

## Article

# Tactile Architectural Drawings—Practical Application and Potential of Architectural Typhlographics

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**Abstract:** The subject of research conducted by the team from the Białystok University of Technology is architectural typhlographics—a kind of specialised tactile drawings dedicated to people with visual impairments. The aim of the publication is to present the specificity of this type of architectural graphics and to indicate the areas of its usefulness. Based on professional experience, available thematic literature, as well as specialist consultations, the authors made a multi-criteria analysis and valorisation of the obtained set of examples of architectural typhlographs. The result of the research is to indicate the main fields of current application, and to outline the potential and possible directions of further development of tactile architectural drawings. The specifics of the examined graphics are also presented, including their functionality, possible forms of representations and differences from typical architectural representations. The historical background of the typhlographics as well as the main principles of their creation are presented, as the supplement and basis for the author's considerations. The research also showed the broad utility and social values of architectural typhlographs and the priorities for their further development.

**Keywords:** architectural drawing; typhlographs; tactile drawings; visual impairment; blind people; spatial orientation; accessibility; architectural education; universal design; graphic information



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## 1. Introduction

### 1.1. Context of the Discussion

Architecture is the most functional of the applied arts, defining the quality of human life. The basic sense that provides access to the rich world of architecture is sight, which allows a person to perceive architectural frames spatially. It allows you to view close and distant views, wide panoramas or small architectural details. Owing to the ability to see, we can get to know the environment, move around in it, and act actively. We can also experience it internally, even co-create space.

The same architectural space is also a place of residence, work, education and recreation for the blind and visually impaired. Just like people who use eyesight, they are also dependent on architecture that influences their functioning and development in all spheres of life.

Understanding and actively using architectural space in conditions of permanent visual impairment are significantly difficult. Due to qualitative and quantitative perceptual and cognitive deficiencies, blind people struggle with significant disorders of spatial orientation [1], which then significantly affect mobility and cause locomotion difficulties [2,3]. Natural aversion and the fear of non-visual exploration of the architectural environment are additionally intensified by the barriers present in the space. Moreover, improper structure or functioning of spatial environment may also carry a serious risk of injuries and accidents [4]. Another huge problem is the difficult access to common sources of information, containing visual images of architectural spaces (photographs, drawings,

TV programs, presentations, lectures, exhibitions), which are a constant, complementary source of information about space for sighted people [5]. Therefore, in the case of blind and partially sighted people, architectural barriers, but also limited access to information about space, not only reduce the quality of life, but often constitute a serious functional limitation, making it impossible to move outside the known zone on their own. In this case, the lack of access to information is equal to the lack of independent access to the space, freedom and liberty of those people.

Shaping correct relations (cognitive, motor, emotional) with an architectural space in a state of permanent vision deprivation requires the use of compensatory solutions, giving blind people equal access to various types of architectural experiences. There are a number of natural ways of making non-visual contacts with the built environment based on the compensatory use of other active sense systems. We can mention here: movement and locomotion, touching the available elements with hands, feet, body, a white cane, listening to the sounds of a given space, using the sense of smell. The development of technology also brings many possibilities of substitute, indirect contact with architectural space through its various representations. Such forms include audio information (for example, audio description, i.e., properly developed verbal or machine-generated messages and sounds) as well as supporting materials adapted to tactile reception (including Braille text and models). There are also multi-sensory solutions where the tactile and auditory systems are connected together. Often they are also complemented by visually adapted elements. The combination of information available through various stimuli enables people with visual impairments to create rich multisensory representations of space.

In the area of providing information through the sense of touch, effective way of “making” architecture available to the blind are appropriately raised graphics, also known as the so-called typhlographics (or alternatively: tactile drawings, textured pictures) [6]. In the opinion of the authors, this subject is an interesting phenomenon on the border of architecture and typhology, deserving of appropriate recognition within the architectural discipline.

### *1.2. The Subject, State and Method of Research and the Purpose of the Publication*

The subject of the authors’ research presented in this publication is architectural typhlographics—graphic representations of built space, drawings intentionally dedicated to people with visual impairments. The selected collection is part of all typhlographics studies relating to various spatial aspects (objects, phenomena and relations).

The first attempts at a scientific approach to the subject of architectural typhlographs (including mainly plans and sketches of routes) took place in Poland in the 1960s and 1970s [7,8]. These studies were carried out by typhlo-rehabilitators who used typhlographics in their daily work with blind people. The works from this period are dominated by the practical aspect, related to the search for universal utility criteria for such teaching aids, created by tutors and teachers themselves. The rapid development of technologies enabling the machine creation of duplicated typhlographics with different quality features, forced the extension of the current scientific perspectives. The theoretical foundations for the intensively developing area of typhlographics in the 2000s were created by teachers from special centres, who raised the need for standardisation of solutions in their works and established documents [9,10].

Over the next decades, in scientific theory, issues in the field of typhlography were developed completely beyond the scientific boundaries of architecture, which explains their insufficient popularisation among architects. Scientific attempts to implement the issue on the ground of architecture have been undertaken by very few Polish scientists [3,11]. Among them, A. Kłopotowska made broader attempts to identify and strengthen this subject in the field of architecture. It should be mentioned here: the narrowly focused work of the author focused on specific type of typhlographics used in architectural education, the so-called “braillons” (ease to duplication, durable half-spatial tactile graphics) [12] and fragments from an extensive monograph devoted to the experience of space by the blind,

in which the author outlined the topic of typhlographics as one of the interesting research issues on the border of disciplines [13]. The author's scientific experience also includes extensive research on architectural models (partly in line with the subject matter discussed here), conducted together with M. Kłopotowski [14,15].

Starting from 2019, a research team from the Białystok University of Technology undertook scientific studies devoted to architectural typhlographics. They were aimed, on the one hand, at the scientific systematisation and consolidation of the subject of typhlographics in architecture, and on the other—at the practical use of the results of author's research in typhlogy. This publication is a report from the research carried out so far as part of a larger project. At the current stage of research, the emphasis is on identifying the set of typhlographs and indicating the areas of their application. The conducted research was based on the method of transferring concepts between the branches of science: typhlogy and architecture. The methods of creative thinking and logical reasoning were used. The authors made multi-criteria analyses of the collected research material, including: comparing typhlographics with traditional architectural drawings, methods of presenting objects and spaces in drawings, spatial scope of drawings, values and cognitive difficulties, defining the areas of usefulness of typhlographics in various tasks related to providing access to architectural information.

The research material consisted of selected architectural typhlographics, learned by the authors experimentally during research visits and viewed in a virtual way. Due to the exploratory nature of the research on the new phenomenon, the authors strove to include the widest possible collection of typhlographics in the study. Thus, the spectrum of the authors' research includes: widespread typhlographics of leading Polish producers (e.g., Altix Sp. z o. o.; Studio S2 PROJEKT Sp. z o. o.; TYFLOGRAF Studio of Typhlographics and Computer Graphics, Marek Jakubowski). The studies were conducted in consultation with visually impaired people, people who create typhlographics, as well as people who use and conduct research in various types of typhlogical practices (rehabilitation, education, exhibition).

