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Mental perceptions of urban space: using underground maps as utopian cartographies for the city of Green Bay (WI, USA)

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Abstract. Underground maps have become an iconic image that has transcended the function for which they were created. Their multiple visual and spatial possibilities include functioning as a cartography that simplifies and organises the perception we have of a territory. A study of the geography of perception is presented based on underground plans of the city of Green Bay prepared for the analysis (WI, USA). The methodological and educational possibilities of this utopian cartography are explored for its use as a mental map. A group of citizens' knowledge and perception of the city they reside in is analysed through a synthetic cartography.

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1. Introduction

The knowledge that people have of the territory varies with time and with the way they relate to it. The individual transforms the geometric space by an existential space governed by vital references and memories. Each of us customises space. Some places attract our attention and stimulate us to record a memory linked to a feeling or emotion (Tuan, 1977). Others, however, go unnoticed for their simple functionality or repetitiveness, such as airports.

The geography of perception and behaviour is the study of personal images of territory. Both individualised perceptions and those of social groups are analysed. Preconceived images determine our behaviour and activity in a territory. The interest in normative behavioural approaches to geography is well known. The focus is on analysing the individual's idea of the territory. However, its development as a field of study depends on data being obtained. This current of thought in geography has not been without criticism ever since the first publication in the 1960s of *The image of the city* (Lynch, 1960). The difficulty of homogenising data collection and the subsequent systematisation of mental maps has limited the advancement of this type of studies compared to other geographical postulates.

The article contributes to the analysis on geography of perception. Its originality lies in the methodological variation for obtaining the information. It proposes to obtain an image of the city through the development of underground plans. This type of iconic mapping is perfectly identifiable and recognised by the vast majority of the population. They have a simplicity that allows them to be elaborated employing few cartographic notions. This exercise is intended to reflect the didactic and analytical possibilities of a utopian cartography made by students of geography at the University of Wisconsin Green Bay, who created an underground map of their city. This city in the upper Midwest of the United States does not have this metropolitan infrastructure. However, the cartographic design of underground maps created almost a century ago serves today as an incentive for the task of analysing, organising and prioritising the main places that each student has in their cognitive

idea of the city where he/she studies. The results are analysed in aggregate form to obtain a synthetic image of urban perception.

The design and elaboration of the cartography of a non-existent transport network is a conceptual challenge in which spatial thinking and creativity provide a diverse field of perceptions and interpretations. The elaboration and analysis of underground maps is a highly subjective exercise in which each student presents their own personal cartographic proposals for the city where they live by prioritising their places and organising them as points and lines. These representations offer a cartographic variant on the perception of the territory that is complementary and more homogeneous for subsequent analysis than traditional mental maps.

1.1. The perception of the territory

The rise and democratisation of Geographic Information Technologies (GIT) have extended the use and consultation of maps as never before. GIT is simplifying and homogenising cartographic results and spatial learning methods. Despite the increase in opportunities and means available, our learning relationship with the territory is decreasing (Quercia et al., 2014). In 2016, at the assembly of the International Geographic Union held in Beijing, the importance of learning to think geographically and improving the way of looking to understand the world around us was highlighted (IGU, 2016).

The geotechnological revolution has increased cartographic positivism, in which we tend to think that maps are neutral, objective and independent (Harley, 2005). The mathematical component gives the principle of truthfulness to what is represented, even when it is accepted that the conversion of a spherical body to a flat one implies the assumption of distortions (Peters, 1991). A map is not a translation of a territory, it is an abstraction of it, an interpretation. That interpretation implies a selection and schematisation of the spatial elements. Such representation can involve high mathematical precision and rigour, but it can also be a qualitative abstraction. Absolute geolocation through coordinates is essential in cartography. In addition, the topological relationships established

between the elements represented are equally or more important (Dollfus, 1982).

The representation and analysis of topology is essential in geographical analyses. Sketches, chromes, carto diagrams and other cartographies that do not maintain projective relationships are images frequently used by geographers and other disciplines, and they provide a strong communicative and analytical capacity (Brunet, 1980). The enormous learning potential of freehand maps is assumed (Agrawala et al., 2011). These maps allow territorial reality to be structured and organised through the relationships between the elements drawn (Tversky et al., 2006; Gieseeking, 2013). The mental map is a powerful visual communication tool that shows, without comparison, the spatial thinking of the respondent; it helps organise relevant information and plan activities; it develops creativity; and, it encourages the use of memory, which is increasingly falling into disuse as people rely increasingly on technologies.

