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# An approach to the map classification problem*

This paper presents an analysis of various types of maps and other geographical scenes from users point of view. The division of people according to their perceptional abilities allows to compare the pragmatic properties of cartographical means being in map users' disposal. Visually, tactile, kinesteticly and sonicly percepted scenes as well as multimedial realisations have been considered to determine differentiation of their usability for recognition of general and particular spatial characteristics of presented map contents as reflection of reality in user's mind. Very composed problems of range of definitions of maps and cartography has been considered (on the base of ICA's definitions formulated in 1995) with a view to their correctness since the latest rapid impact of new technology on the discipline. According to author's opinion new definition of a map should embrace only types of realisations of broadly treated scenes fulfilling precisely determined list of essential properties connected with cognitive as well as applicable map's functions.

## INTRODUCTION

Having in memory that it is only a few highly civilised states where the problems and needs of people with physical incapacities are given the proper consideration there's an urgent need to offer the disabled more adequate assistance and support to their struggle for putting their basic rights into operation. The key principle is that the stereotyped approach towards the impaired individuals ought be exchanged for a more considerate one.

The International Cartographic Association (ICA) as a world-wide organisation is undoubtedly the forum where interests of all groups of map users and map makers must be represented. The totally blind as well as children, women or illiterate people create one of such groups. It is evident that a care for exceptionless formulations of all official documents: opinions, projects, rules and overall definitions concerning with subject-matter of modern cartography ought be a crowning complement of works within of particular ICA's commissions and work groups.

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Such reflections are evoked by the rapid development of modern techniques resulting opening very new cross-disciplinary special fields. Some of them applying different achievements of cartography have a creative influence on the future of the discipline.

## 1. *Sonicly coded geographical scene*

Sonic coding the position of elements using two orthogonal coordinates (sonic variables): $x$ – sound's frequency and $y$ – sound's intensity is original authors' proposal [1] of mapping for congenitally blind users. The method was firstly presented during the 17th Cartographic Conference in Barcelona in 1995 [2]. Consequently modernised digitizer consists of flat operating field, manually steered pointer (mouse, pen) and electronic device for transforming each pointer's hit on previously coded point (elementary area) into sonic signal determining individual position of the point. All elementary areas within the operating field are invisible. Through the decoding process the points forming a scene are audibly percepted, remaining ones created the silent background. Each of graphically coded contour lines has its own, characteristic, alike to real object shape, in case of sonic notation each of sequential arrangement of points composing open lines or closed, contour lines has its own, individual sound track.

It has been experimentally verified that perception of linkage of acoustic and proprioreceptive stimuli make possible to create in congenitally blind person's minds practically usable image of reality. If it is in accordance with that one obtained by visual perception it is still not fully confirmed but arrangement and basic spatial relationships characterising chosen real objects from the nearest surroundings of the blind repeatedly have been correctly recognised. These results give a chance that introduction of sonic method to cartographic education of the blind may appear an efficient way to development pupil's spatial imagination also in the global scale. This important sphere of cognition seems to be not sufficiently manifested in actually realised world programmes, so decision of the Polish Committee of Scientific Researches to give the financial support for three year testing the method in Polish schools for visually impaired children can be recognised as quite justifiable.

As, owing modern technology, various kind of graphical maps may be transformed into sonicly coded scenes it is a time to consider if such form of notation should be called maps, another words which of maps' properties are of primary meaning and what differences distinguish sonic group of notation from the others.

## 2. *Cartography and new technology*

Development of science has got the distinct expression in a permanent endeavour to harmonic a specific language of given branch description with the resource of actual informations, observations and practical solutions. It is essential to enlarge the list of the names, to formulate basic new definitions, to update the choice of characteristics and to

propose completely changed or more accurate criteria of classifications. Disciplines remaining all along the time without significant theoretical or methodological changes are treated as stagnant and consequently – all works in the frame of these fields – as unhopeful to provide the revealing results.

New technologies transforming all stages of maps' redaction and maps' editing demand their algorithmisation. From methological point of view the problem can be solved on the way of searching the analogies between cartography and other more formalised disciplines. As the most significant trial it can be recognised Bertin's proposal to distinguish six visual variables as the key to right creation of symbolic notation accordingly to the character of source data and welcome functions of given map. In comparison with assumption based on enumerical classifications (used in German [3] as well as in Russian [4] cartography) Bertin's proposal was very important step toward linking the measuremental level of data with the type of designation or *expressis verbis* the character of data with a choice of such method of presentation which will guarante the determined, pragmatic properties of a map. Complexity of the problem caused that Bertin's system of visual variables has been broadly analysed and many trials of its improvement have been undertaken [5].

