet de l'univers social, mental et symbolique de la France coloniale. Toutefois, en raison de l'éminente dépendance informationnelle de la France envers l'Autochtone, nous montrerons que le fait amérindien doit prendre une place considérable sur la carte, et cela même si la puissance coloniale dénie une telle dépendance, ainsi que l'influence culturelle autochtone qui en résulte. Cela dit, partant du fait que l'Amérique française est le résultat d'un métissage à tout le moins culturel, nous comptons donc voir en quoi la cartographie néo-française saura mettre en place et en relation deux géographies: l'une eurogène et l'autre indigène.

Introduction

La Nouvelle-France, ce qu'on pourra appeler également l'Amérique française, est l'histoire d'une rencontre interculturelle d'importance. Et qui dit rencontre, dit échange. Les deux cultures que sont l'Occident et le monde autochtone se sont donc interpénétrées pour donner forme au métissage. Les Amérindiens ayant eu cependant l'avantage du terrain (à lequel ils étaient depuis longtemps adaptés), il est alors peu surprenant d'observer davantage de Français adopter le mode de vie indigène que le contraire, et cela même si l'historiographie a longtemps voulu démontrer l'inverse: <<Dans un grand espace comme plusieurs fois le Royaume, la domination française, si l'on peut oser une telle expression, dépend du bon vouloir des Indiens>> [Jacquin, 1987, p. 225]. En contrepartie, il faut garder aussi en tête que la Nouvelle-France est d'abord l'histoire d'une puissance coloniale qui tend à imposer ses modèles d'appropriation de l'espace et comme l'indique d'ailleurs son nom, elle ne peut pas se permettre d'être autre chose qu'une possession française.

Pour mettre en relief cet état des faits, nous proposons de poser un regard sur la cartographie de l'époque. Un tel coup d'oeil est motivé par un objectif général: <<déconstruire>> la carte, à la manière de J. B. Harley [1995, pp. 61-85], en montrant qu'elle ne peut pas être seulement conçue comme un outil technique et scientifique, exact et objectif, mais qu'elle est bien aussi (ou même surtout), un instrument de communication et de pouvoir régi par des objectifs socio-culturels et idéologiques, ainsi que par une rhétorique particulière. De la sorte, la carte de la Nouvelle-France sera perçue ici comme un procédé de propagande coloniale. Néanmoins, nous croyons qu'une telle cartographie n'a pas su éviter de refléter une autre appréhension de l'espace, celle de l'Autochtone. En effet, si la carte est un produit culturel et que la Nouvelle-France est la rencontre de deux cultures, il apparaît alors raisonnable de supposer que la culture et la géographie autochtone doivent transparaître sur la carte. Cela s'avère d'autant plus incontestable que l'Indien est essentiel à la production cartographique, car source principale d'information géographique. En conséquence, la carte de la Nouvelle-France semble être la juxtaposition et l'interpénétration de deux géographies: l'une coloniale et européenne, l'autre autochtone et américaine. C'est la mise à nue d'une telle interpénétration qui dessine l'objectif spécifique de notre présente communication. Pour ce faire, nous tenterons d'abord de montrer en quoi la carte véhicule le discours spatial du pouvoir colonial et en quoi le fait amérindien se doit d'être masqué. Ensuite, nous chercherons à démontrer les traces culturelles amérindiennes que la carte n'a pas su cacher; la toponymie (les noms de lieu), parce que reflet de la culture du désignant, nous sera ici substantiellement indispensable.

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Ce texte est le résultat d'une recherche réalisée dans le cadre d'études de maîtrise. Les documents cartographiques dont il sera question dans le corps de ce texte se retrouvent dans la dernière section de la bibliographie. Ce sujet se trouvera traité dans un article à paraître dans le prochain numéro de Thèmes canadiens - Canadian Issues (1999) de l'Association d'études canadiennes (AEC).

Discours colonial

Représentation et discours cartographique

La carte n'est pas un objet neutre et objectif. Parce qu'elle ne peut représenter l'entière réalité, celle-ci étant par-là beaucoup trop complexe, elle nous en donne une image schématisée. Une telle image ne peut donc éviter d'être le résultat d'un choix dont la pertinence ne peut être que toute relative. C'est la perception qui permet de juger la pertinence d'une sélection comme représentante de la réalité, aidée qu'elle est par ce que Angello Turco nomme le <<dispositif de contrôle>> [1985, p. 73]: on pense aux idéologies, aux mythes, aux traditions, soit en bref à l'univers symbolique et culturel du cartographe. Par conséquent, la carte est l'image subjective d'un espace référent (réalité).

Ainsi la carte n'est-elle pas seulement la somme des connaissances recueillies sur la réalité géographique, mais elle est aussi la contraction d'un savoir. Pour cette raison, et aussi parce que la carte met en encodage toute l'information qu'elle valorise, on peut la qualifier de discours. La carte procède en effet d'une série de règles tant scientifiques et techniques que non scientifiques et et <<inconscientes>> qui permettent la communication du savoir géographique. De plus, étant donné le fait que la carte est le résultat d'un processus socio-culturel et qu'elle est d'abord et avant tout le reflet culturel de celui qui la produit [Harley, 1995, pp. 65-72], la France ici, elle est donc un discours colonial.

Fonctions cartographiques

On comprend dès lors que la carte soit à la remorque des visées, des intérêts et des objectifs eurogènes; elle ne peut faire autrement que de répondre à des fonctions cartographiques [Boudreau, 1994, pp. 107-116]. Les fonctions déterminent les éléments qui seront puisés dans la réalité. Si les fonctions sont souvent nombreuses, nous n'en retiendrons cependant que trois.

La fonction mémorielle est la première et n'est pas propre qu'aux documents cartographiques que nous analysons, mais bien à toute production cartographique. Ceci dit, d'une telle fonction dépend la pérennité du discours cartographique. <<La carte est une image objective qui fixe, pour une société; la figure du monde et de la totalité, c'est-à-dire de ce qui préexiste, de ce qui survit à l'individu, qui en sera le passager éphémère>>[Jacob, 1992, pp. 413-414]. En fait, la carte devient objet de référence et une réponse à de futurs litiges d'ordre spatial. Elle se trouve à marquer dans le temps la possession de l'espace et à fixer le savoir qu'exhibe le pouvoir produisant la carte. Dans le cas qui nous intéresse, la fonction mémorielle tend d'abord à fixer <<à tout jamais>> l'information française en Amérique et à vendre l'image de la possession coloniale de l'espace.

Malgré tout, la carte n'offre pas qu'un regard passé sur l'espace, mais elle propose aussi une vue sur l'avenir; elle possède donc aussi une fonction projective. La carte dessine effectivement un projet spatial qui a pour objectif de s'exécuter sur le terrain. <<Autant que les canons et les navires de guerre, les cartes ont été les armes de l'impérialisme. Dans la mesure où les cartes ont servi à promouvoir la politique coloniale et où des territoires ont été revendiqués sur le papier avant d'être effectivement occupés, les cartes ont anticipé l'empire>> [Harley, 1995, p. 26]. En outre, l'imagination, le rêve et le mythe s'avèrent souvent indispensables pour combattre l'angoisse naissant de l'inconnu et du manque de connaissance réelle sur l'espace représenté [Jacob, 1992, p. 179]. La carte est donc aussi une estimation de ce à quoi le réel peut (ou doit) ressembler.

Néanmoins, la fonction la plus déterminante en Nouvelle-France nous semble être liée à une finalité plus contemporaine à la production cartographique, soit montrer que la Nouvelle-France porte bien son nom et qu'elle est une possession française. Étant donné le lien ténu qui s'établit entre le savoir que la carte exprime et celui qui la produit, le pouvoir colonial français, on ne s'étonne pas alors si la carte tend à démontrer qu'un tel savoir découle de connaissances géographiques d'incidence française; comment serait-il possible d'affirmer posséder un espace tout en le méconnaissant? Cette fonction dominante, a tout lieu d'être dénommée fonction légitimante, car il appartient alors au cartographe de prouver, ou de justifier, que la connaissance géographique de la Nouvelle-France est une connaissance française.

Message cartographique

La carte a quelque chose de particulier à dire et un message à faire passer, allant jusqu'à offrir une certaine lecture d'elle-même; en d'autres mots, la carte est structurée par une certaine rhétorique, laquelle résulte de l'élaboration d'un message cartographique [Boudreau, 1994, pp. 213-235]. La carte de la Nouvelle-France est claire: cette partie de l'Amérique est une possession française, parce qu'une connaissance française, comme le dicte la fonction légitimante, comme l'estime la fonction projective et comme le rappelle la fonction mémorielle.