Sketches and mental maps are the usual tools of the geography of perception. It is the branch of geography that has addressed the study of subjective and individualised space. Almost all authors name Kevin Lynch as the pioneer of these studies. Lynch presented a methodology that allowed the knowledge that citizens have of their city to be analysed through the analysis of these maps. His research started with the elaboration of a mental map of the analysed urban environment upon which the respondent represented their knowledge of the city according to three components: identity, structure and meaning. Identity refers to the ability to distinguish and individualise one element from another. In turn, the map must have a series of spatial relationships between its adjoining elements. A pattern or structure is established between the observer and the objects. Finally, the cartographic composition must have some meaning for the observer that makes it relevant, practical or emotional and that implies being selective when saving it in the mental image, using it in the observer's habit of orientation, and representing it in the maps (Lynch, 1960).

The study employs the concepts of the legibility and "imaginability" of urban morphology as key to understanding the perception of cities. In order to organise and focus on the comprehension of the elements that link the mind image to the

urban image, the representation of that image is organised using several elements according to Lynch's postulates (nodes, landmarks, paths, edges and districts). These items represent various characteristics such as singularity, shape simplicity, continuity, predominance, union clarity, differentiation in direction, visual range, movement awareness and time series, as well as names and meanings.

Criticisms of the use of mental maps in the geography of perception is well known. Since its inception, it has had no shortage of detractors. One of its difficulties lies in the so-called method of continuous comparison (Glaser & Strauss, 1967). Another critique is the loss of information due to limitations in the drawing skills of the respondents. Regardless of these criticisms, mind maps allow for an improvement of the individual knowledge of the territory of the map maker. On some occasions, what is lost is the congruence between the structure and content of the visualisation and the structure and content of the desired mental representation, which makes it difficult to read. Tversky et al. wrote about the apprehension that is created when the structure and content of the visualisation is approached and read as an approximation of what is perceived and understood (Tversky et al., 2006). Some of these differences arise when performing an egocentric representation, which is easier to convey than incomplete visions (Howard & Templeton, 1966).

The aim of this paper is to show a methodology of qualitative and imaginary cartography as a tool for the understanding of territory. It is based on the iconic underground maps and on the elements of the geography of perception. In addition, the students applied a cartographic methodology that allows them to develop cartographic creativity through visual thinking and spatial thinking.

1.2. The underground map as a form of visual communication and spatial organisation

The underground map as we know it today was introduced in London in 1933 by electrical engineer Harry Beck. He applied the structure of electrical circuits to the transport network. The stations become points connected by lines of different

colours that correspond to the transport lines. By doing so, the information was simplified greatly. The drawing was schematised through a geometrisation of its elements. All lines become straight lines and their turns are reduced to angles of 45° and 90° (Haddadi, 2010). This simplification implies that the cartographic readability increases considerably. In addition, providing the user with the minimum of information in the simplest of manners improves its functionality. Stations, lines and interconnections are the elements needed to move mentally through the map and, in its transposition to reality, through the city. It is not necessary to know precisely where the conveyance is going or coming from, only where the user can interact with that service.

The underground map has become an iconic type of image (Degani, 2013). It has far exceeded the function for which it was created, becoming a brand image and merchandising element of countless cities, especially in London (Merrill, 2013). Moreover, it has been extended as a map, with certain variations, to represent almost all metropolitan transport networks (Owenden, 2016). Its cartographic use has been extended to supply networks (Guo, 2011) and to many other cartographies that are closer to graph theory than to spatial representation. However, this optimal form of visual communication, with great success and diffusion, has not been without criticism due to the cartographic licenses it takes and the distortions that it generates (Liu & Li, 2016).

This study presents an approach to understanding the perceived urban environment through the elaboration of underground maps. The elaboration of this type of maps by the students implies at least two learning processes to consider:

- The first one involves knowing the city. A reflexive process is necessary to determine which are the important places in the city and to highlight them. The result in the map is to create an underground station. It requires hierarchising and categorising the space in order to organise it based on some spatial or thematic criteria. Each student illuminates a part of the territory by providing it with an underground station. These, in turn, are organised and structured by connecting them together with segments converted into hypothetical underground

lines. All these elements, points and lines are united in a single message that focuses on the motif of the cartographic design chosen by the user.