Attempts of formalisation of editorial processes as well as categorisation of numerous types of maps accordingly to individual or functionally grouped criteria [6] may be considered not only as inseparable effect but also a necessary condition of the Geographical Information System's development. Connections between traditionally treated maps and spatial information systems are one of the central theoretical subject–matter to be solved nowadays [7, 8, 9], broadly discussion is also continued around the very new form of maps. Besides traditional paper form users have to their disposal numerous type of electronic realisation, tactile models, sonic scenes, various kind of multi–medial presentations and finally – hologrammes.

The achievements of physics, cybernetics, psychology, linguistic, fractal geometry and neuron sets form a very new face of modern cartography. When an infiltration from other spheres to cartography has been commonly accepted it becomes self–evident that some of traditionally determined notions, definitions and rules connected with maps must be changed or only up–to–dated.

## 3. *The range of „map" and „cartography" ICA's definitions*

The 10th General Assembly of the International Cartographic Association held in Barcelona in 1995 has adopted the working definitions for „map" and „cartography". The definitions are as follows:

- „A map is a symbolised image of geographical reality, representing selected features or characteristic, resulting from the creative effect of its author's execution of choices, and is designed for use when spatial relationships are of primary relevance".
- „Cartography is the discipline dealing with the conception, production, dissemination and study of maps".

The first definition consists of very important links which should be acutely analysed. A first association with the term „image" is „a picture" and *per analogiam* with „a symbolised image... representing selected features ... (of) reality" – „a pictorial scene". The consequence of such interpretation is exclusion from the list of map users people without ability of visual perception. But another meaning of the word „image" is [10] „a mental picture or idea". It may be a concept of a map in the cartographer's mind as well as reflection of decoded „scene" in the user's mind. Than the code is not limited so not only graphical maps but also percepted by touching tactile models, decoded using proprioceptive and acoustic stimuli – sonic scenes as well as percepted by simultaneously operating senses multi–medial realisations representing real or abstract geographical objects should be included to maps. The last link of the definition is connected with not precisely determined map's function. The „spatial relationships" may concern real objects, symbols representing objects or elements of mental scene. Also it is not indicated in the definition holistic or sequential manner of map's perception leading to general or particular knowledge of „spatial relationships", so limited, sequential kind of decoding, characterising tactile and sonic „products", may not be a reason for excluding them from the list of maps.

Summarising it can be noticed that a form of the ICA's definition allows to number among the maps all mentioned above kinds of realisation as well as mental maps. Acceptation of this conclusion causes the necessity of up–to–dating the name „the discipline dealing with the ... maps", used in the second of ICA's definition, because of the part „graphy" of *definiendum* distinctly determines as the only subject of the discipline – the graphic maps. Such stand – point is represented by many cartographers [11, 12]. The linguistic puritans can even interpret the word „cartography" as indirectly indicating on paper maps; eventually in regard of commonly used term „computer graphics", also maps on a screen shouldn't be left aside...

The discussion on the right name of the discipline led during the seminar: „The selected problems of theoretical cartography" in the frame of ICA's Commission on Theoretical Cartography held in July 20–21, 2002 in Gdańsk, creates an important impact to the planned next year in Durban during 12th General Assembly of ICA modernisation of both definitions: map and discipline dealing with maps.

## 4. *Final review of modern maps and geographical scenes*

Limitation of sensoral abilities of map users causes significant differentiation of ranges of map's pragmatic properties. In a presented Table 1 the division of various types of maps and, more generally – geographical scenes' realisations has been made from user's point of view because of author's entire acceptation of opinion that „maps appear to be under (direct or indirect) influence of their potential and actual users" [13]. Not adjudicating a question if the main object of study in pragmatics is relation between sign–vehicle and interpretant [14] or „study of relationships between (whole) maps and their users (as tools of social action)" [13] in the table the usable functions of a map have been analysed