Un défi de taille saute aux yeux du cartographe, soit le manque d'information lui-même, résutat de la pauvreté de l'information de source eurogène. En fait, les Européens ont une connaissance très <<riveraine>> et incomplète de l'espace référent, une telle connaissance se limitant aux rives de l'océan Atlantique et à celles des grands cours d'eau navigables dont le fleuve Saint-Laurent est l'exemple par excellence [Harris et Warkentin, 1974, p. 14]. L'ensemble de l'arrière-pays (ou l'hinterland, soit l'espace situé aux marges des cours d'eau les plus importants — le fleuve Saint-Laurent, les Grands-Lacs, mais aussi des cours d'eau <<secondaires>> tels le Mississippi, l'Illinois, l'Outaouais, l'Ohio, la Ouabache, etc.), sera source de méconnaissance eurogène, et cela principalement au Nord et à l'Ouest de la représentation. Les cartographes se virent dans l'obligation de masquer cette méconnaissance, preuve que la Nouvelle-France est avant tout une vue de l'esprit, et mirent de la sorte sous silence des pans entiers de la carte. De surcroît, il existe bon nombre de tactiques et d'<<outils>> pour faire oublier les manquements informationnels dont sont victimes les cartographes: ceux-ci pourront faire appel à des éléments d'ordre technique, telles une échelle graphique ou une rose des vents pour faire office d'obstruction visuelle (voir la rose des vents de Bressani); d'autres éléments cartographiques, tels que les éléments satellites (cartouche, cartons, légende, titre) et les accessoires graphiques (poissons, bateaux et autres dessins), sont aussi très souvent utilisés dans un objectif d'occultation de l'inconnu. Si la plupart de ces éléments sont utiles à la carte, pour ne pas dire nécessaires, il n'en demeure pas moins que leur positionnement dans l'image cartographique est parfois étudié en vue de masquer les manquements informationnels.

Malgré tout, l'ampleur de ce qui est à cacher est telle qu'il apparaît primordial au cartographe de recueillir une connaissance plus approfondie de l'espace néo-français. Or, à ce sujet, si plusieurs explorations continentales seront lancées, et si certains cartographes eux-mêmes (ne pensons qu'à Champlain) s'efforceront de percer les mystères américains, les Autochtones s'avèrent encore les mieux placés pour fournir une information géographique pertinente sur le territoire convoité par la puissance coloniale française, car les seuls à vivre réellement dans un tel espace [Harley, 1995, pp. 95-97; Lewis, 1986, p. 9].

Les Amérindiens produiront d’abord des cartes pour les explorateurs eurogènes qui leur en feront la demande. S’il ne reste rien de ces cartes parce qu’elles furent effectuées plus souvent qu’autrement sur des médiums d’une trop grande fragilité (écorces de bouleau, peaux de cerf, sable...), il semble qu’elles aient été intégrées et assimilées aux documents européens [Lewis,1986, pp. 9-34]. De plus, parce que produites sur le moment, les cartes indigènes sont normalement schématiques et s’embarrassent assez peu de détails superflus, exhibant alors de manière symétrique les réseaux hydrographiques et représentant les lacs à l’aide de formes géométriques simples (le cercle souvent); dans la mesure où le cartographe incorpore la matière brute qui lui vient des Autochtones, il est évident qu’il reproduit sur sa carte l’aspect schématique de l’information cartographique indigène ainsi amassée. D’ailleurs, les espaces moins connus de la Nouvelle-France, soit ceux surtout les plus nordiques et les plus occidentaux, semblent être davantage gratifiés de cette symétrie et de cette géométrie.

Ceci dit, les peuples amérindiens étant des cultures <<analphabètes>>, ils prisèrent naturellement la forme orale pour communiquer leur savoir géographique. Si quelques explorateurs mettront par écrit cette information orale, on doit aux jésuites le plus gros de ces transcriptions, lesquelles se retrouvent en Europe sous forme de lettres, les fameuses relations [Heidenreich et Dahl, 1980, p. 3]. En raison de leurs missions de conversion des <<Sauvages amériquains>>, les pères de la Société de Jésus en viennent à maîtriser de manière respectable quantité de langues autochtones, ce qui leur confère un avantage informationnel certain.

Finalement, il existe une dernière forme d’information autochtone, à cheval entre la carte et la communication orale, la toponymie; bien que les toponymes soient communiqués oralement, ils sont rapidement <<transcrits>> sur la carte européenne [Lewis, 1986, p. 16]. Cela dit, ce qui caractérise le toponyme autochtone, c’est qu’il est pour beaucoup (et non exclusivement) descriptif et imagé, c’est-à-dire qu’il s’attache à la réalité géographique du lieu qu’il désigne [Dugas, 1985, p. 445]: prenons seulement la signification micmac de Québec, <<au rétrécissement de l’escarpement>>, pour nous en convaincre. En outre, comme l’illustre l’exemple de Québec, un tel toponyme, aussi descriptif soit-il, n’en prend pas moins une forme concise et peu expansive (contrairement à la traduction française!), ce qui nécessite un minimum de place sur le document cartographique et permet à l’informateur ou au cartographe d’insérer de manière graphique un maximum d’expressions toponymiques orales sur les cartes. Par conséquent, on est peu surpris de constater que la nomenclature toponymique amérindienne soit une source abondante, généreuse et primordiale de savoir géographique autochtone divulguée aux Européens et on saisit aisément pourquoi elle prend tant de place sur la carte; qu’une part importante de cette nomenclature toponymique se retrouve aux marges <<inconnues>> de la représentation cartographique n’a d’ailleurs rien à voir avec le hasard.

Ce qui est révélé ici, c’est l’ampleur de la dépendance informationnelle européenne envers l’Autochtone. En clair, cela revient à avouer que la Nouvelle-France n’est pas réellement une possession française et que les Amérindiens, détenteurs d’une connaissance géographique considérable, en sont les seuls <<possesseurs>> (dans le mesure où ce terme à un sens pour les cultures autochtones). Surgit dès lors un paradoxe fondamental: la carte ne peut pas, en raison même de la fonction légitimante, afficher une possession spatiale autre que coloniale. Cela serait confesser à la face des autres puissances coloniales européennes que la France n’a qu’un contrôle très partiel des terres outre-atlantiques qu’elle ose qualifier de <<France nouvelle>>. À la lumière de tout cela, il est clair que la carte se doit de nier toute dépendance informationnelle envers l’Autochtone, d’où d’ailleurs une tendance à ne pas faire mention officielle des sources indiennes.

Géographie coloniale

En dépit de sa mise en silence, la dépendance informationnelle eurogène existe réellement et cela explique pourquoi le cartographe accorde autant de place au monde autochtone sur l’image cartographique. En fait, l’arrière-pays se retrouve habillé par une masse considérable d’éléments mettant en valeur une présence amérindienne <<exclusive>> en Nouvelle-France. Effectivement, tant la représentation de l'habitat (symboles en forme de tipis sur les cartes de Champlain, Bressani, Del'Isle et Coronelli, ou de maisons longues pour la carte du Fondateur de Québec) que l'ampleur de la nomenclature toponymique mettent en relief ceux qui vivent vraiment dans l'espace convoité par la puissance coloniale française. Conséquemment, si le cartographe sait malgré tout afficher une présence française minimale dans l'œkoumène laurentien, par une certaine (quoique partielle) renomination toponymique (le fleuve <<Saint-Laurent>> étant l'exemple par excellence) et par la représentation de <<villes>> (Québec, les Trois Rivières, Tadoussac et Montréal), dont les symboles bien visibles rappellent les villes européennes (présence d'un clocher d'église et de maisons aux tendances européennes), il demeure que la majeure partie de la carte est essentiellement marquée par la présence indigène et cela malgré la pénétration des forts français (eux aussi très visibles) le long des cours d'eau arpentant le pays des Illinois et celui des Outaouais, lesquels pays sont au cœur même de l'hinterland américain.

Devant un tel constat, la négation des sources d'information autochtones ne suffit plus et force le cartographe à mettre aussi en veilleuse le fait autochtone. C'est cette unique alternative qui permettra au cartographe de justifier la présence française en Amérique du Nord, car sans spécificité culturelle, l'indigène devient matière à conversion et à assujettissement, il devient <<francisable>>. Concrètement, un Amérindien <<francisé>> est un Amérindien français, ce qui légitime l'appropriation coloniale de cette terra nullius (terre qui n'appartient à personne) qu'est la Nouvelle-France. De toute façon, la puissance coloniale ne peut pas reconnaître à l'Indigène sa spécificité culturelle sans admettre du coup une incapacité à imposer la culture occidentale.

Terre française

Une telle mise en sourdine de la <<souveraineté>> culturelle et politique des Amérindiens semble s'opérer en deux mouvements sur la carte: par un reniement de l'autonomie politique autochtone, d'abord, et par l'<<assujettissement>> amérindien par la suite. Le premier mouvement suppose une analyse des délimitations, lesquelles sont particulièrement nombreuses sur les cartes de Fer et de Sanson. L'intérêt des délimitations tient au fait qu'elles ont pour utilité de diviser et de circonscrire l'espace, permettant dès lors au cartographe de justifier les possessions françaises en Nouvelle-France. On se rend vite compte que de telles limites sont cependant réservées aux autres puissances européennes en Amérique et que les différents peuples amérindiens sont exclus du <<partage territorial>> qui se dessine. Conséquemment, on dénote une négation évidente de l'autonomie politique des Autochtones. Quand au deuxième mouvement, complémentaire au premier, l'assujettissement, il est dépeint par le mention de l'Autochtone sur la carte et pas une certaine hiérarchisation spatiale de celui-ci; les Indiens alliés à la France ont généralement une visibilité plus grande sur les cartes étudiées, ce qui semble vouloir dire qu'ils sont des <<Sauvages>> marqués au sceau du Roi de France, comme s'ils étaient réellement assujettis au pouvoir colonial.