- The second involves the need to know minimally the notions of design and visual communication of this type of maps to make a mapping according to the geometry proposed by Beck, and one that is also pleasant and readable. Simplification and schematisation eliminate the superfluous, leaving visible the important places in a geometry of points and lines.

The result of these two processes is the elaboration of a utopian cartography, where the scale is broken and imaginary elements that add value in its transposition to the territory are created. Utopia is not an idealisation of a society, but rather, the representation of the ideal of each observer. Utopia means “no-place” (*ou-topos*) or “place that does not exist” (Hutchinson, 1987; Philippopoulos-Mihalopoulos, 2001). Each station and each underground line represented by the students is a utopia of the points that are significant and important to each of them. The students’ etymological non-places can help us understand their perception of significant places in the territory.

2. Material and research methods

The research method used has three phases: preparation and collection of information; filtering and tabulation of information; and, finally, analysis and presentation of results. The database was obtained from a task entrusted to first- and second-year undergraduate students in the course, Introduction to Human Geography at the University of Wisconsin in Green Bay. Green Bay is located in the upper Midwest Plain of the United States. The city of Green Bay had 105,116 inhabitants in the 2017 census estimate. The area of influence of the city of Green Bay includes the municipalities of De Pere, Allouez, Ashwaubenon and Bellevue and the towns of Howard and Hobart, making a total population of 205,524 in 2017. It does not have a metro or passenger rail transport between cities. Today, the railway infrastructure is exclusively used for cargo or finished products due to the important industrial

activity of the region. The bay marks the northern limit of the municipality and the Fox River is the excipient origin of the original settlement. The river is the backbone of the city's growth. Urban growth extends beyond the boundaries of the municipality towards the adjacent municipalities (Fig. 1).

The students were instructed to create a subway map for the city of Green Bay. Two theoretical sessions were addressed for this task. The first session introduced the geography of perception and Lynch's methodology¹. The second session addressed the techniques of the cartographic design of metro/underground plans². Both sessions were complemented by a workshop on available work tools that could be used for the technical realisation of the activity: Office programs with drawing functions (PowerPoint, Word); design programs (GIMP); and Geographic Information Systems (QSIG)³. The students were free to use any of the programs they chose. The vast majority of students chose to use the MS Office package as a tool. After a quick and brief review and evaluation of the maps, a final feedback session was done in which the main

results were commented on both in design and in territorial analysis.

The tabulation revealed a richness and diversity of underground maps. The work led to an important process of filtering, simplification, interpretation and generalisation to homogenise and systematise the sample. There are several possible derivatives, such as analysing the number of lines and interconnections, or issues related to the design and themes presented. The design of the network and its structure (the lines) is, in some cases, poor, unconcise and insufficient, making spatial conclusions complex. We chose to explore the stations. These stations become important points of the territory for the respondent who gives them relevance by turning them into a station. The aggregation and representation of the stations allows us to analyse the degree of knowledge that the students have of their city. The information represented on these maps can easily be linked to Lynch's point elements. The stations are comparable to nodes and landmarks. The stations have identity and meaning in an imaginary structure.

