USING OF MODERN 3D PRINTING METHODS FOR CREATING OF TACTILE MAPS AND PLANS

Yuliya N. Andryukhina
Siberian State University of Geosystems and Technologies, 10, Plakhotnogo St., Novosibirsk, 630108, Russia, Ph. D. Student, Department of Cartography and Geoinformatics, phone: (999)466-00-90, e-mail: andryukhina.yuliya@yandex.ru

Modeling technologies and 3D printing are rapidly implemented into many branches of production, they displace traditional methods and allow obtaining new results in different fields. Research and development, based on the use of three-dimensional printing, have not bypassed tactile cartography, which is expected, considering the very essence of tactile perception – the touch of the relief of the studied surface.

The article discusses the possibility of using 3D printing for creating of maps and plans intended for people with limited visual function. The author analyzes printing defects that occur during the manufacture of relief graphics on three-dimensional printers. The author gives the results of the study on the perception by the unseeing of tactile graphics created on a 3D-printer.

The task is to study the possibility of using methods of geographic information mapping in the field of tactile cartography to automate the creating process of tactile maps and plans.

Key words: tactile cartography, visual function limitation, legend, relief graphics, tactile perception, assistive tools and technologies, 3D printing.

REFERENCES

1. Agilera Delgado, T. P. (2009). Development of tactile cartography abroad. *Geodeziya I kartografiya. [Geodesy and Cartography]*, 1, 28–30 [in Russian]

2. Ermakov, V. P. (1988). *Graficheskie sredstva naglyadnosti dlya slabovidyashchih [Graphic means of visualization for the visually impaired]*. Moscow: VOS Publ., 20 p. [in Russian]

3. Nabokova, L. A. (2009). Modern Assistive Devices for Persons with Mobility Disorders. *Defektologiya [Defectology]*, 4, 73–80 [in Russian]

4. Sokolov V.V. (2009). The evolution of typhlo-media. N. N. Malofeev, & I. A. Korobejnikov (Eds.). *Defektologiya [Defectology]*, 5, 57–63 [in Russian]

5. Lisitsky, D. V., & Kazko, S. J. (2016). User segment a single territorial geoinformation space. *Vestnik SGUGiT [Vestnik SSUGT]*, 4(36), 89–100 [in Russian].

6. Lisitsky, D. V. (2012). Mapping of three-dimensional terrain models. *Izvestiya vuzov. Geodeziya i kartografiya [Izvestiya vuzov. Geodesy and Aerophotography]*, 2/1, 98–102 [in Russian].

7. Atoyan Ruben, & German A. (2017). New Technologies in 3-D Mapping. *Buletin of Geography. Physical Geography Series*, 12, 31–40.

8. Lobben, A. (2008). Influence of Data Properties on Animated Maps to appear in Annals of the Association of American Geographers. *Journal Annals of the Association of American Geographers*. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/000456008 02046577.

9. Lobben, A., & Patton, D. (2003). Design Guidelines for Digital Atlases. *Cartographic Perspectives*, 44, 51–62.

10. Lobben, A. (2007). Navigational map reading: Predicting performance and identifying relative influence of map-related abilities. *Annals of the Association of American Geographer*. Retrieved from http://geog.uoregon.edu/geocog/ information/library/lobben _07_navigationa l.pdf.

11. MacEachren, A. (1995). *How maps work: representation, visualization, and design*. New York: The Guilford Press, 513 p.

12. Lawrence, M. M., & Lobben, A. (2011). The design of tactile thematic symbols. *Journal of Visual Impairment and Blindness*, 105(10), 681–691.

13. Guidelines and Standards for Tactile Graphics. (2017). Retrieved from http://brailleauthority.org/tg/web-manual/.

14. Hagood, L. A standard tactile symbol system: Graphic language for individuals who are blind and unable to learn braille. SEE/HEAR. (n. d.). Retrieved from www.tsbvi.edu/Outr each/see hear/archive/tactile.html.

