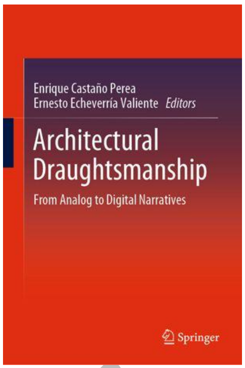
Architectural Graphic Expression not Drawn: A Digital Approach



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Abstract

Architectural Drawing and Architectural Graphic Expression (EGA) are well defined and known disciplines. But there are forms of architectural expression (such as photography or diagrams), which are not necessarily “drawings”. In the last three decades, digital technology has offered architecture multiple forms of expression (digital photography, vector models, CAD), and has proposed multiple forms of structuring and organizing data (data modeling techniques, associative data models, database systems, etc.). The arrival of these data technologies to graphic expression requires the need to look at architecture from the point of view of data.

Keywords

Architectural graphic expression; Drawing; Diagram; Representation

1. Introduction

Architectural Drawing is an ancient discipline that has accompanied construction probably since the beginning. It serves architects to express their thoughts—especially those related to architecture—and to communicate them to others (Sainz 1990). During its long history, particularly since the Renaissance, at which time it is formalized with L.B. Alberti (Carpo 2011), the architectural drawing as a discipline has been well known, well explained and well defined.

More contemporarily, Architectural Graphic Expression (AGE) has been configured as a knowledge and production area, not necessarily coincident with drawing. In this second case, explicit reference is made to the expression, and not only to the system of representation (drawing). In the past the means of expression of architectural ideas was reduced to drawing and painting, and also to scale models.

But today there are several forms of architectural expression that are not necessarily drawn: we refer to photography, collage, video, and also to diagrams, very fashionable in recent years (Bertola Duarte 2014). We can consider that most of these forms are “graphical” in the sense that rely on visual perception of elements that resemble or are assimilated to the elements of reality, and an association or analogy occurs in the eye (Hoffman 1998; Bertin and Barbut 1968).

But not every expression of architecture has a “drawn” or “representational” base: the diagram (and partially the map) does not necessarily have a representational or homothetic similitude to reality. From different disciplines (logic, philosophy, semiotics, sociology, etc.) the idea of the diagram has been proposed and constructed as a “predecessor” of thought, and a facilitator of cognitive activities. This is true for authors like A.N. Whitehead, Ch.S. Peirce, B. Russell, M. Foucault, G. Deleuze, etc. In the latter case, the diagram “does not work to represent, even something real, but constructs something real that is yet to be, a new kind of reality. It is not, therefore, out of history, but always 'before' history, at every moment in which it constitutes points of creation or potentiality." (Deleuze and Guattari 1980) And this matter has not gone unnoticed in the discipline of architecture.

Montaner (2014) makes a wide chronology of the use of the diagram in architecture, from its theoretical foundations to its operational uses, and through the theoretical development of diagramatics in postwar architecture and the 1960s. Many authors (Sperling 2004) have suggested that, at present, the diagram and architecture are closely linked, and this is achieved precisely through digital media. According to Montaner (2014), "today, abstraction expressed in diagrammatic systems, despite its ambiguities and limitations, is an appropriate instrument for an initial knowledge of reality and creation (…)". While Montaner does not give a precise definition (this seems precisely to be the problem of diagrams: they elude definition), we read over his text that the diagram is a good mechanism "to interpret vectors, phenomena and desires of reality". He also refers to Peirce, who defines it as "an icon that makes intelligible relations, often spatial, which constitute a thing."

The importance of the diagram in architecture can not be underestimated. It operates in two divergent mechanisms: in the first sense, the diagram functions as a mechanism of creation and mediation in the design process (Sperling 2004). In its second meaning, it is an abstract reconfiguration of a series of information events and thoughts, "a highly abstract, synthetic and schematic way of presenting cognition or apprehension of a problem, phenomenon or object" (Bertola Duarte 2014). Or put another way: a kind of "image of thought", a concept taken from the thought of Deleuze.