Terre catholique

Un tel impérialisme politique n'est bien sûr pas seul, son pendant religieux sachant ne pas s'en laisser imposer. La Nouvelle-France est sans contredit perçue comme une terre de conversion des <<Païens>> et comme une terre de <<croisade>> et lorsqu'on regarde une carte comme celle de Bressani (lui-même jésuite), où Martyrs canadiens (Brébœuf et Lalemant) et Indiens convertis sont à l'honneur (voir les deux cartons aux coins supérieur gauche et inférieur droit), on ne peut nier l'importance du fait religieux dans la cartographie et ignorer la place accordée aux missions et aux missionnaires en Nouvelle-France.

Toutefois, la présence catholique n'est pas toujours aussi évidente sur les cartes et se dévoile souvent de manière indirect, par le masquage d'une réalité toute contraire aux aspirations religieuses, soit l'ensauvagement et l'indianisation des sujets eurogènes. En d'autres mots, l'Autorité religieuse valorise sa position de force sur la carte en éclipsant le métissage et les traces de l'adhésion européenne pour le mode de vie autochtone. La raison de ce stratagème est évidente, puisque le mode de vie en Amérique est essentiellement nomade [Mailhot, 1993, p. 141] à la venue des Européens et l'Église ne souhaite en aucun cas que ses sujets eurogènes soient <<pervertis>> par une influence païenne si néfaste; le <<[…] nomadisme est contraire aux règles de l'Eglise et incompatible avec le christianisme>> [Dickason, 1993, p. 281]. La carte vient alors porter mains fortes aux autorités politiques et religieuses, car elle possède une capacité de <<fixation>> de l'espace et arrive assez difficilement à représenter la dynamique spatiale des choses et des humains, ce qui est d'autant plus vrai en ce qui concerne les nomades. En représentant l'Autochtone, la carte tend à le fixer en créant une illusoire sédentarité. Cela se vérifie bien sûr lorsque le cartographe mentionne les différents groupes indiens sur sa carte, mais s'observe également quand il appose la nomenclature toponymique. En fait, faute de traduction, le lecteur européen ne peut pas saisir la propriété descriptive, imagée et géographique qui définit une telle nomenclature, et ne peut dès lors associer l'expression toponymique qu'à l'Autochtone lui-même, lequel comme le toponyme, est alors rattaché à un point fixe et unique dans l'espace.

Terre de Passage

Nonobstant, on comprend mieux l'importance discursive de la carte quand on s'attarde à comprendre les ambitions de la France. En effet, si les autorités religieuses et politiques se servent de la carte pour nier l'influence amérindienne, le métissage, ainsi que l'ensauvagement et la <<nomadistion>> eurogènes, d'un autre côté, elle profite pleinement de la réalité américaine qui se trame, car l'adoption du mode de vie nomade autochtone par les Français entraîne certains avantages à la puissance coloniale: pensons à l'apport essentiel des <<coureurs des bois>> dans le commerce des fourrures; ou à l'apport d'informations géographiques découlant des impératifs de ce négoce. De si importants bénéfices expliquent peut-être pourquoi la France fut peu encline à envoyer des sujets disposés aux travaux des champs et pourquoi elle leur préféra des individus plus susceptibles de s'adapter et des conditions de vie assez changeantes et des individus disposés à profiter de cette liberté que les vastes forêts de l'Amérique semblent encourager. Conséquemment, on voit bien que la France n'a pas comme premier objectif le développement agraire et colonial de la vallée du Saint-Laurent. On peut d'ailleurs se questionner sur l'absence des seigneuries, alors que Champlain n'hésite pourtant pas à représenter l'occupation du sol des Autochtones de la Huronie sur sa carte. En fait, la France ne semble pas percevoir l'Amérique comme une terre d'accueil et de vie, mais plutôt comme un obstacle fâcheux:

> Pendant des siècles, le Nord de l'Amérique intéresse beaucoup plus pour le détroit qui reste à trouver que pour l'établissement. Le Nord n'est pas vu comme un territoire mais comme le lieu du passage. C'est là son premier intérêt. La rencontre avec l'Amérique est une méprise. Elle est autre. Terre imprévue. Impossible continent. C'est l'Inde ou la Chine qu'on cherche et veut trouver et si une terre neuve barre la route de l'Ouest, il faut la traverser ou passer outre. Parce que l'Amérique n'est pas le but, mais le passage obligé vers un autre but. Le Nord de l'Amérique, c'est le chemin de la Chine. Tout autant et plus que la fourrure, le chemin de la Chine anime la fondation du Canada [Morissoneau, 1996, p. 222].

Ainsi l'utopie du Passage vers l'Ouest naît-elle de ce houleux contact entre la réalité géographique de l'Amérique et la quête du Cathay. Et il importe peu que ce passage soit une réalité géographique incontestable pour que les cartographes le représente. D'ailleurs, si sa présence est subtile sur les cartes de Coronelli, de Fer, de Delin et de Marquette, et si elle est déjà plus facile à cerner sur les cartes de Champlain, de Sanson et de Jaillot (il ne s'agit que d'observer attentivement les Grands-Lacs, lesquels sont souvent incomplets, ouverts vers l'Ouest et dépassant même le cadre dans certains cas!), elle est sans conteste sur la carte de Guillaume Del'Isle, lequel œuvre même d'audace en affichant la présence d'une Mer de l'Ouest, à la fois embouchure du Passage et à la fois ouverture océane sur la Chine. En regard de ce qui précède, la carte de la Nouvelle-France n'est définitivement qu'une terre de passage pour la France.

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La géographie coloniale en Amérique est essentiellement spéculative. Elle n'existe pas vraiment dans les faits. Elle est invention. Pour tout dire, une telle géographie doit devenir, d'où l'apport primordial de la fonction projective. Si la mémoire joue aussi pour beaucoup (ne pensons qu'au mythe du Cathay), notons toutefois qu'une telle mémoire n'est pas américaine, mais européenne.

Géographie autochtone

On le voit, le pouvoir colonial est dans l'impossibilité d'effacer complètement l'empreinte laissée par l'apport informationnel autochtone, et à travers toute cette information amérindienne, on ne peut manquer de déceler une géographie indigène originale. À ce sujet, on pourrait s'attarder à étudier les traces de l'assimilation des cartes autochtones, ces dernières semblant revéler une prédisposition de la culture indigène pour la schématisation et pour les formes géographiques [Lewis, 1986, pp. 24-25]. Toutefois, la toponymie, parce qu'abondante sur la carte européenne et en raison de son caractère descriptif et imagé, nous paraît être l'élément clé de l'appréhension de la géographie indigène. De plus, le toponyme est souvent perçu comme le reflet culturel du désignant, faisant passer un site impersonnel et interchangeable dans le domaine du lieu, lequel est symbolique, investi et culturellement reconnaissable. <<Attribuer à un être ou à un objet ou encore à un lieu un nom, c'est lui donner une véritable existence, le créer en quelque sorte en le faisant émerger hors d'un anonymat dans lequel l'avait confiné son absence d'identité>> [Dugas, 1984, p. 441]. La nomenclature toponymique délimite donc l'espace en créant un univers symbolique propre à un groupe, ce qu'on pourrait appeler une appropriation spatiale.

Terre de vie et de mémoire

Ainsi, que les noms de lieu indiens soient proches de la réalité géographique est ici un fait capital, puisque preuve d'un savoir géographique réel et autochtone. En effet, en plus d'être un discours sur l'espace, la nomenclature toponymique indigène est aussi et surtout une science des lieux. On comprend d'ailleurs toute l'importance d'une telle forme toponymique pour les groupes indigènes, car elle s'avère être un cadre à l'intérieur duquel peut se développer leur nomadité. En réalité, si la nomadité multiplie les lieux investis par le groupe qui la pratique, elle ne s'appuie pas moins sur un cadre spatial particulier et relativement délimité par les lieux et leur dénomination eux-mêmes, car ceux-ci deviennent alors des points de repère et des balises symboliques dans l'espace. Une relation intense peut donc s'établir entre l'acte de dénomination et la nomadité, car si en un sens la toponymie permet l'expression de la nomadité en lui servant de cadre, dans un autre sens, le caractère nomade permet à son tour une meilleure connaissance de l'espace et une augmentation subséquente des toponymes, vecteurs importants d'un tel savoir géographique. Une toponymie comme celle des Européens, laquelle, comme le rappelle Christian Jacob [1992, p. 265], crée davantage son référent qu'elle ne le nomme, peut difficilement se passer de la carte pour être située dans l'espace. En contrepartie, la richesse informationnelle qui caractérise la nomenclature toponymique autochtone rend caduque et redondante l'inscription cartographique de cette dernière, car elle est déjà une cartographie <<mentale>> (comme le suppose Dugas en parlant de la toponymie inuit). Par conséquent, vue la relation étroite qui s'instaure entre la culture d'un cartographe et sa carte, la toponymie amérindienne, qui prend une large place sur la carte européenne pour les raisons énoncées ci-dessus, ne peut éviter d'être le reflet de la nomadité amérindienne et, du coup, de démontrer que l'Amérique n'est pas seulement une terre de passage, mais bien une terre de vie et d'existence où la connaissance géographique n'est pas une velléité coloniale mais bien une question de survie.