15. Hagood, L. (n. d.). A Standard Tactile Symbol System: Graphic Language for Individauls who are Blind and Unable to Learn Braille. Life Skill Department, Texas School for the Blind and Visually Impaired. Life Skill Department, Texas School for the Blind and Visually Impaired. Retrieved from https://www.tsbvi.edu/selected-resource-topics.

16. Lawrence, M. M., & Lobben, A. (2011). The design of tactile thematic symbols. *Journal of Visual Impairment and Blindness*, 105(10), 681–691.

17. Blasch, B. B., Wiener, W. R., & Welsh, R. L. (1997). *Foundations of orientation and mobility* (2nd ed.) (pp. 284–316). N-Y: AFB press.

18. Medvedev, A. A., Alekseenko, N. A., & Vasyov, M. K. (2016). Tactile Atlas of Moscow a complex cartographic product for the blind. *Geodeziya i kartografiya [Geodesy and Cartography]*, 7, 8–14 [in Russian].

19. Igumnov, A. Yu. (2015). Features of tactile perception of relief graphics in people with visual disabilities. In *Sbornik materialov 53-j Mezhdunarodnoj nauchnoj studencheskoj konferencii: Psihologiya [Proceedings of the 53rd International Scientific Student Conference: Psychology]* (pp. 89–90). Novosibirsk: NSU Publ. [in Russian]

20. Tehno 3D. (2019). Retrieved from https://3dpt.ru/page/faq [in Russian].

21. Poshivaylo, Ya. G., Lesnevskii, Yu. Yu., & Andryukhina, Yu. N. (2016). Development of Conventional Symbols for a Series of Tactile Maps of the Subjects of the Russian Federation. In *Geoinformacionnoe obespechenie prostranstvennogo razvitiya Permskogo kraya [Geoinformational Support of the Spatial Development of the Perm Territory]* (pp. 90–96) [in Russian].

22. Poshivaylo, Ya. G., & Andryukhina, Yu. N. (2017). The study of the characteristics of the perception of tactile symbols by schoolchildren with limited visual function. In *Sbornik materialov Interekspo GEO-Sibir'-2017: Mezhdunarodnoy nauchnoy konferentsii: T. 4. Geodeziya, geoinformatika, kartografiya, markshejderiya [Proceedings of Interexpo GEO-Siberia-2017: International Scientific Conference: Vol. 4. Geodesy, Geoinformatics, Cartography, Mine Surveying]* (pp. 78–83). Novosibirsk: SSUGT Publ. [in Russian].

23. Poshivaylo, Ya. G., Dmitriev, D. V., & Lesnevskii, Yu. Yu. (2014). State of the Art and Prospects for the Development of Tactile Cartography. In *Sbornik materilov InterKarto–Inter-GIS-2014: Mezhdunarodnoj konferencii "Ustojchivoe razvitie territorij: kartografo-informacionnoe obespechenie" [Proceedings of InterCarto-Inter-GIS-2014: the International Conference "Sustainable Development of Territories: Cartographic and Informational Support"]* (pp. 607–609). Belgorod: BGNIU Publ. [in Russian]

24. Andryukhina, Yu. N., Poshivailo, Ya. G., & Anan'ev, V. A. (2018). Methodical principles of tactile map symbols appearance and layout of tactile maps *Geodeziya i kartografiya [Geodeziya i kartografiya]*, *79*(11), 25–33 [in Russian]

25. Litvak, A. G. (1998). *Psihologiya slepyh i slabovidyashchih [Psychology of the Blind and Visually Impaired]*. St. Petersburg: RGPU A. I. Gercena Publ., 271 p. [in Russian]

26. Litvak, A. G. (1985). *Tiflopsihologiya [Tiflopsychology]*. Moscow: Prosveshchenie, Publ., 264 p. [in Russian].

Received 16.01.2019