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FROM METACARTOGRAPHY TO METAATLASGRAPHY

Dresden

2022

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From Metacartography to Metaatlasgraphy
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Metaatlasgraphy is a new theoretic-epistemological concept with synthesis of cartographic/cartosemiotic traditions and atlasgraphic/ atlassemiotic traditions.

The monograph presents a new trend from a map-centric concept to a multidisciplinary atlas-centric concept. Further, it projects a new metascience direction: from metacartography to metaatlasgraphy.

Die Metaatlasgraphie ist ein neues theoretisch-erkenntnistheoretisches Konzept mit Synthese kartographischer/cartosemiotischer Traditionen und atlasgraphischer/atlassemiotischer Traditionen.

Die Monographie präsentiert einen neuen Trend von einem kartenzentrierten Konzept zu einem multidisziplinären atlaszentrierten Konzept. Darüber hinaus projiziert sie eine neue metawissenschaftliche Richtung: von der Metakartographie zur Metaatlasgraphie.

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Introduction

The 20th century will remain a landmark age for cartography. In the second half of this century, the transition from analogical to digital cartography began (digital epoch). This process, on the one hand, was characterized by new technologies and trends, on the other hand by conceptual semiotic transformations and new research directions (e.g. ubiquitous atlassing, storytelling and epistemological photoatlassing etc.).The mainstream cartography was fascinated by geoinformatization and left the theoretical-semiotic and epistemological transformations without much attention.

The 20th century entered the history of cartography and its theory, and as a period of origin and formation of the conceptual movement. However, the theoretical concepts of cartography in the 20th century used only the map as a subject of modeling and research. Atlases, globes and other cartosemiotic models fell out of conceptual consideration.

In the 21st century, modern society received a new generation of atlases - ubiquitous atlases (map atlases and photoatlases for mobile devices with cartographic and non-cartographic traditions), which supplemented traditional, paper atlases and atlas systems. With the help of various thematic photo atlases, new, semiotic-oriented ways and means of acquiring information and knowledge were also introduced into the modern communication society. The 21st century can become not only the century of digitalization, geo-infomatization, democratization in cartography but also the century of carto/atlas semiotization (competent mastery of semiotic knowledge, various language/communication skills, etc.) of modern society.

This book continues the author's series of monographs:
- "Cartosemiotics in Europe" (Dresden, 2002, in German);
- "Atlas cartosemiotics" (Dresden, 2006, in Russian);
- "National Atlas of Germany: Cartosemiotic portrait" (Dresden, 2007 in German);
- "30 years together with cartosemiotics" (Dresden 2011, in German);
- "Semiotics of photoatlases" (Dresden 2016, in Russian);
- "Semiotic evolution in cartography and atlasing" (Dresden 2020),
which were devoted to cartosemiotics, atlas and photoatlas semiotics, semiotic analysis, structuring and study of maps and atlases, taking into account cartographic and non-cartographic traditions. Thanks to cartosemics and photoatlases, atlasgraphy began to form as an interdisciplinary direction. Semiotically substantiated atlas studies became the conceptual foundation for a new concept - metaatlasgraphy.

The book attempts to present the evolution of the carto-centric concept to the multidisciplinary atlas-centric one, from metacartography to metaatlasgraphy. This is a new semiotic theoretical and epistemological direction with a synthesis of cartographic-cartosemiotic and atlasgraphic traditions.

The book summarizes the key results of the author's research in 2010-2020, which characterize the process of semiotic development in theoretical cartography and carto/atlassemiotics. This process includes a formation of theoretical atlasgraphy-metatlasgraphy.

1. Cartography 1970s-2020s: Digitalitization, Semiotization, Ubiquitization...

Modern cartography, largely influenced by geomatics, has become (increasingly) technical. Location with maps (as focus) is now central to all aspects of society, evidenced in spatial management of all information. Without mastering languages like the map language and atlas language (carto/atlassemiotics), knowledge management will often be superficial.

The carto/atlassemiotics, ubiquitous atlassing, storytelling and epistemological photoatlassing etc. have developed some very interesting directions in this respect which have largely been ignored by mainstream cartography and its rush towards technological approaches. Today, e-maps are indispensable for navigation and location (and environs), wherein much of GIS for example is increasingly reductionist and normative in nature (Interview with F. Taylor 2020).

There have been substantive changes in both cartosemiotic theory and atlas-related practice and change is ongoing. Here, the creation of ubiquitous photo atlases in the 2010–2020s should be noted. They appeared in a new format with smartphones and tablets (with an emphasis on the event as a photograph and on the narrative as a narrative), including semiotic-epistemological knowledge and knowledge about the location of a map from cyber-cartographic atlases (Wolodtschenko 2021).

1.1. Selected scientific structures and concepts of cartography (1970-2020)

The time of contrasts and identity of cartography. A comparative analysis of the trends in cartography over the past 50 years (Wolodtschenko 2011, 2020) clearly shows the striking contrasts or contradictions as the "driving forces" of modern cartography. The past three decades, the last decade of the 20th century and the two decades of the 21st century were not particularly easy times for European-continental cartography. It was a time of renewal of the higher education system and professional reorientation and market-economy conditions of university/academic knowledge transfer.

In the 20th century, cartography argued for its "independence" from geodesy and geography. In the 21st century, on the contrary, cartography advocates for their "dependence" on geoinformatics or geomatics. Table 1 shows some contrasts in cartography over the past 20 years, which have been reflected particularly strongly at some European universities. The opposition "technology vs. theory" was regarded as a paradox of "one-sided cartography" (Wolodtschenko 2011). It sheds light on the new and old problems between technological and theoretical cartography in the 20th and 21st centuries. These problems are reflected in the "Conceptual barometer" (after Wolodtschenko, 1995) in the new "opposition phase" in the development of theoretical cartography in the 2010s-2020s (Fig. 1, 1a, 1b).

From the point of view of the theoretical-conceptual tendencies in European cartography of the 1960s-1990s, three phases of the development of theoretical cartography can be distinguished (Wolodtschenko 1994). These phases (see Fig. 1) are particularly characteristic of the European cartographic space, which was free of ideology and without conceptual polarization from the early 1990s.

Table 1: Contradictions of modern cartography (after Wolodtschenko 2011)

20 th century	21 st century
Contradictions of Cartography	
Cartography	Geoinformatics/ Geomatics
Map	Geovizualisation
Theory/Methodology	Technology
Science	Management
Authority	Anonymity
Diploma	Bachelor/Master
Traditions	Conjuncture
Personalities	Top-Managers Hierarchy
"Striving for Independence" (from Geodesy and Geography)	„Striving for Inclusion" (of Geoinformatics or Geomatics)

Fig. 1 „Concept barometer" of the development of theoretical cartography (Wolodtschenko 1995) with friendly, "militant" and consolidate phases

In the 1960 years, the "building blocks" for the conceptual directions in theoretical cartography formed with two publications, one by Kolacny (1967) as basic work on communication theory and the other by Board (1967) as first contribution to model theory. At that time the monographs of Bocharov (1966), Bertin (1967) and Aslanikashvili (1968, 1974) appeared, which were of particular importance for the formation of cartosemiotics and cartosemiotic thinking.

In the theoretical discussion in the 1970s to 1980s, two phases can be distinguished - "friendly" or "peaceful" and "militant" or "combative". It was surprising that at this time the "polarization methods" in cartography gave impetus to theoretical and conceptual thinking (Wolodtschenko 1996). The 1990s are marked by the consolidation of theoretical cartography. But that does not mean that a "reconciliation" is agreed upon between representations of different theoretical views.

Factual discussions and definitions regarding the priorities of this or that theoretical or technological field of research can serve as a conceptual "drive" for theoretical cartography. Unfortunately, in the 1990s there were only a few studies on the conceptual basis of cartography in German-speaking countries. This was shown, among other things, by the 1996 Cartography Congress in Interlaken, where the topic of "New Theories and Concepts" did not appear.

The consolidation phase in theoretical cartography continued until the early 2010s. The further development of theoretical cartography in the 2010s is characterized by its semiotization without mainstream cartography (technological cartography) and by its crisis in the ICA. In the 2010s, the oppositional phase dominates (Fig. 1a), in which theoretical cartography is not accepted by technological cartography. Fig. 1b includes a new-consolidate phase (Wolodtschenko 1995, updated 2022).
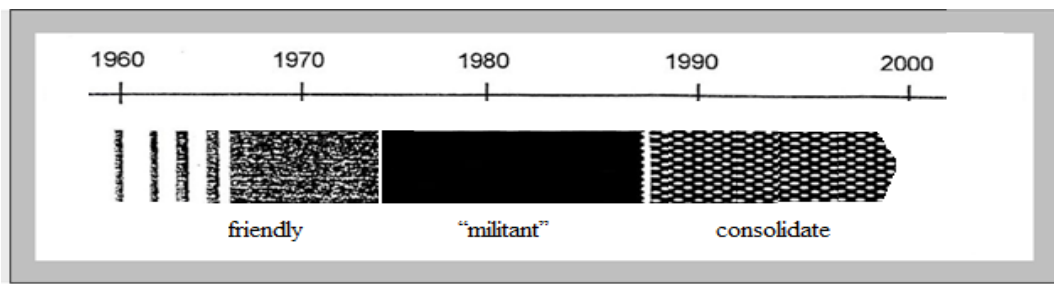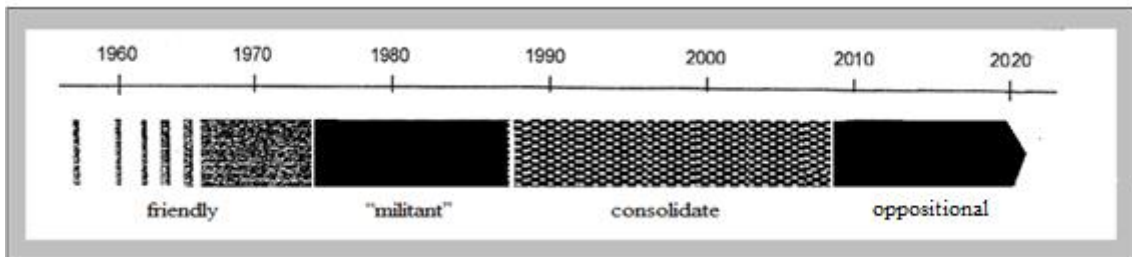

Fig. 1a „Concept barometer" of the development of theoretical cartography (Wolodtschenko 1995, updated 2022) with friendly, "militant", consolidate and opposition phases
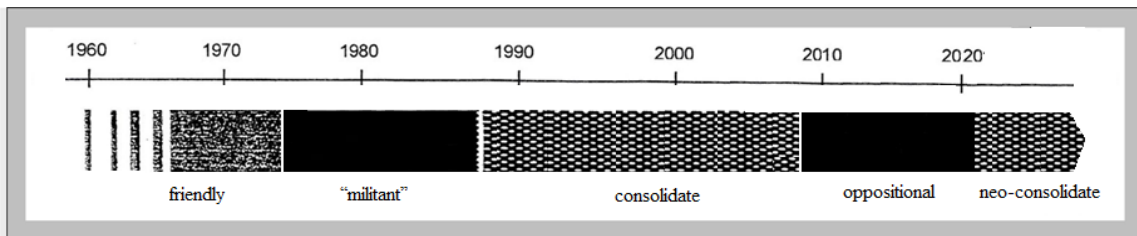
Fig. 1b „Concept barometer" of the development of theoretical cartography with prognostic new consolidate phase (Wolodtschenko 1995, updated 2022)

Structure of neocartography. The dominance of geospatial data and technology is particularly characteristic of modern cartography. According to (Gartner, Schmidt 2010), technological cartography as map-centric one (with five "geo-techniques": internet cartography, neogeography, ubiquitous cartography, location-based service (LBS) and augmented reality) forms the structure of modern cartography or neocartography (Fig. 2).

Fig. 2 Structure of Neocartography (Gartner, Schmidt 2010)

Pentagram-Model. The cartography can be seen as a pentagram of potentials (Fig. 3) with scientific-technical (science, technology, production), professional (education, scientific qualification, work activity), social and individual (associations, societies, individuals, executives), cultural and historical (cultural heritage or cultural heritage, art, etc.), multimedia communication (various media: Internet, TV, press, etc.) forms of appearance.
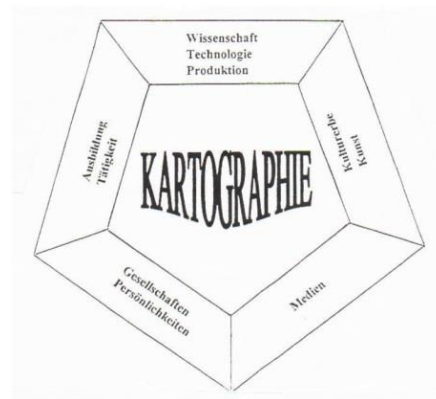
Fig. 3 Pentagram-Model
(after Wolodtschenko 2002)

In 2017 an analytical article on the ICA was published (Kraak, Fabrikant 2017). Fig. 4 shows the structural model of 28 ICA commissions and working groups in the period from 2015 to 2019. The model presented three areas of cartography - art, science and technology - as tools and two processes - creation and use of maps (fig. 4a). In a row are map data related tools and processes of 28 commissions and working groups of which only one commission is dedicated to the atlas (creation process).

art	science	technology	making	using
Art and Cartography	Toponomy	Open Source Geospatial Technology	Atlases	Use, User and Usability Issues
Mountain Cartography	SDI & Standards	Location Based Services	Map Projections	Ubiquitous Mapping
Planetary Cartography	Generalization & Multiple Reprs	Maps and the Internet	Topographic Mapping	Cartography and Children
Map Design	Cognitive Issues in GeoInfoVis	Maps & Graphics for Blind	Map Production & Geoinfo Management	GI for Sustainability
	Geospatial Analysis & Modelling	Cartographic Heritage into the digital	Sensor-driven Mapping	Early Warning and Crisis Management
	Visual Analytics	History of Cartography	Marine Cartography	Education and Training

Fig. 4 Structure model of ICA commissions and working groups (Kraak, Fabrikant 2017)
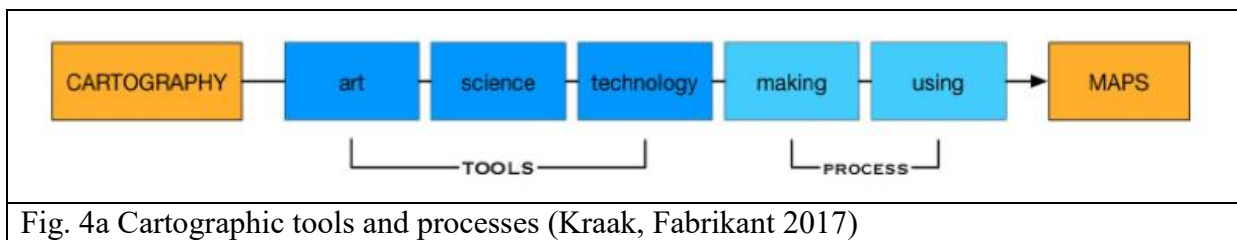
Fig. 4a Cartographic tools and processes (Kraak, Fabrikant 2017)

Modern cartography (after Kainz 2020). The structure includes general and applied cartography (Fig. 5). At the same time, cartography remains part of GIScience and a spatial discipline.
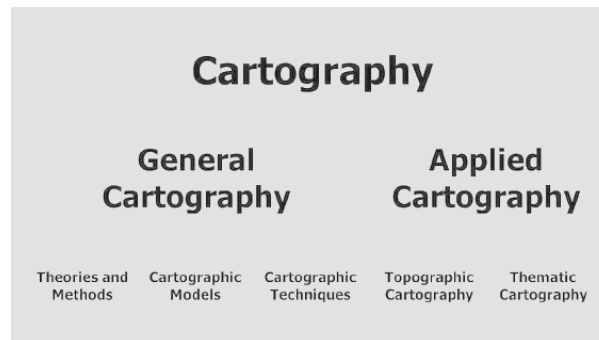
Fig. 5 Structure of modern cartography (after Kainz 2020)

Core model. In the article (Fairbairn, Gartner, Peterson 2021) a graphical model of the "core" of cartography was proposed. The map is the heart of cartography, surrounded by a "belt" of theoretical cartography and two hemispheres (Fig. 6). The upper hemisphere includes map exploration and the lower hemisphere - map production and cartographic modelling. There is a graphic intrusion of medial components between the hemispheres (interactivity, multimedia, 3D/4D, AR/AV). The map-centric and core model of cartography has no relation to atlases and atlas cartography.
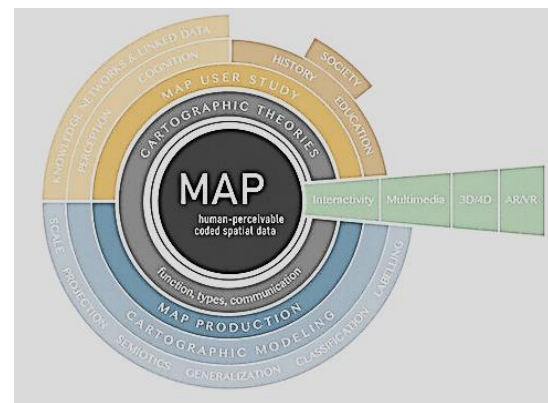
Fig. 6 Core-model of cartography
(after Fairbairn, Gartner, Peterson 2021)

In 2021 an analytical diploma thesis (master thesis) was published, in which the development of the international schools of cartographic thought was considered (Ignateva 2021). Fig. 7 (after Ignateva 2021a) shows the course of theoretical thinking in cartography over 70 years up to 2010 (adapted from Berliant 1994). The three colors (Fig. 8, legend) distinguish only three schools: Russian, French and German-American schools. The untabulated colours are not referenced in the theoretical thinking of cartography.

A remark to fig. 7: until 1990 there were Soviet Cartography School and two German Cartography Schools (GDR and FRG). Further, other theoretical concepts of the 2010s (e.g. cybercartography, meta-cartosemiotics, carto/atlasemiotics, etc.) are not represented. The concepts and theoretical thinking in cartography are "frozen" at 2010 levels, and concepts for 2010s - 2020s are missing.
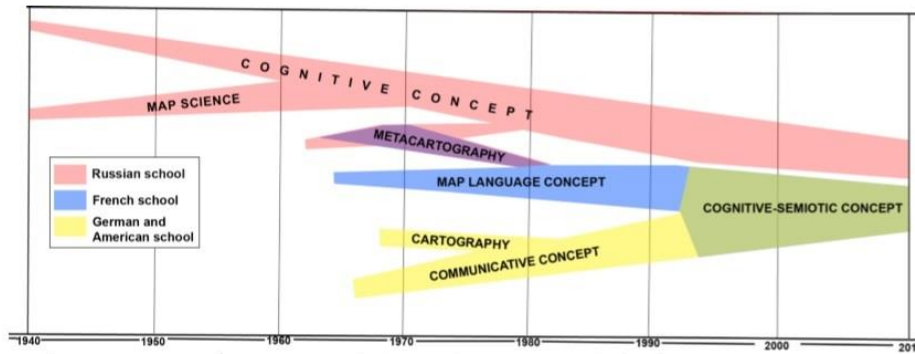
Fig. 7 International Schools of cartographic thought (Ignateva 2021a)

1.2. About paradigmatic transformations of cartography

Double balanced dominants (topographic-thematic, technological-theoretical) of cartographic models of recent decades have been transformed in the 2010s into geoinformation mono-model dominants, that is, the cartography has become a geospatial technology primarily due to the impact of geomatics. Cartosemiotic theory is not accepted by geomatic technology.

1950-	1970-2020	2020s	2030s
Topograph. Kartography / Thematic Kartography	Technics/ Technology / Theory	Geoinformatic Technology	Geoinformatic Technology / Semiotic Theory
a	b	c	d
Dual balanced models		Mono-model	New dual model

Fig. 8 Four paradigmatic models of cartography of the 20th and 21st centuries (Wolodtschenko 2021)

Fig. 8 shows four transformation models of cartography dominants. The long-term dual balanced models of cartography (Fig. 8a and 8b) were transformed into a geoinformatics-based mono-model in the 2020s (Fig. 8c), i.e. cartography became a technology mainly due to the influence of geomatics/geoinformatics. A model of a possible transformation of cartography in the 2030s is shown in fig. 8d and fig. 9 shows a new technology-theory model of cartography in details.

| Digitalitization
Geoinformatization
Visualization
Socialization
Ubiquitization | Geoinformatic Technology

Semiotic-related Theory | Semiotization
Semiotic-theoretical
Evolution
Epistemological
Transformation |
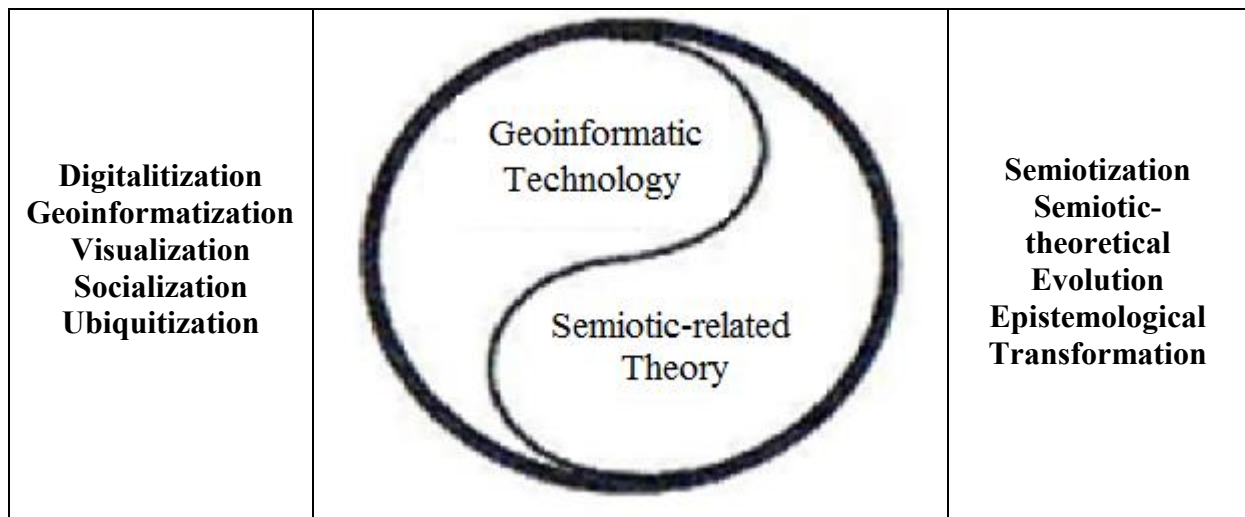
Fig. 9 One of the new technology-theory models of cartography of 2030s

1.3. Critical cartography as post-critical paradigm

Against the backdrop of the polarized world of theoretical cartography, a series of articles on critical cartography (Harley 1989, 1990) emerged in the late 1980s that reassessed traditional or positivist cartography.

The appeals criticized the content of the maps and their social construction as an expression of social and political interests and a rejection of positivist cartography. It is interesting to note here that the calls of Harley and other American geographers echoed the calls for a restructuring of the cartography of Salishchev (1988) as a representative of positive-cartography in the USSR. It was not clear who would implement such revolutionary changes and how such changes would be accomplished.

What has critical cartography brought and changed in the last 30 years? An attempt to answer this question was made with an article (Kühne 2021). The contours of "post-critical" cartography have been proposed as a new paradigm, or rather, a "possible" new paradigm. Such a new paradigm has yet to take shape. "Post-critical" cartography must take on the virtues of "critical" cartography without a categorical rejection of positivist or "traditional" cartography.

Mainstream cartography and academic cartography were not ready for such changes either in the 1990s or today and did not particularly respond to calls for controversy about democratization, deconstruction, decolonization, etc.

From the point of view of cartosemiotics, the calls of supporters of critical cartography concerned semantic changes in the content of maps (with different socio-political and historical contexts). Syntactic changes (graphical methods and variables) have been neglected in critical cartography. Pragmatic aspects regarding the new functions of map users will emerge when using digital social data for new so-called cooperative web maps.