Par ailleurs, le toponyme met en relief une autre caractéristique culturelle autochtone fondamentale, l'oralité: <<Société de l'oralité, le monde indien est fasciné par le verbe, il apprécie l'orateur mimant une situation, le discours imagé, le rythme de la voix, le chant des sons>> [Jacquin, 1987, p. 63]. Une telle fascination pour la parole est évidente, car celle-ci est aux cultures orales ce que le papier est aux civilisations ayant développé l'écriture. Pour les peuples autochtones, la parole est donc le véhicule par lequel sont transportés et mémorisés, d'une génération à une autre, traditions, mythes, légendes etc. et ce faisant, de tels peuples s'inscrivent dans le temps et l'histoire. Or, l'originalité de la toponymie indigène tient au fait qu'elle est en mesure d'exprimer un maximum de contenu dans un contenant (l'expression toponymique elle-même) restreint, ce dont sont bien sûr incapables les traductions françaises. Le contenant et le contenu sont par-là même plus aisés à mémoriser. Le toponyme est par conséquent une mémoire orale qui facilite la communication d'un savoir géographique primordial à la survie. Ainsi, s'il sait signifier à travers sa valeur informationnelle que l'Amérique n'est pas réellement vierge (comme le suppose d'emblée la puissance coloniale), le toponyme emploi également sa capacité mémorielle pour démontrer que l'Amérique n'a pas été mise au monde par l'Europe, mais qu'elle était déjà culturellement et historiquement <<pleine>> à l'arrivée des Européens.

*

L'Amérique n'est pas que devenir, elle a aussi un passé. Elle n'est pas que vide, elle est une réalité culturelle. C'est parce qu'il est reflet de deux aspects culturels d'importance, la nomadité et l'oralité, que le toponyme joue dans l'analyse de la carte néo-française un rôle si important. Il offre une image tout à fait différente de l'Amérique, contraire en bien des points aux visées et aux intérêts de la France coloniale. D'ailleurs, l'ironie est à son comble, c'est la fonction mémorielle qui a permis la <<cristallisation>> de la nomenclature toponymique autochtone, une cristallisation qui, même si elle s'est dégradée avec le temps, fait encore l'originalité du visage toponymique canadien et québécois. En outre, la toponymie exhibe un phénomène révélateur, soit la pérennité sur la carte européenne de l'Amérique d'un fait autochtone qu'une telle carte avait justement pour mission <<secrète>> de nier.

Conclusion

La cartographie de la Nouvelle-France est sans aucun doute le résultat de l'amalgame unique de deux géographies, dont l'une est celle de la puissance coloniale, et l'autre à l'image du monde autochtone. Ces deux géographies s'interpénètrent en quelque sorte; si elles paraissent souvent opposées de par leur origine elles n'en demeurent pas moins à la base d'une interrelation d'ordre symbolique et révèlent ainsi ce qu'est en réalité l'Amérique française dans toute sa vaste étendue, une terre métisse, où l'européanité que projette la géographie coloniale est venue à la rencontre d'une américanité déjà en place. En d'autres termes, l'Amérique française n'est ni totalement française (en déplaise au Roi) et n'est ni tout à fait autochtone non plus, elle est un subtil mélange des deux. Ainsi, même si la géographie eurogène avait pour objectif de se substituer à la géographie indigène, cette dernière persista toutefois en affleurant à maints endroits sur la carte. D'ailleurs, les titres des cartes que nous avons analysées sont à eux seuls des témoins privilégiés de cette interpénétration et de cette coexistence. En effet, des dix documents se retrouvant en bibliographie, six ont un titre qui n'ose pas arrêter le nom de l'espace à représenter: est-ce la <<Nouvelle-France>> ou le <<Canada>>? Si la première illustre le projet géographique colonial, de son côté, le Canada, de par son origine toponymique amérindienne, dépeint la réalité géographique indigène.

Un tel retour sur la cartographie néo-française nous rappelle que tout en étant un outil utile, pour ne pas dire essentiel, la carte n'en est pas pour autant un instrument dénué de subjectivité, mais bien une œuvre sociale et culturelle. Une certaine dose de méfiance et de sens critique s'imposent, car la carte, comme tout discours, risque toujours de balancer dans un processus de rhétorique et même de propagande. Chose sûre, sans ces <<tares>> qui structurent toute production cartographique, l'analyse d'une cartographie comme celle de la Nouvelle-France n'aurait pas autant de portée.

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Meaning in Cartographic Semiology

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Abstract

Semiotic researches in cartography have metacartographic character. Their aim is to systematically integrate the entire parts and subsystems of cartography into one global, coherent and logical unit, i.e. metasystem, as well as to give cartography its corresponding and optimal place, both in the global system of geographical studies and in the general system of all the sciences.

In this way it has been established a multiplicity of meaning of cartographic signs, sign system and the language of cartography. This multiplicity can help us to understand how these signs operate in geographic perception and reception, interpretation and opinion making, prognoses and development of geocartographic culture. A special feature of the language of cartography is the unity of a logical and esthetical code of signs, sign systems and the language itself what makes cartography a relatively independent science.

The results of this research point to the fact that the constitution of the meaning of cartographic signs comprises the following: the constitution of each of the above separate meanings, the constitution of the identity of separate signs and finally the constitution of the maps as textual units written in signs. This process develops on three different levels:

1. *The level of representation – registration of meaning,*
2. *The level of position – communication of meaning,*
3. *The level of composition – processing of meaning.*

This fact clearly shows theoretically as well as methodologically that cartographic signs have all the general characteristics of the other sign systems. The undertaken researches and obtained results give possibilities for further development of the basic elements of the system, i.e. metasystem, of cartographic science and expertise. This system is based on three important suppositions:

- *Ontological, substantial – geographical reality,*
- *Gnoseological, attributive – the theory of universal, particular and singular,*
- *Semiotic, relational – semiology, semiography.*

These are three foundations on which cartography builds up its position in the global system of sciences.

Introduction

Semiotic researches in cartography have metacartographic character. Their aim is to systematically integrate the entire parts and subsystems of cartography into one global, coherent and logical unit, i.e. metasystem, as well as to give cartography its corresponding and optimal place, both in the global system of geographical studies and in the general system of all the sciences.

The subject matter of signs and meaning is still an uninvestigated area of human activity although signs have a great importance in ontological development of man. Signs affect our vision of the world since they carry certain cultural and social heritage. In geography, it is maps through which a science development could be traced since they are a product of geographic knowledge of one civilisation.

In this way it has been established a multiplicity of meaning of cartographic signs, sign system and the language of cartography. This multiplicity can help us to understand how these signs operate in geographic perception and reception, interpretation and opinion making, prognose and development of geocartographic culture. A special feature of the language of cartography is the unity of a logical and esthetical code of signs, sign systems and the language itself what makes cartography a relatively independent science.

Scientific Aspect of Meaning in Cartography

Each mapping starts with visual observation and object imagination. Observation means seeing prominent characters of the object in order to identify phenomena. Making visual images of an object is a specific approach to an object and seeing even invisible part as well as investigating their contours, surfaces and textures thus making a structural pattern. Visual observation followed by mapping is not a mere mechanical illustration of reality but active process where a cartographer formulates reality consciously. That is why cartographic expressions contain a direct and potential information. An investigation on a relationship between the language and thought is an interesting problem as is the relationship between the language of cartography and thought.

The sign and meaning have their own autonomy. The sign is a sensual stimulus while meaning is a complex of intellectual and emotional relations between a certain sign and subject, sign and sign object and other signs of the same system and sign and measure in the process of studying reality. Cartographic signs are monosemic, but there is also a possibility of their polysemic meaning. For example, contour lines denote the height above sea level, but also a shape of relief.

Meaning is complex relation of some sign to:

- Mental state which it expresses,
- Object which it designates,
- Other signs of same system, and
- Practical operation needed for making, changing, using or pointing of designated object.

All the cartographic signs are linked with meaning through associative and symbolic meanings. Associative connections of signs and meanings are less investigated in the theory of meaning than symbolic connections. In conjunction with them they formulate a special kind of signs called symbols. A notion of cartographic symbol is used in cartography in various meanings with no definite distinction between that notion and the notion of cartographic sign. In theory, symbols are regarded as signs of a higher level.

