MAPPING CULTURAL CITYSCAPES IN THE DIGITAL ERA AND THE CENTURY OF COMPLEXITY

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Abstract

21st century has been characterized as both digital age and century of complexity. The two concepts interact, coexist and eventually shape the contemporary condition, in which urban cartography is developed. Now, acting in completely innovative ways, urban cartography succeeds in highlighting both the material and immaterial dynamics of cultural cityscapes. Digital technologies offer techniques that allow the recording and visualization of diverse urban data, obvious and hidden, material and immaterial, visual and multisensory, quantitative and qualitative. The introduction of new digital mapping techniques, such as big data assessment, polymorphic processing, multiple modes of representation, reproduction and transportation, the increased production speed and access to general public are some of these. Contemporary urban mapping contribute therefore to the creation of a new form of communication and enhancement of cultural identities, which is characterized by multiplicity, diversity and interaction. All the above help us realize the correlation of cultural cityscapes with the contemporary concept of urban complexity.

Keywords: *big data, critical cartography, intangible place identity, cultural cityscapes, complexity, digital media.*

The material and immaterial aspects of cultural place identity

It is now a common fact that space evaluation is based on its cultural content, a concept referred to as 'place'. Space becomes place as human fills it with its actions, functions, images and representations. Place arises through the psychological connection of people to space, through dreams, hopes, feelings and meanings attributed to it. Space becomes place and we learn about all its dimensions, material and immaterial, obvious and hidden, quantitative and qualitative, physical, psychological and ideological. Due to the above, place becomes unique and people attribute to it a physiognomy, an identity, a sense of place. We will use the term *landscape* (*cityscape* in the urban context) to identify *the sum of all material and immaterial elements of place that interact with the cognitive functions of human beings and lead to the formation of its image*. With other words, *landscape is a territorial context on which culture is projected, the imprint of the collective consciousness of its inhabitants* (Moraitis, 2014). *Place image* (a similar expression) *is the perception, the intangible imprint, the internal, mental representation that place offers in sensory, sentimental and ideological level that arises from*

the interaction of material and immaterial elements, physical and social conditions (Tsakiri, 2018).

This unique *place image, identity, landscape*, is a palimpsest of spatial and social phenomena as they evolve and transform into time. It consists of elements that have material character, structure, shape, natural or anthropogenic properties, and of elements that are mental, elements that are shaped by the cultural character and spiritual content of the place. All these contribute to the deep acquaintance with a place and construct the overall view of its entity. Every sense (vision, hearing, smell, touch, taste) and every emotional, logical and temporal dimension contribute to the knowledge and experience of place and to the formation of its image, identity, landscape (Stephanou, 1996). With all of their senses people perceive every part of a place and imbue it with distinctive meanings and emotions, constructing thus a multidimensional and polymorphic landscape. Mapping cultural landscapes should involve both material and immaterial data, psychological, emotional and perceptual functions. All these elements, which until recently seemed impossible to be recorded and evaluated, can be mapped today through the new techniques introduced by digital technology.

Places found within cities have the particularity of creating cultural cityscapes that share common meanings with their environment. Cities are considered as sets of places. They are spatial formations that evolved around important and distinctive places, such as most of the European cities that were once enclosed within medieval walls. These places that gave birth to modern cities are still important centers of memory, history and culture. Aldo Rossi in his book *The Architecture of the city* (1982) calls them *urban artifacts* and explains that they have formed the morphological and functional matrices of modern cities and that they are characterized by durability and resistance to the passage of time, in other words, they exhibit resilience. Urban places, however, acquire today new roles, as they reflect recent changes in contemporary cities and present liquidity and dynamism. Urban places and their cultural landscapes are redefined by cities as they change. Mapping these in the digital age and in the century of complexity, as we shall see below, provides new possibilities that may compose up-to-date cultural landscapes, in which both duration and evolution will be imprinted.

21st Century: Digital Age and Century of Complexity

In the turn of the 21st century humanity has seen the development of two important scientific achievements, which have been applied to various aspects of technology, culture and arts, ending up to characterize vigorously our world. Digital technology and the evolvement of complexity science nowadays shape our world understanding and form the background of contemporary urban mapping.

The 21st century has been named “digital era”, a characterization that brought about digital revolution, that is, a change of paradigm from the use of machine to the use of information. However, what exactly means the term *digital* still remains unclear, as the definition is constantly being reformed so as to include recent developments and applications that occur at a rapid pace (Castells, 1999). The most prominent achievement of digital era is the unprecedented development of computer science and technology that accelerated the entry of human culture into the information era, which is characterized by the internet, smart technologies and big data. But the rapid changes that took place led also to expressions of concern and criticism: The processing speed of contemporary computers resulted in the

accumulation and transportation of gigantic data loads that brought about the rapid production of knowledge to an extent that human is in danger of losing control (Shepherd, 2004).

Network society is the 21st century model of society that emerges within the development of the internet. This model is evolving rapidly, so we cannot yet identify either its characteristics or its consequences. It is true, however, that all the above have had a drastic influence on the evolution of urban mapping and have brought an revolution, which is not a revolution of the means of representation (as it was in the 20th century due to GIS), but rather a revolution of information (Corner, 2014).