The aim of this publication (describing the results of the research carried out so far) is to present the specificity of this type of architectural graphics, to define the areas of its current usefulness, as well as to outline the potential and possible directions of further development of tactile architectural drawings. The elements of the author's speech are: presentation of the historical outline of this topic as well as explanation of the principles of creating and reading typhlographics.

## 2. Typhlographics as Supporting Materials for the Blind and Visually Impaired

### 2.1. Explanation of the Concept and Further Delimitation of Research

In Polish scientific literature there is no consistent definition of typhlographics. Most often we meet phrases such as: drawing for the blind, drawing accessible by touch, an embossed drawing or a Braille drawing. According to the M. Jakubowski, these terms (reflecting the nomenclature of Western countries) do not reflect the full potential of applications and the growing range of contemporary technologies for creating such graphics. In an attempt to systematise the unclear nomenclature made in 2009, M. Jakubowski formulated the definition, where the term typhlographics should be understood as: “a graphic representation presenting reality, using a scale, proportion and generalisation in a tactile manner accessible to blind people [as well as—AK, MM ] ( ... ) visually accessible to people with limited visual perception” [6] (p. 37) In the broad definition of the author, there are three subgroups of help:

- Those in which the raised image is the main intention of the presentation,
- Those in which attention is directed to the most readable presentation of visual content (identified by some typhlogists as the so-called magnigraphs, which include modifications that increase the chances of their effective reception by visually impaired people [16] (p. 233),
- Those in which the tactile image is complemented with a more or less complex visual image.

In this text, the authors' attention is focused only on spatialised typhlographs, intended for haptic and haptic-visual viewing (excluding flat contrasting graphics). Sensory dualism seems to be a particularly important topic due to the universality of information transfer, which guarantees the highest flexibility of its use.

## 2.2. Creation Principles and the Ability to Read Typhlographs

Experts in the field of typhlography including E. Więckowska (typhlo-pedagogue from the Care Society for the Blind in Łaski, Poland) emphasise that not all tactile graphics can be considered appropriate for people with visual impairments [9] (p. 6). Due to the fact that: "A drawing is not similar to an object for a blind person, a drawing describes an object to a blind person" (translation from Polish) [10] (p. 13), it cannot be a simple copy or a reproduction of the original, but requires appropriate adaptation. The scope of such modifications may include: changing the convention (manner) of presentation, changing the scale (sometimes in one of the directions), changing the level of generalisation (resigning from an excess of elements that complicate the perception of the whole picture), division of the content into two or more representations, changes of lines, signs or drawing colours (sometimes the use of contrasting colours that differ from the original). These modifications, resulting from the specificity of tactile reception, are often necessary to achieve the appropriate legibility of the image [17].

Detailed principles of such adaptations for all typhlographics have been developed by a team of Polish teachers from special educational centres for the blind and partially sighted and described in the document entitled: Principles of creating and adapting graphics for blind students (title translated from Polish). The authors draw attention to the non-obvious graphic representations for blind people, especially those blind from birth, where the development of life skills from the very beginning took place without the participation of eyesight. Their way of learning is in complete contradiction to the naturalness with which the content of the drawings is recognised even by small children raised in the visual culture, "the blind does not automatically learn subsequent drawing conventions, a person must consciously learn them just as we learn a foreign language" (translation from Polish) [9] (p. 11). For the correct reading of typhlographics, it is necessary to properly prepare a visually impaired person, including the prior knowledge of orientation systems in the drawing space and the knowledge of many base concepts (figures, angles, geographic directions, etc.). The learning of these skills (as well as the teaching of self-preparation of typhlographics), systematised in the form of a multi-level didactic program, is now an important element of general education of blind and visually impaired children and young people educated according to a special model. Unfortunately, many blind people in Poland (including: students from outside the special model, people who are blind at a later age, people who are not rehabilitated) do not have sufficient competences needed to effectively receive tactile graphics.

## 2.3. Historical Background and Development of Typhlographic Technologies

The use of tactile graphics in the education and rehabilitation of the blind has several hundred years of history. This includes the various techniques and technologies for making typhlographs, as shown in Figure 1. The starting point of tactile graphics were the simplest relief techniques (e.g., drawing on foil) (Figure 1a). In the European archives of typhlological museums from Vienna, Prague, Brno, Paris, Leipzig, Ottawa and Marburg, you can find real unique items, dating back to the 18th century [6]. The resources of national special centres include thousands of tactile drawings, made by hand (by typhlo-pedagogues, sometimes with great commitment and effort) using wood, cardboard, wire, string, pushpins, metal plates, gypsum or solidifying masses [18] (Figure 1b). Most of them are individual studies or works made in short series (2–4 copies).





**Figure 1.** Various techniques and technologies of making typhlographics: (a) A simple drawing on tracing paper; (b) sticker made of various textures; (c) dotted drawing from a braille printer; (d) thermoprint; (e) “Braillon” made by thermoforming; (f) relief in metal. Photo by: (a,b,d,e) Kłopotowski, M.; (c) Magdziak, M.; (f) Jakubowski, M.; Figures edited by Magdziak, M.

In museum collections and libraries, you can also see typhlographics from the first copying devices, including: maps and illustrations signed by the Swiss typhlo-pedagogue Martin Kunz, graphics embossed in cardboard at the end of the 19th century, or maps made with Braille printing matrices. The successors of these technologies were the next generations of Braille printers (Figure 1c) (including the famous, commonly used „Tiger”), as well as a number of other mass production technologies, including: screen printing, ink-jet printing and flocking, thermal printing and explosive techniques, e.g., heat-sensitive 3D paper (swell paper), embossing, extrusion—thermoplastic moulding, polymer washing, etc., [19,20] (Figure 1d). The devices using thermoforming technology (also called duplicators for the blind), developed in the 1960s in the USA, which reached Polish centres in the 1980s [21], were a huge technological leap. These methods, allowing for obtaining various effects, depending on the preferences of the recipient, are currently intensively developed by individual producers, specializing in making representations with any the desired features (Figure 1e). In addition, on the tactile graphics market there are also sophisticated drawings made of noble, elegant materials, made in the technology of casting, engraving (e.g., laser) or milling (Figure 1f).

The next generation of devices for creating typhlographics have become various types of electronic displays used to project variable images (whose predecessors were

the once popular “optacons”). In parallel with the development of technology, hand-made typography is constantly being developed further. With the appropriate knowledge and skills of the producers it can lead to very interesting, unique effects. Unfortunately, both among manual and machine studies, there are many defective pseudo-supporting materials-characterised by low quality and little cognitive value, and even being harmful by misleading the recipient.

