Franklim Morais

Trends in Language Formalization in Architecture

ALBERTI

Alberti has a very significant place in architectural history for more than a couple of reasons. It is its historical first theorization of architecture as a formalized language, condensed in its concept of *concinnitas*, that will be used as a pretext for the subject of this paper.

> ***"(...) the three principal components of that whole theory into which we inquire are* number (numerus), *what we might call* outline (finitio), *and* position (colocatio). *But arising from the composition and connection of these three is a further quality in which beauty shines full face: our term for this is* concinnitas;".**
>
> (Alberti, 1452/1782, p.135)

> ***"That means that, in Alberti, Architecture is knowledge / representation of the World as it manifests in the concrete work of art, the languages the World uses to organize itself (...). Concinnitas, as language present in Nature, is transferred to Architecture as the regulator of beauty."***
>
> (Ruivo, 2011, p.05.02).

Alberti's *concinnitas* is the exact opposite to the spread position that is very well expressed in allegedly Niemeyer's cry of war: "Architecture must be beautiful. If it functions, all the better". First, there is no escape from functioning, architecture functions all the time. And also, if we attend to the contradictory and adverse nature of life, often it doesn´t function for the better, but for the worse. Alberti tells us when architecture rises to the state of art. And that is when if functions. Not always, but when the essences of the world are not only present through the structure of the language of the work of art (which occurs every time), but when they impose themselves on us, through *concinnitas*.

Alberti's concept is not unusual in History. It positions itself in the great stream of aristotelean art theory, publicized in its Poetics (see Morais, 2007). Art is a knowledge form, a very strong manifestation of the conceptual (the essences of the World) in the concrete work of art. As in Goethe's aphorism "The law that manifests in phenomenon is elevated to art". (Goethe, 1833, p. 54).

FORMALIZATIONS

Languages

Languages are mechanisms, specific to the *homo sapiens* species, that intermediates action from circumstance in the process of human behaviour in a material (natural and social) environment. Languages are expressions of the mental representations of the material world accomplished by the human mind. Unlike other species, humans are called 'rational animals' because they have a very complex mediation process.

"between the organism and the external environment... [In humans,] another system of signalization is added: it can be assumed that this system relates to the frontal lobes ... a principle which ensures unrestricted orientation in relation to the surrounding world and ensures the highest degree of adaptation, namely science ... This second system of signalization and its organ, representing the latest acquisition in the process of evolution..."

(Pavlov, 1932, p.12).

Early languages already revealed some of the characteristics that later languages would accomplish:

- Their main function is solving problems of the primordial relation between man and environment.
- The problems are solved firstly in idea, through the language. And only later, the 'solution' is transferred to reality. "... a bee puts to shame many an architect in the construction of her cells. But what distinguishes the worst architect from the best of bees is this, that the architect raises his structure in imagination before he erects it in reality". (Marx, 1867)
- Semantic universality: it can transmit information on aspects, domains, properties, places and events from the past, the present or the future, real or possible, true or false, near or far.
- Displacement. The phrase is emitted in a situation in witch the emitter has no contact with the conditions or events to witch the message refers to.
- Productivity. The creation of new phrases in the language is accomplished with a limited set of elements. Those new phrases have an informational content that cannot be deduced from the ancient phrases.
- Arbitrariety. The signs used in the language are not programmed in the genes of the species. The decoding codes of other animals are genetically programmed. (Harris, 2004, pag. 183-207)

Theories

The development of human languages conducted to formalization. Those formal languages enable the production of theories. Theory is one of the forms of knowledge – a mental representation of the material reality, explicit and with self-conscience – but has some unique characteristics, not only as a product, but also in its production processes.

As product, theories are formalized linguistic structures, originated in logical-deductive sciences, populated by connotation semantics that represent the specific domain to which they refer/denotate. These structures allow the generalization of the understanding of empirical facts in a very condensed form that reflects material reality – its reciprocal action and universal connection.

The concepts of those structures are becoming more and more diverse from those immediately tied to empirical perceptions of the objects and try to search for essences of the reality, far away from our senses.

Theoretic knowledge, much more than others, is not a passive container, but mainly an active process of creation of more knowledge. Primarily by its structured integration in later conceptual concrete knowledge. But also by means of its own organization. Total explicitation of knowledge needs the inclusion of the interpretative code to be used by other languages, making clear assumptions. And theories also include production rules of new knowledge. This major advance has been accomplished some 25 centuries ago. Euclid's "Elementi" concentrated in a text the mathematical knowledge of the epoch, but also introduced 'Deduction', a powerful metamathematical method of producing new knowledge. 20 centuries later, Newton's "Principia Mathematica" not only established the theory of mechanics. It also established the first natural theory and, in the process, the 'Theory' as civilizational achievement, something to be attempted by every new science.

Formalization attained formal languages themselves. Weakly since Aristoteles, but firmly since the second half of the XIX century, languages have acquired very precise structural definitions: lexicons, syntaxes, grammars, statical, denotational, conotational and operational semantics, pragmatics and production algebras. They also acquired qualitative (and quantitative) parameters (such as expressivity, completeness, simplicity, complexity, determinism, decidability, soundness, finiteness, recursivity) that permit to assure metatheoretically the desirability of their use in the set of problems we have to deal with. In the same way, formal rules of acceptability of sentences in the chosen language do an active depuration over acceptable knowledge. Maintenance of formal coherence became a powerful tool of knowledge.