T a b l e 1. Review of maps and geographical scenes according to differentiation of users' perceptual ability

| Type, version | | Kind of code | Manner of realisation | Size of point (unit area) | Kind of support | Group(s) of users | Type of perception | Perceptually usable variables | Identification of element | | Range of pragmatic properties of map's perception | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | localisation | meanings | general | particular |
| A | 1 | graphical | coding by visually contrasting against the background designation of all elements | $\varnothing \geq 0{,}1$ mm | – paper,<br>– flat surface in different materials | sighted people (with sight) | visual (by vision) | – size<br>– colour<br>– value<br>– pattern<br>– direction<br>– shape | absolute:<br>– direct by values of coordinates,<br>– approximative based on drawn lines of (geographical) grid | – by name<br>– by associative form of designation<br>– by listed key of conventional signs (legend) with verbal explanation<br>– by scale of value | – holistic image of reality (original)<br>– recognition of main and marginal elements<br>– knowledge of spatial distribution of elements' groups their arrangement and differentiation of density within whole mapped area | – spatial knowledge of chosen part of mapped area<br>– recognition of arrangement of chosen group of elements<br>– differentiation of their density<br>– determination of given element's dimension, shape, absolute and relative location |
| | 2 | electro visual | as A1 | pixel | monitor's or TV's screens | as A1 | as A1 | as A1 | as A1 | as A1 | as A1 | as A1 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | as A2 + sonic | as A1 with distinction of some elements by twinkling | as A2 | as A2 | people with sight and hearing | audio-visual (by sight and audition) | as A1 and twinkle | as A1 | as A1 with complementary phonetic commentary | as A1 and additionally directly, holistic percepted lay-out of twinkling elements as intentionally distinguished layer of map's contents | as A1 and additionally recognition of spatial relationships between twinkling elements and others in chosen part of mapped area |
| | | | | | | * visually impaired people with hearing | * audio-visual (by audition and limited sight) | twinkle (word) | relative, only within the twinkling elements | * phonetic commentary | knowledge of arrangement of whole group of twinkling elements within mapped area | recognition of relative location of given twinkling element within whole subgroup situated in studied part of mapped area |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | as A2 | as A1 with distinction of some moving elements by changing brightness of stimuli (colour or shining) | as A2 | as A2 | as A3 | as ,A2 | as A1 | as A1: fixed elements, moving points relatively to the fixed ones | as A3 | as A1 and additionally observation of moving elements on the background of fixed ones resulting recognition of holistic distribution of spatio-temporal changes of positions intentionally chosen points as the characteristics determining given process | as A1 and observation of speed and direction of element's motion within chosen part of whole mapped area |
| | | | | | | as A3* | as A3* | (luminosity as value) | only relative by sequential positioning of moving element | as A3* | only accordingly to the supplement given in A4 | only accordingly to the supplement given in A4 |

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| B | 1 | tactile | elevations of two layers: the first one serves as a background against the scene composed by collection of points representing open lines, contour lines and/or isolated objects – elements of coded scene may be prepared to decoding before the work or evoked by stippling by users | ∅ ≥ 2 mm | paper with ability to bring into relief under the influence of warming up (swell-paper) or wetting, capsule paper (flexi-paper), transparent paper or foil with ability to engrave (stippling) | visually impaired and totally blind people with proprioception | tactilo-kinestetic (by touch and ability to displace his/her fingers for searching of elements) | – elevation or lowering (abetment) – size direction shape (pattern) | absolute, approximate using exterior, pressed designation of values of parameters lines commonly as geographical coordinates (lambda, fi) in Braille system, relative, within elevated (or abated) contour line recognised by sequentially conducted positioning of points | by supply a scene with additional verbal explanations of chosen objects (individual names) as well as whole scene contents (a title of a scene) | holistic image of shape and size of the whole presented object (and its structure) | recognition of given points of whole contour line: changes of direction, complexity knowledge of given point's absolute localisation |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | as B1 and reduced A1 | diversification of elevations of numerous (3, 4) layers of [divided into numerous (3, 4)] groups of contents elements (sea, coastline, rivers, cites), diversification of sharpness (roughness) of elements (objects), distinction some of elements by brightness of their colour or shining | as B1 | plastic with ability to press-forming, different materials with different textural properties | visually impaired people with proprioception | as B1 (by sense of various temperatures of high colours ability of users with residual vision) | as B1 and: sharpness roughness, luminosity (colour) | as B1 | as B1 and – by associative form of designations – by legend in Braille system | as A1 but less precisely corresponding with reality (original) | as A1 but determined less precisely and within more limited part of mapped area |
| | | | | | | * totally blind people with proprioception | as B1 | as B1 and: sharpness, roughness | as B1 but determined less precisely | as B1 | as A1 but very reduced in: knowledge of spatial distribution of groups of elements, their arrangement, cross – groups rotation and differentiation of density within whole mapped area | as A1 but with only comparative kind of recognition of element's dimensions, size and location (10% less than visually in length, 1% for dimension [15] |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1 | sonic | coding by sound (changing dependently on the element's position) only elements creating a scene; to evoke a signal user has to touch the element by pointer, searching of elements is realised by manual stering of pointer's move within operation area (in case of contour line or open line the move is realised sequentially) | separateness of signals 1 mm × 1 mm (unit area), changing of sound 5 mm × 5 mm the minimal size of element 2 mm × 2 mm [16] | plate or field as a part of System of Sonic Localisation (SSL) | as B2* | audio-kinesthetic (by audition and ability to displace his/her palm with a pointer for searching of elements) | pitch = (sound 's frequency) loudness = (sound 's intensity), (sounds colour) | absolute: direct by recognition of coordinates – $\Delta x$ – semitone, – $\Delta y$ – 1 dB of element [16] ($\Delta x$, $\Delta y$ 5 mm); relative: according $x$ direction by natural sound lines with modules in Orff-Kodaly's scale – by differences of sounds | by phonetic announcements during a choice of a scene from stored in diskette collection (in case of multicolour version by sonic legend limited only to phonetic explanation of each colour's meaning (borders, rivers, cities) | as B1 | as B1 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D | | compound: audio, tactile and others | multimedial coding: (in NOMAD audio-tactile template is placed on the surface on the touch sensible platform and numerous drawing function may be selected [17]) | various parameters | flat, operation fields with ability to be pressed, in numerous places to evoke the sound signal or verbal explanation, a template plate sheet with platform touch sensitive | as B1 (as A1) | audio-tactile-kinesthetic (visual) | sound signal's: – duration – pitch – loudness (others as above) | – absolute indirect by (intentionally accessible) information – as above | – by legend in Braille system – by legend explaining meaning of differentiationed kinds of (3–5) sound signals, – by enlarged (intentionally accessible interactive verbal explanations of given place [17] | holistic image of spatial distribution of elements, very generalised image of shapes and elemets' density (as A1) | recognition of location of chosen group of elements, determination of relative position of element (as A1) |