Beyond the diagram idea, which we will recuperate later in this text, we propose the term "representation" (which is no stranger to the AGE and the architectural drawing), or "architectural representation", to refer generically to the expression of all or part of an architectural element, without emphasizing its final visual form. "Architectural representations" therefore include architectural drawings and architectural graphic expression forms, but also diagrams and data-based systems.

2. The Importance of the Data Model

In the last two or three decades, digital technologies have offered to architects new forms of data-based representations which have only just begun to bear fruit: digital photography, vector models in two and three dimensions, drawing computer assisted BIM, associative models, generative systems, etc.

Although these end up, in most cases, materialized as geometric shapes or "drawn" forms, close to architectural drawing, the captured or obtained data are stored "internally" in different formats, in digital systems and networks (the Data Model, see below). We must therefore distinguish between the display of data and the "internal" and "original" structure (so to speak) in which data is stored. Think for instance in the display of a three-dimensional model on the screen of a computer, which is nothing more than a momentary re-creation of a graphic stemming from an internal data structure (Manovich 2002; Mitchell 1992).

To provide a 100% digital system to document and represent buildings, we must reinterpret the methods of expression (graphical or else) from the point of view of digital data models: there will be no computer—or digital graphic expression—without data, and no data without an underlying structure.

Digital technologies have their origin in mathematics, and have therefore placed special emphasis on data types and ways to structure and organize information. At the lowest level, the data is of integer or real type (in the case of numbers), a character or a string of characters type (for text). These types (and some others) are the smallest units of information: grouped into more complex assemblies, several heterogeneous types can create data structures (see Fig. 1).

Type	Definición	Valor
Texto (50 caráct.)	Propietario	Juan Sánchez
Num.Entero	DNI.Numero	46249937
Carácter	DNI.Letra	R
Entero (10 cifras)	Num.Cuenta	0201234528
Entero(4cifras)	Oficina	326
Real (2 decimales)	Saldo Euros	270,78
Fecha	Fecha saldo	12/09/2014

Ejemplo de tipos y datos en una "Cuenta Bancaria"

Type	Definición	Valor
Texto (25)	Nombre	Juan
Texto (50)	Apellido	Sánchez
Texto (250)	Dirección	c. Comercio 23
Texto (25)	Ciudad	Granada
Numero (5)	CP	18015
Entero (9)	Teléfono	958342788
Texto (100)	Email	jsanchez@google.com

Ejemplo de tipos y datos en un "Contacto personal"

Figure 1. Data types examples

These data structures are defined prior to their use: through a process of abstraction (or elimination of superfluous detail), the designer decides which data are necessary and which are expendable, foreshadowing the final form of the information. In addition, this data can be interrelated in various ways, depending on the design and the use to which they will be devoted. These relationships between data structures are also part of the definition of complex data structures, to put them in contact with each other (see Fig. 2). This process of defining data types and their relationships is called data modeling, and is of a vital importance in the digital world (Silberschatz et al. 1997; Hughes 1991).

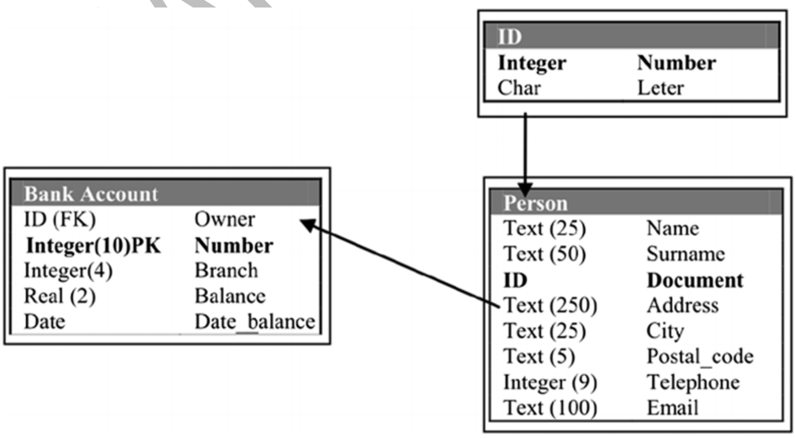

Figure 2. An example of complex relationships among data structures

Once the data model has been so defined and codified, can then the data (and only then!) be stored in a database. The database also has a predefined structure and relationships, which is merely a physical implementation of the data model explained above (Fig. 3).