The 21st century was also been characterized as *century of complexity* by the great British scientist Stephen Hawking (West, 2017). It is a common scientific fact that many phenomena are complex, reflecting a radical change in the way we view the world and the emergence of a new way of describing phenomena applied to natural organisms, society, the internet and cities. A complex system consists of multiple interconnected parts that interact in non-linear ways, co–operate and are self–organized, causing chain reactions that transform local into global behaviors and formations, resulting eventually in the emergence of innovative properties (novelty) overall in the system (Heylighen, 2008). The connection of the city with complexity is not recent. The roots of 'complex city' can be traced back in antiquity, in myths, descriptions and archaeological sites, such as the renown Knossos Palace labyrinth in Crete and the non-geometric urban cores in the Middle Ages. The dawn of the complex city concept is placed in the industrial revolution era and the unprecedented population and spatial expansion of the city. But the understanding of the city as a system of organized complexity has been established after the mid-20th century. Since then, many urban studies have been produced based on complexity mathematics, such as urban fractals and cellular automata (Batty & Longley, 1994). Shortly, geographers and cartographers developed tools for recording and representing urban complexity data, such as is the layered representation of thematic maps. As urban theory describe it, urban complexity appears due to the constant interaction of diverse factors, such as demographics, transport, ecology, housing, ecology, economy, culture, networks, urban morphology, and becomes more complex due to the perceptual diversity of urban landscape. Urban complexity, however, can be traced both in the actual content of the physical urban environment (which, as we already explained includes myriads of elements, obvious and hidden, material and immaterial) and in its intangible inscriptions and mental representations, which include data, such as multisensory, ideological, psychological, social, etc. The cityscapes that arises are moreover complex, since they project the views and perceptions of the mapping subject (the 'cartographer). From all of the above we can conclude that contemporary urban mapping is a twofold complex process, both because it maps a complex object (reality) and because it involves complex mental procedures as well as the interaction of ideas and objects.

Mapping approaches in the digital age and the century of complexity

In the last decades of the 20th century urban cartography develops its contemporary character. New approaches have being developed already in the mid-20th century that interacted with older ones and contributed to the creation of new ones. Gradually they merged and at the end of the 20th century, critical cartography emerged, a dominant approach of contemporary mapping, which borrows theoretical concepts from post–positivist social sciences in general and *critical realism* in particular. According to critical realism the causes, agencies, structures and relations are more important than the objects themselves. In that

philosophical approach urban cartography is concerned with the ontological character of social reality, the reality of the senses, the practices and experiences. It combines the quantitative with the qualitative, the explanation with the interpretation, incorporates elements of history, culture, social structures, human action and interaction, forming thus an interdisciplinary field of study (Archer et al., 2016). In accordance, critical cartography addresses a new reality, consisting of layers and interdependent processes. In this sense, it is connected with the contemporary understanding of the city as a system of organized complexity.

The reasons for the development of critical cartography lie in three historical periods: A) Modernism, where urban analysis has been used as a tool to confront the problems of population increase and urban space expansion that industrial revolution brought about. B) Early 20th century and Modern Movement, where technology improvements applied in urban analysis and design. C) Subjective turn of the mid-20th century, which following the end of the Second World War and its disasters, proposed anthropocentric approaches that focused on human beings, their senses, perception and experience. Among the basic mapping approaches of the subjective turn are: Psychogeography of Debord, developed in 1955, mental mapping of Lynch in 1960, serial vision of Cullen in 1961, sonic and isobel maps of Schafer and Southworth in the 70s and multicultural landscapes of Ventury team in 1972. These approaches interact, exchange data, merge, and through them other complex ones arise. Elements from other disciplines, such as architecture, visual arts, philosophy are added. New techniques and tools are being developed, and, as digital culture and city description as system of organized complexity becomes widespread, new mapping approaches emerge, such as critical cartography, which incorporates elements that question the traditional map, its production methods, and symbolism, and embraces new practices that combine subjectivity and objectivity, multiplicity of expressive media, that express great communication and originality.

Critical cartography contrasts with traditional practices in that it proposes *mapping* (a fluid and polysemic concept) over *cartography* (that signifies the traditional art of map making). Mapping adopts the concept and function of a subjective and perceptive procedure that focuses on human and describes the relationship of human and space through reading, observation, exploration, experience, emotional projection. Mapping values the process and the action rather than the product of the relationship between human and space (Tsakiri, 2018). It is characterized by: a) combination of scientific and artistic principles, b) mixture of urban theory practices with visual arts, c) combination of subjectivity and objectivity, facts and perceptions, quantitative and qualitative data, narrative and scientific analysis, d) bottom–up procedures, knowledge that is built gradually from the synergies of factors in local level, e) complexity, the outcome of multiple intertwined factors that reflect a multilevel complex social reality.