accordingly to the holistic and measuremental levels of map's reading although as a consequence of such approach the totally blind users have been left aside. To „general" level have been included such information connected with a whole mapped area as: structural skeleton of a scene and diversification of density of groups. As related to „particular" level of percepted information have been treated various quantitative characteristics of chosen element: object: its shape, size and location and various users' interests focused to the part of mapped area or sub–group of elements.

It can be emphasised that analysis of general level's perception has been led without determination if evoked imagination are user's mental reflection of reality or are only acquaintance of symbolised scene.

As a very important, if not necessary, condition of right specification of cognitive properties of maps has been treated a manner of element's (object's) identification dependent on perceptive abilities but also – limitation within different users' groups. In the table identification of element has been considered as a composition of: localisation and determination of meaning.

Analysis according to the types of realisations shows that sonicly coded as well as visually coded geographical scenes not fulfil the condition of holistic perception in the case of totally blind users. If it is the argument to exclude them from maps is the question to be carefully recognised.

Summarising it can be noticed that division the people according to their perceptive abilities into the groups allows to compare the usability of cartographic means being at their disposal as well as distinct the list of usable variables. With regard of very general character of user's division more detailed treating of each sub–group within given group is necessary for right solution of a problem of creation full range of maps' types in accordance to full variety of perceptive differentiation of people. For map's efficiency specially important seems to be a question of searching among the variables distincted in the table, separately for each user's group the best linkage of variables for initially determined map's function. Till to–day probably not all junctions of simultaneously used senses are being applied as receptors in multimedial techniques introduced to cartography. Continuation of researches on this field may not be hopeless, moreover – seems to be proper direction towards exceptionless dissemination of map as a mean to spatial knowledge of reality not only limited to the nearest surrounding of various types of maps' users but also – in global scale.

## REFERENCES

[1] Krzywicka-Blum E., Kuchmister J., Ćmielewski K., *Sposób sonoryczny lokalizacji zbiorów punktów.* UP RP: P–310603, Biuletyn Urzędu Patentowego Nr 6/580/Rok XXIV, Warszawa 1996.

[2] Krzywicka-Blum E., *Sound map as a way to topological recognition of reality for the blind.* Proc. of 17th Cart. Conf. of ICA, Barcelona, 1995, pp. 2527–2530.

[3] Witt W., *Thematische Kartographie. Methoden und Probleme. Tendenzen und Aufgaben.* Gebr. Jaenecke, Hannover 1967.