Research Methodologies

R&D is the production process of theories and is becoming a very well settled methodology, with increased formality.

It has a great commitment with a set of empirically observable facts and phenomena. The definition of the domain is one of the kernel problems of the establishment of the theory. The simple collection of samples and facts must obey to a previous hypothesis, which is followed by a very interactive and mobile definition. Even the acceptance of empirical facts must overcome a process of formal validation. We are far away from the empiristic mechanical transition from facts to theories.

To arrive to the formalised linguistic structures, a concatenation of data is not enough. Those concepts and that structure are not at all immediately given by the phenomenon of the domain. Abstraction and generalization are necessary to create the above cited structure of concepts.

Those Cartesian methods have the very bad reported consequence of narrowing the meaning of the knowledge. In the normal agenda, to generalize to further classes of phenomena, we have to abstract, i.e., to let fall more and more properties of those base entities. But the real 'magic' of Theory is that, through the establishment of a convenient structure of relations, abstraction can lead simultaneously to a very deep penetration in the essence of the material domain without any loss of generalization.

Scientific praxis doesn't culminate in the production of the theoretical abstract. They are indeed fundamental elements in the overall evolution of the behaviour of the primordial relationship between man and reality, which is not a mental and abstract relation, but an active, material and concrete one. There is no such thing as an abstract action. So theories must go back to reality.

What proves the value of the theory is not the formal coherence or the scientific esprit, but the tight adjustment to reality and the capacity of solving problems. Many theories didn't survive the rigours of the confrontation to reality, or the lack of operational capacity.

Before being thrown to the real world, theories have also to pass a severe set of tests in controlled environment: scientific experimentation. They must have the capability of 'previewing the future', previewing a set of results for a set of tests.

Finally, this idea of permanent opening to confrontation and refutation by reality and by debate is an integrant part of the scientific process. There are no immutabilities based on faith, dogmas, 'magister dixit' or obscure oracle-type speeches. And also that mistakes and errors happen and are not dramatic, because they can be corrected.

STRUCTURAL TECTONICS

Structural engineering is one of the domains in the architectural *ars* and tectonics *téchné* where formalization acquired a particular importance quite early, primarily through infinitesimal calculus and field theory. Its development has suffered all the pains of growing up, thus having a great diversity of very interesting stories to learn from.

The construction of a fundamental theory

The definition of the theory had to pass through several theoretical *tour de forces*, epistemological cuts in the domain and radical abstraction from apparent reality.

Ups and downs of the epistemological cuts

The resistance of the buildings is dependent on three factors: construction, materials, and form. Since Vitruvius, where the 3 aspects maintain an amalgamated whole, history of structural theories is a fight for isolation of one resource – form or geometry. The first to fall was the constructive production, compelled to find the better production methods to do the job well done. And nothing else.

To arrive to the present paradigm, where structure theory has geometry as its central resource, liberating it from material, was a much trickier process, with many moments – Galileo, establishing the complete different role of material-substance and material-shape; Navier, separating the C (absolute elasticity) of Euler in C=ExI with I, dependent on shape and E, dependent on the material.

Sometimes there is an oversimplification. Statics won a general theory of structures based only on the concept a single magnitude – force. Soon, structural theory had to recognize that it wasn't enough, and had to introduce a new concept – movement and relate it to force in an amazingly fruitful concept – energy.

Some other times, the problem is the inverse, Navier elasticity's theory (1821) was based upon an atomistic theory of matter. But Cauchy, in 1822 proposed another elasticity theory only based on some abstract concepts as infinitesimal stresses and strains. Later, Lamé demonstrates that they are two syntaxes for the same semantic. Nowadays we use the Cauchy formulation. It once more liberates structure from material. The atomistic view of Navier (in 1821) was, of course, wrong. If we insisted in that dependence, our theory of structures would be founded, now, on quarks and leptons. But those exclusive concepts of stresses and strains fit so well in our practice that we are not required to walk in such overcomplex paths.

Penetrating into the essence of reality

Field theory in structures has three working formulations: "compatibility of displacements", "virtual work" and "minimal energy". This last one, for example, is defined in a single equation. It would be difficult to do better in abstracting and generalizing without any lack of concreteness. Although absolutely general and abstract they don't loose any semantic power. It's what theoretical science do – it provides us with the 'great narratives' that allow mankind to control its future. So important they are, that when some visionary defended the minimal energy principle some centuries ago, he could end his days burning in the fires of the Inquisition.

SPACE SYNTAXES

Space syntaxes are one of the established new formal methods for architecture. For the development of some lines of thought in this text, I'll use (el-Agouri, 2004). Using the core concepts of Bill Hillier theories, the author develops a noteworthy work.

At first, a little presentation of its operational semantics, and then some important remarks.