In English-language cultural and social geography, since the 1990s, many essays and anthologies and even a first textbook (Crampton 2010) have dealt with the debatable fields of critical cartography and the "critical GIS" (Glasze 2009).

The development of a "Critical Cartography 2.0" was an important topic for research and teaching of geography as well as geography lessons in German schools in Germany in the 2000s. But at the same time, it is still in its infancy (Glaze 2009).

The 2010s show new orientations of critical cartography in Germany in the social science GIS and Geoweb research (Glaze 2014), indicating that as a rule, the cultural and social geographers act actively as initiators of the social-scientific cartography research.

A recent article in German „Kartographische Nachrichten" (Edler, Kühne 2022) continues to discuss possible approaches in the development of post-critical cartography, which has its origins in critical cartography (the awareness of the social constructability of maps and their immanent power). The term „deviant cartography" is proposed, which offers four alternative approaches to the development of cartography: functional, dysfunctional, afunctional and metafunctional. Such a conditional and corrected interpretation of the development of cartography is presented in the article (Edler, Kühne 2022) on the basis of the sociological concept of deviance.

Post-critical cartography retains approaches of functional deviance, but according to the authors (Edler, Kühne 2022), today it looks more like a "relationship" than as a significant research direction in cartography. Such post-critical cartography as a "soft" form of critical cartography is unlikely to become the paradigm for all cartography.

In the early 2020s, articles appeared (Gavrilova 2021, Ignateva 2022) devoted to criticism of national atlases and positivist atlas cartography of the USSR and Russia. The atlas cartography in all countries was based on positivist concepts and traditions of creating national atlases (Ormeling 2022). It is still difficult to say whether such critical works will receive the status of critical atlas cartography, since the creation of national atlases in many countries has been and continues to be of a positivist nature. The concepts for creating critical (non-positivist) national atlases are interesting in themselves, but who will promote and finance them?

1.4. Cybercartography: Canadian model of interactive atlascartography and theory-technological concept

The theory-technological concept of Cybercartography was introduced at the 1997 ICC Conference and the Geomatics and Cartographic Research Centre (GCRC) was launched in 2002 at Carleton University, Ottawa, Canada. Professor Taylor was a "father" this concept. Around the same time, cybernetic studies of cartosemiotics in Europe were one of the five directions of cartosemiotic research (Wolodtschenko, 1991).

The author of the book met Professor Taylor at the ICS 1993 conference in Cologne, Germany (Fig. 10), where a new concept of "Cartography visualization" was presented (Taylor 1993). In this model, Taylor (1993) suggested linking the conceptual framework model of cartography to visualization (Fig. 11).

Fig. 10 Fraser Taylor (left), Alan Mac-Eachren and Hansgeorg Schlichtmann (ICC 1993)
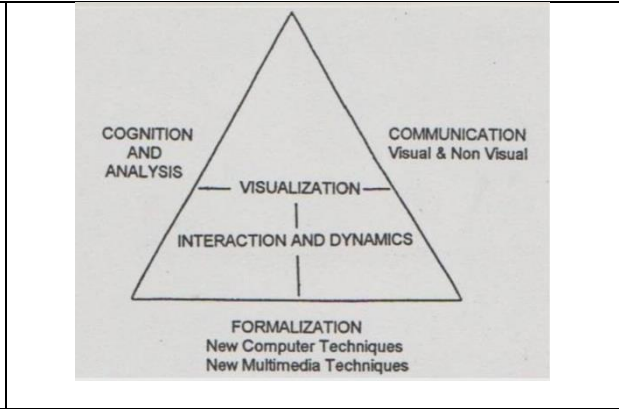
Fig. 11 1993 Concept model of cartography (Taylor 1993)

A few years later, the concept of cybercartography was introduced at the 1997 ICA Conference (Taylor, 1997); and shortly after, in 2002, the Geomatics and Cartographic Research Centre (GCRC) was launched at Carleton University, Ottawa, Canada.

Here, cybercartography of the 2000s evolved as a multimedia, multisensory and interactive online cartography developed on the innovative Nunaliit Atlas Framework Platform, an innovative open-source technology that facilitates participatory atlas creation (Taylor at al 2021).

As such, cybercartography is viewed as much more than a web-based mapping technique. It involves imagination, foresight, as well as a holistic approach that includes bridging science and art, and Indigenous and non-Indigenous perspectives. It is also a part of the paradigm shift towards critical approaches to cartography, presented in an iterative, evolutionary manner. It has a strong qualitative element and includes art, theatre and a range of human activities, emotions and topics not usually 'mapped'" (D. R. F. Taylor: Cyber-cartography Revisited. In: Taylor, D. R. F., Anonby, E. and Murasugi, K. Further. Deve-lopments in the Theory and Practice of Cybercartography. San Diego, Elsevier 2019, p.6).
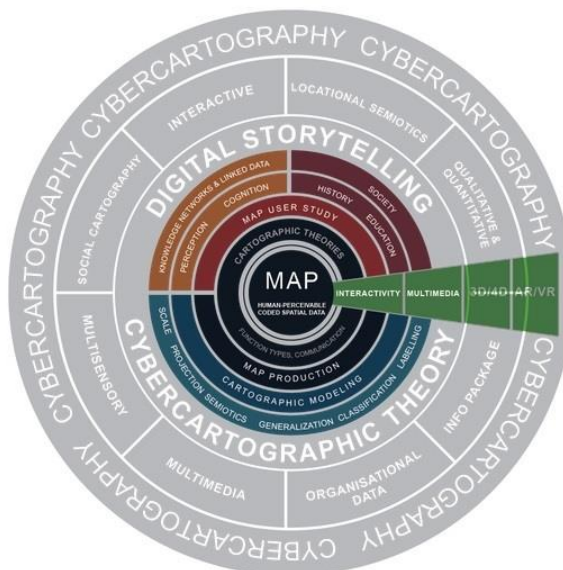
Fig. 12 Graphic model of cybercartography, after Fairbairn, Gartner and Peterson 2021 (Thumbadoo, Taylor, GCRC 2022)

The integration of the concepts in the "Core-model of Cartography" (Fig 6, after Fairbairn, Gartner, Peterson 2021) with the concepts articulated in cybercartography are presented in an adaptation of the "Core-model": here, a grey transparency layer emergent from the map foundational level and incorporating the green graphic intrusion of medial elements, is overlaid over the image; and the conceptual elements of cybercartography are presented in the outer circles, with semiotic/storytelling/interactive features noted in the upper hemisphere and technical features in the bottom hemisphere, consistent with the structural analysis in the original model.

This model (fig. 12) was developed to show how cybercartography also evolved from the pivotal map description; and the gray transparency over all the text indicates that it incorporates the elements of the Fairbairn, Gartner and Peterson, 2021 model, but also includes the elements of the cybercartography, all also impacted by the medial elements.

2. Theoretical-Semiotic Evolution in Cartography 2010s - 2020s without Mainstream Cartography

In the development of theoretical cartography and cartosemiotics from 1990 to 2020, three periods can be distinguished. These are the 1990s - new opportunities for the revitalization of cartosemiotics as a new research direction; 2000s as the years of semiotic-based theoretical cartography in the ICA; and the 2010s as a time of crisis in theoretical cartography in the ICA and the search for an atlassemiotic alternative and the formation of atlassing with atlasgraphy and atlas semiotics (Wolodtschenko 2020).

From 1990 to 1995 the non-institutional cartosemiotic "Dresden-Bratislava club-1" was active, where it published a series of booklets "Cartosemiotics". In 1995 a Working Group (WG) "Map Semitics" of the ICA was formed, and in 1999 the WG edited a monograph "Map semiotics around the world" (ed. H. Schlichtmann).

The 2000s are the years of the development of semiotic-based theoretical cartography within the framework of the ICA (Commission for Theoretical Cartography 1999-2011): the Dresden non-institutional cartosemiotic "club-2" with the booklet series "Discussion contributions to cartosemiotics and to the theory of cartography" (since 1998); and the non-institutional e-journal for theoretical cartography and cartosemiotics "Meta-carto-semiotics" (since 2008).

The 2010s are the years of the development of atlasemiotic and alternatives. Theoretical cartography turned to semiotics. Semiotics offered a place for the search and formation of new disciplines of a theoretical and methodological nature. Cartographic atlas semiotics developed within the framework of theoretical cartography and at the interface to semiotics. The 2010s also brought about the semiotics of images and finally a new direction - atlassing with atlas semiotics and atlasgraphy or image atlasgraphy (Wolodtschenko 2012).

Crisis of mainstream cartography. In view of cartography as a young science, the Viennese professor of cartography and geo-information science Wolfgang Kainz analyzed crises in cartography in the late 20th and early 21st centuries (Kainz 2020). The rapid development of Geographic Information Systems (GIS) and Geographic Remote Sensing Technology (GFE) in the late 20th century had led to an identity crisis in cartography.

Cartography is part of GI science and cartographic research (according to Kainz 2020) must concentrate on three aspects: a) map graphics (semiotics as the language of cartography); b) Epistemological aspects: modeling and object relations in space and time (ontology); and c) Spatio-temporal communication. He notes that semiotics is a fundamental pillar of cartographic visualization (Kainz 2020).

Theory crisis in the ICA. The International Cartographic Association was an active institutional supporter of cartosemiotics and theoretical-conceptual thinking in the period 1995-2011. After 2011, the ICA stopped supporting and collaborating in the field of carto/atlassemiotics. It was a fatal mistake by the ICA.

In 2011, at the 15th ICA General Assembly in Paris, a new ICA strategic plan was adopted and a new ICA leadership was elected with President G. Gartner from Austria and Vice President L. Zentai (Hungary) as well as new ICA commissions for the period 2011-2015. The ICA Commission on Theoretical Cartography for 2011-2015 was chaired by Prof.

Ch. Du from China but is no longer working. The fate of the Theoretical Cartography Commission was clearly decided at the ICA Congress in Rio de Janeiro in 2015. In 2015, new ICA leadership was appointed with President M.J. Kraak from the Netherlands and Vice President L. Zentai (Hungary) elected. The Theoretical Cartography Commission has not been included in the lists of ICA commissions for the period 2015-2019. The 2019 Tokyo Cartographic Conference had a good chance of reviving the status quo of theoretical cartography, but Tokyo's Theoretical Cartography Commission was not on the 2019-2023 list either. A new ICA leadership was also elected in Tokyo with President T. Trainor from the USA and Vice-President T. Schulz (Switzerland).

2.1. Cartographic thinking and cartosemiotics

In 1994, Jan Pravda, Hansgeorg Schlichtmann and Alexander Wolodtschenko prepared a special issue of Geographica Slovaca (number 5, 1994) as a monographic collection entitled "Cartographic Thinking and Map Semiotics", dedicated to the colloquium "Modern Problems of Cartosemiotics" (October 1994, Dresden) and the 17th International Cartographic Conference (September 1995, Barcelona) and containing three articles:
-       Cartographic Thinking, Map Language and Map Semiotics (J. Pravda)
-       Map Symbolism Revisited: Units, Order and Contexts (H. Schlichtmann) and
-       Cartosemiotics – Components of Theoretical Cartography (A. Wolodtschenko).
These studies used various diagrams to present the results of the analysis of the literature on theoretical cartography.

Fig. 13 "Development trees" with 178 sources (left) and with 151 sources (right)

Two graphics from the article (Pravda 1994) show selected "development trees" (Figures 13 left and 13 right). The first tree reflects the development of theoretical cartography in the period 1900-1991 based on 178 sources (according to Pravda 1994), the second tree, according to 151 sources (after Kanakubo 1993). The bibliographic cartographic sources were monographs, textbooks and individual articles. The construction of the "tree" included the trunk (general cartography), the left side of the tree (sections of thematic cartography) and the right side (applied theoretical sections - the language of maps, cartosemiotics, cartology, etc.).

The diagram in fig. 14 gives a comparison of the frequency of cartographic publications in chronological order based on two graphic constructions" (figures 13 left and 13 right).
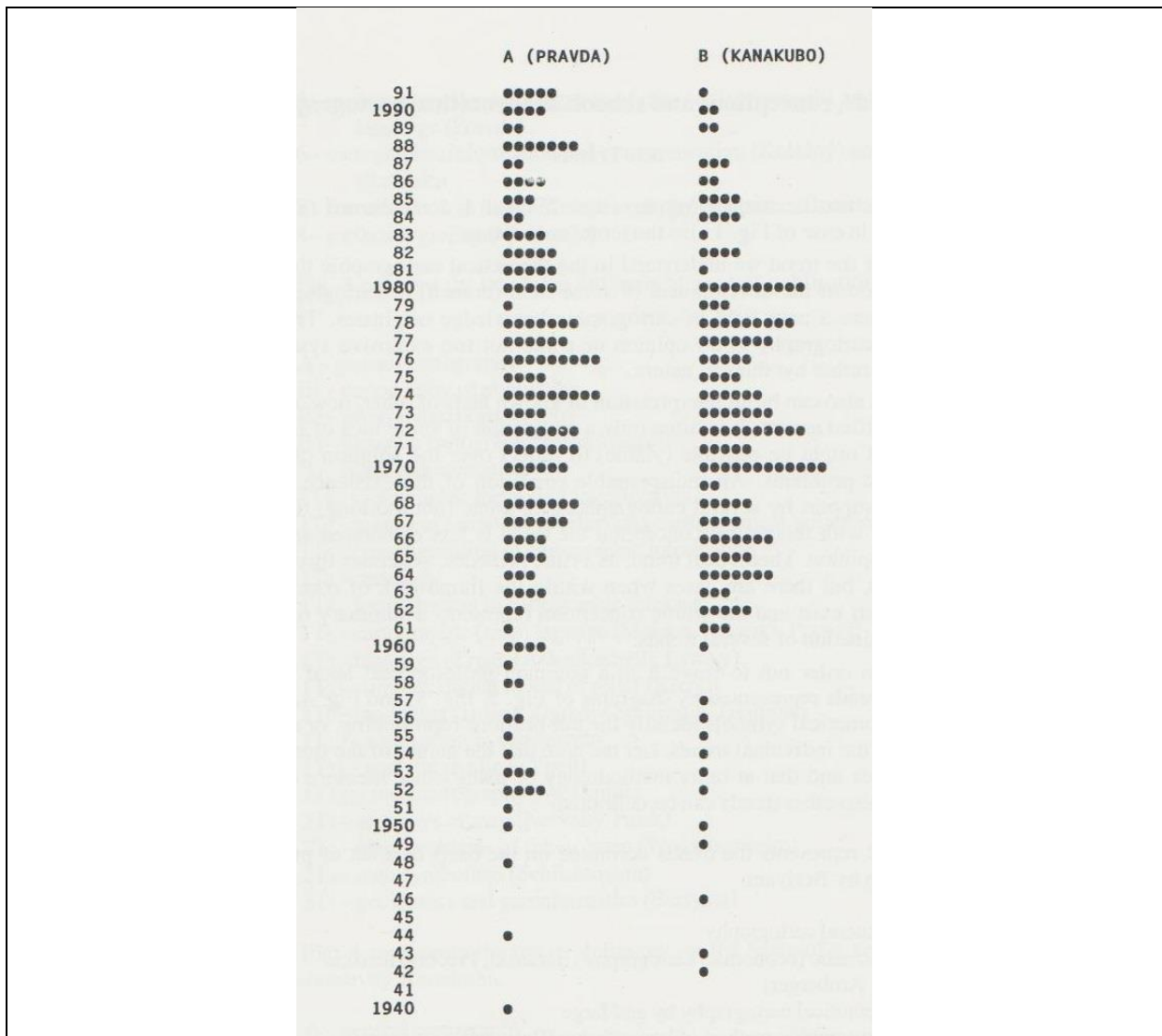

Fig. 14 Frequency of cartographic publications of 178 sources (left) and of 151 sources (right)

Jan Pravda used fig. 13 left for new development directions or "big bangs". Fig. 15 shows four epicenters/positions (1, 2, 3 and 4) for new activity branches in theoretical cartography.

Epicenter 1 was associated with the formation of the ICA and the publication of the International Cartographic Yearbook in 1961 and the reference journal "Cartography" by K. Salishchev in 1964. Epicenter 1 had an institutional format with several branches.

Epicenters 2, 3, 4 had an individual author's research format. Pravda called epicenters 2 and 3 as "young" and promising ones, epicenter 4 - hypothetical one (based on geoiconics according to Berlyant). Epicenter 2 was based on the work of Bocharov, Aslanikashvili, Kolachny and others. Epicenter 3 was based on the work of Nebsky, Palek, Schlichtmann and Wolodtschenko. It should be noted that the works of Bertin (1967, 1974) had their own branch from epicenter 1.
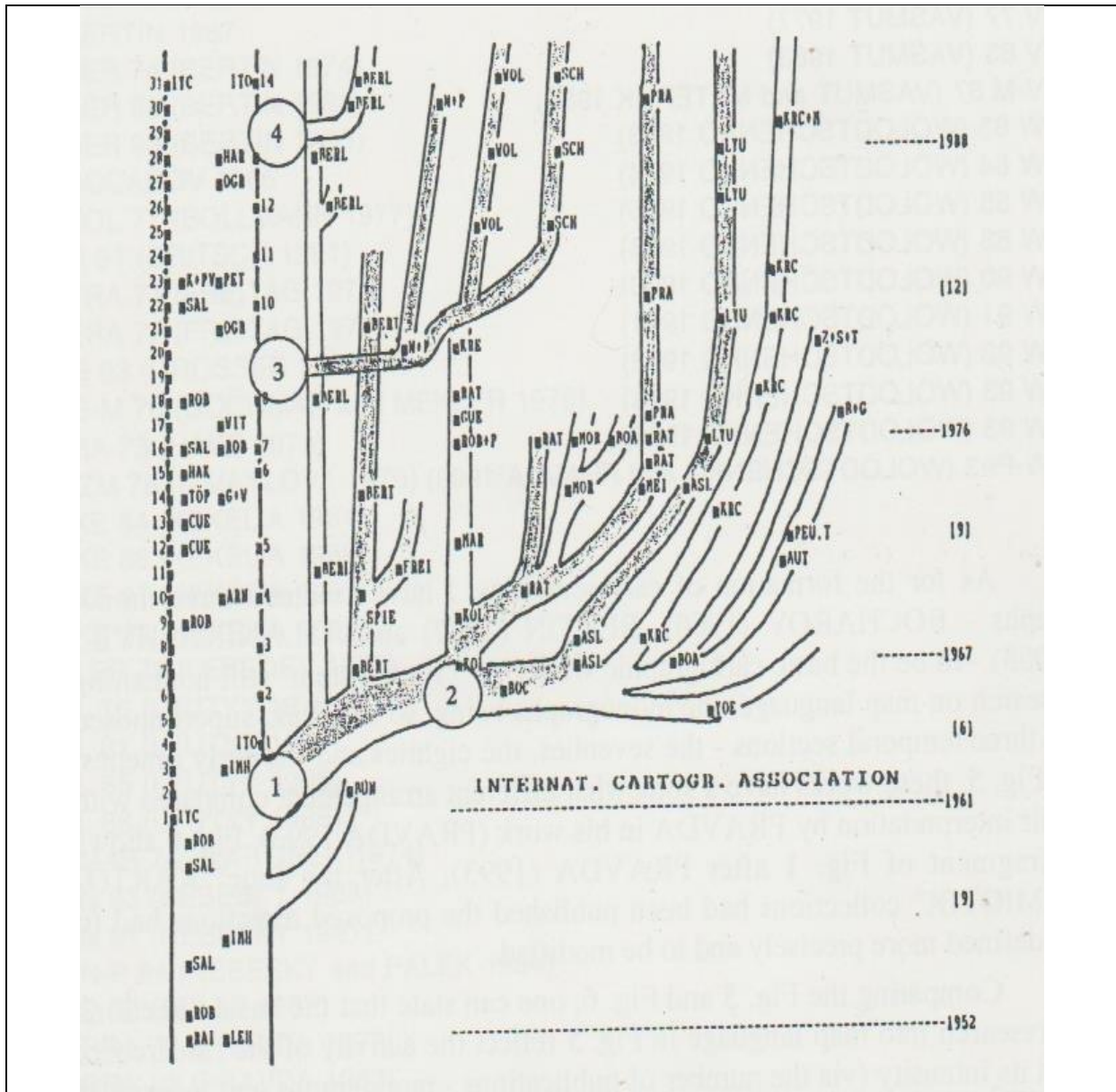

Fig. 15 Four epicenters of theory-cartographic development after (Pravda 1994)

How realistic were J. Pravda's predictions by the mid-1990s on the identification of four epicenters of theoretical and cartographic development? This question remains open, since Pravda did not return to this topic any more.

Tree diagram of map language research. The article (Wolodtschenko 1994) used a tree diagram in the analysis of bibliographic sources by the language of maps in the early 1990s.
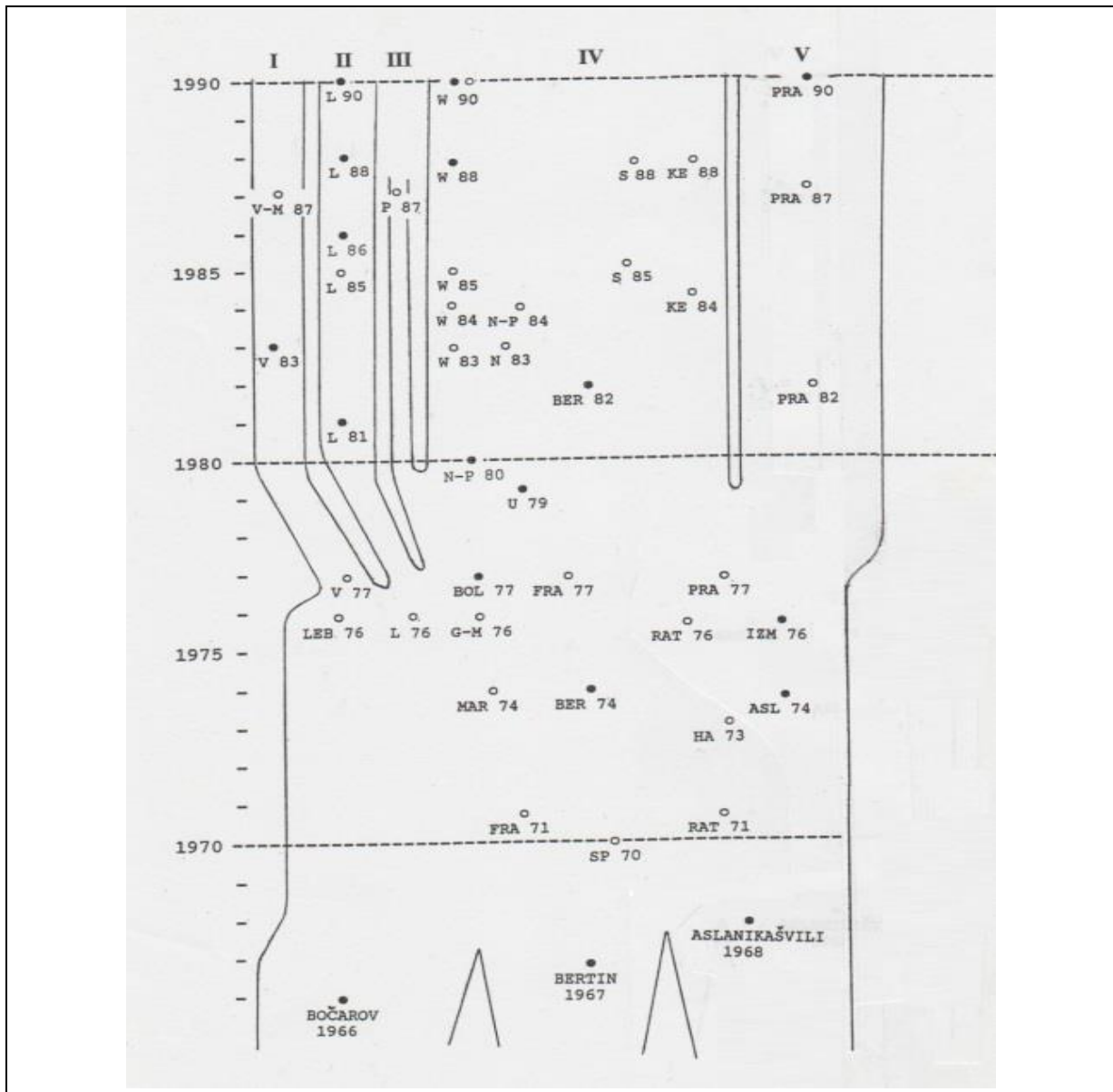
Fig. 16 "Tree of Development" with five areas of map-language research (after Wolodtschenko 1994)

Fig. 16 shows the "Tree of Development" for cartosemiotic literature from 70 sources, highlighting five areas of research: cybernetic (I), sublinguistic (II), logical (III), cartosemiotic (IV) and morpho-linguistic (V). Such a graphic construction was implemented according to bibliographic sources published by the mid-1990s. The monographs Bocharov 1966, Bertin 1967 and Aslanikashvili 1968, 1974 laid the foundation for cartosemiotic research.