Among the most widespread approaches of critical cartography are: a) *subjective mapping* that records sensations, narrates personal stories and communicates personal believes and ideas, b) *creative mapping* that focuses on ways to represent data with originality or collects original, unusual, unconventional, inventive data c) *participatory mapping* that includes data collection practices that involve people through collective meetings, interviews, questionnaires, d) *cognitive* or *perceptual* or *mental mapping* that modernizes Lynch's approach through the integration of new techniques that focus on the recording of perceptual data, e) *multi-sensory mapping* that records non-visual data, f) *network and interaction mapping* that investigates the way public space operates as a network through the identification of traffic channels, and the relationships between different nodes and places, g) *neo-geography*, an amateurish production of maps by the public that is using common digital technologies, mobile applications and free-

share mapping apps, h) psychogeography that is based on Debord and the Situationist tradition, recording the unconscious and focusing on behavior in urban space without norms and rules, and finally h) *map art* which uses map as a symbol and metonymy, through which it criticizes status quo. Some of the most important features of the contemporary map that derive from its dual (digital and complex) character are: –the increase in mapping capabilities due to the digital, smart technologies that lead to a new mapping universe in which immaterial transcend the material and the maps are constantly changing as the footprint they try to record is fluid and vague, –the map records multiple, diverse and interconnected elements, –the mapping footprint is dense and complex, –the map ends up depicting the intangible "ghost" of reality; the image does not refer to spaces, but to actions that form networks, sometimes identical, sometimes not, with the spaces they are related to, –the amount of data being transferred is inconceivable (Tsakiri, 2018).

Thus, the revolution of the map in the 21st century is characterized as 'information revolution' opposed to the representation revolution' of the modern map. The contemporary map becomes a high-profile and demanding communication object with a dual role: a) quality and quantity of data and b) high visual communication.

Mapping using digital media

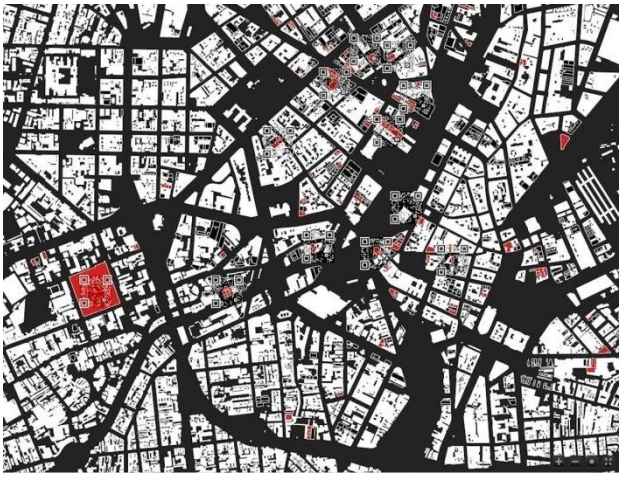
Contemporary mapping practices use digital media and reflect the dual, digital and complex character of contemporary mapping. The examples below illustrate the benefits of applying digital technology to the recording of the material and immaterial data of urban space and the thereby highlighting of cultural cityscapes. The collection, organization and management of multifarious data, the possibility of polymorphic processing, the diversity in expression, multiplicity in the representational modes, the convenience in reproduction, the ease of transportation and access to the general public, and the map production with high speed are the most important benefits. Digital and smart technology combines tools such as: a) smart devices (mobile phones, tablets, etc.) that allow the user to collect, store, share, reproduce, transfer data, or participate with other users in common data mapping programs using Wi-Fi technology, b) GPS tracing and tracking that uses GPS (Global Positioning System), and allows the correlation or phenomena with particular places, c) QR Codes (Quick Response Code), graphic code readers placed on smart devices, through which the user can access various data (metadata, hypertext), d) Google Earth and related mapping platforms that allow the user to directly supervise every point of the earth and equip them with various data, e) social networking in which many users participate and exchange data in common platforms (also called information landscapes). The examples that we will present here belong to the following categories: a) big data, which involves mapping of multifarious data, b) layer superimposition that maps correlations of data, c) ABM (Agent Based Models) that simulate phenomena that emerge through bottom-up procedures, d) geo-tagging / geo-tracing maps that correlate data to specific geographical areas, e) quali-maps, qualitative mapping of intangible data such as multi-sensory and emotions.

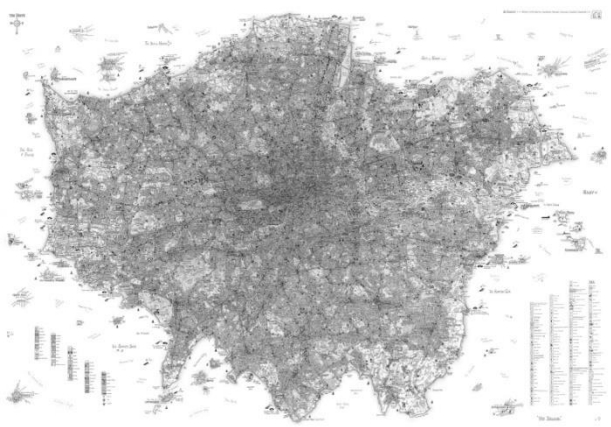
Big Data: mapping multifarious data

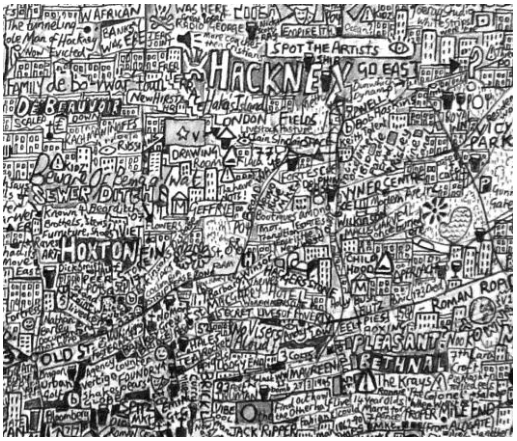
An important feature of the map is that it can record and contain huge amounts of data. For this reason, the map has been widely characterized as a compact, multi-functional object

