Systemic Design, Affordances and Architectural Profiling

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Abstract

This presentation aims at providing an overview of the design methods in systemic architecture (or systemic design) developed by a team of teachers-researchers of the Ecole Nationale Supérieure d'Architecture de Paris - Val de Seine. We will briefly outline some key notions so as to better understand the specificity of our approach, such as the concept of "architectural affordance", as well as another important concept of our design methodology that we call "architectural profiling". To illustrate our design processes, we will show some examples of interesting cases developed by students during their Master studies.

Key Words


INTRODUCTION

Our presentation plan is organized as follows:
1. The Principles and approach to Systemic Design and Projective Ecologies,
2. The Principle and Processes of Architectural Profiling,
3. Explain the emergence of places: the theory of affordances,
4. The Architectural Profiling,
5. Architectural Systemic Design and Projective Ecologies / vs / Parametric Design?

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1. **PRINCIPLES AND APPROACH TO SYSTEMIC DESIGN AND PROJECTIVE ECOLOGIES**

Since the 1990s, our research has been concerned with the science of language [A1] and cognitive science, which has led us to consider, on a general level, the issues around the morphogenesis of inhabited territories, and, more specifically, of cities and buildings, namely the manner in which the inhabited organizations were born, structured, and had disappeared – in addition to the various factors which have determined their emergence. Several of the theories employed concern the morphogenetic approach of architecture: R. Thom has dealt with the theory of catastrophes (Thom, 1989) as well as those dealing with the complexity of E. Morin and corollaries relative to systemic methodology (Morin, 2005). We found other related issues, such as the care of the territories (Ethics of Care) and phenomenological thought, rather decisive (Gilligan, 1982; Ceccarini, 2012). It was in the early 2000s, while tackling higher education in architectural studies in terms of design, that we proposed synthetic educational models of architectural design based on complex thinking and the systemic method (Ceccarini, 2004). Between 2005 and 2010 we had already developed the main principles of systemic design.

Between 2005 and 2010 we had already developed the main principles of design in the field of architectural systems. By 2014-2016, these processes had found a certain maturity in both a pedagogical and scientific level. Nevertheless, the systemic approach to architecture in France remains virtually unknown, at times even challenged, although there is no doubt that it will become main stream [A2] in terms of architectural design in the near future. For this reason, today, we join the international systemic design community to exchange both our knowledge and strengthen our institutional positions in France.

2. **PRINCIPLE AND PROCEDURE OF ARCHITECTURAL PROFILING.**

In short, the general structure of architectural profiling, as we have defined it, is very close to a model developed around 1930 by Conrad H. Waddington (Waddington, 1957), an English biologist who exchanged correspondence with R. Thom (Thom, 1983). This model, described as an epigenetic landscape (Figures 1, 2), is a metaphor of how the gene regulation modulates and regulates the development of an organism in the form of a process of channelling networks or paths (creodes).

![Figure 1: Complex interactions underlying the epigenetic landscape. (C.H. Waddington).](image1)

![Figure 2. Epigenetic landscape and Creode. (C. H. Waddington).](image2)

2.1. **The Environmental Information Column (EMC).**

The systemic structure of information processing represented spatially here in two dimensions can take on the form, in three 3 dimensions[A3], of a "creode" tube in which all the stages of...
transformations are represented. The major transformation stages leading to the production of an architectural form are the following:

The environmental information column (also known as the Environmental Genetic Code (EGC) serves as the basis for the general classification of information: it is made up of a classification organized systematically into two major sets of information:

1) The first set records the physical information composed of data: 1.1) geophysical, 1.2) climatological, 1.3) bio-topical; in the latter, human organic and physiological properties are recorded.

2) The second set includes anthropological information divided into (2.1) historical anthropological, (2.2) contemporary anthropological, and (2.3) programmatic anthropological data. This second group concerns the human and social symbolic and practices of the past, present and future, integrating the official political and social strategies and civil society. The entire environmental information column of a given context is made up of information in the form of data, diagrams and maps, systematically classified into systemic categories or levels (big-mapping). We must add to the axis of the systemic levels, the axis of the scales or scalar levels on which the systemic levels act. A third axis corresponding to the temporality linked to the transformations (or, in other words, the morphogenetic axis serving as the central support for the "creode tube") must also be added.

This informational column is used to define the identity of the study context (both physical and anthropological) during the observation (or state of the places and inhabitants). This informational column constitutes a sort of context genetic code and forms, the fundamental basis for all the design procedures, whatever their nature, whether it be programming, territorial / urban or even strictly architectural design.