European pioneers of cartosemiotics. Mikhail Bocharov, Jacques Bertin and Alexander Aslanikashvili can be considered pioneers of cartographic semiotics. Their

innovative monographs (Fig. 17) formed a new direction of research and a new subdiscipline of cartography at the end of the 1960s.
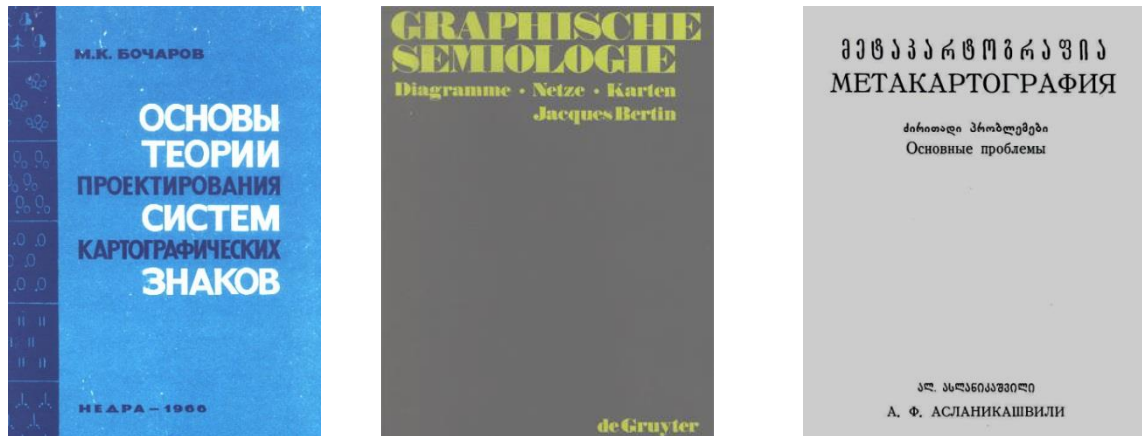
| Bocharov M. (1966) | Bertin J. (1967, 1974) | A. Aslanikashvili (1974) |

Fig. 17 Three cartosemiotic monographics

The name Jacques Bertin and his monographs (with translations into German, English, Japanese) were world-famous, but the monographs of the two East Europeans were not translated into other languages in the 1960s-1980s, for certain reasons (for example, M. Bocharov was a cartographic dissident in the USSR). This prevented many Western European cartographers from objectively and critically evaluating Soviet cartosemiotics.

Prof. Dr.sc. Mikhail K. Bocharov (1914-1997) was a military cartographer at Moscow's Kuibyshev Military Academy. In 1958 he was banned from lecturing and was then dismissed. The book "Fundamentals of a theory of the creation of cartographic sign systems" (Bocharov 1966) is one of the few pioneering books of cartographic semiotics.

Prof. Dr. Jacques Bertin (1918-2010) was a well-known French cartographer and geographer. From 1954 he was director of the "Laboratoire de Cartographie de l'École des Hautes Études en Sciences Sociales" in Paris. In the 1960s, under his direction, fundamental studies were carried out on the application rules of graphic means in all sciences, especially in the geosciences, and were laid down in 1967 as a monograph "Sémiologie graphique" (Bertin 1967). The German edition is known as "Graphische Semiologie. Diagramme, Netze, Karten" (Bertin 1974) and the English edition (Bertin 1983) as "Semiology of Graphics: Diagrams, Networks, Maps".

Prof. Dr. Aleksander F. Aslanikaschvili (1916-1981), was a well-known Georgian cartographer and geographer. He worked as a professor and head of the Department of Cartography and Geodesy at the University of Tbilisi (Tbilisi) from 1973 to 1981. His contribution to the development of theoretical cartography can be demonstrated with two books (Aslanikashvili 1969, 1974): "Cartography. questions of general theory". Tbilisi 1969 (in Georgian language) and "Metacartography. Basic problems". Tbilisi 1974 (in Russian). The second monograph was not approved for English translation by the USSR Cartographic National Committee. But in 1998 it was translated into Japanese by the ICA Vice-President

Tositomo (Kanakubo /Aslanikashvili 1998): Tositomo Kanakubo translated the book "Metacartography" by Aslanikashvili (1998) into Japanese and published it in Tokyo.

From dual unity to quadro unity of map language. In 1988 A. A. Lyuty proposed a new concept of cartography as a science - "cartonomy", in which a special place was given to the structure of the map language. The dual unity of the map language system (Fig. 18) consisted in a combination of two sublanguages (layers) - sublanguage I and sublanguage II. The third sublanguage (sublanguage III) with place names, characteristics, etc., does not belong to the language of the map. The concept also focused only on maps, ignoring atlases, globes, photographic maps, photographic, radar and other images, etc.

Fig. 18 Two-united map language system (after Lyuty 1981, 1988)

Fig. 19 Four modular map language system (after Wolodtschenko 1999)

The language of maps can also be considered as a system of four subsystems used in the creation and use of various cartosemiotic models. The map language system on a four-module basis or quadro unity system (graphic, mathematic, verbal and photographic languages) was proposed in (Wolodtschenko 1999) and can be extended to various types of semiotic models (Fig. 19).

From graphic variables to semiotic meta-variables. Under the leadership of J. Bertin, the well-known French geographer and cartographer, basic research was carried out in the 1960s on the use and selection of graphical representations in the earth sciences. The monograph "Sémiologie Graphique. Les Charts, Les Réseaux, Les Cartes" (Bertin 1967) has taken its rightful place in semiotic studies of maps, diagrams and nets.

Bertin's graphical variables or the system of visual (graphical) variables applied to traditional (paper) maps, diagrams, networks (atlases were not included in the research) have already become a classic example in 20th century cartosemiotics become. The 6 graphic variables with syntactic principles and logical rules include shape, size, orientation, color, internal structure and hue (saturation).

After more than 50 years of development in cartography and cartosemiotics syntactic principles and logical rules for the use of graphic visual means, 20th-century graphic semiotics switched to 21st-century multimedia semiotics, and six graphic variables received a conceptual and methodological continuation through a 3-axis coordinate system of information-semiotic metavariables in atlas semiotics (Wolodtschenko 2007, 2020). Fig. 20 (left) shows six visual (graphic) variables and fig. 20 right - a three-axis information-semiotic coordinate system of atlas-related metavariables: map, text and photo (illustration/ image).
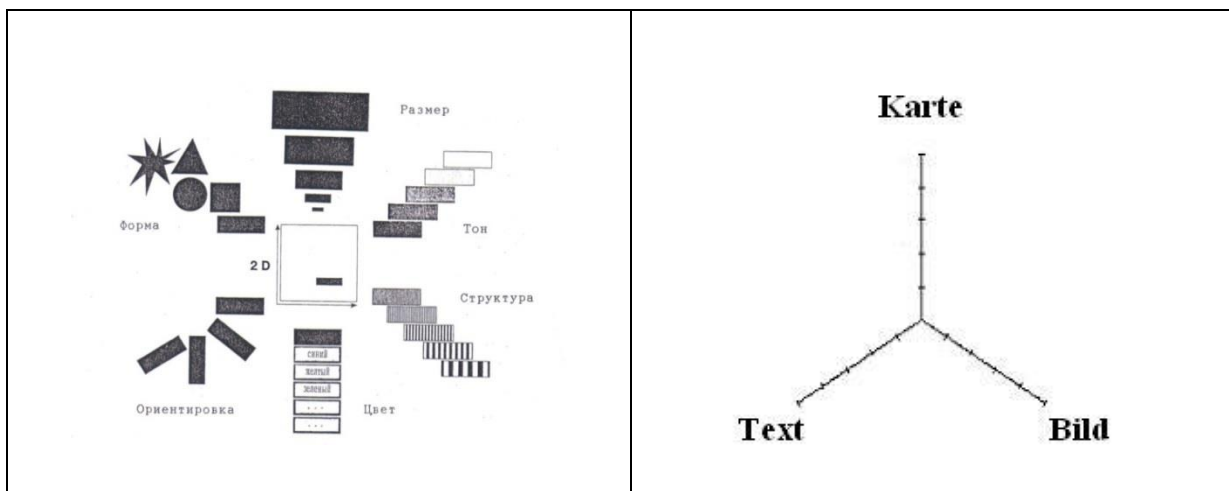

Fig. 20 (left) – Graphic system of visual variables (Bertin 1967); (fig. 20 right) - model-semiotic coordinate system of metavariables (Wolodtschenko 2007).

TEXT-PHOTO(BILD)-MAP as meta-variables form a semiotic whole for the conception, production and competent use of various atlases. This holistic principle allows the user to quickly and optimally classify, select, quantify, combine, dynamize, etc. space-time-topic-related knowledge on three information levels. Each atlas is a kind of semiotic model

that is composed in the coordinate system of metavariables. Atlases accumulate in structural form spatial-temporal-thematic knowledge about the earth or any other body (e.g. celestial, human, etc.) with its real and/or fictional objects and phenomena. When designing an atlas, a distinction is made between static and dynamic metavariables, as well as local (relating to the page/slide of the atlas) and global (relating to an atlas or a group / series / collection of atlases).

Competence borders of cartosemiotics. Cartosemiotics is a border discipline between cartography and semiotics, which arose in Europe in the second half of the 20th century. The development of cartosemiotics basically took place within the framework of theoretical cartography. One can differentiate between research-related, methodological (with cartographic and non-cartographic traditions) and map language competence (Wolodtschenko 2006).

The question of the limits of map language competence is new and little researched, but a very important question for cartography and cartosemiotics. The map language as a phenomenon is still insufficiently recognized and studied. But the modern communication society needs them, especially in the "new" media such as mobile and non-mobile internet etc. for the cartographic (static and dynamic) visualization of real and/or fictitious phenomena and objects.

The use of the term "map language" is relatively new in theoretical cartography. It is often confused with the term "cartographic language" (scientific language of cartography).

Non institutional cartosemiotic editions activities (1991, 1998, 2008). The cartosemiotic publications as special scientific and theoretical publications for cartographers, cartosemiotics, atlas semioticians and anyone interested in carto/atlas topics were created from the 1990s. Fig. 19 presents three non-institutional international cartosemiotic publications.
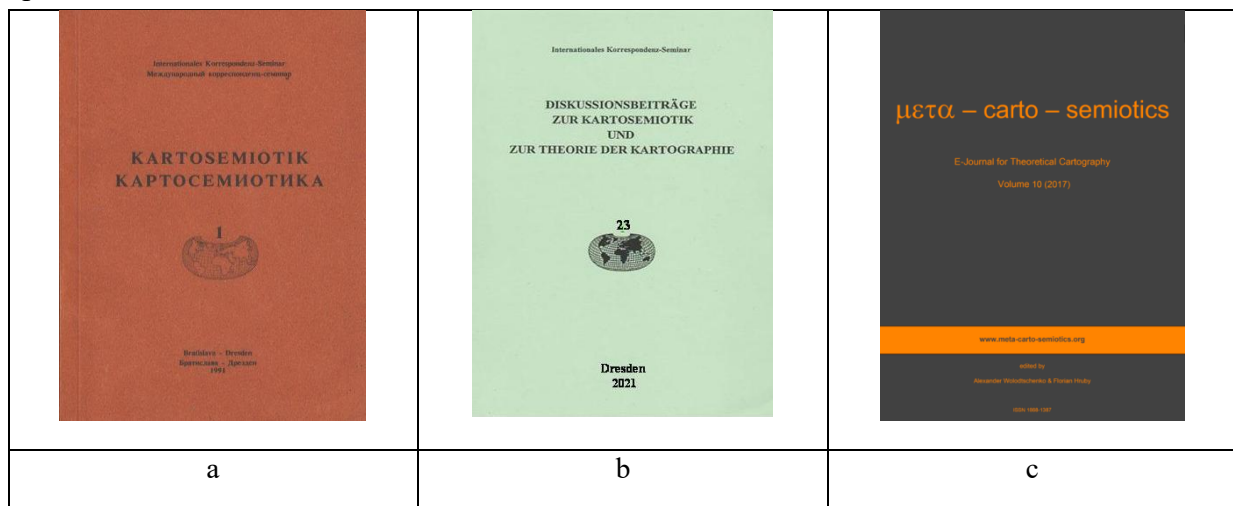

| a | b | c |

Fig. 21 Covers of three cartosemiotic editions.

Publication of collections "Kartosemiotika / Kartosemiotik" (1991-1995). In 1990, on the initiative of Jan Pravda (Bratislava) and Alexander Wolodtschenko (Dresden), the publication of a series of bilingual collections Kartosemiotik / Kartosemiotika was conceived as a non-institutional international cartographic correspondence seminar.

Six issues were published between 1991 and 1995 (Fig. 21a). The articles published in them deal with the semiotics of maps (cartographic images) and are written in German or Russian. Issues 1-4 and 6 feature presentations from international correspondence workshops where scholars working in the field of map semiotics could present and discuss their ideas and research results at no significant financial cost. The collections significantly stimulated the acquisition and dissemination of new knowledge and exchange of ideas on cartosemiotics. Issue 5 presented reports of the Cartosemiotic colloquium in Dresden in 1994.

The cartosemiotic colloquium of 1994 in Dresden and in united Germany was the first international forum of cartosemiosis initiated by J. Pravda and A. Wolodtschenko. Colleagues from eight countries (Austria, Bulgaria, Germany, Denmark, Canada, Russia, Slovakia and Ukraine) and from 13 European universities, Canada and Asian Russia, took part in the colloquium. All six editions are available from the Saxon State Library - Dresden State and University Library (SLUB). In 1995, correspondence seminars and publication of collections were suspended partly for objective, partly for subjective reasons. The first international cartosemiotic "club" in Europe ceased its mission.

Publication of the collection "Discussion articles on cartosemiotics and the theory of cartography". In 1998, the second international cartosemiotic "club" was formed by Alexander Wolodtschenko (Germany) and Hansgeorg Schlichtmann (Canada). A new series of correspondence seminars and collections began under the title "Discussion articles on cartosemiotics and the theory of cartography" (Fig. 21b), which replaced the first series "Kartosemiotik / Kartosemiotika". The collections included reports in three languages - German, English and Russian. From 1998 to 2021, 24 volumes have been published. This 24-volume series consists of 17 collections of articles and 7 monographs. All 24 volumes are freely available on the website: https://atlas-semiotics.jimdofree.com/projekte/

In 2020, the editorial board unexpectedly lost a co-editor. On May 31, 2020, H. Schlichtmann (1938-2020), co-editor of series of cartosemiotic collections (since 1998), co-founder of the ICA Commission on Theoretical Cartography (1999) and co-head of the section "Environment and Carto/Atlas Semiotics" of the German Semiotic Society (since 2017) died after a short serious illness.

The publication of the electronic journal "Meta-carto-semiotics" (since 2008). The initiators of the creation of a bilingual (German-English) web journal (Fig. 21c) on theoretical cartography and cartographic semiotics were Alexander Wolodtschenko (Germany) and Florian Hruby (Austria). The first thoughts about an electronic journal on theoretical cartography and cartosemiotics came at the 8th International Semiotic Conference in Helsinki in 2007, and in 2008 the first issue of an electronic journal called "Meta-carto-semiotics" was published.

Meta-carto-semiotics was associated with the cartographic-semiotic traditions of the 20th century, but developed new traditions of the 21st century in scientific publishing culture and communication. The journal consists of two article forms: main articles and additional ones. Main articles include individual articles of 5 pages or more, short articles / research

notes contain texts up to 5 pages. For the period from 2008 to 2022, 14 issues of the journal were made. All issues are freely available on the website:

http://ojs.meta-carto-semiotics.org/index.php/mcs

New carto/atlassemiotic drivers (2015-2022). As a prototype for the combination of three thematic levels, a multidisciplinary atlas-map-semiotics interface was proposed as early as 2010 in a project by the author at the Faculty of Forest, Geo and Hydro Sciences (FGH) at the TU Dresden (Fig. 22). Unfortunately, it was without success (Wolodtschenko 2010). Institute of Cartography had other priority research directions such as mountain and cave mapping.

In 2015, the FGH faculty was renamed the Faculty of Environmental Sciences. What was not possible and not feasible in 2010 at the Institute for Cartography and the FGH faculty was realized in 2017 in the new section for eco- and carto/atlassemiotics (ECS) of the German Society for Semiotics (GSS). The GSS is unique support in Germany for photoatlasing (creation and semiotic analysis).
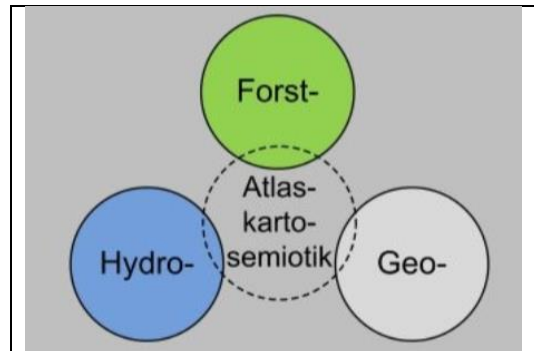

Fig.22 Emblem of three levels project

A key objective of the 2015-2017 combi-section was the popularization of eco / carto/ atlassemiotic products on mobile devices and the inclusion of electronic media, e.g. in the form of e-journals, multidisciplinary and multimedia (mini) atlases, etc. visualizations.

In 2017, a strong structural connection between the three levels of environment, cartography and atlas semiotics was realized. It was therefore logical to change the name of the "Eco- and Cartosemiotics" section to "Environmental and Carto-/Atlassemiotics". From 2017 to 2020 the section was chaired by Monika Huch, Alexander Wolodtschenko and Hansgeorg Schlichtmann (fig. 22a). http://www.semiotik.eu/Oeko-und-Kartosemiotik

Fig. 22a. Section Leadership: Monika Huch, Hansgeorg Schlichtmann and Alexander Wolodtschenko

The international conferences – 13th IASS in Kaunas (26th to 30th June 2017), 28th ICC in Washington (1st to 7th July 2017) and 15th International Congress "Borders. Contact - Communication - Contrast "in Passau (12-16 September 2017) show that carto/atlasasemiotics needs a multidisciplinary synthesis.

In 2019, in Dresden, the section held a semiotic mini-forum "From Cartosemiotics to Atlas Semiotics". It is noted that 25 years earlier, also in Dresden (in 1994), an international cartosemiotic colloquium had been organized for the first time in Germany.

In May 2020, the Environment and Carto/Atlas Semiotics section lost one of its leaders. Prof. H. Schlichtmann (1938-2020), one of the most active cartosemiotics since the end of the 20th century, died suddenly.
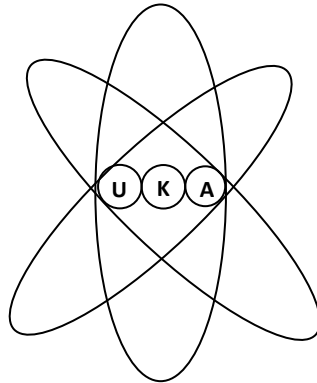

Fig. 23 Logo of combi-section Environmental and Carto /Atlassemiotics (Umwelt- und Karto/Atlassemiotik/UKA)

Carto/atlassemiotics needs a broader environmental platform (from nature-related to socio-cultural applications) as a thematic and multidisciplinary interface to various disciplines such as biosemiotics, geosemiotics, cultural semiotics, ecosemiotics, etc. This platform can be a combination of environment and carto/atlassemiotics (Fig. 23).

The methodological synthesis of environmental and carto/atlassemiotics should be based on cartographic as well as non-cartographic traditions, and on digital and analogue representation models. Thise synthesis reflects the transition from theoretical cartography to semiotic cartography and atlasgraphy.

2.2. Atlases and atlascartography

Atlas cartography is defined and postulated as a field of cartography. Atlas cartography (according to Stams 1983) is a field of practical cartography aimed at the production of atlases. Atlas cartography includes planning, designing, drafting, publishing and maintaining atlases.

Atlas cartography (according to Denk, Lambrecht 2000) is a field of cartography that deals with the planning, organization, production and maintenance of map-related atlases. Atlas cartography (according to Wolodtschenko 2013) is a market-dependent, cyclical field of cartography that is oriented towards the production of atlases, lives from map-related project to project, and thus exists.

According to Denk, Lambrecht (2000), the map-related atlases dominate in Germany with the following 10 atlas types: 1. Specialist atlases, 2. Leisure and tourism atlases, 3. Area atlases, 4. Historical atlases, 5. Reference atlases, 6. National and state atlases, 7. Planning and environmental atlases, 8. School atlases, 9. City atlases, 10. World and universal atlases.

The 10 atlas types cover almost all thematic areas and are placed in a map-related "coordinate system" according to map types and scales. A structural-semiotic analysis or study of the above 10 atlas types and their potential is missing. A comparative analytical

study is difficult to implement in the classic map-related "coordinate system". And the system of 6 graphic variables (according to J. Bertin) no longer helps either. This requires a new semiotic theme-module methodology in the three-axis system of metavariables (Wolodtschenko 2010, 2013a).

Fig. 24 Production and task area of atlas cartography (Denk, Lambrecht 2001)

Fig. 25 Topographic/thematic and scale related atlas system (generalized from Fig. 24)

The presentation of atlas cartography as a field of cartography (Fig. 24) demonstrates production-oriented tasks with competence only for map-related thematic and topographical atlases. A generalized model of the two-axis atlas system (with topographic-thematic and scale-related axes) is presented in Fig.25.

Quo vadis German Atlascartography? What future do map-related atlases or map series have in Germany? The Atlas Cartography Commission of the German Society for Cartography is also asking many questions today. The Commission was established in 1996. For almost 20 years, the commission has been headed by Prof. Dr. H. Asche (Emeritus, since 2017). In one of the last articles (Asche 2007) an attempt was made to describe the future tendencies of atlas cartography (regarding digital thematic atlases and complex atlas information systems) in general. What will German atlas cartography and the Atlas cartography commission do in the future has unfortunately remained open. The German commission of atlas cartography is in a crisis and urgently needs a renaissance.

The author's analysis of the German journal "Kartographische Nachrichten" (KN) according to specialist articles (without specialist reports) for the last 12 years (2010-2021) revealed only six atlas-related articles out of 283, or only 2.1%. Tab. 2 shows atlas-related contributions from KN. Articles in English dominate in the KN of the 2010s and 2020s. It is noteworthy that the KN Journal of Cartography and Geographic Information is mainly published in English.