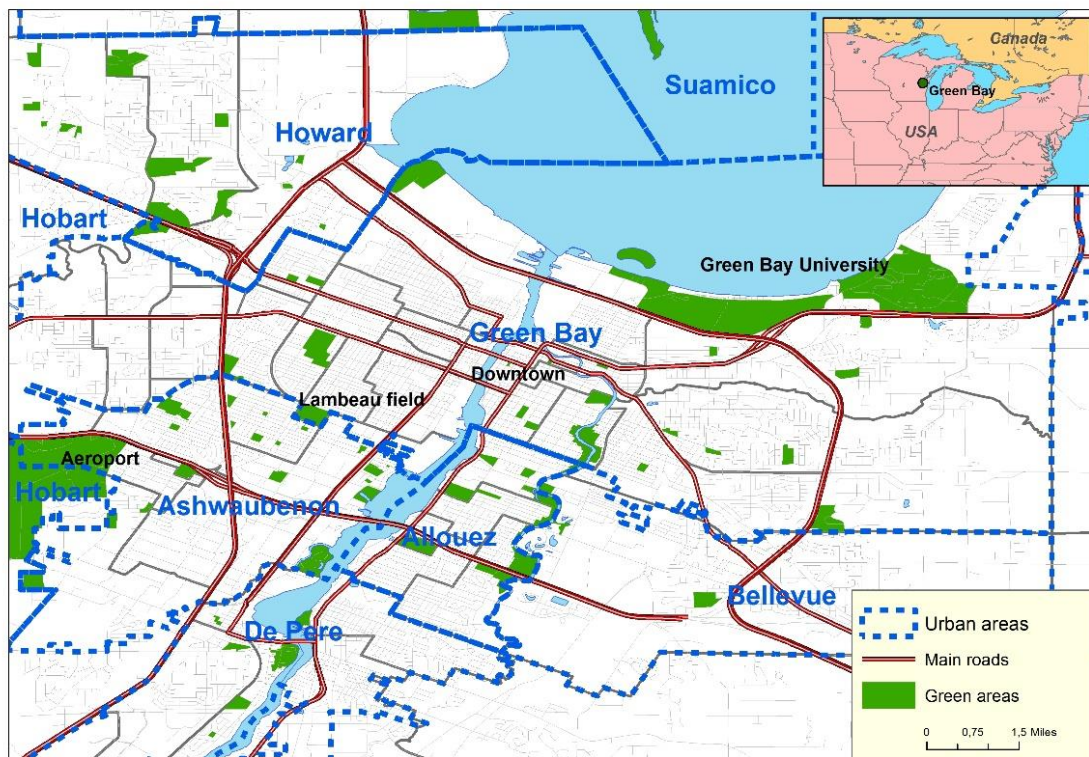


Fig. 1. Study area
Source: authors

The melting pot of responses was varied, which obliged us to make a series of decisions as to homogenising and geo-locating the points (stations).

- Include in the same item two stations that refer to the same place and have a similar name.
- Geo-locate stations defined according to linear elements. In many cases, the crossing of two streets is cited as a station, but in other cases only one of the streets is named. Its relative position in the plane and the proximity of some significant element of the city helped in the decision.
- Homogenise terminology in obvious cases that refer to the same place. There is a significant number of values with a single designated point, creating a polarised schematic. Homogenising terminology filters and reduces the degree of polarisation.

Finally, we tabulate the stations and their cartographic representation. The conclusions are linked to Lynch's elements of reading the urban environment. This seems evident in identifiable

landmarks and nodes represented in their point geometry.

The development of metro maps is a methodology of learning the territory from an active, creative and intuitive exercise (García, 2017). It allows students to represent their conceptual image of the territory in a more systematic and imaginative way than would a traditional sketch. You get a perceptual mapping of the city that follows a pattern in its representation. This type of map reduces some of the criticisms of mental maps analyses. The two representations – mental and underground maps – have as their central element subjectivity guided by a personal and qualitative visionary exercise.

This effort in the preparation of the primary information, as we have already mentioned, reverberates in the respondent's learning process, and also has the advantage that all urban perceptions are organised under the same work pattern, which facilitates its tabulation and comparison to obtain a synthetic image. In mental map sketches, there are no guidelines that determine how to organise and present the structure and morphology of the city. The underground map marks a pattern