and an information capacitor. Coding and abstraction, both common mapping techniques, are used in cartographic representation in order to graphically manage the large amount of data found on maps. Maps that depict big data are based on the realization that the urban environment is a container of multifarious elements. Contemporary cities are characterized by multiplicity that arose from the accumulation and interaction of artifacts and people in time and space. The city gradually evolved into a large-scale, complex artifact consisting of multiple complex artifacts that have accumulated in the process of an ever-accelerating evolution. Multiplicity is temporal and spatial, as each point in space is unique and the physical environment displays differentiations that become carriers of various urban forms. Consequently, urban environment is a transmitter of multiple sensory stimuli that interact with human psyche, trigger identities, emotions, thoughts, social and ideological correlations, are associated with semantic contexts, and ultimately constitute entire civilizations. Maps that attempt to visualize the multiplicity of the urban environment present detail, concentration of large amounts of data, and visual density. Nowadays the once common, conventional 'paper map' is overridden by the digital, the incorporation and representation of big data into maps is possible and common. The use of digital technology enables both the collection of data and the increase of map's capacity through functions such as QR codes, hyperlinks and zoom.

Occupying Sao Paolo map (image 1) is an example of a social map that uses QR codes as data compressors. Through them the viewer can access a digital environment, where he can get information about buildings occupied by the Occupy movement in the center of Sao Paolo. The problem of the limited capacity of the conventional map, due to its small physical dimensions is resolved by QR code technology that reveals information concerning the profile of residents and their personal history. This enriches the map with social, historical, anthropological, and political data. The map aims to bring the average map observer closer to the inhabitant who has occupied the buildings in order to alter and neutralize possible prejudices associated with the occupation of the space. In the next example (image 2) Steven Walter's psycho-geographical, black and white map of London depicts with extreme detail and density the city's cultural landscape and at the same time the way people think, perceive, experience space using a variety of expressive means, such as words, symbols, lines and objects. When the map is viewed on its original scale, it displays a patch of lines and symbols that resembles an undefined cloud, but zoom-in in the digital map reveals its rich content and large information capacity.