It is needed to establish the basic relation of meaning of cartographic science, i.e. the scientific aspects of meaning in the language of cartography. Those are following:

- From the point of view of its mental disposition, **thematic meaning** of the signs, i.e. **semantic aspect** of the language of cartography;
- From the point of view of its object, **spatial meaning** of the signs, i.e. **sigmatic aspect** of the language of cartography;
- From the point of view of measure, **scale meaning** of the signs, i.e. **semiometric aspect** of the language of cartography;
- From the point of view of linguistics, **apparent meaning** of the signs, i.e. **syntactic aspect** of the language of cartography;

- From the point of view of practice, **interpretative meaning** of the signs, i.e. **pragmatic aspect** of the language of cartography.

The essence of this language lies in the unity of quality and quantity of its logical and esthetical parts. In other words, all aspects of meaning of this language either obtained by direct observation or by abstract thought, i.e. either the appearance or the expression, should be assembled in a certain proportion.

The language of cartography has not evolved from the natural language but simultaneously with it as its graphic equivalent. The language in which maps are constituted, drawn and written is considered the language of cartography. It has its own structure, function and genesis. The structure of cartographic language consists of a system of cartographic signs constituted as unity of sign parts, identified through cartographic practice, with multidimensional and complex meaning. Basic functions of the language of cartography, cognitive and communicational, are derived from the system of cartographic signs.

Unity and hierarchical progression of universal, particular and singular characters of each cartographic unit achieve systematisation of the structure of the language of cartography. A unique characteristic of each singular unit of cartographic signs is its multidimensional meaning, while hierarchical progression of the unity is expressed in the shape and colour of cartographic signs. Another organisation of the language of cartography structure originates from scale (metric) equilibrium of the system of cartographic signs, i.e. from metric scales.

Apparent (linguistic) meaning and interpretative (practical) meaning is another way of playing communicational role of the cartographic language. In relation to reality, the language of cartography is analogous, illustrative, but it also has all the elements of convention, i.e. of agreement on in which way created signs will be denoted.

A connection between analogous and conventional interpretation of the system of cartographic signs is established on the basis of rules called codes. The codes may be logical and aesthetic. The system of cartographic signs becomes complete when its logical and aesthetic codes are defined. In old maps, the aesthetic code is a principal code. When mathematical projections were invented aesthetic coding gave place to logical one.

Logical and aesthetic coding is also applied in defining relations between elements of signs in cartographic texts. By applying the mentioned codification a relationship between the language of cartography and reflections of cartographer and mapped object is established.

The results of this research point to the fact that the constitution of the meaning of cartographic signs comprises the following: the constitution of each of the above separate meanings, the constitution of the identity of separate signs and finally the constitution of the maps as textual units written in signs. This process develops on three different levels:

4. The level of **representation** – registration of meaning,
5. The level of **position** – communication of meaning,
6. The level of **composition** – processing of meaning.

Construction of meaning and construction of maps as a picture is unique process which understanding substantial, attributive and relation, matching and connection in both logical and linguistic way. That matching was conceptualized in following way:

1. Registration of meaning on representative level

Aestethic code	Logical code
Expression	Content
Census	Weight
Simultaneous representation	Synoptic representation
Picture	Model.

2. Notification of meaning on position level

Real perspective	Opposite perspective
Exponent content	Immanent content
Without of scale mapping	Scale mapping
Communicative function	Cognitive function
Operational purpose	Social purpose.

3. Processing of meaning on composite level

Thematic meaning	Semantic aspect
Spatial meaning	Sigmatic aspect
Scale meaning	Semiometric aspect
Apparent meaning	Syntactic aspect
Interpretative meaning	Pragmatic aspect.

This fact clearly shows theoretically as well as methodologically that cartographic signs have all the general characteristics of the other sign systems. The undertaken researches and obtained results give possibilities for further development of the basic elements of the system, i.e. metasystem, of cartographic science and expertise. This system is based on three important suppositions:

- **Ontological**, substantial – geographical reality,
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These are three foundations on which cartography builds up its position in the global system of sciences.

Semiometric of cartography studies autonomous measure (unit of qualitative and quantitative) or identity of cartographic signs and meaning, system of signs and language of cartography, as well as others: metric, correlative, comparative measure and standards.

Thematic Meaning – Semantic Aspect

Themes of mapping, geographic or thematic exactness show mental meaning of cartographic signs and it can be called thematic meaning. On that way notions like as territory of mapping, mathematics or geometric accuracy point on spatial meaning of cartographic signs.

Thematic mapping is notion that is related to thematic maps, as well as to general maps, and expresses ideas about mapping. That idea is a principle and mental picture and expression, i.e. complex of psyche disposition of different kinds. Thematic mapping, as carrier of mental meaning of cartographic signs, has all three functions: designation (showing, informing), expression (motivation) and prescription (willing impulses). If thematic mapping is based on scientific conclusion then mental meaning is most directed to function of designation with particular or complete disconnection of emotional and prescriptive function. In that way cartographic signs are directed to the relation of notions, by which they fulfil one of the important conditions for logical meaning.

Thematic meaning is always direct relation of designation. Because of that designation is polysyllabic and it is consisted of two shapes:

- Denotation (appointing) or applying sign on particular object,
- Connotation (designation) or description of object characteristics on which the sign is applied.

Spatial Meaning – Sigmatic Aspect

Spatial meaning of cartographic signs is designated by territory of mapping, i.e. mathematics or geometric accuracy, spatial and mutual location, spatial forms and orientation of phenomena or reality, which are mapping in fixed time moment or interval.

Spatial meaning of cartographic signs, as indirect designation, has two aspects of determination: spatial denotation and spatial connotation. Spatial denotation of cartographic signs appearing by applying of all types of graphic signs, starting from diagrams (cartographic co-ordinate systems), networks (cartographic networks) until dots, lines, surfaces and volumes. Denotation considers that spatial distribution (location, mutual location, orientation and spatial form of objects and phenomena) are suitable to established relations on maps.

Spatial connotation is considered of description of ways for applying signs on particular object. It can be done, first, by defining mathematical conditions for projecting spatial relations on map (cartographic content) and, second, by giving geographic names to objects and phenomena.

Scale Meaning – Semiometric Aspect

Scale (metric) meaning of cartographic signs brings about an introduction of measure and measuring into the process of mapping of thematic and spatial elements in accordance with objectives, intentions and needs of certain mapping. Scale meaning represents a connection between cognitive and communicational aspects of the language of cartography.

The scale is the principal cartographic feature representing a ratio between the dimensions of a representation and those of the object and phenomena of reality mapped. The scale represents reduction, enlargement and the ratio 1 to 1.

There are several kinds of scale classification. One of them is a distinction between principal and partial scales. The principal scale is a real scale of the model of Earth's ellipsoid rolled out flat. The partial scale is a ratio between an infinitely small surface in the map with a corresponding surface in reality. Development of thematic cartography brought about the appearance of area scale and semioscale. The area scale is a surface scale of the map, while semioscale is a scale of signs on a thematic map and they may be called a scale of space and a scale of content.

The scale in cartography is represented in two ways: as heteronomous metric measures and as an autonomous measure. The scale as a metric measure, in wider sense a heteronomous measure, was invented in classical cartography, where it was a means of quantitative comparison between sizes of the same qualities, i.e. as principal, partial or slope scale. However, contemporary cartography sees a scale as a proportion of shapes and relations, i.e. as an autonomous measure, a unity of quality and quantity establishing an origin and maintenance of real and wanted identity of cartographic signs and their meaning, genesis of the system of signs in the key and their textual presentation on the map or systems of maps.

A connection between scales, comprehended as both a metric measure (heteronomous measure and an autonomous measure), is expressed in the fact that change of a metric measure leads to a greater or smaller change in the type of unity of quality and quantity of mapping or maps. The change of principal scale from large and medium towards small one, in a metric sense, is considered a different unit of mapping in an autonomous measure sense, where large scale corresponds to topographic mapping, medium to readable topographic, and small to readable geographic mapping. In that way, only through scale meaning seen as a connection between autonomous and metric (heteronomous) measures, may cartographic generalisation be better understood as generalisation of the size and contents of mapping.

Division into area scale and semioscale, or scale of space and scale of content may be regarded as a division of scales from the point of view of metric and autonomous measures. They may be seen as an expression of outer and inner measures of the same scale meaning, cartographic signs and their textual presentation on the map.

The scale meaning, as an autonomous measure of cartographic signs, means a measure of the signs themselves, i.e. essential relations and connections, such as relations between mental (thematic) and object (spatial) meanings as well as between linguistic (apparent) and practical (interpretative) meanings. It is the autonomous measure of cartographic signs and their textual presentation that defines the subject matter and territory of mapping and expresses their thematic faithfulness and geometric exactness as well as readability and usability of maps.