Tab. 2 Atlas-related articles of the KN (2010-2021)

Nr./Year	Authors/Titles
1/2011	Cron, J., Moll, P., Häberling, C. & Hurni L.: 100 Jahre „Schweizer Weltatlas " und neuer „Schweizer Weltatlas interaktiv. KN, 1/2011, 32-35 S.
2/2011	Sieber, R., Hollenstein, L. & Hurni L.: Der neue Atlas der Schweiz 3 auf DVD. KN 2/2011, 86-89 S.
1/2013	Zwakhals S.L.N., H. Giesbers,H., Van Bakel, A.M., Van Oers J.A.M.(2013): The Dutch National Atlas of Public Health and Health Care. KN 1/2013, 27-31 S.
5/2013	Hanewinkel, C. & Losang E.H.: Europe in Maps‐Europa einmal anders sehen. KN 5/2013, 255-261 S.
5/2015	Hruby, F.:Von analogen Atlas zum cloud-basierten Atlassing. KN 5/2015, 265-271 S.
4/2018	Harvey F.: Die fortbestehende Bedeutung von Herbert Bayers World Geo-Graphic Atlas von 1953. KN 5/2018, 202-207 S.

The International Atlas Conferences (initiated by J. Espenhorst, and partly in connection with the D-A-CH working group on the history of cartography), were an interesting forum for experts and collectors of atlases in the 2010s.

The question: *What are an atlas and atlas cartography of the 21st century?* remains open, because the atlas and atlas cartography have not received a semiotic-theoretical justification (Wolodtschenko 2013a, 2014, 2020).   The technologization of modern cartography and atlas cartography is firmly linked to geomatics or geoinformatics, but continues without considering semiotization processes, i.e. without considering the semiotic-epistemological potential. Unfortunately, this potential is not yet used in atlas cartography and cartography. The semiotic lethargy is reflected in the German atlas cartography and also in the European-continental and ICA atlas cartography.

The market-dependent, production and project-oriented atlas cartography as a field of cartography has had little effect on universities in the formation of new atlas-oriented disciplines and training courses in the last 20-25 years. Atlas cartography as the production of map-related atlases has a future with e-atlases, but is facing competition from ubiquitous photoatlases.

2.3. Semiotic-related atlassing
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About atlassing. In the 2010s, the articulation and development of atlassing began as new interdisciplinary, conceptual-semiotic research inclusive of technological direction, which plays an important and integrative role in the analysis, creation and use of all atlases with cartographic and non-cartographic traditions. The atlassing unites all three generation of atlases (classic or print atlases, digital atlas information systems and digital ubiquitous atlases).

The term atlassing (with two "s") is a new term in atlas semiotics and atlas cartography. It was used in the presentation "On the new generation of digital mini-atlases" at the AutoCarto 2012 conference in Columbus, USA as a contrast to mapping (Wolodtschenko, 2012). The relation "atlassing" characterizes a new driving force of atlases as semiotic knowledge products and models. It has been proposed for a multifunctional research direction and range of use of various atlases. Atlassing as a trend has European cartosemiotic roots.

Atlassemiotics does not belong directly to the "seismographic" disciplines of the future, but rather spatial, image- and text-related semiotic models can be used as knowledge models, e.g. for analytical-comparative research. A related interdisciplinary subject "Applied atlassemiotics" is also missing in the bachelor's degree course in geography, geodesy, cartography, forestry, water management etc. at the universities.

The first structural model of atlassing (after Wolodtschenko 2012) included two new atlas-related blocks: semiotic analysis and creation (Fig. 26). They formed two subdisciplines: atlassemiotic and atlasgraphy (atlascreation). The atlassemiotics deals with theoretical, methdological and analytical tasks. The atlasgraphy deals with creating of diverse atlases (map-/photo-/text-related atlases) based on cartographic and non-cartographic traditions.
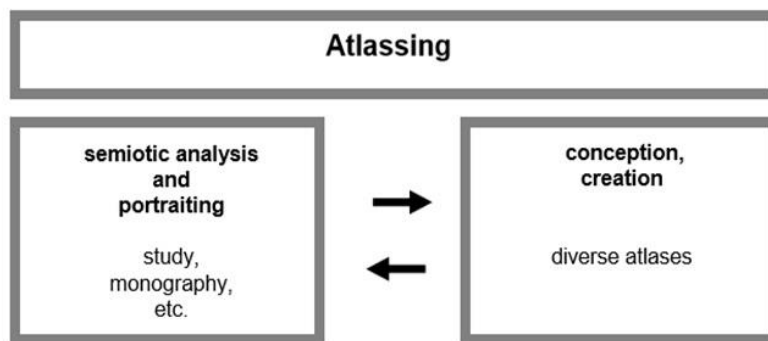
Fig. 26 Two structure blocks of atlassing (after Wolodtschenko 2012)

The derivative structural model of atlassing was implementing to photoatlassing (Fig. 27) and included three function-related blocks: creation, semiotic analysis and collection of photoatlses. Photoatlassing is one of the components of atlassing, a new applied and epistemological direction in the study and creation of various photoatlases (with cartographic and non-cartographic traditions) based on their semiotic classification and in a semiotic coordinate system.
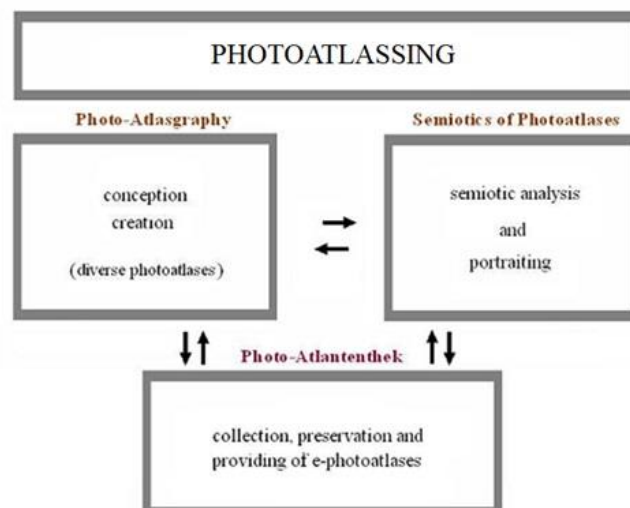
Fig. 27 Three structure blocks of photoatlassing (after Wolodtschenko 2020)

The terms "photoatlas" and "photoatlassing" are derived from the German words "Bildatlas" and "Bildatlassing". The term "Bild" is a polysemantic word and can replace other words or concepts, for example, in English: photo, image, illustration, picture, painting, etc.

The author chose the term "photo" to form new atlas-related terms, phrases and concepts. The photoatlassing and photoatlases are new terms, concepts and designations in semiotic, cartographic and geographic scientific research and practice.

.**Semiotic atlas classification.** The semiotic classification of atlases (Wolodtschenko 2012) is a system for identifying and dividing all atlases (with cartographic and non-cartographic traditions) into four groups based on the definition of the semiotic information load. The classification of all atlases as semiotic models includes the following four main groups (Fig. 28):

a) Map atlases (variable MAP dominates with > 50%)

b) Text atlases containing text (the variable TEXT dominates with > 50%)

c) Photo atlases (the variable FOTO/BILD dominates with > 50%)

d) Atlases with mixed content (without dominance of a variable with > 50%).

In the first three groups (map atlases, image atlases and text atlases) characterize dominance (> 50%) of metavariables (map, image, text). The fourth group of mix atlases includes atlases without information dominance of a metavariable.
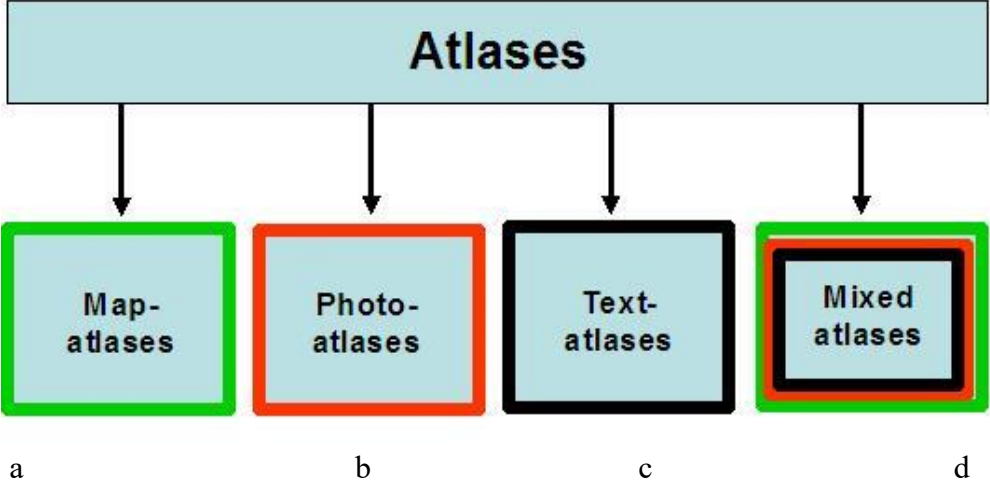
Fig. 28 Semiotic classification of atlases (Wolodtschenko 2012)
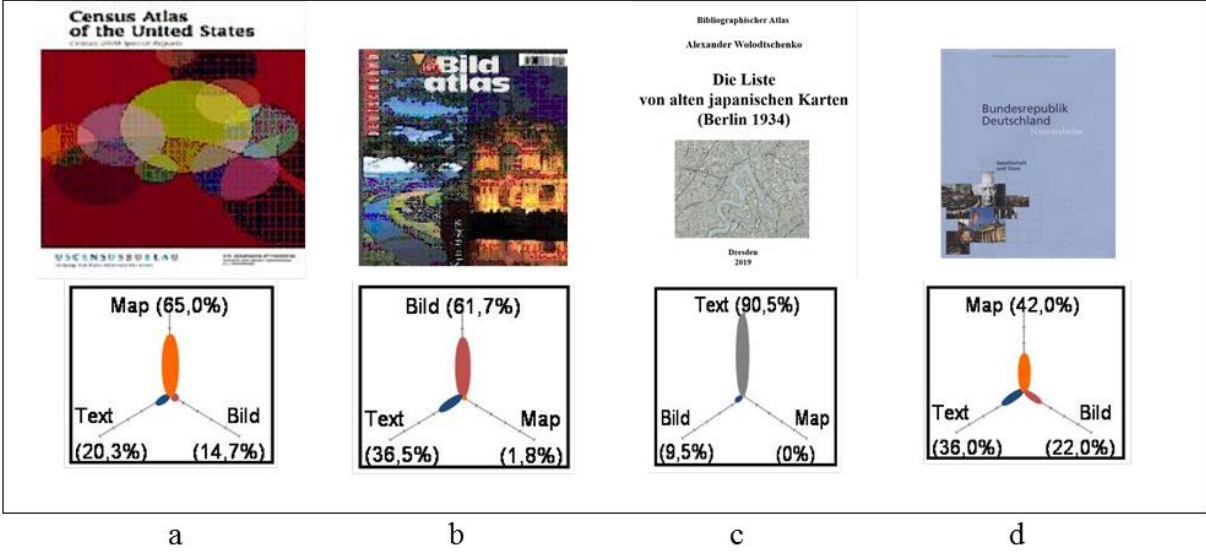
Fig. 29 Four examples of atlas classification (Wolodtschenko 2021)

30

Four title pages of selected and semiotically classified atlases: (a) map atlas, (b) picture atlas, (c) text atlas and (d) mixed atlas, demonstrate their semiotic-quantitative potential in the three-axis system model of metavariables (fig. 29).

This classification of atlases specifies semiotic meta-variables and separates cartographic and non-cartographic traditions when creating any atlases. Classification makes it possible to unite and simultaneously subdivide all atlases into groups, streamline knowledge about atlases, speed up orientation in the semiotic coordinate system, and implement a quantitative analysis of atlases.

Three structure blocks of atlassing. The three-part "Atlassing" block model: function block, generation block and classification block is shown in Fig. 30. The function block as a basic block (product and knowledge-building block) was first in two parts (atlasgraphy and atlas semiotics), then it was supplemented with two accumulating components (atlas collection/library and atlas history). The generation block is a technology-driven block with three atlas generations (one non-digital and two digital atlas groups). The classification block is a semiotically ordered block with four atlas classes.

Funktionsblock

ATLASSING

Generationsblock

Klassifikationsblock

Function block			
Atlasgraphy	**Atlassemiotics**	**Atlassing history**	**Atlantenthek**
Creation and design	Analyse and semiotic portraying	Facts and datum	e-collection and reception

Generation block		
Generation I	**Generation II**	**Generation III**
Analoge atlases	Digital atlases	
Print-atlases	GIS- and Atlassistems (Cybercartography-atlases)	Mini-atlases (Ubiqiutous photoatlases)

Classification block
Map Atlases   Bild-Atlases   Text-Atlases   Mix-Atlases

Fig. 30 Three structure blocks of atlassing (after Wolodtschenko 2021)

2.4. Evolutionary trajectories in cartography and cartosemiotics

Selected trajectories of development of cartography. These are usually evolutionary trajectories with technological and theoretical-semiotic directions and traditions in the period 2000-2020 (Wolodtschenko 2021).

Four scenarios for the technological development of cartography will be discussed below (Fig. 31). The first scenario can be called as technological or mainstream cartographic one. Such a scenario for technological cartography is already being implemented, where the "evolutionary path" will reflect the absorption of technical cartography by geomatics or geoinformatics (Wolodtschenko 2020).

Technological development of cartography	1) From cartography to geoinformatics 2) From (atlas) cartography to cybercartography 3) From cartography to neo-cartography 4) From cartography to neo-geography

Fig. 31 Four scenarios of technological development of cartography (Wolodtschenko 2021)

The second scenario for atlas cartography is already being implemented by Prof. D. R. Fraser Taylor and colleagues in Canada. His cybercartography can be seen as an interactive web atlas cartography. In 2002 Prof. Taylor founded the Geomatics and Cartographic Research Center/GCRC at Carleton University in Ottawa. Today one can safely state that Prof. Taylor managed to create a unique scientific school on cybercartography, similar to the Moscow scientific cartographic school of Prof. Salishchev in the 1970-1980s at Moscow State University. M.V. Lomonosov.

The accumulation of cybercartographic and carto/atlassemiotic conceptual knowledge on the basis of joint projects made it possible to designate cyberphotoatlassing as a new direction of interdisciplinary cooperation in the carto/atlasgraphic field in the creation and use of ubiquitous photoatlas products (various thematic mini-photoatlases). In 2021, the ubiquitous photoatlas "10 Selected Indigenous Cyber-Cartographic Atlases" was published as the first German-Canadian project with the participation of F. Taylor, R.V. Thumbadoo and A. Wolodtschenko (Taylor et.al. 2021). In 2022, another photoatlas "Cybercartography and Photoatlassing Projects"was published. The publication of two photo atlases supplemented the synthesis of cybercartography and photoatlassing.

A third possible scenario refers to "Neocartography" or modern cartography by Gartner, Schmidt (2010). It develops due to the technological basis (geospatial technology and geospatial data); the role of the superstructure belongs to the theoretical and methodological foundation. The problem is that the role of the add-on is simply declared. There is simply no specific development on this issue. Such a scenario for the development of cartography according to Gartner, Schmidt (2010) is not yet sufficient for an evolutionary trajectory.

The fourth scenario for the development of technological cartography was associated with the term "Neogeography", which gained popularity after the publication of the book Introduction to Neogeography by Andrew Turner (Turner 2006) in late 2006. A new

generation of tools and methods for working with geospatial information has assigned a "geographical residence permit" or a "neogeography". Not all geographers and cartographers liked this name.

Semiotic-epistemological evolutionary path of cartography. It is associated with theoretical cartography and carto/atlassemiotics and is characterized by new interdisciplinary trends and applied disciplines at the borders of semiotics and theoretical cartography in the second decade of the 21st century.

Technological processes in cartography were monopolitically dominant in the 21st century. The academic (institutional) theoretical cartography has been stagnating for the last 10-15 years. But in the 2010s, the new evolution-interdisciplinary, semiotic-epistemological methods in atlas cartography are being developed. Atlassing, photoatlassing, atlasgraphy, atlas semiotics, etc., as alternative formations of the 2020s, have a chance to play a leading role in these processes (Fig. 32).

| Theoretical-semiotic evolutionary path of cartography | 1) From theoretical cartography and cartosemiotics to atlasgraphy and atlassemiotics |
| | 2) From science of cartography (Kartenkunde) to science of atlasgraphy (Atlaskunde) |

Fig. 32 Theoretical-semiotic evolutionary path of cartography (Wolodtschenko 2021)

Carto/atlassemiotic trajectories. In an analytical study over the past 30 years in cartography and cartosemiotics, one can distinguish characteristic trajectories or traces of changes-transformations. The formation of new disciplines (atlas cartosemics, atlasing / photoatlasing, atlasgraphy, atlas semiotics, atlas science / photo atlas science, etc.) took place sequentially on the basis of the basic disciplines - cartography and cartosemiotics and against the background of functional processes and transformations. Tab. 3 includes some disciplinary, technological and methodological transformations in cartography and cartosemiotics.

Tab. 3 Selected functional transformations of cartography

|	
The formation of new disciplines	- from cartography to atlasography, -from mapping to atlasing, -from atlascartography to photoatlasography -from cartosemiotics to semiotics of ubiquitous atlases (mini-photo-atlases)
Technological transformations	-from mapping to atlassing (photoatlassing) - from map atlases to photoatlases -from web atlases to ubiquitous atlases (mini photoatlases)
Methodical transformations	- from the analysis of a single atlas to the analysis of digital data of atlases - from map classification to parity-semiotic classification of atlases - from graphical variables to model-semiotic metavariables
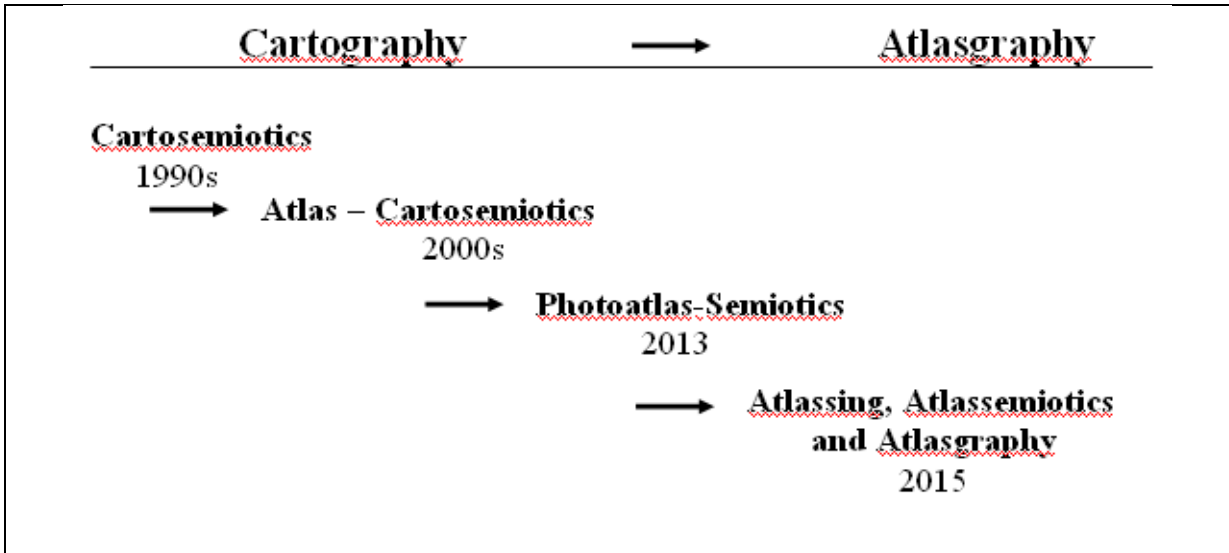
Fig. 33 Conceptual terminological evolutionary carto/atlassemiotic trajectories (Wolodtschenko 2020)

Carto/atlassemiotic trajectories (fig. 33) characterize evolutionary processes in cartography and atlasgraphy which includes introduction of semiotic metavariables, new semiotic disciplines, and semiotic classification of all atlases.

The evolutionary-semiotic trajectories of new carto/atlasgraphic disciplines have highlighted specific examples of the development of photoatlasography and photoatlas semiotics as younger "sisters" of atlasgraphy and atlassemiotics. Their formation takes place at the intersection of theoretical cartography and semiotics on a parity basis.

3. New Atlassemiotic Trend: Photoatlassing

The third generation. In the 21st century digital ubiquitous atlases (photoatalses) as "third generation" (Fig. 34) completed classic or print atlases and digital atlas information systems or cybercartographic atlases. The third generation of atlases brought **new terms and disciplines** into atlas-related practice and theory, such as: atlassing, photoatlassing, atlasgraphy, semiotics of photoatlases, etc.

A new generation of users of ubiquitous atlases with cartographic and non-cartographic traditions does not have its own atlas society or an association. It would be useful to discuss about formation of an informal working group entitled "Ubiquitous Photoatlases " or "Photo-Atlassing".
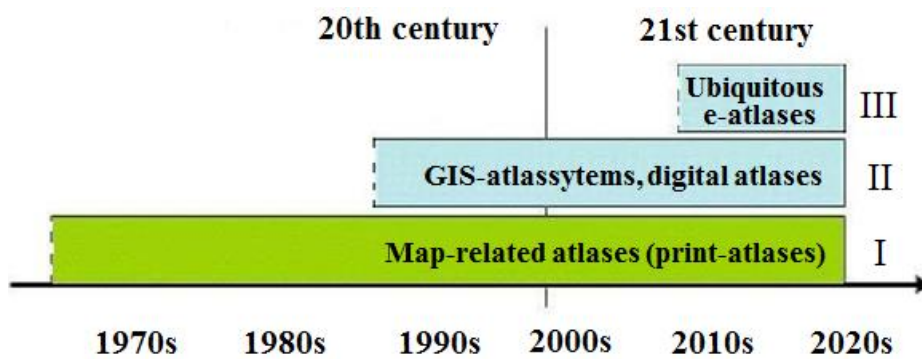
Fig. 34 Three atlas generations (Wolodtschenko 2017)

3.1. Ubiquitous thematic photoatlases

The history of the ubiquitous thematic photo- atlases started in the 2000s at the TU Dresden, Iinstitute for Cartography and was connected with student projects. The selected student mono-, two-, three- and four-display photoatlases (fig. 35) for smart-phones/tablets demonstrate methodical photoatlas projects with display-related limits (potential) and creative possibilities (Wolodtschenko 2021). Ubiquitous photoatlases implement and contribute to the transition from atlas cartography to photo atlasgraphy

Fig. 35 Selected student ubiquitous photoatlases (2008-2010)

In 2008, a pilot project "Photoatlas as a semiotic model" (Fig. 36) started at the Institute for Cartography of the TU Dresden for non-cartography students (geography and computer science). The students were offered a special course "Conception and creation of

mini-atlases" as well as pilot projects for the design and implementation of illustrative mini-atlases with smartphones. Our first experiences have shown (Koren, Wolodtschenko 2011) that the development and creation of photo atlas-oriented applications is not only the task of computer scientists.

Fig. 36 Presentation of photoatlases (Wolodtschenko 2009a)

In the period 2006-2013 within the Iconic Atlassing project there were three types of pictorial atlas activities: student projects, individual (author) activities and collective (author) projects. Fig. 37 shows selected student projects at the TU Dresden.