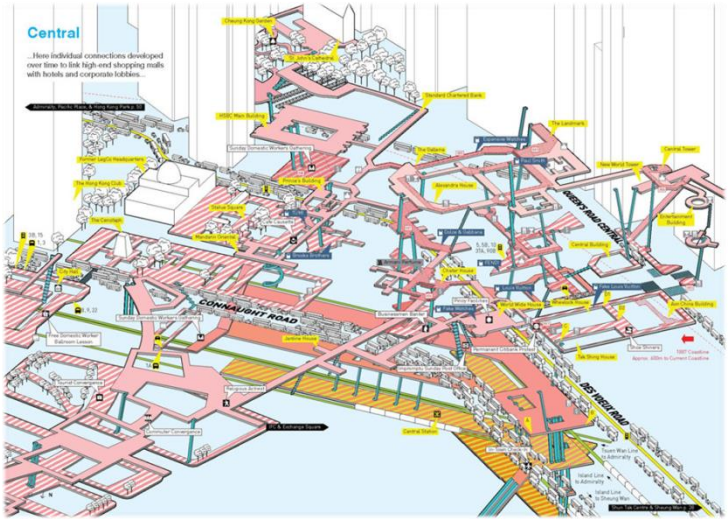




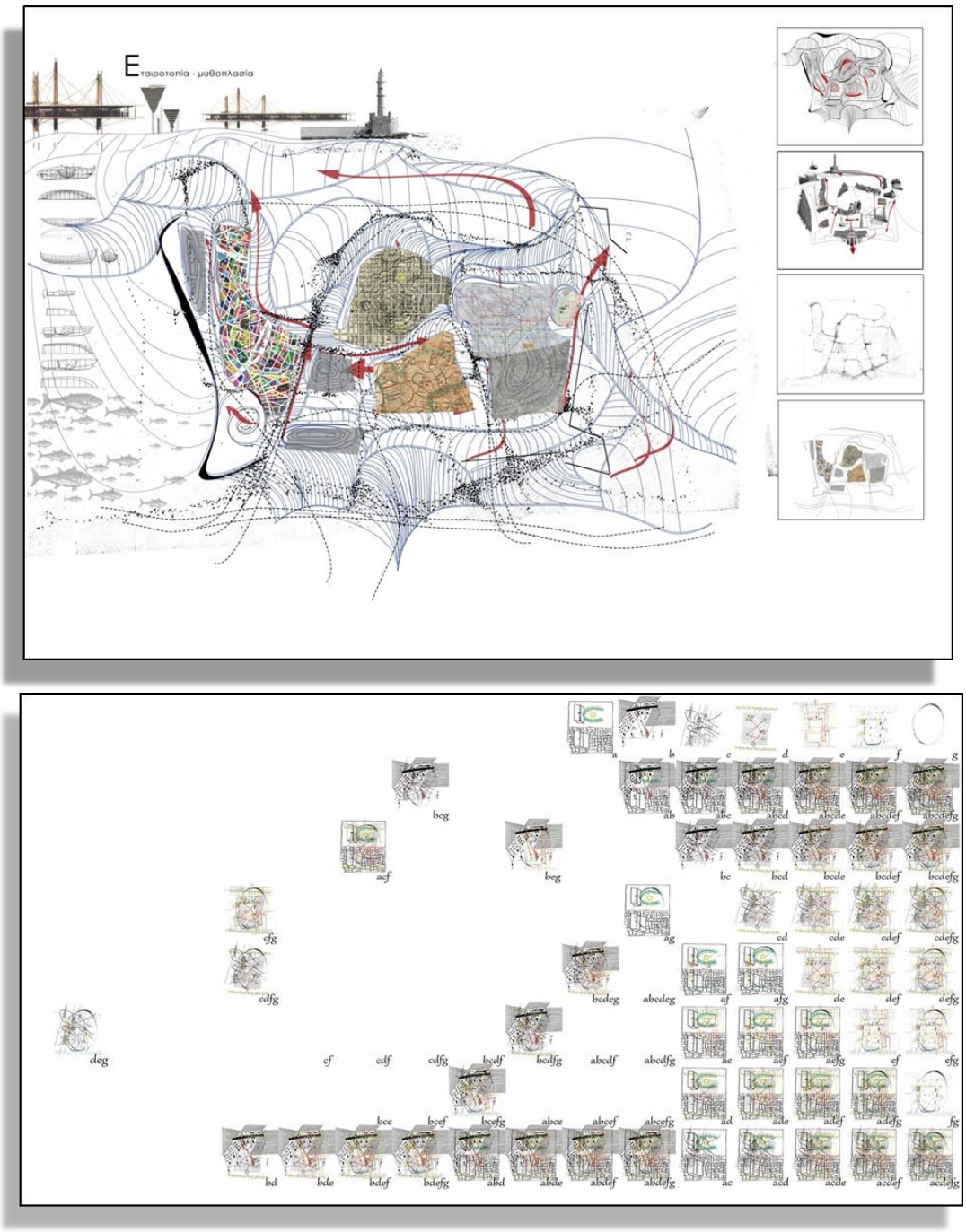


Layering: correlation or 'composite' maps

Correlation maps investigate the relationships between phenomena depicted in different layers. After the mapping process is finished, layers are superimposed and complex maps arise that reveal relationships, contradictions, concurrences, groupings, repeating patterns, similarities, differences, and so on. Composite maps that depict at the same time different elements in various layers can also be comprised of different maps placed in a common observation system (not necessarily in layers), in other words, a multi-layered system in the broad sense. Layer superimposition mapping was developed in the mid–20th century in the context of analytical mapping, which creates thematic maps (such as land use, construction date, distribution of income groups, housing types, etc.). Superimposition allows an in-depth study of space through correlations. Layer superimposition is a tool that has been originally used in archeology, where the layers account in soil stratums that are indicators and witnesses of the succession of civilizations in the same place. The similar concept of palimpsest (papyrus, parchment or generally an archaeological or historical manuscript that the original text has been scraped to write another on top of it) has been used to characterize the city, in particular the layered structure of its historical identity. Moreover it can indicate that every place can be a carrier of multiple manifestations, material and immaterial, traces of which can be found in the present and interact with contemporary elements. The composite, multi-layer map becomes vector of expression for cultural cityscapes with multifaceted references. Digital technology has contributed to the creation of a multitude of multi-layer mapping applications, tools and techniques, many of which appeal to the general public rather than to specialized cartographers. The contribution of computer-aided design programs allows the creation of three-dimensional multi-layer maps, as in the example of Hong Kong Central Metro Station, where several layers are simultaneously depicted (image 3).



The next two examples present a multi-layer cityscape mapping that has been created through a mechanism that guides the visualization of cultural cityscapes in context of complexity by combining scientific and artistic elements. *Poli-Plex-Icon* (Tsakiri, 2018) combines interdisciplinary theories, techniques and tools from sciences and arts, such as urban mapping, textual analysis, visual semiotics and layer superimposition in order to create polysemic images that incorporate elements of plan, map and painting. In *Poli-Plex-Icon*, an acronym deriving from the words *Polis*, *Complexity* and *Icon*, the various material and immaterial elements that constitute the identity of a place are collected, organized in groups, visually encoded and placed in superimposed layers. The outcome functions as complex map that includes large amount elements and their correlations. The first example (image 4), depicts Old City of Chania and has been designed by a group of students who applied the *Poli-Plex-Icon* mechanism in an architectural workshop of city research and representation. The students created layers with different mappings of Chania, such as Lynch, Psycho-geography, Cullen, Ventury, and so on. After the layers have been superimposed, composite maps emerged, that highlighted correlations among layers (as is the case with analytical cartography). In the second example (image 5) a group of visual artists that participated in a collective city mapping workshop, depicted Victoria Square. Each member of the group has been asked to write a short description or story (like the ones of the book *Invisible Cities* by Italo Calvino) for Victoria Square. Afterwards the visual artists drawn their stories into transparent layers. The layer superimposition that followed, revealed patterns, some of which stronger, and other weaker. The strong patterns dominated the visualization and this observation has been parallelized to the way place identities, although are created by a democratic way, are however biased, as there are always certain stories, narratives and ideologies that are more powerful and influence the overall impression.