The scale meaning, as an outer heteronomous measure, expresses a kind of relations between two or more autonomous measures, established in a series of, e.g. topographic, readable topographic and readable maps, whether in their interrelations or comparative changes, or in an array of connections and relations such as correlative measures, compatibility, interdependence etc.

Exponential aspect of proportions in cartography is a scale regarded as the degree of reduction while its immanent essence is a proportion or harmony between every cartographic sign and mapped contents. It is especially conspicuous on thematic maps. The scale, therefore, may be numerical and graphical.

Such a harmony of elements and their interaction enabling maintenance of certain unity of quality and quantity is seen in every cartographic sign, a basic unit of meaning in cartography. Such a harmony connected with an autonomous measure is an autonomous harmony, i.e. a basic issue in scaling whereas the scale as a degree of reduction may be seen as a relation connected with a heteronomous measure of cartographic signs. Therefore, two kinds of scales may be distinguished in cartography: autonomous scale and heteronomous scale.

The autonomous scale shows an autonomous harmony of cartographic signs, i.e. their meaningful (logical) and perfect (aesthetic) analogies with objects or phenomena mapped. It is an indirect measure of mapped reality, establishing the following: the degree of discreteness (indicative level), the level of universality, causes, genesis, origin and duration as well as basic content features of objects and phenomena mapped.

The heteronomous scale shows a heteronomous harmony of similarities and differences of cartographic signs and mapped reality in view of complexity of size, importance, interrelations, harmony of form and content, and coherence and consistence of certain types of mapping. Establishment of autonomous and heteronomous scales brings about scale meaning of cartographic signs, i.e. semiometric aspect of the language of cartography. Using the scale meaning in discovering inner traits of mapped phenomena, a place of certain phenomenon such as its kind and subordination may be established, but also its characteristics such as immanent traits, specific differences, etc.

The autonomous scale is concerned with inner, while the heteronomous is concerned with external identification of signs. Difficulty of signs signifies the autonomous scale, while census of signs signifies the heteronomous scale. The autonomous scale corresponds to semioscale whereas heteronomous corresponds to area scale.

The semioscale cartography is a complex process comprising several phases. The first phase is equation, a conditional equalisation of numerical value of mapped object with the same number of size units of certain metric of geometric figure. Limitation is the most susceptible phase of mapping. It defines the size of signs for the highest or lowest numerical value of the mapped indicator/unit. Reduction is a scale reduction of the numerical value of the indicator. Scaling is defining the size of the scalar. A last operation in algorithm of semiometry is cartometry, i.e. calculation of numerical values of the indicator of the mapped object.

The semioscale cartography is divided into differential, unified and comparative. The differential semioscale cartography is applied in the following cases:

- When a series of numerical values is represented with a series of similar cartographic signs in a certain semioscale;
- When several series of numerical values are represented with a series of different signs in several semioscales, where each series of data corresponds to a series of similar signs in a particular semioscale.

Unified semioscale cartography is applied in the following cases:

- When several series of numerical values is represented with the usage of several series of similar signs in the same semioscale;
- When several series of numerical values are represented with several series of different signs in the same semioscale.

Comparative semioscale cartography is a partial unification of an object such as:

- Equation of basic scalar for similar signs, or
- Equation of basic value for different signs.

Semioscale thematic cartography can be applied on different kinds of thematic maps.

Apparent Meaning – Syntactic Aspect

Linguistic or apparent meaning of cartographic signs is defined through cartographic key or legend in way of nominal definition for every sign. By cartographic key it is established relation of one sign to another.

Apparent meaning of cartographic signs is consisted of two level, two types of signs by which is appointing and designating object and phenomenon of mapping.

At the same way linguistic meaning is characteristic for co-ordinate systems, map projections, co-ordinate networks and other elements of spatial meaning which are implicit designating in cartographic key or on map with special data. Cartographic key is system of cartographic signs.

By mapping cartographic signs pass from implicit form of cartographic key to explicit form of map. Elements of linguistic meaning by appointing and designating get into cognitive, expressive and prescriptive element of mental meaning, i.e. into thematic and spatial meaning. Special level of meaning contexture is Atlas.

Interpretative Meaning – Pragmatic Aspect

Interpretative (also can be called practical) meaning of cartographic signs originates from all others meanings. Interpretative meaning is realised through usage value of map or Atlas.

Conclusion

Studying multiplicity of meaning of cartographic signs, sign system and the language of cartography, can help us to understand how these signs operate in geographic perception and reception, interpretation and opinion making, prognoses and development of geocartographic culture.

In the creation of this work it has been used methodological concepts of the contemporary theory of systems what has enables us to undertake a certain reconstruction of already existing and to construction of newly acquired knowledge for the sake of greater heuristic richness of cartological and cartographic science and expertise. By highlighting some semiotic problems of cartography it has given a clearer concept of logical and protological foundations of cartography.

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Session / Séance 38-A

The Changes in Geographical Thought and their Impact on Messages Represented by Maps

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Abstract

The title of the enclosed paper contains three parts: The Changes in Geographical Thought, Messages Represented by Maps, and a discussion of their possible relationships, either a mutual connection, or a one-way relationship. The paper presents a geo-historiographical analysis of the conceptual changes which occurred during the development of Geographical thoughts. Special emphasis will be given to explain the definition and determination of its spatial unit. In accordance with that analysis, a comparative examination of the messages expressed in maps is discussed, with application to the demarcation of the space of Israel. Does Conceptual Conciousness affect mapping objectivity? The conclusion will be based on answering the above question.

Introduction-Definition of the Research Topic

Throughout the development of Geographical Thought, many conceptual changes have occurred. These changes do not merely relate to the accumulation of knowledge, analytical and research methods, or to the language and terminology of Geography. Its major development lies in the definition and determination of its spatial unit. From an unlimited recording of the **earth** and of the **world,** Geography moved from the classification of **natural regions** to the demarcation of **spaces** based on human characteristics. Lastly, at present, it arrived at the analysis of functional **territories** and their significance in terms of sovereignty[Hartshorne, 1979].

It is possible to observe a reciprocal relationship between the development of Geographical Thought and the characteristics of its research methods. Thus, on the one hand, the choice of the conceptual approach and its attendant research method, left its impact on the demarcation of the space and its internal substance. 'Regionalization', on the other hand, the choice of type, character and delimitation of space, dictated a certain related conceptual and analytical approach.

This mutuality (or dialectic) between Geographical Thought and the object of its research is reflected throughout the history of Israel's Geography and it's representation on maps. The names of the land are not arbitrary: **'The Holy Land', 'Eretz Israel', The State of Israel', 'The Jewish State', 'National Entity'** - All of these are derived from conceptual developments in the discipline of Geography [Baker and Biger**,** 1992].

In addition to this 'academic' component, changes were also brought about contextually (in a non-academic way), through the ideological structure of the society and nationhood of Israel.

The usage of different terminologies and alternative classifications for spaces, has not served only as a framework to analyze the characteristics of **'landscapes'** and their intrinsic human activities. But it has also left its signature on the way geographical characteristics of **'Eretz Israel',** became known. For example, on its social distribution and the curriculum planning of Geography and it's teaching. Maps were the official documentations, in which conceptual messages were published.Through the latter, it left an impact on the knowledge and the education value gave for the '**Conceptual Conciousness of Eretz Israel'.** These were the main factors in the formation of Israel's spatial-political image, and consolidated its demarcation within **'consequential boundaries'.** The latter turned, at a later stage, into **'natural', 'secured'**, **'accepted'** and '**agreed'** borders, and into the object of its spatial image.

The importance of the present research, therefore, results from the fact that the interrelation between the changes of Geographical Thought and their expressions in the characteristics of Eretz Israel, is explicit on maps. It has implications on the demarcation and design of the various spatial frameworks, political as well as administrative, of the past century. **'The signature on the landscape'** left by these frameworks is not easily erased. It is likely to continue to determine 'our space', and therefore required to be studied and discussed at the outset [Pakula-Shlomi, 1995].

1. **The 'Conceptual-Geographical Signature'** (Definition of the Geographical Nature of the Present Study - fundamental ideas and ideologies that form the basis of the Geographical Thoughts).

Examinig the historiographical progress of Geographical Thought, shows changes in periods of agreement with a common conceptual denominator and their occurance in the research of space. As opposed to this, periods of disagreement and different knowledge stuctures exist. The nature of the knowledge base, during the different periods of time, are examined on three main levels (see Table 1):

(One) **The Geographical Research Object/ Spatial Unit Demarcation.** It was explained in the opening paragraphs on two different scales: one, the world as a whole, and the second concerns the space of Israel [Hartshorne, 1979; Bird, 1989, Haggett, 1990].

(Two) **The conceptual level** which forms the basis of Geographical analysis is divided into a philosophical background and a methodological framework, with the latter not necessarily being bound to the former. A frame for a retrospective analysis of developments and changes in the notion of space, that served Geographical Research, was constructed. This framework, its influence on the study of Israel, and its ideological evaluation, forms the basis of the present work. This chapter elaborates on the relationships amog philosophical approaches individuals have, their ideas and concepts, and the ways they conduct their researchs. At the conclusion of this chapter, the essence and stucture of present Geographical Science is discussed. The problematics and obscurities of the definition of contemporary Geographical Though is addressed [Bird, 1989, Brown, 1980, Holt-Jensen, 1988]. The question dealt with is whether the change that has occurred in Geographical schools is part of a general tendency in the development of sciences. If this is the case, what are the implications for the research object-unit of Geography and for its conceptual definition?