### 3. Architectural Typhlographics

#### 3.1. Types, Characteristic and Forms of Presentation of Architectural Typhlographics

Among the typhlographics relating to architectural content, we can distinguish groups illustrating external spaces (large space, which in the architectural nomenclature correspond to the terms of planning, landscape, urban and architectural scales) and internal spaces (medium and small space, which corresponds to the architectural concept of interior scale). The subject of the drawings may be objects that exist now or in the past (historical objects), newly designed (planned) objects, imaginary objects as well as typical objects (model solutions or sample spaces, buildings and interiors).

These images can take the form of various drawing views, such as: maps (cartographic description of specific spatial systems), diagrams (simplified, highly reduced drawings of space), plans (space drawings, building plans, rooms), elevations (drawings of building walls), cross-sections (intersections of space), views (in axonometry, perspective or with elements of perspective), views of the building’s interior (wall expansions and perspective views), details (fragments of urban and architectural spaces or interior design elements) as well as complementary views, thematically related to the architectural space (e.g., furniture, costumes, props, paintings, coats of arms, etc.), as shown in Figure 2a–f.

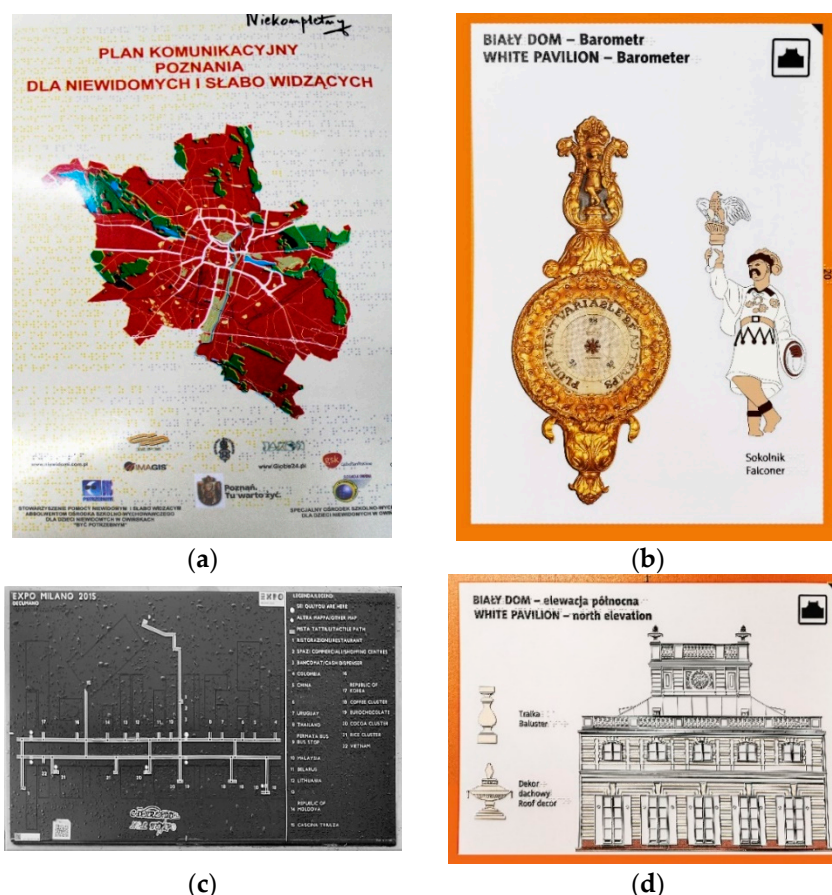
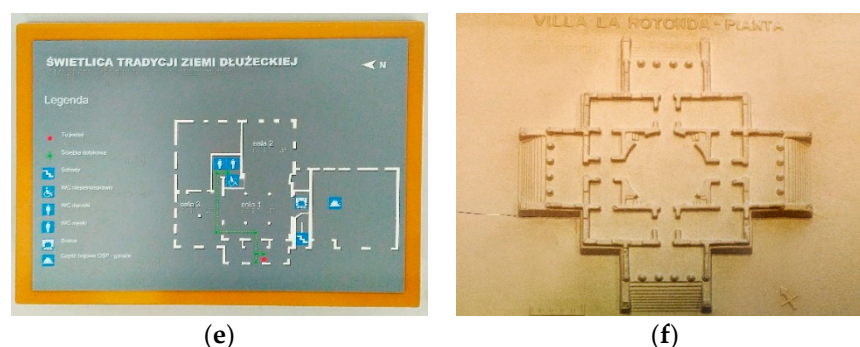


Figure 2. Cont.



**Figure 2.** Various drawing approaches to space presentation: (a) map; (b) additional views; (c) scheme; (d) elevation and detail; (e) interior plan; (f) building plan. Photo by: (a) Jakubowski, M.; (b,d,e) S2 PROJEKT Sp. z o. o.; (c,f) Kłopotowski, M. Figures edited by Magdziak, M.

It is worth noting that although the basic categories of this type of typhlographs coincide with the generally accepted methods of presenting architectural space, they have a number of specific distinguishing features. One of the most important is the graphic difference of such drawings, resulting from the necessary transcription of a visual image into a haptic image. Such a translation of the drawing involves the conversion of lines, markings, descriptions, as well as the reduction of any unnecessary elements that may interfere with the reception. The key issue is also to properly show the closer and further elements of the architectural plan, which can be achieved through: semi-flat contour or figural obscuration effects, graded elevation (layered contour effect), but also other methods of spatializing parts of the drawing, for example bending or skewing some of its elements, and even resizing, which may change the dimensions of the image. The content of the drawings may contain additional specific elements—not considered as priorities or not found in traditional architectural drawings, but necessary for the visually impaired (e.g., marked landmarks, barriers, amenities, etc.).

In the case of colour representations, the colours may also be incompatible with the original. This fact results from the desire to obtain the appropriate clarity (colour contrast), which is preferred over compliance with the original. The approach to the issue of scale in drawings is also different, which in architectural representations remains proportional to the original (the drawings are its reduction, enlargement or faithful reproduction on a 1:1 scale), and usually adopts constant scale sizes, depending on the type and purpose of graphic representation.

In typhlographic drawings (intended for sensory perception with fingers and hands) the scale may or may not reflect the actual proportions of specific elements. The so-called “contaminated (disproportional) scale” is often used in drawings [14] (p. 104), [15]. This means different scale factors for both directions on the horizontal plane of the drawing. Such a drawing can therefore be shrunk or stretched in the longitudinal direction (right-left axis in relation to the touching person) and in the transverse direction (axis closer-farther in relation to the touching person). However, almost every time there are differences between the scale of vertical elevation of the drawing (axis up-down) in relation to the scale or scales on the graphics plane. This fact distinguishes semi-spatial tactile graphics from models.