Num Cuenta (PK)	DNI (FK)	Oficina	Saldo	Fecha_saldo
0201234567	46389767-R	0346	1.000.000,00 €	23/12/2014
0201234589	36789344-L	1389	2.345,35 €	20/09/2015
0201234789	35676633-S	2345	3.434,34 €	21/12/2015
...	...	...	...	...

Figure 3. A "data-base"

Accordingly, and as mentioned above, the details of any domain must be structured for their use in a digital environment. And this is also true in the field of data related to architecture (digital representation of architecture).

In the field of AGE, so far, the digital expression of architecture has had a largely graphic expression. It is the case of the well-known computer-aided architectural design or CAAD: in it, the internal (digital) representation of any architectural element is abstracted out of its geometry, decomposed and modularized, and each part or module converted into digits [the first two basic principles listed in Manovich (2002)]. In the worst case, that geometry is just a set of simple and low level data structures (lines, points, arcs, planes), with little or no relationship between them; in the best of cases, architecture will be represented by more abstract and complex structures (walls, doors, windows) with a certain association among them. This is the case of modern BIM systems. Starting from this geometry, there is a "transcoding" [fifth principle in Manovich (2002)], i.e. the ability to convert data from one format to another, this time over as a graph, which will be displayed on a "raster" device such as a monitor or a printer. However, what we finally "see" or "perceive" is nothing more than an architectural representation based on data, and converted into geometry: lines, points, planes, surfaces or solids.

As we see, much of the visual intelligence that architects have dedicated to representation is used to determine the geometry (shape) of architecture (March and Steadman 1971; Damisch 1994; Sainz 1990). The architectural drawing has a strong base in the geometric drawing, but in the process of architectural design—or representation or "rilievo" (Docci and Maestri 2009)—we generate numerous and heterogeneous information pieces, equally important for the understanding of the represented element. We generate qualitative information, such as color or temperature of a room, or the amount of noise from the street. It is true that these variables are often captured by different systems (analog, digital or mental, such as memory), and converted into number and unit. But there is in them a qualitative character that is lost in measurement [the fifth principle in Manovich (2002)]: the ability to convert data from one format to another.[1] Also, we are able to relate elements that in geometric drawing are not united: building elements linked to construction details provided by the manufacturer and available in a catalog; photographic examples of ideas or suggestions; annotations in travel

[1] See the discussion about intensive and extensive variables in Deleuze (1966) and the intelligent comment in De Landa (2002).

diaries; various forms of inspiration; notes on the construction process; etc. In other words: the cognition or apprehension of a building is much richer, more complete, more complex than what we usually deliver on paper, and especially in digital data models that have been dedicated to the representation of architecture. These data models are clearly too poor or insufficient for a holistic knowledge.

Also, the history of a building is inseparably linked to its author and its context; to the circumstances in which the building was commissioned, planned and carried out; to the subsequent amendments; and to all the circumstances and contingencies it has suffered in its use and ownership. All this information is often left "in the pipeline", lost in the drawing by the inability of our systems to represent and capture them. Geometry is too analytical and too abstract to give historical, cultural and semantic meaning to the representations of buildings. In this, geometry hides a problem behind its appearance of absolute intelligibility, and this is especially true in what is called "the initial phases of the design"—or the conceptual phase—in which the non-geometric data are much more abundant.

But it need not be so: the computer provides plenty of systems to collect, to "capture" and to link and associate heterogeneous data. Through a proper data modeling process architecture could be easily represented in a richer way, more expressive, and more comprehensive (Sola-Morales 2014).