Fig. 37 Selected student projects at the TU Dresden (2006-2013)

Photoatlases related to various events can be considered as storytelling products. Event photo atlases can be created as independent media products or as a complement to other media products, such as high-interest reports or articles in newspapers or magazines. Three professions - photographer, journalist and media designer - are the "protagonists" for creating

event photoatlases (Fig. 38), but they can also be used for other types of photo atlases, such as travel and cultural-historical photo atlases.
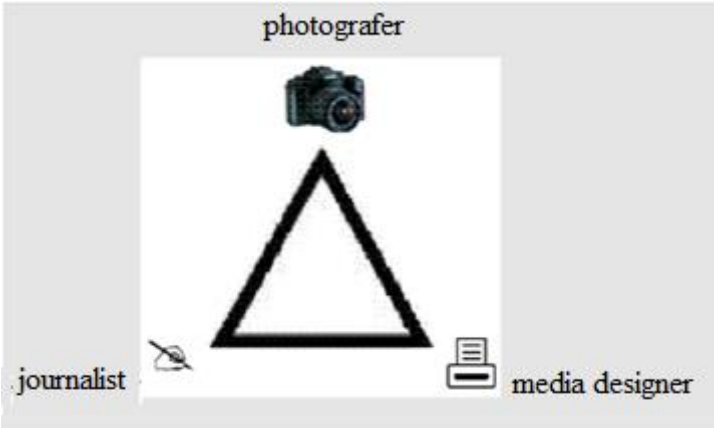
Fig. 38 Three "photographic" professions: photographer, journalist and media designer

Photoatlas-collection (Bildatlantentek) on website. In 2017, a virtual collection of thematic photoatlases was opened on the author's website and by mid-2022, more than 200 thematic photoatlases were available for use on the website: https://atlas-semiotics.jimdofree.com/bild-atlantothek/

The collection of thematic photoatlases (Fig. 39) on this website includes over 20 selected topics: amateur, bibliographic, biographical, Christmas, cultural-historical, derivatives, educational, environment, event, for experts, fashion, hobby, individual, monitoring, New Year's, personal, professional, school, selfies, sightseeing, student, tourist, etc. The real list of topics for photoatlases is undoubtedly broader and more diverse.
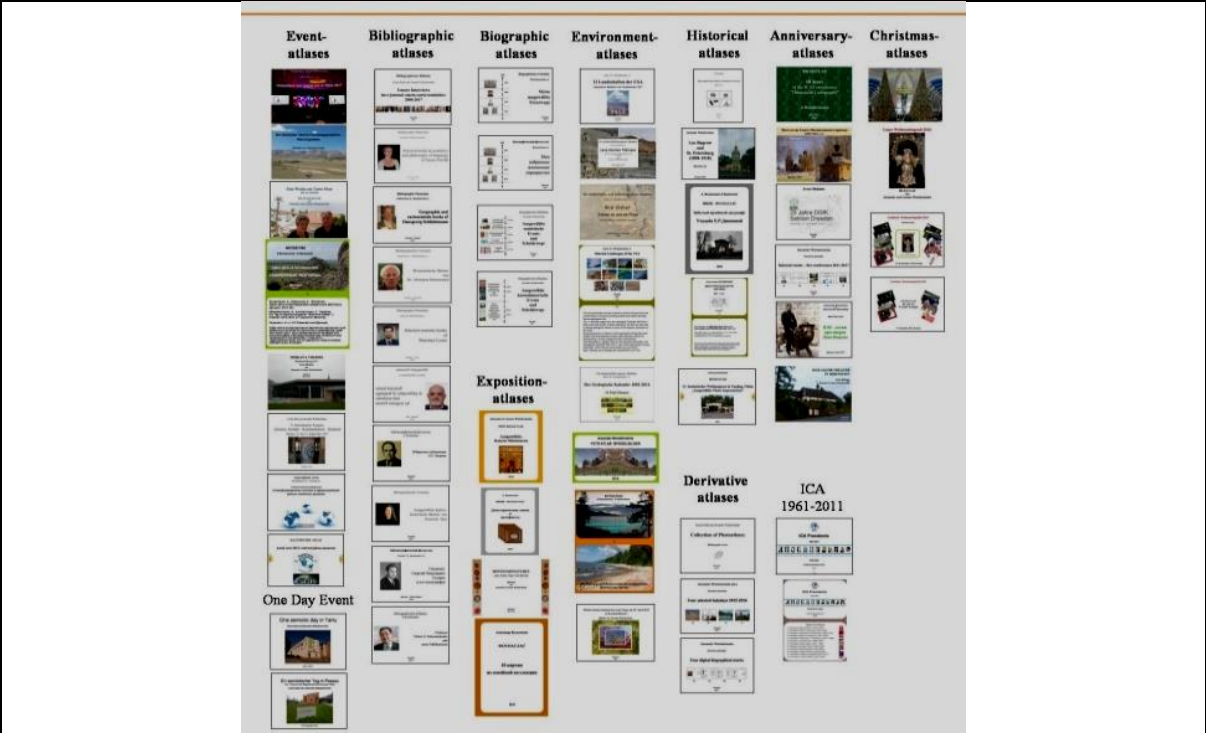
Fig. 39 Poster of selected thematic photoatlases

An interesting future awaits the photoatlases with new forms of appearance (e.g. ubiquitous storytelling photoatlases). In the 21st century, the pictorial form of thinking (iconic thinking) will dominate over the linear-textual. It is still difficult to say where this thinking will take us.

Thematic priority of photoatlses and storytelling. In the period 2009-2021, 157 thematic atlases were created and presented by the author on the homepage: https://atlas-semiotics.jimdofree.com/bild-atlantothek/

In this thematic photoatlas collection, the storytelling-related themes dominate – 132 out of 157. Storytelling photoatlases form a special thematic direction. Selected examples of these storytelling photoatlases are presented in chapter 3.2.1. „Structure-semiotic features of photoatlases".

Tab. 3 shows the results of the analysis of author collection (2009-2021) with a clear priority of narrative photoatlases. At the end of 2022, there were more than 200 photoatlases on the site.

Tab. 3 Dominance of photoatlases 2009-2021 (Wolodtschenko 2021)

Photoatlas themes				
Storytelling	Bibliographic	Science-methodical	other	sum
132	15	6	4	157

The storytelling photoatlases usually have multi-thematic areas, for example, event-tourism-storytelling, anniversary-storytelling, city-excursion-storytelling, map-exposition-storytelling, etc. Fig. 40 shows a mini- exposition of pseudo-cartosemiotic graphical models or "cartosemiotic phantoms" on pebbles.
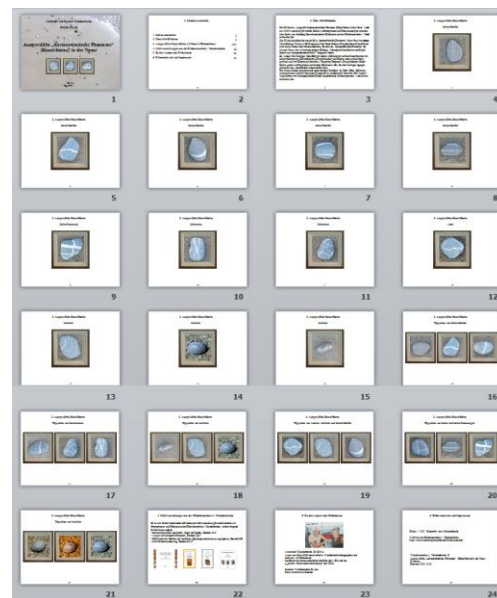

Fig. 40 Title slide (left) and photo gallery (right) of the a mini-exposition "Cartosemiotic Phantoms" (Wolodtschenko 2021)

Bibliographic photoatlases takes a second position in collection. They can connected with anniversery or memory subthemes. Fig. 41 shows a bibliographic photoatlases by S.Petrilli and fig. 41a - selected bibliographic photoatlases from site: https://atlas-semiotics.jimdofree.com/bild-atlantothek/
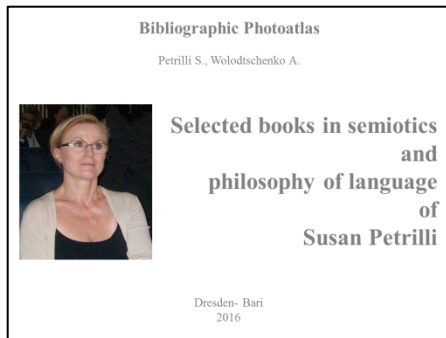

Fig. 41 Title slide (left) and photo gallery (right) of the S. Petrilli´s bibliographic photoatlas

Fig. 41a Selected bibliographic photoatlases

Under other or exitic photoatlases one can name a "Children's poetry photoatlas", where children's poems as short stories about a hare, bees, goats, squirrels, dogs, raccoons and mice, are supplemented with photographs. The author of seven verses is V. Filimonov from Omsk. Fig. 42 shows an exotic photoatlases.
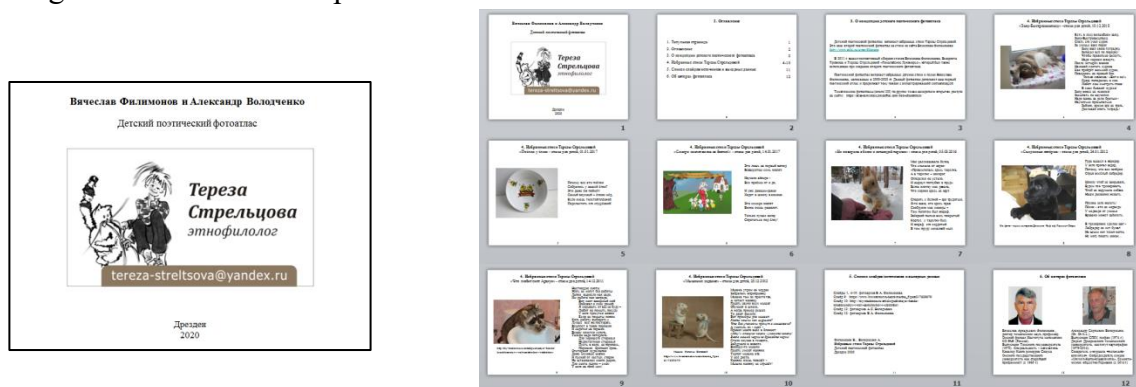
Fig. 42 Title slide (left) and photo gallery (right) of Children's poetry photoatlas

Project: Image data analysis with SuAVE. In 2019, the first 100 photoatlases were submitted for testing with the online system SuAVE (Survey Analysis via Visual Exploration) for visual analysis. SuAVE is a new online visual analytics platform for surveys and image collections (http://suave.sdsc.edu/). The author of the SuAVE system is Dr. Ilya Zaslavsky (Director of the Laboratory for Spatial Information Systems at the University of California, San Diego, USA).

The system allows to combine visual and statistical analysis. The interactive search and selection of the required image atlases in the library is also done by year, subject, language, author, place of publication and number of slides in each atlas. The structure of

metadata (e.g. 100 atlases) includes a semiotic classification of atlases (Zaslavsky, Wolodtschenko 2019).
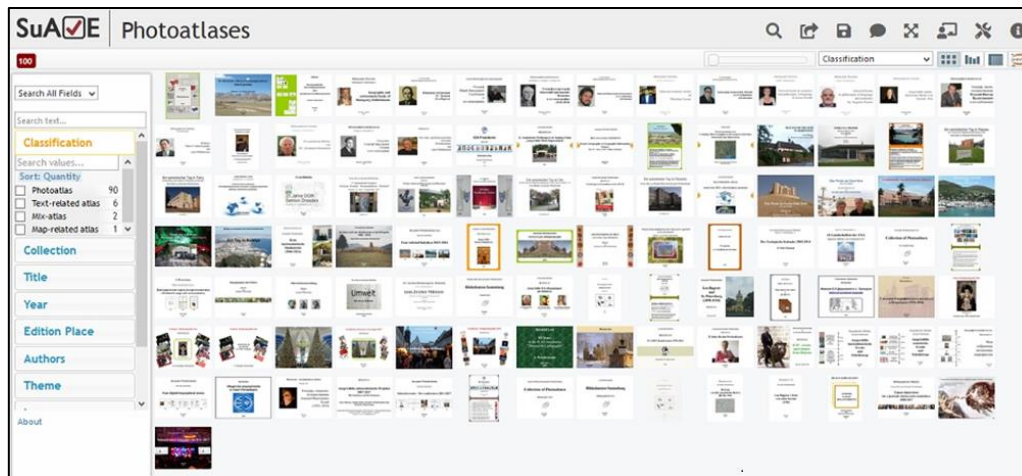

Fig. 43 Screenshot with 100 thematic photoatlases

The results of the semiotic analysis of 100 photoatlases (Fig. 43) were presented at the International Semiotic Congress in September 2021 in Chemnitz (Wolodtschenko, Zaslavsky 2021). The results of the thematic classification of photoatlases are shown in Fig. 44 and the semiotic classification - Fig. 45.

Fig. 44 Screenshot with thematic classification

The project shows new possibilities not only for statistical, but also for the semiotic analysis of primary and secondary or derived photoatlases and photoatlas data.
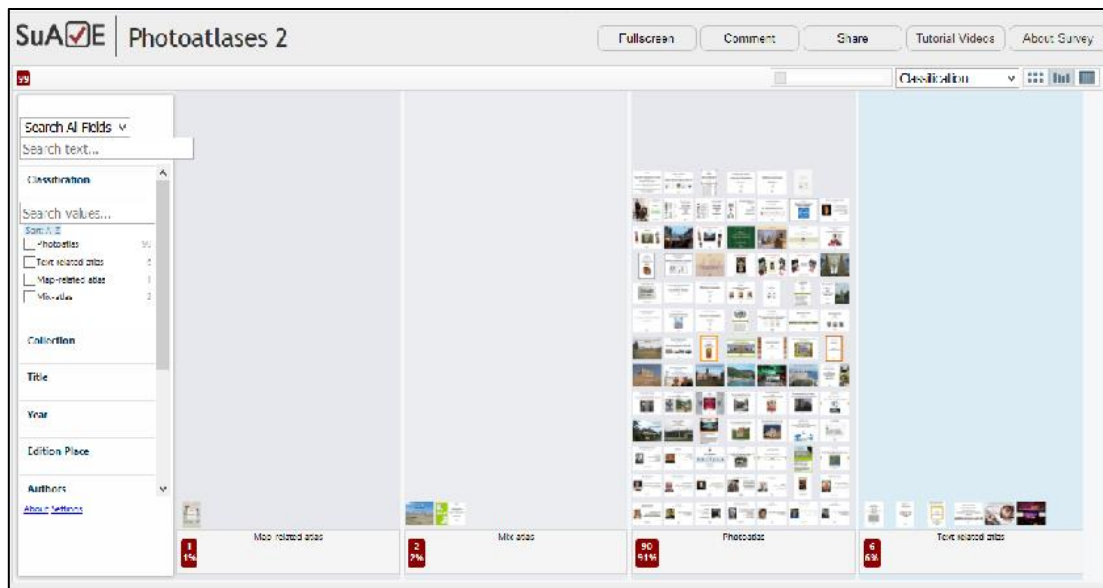
Fig. 45 Screenshot with semiotic classification

Ubiquitous photoatlas-related "comfort". Semiotic evolution processes in cartography and atlasgraphy are reflected particularly in ubiquitous photoatlases. The model of information characteristics and meta-variables (text-photo-map) as communication categories or 4M-categories of "comfort" of ubiquitous mini-atlases is shown in fig. 46. Table 4 presents four categories of "comfort" of ubiquitous photoatlases. 4M "comfort" – four characteristic conditions for the realisation of ubiqiuty by photoatlases.

Table 4 Categories of "comfort" of ubiquitous photoatlases (Wolodtschenko 2013)

| Mobility	Ability to use the atlas while moving
Minimality	Maximum-optimal dimensions of the atlas, for example, using smartphones and tablets
Multimediality	Combination of several types of visual information, such as textual, map and illustrative information in static and/or dynamic form. Visual information can be supplemented by an acoustic component: music, rustles, separate sounds-signals, etc.
Multi-displaying	Presence of two or more screens for visualization and information management
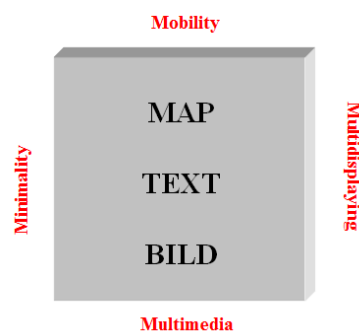
Fig. 46 Model of "comfort" and meta-variables (Wolodtschenko 2011a)

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3.2. Semiotics of photoatlases

The semiotics of photoatlases is part of atlas semiotics, which was formed within the framework of cartosemiotics, but it did not replace cartosemiotics. In the study and analysis of photoatlases, a cartosemiotic approach is used to study traditional atlases as thematically modular semiotic models of reality or fictitiousness in a particular space and time.

Semiotics of photoatlases is formed as an interdisciplinary direction in the study and analysis of various electronic and non-electronic photoatlases with cartographic and non-cartographic traditions. The structural model of semiotics of photoatlases is presented in tab.5.

Tab. 5 Structural model with diverse traditions

Semiotics of photoatlases		
With cartographic traditions (in cartography)		With non-cartographic traditions (in medicine, art, tourism, etc.)
Photo atlases (aero / space photo atlases)	Geopanoramic atlases	Illustrative atlases: atlases of photographs, drawings, panoramas, etc.

In one of the first monographs on the semiotics of photoatlases (Wolodtschenko 2014), the results of the analysis of photoatlases as semiotic modes on the following topics were presented:
- modular-thematic structuring
- semiotic (quantitative) potential
- structural and thematic diversity
- 1/2/3-display layout and design
- primary (initial) and secondary (derivative) models
- basic and additional semiotic models
- pragmatic types of users of photoatlases, etc.

This chapter will not only consider the theoretical and methodological exploration of selected photoatlases as a new applied semiotic direction, but also new examples from a range of thematic primary and derivative photoatlases and meta-atlases.

3.2.1. Structure-semiotic features of photoatlases

Three main approaches can be distinguished in structuring of photoatlases: modular, thematic and slide-related. The first approach is characterized by the structuring of one photo-atlas or a group of photoatlases with the allocation of information-semiotic modules and submodules. Such modules can be considered as independent parts of any photoatlas, a group/series of photoatlases, and even a whole collection of photoatlases (Wolodtschenko 2006). In the second approach, the structuring of the photoatlas is carried out according to its thematic component, i.e. according to the composition and correlation of thematic sections in

the table of contents. The third approach makes it possible to filter out structure-content models from photoatlases and serves to quantify the potential of photoatlases. Some examples of modular, thematic and slide structuring will be described below (Wolodtschenko 2016).

Multimedia module structure of the photoatlas. The illustrative atlas "19th Baikal Conference 2014" is an example of three multimedia modular-structural models. Tab. 6 shows the structural model of the photoatlas and fig. 47 - front pages of the basic photoatlas with three multimedia models (video/geo panarams, photo galleries and photo albums).

Tab. 6. Module-related structural model of the photoatlas

Basis-Photoatlas		
32 slides (62 photos)		
Module 1	**Module 2**	**Module 3**
Geo-Panorams (3 videos)	Photo Galleries (7 x day photos, 10 photos/day)	5 Photoalbums (5 authors and 59 photos)

Basic Photoatlas

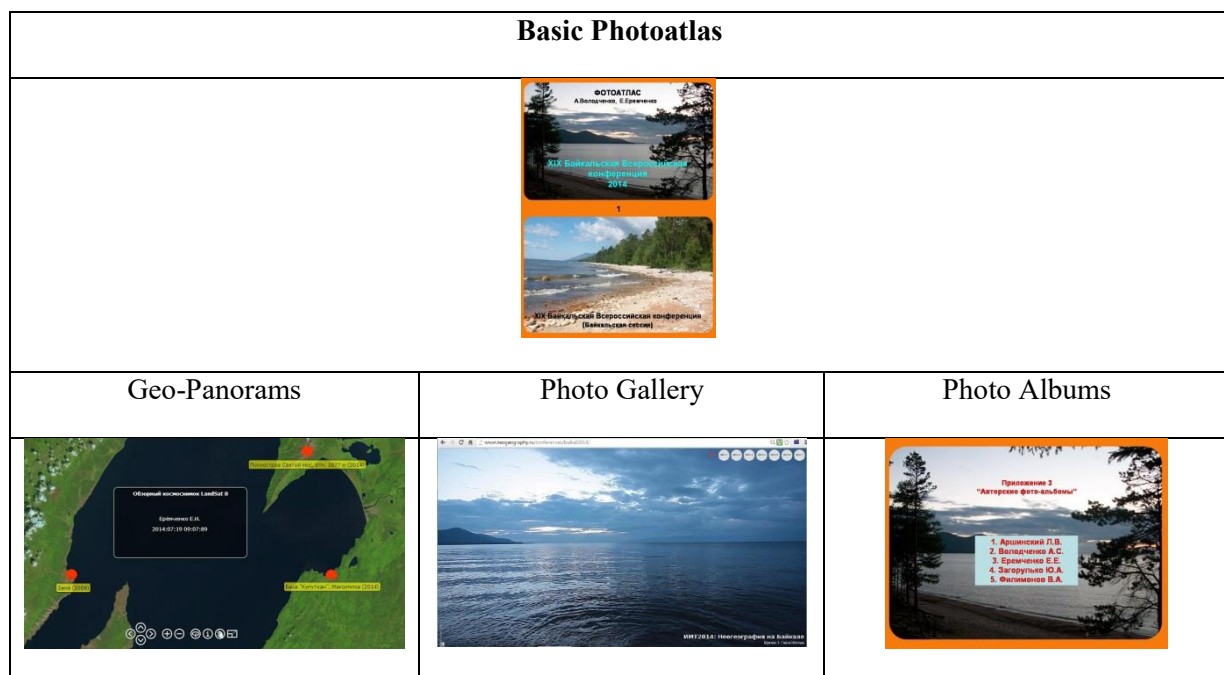| Geo-Panorams	Photo Gallery	Photo Albums

Fig. 47 Title pages of basis photoatlas

Thematic structure of the table of contents of the photoatlas. The event picture atlas "Max Jakob Puppen-Theater" in Hohnstein with 16 slides served as an example. Tab. 7 shows a slide-related table of contents of the picture atlas, with the section "75 years of puppet theater in Hohnstein" dominating with 10 slides.

Tab. 7 Structure models of the table of contents of photoatlas

Table of contents	Slide №	Nimber of slides
Titelseite	1	1
Inhaltsverzeichnis	2	1
75 Jahre Puppentheater in Hohnstein	3-12	10
Google Maps	13	1
Literatur	14	1
Impressum	15	1
Über die Autoren des Fotoatlas	16	1

Slide-related profile of photoatlas. This structural model of the photoatlas of the Max-Jakob-Theater in Hohnstein supplements the thematic structural model in table 7. Figure 48 shows three profile levels of the photoatlas and their shares: "Facade" (12.5%), "Core" (62.5%) and "Supplement" (25.0%). The topic of the photoatlas is represented by 13 photographs, which form the "core content" of the photoatlas.

Facade
12,5%

Core
62,5%

Supplement
25,0%

Fig. 48 Slide-related profile of photoatlas

Slide-related structuring of a photoatlas. The photoatlas "Max-Jakob-Theater" serves as an example. This is an event photo atlas. The layout and foil model can be found in Fig. 50. The atlas contains 16 slides: 11 slides with 20 photos; text with four slides and one slide with two maps from "Google Maps". The slide model serves to quantify the potential of the photoatlas and its subsequent structuring.
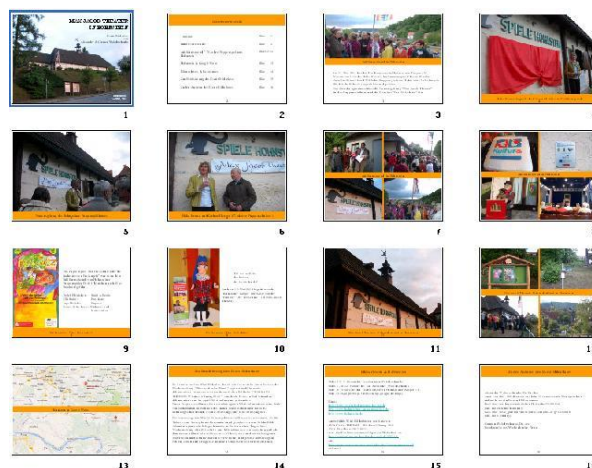

Fig. 50 Layout and slide model of the photoatlas „Max-Jakob-Theater"

The semiotic potential of the photoatlas in % is: 69% illustrations/photos, 25% text information and 6% maps. Figure 50 shows the potential of the photoatlas in the form of a diagram. The photoatlas is dominated by photographs, which are supplemented by comments. Two maps from "Google Maps" are used for orientation in the region.
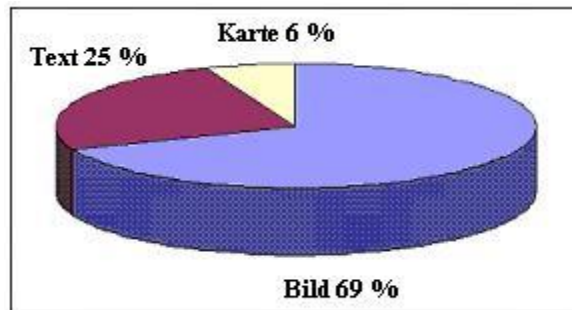

Fig. 50 Semiotic potential of photoatlas „Max-Jakob-Theater"

3.2.2. - Derivative photoatlases

A derivative photoatlas is defined as a semiotic atlas model that is created on top of another atlas or an atlas-like model (e.g. calendar, photo book, infographics, etc.). A derivative photoatlas is a meta-model composed of multiple models.