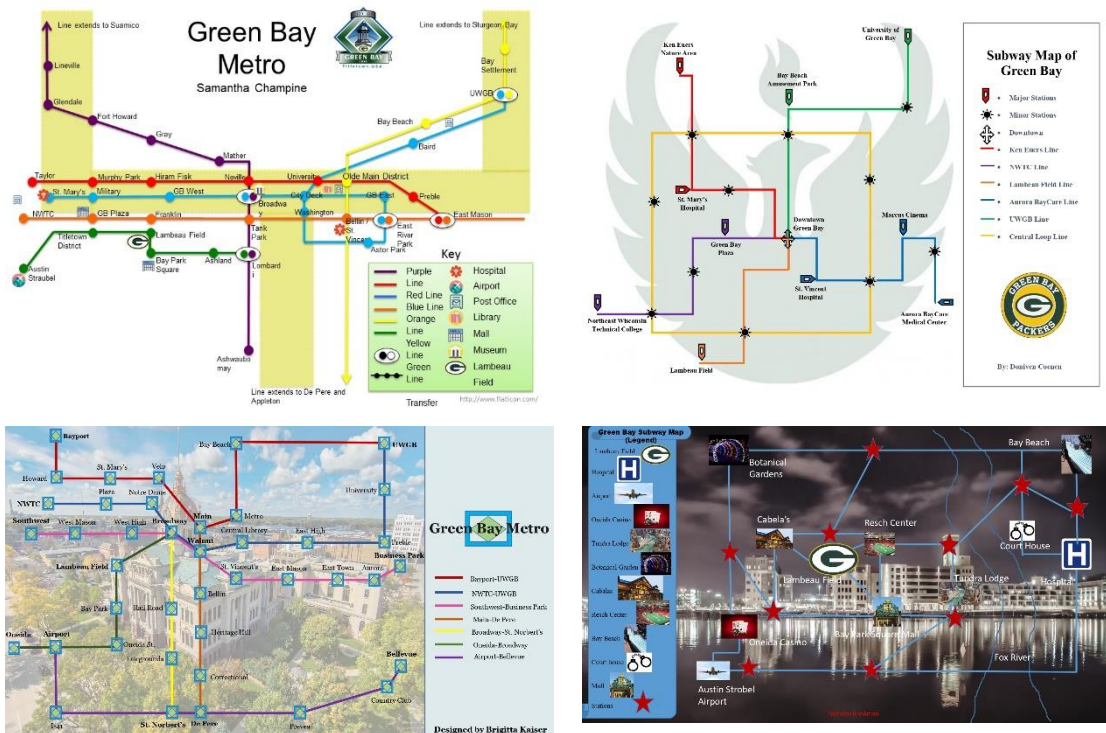


Fig. 2. Examples of student’s underground maps of Green Bay
Source: authors

that organises the information represented and encourages creative development in the finished product. The result is more elaborate and thoughtful than a mental map. The underground map entails learning about how to represent the territory, in this case a city, in the face of the complete absence of rules for drawing up the sketch of mental maps.

3. Results

A total of 53 maps were delivered after a week of individual work (Fig. 2).

The data reveals a high degree of polarisation in the responses. Only 62 of the 158 catalogued stations have more than one response (39.2%) and only 20 stations received five or more responses (12.6%). The lack of common elements/nodes that agglutinate the city is evident. The four most represented elements/nodes are the university (Fig. 3), Lambeau field (Fig. 4), Bay Beach Amusement Park (Fig. 5) and

the airport, respectively. These four elements/nodes of the city are distant and disconnected from each other. This result reveals the profile of the sample – young university students who represent the city in a polarised schematic.

Having said this, the university is the element/node that is common to all respondents. It represents the central element of the group's cognitive image and its prevalence in the maps was predictable. On the other hand, the American football stadium is the territorial anchor of the image that the city projects. The NFL team dominates any other image of the city. The Green Bay Packers is the most representative and iconic element of the city, including for students. This image is marked by the uniqueness and fame of the team linked to the city. The difficulty of escaping from this stereotype is evident. Almost all the maps created by the students mentioned and identified the element. In turn, the built environment surrounding the stadium, with its high symbolism, reinforces the significance of