Presentation

- **Delimitation of samples**
  The object of study is the city of Ghadames, but in comparison with other cities of the world and of Libya. In the city there are three set of studies – one global, one related to genre distinction (ground floor as men's domain and first floor as women's domain) and the last with an analysis of nine small--area neighbourhoods with 3 different libyan communities – arab, barbar and tuarg.
- **Construction of initial lexicon**
  From the actual places a large set of space measures will be retained – the first denotation lexicon, with immediate reference to reality: distance, visibility and so on.
- **Construction of derived concepts**
  To those first elements of the lexicon, the successive formerly constructed concepts of the space grammar will be applied, for example grid convexity.
- **Concept representations**
  Those concepts are measurable quantities. They can be represented either numerically or graphically.
- **Anthropological theories validations**
  Comparisons have been made with other figures, in the world and in Libya. Formal connotation/internal semantic is confronted with denotational/external semantic established with anthropological theories – genre and ethnic studies. For example there are differences in parameters like accessibility, control or intelligibility that have strong relation with those sociological concepts of privacy and segregation.

Remarks

The first remark is about the intense commitment to reality through empirical studies. We have seen that when a science is trying to establish itself, or in crises scenes, the evolutions are made with a very strong dive into the realm of reality.

The second and related remark is that general theory is applied deductively in the case study, and simultaneously is submitted to proof by the case study. Empirical and theoretic come together in the knowledge effort. And complementary, one must note the humble and very scientific way in which the shortcomings of the method and the required future research are presented and discussed.

The third remark is about the sophistication already reached by the connotational semantics. Its concepts have a high degree of abstraction and generalization. It defines basic concepts such as axial lines or built areas, but it 'rapidly' passes to concepts such as grid articulation, and then to convexity or symmetry and finally to integration, intelligibility and synergy. Although these concepts have still an evident denotational 'flavor', that make us 'remember' something of our current language, they add much precision, very far from the 'impressionistic' words of many 'literature'.

Fourth, these space grammars have strong relation with other sciences. Although the case study is directed to genre and ethnic evaluations, many other denotational semantics are touched. This particular case introduces even some innovation in a domain not yet studied – multi-cultural environment. Examples are natural human behaviour (the fountain is the most accessible point in the city), studies on ideologies (for example monumentality), differences between cities with organic development and more designed ones, traffic patterns, and so on. It appears to be a very expressive language.

The language identifies clearly the 'variables' that are the resources of architecture to dominate the world (of privacy and segregation). They are field characteristics – shape, size, orientation, and environmental conditions. size, shape, height, entrances and its clustering as well as public open spaces as a spatial system including dead-end passages, streets, public squares, and the relation between both these masses and volumes and barriers – walls, screens, objects, and symbols. This means that it can be a base theory for a methodology of design of the cities. But it has two great limitations: the design of the city has many other problems that the expressivity of this language, although large, is not able to fulfil. For example, traffic is not only a matter of visibility and accessibility. The other inadequacy is the analytical flavour of the theory. Although it can be surpassed, analytical languages are more difficult to apply to problems than algorithmic ones, like generative space grammars.

Sixth, this is not yet (and this 'yet' is very doubtful) a true essential theory. The kernel is yet very empirical. If it is possible to arrive to fundamental theories in such broad domains as the ones architecture deals with, as the theory of energy minimization is for natural domain, is yet to prove. Nevertheless, some theoretical basis like Hillier's of "natural movement", "movement economy", "centrality as a process" and "the city as object" are good attempts(see, for example, Hillier 1996).

References

Alberti, (1782). Della Architettura della Pittura e della Statua. (Bartoli, C., trans.). Firenza: Instituto delle Scienze. (Original work published 1452)

—

El-Agouri, F. A. (2004). Privacy and segregation as a basis for analyzing and modelling the urban space composition of the libyan traditional city. Case study: the city of Ghadames (online). Retrieved from http://etd.lib.metu.edu.tr/upload/12605560/index.pdf

—

Goethe, J. W. v. (1833). Maximen und Reflexionen. In J. P. Eckermann, F. W Riemer (Eds.). Alemanha: Cotta Buch.

Harris, M. (2004). Introducción a la Antropologia General (7.ª edição). Madrid: Alianza Editorial,

—

Hillier, B. (1996). Cities as movement economies. Urban Design International (1996) 1 (1), 41-60. Cambridge: Cambridge University Press.

—

Marx, K. (1867). O Capital – Vol.1, parte III, cap VII, section 1. Retrieved from https://www.marxists.org/archive/marx/works/1867-c1/ch07.htm

—

"Matisse 1869-1954". (1994). Lisboa: Editora Globus.

Morais, (2007). Arte: função catártica e orgânica mimética — actualizações. Proceedings of the conferences of doctorship course. 2007. Porto: ESAP

—

Pavlov, I. P. (1932). Essay on the Physiological Concept of the Symptomatology of Hysteria. Moscow: Myr.

—

Ruivo, (2011). Linguagem, Mensagem, Matéria — A Teoria da Arquitectura e o Uso Social da Formalização Linguística. Proceedings of "1st meeting in formal and semi-formal methods in architecture 2011". Porto: ESAP.

β