In this section, four examples of derived photoatlases are considered as a new pictorial form of information presentation. The first two photoatlases belong to the event photoatlases, the third to the landscape atlases, the fourth is a virtual museum of three photoatlases.

1) Christmas message with photoatlases. On the eve of the Christmas holidays 2016, the author had the idea to create a photoatlas entitled "Christmas Greetings 2016" and to send Christmas greetings in such a symbolic picture form to friends and colleagues by e-mail. The picture atlas can be found on the Internet at the web address:

http://rcswww.urz.tu-dresden.de/~wolodt/BILD-ATLAS/Weihnachtsgruss-2016.pdf1)

The photoatlas as a Christmas message and a new form of communication unexpectedly found an interesting response through feedback (in text and photo cards) from my friends and colleagues. From the photoatlas "Christmas Greetings 2016" was created a new photoatlas "Feedback - Christmas Greetings 2016", which was created as a reaction to the original photoatlas.

a   b   c

Fig. 51 Christmas message 2016 from three photoatlases

In return, a new "feedback" - the photoatlas became the basis for the second derivative photoatlas, but only for my colleagues from the International Cartographic Association, who sent me their Christmas greetings. The photoatlas Christmas project consisted of three photoatlases (base or original, fig. 51a and two derivative photoatlases, fig. 51 b, c). Fig. 52 shows a photo-gallery of photoatlas "Christmas Greetings 2016".
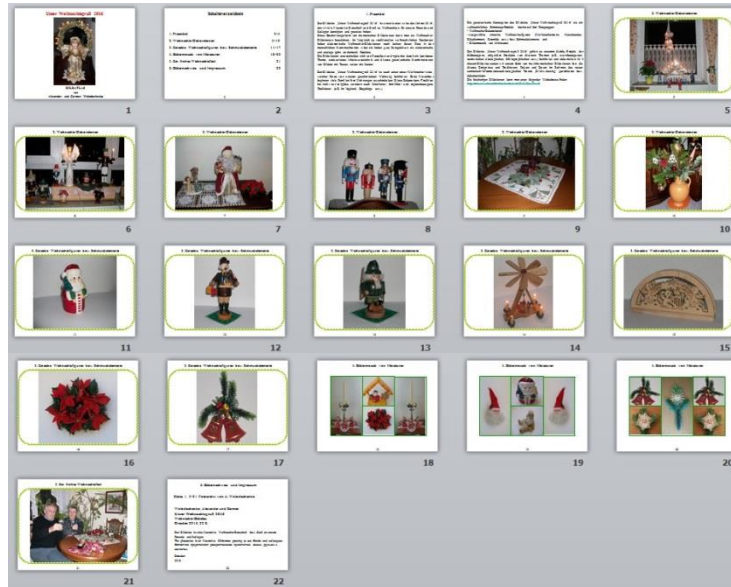

Fig. 52 Photo-gallery of photoatlas "Christmas Greetings 2016"

Electronic photoatlases for Christmas (and New Year) in the form of greetings are not yet as well known and popular as e-postcards. This is a new and interesting form of joint congratulations and communication. In his Christmas greetings to the author of the article, Prof. F. Taylor from Canada called Christmas photoatlases "A very innovative and impressive way of celebrating Christmas". E-Christmas and New Year's photoatlases have good prerequisites and chances of becoming popular and in demand in modern communications society.

2) Event photoatlas and newspaper. The first projects to create event photoatlases to supplement newspaper articles or reports were tested and implemented in 2014. Such projects not only shaped a new form of cooperation, but also the emergence of a new form of hybrid media products: newspaper and photoatlas.

An event photoatlas and a report in the "Wochenkurier Pirna" (Fig. 53 and 55) documented the anniversary evening on May 13, 2014 in Hohnstein on the occasion of the 75th anniversary of the city puppet theater and gave it the name "Max Jacob Theater". Max Jacob was the Founder of the puppet theater.
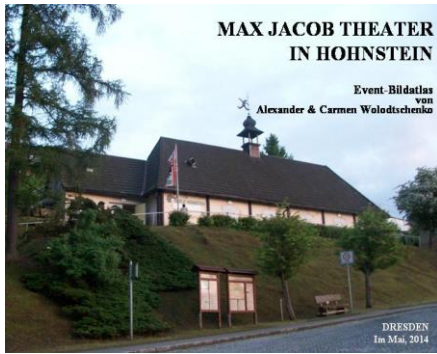
Fig. 53 Title page of photoatlas

Fig. 54 Screenshot:
http://www.wochenkurier.info/epaper/

The derived photoatlases supplement a particularly interesting thematic reporting in a daily/weekly newspaper or magazine with a combination of photos, text and map material and document various natural and social facts and events in a semiotic information space.

3) Photoatlas and calendar. In 2015, the section "Geo- and cartosemiotics" of the German Semiotic Society started to create hybrid products (models), in which a thematically derived photoatlas was combined with the calendar. The co-section leader, Monika Huch and the author were co-authors of the first joint photoatlas, which was created in 2016 and was named "Landscape Geological Photoatlas". The title pages (Fig. 55) of 13 geological wall calendars "The Geological Calendar 2002-2014", edited by M. Huh, served as source material. The photoatlas can be found on the website: http://rcswww.urz.tu-dresden.de/~wolodt/BILD-ATLAS/3)

Fig. 55 Title pages of calendar „Der Geologische Kalender 2002-2014"

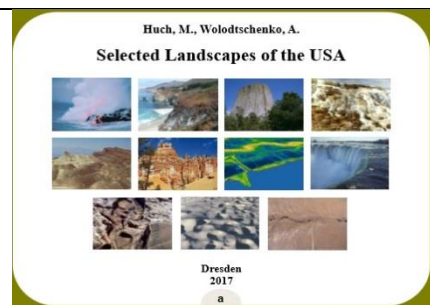|	
Fig. 56 Table calendar "USA Landschaften 2017"	Fig. 57 Title page of photoatlas „Selected Landscapes of the USA"

Based on 13 geological wall calendars, M. Huch has designed a new table calendar (Figure 56) "USA Landscapes 2017" (Huch 2016). The concept for the second photoatlas "Selected Landscapes of the USA" was based on the desk calendar "USA Landscapes 2017" and the geological wall calendar "The Geological Calendar 2002-2014". Fig. 57 shows the title page of the illustrated atlas "Selected Landscapes of the USA

4) Photoatlases and virtual museum. The collection has thematic photoatlases as virtual photoatlases museums made up of three photoatlases about Swedish-Russian map historian Leo Bagrow (1882-1957): a) Leo Bagrow and St. Petersburg (1898-1918): b) Leo Bagrow in Berlin (1919-1945); c) Leo Bagrow in Stockholm (1945-1957). Fig. 58 shows screenshots of the virtual photoatlas museum. Such a photoatlas museum can be viewed as a three slide gallery (Fig. 59).

a   b   c
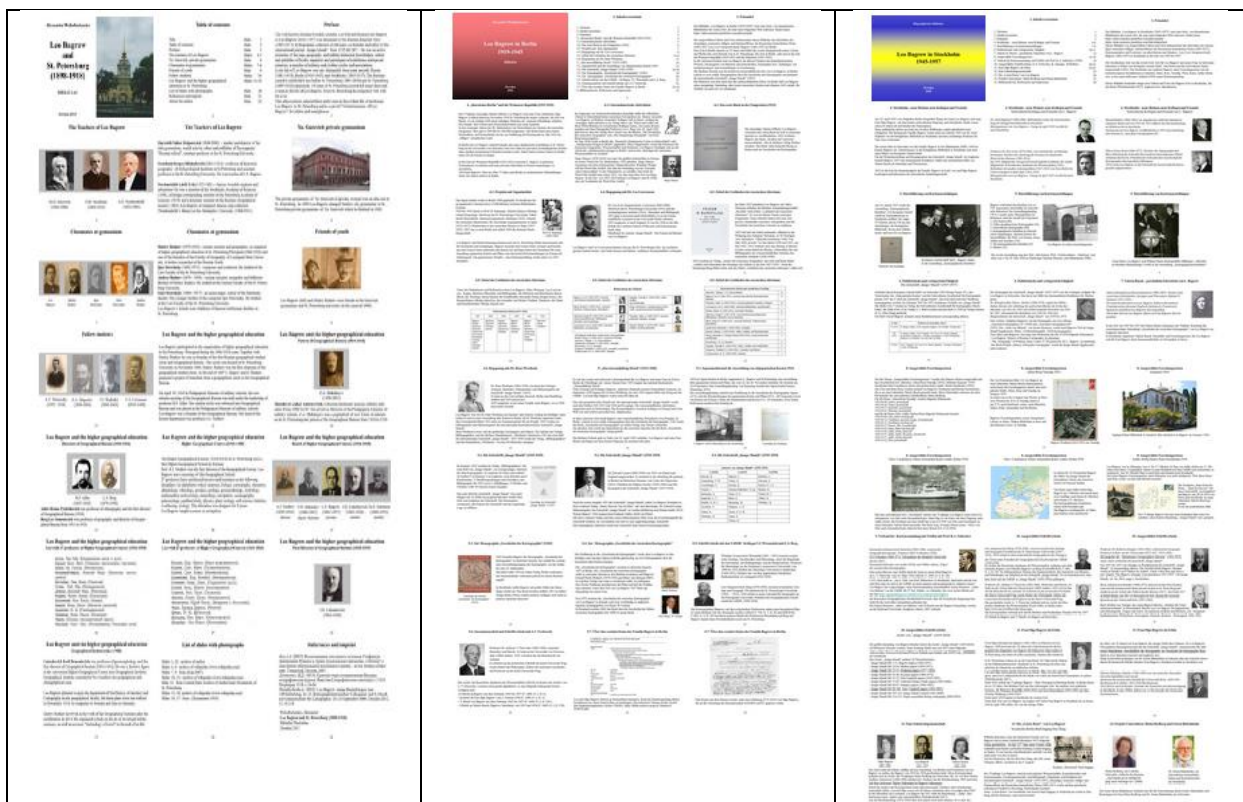
Fig. 58 Screenshots of selected virtual photoatlas museum about Leo Bagrow ((https://atlas-semiotics.jimdo.com)

Fig. 59 Virtual photoatlas museum about Leo Bagrow as slide gallery (https://atlas-semiotics.jimdo.com)

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3.2.3. Photoatlas design of one, two and three slide/parts layout

The traditional "architecture" of single-display photoatlases is a series of ordered slides or pages (Fig. 60). A smartphone based on a single display will always be in demand as a classic variant for many users, but smartphones of the future will be designed on a multi-display basis.
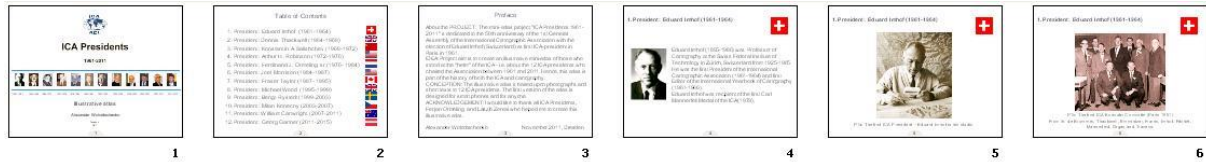

Fig. 60 Layout profile for one-slide-related image atlas "ICA Presidents 1961-2011" (test with 6 slides)

For event-related and cultural-historical topics, two atlas pages were simulated on the screen of a tablet/smartphone, on which graphic information was presented like on a slide. A two-sided slide of the atlas space offers more compositional and creative possibilities for the construction of mini-atlases (photoatlases) than a one-sided slide. Fig. 60 and fig. 61 show fragments of one and two page constructions of the same photoatlas "ICA Presidents 1961-2011". The comparison of two layout profiles of these photoatlases enables you to optimally select and combine two meta-variables (text and photo).
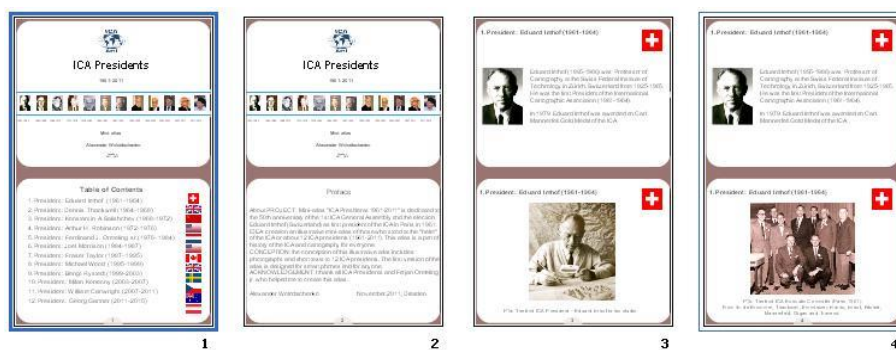

Fig. 61 Design profiles of two page construction of the photo atlas "ICA Presidents 1961-2011" (test with 4 slides)

The visual analyzes and comparisons based on two- or three-page atlas designs can be used effectively on monitoring issues. Fig. 62 presents a comparison of a satellite image and a map from "Google Maps". Fig. 63 shows the congress center in Dresden during and after the flood of June 6, 2013. The example was designed from two metavariables – photo (2) and text (as a comment).

Fig. 62 Satellite image and map (from "Google maps")

Fig. 63 Congress center in Dresden 2013 (before and after the flood)

Concepts for creating three-part or triptych slides of photoatlas can be used for comparative analytical developments based on photographs or facts and events of different times. The investigations of photoatlas systems as dynamic models are very perspective. In any case, the creation of dynamic photoatlases based on newly acquired data and knowledge, including meta-photoatlases (atlases of photoatlases), becomes imperative. Fig. 64 shows a title slide as triptych design (left) and photo gallery (right) of the photoatlas "Touristisches Triptychon von Dresden".
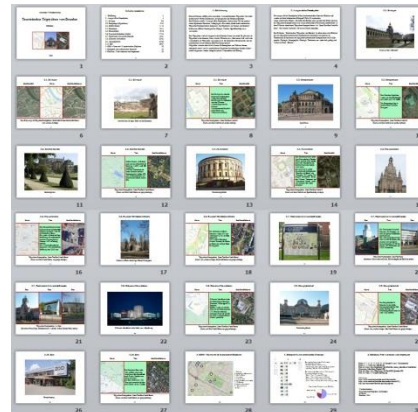

Fig. 64 Title slide (left) and photo gallery (right) of the photoatlas (Wolodtschenko 2021)

3.2.4. Methodic-analytical photoatlases

Methodic-analytical or methodic-semiotic photoatlses (Wolodtschenko 2021) form a special group of photoatlases from the author's collection. Fig. 64a shows two examples that form a methodical series:

a) Slide-related design and compositions of e-photoatlases (2021)

b) Outline of the semiotic photoatlas science (2021).
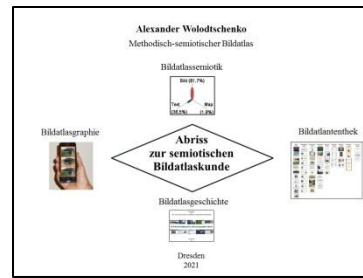
a   b

Fig. 64a   Methodic-analytical photoatalses

These photoatlases document examples of atlas-semiotic analysis or content-related structuring of various atlases. The photoatlas "Slide-related design and compositions of e-photoatlases" presents selected examples of one-, two- and three-part slide compositions from the photoatlas collection on the author's website.

The photoatlas "Outline of semiotic photoatlas science" presents selected methodical examples of photoatlas studies as a new semiotic-oriented training subject, photoatlasing, which deals with the design, analysis and portrayal of thematic picture atlases as well as the historical outline of photoatlases. This photoatlas fixes only methodological contours of the new teaching discipline - photoatlas science.

3.2.5. Meta-photoatlases

Creation, study and analysis of derivatives and meta-photo-atlases is a new research field of meta-photoatlassing. Any photoatlas is an information-semiotic model dominated (more than 50%) by photos, videos, drawings, etc. One can distinguish between primary or source and derived photoatlases. Derivative photoatlases created on the basis of original atlases, calendars, books, etc. and form meta-photoatlases (as derivative semiotic models).

Fig. 65 shows a title slide and photo gallery of the derivative meta-photoatlas "Semiotic Analysis of Atlas Index" by A. Wolodtschenko, Dresden 2022 and fig. 66 – a structure model. The project aims to create a methodical meta-photoatlas. The methodical focus of this derivative photoatlas is a semiotic analysis of the Atlas Index of Nationalatlas Deutschland and a monography (Wolodtschenko 2007).
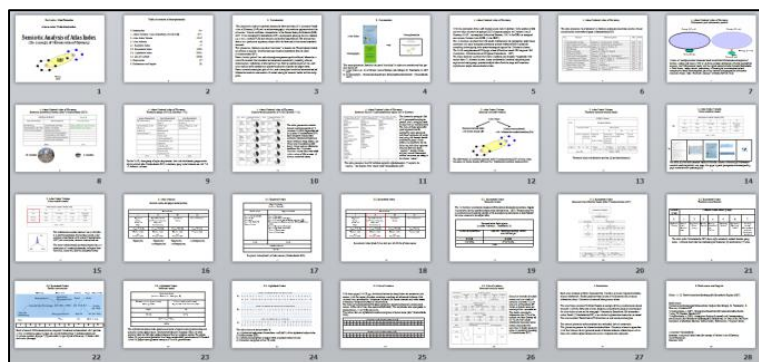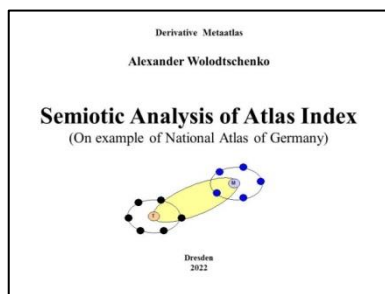

Fig. 65 Title slide of (left) and photo gallery (wright) of derivative atlas

Fig. 66 Structure model of meta-photoatlas "Semiotic analysis of atlas index"

Other example of meta-atlas includes five photoatlases: three derivative photoatlases from e-book "'Learning From a Kindergarten Dropout" (Thumbadoo and Commanda 2005), one photoatlas from calendar "William Commanda CAN TEACH Calendar 2022" (Thumbadoo 2022) and one photoatlas from web-site of "Circle of All Nations". Fig. 67 shows a structure model of meta-atlas and fig. 68 - a title slide and photo gallery.
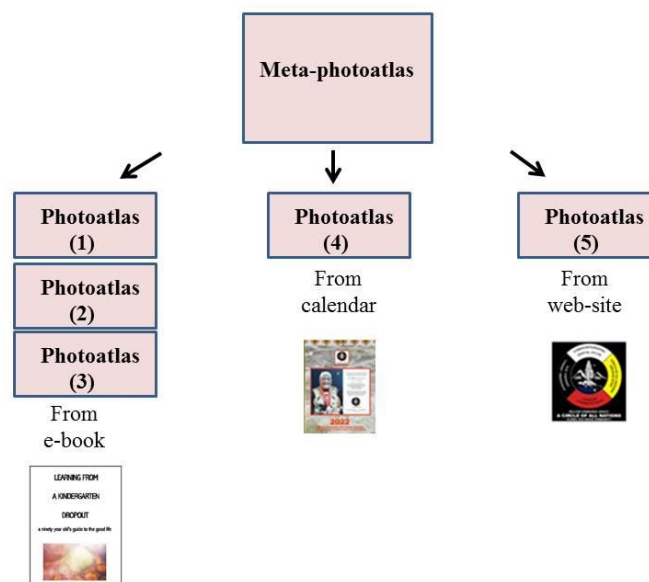

Fig. 67 Structure model of meta-photoatlas "Indigenous Elder William Commanda in e-book, calendar, web-site, photoatlas collection …" (Thumbadoo, Wolodtschenko 2022)
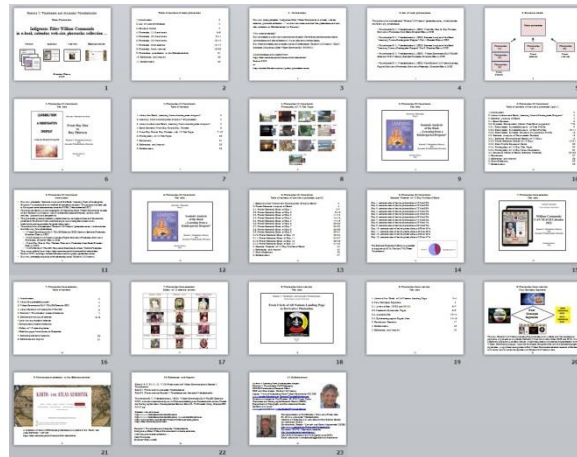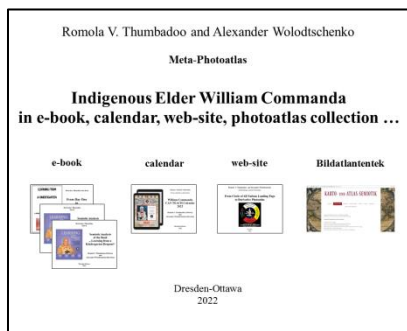
Fig. 68 Title slide (left) and photo gallery (right) of meta-atlas

3.2.6. On robotic photoatlases

Automated creation of maps and photomaps from satellite images, for example, for weather forecasting has long been realizable task. In the media, the "textualization" of data or automatic generation of texts from an array of data. In 5-10 years, robotic journalism can dramatically change the situation with the demand for journalists. Many special topics can be mastered and processed only by "robot-journalists" on the basis of the collected data arrays.

Can we talk about robotic photo atlases today? Sure. But for now, in the future. Map containing statistical photoatlases, fashion photoatlases, event and travel photoatlases, etc. have a chance of their implementation and use in the form of robotic products. Robotic or "algorithmic" photoatlases and photoatlas systems will also have an impact on the formation of a new atlas culture in the modern information society.

3.3. Cyberphotoatlassing – a new interdiscipline synthesis

In the 2000-2020 years, two conceptions in cartography were independently developed: one technologically-oriented "cybercartography" in Canada (Taylor 1997, 2003, 2019) and the other theoretically-oriented "metacartosemiotics" in Germany (Wolodtschenko 2011). By 2020 a cybercartographic and carto/atlasemiotic accumulation of knowledge and products reached a level to discuss the formation of a new integrative concept (Interview with Fraser Taylor, 2020).

Over the last two decades (2000-2020) different resources have evolved and they demonstrate the potential of a synthesis of cartography in Canada and Germany (Tab. 8). The cybercartographic and carto/atlasemiotic accumulation of knowledge and products has reached a level to enable the discussion of the formation of a new integrative conceptualization.