3. A Proposal for Working with Data

In the School of Architecture at the URV (ETSA), in collaboration with the Catalan Institute of Classical Archaeology (ICAC) we are rehearsing more advanced ways to represent, manage and disseminate architecture, through a clever combination of data models and diagrams. Taking some existing architectural elements and drawings of them, we can complement the latter with all kinds of qualitative information, especially relational.

This is not a diagram in the sense that it is not a generative device [as referred to it in Bertola Duarte (2014)] from which multiple solutions can be derived (or "actualized"): the representation we propose has the characteristics of a medium of representation or expression.

The method used is not unlike that of rilievo architettonico (Docci and Maestri 2009), although the means and instruments used are different:

1. First, we studied the object and data field in which it is inserted. We discover what information is relevant to better represent the object, and list it on paper. We also try to understand the history, structure, shape and the vicissitudes of the building through comprehensive documentation.
2. Based on these initial observations and knowledge, we decompose the work on a number of variables and a set of relationships using the method of Entity-Relationship Diagram (E/R diagram) (Chen 1976) and its extended version (Teorey et al. 1986). The

EER diagram generates a proto-data model, easy to implement in a relational database (Microsoft Access in this case, for ease of use and access).

3. After the initial definitions (which already take into account necessarily the knowledge of the object) we proceed to data collection. This is the most laborious part of the process, and representing more effort. Geometrical data (dimensions of space, etc.) are collected through traditional survey and with the use of topographic and laser-scan stations; other data is manually collected through observation and in situ completion of cards, which are subsequently incorporated into the database; graphic information comes from photo shoots, and help explain some of the visual elements; finally, other forms of "data" are associations between data types and values that are manually entered based on the information available, so establishing relationships between data, from observation and understanding of the user, gives semantics richness. This is the analytical process of a research project, but the same methodology can be applied to architectural restoration or maintenance activities, emphasizing to the creation of assets or heritage management tools.
4. The last step, no less laborious but resolute, is the visualization of data collected by one or more graphics or graph software. In this case we use different options, but above all Visual Understanding Environment (VUE) and PAJEK. An initial ignorance of what the software can render makes this implementation a kind of discovery process, which seeks the way, the "language" (so to speak) that makes the graph better explain the architectural element, and in a most rich way. Depending on the capabilities of the software, we can add photos, text or items to each node of the element (see Figs. 4, 5, 6, 7 and 8).