(Three) **The level of the Language of Geography and of the Research Structure** which forms the basis of the analysis of space. A number of Geographical schools are associated with different methodologies, during the course of time. They have generated theories in accordance with their methodologies. These theoretical structures were accompanied by their research methods and tools. This chapter is dominated by the relationship between methodologists and their influence on the nature of geographical research, and its expressions [Haggett, 1990]. The uncertainty regarding the present characteristics of Geography is dealt with in analogy with the general, philosophical unclarity. Moreover, certain domains are unique to geography, while others are adapted from other sciences (e.g. mathematics).

(Four) The external framework - the 'Space - Place' which underlies the geographical analysis: non-academic related systems, such as that of the 'place', influence the changes in geographical viewpoint. The content is intergrated by historical events, by political outlooks and by ideologies.It is determined by the social, general and non-academic framework. It is discussed in parallel with philosophical and structural changes. This chapter aims to illustrate how the use of space-related terminology is not coincidental or arbitrary. Notions, such as earth, land, region space or territory, represent a significant difference in terms of research. The chapter concludes by defining criteria for the knowledge base with regard to all the different periods in Geographical Thought. The historiographical discussion reveals the significance of the use of the research unit, which is an object that varies over time. In this chapter, the research model is constructed, and on its basis the 'space' will be evaluated. Special emphasis is put on understanding the way in which space is delimitated and on how its subdivisions are formed. This model then serves as a framework for the investigation on the nature of the space in the geographical research of Israel.

Table 1. Definition of Space in the Geographical Thought-A General framework for analyzing the Geographical Thought/ School According to the acceptance in geographical science [Pakula-Shlomi, 1995]

Geographical Thought/ School					
	Inductive	*Regional*	*Spatial*	*Functional*	*Rational*
Spatial Unit Demarcation					
World	Earth, Globe, Wholeness, Erdkunde	Region, Natural Zone, Environment	Space, Ecosystem, Landscape	Territory, Functional Zone	Ethnic Entity
Israel Image	Holy Land	Land, 'Eretz Israel'	'The Jewish State'	The 'State of Israel'	'National Entity'
Ideas & Ideology Basis					
Philosophers' attitude	Bacon, Kant (Empirism)	Darwin (Naturalism)	Einstein (Relativism)	Marx (Radical Materialism)	Popper (Rationalism)
Methodologist Approach	Humboldt, Ritter (Classical)	Ratzel, De la Blache (Structural)	Hartshorne (Spatial)	Isard, Friedmann (Functional)	Buttimer (Humanistic)
Conceptual Conciousness	Positivism, Pragmatism, Colonialism, Theology	Structuralism, Determinism, Teleology	Possibilism, Probabilism, Phenomenology	Functionalism Marxism	Criticism
Language of Geographical Research: Structure and Methodology					
Methodsand Tools	Empiric, Qualitative, Subjective	Analytic, Quantitative, Objective	Analytic, Quantitative, Objective, Theoretic, Hypothetical		
Process & Relationship	Randomalic collection	Systematic, Interdependency Cause & Effect	Systemic Interaction Man & Ecosystem	Spatial Organization, Interrelation, Man, Society & State	
Subjects	Concrete World Unity	Diversity Homogeneity	Wholeness Heterogeneity	Abstract Space Integration	
Mapping	Basic Knowledge, Documentation	Topical mapping	Thematic Digital mapping	Orthophoto, GIS	
External level - place, events					
Historical dimension	1800- 1859	19^{th} century -1945	1935-1960	1945-1975	1970- now
Social Structure	National societies	Local societies	Associations	Institutes	

The following study is based on the observation of the reciprocal relationship among three components' characteristics: Spatial Unit Demarcation, Conceptual Conciousness and Mapping**.** Thus, **'Regionalization'** on the one hand, the choice of type, character and delimitation of space, dictates a certain related conceptual and analytical approach. On the other hand, the choice of conceptual outlook and its attendant research method, leaves its impact on the demarcation of space and its internal substance. From this inner structure, the main research questions arose. The main research questions are: How does this mutuality (or dialectic), between Geographical Thought and the object of its research, reflect throughout the history of Israel's Geography and it's representation on maps? How does the relationship of the two mentioned components affect mapping the image of Israel? Has it any effect on knowledge documentation, selection and generalization of maps? Does conceptual conciousness affect mapping objectivity?

The major part of the study is quantitative research, but the analysis' results show that some ideological questions cannot be dealt with by this method. The conclusion of this chapter consists, therefore, of qualitative, and critical research.

2. Examination of the Ideas of the present study

Examination of the Ideas of the present study is carried out by means of an analysis of the 100 years of the Geographical Research in Israel. Since geographical research of Isreal has been at the center of worldwide attention, it has significantly contributed to the understanding of the nature of general Geographical Thought and to its spatial expression. Interest in Israeli space has declined from the second half of the 20th century. It investigates the special nature of the research that attracted methodologist to the space of Israel, as well as their ways of thinking and their influence on the shaping of its space. Alternatively, the structure of the geographical knowledge-base of its content, which has not yet been applied in Israel, is also examined. The entire chapter is dominated by an emphasis on the relationship, ideological viewpoint, methodological approach, and the actual performance in spatial planning through geographical research methods.

Two main schools dominated the geographical analysis of Israel, through the development of its Geo-spatial knowledge: inductive and regional thoughts. They design the complete positivistic and structural values and viewpoints of Israel. The contributions made by the Geo- Metodologists and empiricists, Humboldt [Kosmos, 1845-1862] and Ritter [Erdkunde, 1817-1818; 1822-1859] and their inflence on Israeli spatial analysis, is essential and proven (59.0%-1859-1950, 24.0%-1900-1993).

(One) The preliminary process in the formation of the image of Israel was made by the individuals engaged in the 'redemption of the land' in the holy land. Ritter (1850), for example, had two opposed attitudes, realistic and idealistic. He left an impact on the ideological meanings and symbolizations given to **'The Holy Land'** and its biblical image from Dan to Be'er-Sheva. Ritter's interpretation of 'empirical' borders, based on general descriptions of the **'Promised Land'**, served as the idea for the 'National- Jewish Homeland'. Many supporters followed his footsteps [Kitto,1841; Smith, 1850; Robinson, 1865] and validated the ideographic motivation and ratified it in the educational geography of Israel. They influenced the struggle over borders delimitation and residence area preference, by emphasizing their colonialist, theological outlook, concerning religious centers and archeological sites. Moreover, their inductive and descriptive aproaches, conceived as objective information, influenced the priority given to the choice of areas by Zionist authorities. Pperipheral land, as in the east bank of the rift valley, was purchase to establish colonies- pioneering settlements [Smith, 1975] **(see:** Ritter's Biblical image of **'The Holy Land'**).

(Two) The conceptual-Regional signature remaining on the landscape of Israel is no less significant than the one left by the Inductive school. Even though the regional school opposed the inductive thought, its effect on Israel's image is no less (34.4%, 29.4%). It expressed a confirmed and totally different attitude-a direct connection between naturalism and uniformity, without adopting or adapting the determinist concept. Brawer, A.Y., for example, wrote that 'through thousand years of demarcation, in the political circumstances of our land, it will always stay in its 'natural borders'' (1931). He was following Hettner (1907), Huntington (1911), who were political activitivists toward the creation of an image of the national home, accompanied by the infiltration of marginal areas and the expansion of 'Eretz Israel'. He and Amiran [Kalner, 1937, 1939] taged an impact on the fact that the **'Land of Israel',** in its physiographical image as **'Eretz- Israel',** is the desired one. The ideological meanings and symbolizations, given to the Land of Israel and its biblical interpretation, goes from the 'River to the River' (either, the Litanic river to the Nile river, or the Jordan river to El-Arish river). These interpratations were justified with the comment that physical demarcation has been 'solid, good, convenient and reliable' [Brawer, M.,1988]. It was so agreeable that the British Empire and the Israeli authorities adopted the Jordan river as the border between the two national entities.The Israelies adopted it twice: once- after the 1967 war as the 'clear, natural, secured, accepted and safe' border; and once- in the 1995 Peace Agreement as 'Jordan is the natural barrier of Israel' (1995). This means that the regional thought is yet valid in demarcation decision making and the image of the land of Israel is so instituted that it is impossible to change it. Moreover, all the physical planning of **'Eretz Israel'** under the British Mandate was based on natural zonal demarcation, both political and administrative. The physiocratic outlook of the authorities reflected the urban development (Haifa seaport), the transportation network (railway Jaffa-Jerusalem), and the agricultural regulations and their exceeding marginal residence area. Furthermore, the structural aproache influences today the official data base given for planning purposes, thus the Israeli statistical zonning categories is based on the natural zone sub-division (**see**: Amiran's Physical image of the land of Israel). With all the difficulties of the regional school, its contribution to accumulation of Knowledge is enormous in topic maps. It expressed one confirmed and totally different attitude, a direct connection between naturalism and uniformity, without adopting or adapting the determinist concept.