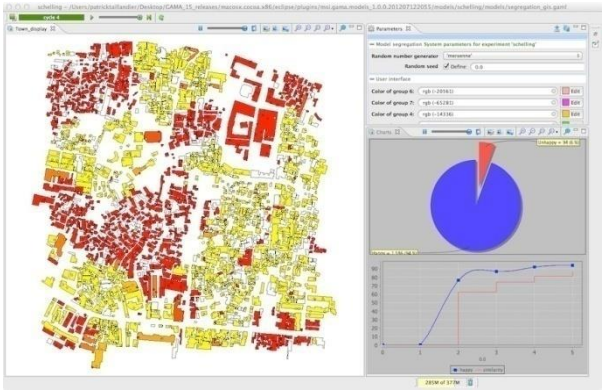


ABM: simulation maps with bottom–up procedures

Maps that simulate phenomena that arise from bottom-up processes attempt to demonstrate the evolution of contemporary city into a system of organized complexity. Complex cities tend to balance at a threshold between order and chaos, they avoid chaos and entropy by processes of adaptations to the external circumstances. The diversity, variety and uniqueness of the urban environment, the elements that form its identity, the elements which are responsible for the duration of a city over time and its resilience to changes, arise from the synergy of factors that produce self-organizing structures in the local scale (bottom-up). In order to: –examine how synergies are created –how patterns of order evolve from the small, local scale to the large, global scale and –identify which are the system's weak points that could be responsible for damages, complexity scientists designed computer programs that simulate the

evolution of the city step by step, beginning with some initial simple rules applied locally that are repeated. These are called *simulation models* and are defined as "*processes of creating and analyzing a digital prototype that duplicates a physical model so as to predict its performance in the real world*" (Peter & Swilling 2014). Simulation models are also called ABM (agent based models), i.e. models that run through agents -simple, autonomous units (information carriers) that interact either randomly or under initial laws. As the model run, they create phenomena that simulate the operation of physical complex systems (that evolve spontaneously and not through simulation in a laboratory environment).

Simulation models can be either 'hard' or 'soft' –the former use complexity mathematics and run in computers: in the following image, such a computer program is used to simulate the emergent patterns of urban land use mixtures in large UK conurbations. The model has been designed by a team of the Center of Advanced Spatial Analysis (CASA) in the Bartlett School of UCL (image 6). The input and output data are digital and have been encoded with the aid of mathematical tools. In the next image, we see a paradigm of a soft simulation model. As *soft* are characterized open scenarios, natural strategies and hand-made models. An example is *Ukrania* map by architect Jerry Gretzinger (image 7), which represents a fantastic city and consists of 3200 A4 pages. Each page is designed according to rules randomly selected from a set of 114 cards. The rules include phrases like "do the opposite", "continue in the same way", "increase density", "create a gap", and so on. Gradually, Ukrania acquires an overall shape and identity, resembling a real city. Gretzinger began designing the map in 1963 (long before the invention of ABM digital models) and lasted more than 30 years. Although Gretzinger's effort is interesting, we now realize how much the use of digital technology speeds up the process, as we can run that kind of operations in days or even hours. Essentially, the whole science of complexity and its implementation in the description of the contemporary city, has been based on the speed of digital simulation. Before that, many phenomena have been wrongly characterized as complex, only because it was difficult to calculate their multiple functions and behaviors.

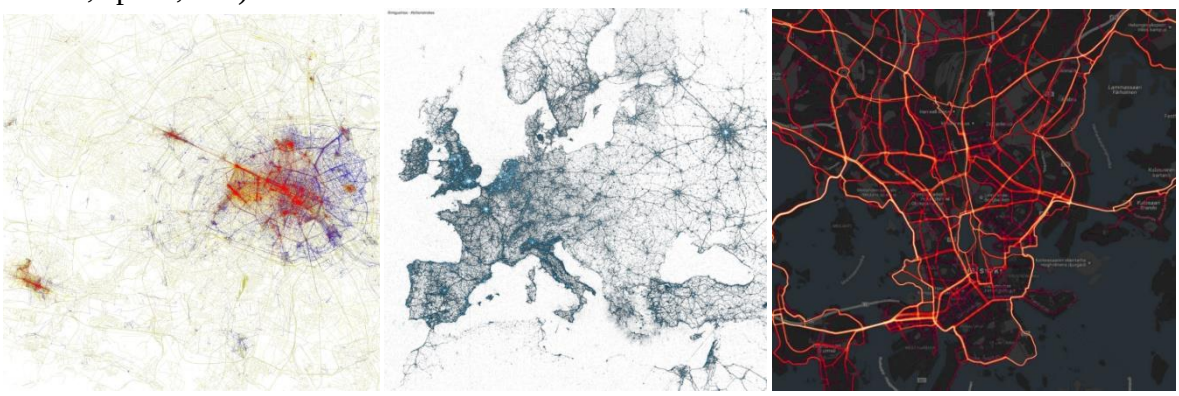


Geo-tagging - geo-tracing: geographic data correlation maps

These are maps that use *locative media*. The term was introduced in 2004 by Karlis Kalnins and describes the means used to communicate and associate digital data with specific geographic locations. There are two main practices: *geo-tagging*, where a file (image, sound, text) is linked to geographic coordinates, and *geo-tracing*, which records, tracks and represents the real-time location and movement of a user in space. The collection of this kind of data was made possible with the development of technologies such as Wi-Fi and GPS and the use of