Some of these modifications (especially: changing the proportions of the elements, simplifying the shapes, or the colours that differ from the actual state), from the perspective of architectural discipline (where the basis of the designer’s workshop is a faithful representation of the object on a dimensioned technical drawing), may seem to be deceptive and unacceptable. However, it should be remembered that such interventions result from important typhlological purposes, related to the need to adapt graphics to the conditions of haptic perception. This applies to such issues as: the need to fit into a specific dimension of the drawing, the legibility of the image and finger access to each element of the study. It is worth noting here that the phenomenon of using the “contaminated (disproportional) scale” is also present in visual arts and other “ordinary” visual representations of space,



where the authors do not care about the precision and truth of the reproduction, but about achieving other cognitive effects (for example, showing elements of a larger whole that would not fit in the format otherwise).

In practice, there are a number of forms of developing architectural typhlographs, ranging from: cards, forms, boards, moulds, plates, through many overlays or reliefs made on the surfaces of various objects, to spatial displays: boards, tables, pedestals, stands, posts, poles, pylons, etc., as shown in Figure 3a–e. This collection is also characterised by various forms of presentation. Some of the portable studies are made available in the form of single copies (individual or duplicated). A popular way of presentation is also grouping them into loose sets that can be freely enriched or separated, depending on the user's needs. For example, such studies take the form of folders and binders that can be conveniently taken on a tour (e.g., getting to know the city, visiting a museum), as can be seen in Figure 3f. Another form of presentation are coherent, arbitrarily determined sets of several complementary representations of spaces and objects. Most often, these are permanently fixed sets of book publications (brochures, textbooks, guides, albums, atlases, manuals, study and play books, calendars, etc.), as well as their entire series (several publications creating consistent content). Sets or series can also be created in the form of spatial displays. Such statements may show, for example, different parts of large spatial plans or present a history of changes taking place in specific time intervals.

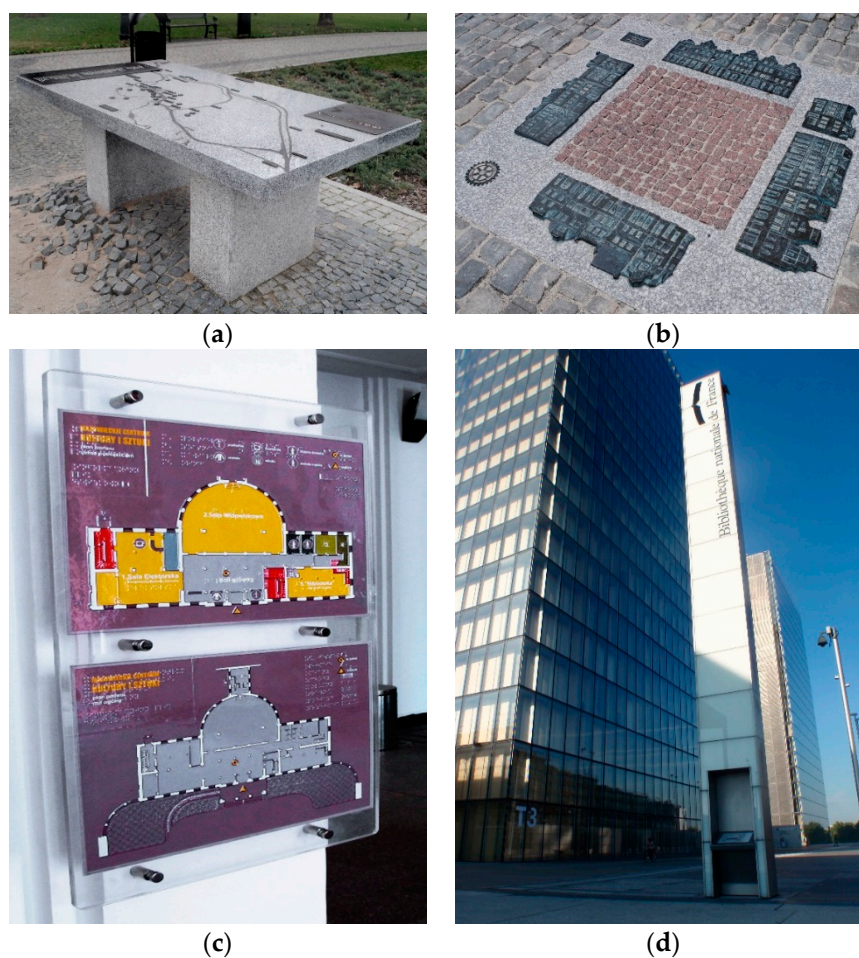


Figure 3. *Cont.*





**Figure 3.** Various forms of displaying typhlographs: (a) table display; (b) relief made in the floor; (c) a standing display panel; (d) a display hidden in a pylon; (e) relief on an inclined panel; (f) typhlographics in the form of folders, segregators, books. Photo by: (a,b,d,e) Kłopotowski, M.; (c,f) Jakubowski, M.; Figures edited by M. Magdziak.

They can take the form of mobile studies, or they can be installed permanently in specific architectural spaces, which gives them the character of “street furniture.” Typhlographics can be presented on them horizontally, as shown in Figure 3a,b,d, vertically (Figure 3c) or tilted under a convenient angle (Figure 3e).

### 3.2. Areas of Utility of Architectural Typhlographs in the Past and Now

The practice of using typhlographics to present architectural content is not a new phenomenon, and their centuries-old history coincides with the history of typhlographics in general. The conducted analyses allowed to identify four main areas of current application of this type of supporting materials, including:

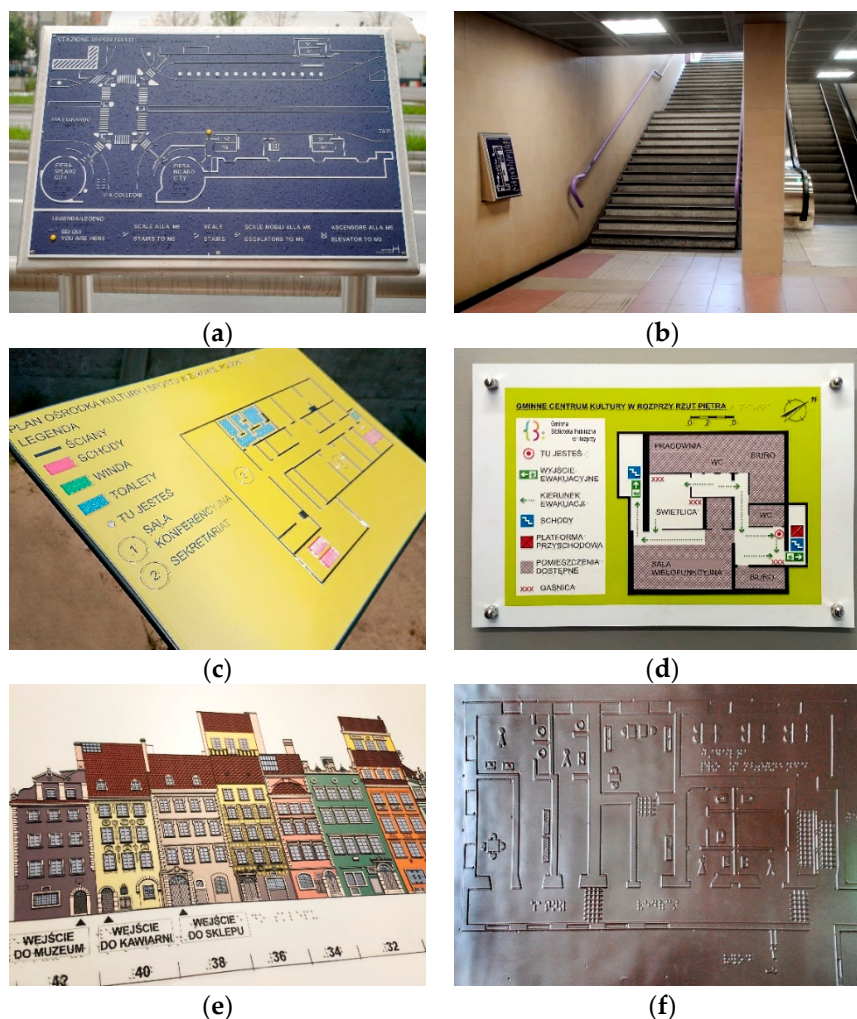
1. Acquiring spatial orientation skills for safe locomotion;
2. The process of teaching orientation and space exploration influencing the independence of the individual;
3. Education in the general-cognitive area influencing the personal development of an individual;
4. Promotion of places by providing information and space in the tourism industry.

In the indicated areas, there are types of drawings that are simply an improved version, a newer generation of historical typhlographs, which have maintained their validity until today. Others, on the other hand, are completely new forms due to the ongoing revaluation and technical possibilities.

#### 3.2.1. Spatial Orientation and Safe Locomotion

One of the first applications was to use typhlographic as the supporting material for gaining spatial orientation and safe locomotion in an urbanised space, examples of which are shown in Figure 4. In the mentioned group of typhlo-architectural studies, the leading role was played (just like today) by tactile drawings of plans, diagrams and maps [22]. They were initially developed in the form of individual cards, intended for the needs of an individual recipient or groups planning to move independently along a specific route [7,8]. Over time and with the development of technology, they evolved into handy (although often complex) studies intended often for mass use. Among them, you can find coherent series-collections of studies supporting the use of specific zones and facilities (e.g., city communication plans, metro station plans, etc.). In recent years, city typhlographic plates (on-wall displays or free-standing) have been gaining great popularity. They are most often intended for installation in a permanent, well-defined place, which is the subject of a given study, as in Figure 4a,b. Such amenities, which are increasingly appearing in public spaces in European and Polish cities, are located, for example, in transport nodes (such as: airports, railway stations, metro stations, etc.), or in front of the entrances to public facilities (such as: tourist attractions, offices, libraries, museums, etc.),

or in their interiors, as in Figure 4c [11]. It is also becoming more and more common to use mini communication schemes, placed, for example, on posts activating street signals, on handrails (Figure 4b), bus stops and explaining the principles of safe movement in urban and architectural spaces [11]. A complementary area of application of information charts or typhlographic boards is their use to ensure safe evacuation from spaces and buildings, as shown in Figure 4d.



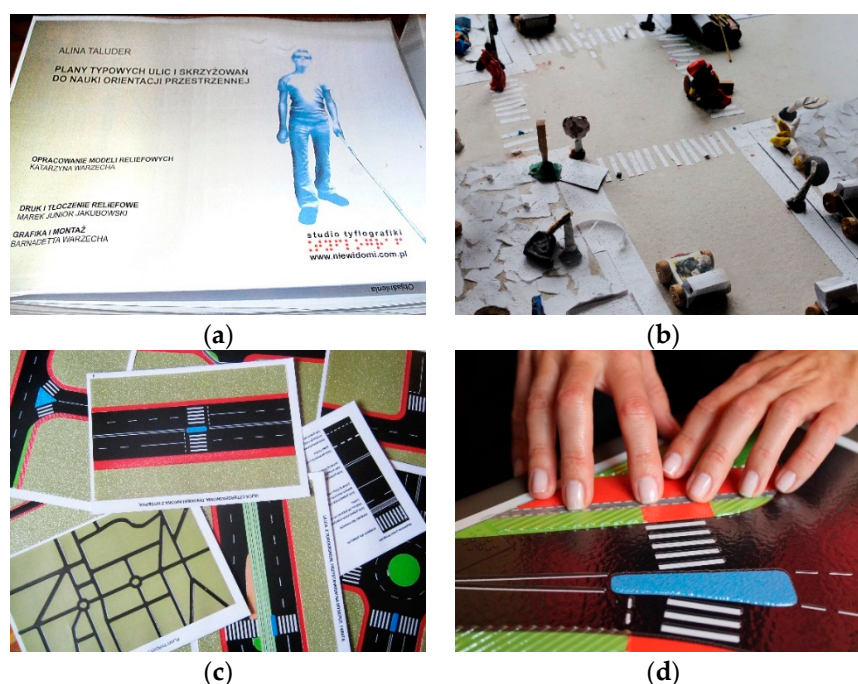
**Figure 4.** Typhlographics supporting spatial orientation: (a) Standing road intersection plan; (b) wall board with a map of the metro station and scheme on the handrail; (c) interior plan of the building; (d) evacuation scheme of the building; (e) frontage of the street with building numbers and marked entrances; (f) plan showing the functional zones of the interior. Photo by: (a,b) Kłopotowski, M.; (c,f) Jakubowski, M.; (d,e) Studio S2 PROJEKT Sp. z o. o.; Figures edited by M. Magdziak.

Taking into account the entire group of studies, it should be stated that the architectural space is captured mainly in a “functional” way, with emphasis on the elements important from the perspective of a person’s mobility. Therefore, such drawings contain information such as: development lines of buildings of the urban plan and its boundaries, markings of building functions, address data, building entrances (Figure 4e), directions and plans of communication routes (streets, sidewalks, lawns, communication junctions, road crossings, additional amenities, e.g., tactile guide paths, communication stops, etc.), fixed or movable elements of space equipment (including: lanterns, benches, “street furniture”), division into functional zones (Figure 4f). The general topic of this type of study is the principles of space organisation and use, including safe corridors for the movement of visually impaired people. Such drawings, which are substitutes for real space, make it easier to prepare and

implement a specific route in an urbanised area. They reduce the time needed to learn the principles of construction and operation of selected zones and elements of the urban environment. Moreover, by presenting landmarks and possible barriers and dangers, they reduce the fear of independent movement in space [7].