Tab. 8 Selected facts of concepts synthesis (Wolodtschenko 2021)

2000s-2010s	
Concepts	**Selected facts**
Cybercartography	- In 2002 a major investigation was made at Carleton University, Ottawa and the Geomatics and Cartographic Research Center (GCRC) was established. Prof. Taylor became the founder and director of the GCRC. - Book "Cybercartography: Theory and Practice" (2005)
Meta-cartosemiotics	- At the beginning of 2000, an optional course "Cartosemiotics" was set up at the Institute for Cartography, TU Dresden. - Since 2008 the international e-journal <meta-carto-semiotics> (in German/English) has been published - e-lexicon "Cartosemiotics" (2009) - Cartosemiotic seminars and workshops with the ICA Commission Theoretical Cartography
2011-2019	
Cybercartography	- Book: "Developments in the theory and practice of Cybercartography: Applications and Indigenous mapping". (2014) - Cybercartographic atlases dominate in GCRC.
Meta-cartosemiotics or Meta-carto/atlassemiotics	- new section "Eco- and Cartosemiotics" (2015), 2017 renamed Section "Environmental and Carto/Atlassemiotics" - a new multidisciplinary research direction "Atlassing" (2012) is defined. - Book "Semiotics of Photoatlases"(2016).
2020s	
Cyber-Photoatlassing	- Book „Semiotische Evolution in Kartographie und Atlassing" (2020). - First German-Canadian project: photoatlas „10 Selected Indigenous Cybercartographic Atlases" (2021) - Presentation „Cartography in the Social Media Era: A New Balance and Synthesis", ICC 2021 in Florence, Italy - Circle of All Nations CAN Photoatlas Projects (2022)

What does the new synthesis concept of "Cyber-Photoatlassing" for cartography and atlasgraphy bring?

The concept offers new balance for technology and theory. The concept offers methodological synthesis of cybercartography and carto/atlassemiotics, mapping and atlassing, cartology (Kartenkunde) and atlasology (Atlaskunde). The concept notes also two user-focuses of interests: map atlas-centric focus and photoatlas-centric focus with cartographic and non-cartographic traditions.

Two projects of cybercartographic photoatlases (Fig. 69) demonstrate an example of multidisciplinary cooperation in technology, methodology and practice in the evolution of innovative approaches to cybercartography and atlasgraphy.

The photoatlas "10 Selected Indigenous Cybercartographic Atlases" (Fig. 69, left) was

the first German-Canadian project of 2021, by Fraser Taylor, Romola V. Thumbadoo, (Geomatics and Cartographic Research Centre/GCRC, Department of Geography and Environmental Studies, Carleton University, Ottawa, Canada) and Alexander Wolodtschenko (Section "Environmental and Cartographic Atlas Semiotics", German Society for Semiotics/DGS). The photoatlas is designed for smart phones and tablets. It is compact (up to 25-35 slides with a file "weight" of 10-20 MB), ubiquitous (usable anytime and anywhere), and it presents generalized thematic information about ten selected Indigenous cybercartographic atlases. Fig. 69 (right) shows our second photoatlas "Cybercartography and Photoatlassing Projects" 2022.
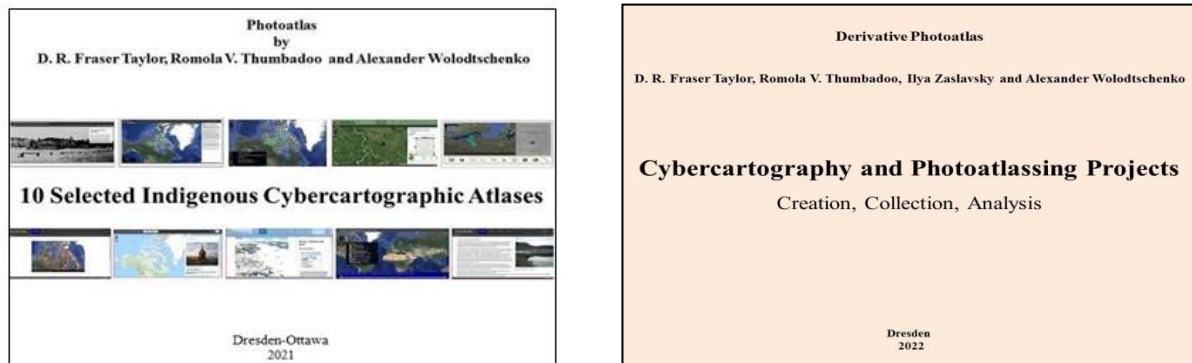

Fig. 69 Two title slide: photoatlas „10 Selected Indigenous Cybercartographic Atlases"(left) and "Cybercartography and Photoatlassing Projects"(right)

Photoatlas series "Circle of All Nations" (CAN). The initiators of the series of photoatlases are Romola V. Thumbadoo (Ottawa) and Alexander Wolodtschenko (Dresden). The series of photoatlases "Circle of All Nations" (CAN) are dedicated to Indigenous Elder William Commanda (1913-2011).

William Commanda (1913-2011): Indigenous Elder, Political Algonquin leader, chief the North American Indigenous Nations Government, Founder of the Circle of All Nations (a global eco-peace community dedicated to advancing environmental stewardship and racial harmony), Officer of the Order of Canada and recipient of two honorary doctorate degrees.

Over the past two decades, Circle of All Nations (CAN) work has remained focussed on five priorities: Training, Education, Advocacy, Communications and Healing, and hence uses the acronym CAN TEACH to brand its work and efforts. The reflexive text, visual imagery and semantic design employed in the overall work aim to bridge incommensurabilities of diverse knowledge streams.

The first photoatlas, a memory photoatlas "William Commanda CAN TEACH Calendar 2022" is based on the William Commanda Calendar 2022. The second project, the photoatlas "From Circle of All Nations Landing Page to Derivative Photoatlas" is based on the innovative Circle of All Nations Landing Page which introduces the new and old websites and other online work on one platform. The thematic photoatlases "From Day One to Day Thirteen" is the third project which deals with creation of derivative photoatlases, and one of a series of three on the book, "Learning from a Kindergarten Dropout". The fourth and fifth projects are storytelling, methodical and commemorative photoatlases;the methodical focus is a semiotic analysis of the book. The sixth project is a derivative atlas including five photoatlases and one atlas collection or Bildatlantenthek (in German). The list of the six photoatlases follows:

1) Thumbadoo, R.V., Wolodtschenko A. William Commanda CAN TEACH Calendar 2022. Memory-Semiotic Photoatlas. Dresden-Ottawa, 2022

2) Thumbadoo, R.V., Wolodtschenko, A.(2022): From Circle of All Nations Landing Page to Derivative Photoatlas. Derivative Photoatlas, Dresden-Ottawa 2022

3) Thumbadoo, R.V., Wolodtschenko,A.(2022): From Day One to Day Thirteen (From e-book „Learning from a Kindergarten Dropout" to Photoatlas). Derivative Photoatlas, Dresden-Ottawa 2022

4) Thumbadoo, R.V., Wolodtschenko, A.(2022): Semiotic Analysis of the Book „Learning from a Kindergarten Dropout" (Part 1). Derivative Photoatlas, Dresden-Ottawa 2022

5) Thumbadoo, R.V., Wolodtschenko, A.(2022): Semiotic Analysis of the Book „Learning from a Kindergarten Dropout" (Part 2). Derivative Photoatlas, Dresden-Ottawa 2022

6) Thumbadoo, R.V., Wolodtschenko, A.(2022): Indigenous Elder William Commanda in e-book, calendar, web-site, photoatlas collection … Meta-Photoatlas, Dresden-Ottawa 2022
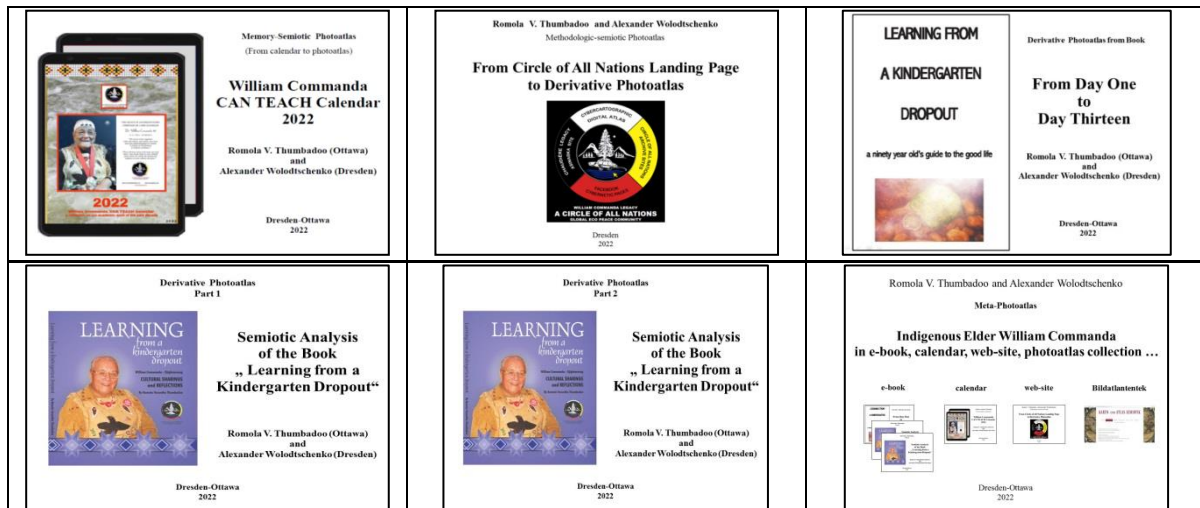

Fig. 70 Six title slides of photoatlas projects (Circle of All Nations/CAN Projects)

All photoatlases (fig. 70) are available from: https://atlas-semiotics.jimdofree.com/bild-atlantothek/ and https://circleofallnations.ca

The Circle of All Nations atlases demonstrate the growing integration of the semiotic analysis of photo-narrative locational and cognitive mapping products.

3.4. Photoatlas science as academic discipline

The teaching-related or academic discipline in cartography was named Map science or Kartenkunde in German (Ogrissek 1983, Salischev 1976, 1990), with map making and map design being the main disciplines. The structural model of photoatlasology or photoatlas science (Bildatlaskunde in German) (Fig. 71) as a new semiotic-oriented academic discipline is based on four sections or parts: photoatlasgraphy, photoatlas semiotics, photolatlas collection (or photoatlasothek) and photoatlas history (Wolodtschenko 2021).
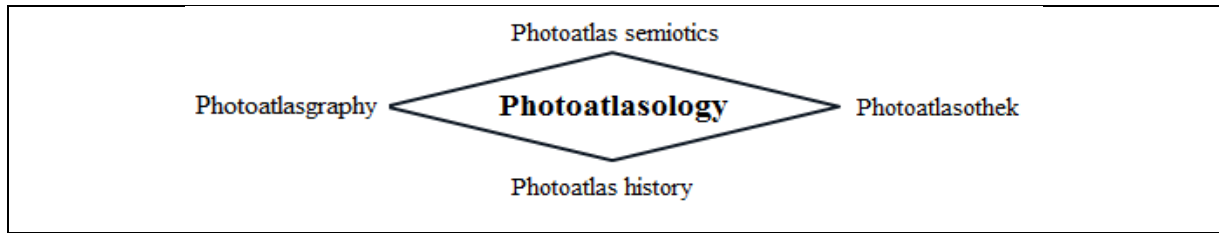
Fig. 71 Academic disciplines of photoatlasology (photoatlas science)

The academic photoatlas disciplines orientate the user, especially from a semiotic-epistemological point of view, to the discipline-related novelty in photoatlasing, a sub-area of atlasing. Photoatlasology or photoatlas science reflects a cartosemiotic evolution (Wolodtschenko 2020) at the interface of cartography and semiotics through various development and conversion processes from cartography to atlasgraphy, from cartosemiotics to photoatlas semiotics, from individual atlas analysis to atlas data analysis, from graphic variables to model-semiotic metavariables, parity-semiotic atlas classification, etc. This ended the long-standing monopoly of map atlases with ubiquitous photoatlases (mini-atlases).

Photoatlaslogy (Bildatlakunde in German) as a new academic-semiotic discipline with cartographic and non-cartographic traditions can be used by students of geography, ecology, cartography, cultural histories, applied semiotics, etc.

4. About metaatlasgraphy

If the first three chapters of the book describe some trends in the development of cartography in the 1970s-2020s, the accumulation of cartographic/atlas semiotic knowledge, evolutionary processes in cartosemics and theoretical cartography in the 2010s-2020s, the emergence of atlasing/photoatlassing and atlasgraphy, as well as the prerequisites for the formation of meta-atlasgraphy, then the 4th chapter describes models of metatheoretical research and metacartographic epicenters, the first forms of metaatlasgraphy, its structural model, bipolar terminological field and basic semiotic-democratization principles.

4.1. Models of metatheoretical research and metacartographic epicenters

At the beginning of the 2020s, several (meta) theoretical approaches can be distinguished in the development of theoretical cartography and its role in the study of maps as basic geospatial models. A few models of "development trees" diagrams regarding the development of metacartography, metacartosemiotics, metaatlasgraphy and metatheoretical epicenters will consider in this chapter.

Epicenters of development theoretical cartography. The development of theoretical thought in cartography can be documented and illustrated in many ways. One of them is the diagram "development tree". Jan Pravda (1994) used such diagram to present the results of the analysis of the literature on theoretical cartography, which reflected the development of cartographic thought in concepts, scientific schools, etc. (see fig. 15). The metatheoretical studies and their epicenters were left without attention.

The term "metacartography" was used by the American geographer W. Bunge (1962) within the framework of theoretical geography when studying the most general spatial properties of maps, photographs, drawings, etc. at the intersection of pre-maps and maps, maps and mathematical models. (Photo from/fig. 72: https://geografiamungia.wordpress.com/2012/09/13/geografo-interesgarri-bat/

Bunge W. (1928-2013)

The famous Soviet and Georgian geographer and cartographer A.F. Aslanikashvili (1974), used the general principles of semiotics in his research on the theoretical and epistemological aspects of the map language. His map-centric metacartographic concept was focused on the logical and methodological basis of geocartographic knowledge through the map language and the cartographic method. (Fig. 73 from: https://en.wikipedia.org/wiki/Alexander_Aslanikashvili)

Aslanikashvili A.(1916-1981)

If Bunge (1962) in his research used the term "metacartography" for one of the sections of theoretical geography, Aslanikashvili (1974) went further and identified a new theoretical direction in cartography and a new concept of "metacartography".

It can be considered that the first metacartographic ideas are contained in the work of Max Eckert (1921, 1925) entitled "The Science of Maps"/Kartenkunde. It can also be considered that Eckert's master work formed the first metacartographic epicenter in Germany and Europe in the 1920s and 1930s. (Photo from/fig. 74: https://de.wikipedia.org/wiki/Max_Eckert-Greifendorff)
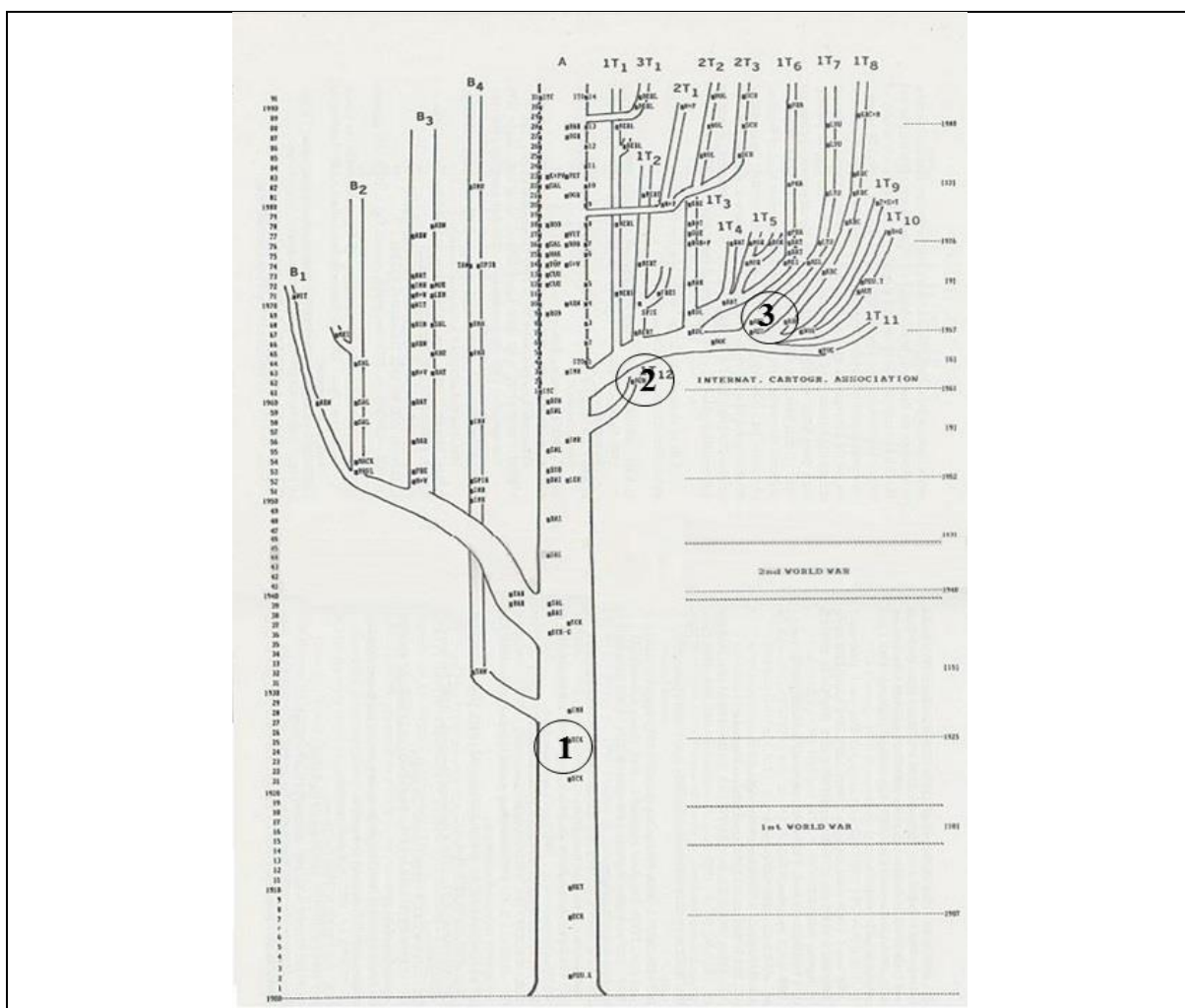
Eckert M. (1868-1938)

Fig. 75 Three epicenters (1,2,3) of metacartography concept (proposal of Wolodtschenko) based on "development tree" after (Pravda 1994)

Fig. 75 shows three concept metacartographic epicenters: 1) "The Science of Maps" epicenter after Eckert (1921, 1925); 2) Bunge (1962, 1967) metacartographic epicenter and 3) metacartographic epicenter after Aslanikashvili 1974).

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Amid the stagnation of theoretical cartography in the ICA since the mid-2010s, Morita (2022) reported new research on metacartography in Japan. It should also be noted that in 1998 the Japanese cartographer Tositomo Kanakubo translated the book "Metacartography" by Aslanikashvili (1998) into Japanese and published it in Tokyo. It is still too early to talk about the **new** metacartographic epicenter in Tokyo but its formation is real in the 2020s.

One more metacartographic epicenter can be formed in Irkutsk at the Institute of Geography of the Siberian Branch of the Russian Academy of Sciences. However, the metatheoretical studies in the article of this collection (Cherkashin 2022) have not yet found a conceptual completion in terms of their place in relation to metaatlasgraphy. This approach is rather map-centric and is formed to provide atlas-mathematical layer-by-layer modeling and geoinformation mapping of geospatial systems.

4.2. From metacartography and metacartosemiotics to metaatlasgraphy

The three concepts (metacartography, metacartosemiotics and metaatlasography) characterize the semiotic-oriented transformation in cartography and atlasgraphy. Fig. 76 shows the chronological trajectory of the three concepts from the 1960s to the 2020s.

Metacartography (Cartography) Primary concept		
⟶ 1960-1970	**Metacartosemiotics** (Cartosemiotics) Derivative concept	
	⟶ 1990-2000	**Metaatlasgraphy** (Atlasgraphy) Derivative concept 2020s

Fig. 76 Trajectories of cartography-cartosemiotics-atlasgraphy concept transformations (Wolodtschenko 2009, 2022)

Metacartography Metacartography is a one of the theoretic concepts in cartography and a one of the metatheoretic research direction. The term "metacartography" was used by Bunge (1962) as a part of theoretical geography. Aslanikashvili (1974) proposed a new theoretical direction in cartography and a new concept of "metacartography.

Metacartosemiotics. A new term in cartography and cartosemiotics. The lexicon (Wolodtschenko 2009, 2021a) describes three options for the possible use of this term:

1) Metacartosemiotics as a conceptual construction in theoretical cartography on the basis of "new cartosemiotics" (Wolodtschenko 2009). The conceptual development of the "new cartosemiotics" in the late 1990s included a system of language maps (s), which was based on a four-component (sublinguistic) basis, as well as a structural division of cartosemiotics into general and applied. Metacartosemiotics can become a new conceptual "beacon". This

concept has a huge interdisciplinary potential and is capable of forming a new generation of cartosemiotic concepts in geoinformation and outside geoinformation space.

By the end of the 2000s, the concept included three types of models and methods for their study: cartographic models (CM), cartosemiotic models (CSM), and metacartosemiotic models (fig. 77). The beginning of the 2020s is characterized by the evolution of metacartosemiotic models (Meta-CSM) in Meta-cartoatlas- semiotics models (Meta-CASM).
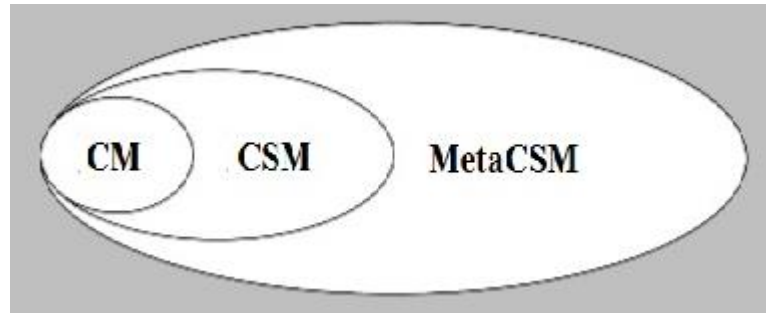

Fig. 77 Semiotic development of concept (Wolodtschenko 2008)

The new conception of cartography „metacartosemiotics" is a derived model of metacartography and represents new semiotic - epistemological orientations and priorities in research; it includes new objects to be examined (apart from maps, photomaps and globes,) e.g. various atlases as semiotic knowledge models and a new semiotic-quantitative analysis of atlases.

2) Metacartosemiotics as a new discipline that studies applied cartosemiotics (environmental, atlas, tourism, etc.) with cartographic and non-cartographic traditions.

3) Metacartosemiotics as an electronic journal on theoretical cartography and cartosemiotics (in English and German). Founded in 2008 by A. Wolodtschenko (Germany) and F. Hruby (Austria). The web address of journal is: http://ojs.meta-carto-semiotics.org/index.php/mcs

The new conception of cartography "meta-cartosemiotics" (Wolodtschenko 2009) represents new orientations and priorities in research and education; it offers new objects to be examined (maps, picture maps and globes, and now also various atlases, etc.) as spatial knowledge models and a new quantitative analysis (e.g. of atlases).

Structural model of metacartosemiotics. Since the 1990s, there has been a clear shift in the individual research directions in the research fields of cartosemiotics (Wolodtschenko 2002). There is a certain shift in the research focus from the semiotic investigation of individual components of the cartographic sign system (e.g. syntactic peculiarities of the map signs) to the structural investigation of various cartosemiotic models (e.g. map series, an atlas or series of atlases, etc.) as a carrier and accumulation of spatial-temporal knowledge.

A structural model of metacartosemiotics (Fig. 78) clearly shows three structural levels as a transformation chain from semiotics of maps to semiotics of cartographic, map-like and cartographic-textual models) to metacartosemitics (semiotics of cartosemiotics).

Research object	Languages	Spatial refernce	Semiotic discipline
Cartographic Knowledge models	Map language	elemntary systematic	Map semiotics
Cartosemiotics Knowledge models	Language of cartosemiotic models	polysystematic	Cartosemiotics
Meta-Cartosemiotics Knowledge models	Meta-map language	metasystematic	Meta-Cartosemiotics

Fig. 78 Structure model of meta-cartosemiotics (Wolodtschenko 2008)

Metaatlasgraphy is a new term and multidiscipline theoretical concept (Wolodtschenko 2022) as well as one of the new metatheoretic research direction. Selected terminological, functional, structural features will be described in the section below.