[4] Saliszczew K. A., *Kartografia ogólna.* PWN, Warszawa 1998.
[5] Żyszkowska W., *Semiotyczne aspekty wizualizacji kartograficznej.* Studia Geograficzne LXXIII, Wyd. Uniw. Wrocławskiego, Wrocław 2000.
[6] Korycka-Skorupa J., *Metody prezentacji kartograficznej w dobie nowych technologii,* [w:] tomie pod red. A. M. Berlanta i J. Pasławskiego *Metody kartograficzne a możliwości systemów komputerowych,* Wyd. Uniw. Warszawskiego, Warszawa 2001, pp. 25–35.
[7] Ney B., *Geodesy and cartography on the threshold of the XXIst century.* Geodezja i Kartografia, XLII, z. 1–2, 1998, pp. 7–22.
[8] Makowski A., *Cartography versus spatial information systems.* Geodezja i Kartografia, t. 46, z. 3, 1997, pp. 185–202.
[9] Berlant A. M., Pasławski, J. (red.), *Metody kartograficzne a możliwości systemów komputerowych.* Wyd. Uniw. Warszawskiego, Warszawa 2001.
[10] Phillips J., *Oxford Wordpower,* Oxford Univ. Press, p. 386, Oxford 1997.
[11] Keates J. S., *Symbols and meaning in topographic mas.* Int. Year of Cart., 12, 1972, pp. 168–181.
[12] Schlichtmann H., *Sign units in map symbolism* (I): *focus unit and topeme,* [in:] Proc. of 10 Seminar of the Commission on Theoretical Cartography of ICA, Dresden 2001, pp. 45–58.
[13] Zarycki T., *On the pragmatic approach to map analysis. Remarks on the basis of MacEachren's approach to map semiotics.* Proc. of the Seminar, ICA Commission on Theoretical Cartography, 2001, pp. 64–70.
[14] Mac Eachren A. M., *How Maps Work. Representation, Visualisation and Design.* Guilford Press, New York, London, 1995.
[15] Kato T., *The background and current situation of tactual and low vision maps in Japan.* Proc. of the 3rd Int. Symp. on Maps and Graphics for Visually Handicapped People, Yokohama, 1989.
[16] Krzywicka-Blum E., Kuchmister J., *The sonic modelling in blind people education.* Katedra Geodezji i Fotogrametrii AR Wrocław, 1999, pp. 70–100.
[17] Parker D., *Access to Complex Environments for Blind People: Multi–Media Maps, Plans and Virtual Travel.* Proc. of the 17th ICC, Barcelona, 1995, pp. 2449–2460.

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**Pewne podejście do problematyki klasyfikacji map**

Streszczenie

W pracy przedstawiona została percepcyjnie zorientowana analiza różnych typów map i scen o treści geograficznej. Dostosowany do sensorycznych zróżnicowań podział użytkowników na grupy stworzył warunki porównania wynikających stąd ograniczeń zakresu pragmatycznych własności dostępnych dziś rodzajów map i scen. Dla każdego typu notacji, a więc graficznej, dotykowej, dźwiękowej czy multimedialnej, zastosowanych przy konstrukcji scen geograficznych, określony został zakres mentalnego rozpoznania ogólnych i szczegółowych charakterystyk przestrzennych, odnoszących się do rzeczywistości. W świetle bardzo znaczącego wpływu na kartografię nowych technologii w pracy została poddana analizie aktualność sformułowanej przez Międzynarodową Asocjację Kartograficzną w 1995 roku definicji mapy, a następnie dyscypliny, której jest ona przedmiotem. W opinii autorki nowe definicje mapy powinno się budować przez uważnie dobrane postulaty

związane z uznanymi za podstawowe funkcjami poznawczymi i aplikacjami, a do map zaliczać tylko te „przedstawienia" szeroko pojętej rzeczywistości, które spełniają określone w definicji warunki.

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**Среди карт сонорично кодированные географические сцены**

Р е з ю м е

В работе представлен перцепционно сориентированный анализ разных типов карт и сцен с географическим содержанием. Соответствующее сенсорическим дифференцированиям разделение пользователей на группы создало условия сравнения вытекающих отсюда ограничений объёма прагматических свойств доступных сегодня видов карт и сцен. Для каждого типа представления, т.е. графического, при помощи осязания, звукового или мультимедиального, примененного при конструкции географических сцен, был определен психический объём общих и подробных пространственных характеристик касающихся действительности. Учитывая очень значительное влияние на картографию новых технологии, в работе проведён анализ актуальности дефиниции карты определенной Международной Картографической Ассоциацией в 1995 году, а затем дисциплины, которой предметом она является. По мнению автора новые дефиниции карты должны быть определены путём внимательно подобранных пожеланий, связанных с признанными основными познавательными функциями и применениями, а к картам причислять только эти представления широко понятой действительности, которые выполняют определённые в дефиниции условия.