### 3.2.2. Learning Orientation and Independence in Space Exploration

The second area of application of architectural typhlographs is learning orientation and independent movement, which is an inseparable element of rehabilitation and revalidation of blind people. Examples of such typhlographics for orientation learning are presented in Figure 5. This extensive section of typhlo-rehabilitation is aimed at acquiring general competences allowing for non-visual use of space, including also architectural space [23]. In the case of people who are blind from birth, it is necessary to know the principles of construction and functioning of the urban environment in all its aspects. For several decades, students of specialist educational institutions have been learning this kind of relations from books and simplified drawings of urbanised space, as shown in Figure 5a, but also independently make typhlographics [24], introducing the concepts and problems related to moving in urban space (buildings, crossroads, crosswalks, road signs, etc.,) [14,15] as can be seen in Figure 5b. The learning of this important skill is supported by the types of representation analogous to the above-mentioned, such as: plans, organisation charts, maps, made for theoretical or real urban spaces (Figure 5c,d).



**Figure 5.** Typhlographics for orientation learning: (a) Book for orientation learning; (b) plan of an exemplary urban space made by blind and visually impaired students; (c) presentation of typical elements of urban space; (d) plan of a typical street intersection. Photo by: (a,b) Kłopotowski, M.; (c,d) Jakubowski, M.; Figures edited by Magdziak, M.

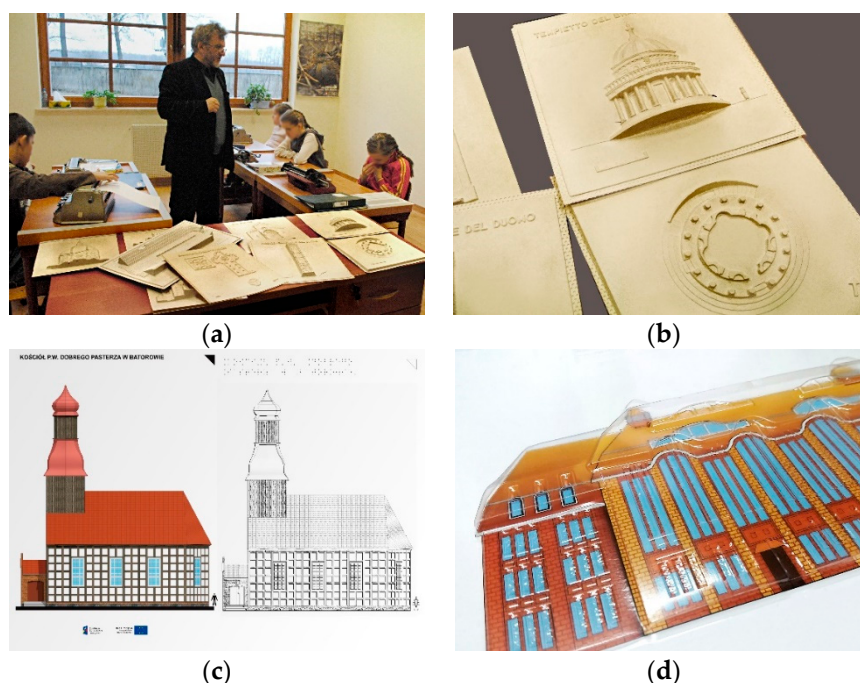
It is worth mentioning that because of difficulties that may occur in reading semi-flat representations of space, learning to use this type of representation is often preceded by previous training in reading models that show architectural elements in a way that is easier to understand. The most important thing, however, is that such studies familiarise a visually impaired person with situations that can certainly or potentially appear in real space. In the case of newly blinded people (who got to know the urban space at an early stage in full-sensory conditions or in the losing sight phase), they play the role of an



important tool “tuning” the body to use the architectural space without eyesight. Each time they play the role of safe training, preparing for real physical movement in the city.

### 3.2.3. Education in the General-Cognitive Area

The usefulness of the discussed typhlo-architectural studies also extends to the general cognitive area, including general education and personal development of an individual. Getting to know architectural and urban space is an important element of general knowledge, enriching mental resources and simplifying human functioning in spatial reality. Architectural achievements are also an integral part of the cultural heritage of mankind and their knowledge is appropriate for educated people and shapes its social image. In special education programs for the blind (as in general education courses), there are a number of issues in the field of architecture and urban planning (including: examples of important, historical architectural objects, features of architectural styles, examples of well-known contemporary buildings, problems of ancient and modern cities, basic elements of urban composition) [12,13]. Examples of such typhlographics are presented in Figure 6.



**Figure 6.** Architectural typhlographics supporting general education and personal development of blind people: (a) School materials supporting architectural education—“Brailions”; (b) a set of “Brailions”: elevation and plan; (c) the elevation as a side plan, made in the architectural convention; (d) elevation with perspective elements. Photo by: (a,b) Kłopotowski, M.; (c) Jakubowski, M.; (d) Magdziak, M.; Photo edited by M. Magdziak.

For many decades, typhlographics, made in various technologies, have been an inseparable help in educating blind students. They are usually handy forms (single or combined in book form), containing single-colour (as in Figure 6a) or multi-coloured studies in the form of various architectural representations: plans, sections, elevations and sometimes also perspective views [25,26] (although this type of study with perspective elements is usually very difficult to read). Plans, sections and elevations can be mutually complementary representations, made on the same scale, which the student (with some practice and under the supervision of a teacher) can relate to each other and put together into a coherent spatial image, as shown in Figure 6b. Among the typhlographs showing the facades of buildings, there are pictures that are analogous to technical drawings of architectural facades, which, in accordance with architectural principles, are shown as side plans, as in Figure 6c. The development of technology allows for presentations that are