4.3. Metaatlasgraphy
4.3.1. Terminological aspects

The term "metaatlasgraphy" is a newer term in cartography and cartosemiotics than the term "atlasgraphy". The term "atlasgraphy" was formed in carto/atlas semiotics in the late 2010s, and the term "metaatlasgraphy" in the early 2020s. Until recently, their use in cartography or geography did not make sense, since the term "atlas cartography" included and defined the whole range of issues on the creation and use of various atlases in cartography. Diverse geographical, geological, historical, and other thematic atlases as cartographic or map centric atlases dominate modern society.

Atlases with non-cartographic traditions (for example, illustrated atlases) are usually created in small editions in various thematic sections (from anatomy to zoology) in publishing houses and cannot compete, for example with school or national atlases.

The term "metaatlasgraphy" is product of theoretical-semiotic evolution in cartography and cartosemiotics. The possible use of this term:
1) as theoretical concept
2) as one of the new metatheoretic research direction.

Map-Atlas (bipolar) terms. The list of selected comparative "bipolar" cartographic and atlasgraphic terms is given in tab. 9. Some atlasgraphic terms (shown in bold) are new words and often have working definitions. They form a new conceptual and terminological apparatus, which is now at the stage of its development.

Tab. 9 Selected Map-Atlas (bipolar) terms

Cartography	**Atlasgraphy**
Cartosemiotic models	Atlassemiotic models
Cartosemiotics	Atlassemiotics
Graphic variables	Semiotic metavariables
Map	Atlas
Map design	Atlas design
Map centric paradigm	**Atlas centric paradigm**
Map language(s)	**Atlas language(s)**
Map sceince (Kartenkunde)	**Atlas science (Atlaskunde)**
Mapping	**Atlassing/ Photoatlassing**
Metacartography	**Metaatlasgraphy**
Metacartosemiotics	**Metaatlassemiotics**
Photo map	Photoatlas
Photo map science	**Photoatlasology**
Theoretical cartography	**Theoretical atlasgraphy**

Bildatlas-related terms. The German term "Bild" is a polysemantic word and can replace other words or concepts. Tab.10 shows some examples of term "Bild" and "Bildatlas" in German, English and Russian.

Tab. 10 Examples of the use of term "Bild" in three languages

Bild	Foto, Darstellung, Illustration, Gemälde, Malerei usw. photo, image atlas, illustration, picture, painting,etc фото, изображение, иллюстрация, картина, роспись и др.
Bildatlas	Fotoatlas, illustrierter Atlas, Atlas der Abbildungen usw. photoatlas, illustrated atlas, picture altas, etc фотоатлас, иллюстрированный атлас, картинный атлас и др.
Metaatlas/Meta-Bildatlas	Metaatlas, Meta-Bildatlas metaatlas, meta-photoatlas метаатлас, мета-фотоатлас.

The author proposes to introduce the German term „Bild" into scientific practice without translation into other languages.

4.3.2. From cartosemiotic models to atlassemiotic models

The monopoly of maps in the 21st century is gradually losing its positions. It is supplanted by the use of various semiotic map-atlas models, for example, photo atlases, panoramas, infographics, etc. Within the framework of cartosemiotics, questions were repeatedly raised in which the competence of cartography in relation to atlases, atlas-thematic (tourist, ecological and other) information systems, geoportals, etc. was discussed. as an element of a new electronic culture and new information resources (Wolodtschenko 2006).

Analytical studies in the 2000s on the semiotic portrayal of atlases as cartographic-textual models (Wolodtschenko 2010, 2011) led to the conclusion that cartosemiotic models were distinguished (Fig. 79, left), and then that atlasosemiotic models were distinguished. For all types of atlases with cartographic and non-cartographic traditions, a semiotic classification system has been proposed. Such a classification system unites all atlases as semiotic models and distinguishes four classes of such models (Fig. 79 right).
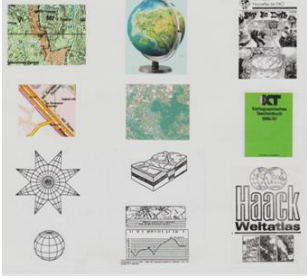
Cartosemiotic models	Atlassemiotic models
1　　2　　3	1　　2　　3　　4
cartographic models (1)	map-related atlas models (1)
map-lake models (2)	photographic atlas models (2)
cartographic-textual models (3)	text-related atlas models (3)
	mix(map-photo-text) atlas models (4)

Fig. 79 Cartosemiotic models (left) and atlassemiotic models (right)

From meta-maps to meta-atlases. The years 2010-2020 are characterized by innovative developments in atlasgraphy and atlassemiotics (Wolodtschenko 2020, 2021), reflecting the paradigm shift from the map-centric to the (photo) atlascentric paradigm. This does not mean that atlases will replace maps. Atlas maps can be used, for example, in meta-atlases (atlases about atlases).

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One of the author's projects in the 2010s included the cartosemiotic analysis of the "Google maps" (as a digital meta-map project) and the construction of primary and derivative photoatlases based on selected 19 scale sections (as combinations of maps and photo maps from 1:10 000 000 to 1:100.

Maps from Google are a set of digital base maps and photo maps (from shallow to cadastral), folded into a large-scale "leporello". Each scale cut (from 1:500 000 to 1:100) can be overlaid with selected thematic information (search, tourist, road, city, etc.).

The creation of thematic screenshot photo atlases was tested in two- and three-scale formats or triptych design. (Fig. 80). This meta-atlas project will have new possibilities using foldable 3-screen smartphones. The first models of 3-fold smartphones as foldable tablets have already been patented by Samsung and Microsoft.
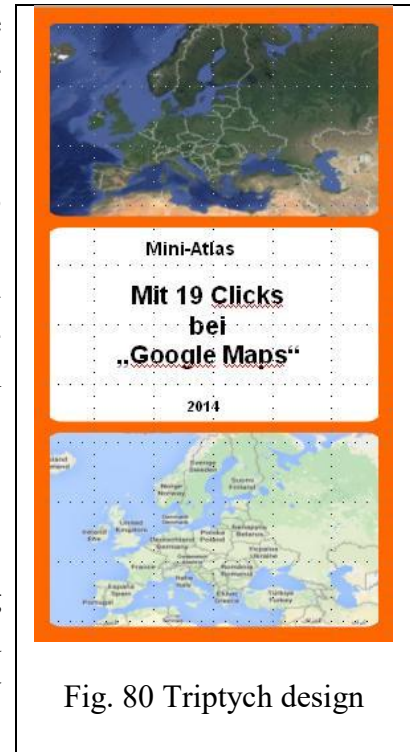
Fig. 80 Triptych design

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4.3.3. Structural model of metaatlasgraphy

Metacatlasgraphy is a conceptual construction in theoretical atlasgraphy. Concept includes diverse types of atlases as semiotic models and methods for their study. Tab. 11 shows one of the first structural models of metacatlasgraphy consisting of five model blocks (classification, analysis, languages, knowledge and traditions).

Tab. 11. Five model blocks

Block- structural model				
Models of atlas semiotic classification	**Models of semiotic analysis (primary, secondary)**	**Language system models**	**Research-epistemological models**	**Discipline traditional models**
Map-atlases Photoatlases Text-atlases Mixatlases	Atlas-related maps Atlases Metaatlases	Map language(s) Atlas language(s) Metaatlas language(s)	Cartographic knowledge models Atlasgraphic knowledge models Metaatlasgraphic knowledge models	With cartographic (geospatial) traditions With non-cartographic traditions

4.3.4. New metatheoretic epicenters

In the 21st century, two new concept epicenters appeared - metacartosemiotics and metaatlasgraphy, which are marked on the "development tree" (fig. 81) as epicenter 4 and epicenter 5, and as a continuation of the development of the cartosemiotic branch of 1990s.

Epicenter 4 was formed on the basis of the author's cartosemic activities (publications) in the 1990s-2000s and the emergence of a new metacartosemiotic concept (Wolodtschenko 2008). Tab. 11 shows the author's selected monographs on cartosemiotics.

The metacartosemiotic concept can be considered a derivative concept from metacartography according to Aslanikashvili (1974), where the methodological approaches of geocartographic knowledge through the language of the map and the cartographic method dominate.

The metaatlasgraphic concept is derived from the metacartosemiotic one. The concept of metatlasgraphy "lit up" in 2021-2022, almost 100 years later, when in 1921 the foundational monograph by Max Eckert "Scientific Cartography" (Eckert 1921) appeared in Germany, laying the foundation for the theoretical concept of scientific cartography.

Tab. 11 Selected monographs of the author on cartsemiotics (1990-2010)

Author, year of publication	Title oft the monograph
Wolodtschenko A.(1993)	Problemy yazyka kart i kartosemiotika. Dresden 1993. (in Russ.).
Wolodtschenko A.(1997)	Kartosemiotika i doistoriceskie karty. Brnaul-Dresden 1997. (in Russ.).
Wolodtschenko, A. (1999)	Kartosemiotische und konzeptionelle Aspekte der 1990er Jahre. Dresden 1999.
Wolodtschenko A.(2002)	Kartosemiotik in Europa. Dresden 2002.
Wolodtschenko A.(2003)	Ausgewählte Beiträge zut Kartosemiotik und zur Theorie der Kartographie.(Habitation). Dresden 2003.
Wolodtschenko A.(2006)	Atlasnaya kartosemiotika. Dresden 2006. . (in Russ.).
Wolodtschenko A.(2007)	Nationalatlas Deutschland: ein kartosemiotisches Portraet. Dresden 2007.
Wolodtschenko A.(2011)	30 Jahre mit und für die Kartosemiotik. Dresden 2011.

Epicenter 5 is associated with the formation of a new concept "metaatlasgraphy", a derivative one. It development is yet to come. The new methodological framework of metaatlasgraphy (Wolodtschenko 2022) is related to the study of metaatlasgraphic democratic principles of various carto/atlasgraphic models.

The next epicenter 6 is in progress. This epicenter is based on Taylor's (1993, 1997) cyber-cartographic concept (CC) and presented as a CC symbol on the "development tree" after Pravda (1994). The theory-technological concept of cybercartography was introduced at the 1997 ICC Conference and the Geomatics and Cartographic Research Centre (GCRC) was launched in 2002 at Carleton University, Ottawa, Canada. Professor Taylor was a "father" this concept.
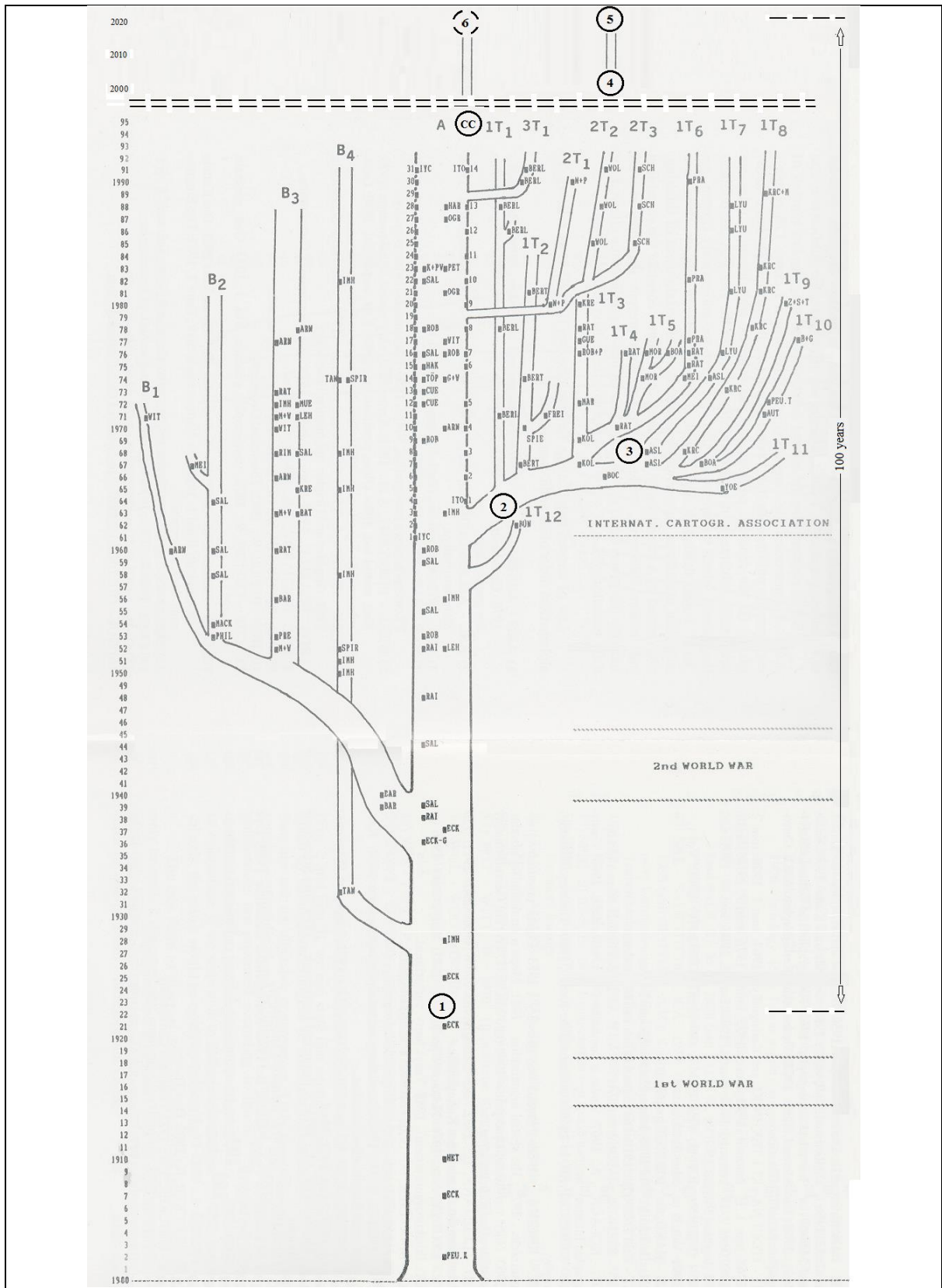
Fig. 81 Metacartosemiotic epicenter 4, metaatlasgraphic epicenter 5 and cyberphotoatlassing epicenter 6 (proposal of Wolodtschenko) placed on "development tree" after (Pravda 1994) with three epicenters (1,2,3) of metacartography concept.

Cybercartography of the 2000s evolved as a multimedia, multisensory and interactive online cartography developed on the innovative Nunaliit Atlas Framework Platform, an innovative open-source technology that facilitates participatory atlas creation (Taylor at al 2021).

Epicenter 6 has a draft name of concept "cyberphotoatlassing" (Wolodtschenko et. al 2022). This concept is also derivative one from metaatlasgraphy and reflects a synthesis of cybercartography and photoatlasgraphy (after Wolodtschenko 2021). It characterizes a new phase of multidisciplinary cooperation in practice and methodology. The research-theoretical focus of this concept is creation and semiotic analysis of storytelling, methodical and commemorative photoatlas series (Thumbadoo, Wolodtschenko 2021; Thumbadoo, Wolodtschenko 2022; Wolodtschenko et.al 2022).

4.3.5. Metaatlasgraphic democratic principles

The beginning of the 2020s is characterized by the concept evolution of metacartosemiotics into metaatlasgraphy. Metaatlasgraphy (as derivative concept of metacartosemiotics) proposes a new parity methodology for all atlases, for semiotic analysis and portraying, classification of all atlases, atlas traditions, cluster functions and carto/atlasgraphic knowledge (tab. 12).

Tab. 12 Examples of metaatlasgraphic democratization principles

1.Parity of Atlas Classification			
Map-atlases	Photoatlases	Text-atlases	Mixatlases
2. Parity of research methodology for all atlases			
Creation and using of map atlases	Creation and using of photoatlases	Creation and using of text-atlases	Creation and using of mixatlases
3.Parity of Semiotic Analysis and Portraying			
Maps		Atlases and metaatlases	
4.Parity of Function Clusters			
Education cluster	Science-research cluster		Publishing and popularization cluster
5.Parity of Traditions			
Cartographic traditions		Non cartographic traditions	
6.Parity of Acquire Knowledge			
Mapping and cartographic knowledge		Atlassing and atlasgraphic knowledge	

Parity of atlasclassification is a basic principle of evolutionary-carto/satlassemiotic development. The **research methodology** is based on semiotic classification for all atlases, i.e such atlas technique is based on the democratic principle of parity of all four classes/groups of atlases as carriers of information and knowledge. The **classification** clearly reflects the information-semiotic nature of atlases.

The concept metaatlasgraphy implements the atlas-semiotic democratization semiotic **analysis and portraying** for all maps, atlases and metaatlases.

The principle of parity for the three **functional clusters** (education, research and publishing/popularization) reflects the carto/ atlassemiotic development of modern society.

Metaatlasography forms new views on its role in the study of atlases as basic semiotic-epistomological models with cartographic and non-cartographic **traditions**. Metaatlasgraphy democratizes cartographic and non-cartographic traditions as well as develop the evolutionary processes of transformation of map/atlas **knowledge**.

5. Conclusion

The evolutionary-semiotic process in theoretical cartography in the 21st century highlighted the change of milestones in cartography and cartosemiotics. The process went beyond cartography through the semiotics of photoatlases into new multidisciplinary, atlas-forming areas - atlassing and atlasgraphy. If cartography included the creation and use of maps, then atlassing combined atlasgraphy (creation of atlases with cartographic and non-cartographic traditions) and atlassemiotics (analysis, study or study of various atlases, map, text, illustrative and their combinations).

The 21st century not only brings new technological innovations and momentum to electronic atlases, but also a new atlas culture for mobile users. Learning and acquiring knowledge or experience related to atlases requires knowledge of languages, verbal, scientific, cartographic, etc.

But where are these languages taught, which combine text, photo and map components (in static, dynamic, or static-dynamic representation forms)? Where are the departments of atlas semiotics or cartosemiotics in Europe or in the world? Unfortunately, there are no such departments anywhere in the world yet, they are not yet in demand in the modern communication society.

The search for new directions in cartography and atlasgraphy can be implemented within the framework of new concepts, for example, metaatlasgraphy, which has significant metacartographic traditions of the 20th century by M. Eckert, W. Bunge, A. Aslanikashvili and others. Not all metacartographic ideas contained in the work of Max Eckert (1921, 1925) entitled "The Science of Maps" were realised. Eckert's ideas and plans for the institutionalization of cartography (for example, the creation of the Deutsches Kartographie-Forschungsinstitut) were not implemented in Germany, but paradoxically, they found a place in the USSR in the 1930s (Papay 2017). In Moscow and Leningrad cartographic academic and research institutes were founded.

After 100 years in Germany, there is a unique opportunity to create a multidisciplinary Deutsches Atlasgraphie-Forschungsinstitut (German Institute for Atlasgraphy Research), which will accumulate theoretical and practical carto/atlasgraphic developments with cartographic and non-cartographic traditions.

The beginning of the 2020s was marked by the emergence of a new metascientific direction in the family of metasciences – metaatlasgraphy. The term is completely new and is also derived from the new term atlasography. These terms have yet to be established in scientific practice. How meta-atlasography will develop as a concept and direction will

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depend on the development of atlas-applied disciplines, such as atlas cartography, photo-atlasgraphy, carto / atlas semiotics, etc.

Metaatlasgraphy forms new views and positions on the role of atlasgraphy in the study of atlases as basic semiotic-epistomological models with cartographic and non-cartographic traditions. Metaatlasgraphy reflects the evolutionary processes of transformation of knowledge from map to atlas, from mapping to atlassing and photoatlassing, from cartosemiotics to atlas semiotics, from the language of maps to the language of atlases, from graphic (syntactic) variables to semiotic atlas metavariables, etc.

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8. Short atlas semiotic dictionary

Atlas is a system information-semiotic, static-dynamic model of accumulated knowledge in a hybrid (text-photo-map) form and constructed in the semiotic coordinate system of meta-variables.

Atlas cartography is a section of cartography that deals with the theory and practice of creating (cartographic) atlases**.**

Atlasgraphy is a new discipline that deals with the theory and practice of creating atlasgraphic models cartographic and non-cartographic traditions or profiles.

Atlas language is a system of semiotic metavariables (map, text and illustration/photo) in the creation and use of various atlas-semiotic models. In this context, it would be fair to speak of the language of atlases as meta-semiotic models. There is simply no one universal "atlas language".

Atlas semiotics is a branch of applied semiotics that studies and analyzes all types of atlases and atlas-like models for scientific and practical purposes.

Atlassing is a new interdisciplinary direction in the study and creation of e-atlases with cartographic and non-cartographic traditions in the semiotic system of coordinates-metavariables and on semiotic classification basis.

Infographics is one of the types of semiotic atlas-like models, a graphical method of presenting information as a visual correlation of objects and facts in time and space in one complete image.

Mini-maps are one of the types of semiotic models. One can select analog mini-maps (for example, on postage stamps) and mini-maps on mobile devices (smartphones and tablets), as a rule, "legendless" maps as mini visualizations.

Metacartography is one of the theoretic concepts of cartography and one of the metatheoretic research direction.

Metacartosemiotics is a one of the theoretic concepts with cartographic and semiotic components and a one of the metatheoretic research direction.

Metaatlasgraphy is a new term and theoretical concept as well as one of the new metatheoretic research direction.

Photo album is one of the types of semiotic atlas-like models, which is dominated by various photographs.

Photoatlas is one of the types of semiotic models dominated by various illustrations (drawings, photographs, diagrams, etc.). There are photo atlases with cartographic and non-cartographic traditions or profiles.

Semiotic classification of atlases is a system for identifying and distributing all atlases (cartographic and non-cartographic) into four groups, based on the determination of the semiotic information load. In the three groups, the distribution of atlases is implemented by a quantitative attribute or by calculating the information load in atlases based on the dominance of meta-variables (map, text, or illustration). The fourth group includes atlases without

informational dominance of any one meta-variable. The classification of all atlases as semiotic models includes the following four main groups:

 - map containing atlases (the variable MAP dominates with >50%)
- text-containing atlases (variable TEXT dominates with >50%)
- illustrative atlases (variable PHOTO/ILLUSTRATION dominates with >50%)
  - atlases of mixed content (without the dominance >50% of any one variable).

Semiotic "coordinate system" is a conditional three-axis system for the compositional modeling of atlases and atlas-like constructions with the help of information-semiotic meta-variables (text, map, illustration).

Semiotic meta-variables are a system of model (visual) components (map, text and illustration/photo) that are used to form more complex information structures or meta-models (model of models), for example, atlases and atlas information systems.

Semiotic "portraying" of ubiquitous photoatlases is a new form of semiotic study, thematic-modular (T-M) analysis and presentation of any photoatlas (ubiquitous or mini-photoatlas). The result of the study and evaluation may be a separate analytical article or monographic work, and even a new atlas about the atlas as an expert atlas (metaatlas).

Semiotic potential of the atlas is a quantitative assessment and calculation of information on pages / slides, on thematic sections, on structural and information modules, on slide profiles with the allocation of textual, map and illustrative content of atlas components.

Ubiquitous atlases (mini-atlases) are atlases created and available to the user of mobile devices, for example, smartphone or tablet anywhere and anytime.

9. Information-semiotic profile and potential of book

The book has 81 pages. The semiotic page-related profile includes 4 pages-face information (or 5%), the core of book with four chapters has 65 pages (80%) and attachment or application has 12 pages (15%).

Four chapters form a thematic-content core of book:

§1 Cartography 1970s-2020s: Digitalitization, semiotization, ubiquitization. (10 pp. – 12%)

§2 Theoretical-Semiotic Evolution in Cartography 2010s - 2020s without Mainstream Cartography (20 pages or 24%)

§3 New Atlassemiotic Trend: Photoatlassing (24 pages or 30%)

$4 About Metaatlasgraphy (11 pages or 14%)

Face 5 %	
Core 80 %	
Attachment 15 %	