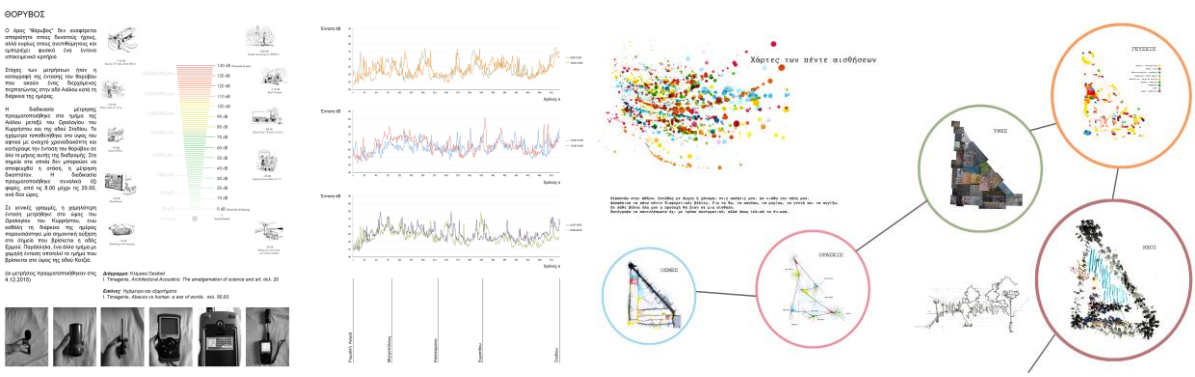
smart devices. The dependence of these data from specific geographic locations combined with various free-to-use mapping apps such as Map Maker, U-Mapper, etc., allows the mapping and production of many different maps by the public that record a multitude of data.

The geo-tagging map of Paris (image 8) depicts in different colors the locations from which visitors and residents of Paris took pictures and then uploaded them to social networks. The map indicates differences in the perception and popularity of cityscapes. The project is part of Flickr's *Geo-taggers World Atlas*. A paradigm of that database is a map depicting the tweets sent by different users from different places across Europe. These action fingerprints of social networking that are collected for years in the database, make it possible to monitor the evolution of the tweet communication patterns in time (image 9). Project Supra is a geo-tracing map that depicts real-time heat data from sport workouts (image 10), in particular the roads that are selected by groups of athletes as routes for their physical exercise (bicycle, jogging, skate, etc.). The purpose of the map is to inform the trainee about the most popular and best sports routes he chooses at any given time. Information is gathered by trainees through their geo-tracing apps in their mobile phones and is then mapped based on criteria (such as type of exercise, time, distance, speed, etc.).

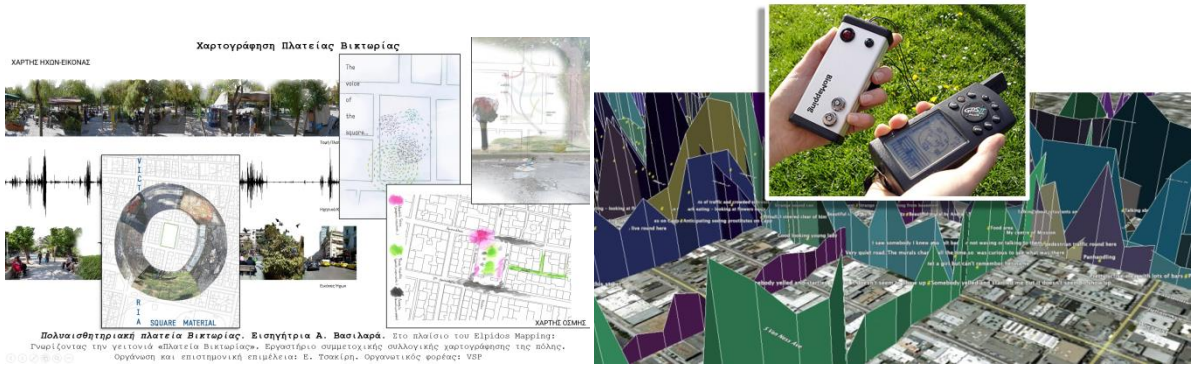


Quali-maps: maps of qualitative intangible data

The great challenge of recent years has been the mapping of the qualitative spatial data. These are data relating to senses, perception and emotions. Nowadays digital technology offers the ability to create meta-linguistic systems that can be used to decode quality data. Through specific applications the reader can recognize and assess qualities, such as sound, odor, flavor, and touch, in a similar way he can read a written text or recognize a visual symbol. A quali-map acts as a communicator of aesthetic data in a similar way a visual image or a geometric shape acts as a symbol of reality that help the user understand reality, without the need to have a direct experience. In the following examples, we will see various ways students used to depict quality data in various places in Athens: In the course *Special Topics in Environmental Design* (2014-2015) the students mapped quality elements of Aiolou Street (image 11). In the course *Urban Planning 1*, (2016-2017) the students recorded the sensory qualities of the Commercial Triangle (image 12) and in the Victoria Square collective workshop of urban mapping, the participants created multi-sensory maps of space (image 13).