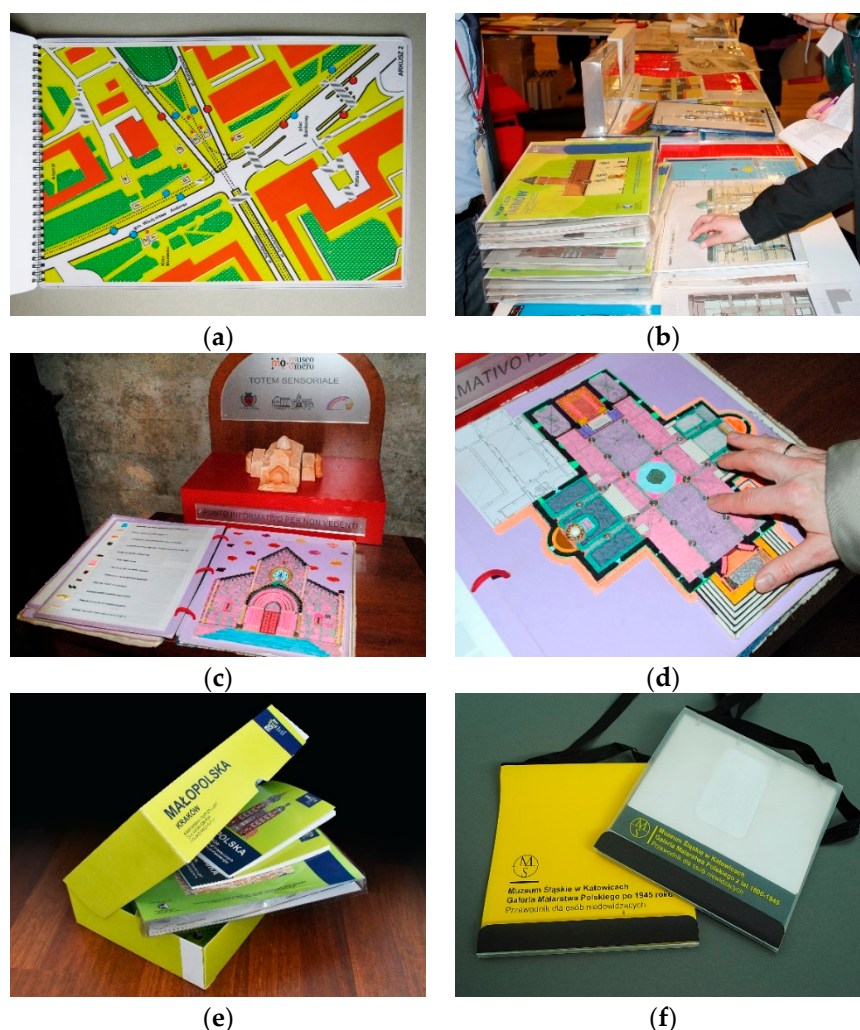
also highly plasticised and suggestively reflect the three-dimensionality and spatiality of the facade, starting from presenting them in a semi-spatial form (similar to the model), to views pretending to be perspective or having lines converging to the horizon, as shown in Figure 6d. In the case of graphics referring to the wider city space, the common forms of representation are their plans and (quite rare) drawings of panoramas or silhouettes showing the horizon as well as the shapes of buildings towering over.

The utility values of such representations are integrally connected with their potential for shaping rich mental and emotional images. This type of typhlographics can therefore become an extremely valuable alternative tool enabling blind people to learn about inaccessible elements of physical architectural space (such as: the principles and composition of spatial arrangements, the construction of an architectural form, its spatial parameters and components, decorations used, etc.). Multi-coloured typhlographics, e.g., enriched with an appropriate (matching the original) underprint or tactile colour code, may also provide information about the colour composition of buildings and spaces.

#### 3.2.4. Tourism Industry

Another, well-established area of usefulness of architectural typhlographics is the tourism industry, which is more and more effectively opening up to the needs of people with disabilities, including the blind [27]. For over a dozen years, the number of typhlographic representations in Poland has been systematically increasing, referring to spaces and objects that are the greatest tourist attractions of cities and towns. Examples of such typhlographics are presented in Figure 7. The most common subject of these representations are monuments, although there are also typhlographics presenting contemporary objects. In this group, portable information materials, in the form of small-format graphics, which can be conveniently taken in hand and even taken for a long walk, gained the greatest popularity. They can take the form of loose cards, although nowadays a noticeable tendency is their proper grouping and systematisation into catalogues, guides, albums, atlases, as shown in Figure 7a,b,e. Such studies can be viewed and even obtained free of charge at tourist information points. Similar materials supporting sightseeing by the blind are also offered for internal use by some cultural and tourist institutions [28,29]. Among them, there are interesting ideas, such as: specially organised points for haptic reception, as in Figure 7c,d, or catalogues in the form of a bag, hung on the shoulder, as in Figure 7f. An interesting solution is also typhlographic souvenir gadgets (e.g., study and play books, calendars, etc.), combining elements of tourist promotion as well as entertainment and utility. Unfortunately, such studies are still a very small part of tourist souvenirs available to sighted people.

Typhlographics used in the tourism industry present space at all scales: from large landscape areas, through urban fragments of cities and complexes of buildings, architectural objects and their elements, to interior spaces and their equipment. The thematic scopes of the drawings correspond to the appropriate drawing approaches: maps, plans, diagrams, elevations, views, wall expansions, details, etc. The main advantage of this type of typhlographics is their usefulness as additional tools supporting sightseeing for the visually impaired. Owing to such amenities, they can get to know the architectural space in a more rich and satisfying way. In situations where physical (and sensory) contact with the tourist offer is not possible, such typhlographics become the main source of information, reducing the distance of people using them in relation to all tourists. It is worth remembering that due to the universality of this type of assistance, it can also be used by other groups of people at risk of exclusion in tourism spaces, e.g., people with reduced mobility.



**Figure 7.** Typhlographics supporting the tourism of blind people: (a) Tourist plan of the city; (b) sets of tourist and sightseeing tactile graphics; (c) tactile information stand for blind tourists inside a historic building; (d) typhlographics in the form of a book showing a tourist facility; (e) briefcase with a set of touristic materials; (f) catalogue in the form of a shoulder bag for exploring the museum space. Photo by: (a,c–f) Kłopotowski, M.; (b) Jakubowski, M.; Figures edited by M. Magdziak.

In addition to the undoubted advantages resulting from compensatory forms of access to real space, these supporting materials also play an extremely important role in promoting places and attitudes. They not only expand the group of recipients of specific tourist attractions, but also show the social openness of a cultural and tourist institution, expressed in the care for meeting the needs of all recipients of architectural space without exception. These solutions, visible in the public space, determine a clear message of support for the idea of equality and universal design [30].

### 3.3. New Areas of Potential Development of Architectural Typhlographics

Recognition of contemporary areas of utility, as well as the analysis carried out by the authors on the common fields of interest of both fields of knowledge: architecture and typhlology, allowed to indicate potential directions of further development of this type of graphics. We can list here:

- Extended architectural education;
- Creating professional project documentation;
- Market of gadgets for fun, entertainment and leisure;
- Tactile elements in the area of interior decoration and ornamentation.