Fig. 3. University of Wisconsin, Green Bay
Source: authors



Fig. 4. Lambeau Field
Source: authors

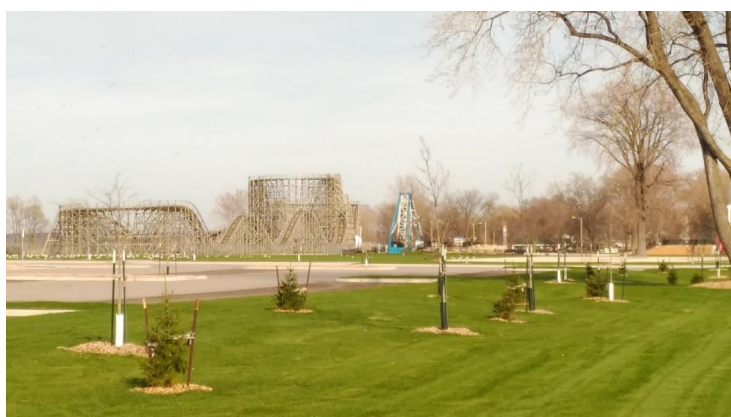


Fig. 5. Bay Beach Amusement Park
Source: authors

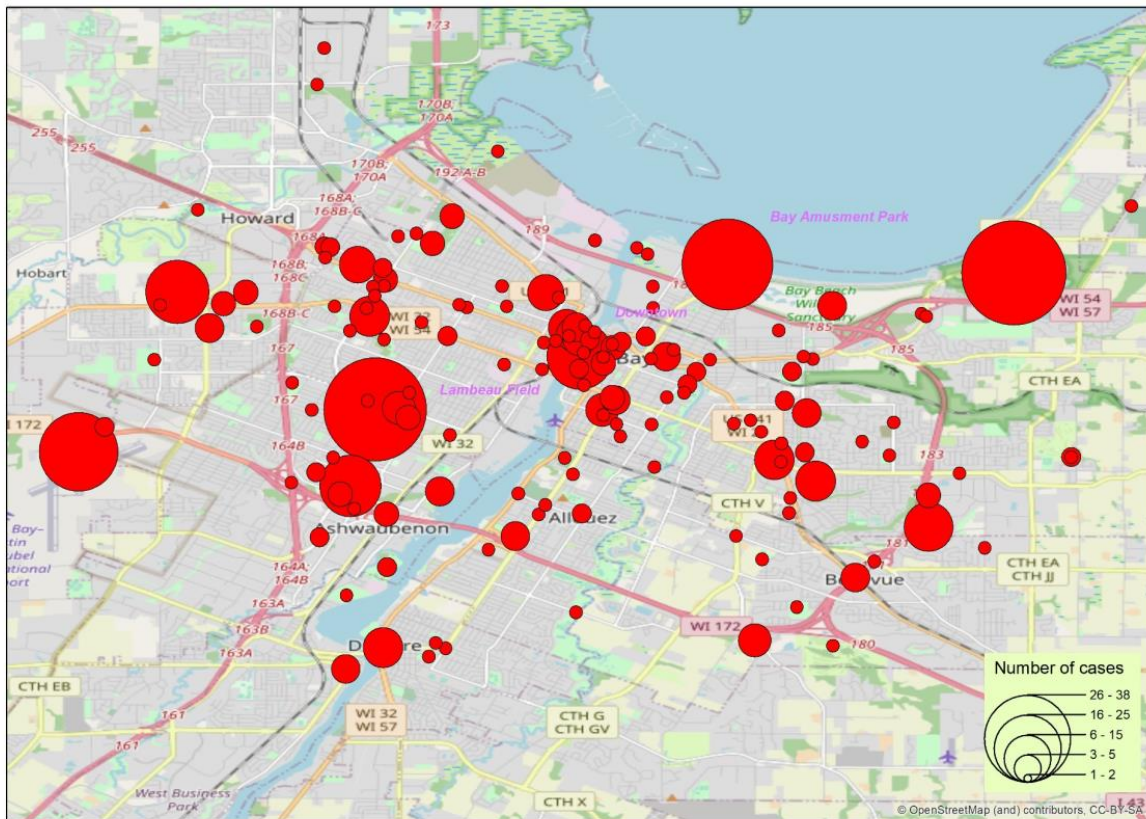


Fig. 6. Cognitive image of Green Bay
Source: authors

the district / area of the city. The stadium is located within the municipal limits of Green Bay, but much of the retail and hotel accommodation services surrounding the stadium are in the neighbouring suburb of Ashwaubenon. This fact makes the perception of the city exceed its administrative boundary.

The third element / node is the Bay Beach Amusement Park (Fig. 5). It is the other great leisure element of the city and is located on the banks of the lake and disconnected from the city by a nature reserve and a section of the city’s industries. Finally, the airport is located on the periphery, and serves not only the municipality but also the metropolitan area. This leads to a wide cognitive image of the city with important gaps within the image. Two of the most recognised elements/nodes – the university at the eastern end and the airport at the western fringe – are more than 17 kilometres apart (Fig. 6).

This peripheral positioning results in a wide perceptual footprint with important intermediate gaps. The aforementioned commercial and tourist

environment around the Packer Stadium and the variety of elements/nodes mentioned by the respondents in the downtown district fill some of the gaps. The downtown district is the place that concentrates the greatest number of stations elaborated by our sample. It was identified on 17 maps, and other nearby stations also featured on many maps. One such station is Broadway Street (Fig. 7). The city has revitalised this street to become a lively retail and tourist destination in its attempt to revitalise the downtown district (Cruz, 2009). The street runs parallel to the Fox river (Fig. 8). The Fox and East rivers that provided the origin and motivation of the city’s growth organise the cartographic representations and served as initial points of reference. Rivers are a crucial element in the structure of cities in the dichotomy of centre and periphery as a city hinge (Kulczyńska & Matykowski, 2011).