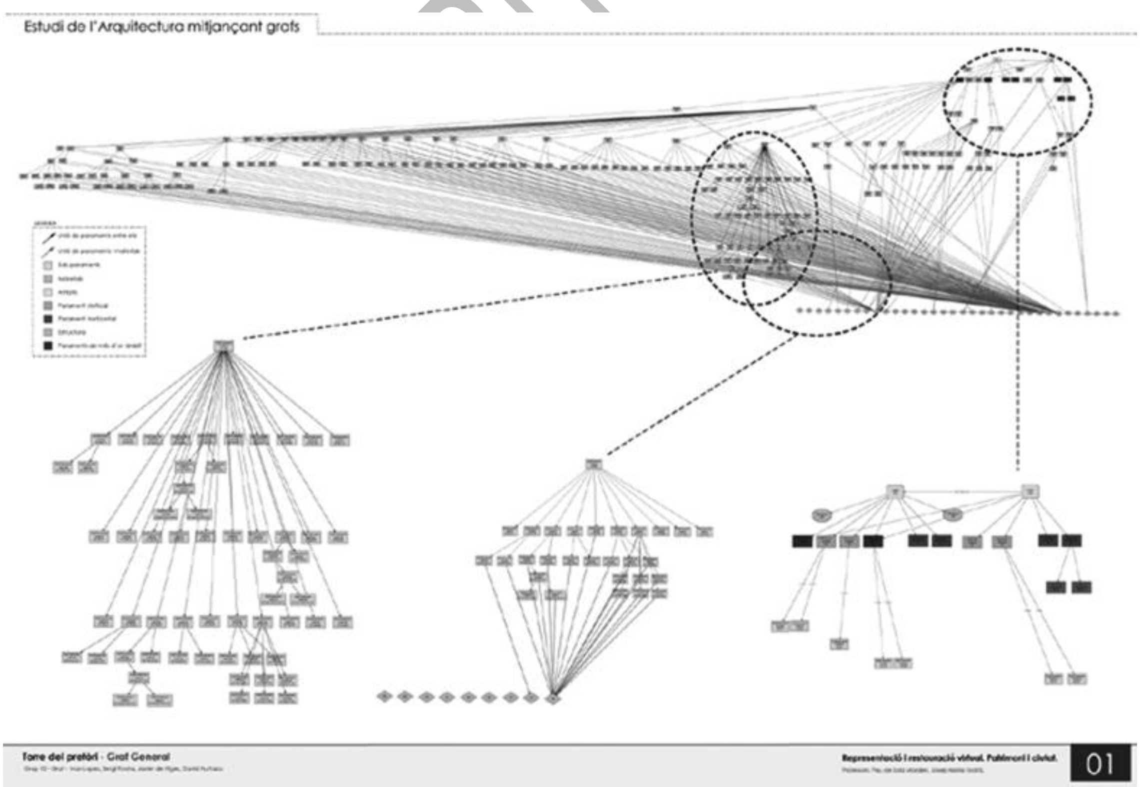

Figure 4. Stratigraphical diagram of the Tower of Pretori

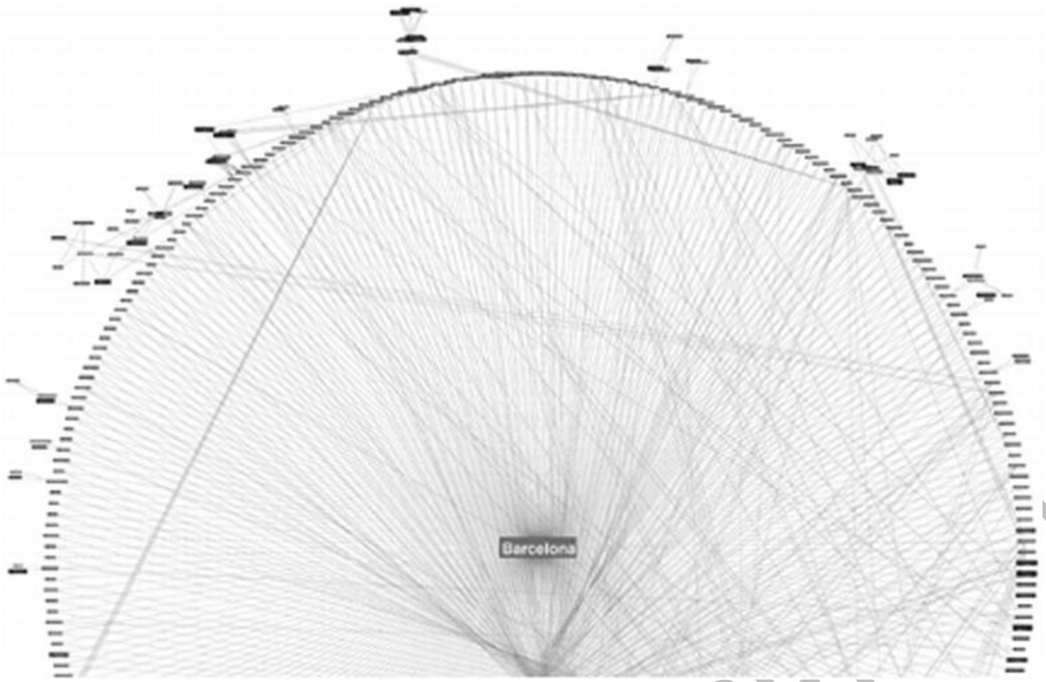

Figure 5. Distribution of buildings by place

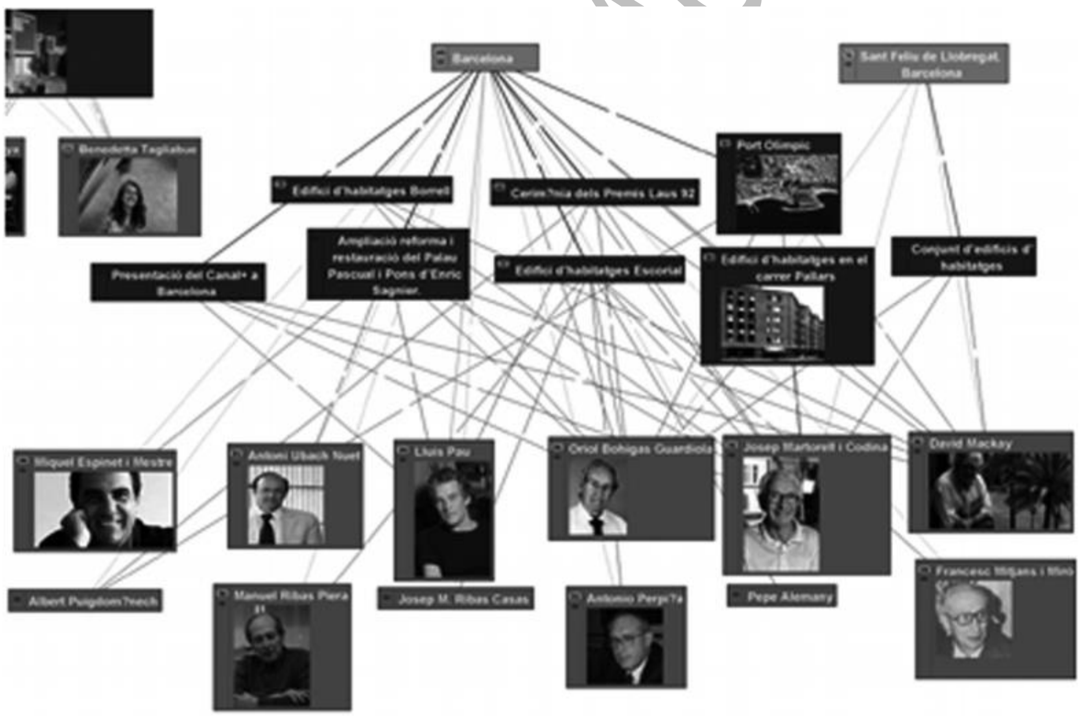

Figure 6. “Author” photographs inserted in the nodes of the diagram

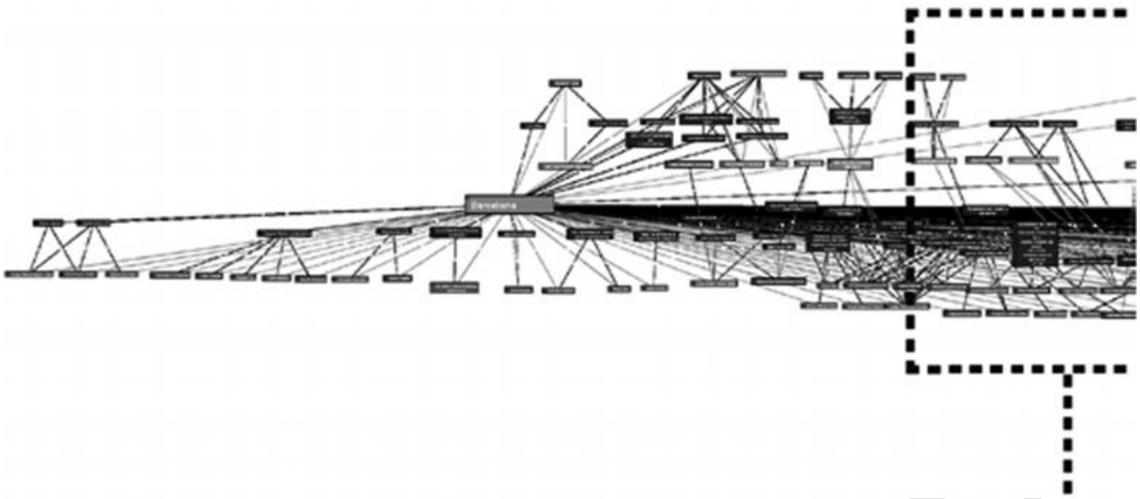

Figure 7. Detail of a diagram

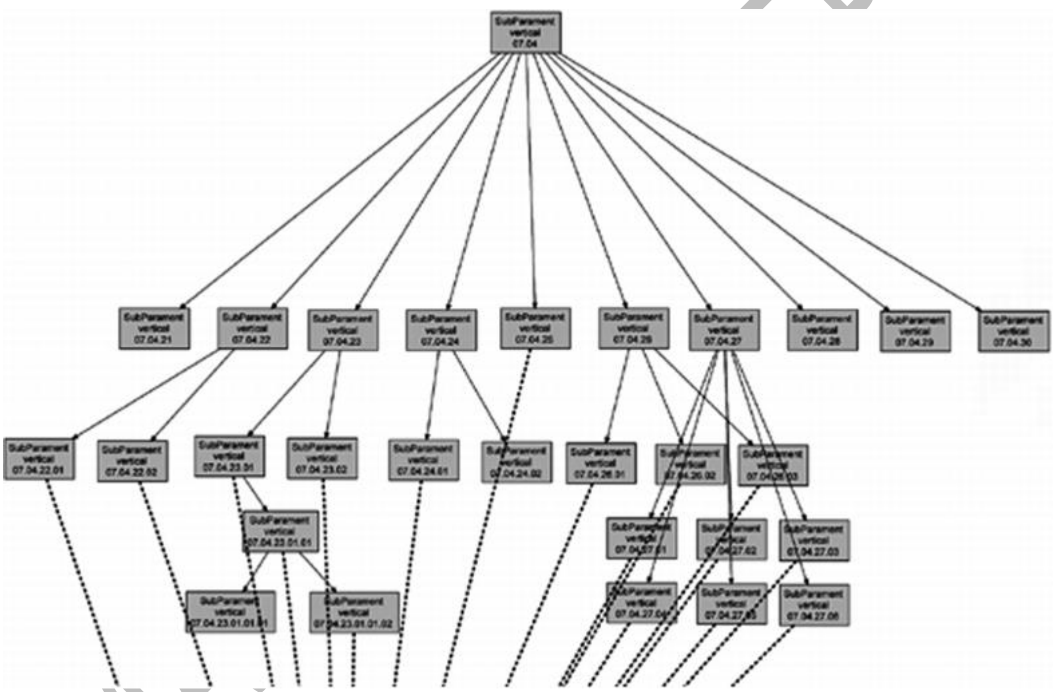

Figure 8. Detail of the diagram of the vertical stratigraphy. Torre del Pretori (Tarragona). ETSA/ICAC 2015

5. As a final step we evaluate the result and, as a consequence, do several iterations of steps “4. Viewing” and “5. Evaluation”, until satisfactory (visual) results are reached.

4. Presentation of Two Examples of Application of the Method

In the images of Figs. 5 and 7, we have tried to represent the architectural landscape of the city of Barcelona between 1960 and 2000, showing the main buildings, and the leading architects and architectural firms (authors), interrelating with each other and with the places where they are, their dates of creation, mutual partnerships, etc. Although the database is not exhaustive, some interesting results can be viewed from it with this method. Some of these results are trivial, such as: “most buildings are based in Barcelona” (Fig. 5). But we also discovered that some architects are central in Barcelona’s architectural discourse of the post-Franco era (Fig. 6). Although this is a well known argument to the architecture historians of the Catalan capital—and to anyone who knows the context of contemporary architecture in Barcelona, the graphic display or the indirect discovery of this phenomenon out of raw data is not as clear. That is, the proposed method “draws” or shows diagrammatically—as was expected, some non-geometric, non-quantitative concepts that would otherwise only be retained in the memory or be expressed in text, ¡but not draw!