(Three) The conceptual-Spatial signature marked on the landscape of Israel, is less significant than the one left by the previous schools. Its effect on Israel's image is very law (1.6%, 10.3%). The conscious acknowledgment of the term 'Jewish National Home', which forms the settlements planning of the 'State of Israel' and contributes to the demarcation of its borders and their spatial consolidation, was never theoretically discussed [Reichman, 1989]. The territorial image of the state has frequently changed according to non-academic, war-related events. However, the subject-matter and the characteristics of the peripheral regions are the result of the functional planning that consolidated this image within its varying boundaries. Thus, the relationship between conceptual changes and historical events leaves its traces on the nature of the marginal areas of the State of Israel. Since 1967, the territorial image of the State of Israel and the areas of its sovereignty and dominance, have been major issues in contemporary Israeli geography. No common image is agreed upon.

(Four) In spite of the fact that most Israeli geographical processes were human, such as emigration, urbanization and industrialization, the impression of Spatial, Functional and Humanistic schools, is less than the previously mentioned schools had (4.9%, 37.3%). The image of the Jewish Land was instituted under accidental partition and transfer, in the shadow of the 2^{nd} world war events. No spatial analysis had been made and the signature on the landscape, therefore, is invisible compared to the signature of the functional - planning school's seal. Despite the fact that **The State of Israel** is declared as a **'Jewish State',** no theoretical discussion has been made on its iner-spatial uniqueness as a cultural-Jewish organization (**see**: the State of Israel in 1949 and 1974 boundaries). Some ideological and political landscapes were established, such as the kibbutz spatial organization or the settlers' occupation areas, but with no previous spatial- conceptual planning. On the contrary to the accidental demarcation of the State of Israel boundaries, their variability, as well as their consolidation within 'consequential boundaries', a great deal of functional planning was invested in stabilizing the frontier zones. Israel's military, political and economical needs were important prior to its inhabitants needs (emigrants or senior citizens). Almost no humanistic or phenomenological research has been made, and the diversity among minorities has not been studied (see: the Oslo Agreement Map).

Is it pluralism in thought or prevention from analytical decision making? What kind of space is Israel? As explained above, the names of the space of Israel are not arbitrary. **'The Holy Land', 'Eretz Israel', The State of Israel', 'The Jewish State', 'National Entity'** are all derived from conceptual historiographical developments in the discipline of Geography, and the ideological attitude toward the image of it.

Does the conceptual and ideological changes affect the cartographer's decision making?

How does a cartographer draw a line representing a border? How does he choose or select the importance of outstanding points while generalizing?

3. Conceptual developments of Geographical Thought, their Expressions in the maps' messages of Israel's territorial configuration and their implications for the design of Israel's image.

This chapter aims to examine the relationship between the 'conceptual signature' in the study of Israel and the applications of its 'landscape' into the maps' messages.

(One) **Biblical image** - The origin of the 'Holy Land' mapping and its documentation within the inductive school, lies in the French and British colonial needs. They laid the logical foundation and the mathematical basis for detailed and topographic mapping, which is used until today. [Jaqotin, 1799; Tristram 1875; G.A. Smith 1915; P.E.F Survey 1871-1977, 1880-1889 and P.E.F topographic mapping 1916-1936, in the National Atlas of Israel, 1956].

The cartography in the Holy Land, as well as in the world, concentrated on 3 aims:

- The size and shape of the globe - establishing the infrastructure of the geodetic, mathematics, and cartographic databases. The explorers' paths were designed and described relating on projections and expressions of topography.
- Detailed, empiric and accurate data accumulation about locations, places, natural resources, transportation networks. To all these items symbolization was developed;
- Colonial, theological motivation for ideograph and subjective description of their destiny, supported by governments and exploration funds.

Even though, the inductive mapping's contribution to the improvement of cartography was unquestionable, their messages were clear. The circumstances in which those maps were created are recognizable. Biblical names to the mountain ridges (Bashan, Amorites), religious towns (Jerusalem, Tiberias) and archeological sites (Caesarea). The land is dense with perennial streams and water resources. Why do maps include so many religious service centers? Whom did they serve? Where were the population and settlements they served? Did those maps mean to only serve pilgrim tourists? The ideological message is clear: 'the land of milk and honey'.

(Two) **Topical mapping of the physiographical image of the Land of Israel** - Incredible amount of physical information was gathered in field observations and represented in topical mapping. Many geographers transferred the data into prototype maps and edited them into a national atlas. 'Brawer means atlas and Geography', saying the dominance of father and son in creation, application and representation of geographical knowledge into the 'Geographic map of Israel' (1929) and the 'general map of Israel' (1943). Amiran, like the Brawers, concentrated in the role of the topographical map of Israel (1937), its development (1941) and ended in the 'national atlas of Israel' [Amiran et al., 1956]. In the last one, out of 62 sheets, 28 were physical maps, and the balance between physical and human presentation was kept. Special emphasis was made to enlighten the relief features, the drainage basins and the structural demarcation of natural regions. The cartography in the land of Israel, as well as in the world, focused on three aims:

- The size and shape of topography and its 3d expression, establishing the geodetic, mathematics and cartographic database, with its description in the colors ladder, contours, or hachuring.
- Systematic organization, accurate, detailed, deductive, classified data collection and chorological articulation, about natural features and physical surface. All those were symbolized in prototype topical maps (geology, geomorphology, hydrology, climate, lithography etc.).
- Theoretical-regional and rational motivation was applied for an objective description but nominal phenomena. The mapping was concerned in the phenomena's location, dispersion and distribution.

Even though their benefactions to objective cartographic representation were indisputable, they communicate hidden messages. The image of 'Eretz Israel' was expressed as a rich ecosystem, plain, fertilized landscape or wealthy environment for agricultural purposes.

(Three) ''The '*Atlas of Israel*' is intended to add significantly to this volume of knowledge and information, not only for the benefit of citizens of Israel itself, but for all those to whom the Land of Israel is part of their historical and religious heritage' [Amiran et al., 1970]. This declaration briefly describes the editors' intention. As mentioned in the above, (3(c)), almost no theoretical discussion on Israel inner-spatial uniqueness, as a cultural- Jewish organization, has been made. A traditional point of view was asserted. Incredible amounts of quantitative data of the cultural image of the Land of Israel was gathered in field observations but represented in topical mapping. Many geographers contributed raw material to maps and edited it into a national atlas. The proportion between human and physical activities changed. Out of 66 maps in the national atlas, 13 were in cartography, 18 were in physical geography, and 45 were in thematic maps of history and population behavior. The atlas was a huge database. Neither computerized, digital nor new mapping improvements, of the cultural image of the Land of Israel, were assembled or represented in the 'National Atlas of Israel (1970). Special emphasis was made to enlighten the human features: the population, settlements, and economy, all under a basis map of the structural demarcation of natural regions. The cartography in Israel, as well as in the world, concentrated in 3 purpose:

- The size and shape of the human activities database and its 3d expression with its description in dasymmetric, isometric or isoplethic mapping.
- Systemic spatial organization, accurate, detailed, computerized and comparative data accumulation, about human features and behavioral surfaces, symbolizing it as prototype thematic maps (density, demography, land utilization etc.)
- Theoretical and analytical motivation for a centralized and objective description of geographical phenomena was applied. Their location, site, situation, dispersion and distribution were represented. Even though, their contributions to cartography representation were uncontroversial, no messages or statements were declared in the above '*Atlas of Israel*'. No image of 'the State of Israel' was expressed. None of the human processes such as urbanization, industrialization or emigration were used to delineate the Israeli space. Unity of the surface dominates the space of Israel with no consequential trace of any diversity among populations, their origins, religions, entities or occupations. The population density is based on natural regional zoning and structural demarcation, in which the statistical results are conditioned by the basic choropleth mapping.

Conclusion - Why don't we draw maps? (Rabbin's remark)

This paper dealts with the logical connection among Geographical Thought, Messages Represented by Maps, and their mutual interrelation, as well as their impact on the signature on the landscape of Israel. The geo-historiographical analysis shows a clear outlook in two schools (inductive and regional) with distinctive messages in maps (holy and structural). Since the establishment of the State of Israel, no Geo-conceptual point of view is dominant. No theoretical discussion or prediction making procedure on its inner-spatial uniqnuess as a cultural, Jewish or plural organization, was made.It means that cartography in Israel has no messages to deliver. It concentrates in GIS database collection with no mapping development or cartographic representation. No spatial emphasis is made to explain the definition and determination of the Israel spatial image. In accordance to the above analysis, maps are not drawn because there is no common desition on the state of Israel's image and its final spatial shape.

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