Also, this large extension leads to the conclusion of the dominant nature of the automobile as the preferred choice of travel. The means of transport



Fig. 7. Dousman & Broadway Streets
Source: authors

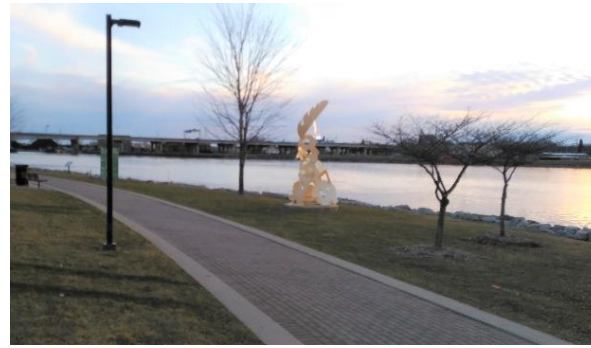


Fig. 8. Fox river
Source: authors

by which we travel in the city conditions the knowledge we acquire from it. In the case of Green Bay, urban planning and mobility are planned and designed for the private vehicle. This is made clear by the high number of references that use street intersections instead of destination points. These nodes reflect the wayfinding method and proximity of places of leisure and commerce frequented by the respondents.

4. Conclusions

The iconic image of the underground plans is one of the most represented cartographic styles in many of the cities on the planet. Its immense versatility and implantation in today's globalised society allows us to apply it even to territories where there is no such transportation infrastructure. The structure designed almost a hundred years ago to represent the transport network is used to bring students closer to cartography and spatial analysis. The breakage of the Euclidean scale and distance allows us to work an imaginary space based on topological relationships and individual perceptions. Imagination and creativity can be a perfect method to create interest in the city. From a map based on geometric simplification, a perceptual and topological universe is shown. A territorial identity is created by illuminating places and obscuring others.

The organisation of the network represented is practically nil. The network is generally unreal and focused on strengthening the cartographic design instead of thematic or territorial connections. However, in all cases there are a number of points that give us valuable information about what the

respondent considers important in the study area as designated as an underground station.

This perception, far from being better or worse, is complementary to the studies carried out to date. The information it provides is not as rich, but it is easier to tabulate and geometrise using points and lines. The use of the filter of the underground maps causes a different conceptualisation that is complementary to the traditional mental map. Metro plans are global in their own conception, while mental maps are local. The holistic representation of the city itself leads to a different treatment and response. The way of taking the data for an underground map allows it to be differentiated from a mental map. While, in the mental map, one represents what one remembers, in the underground plan, one considers the city as a whole by locating stations in all areas of the city with a more homogeneous distribution. In mental maps, a lived city is more appreciated, while the analysis with an underground map implies a more planned image. Which places of the city should be important for the city dweller? The underground plan involves a prior analysis of the respondents that presents not only what they consider important places, but also what are the important places in the city, holistically. The aggregate result, in addition to being an image of a social group – in this case, university students – also shows the most significant places in the city.

The exercise also has another point in favour in its own development beyond the result obtained. The work allows an exploration and rediscovery of the significant places for each student and introduces the student to cartographic design with simple tools to create an image with previous knowledge of the territory acquired by the student. Understanding

the territory through mapping is the basis of the exercise. Map-making is much more than just displaying a map. The promotion of creativity in constructing and reconstructing imageries increases the skills in visual and spatial thinking. This creativity is added to the manual and technical skills of computer-aided tools. The esteem of the users in their spatial skills is revalued from the individual reflection of their relationship with the territory. Geography is learned in an individualised, active and fun way that increases motivation and positive attitude.

In conclusion, there are several issues to consider and directions for further research:

- The map representation undoes the path taken by the individual from the objective to the subjective space. Space is transitioned from the geometric reality of urban form to the topological reality of the individual's perception. This is represented and again recoded to a georeferenced geometric cartography.
- There is a great visual variety in the presentation of results, and more investigation is needed to explore this diversity. For example, the gender, class and ethnicity of the respondent can give us a clearer social geography of the city and the different perceptions of the city that are being reconstructed.
- It increases the closeness between geography and the user because the results, in addition to being easily interpretable, allow those who see them to identify themselves with at least part of the results obtained.

The creation of the underground map serves more to know priorities than preferences, at the same time that it feeds back the spatial knowledge of the respondent and improves their spatial and artistic skills. The utopian cartography of the underground plans opens a working path to deepen active methodologies of knowledge of the territory, but also to analyse it in studies on the geography of perception. The deepening and improvement in the design of the analysis methodology will facilitate the systematisation and homogenisation of qualitative studies of territory.

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