In the other case presented (Figs. 4 and 8), the building of the Roman tower of Pretorio, in Tarragona (Spain) was taken as an example. The tower has been documented by the ETSA and the ICAC in successive campaigns between 2008 and 2015. The building, now a museographic space belonging to the History Museum of Tarragona, is actually a stairwell between the Roman circus and the representation square of the former headquarters of the Roman province, reused as a medieval castle, with many contemporary restorations (Vinci et al. 2014). The end result is a cubic structure of 29 m long and 23 m wide and high, incomprehensible to the public due to its long history.

Students of the ETSA undertook a laborious data collection process, akin to vertical stratigraphy, well known to archaeologists in the sub-discipline of Archaeology of Architecture. This method consisted in using cards and photographs to document each and every walls and sub-structures of the building, and in particular its relative location (A in B, B in C, C to D, D with E, etc.). Although accurate geometric features or their exact topographical location was not known, the walls can be described with absolute independence of it. This description is based on its material composition, relative situation, technical characterization and temporal location.

5. Discussion and Conclusions

The collaboration between architects and archaeologists has proved very positive: each has contributed its know-how and methodologies and knowledge was exchanged. We recognize that there are many and very complete software packages for 2D and 3D CAAD in the market for the representation of architecture based on geometry. With this innovative method of representation focused on data we can approach architectural visualization without depending entirely on the geometry of the object. We have seen how it is possible to express some features of any architectural object—including geometry, and make descriptions thereof beyond its form and the traditional forms of representation (based on the drawing). Furthermore, we have shown how it is possible to enhance the representation of architecture, adding information (data) and relationships between the pieces.

In both cases presented, we have found some difficulties that must be appropriately explained. Out method results in a tedious job, with no possible automation: as a novel method, we need to create data structures ourselves, and this entails a lot of time. Data collection, for the same reasons, is slow and complex to organize, but probably no more than other data collection systems (such as market research). What is clear is that we do not have (yet) an automated data collection protocol, and that means a certain dispersion of efforts. In the archaeological case, the objective is to rationalize the extensive descriptive databases in its diagrammatic application (Pizzo 2010).

So the result is slow but full of hope, as some features of the buildings can be "seen", as expected, that were not present in the geometric drawing, and the stratification of its representation, which mimics the relative sequence of the architectural work.

Besides, the used method and the diagrams obtained result interesting and promising, but the visual results are more difficult to understand. Specifically, we found that the architectural drawing (the "traditional" geometric pattern) is so ingrained and so well established that crossing over the cognitive barrier with the diagrams we are proposing is a great intellectual effort, even for the AGE specialists themselves. Even, some of these specialists so strongly assume that the geometric drawing is "the" means of expression of architecture, that they are not quite ready to accept a change.

In the more material and operational aspects, we have found that the software used is too generic and not specifically designed for this purpose. For this reason, it does not necessarily respond to our data structures as we hoped, but makes its own graphic assumptions instead. This involves a process of trial and error, and thereafter an adjustment to the characteristics of the software, which only serves to further complicate the visualization process.

This very preliminary experience is promising, and encourages us to continue exploring ways of "network" representations, that is, based on data and displayed in graphs. It is important that we consider the continuation of this research in a more structured way, without the haste in which we have been in this "exploration mode". We will have to continue to investigate this system of representation with other data sets of different types, to understand in which areas the sets lend themselves to data representations and interesting displays. We also have to investigate whether we can detect patterns that repeat over and over again, which could be abstracted in "features" or "attributes" or "characteristics" of the data. We believe that we can find them.

Note

This document is part of the Activities of the ArcHcrA (Research Group on Architectural Heritage and Archaeology—ICAC/ETSA-URV), and are included in the project "Técnicas constructivas y Arquitectura del poder en el noreste de la Tarraconense" (HAR2009-10752).

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