

Automated analysis of ordinary buildings and synthesis of their patterns: post-war ordinary collective mixed-use buildings in Galicia-North Portugal Euroregion

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Architectural studies usually deal with special, privileged or representative buildings and they use manual methods adapted to these cases. Thus, a double lack of research was detected: firstly, ordinary architecture was not sufficiently studied, despite its quantitative importance and, secondly, automatic methods were not used as much as in other disciplines. The study of ordinary buildings using new automated methods is then not only especially relevant in terms of knowledge, but also constitutes a perfect symbiosis of object and approach: this regular heritage, normally described as banal or trivial, has very repetitive patterns in numerous cases, and technology is particularly effective for recurrent problems on a large scale. In order to circumscribe the problem and the methods, a case study and certain technologies were selected.

Collective mixed-use buildings can be a representative case for several types of constructions since they contain housing on the different floors (with the same or different layouts), commercial spaces, offices, warehouses, garages, etc. Due to their speculative purpose, its design is normally extremely utilitarian, simple and repetitive: a tree-scheme of units of use, specialisation of spaces (corridor/rooms), minimal cells contacting the façade, and generally accepted models for each use. Collective buildings are the natural continuation of the supervisors' research, who separately studied post-war regular houses in Northern Portugal and Galicia and discovered recurrent patterns in their design. This Euroregion is particularly interesting in the second half of 20th century, because due to its underdevelopment, modernity was widely implemented in a short period of time by ancient migrants who applied international patterns in their buildings. This period is marked by the approval of Horizontal Property Law on 1955 in Portugal a five years later in Spain; since then a built explosion in inner peripheries was produced, mostly filled with collective buildings. Nine municipalities were chosen to study equal number of neighbourhoods in renovation programmes and some of their post-war buildings. GIS/CAD cartography in two and three dimensions will be treated by computer processing to extract their patterns of design. For instance, the Spanish cadastre offers massive free GIS shapefiles with the plots and their uses and another with the definitions of each building's parts (height, age, typology, quality, surface, function). This amount of data requires theoretical and practical methods in architecture to process it.

For the modelling, this research use CityGML, a standard that allow architects to simulate reality in different degrees of complexity. Buildings will be modelled on a medium scale (1:200 to 1:500) using the definitions LoD1 (prismatic extrusion solids), LoD2 (spaces below inclined roofs), and LoD0 (2D analysis, e.g. sections). These tasks can be semi-automatically done by GIS processing from a map with metadata (floors, heights, uses). In order to create an analysis model (and not a

visual representation like Google Earth), it is necessary that the algorithms recognise façades -in contact with open space- and blind walls -with adjacent plots-, and thus, these ontologies should be theoretically defined and practically programmed in Python routines.

The previous modelling is the first key, because since there an automatic assessment of physical form metrics could be implemented using Shape grammars. Thus, the model will serve to calculate technical properties for each space, depending on its geometric and built attributes. Some of them -such as light, views, sun exposure- and size constitute a classic definition of quality and are regulated by Civil Code and habitability laws.

The second key is the knowledge of the patterns of ordinary post-war collective mixed-use buildings: it can feed technological methods and, reversely, these systems can help to research these patterns. In these conventional buildings, cultural patterns define a tight range of possible ordinary solutions, then probabilistic processing enables the research of regular interiors from their shape, use, and age. Thus, a spatial and quantitative summary of each building could be obtained. This is particularly useful for standardised and regulated private uses (housing, offices, parking), where access is problematic. Shape grammars technologies can be used then to develop non-intrusive methods to estimate internal division. These automatic outputs will be controlled firstly by indirect independent information and secondly by visits of the case study buildings. These methods are the basis for further semi-automated morpho-typological classification and machine learning processes, both systems out of this research. The simulation of planning and evolutions is also possible since urbanistic norms are mainly considered in relation to ordinary buildings, and follow simple patterns which can easily be modelled.

The final objective of this research consists of obtaining a deep knowledge of recent ordinary buildings in the Euroregion and establishing some properties and qualities. The previous explanation describes technology's potentials to assess certain parameters, which can be defined as material qualities: they are objective, stable, quantitative (or vector), and determined by formulas (or geometrical processes). New technologies offer the possibility of integrating results on various scales and getting any statistic from a suitable modelling. Partial results could be semi-automatically extrapolated to bigger realities and general properties divided between the more probable participant elements. This means a change of approach: from the detailed non-integrable studies of a few singular projects, to a basic analysis of more ordinary buildings whose results can be related horizontally and vertically. In order to do this, the theoretical conception of the model and the discovered patterns are crucial, and they constitute the main contributions of the research.

Technology allows researchers to analyse more cases, more rigorously, more accurately, and in less time. As with previous technological revolutions, the development of these techniques requires research which will be returned in the mid to long-term. This study is restricted to existing buildings, but the potential is immense for the automatic generation of new architecture and urban forms. Current software like ESRI CityEngine also uses the idea of ordinary buildings and a similar modelling and highlights the necessity of research in this field.