Another example of quali-map is *Bio Mapping* (image 14). The creator Christian Nold maps the emotional responses of individuals to various environmental stimuli. The data are collected by combining two technologies, finger cuffs from lie detectors technology and GPS. The cuffs record the levels of emotional stimulation of the individuals, but there is no distinction between positive and negative emotions. The levels describe the attitude of the individual towards the environment, such as indifference, interest (which may correspond to liking or irritation) and deeper identification (admiration, anger). While an individual is moving and passes through certain points, the emotional responses are recorded through GPS technology and consequently they are depicted on a geographical background that creates an emotional fingerprint of space. Although there is no differentiation between positive and negative emotions, this system allows many conclusions to be drawn (Smith, 2006).



Nowadays, that digital technology has made it possible both to record and visualize qualitative data, A scientist can incorporate them in planning and in everyday applications. In odor, for example, digital technology has done a tremendous progress in recording, representing and technically reproducing smells (image 15). In contrast to vision, hearing and touch, odor along with taste belong to the category of chemical senses, whose exact function in the human body is not yet fully understood. In consequence it has not yet been possible to digitize them in the way this has been possible with sound and visual image. Electronic nose, and the recently introduced bio-electron nose are various inventions that aim to investigate possible ways of modeling and reproduction. The technology for the emission of odor on promotional brochures has recently evolved together with the use of sensors in mobile phones that warn for pollutants in the atmosphere through the technology of "electronic nose", while the diagnosis of illnesses has been made possible using a technology with fiber optic bundles that mimic the epithelium of the nose. By means of digital technology, odors are already being used in security issues, such as the emission of unpleasant odors by the police for the dissolution or demonstrations, or

the similar to fingerprints odor identification of suspects. In addition, various odor libraries have been created today in order to store and save rare odors before they are permanently lost (Vasilara, 2010).

Virtual smell is the process of creating an odor stimulation according to a digital 'footprint' through a suitable electronic device using odor technology. The virtual smell device and the appropriate software makes it possible to interact with the user. Below there are some examples of digital odor mapping and reproduction. The first example is the *Beaglebone Black* micro-controller, that helps scientists to design and implement a system that is able to exploit the odor capabilities of insects (like bees, wasps, flies and butterflies). The system can be used in smuggling and explosive detection systems, as part of laboratory equipment for molecular biologists, and by scientists researching the odor modeling through insects or studying their behavior. Another technique records and archives smells that emit old books, a study that confronts these smells as important part of the cultural heritage. The 'Wheel of Odor for Historical Books', created by UCL researchers, records two kind of data for each old book: a chemical analysis of organic volatile substances that give the book its distinctive odor, and a description of the smell that visitors sense when they smell it. The first camera that captures odors instead of images and video is now a fact and is called Madeleine. Designer Amy Radcliffe has developed it using technology similar to that used in the perfume industry. Madeleine says that it works just like a 35mm camera: in the same way the conventional camera records light information and creates the photo, Madeleine records molecular odor information and reproduces them. The source of odor is placed inside the glass dome that is connected to the main part of the camera. A pump extracts the odor molecules, traps them into a specific resin socket and then sends them to the laboratory for analysis and re-production. (Vasilara, 2013). Other intelligent odor recognition and reproduction devices include Bionaire BSSP101-U Febreze Scentstories Player, iSmell, AromaJet Pinoke, etc. (image 16).

Conclusions

In conclusion, contemporary mapping approaches that record both the material and immaterial data of space contribute to the management and promotion of cultural cityscapes, mainly because they present urban environment as a container of multiple and moreover interacting elements. While data mapped by conventional mapping practices of the 20th century are restricted, contemporary urban mapping practices record large amount of data and correlations among them. Through digital technology intangible data such as multi-sensory and qualitative, emotional and subjective can be detected, recorded, simulated, processed and represented. This way, scientists can acquire a rich, real and profound knowledge of place, identify its symbolic and ideological content and see it as a comprehensive entity. Urban design based on contemporary urban mapping can take into account all diverse material and immaterial data, psycho-mental, emotional and perceptual functions of a place, forming thus a multifaceted background for the design, enriching moreover the morphology and atmosphere of the produced architectural forms.

Acknowledgments

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02 *The Island* (London), Stephen Walter (2008)
03 *Hong Kong central*, J. D. Solomon, C. Wong, A. Frampton (2012)
04 *Multilayer Narration of Chania*, group of students (2017)
05 *Multilayer narration of Victoria square (Elpidos Mapping*,) group of students (2018)
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14 *Kensington Emotion Map* – 39 participants (Bio Mapping), Christian Nold (2004)
15 *New York's Thresholds of Smell*, Kate McLean (2014)
16 Madeleine Smell Capturing Camera, Bionaire BSSP101-U Febreze Scentstories Player, iSmell, Pinoke.