The most important of these areas seems to be extended architectural education, going beyond the requirements of general knowledge and addressing to blind people of all age groups (lifelong education). As evidenced by the previous research by A. Kłopotowska [13], such education can and should enrich the offer of the general education system at all levels, ranging from architectural classes for the youngest children (cognitive workshops in the field of aesthetics, simple architectural concepts, curiosities of the world of architecture), advanced educational forms (workshops, lectures, conferences), intended for pupils, students and finally adults who want to deepen their knowledge of architectural art. An important issue here is the appropriate adjustment of the content and form of the drawings to the cognitive abilities and haptic conditions of various user groups. At each cognitive stage they should be interesting, user-friendly and unambiguous (clear) in reception. Examples from around the world indicate the possibility of using this method as a form of supporting the graduation of architectural studies by partially sighted students, and even rehabilitation of blind people who received professional architectural education before losing their eyesight [31]. Using and independently creating typhlographics, they could continue their professional work in certain areas of this profession (for example, they can be consultants supporting the process of universal space design).

An important field of using typhlographics may also be the creation of professional project documentation adapted to tactile reception in order to present it to blind investors or consultants. As a result, this could broaden the list of artistic professions open to the visually impaired. This issue seems to be very important, because despite the long professional history of activation of this group of disabled people, such offer in many countries is limited to narrow areas of handicrafts (basket weaving, pottery, sculpture), literary and musical professions.

Another, so far insufficiently explored area is the market of gadgets for fun, entertainment and leisure, which can successfully promote architectural themes among the visually impaired. Such typhlographics may take the form of puzzles, labyrinths, point graphics for connection with lines, defining the contours of buildings, board games, etc. In the field of tourism, an interesting enrichment of the current offer may become typhlographic postcards, which can be an interesting souvenir from a trip, allowing tourists to remember the architectural objects they have known.

The authors also see a large (although currently completely unused) potential in the area of decorating and ornamentation. Rich, carefully and precisely made spatial typhlographics, especially with colourful under-prints, can become a decoration of many stylish interiors and at the same time be a carrier of information for the blind. The existence of such elements can also have a social dimension, by drawing the attention of sighted people to the important issue of participation of the blind in the field of culture and art.

In all the above-mentioned fields, the help of volunteers is extremely important. Professional designers and students of architecture have a special role to play here, as experts in their own discipline can actively support the creation of tactile graphics of high cognitive value. Each time, such tactile graphics must be carefully developed in accordance with the design principles and image adaptation rules, as well as obligatorily, in consultation with experts and the recipients themselves.

#### 4. Discussion

This work is an attempt to fill in the existing scientific gap resulting from the mono-disciplinary description of clearly interdisciplinary issues. Analyses conducted from an architectural perspective complete the picture of the phenomenon so far studied almost exclusively in the field of typhlogy. The architectural approach seems to be valuable mainly due to the subject of the studied typhlographics, concerning the relations taking place in the architectural space. An important reason justifying the inclusion of these issues in the scientific competences of architecture is the fact that typhlographic information becomes an integral part of the architectural space (elements of its equipment and the

so-called “urban furniture”), which gives the basis for their observation and description from an architectural point of view.

The described issues present the problems of specific architectural drawings, which so far have not received adequate interest in the field of architecture and have been on the margins of scientific research. The fragment of knowledge developed by the authors on the substitute form of experiencing architectural space is part of a wide stream of research in the field of universal design and the idea of sustainable development.

The conducted analyses allowed for the identification of research issues that the authors plan to undertake in further scientific research. Extensive research is especially required for: technology and cognitive values; specificity of presenting architectural space in tactile drawings; utility problems and the principles of creating proper architectural typhlographs. Due to the strong differentiation of the entire collection of architectural tactile drawings, the authors see an urgent need to develop a classification of typhlographics, allowing them to be organised according to specific features and properties.

The studies of the research team confirmed the initial hypotheses about the clearly functional nature of this type of graphics. However, as evidenced by the presented analyses, it does not exclude the possibility of designing and producing representations of high aesthetic value. In this context, the authors’ research also opens an interesting thread of discussion on the possibility of reconciling both values: utility and beauty, which is part of a broad architectural discourse.

## 5. Summary and Final Conclusions

As the research of the authors’ team has shown, among the various types of typhlographical auxiliary materials compensating lack of sight, an important role is played by architectural typhlographics, used to obtain a substitute access to architectural space and/or to support its reception. The content of such representations may refer to the external or internal space, real or unreal (e.g., abstract, typical, imagined, created). These drawings can present architectural space at all scales, in a comprehensive or fragmentary way. They can be portable or permanently placed in space.

The conducted studies, aimed at preliminary recognition of the architectural typhlographics collection, allowed to identify several basic types of functionality of the drawings. They can be used to transfer specific architectural content with the purpose of:

- Presentation—illustrative graphics showing given objects and spaces;
- Information and warning—graphics informing about the rules of spatial systems organisation, as well as communicating the presence of certain important or dangerous elements;
- Remembering, preserving—drawings aimed to help in creating a mental map in the memory to preserve the possibility of recalling images of space or spatial relations at a later time;
- Instructional—utility graphics showing the rules of practical use of a given space;
- Didactic—drawings with content increasing the user’s competences;
- Documentation—a mutual communication tool in architectural design.

These groups do not have to be separate collections—individual graphics may fulfil two or several different functional tasks.

The ways of presenting space in typhlographs basically correspond to the conventions of presenting architectural graphics (flat plans from the top or side, sections, elements of perspective drawings). However, differences in the aesthetics and graphic form of such representations can be indicated, which results from such premises as: the different needs of people without visual control of space, the conditions of haptic perception as well as the technological capabilities of devices selected for the production of such drawings. These differences may include the content of the drawings (reduction, addition, accentuation of certain elements), as well as their form (including the scale and convention of representation).

The results of the analyses obtained so far by the authors' team make it possible to indicate a number of areas of usefulness of architectural typhlographs as a tool for rehabilitation and revalidation of blind people. These types of studies fulfil important tasks in such areas as:

- Supporting spatial orientation and safe locomotion in an urbanised space;
- Learning orientation and independent movement;
- General-cognitive area, including general education and personal development of the individual;
- Tourism for visually impaired people.

These studies also allowed to indicate areas in which typhlographics may fulfil important functional tasks in the future, such as:

- Extended architectural education;
- Vocational rehabilitation of blind architects;
- Professional architectural documentation;
- Toys, souvenirs;
- Interior decorations and ornamentation.

According to the authors, it is important to further develop and popularise architectural typhlographs, which can fulfil a number of socially useful roles. Among them, in particular, the potential of eliminating barriers and ensuring the accessibility of architectural space (and art) for the visually impaired should be mentioned. Equally important is their social impact as effective tools that help in shaping proper attitudes towards disability.

Due to the special perceptual and mobility conditions of blind people, such typhlographics must present the appropriate design and implementation level to guarantee reliable cognitive information transfer, as well as the comfort and safety of users. Architects and students of architecture can and should play an important role in the preparation of the typhlographs covered by the study. Further research should also include the involvement of designers. This cooperation would help to investigate the phenomenon and permanently introduce the issue of typhlography in the theory and practice of the architectural discipline.

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