![Figure 3. Environmental Genetic Creodic Tube. (© P. Ceccarini)](image)

2.2. The Genetic Creodic Tube.

For productivity reasons, the planar classification system can be synthesized by closing the information column upon itself (Figure 3). The column, thus closed on itself, constitutes a perimeter disk of systemic levels of information to which the spatial scales are concentrically added, from the largest to the smallest (+ infinity, continental, country, region, province, urbanized spaces, city, district, building structure, sector, rooms, furniture, technical components, molecular-chemical components, - Infinite). This information disc, the temporal axis of the mutations and namely: a) observation phase; (b) diagnostic phase; (c) program strategy phase; d) morphogenetic strategy phase

a) The observation phase: corresponds to the compilation of the homogeneously processed information in order to facilitate information processing and manipulation. All the systemic information levels required for the architectural process is gathered then classified according to their scalar levels. This sets up the diagnostic phase.
b) Diagnostic phase (Figure X) : deals with the interpretation of the data (data, diagrams, maps) in order to evaluate each systemic level (for example, hydrology) using the SWOT method. After processing all the levels, they are linked together, combining systemic levels of a varied and contradictory nature; this makes it possible to see the gradual emergence of information levels, which then form systems. Thus, several sets appear to establish systemic links with each other. This gives rise to the emergence of potential directions, which are emerging strategies.

c) The programmatic strategy phase (Figure X): the potential directions offered are evaluated by the different actors acting in the context of the study. Depending on their position, relationships and interests, the (hermeneutic) interpretation of the diagnosis is oriented towards a strategic formulation. The goal of the procedure is to create transparency for the decisions and the nature of the interpretations of the decision-makers, but also of civil society. From this stage onwards, one can give the guidelines of programmatic strategies but also the appropriate qualitative spatial locations where they will have to be located spatially. In this phase, it is essential to produce programmatic strategies (social, environmental, etc.).

d) The morphogenetic strategy phase: if the programmatic strategy phase is seen mainly in the form of strategic axioms, the morphogenetic strategy phase is a prominently morphological phase and the very site of the architectural morphogenesis process. One must carry out the 'reconfiguration' of the 'diagnostic' maps by making the modifications prescribed by programmatic axioms in the previous step. The "diagnostic" maps are thus "corrected" and spatially "reconfigured"; the maps of the different systemic levels, once modified, are superimposed on one another, revealing the properties of the specific spatial and territorial organization of ambient environment; this is in line with the environmental phenomenological properties of the surrounding territories where the functional programs will be located. This guarantees the right fit between ambient ecology and virtuous programming.
- In this respect, in order to carry out this synthesis operation, this virtuous appropriation invokes an essential notion of environmental psychology: the theory of affordances.

![Figure 4. Humps. Barren Land.](J.J. Gibson, 1979).

![Figure 5. Programmatic Affordances](© E. Coston, P. Ceccarini)
3. EXPLAINING THE EMERGENCE OF PLACES: THE THEORY OF AFFORDANCES

Indeed, the virtuous fit between programming and the environment is the key to the success of an adequate functional and spatial conformation, referring to the essential notion of ecological niche and the theory of affordances of James J. Gibson (Gibson, 1979). It should be noted that an affordance is a form of mutual subjective appropriation of an animal species within a specific medium of a given territory (Figure 4). An animal species "affords" a particular "place" of a natural territory, such as the latter; in a simultaneous and reciprocal manner, it "affords" the animal, in the sense that it offers the animal everything it needs to live with ease. The same goes for humans who, according to their ethnic group, do not occupy the same environment for ritualistic or physiological matters. The architectural creation is based exactly on this very notion: the apt foundation of an inhabited place is preceded by a process of affordance[A4]. This affordance process is a major key in the systemic process that we have developed here, indeed, for the following reasons:

Figure 6. Potential affordances (© L. Palatin, P. Ceccarini)

- a) The maps relating to each systemic level of the information column are intended as morphologies represented by topological figures bearing phenomenological or semantic qualities.
- b) The superposition of cartographies / morphologies makes it possible to reveal the emergence of potentially habitable niches by humans with specific needs: in other words, on the basis of their topological qualities, one can highlight the potential affordances, physiological / psychological / symbolic characteristics which are specific to each human group (Figure 6). And it is because humans spontaneously recognize these environments that emergences of inhabited places occur with their unique characteristics. Thus, it is a process of speciation of human habitable ecological niches. This then gives:
- c) The possibility of matching qualitative programs with potential affordances. Recognition of ambient environments and a good relationship with human needs produces the correct positioning of a function in a given territory (Figure 7). This is an effective affordance. This process is repeated on all spatial scales, which implies:
- d) The systematic global / local repetition of the affordances (or alignment[A5]) process. Thus, the morphogenetic operation is systematically reiterated from the largest scales (territory) to the smaller ones of the tectonic parts and components of a building. Indeed, the process ranges from the global scale and extends to the micro-local scale of technological hardware components[A6]. This implies:
- e) A continuous organic design process (or principle of spatial and phenomenological continuity) based on the variation of factors emphasizing an obvious analogy with the morphogenesis of living organisms (Figure 8). There is a homology / analogy to be found with the principle of the Waddington
paths (creodes) of and the plasticity of the forms edified in relation to the principle of epigenesis, i.e., the influence of the external environment on an organism.

Figure 7. Potential affordances and Programmatic Strategy (© S. Grifo, P. Ceccarini)

In summary, our approach to systemic design implies a general theory of architectural affordances that allows: a) the modelling of the phenomena and properties of the ambient environment explaining the phenomenon of emergence of places; b) the possibility of a virtual modelling based on the study of the general context (physical field, past anthropological fields, present and future actors[A7]) giving rise to a dynamic and phenomenological topological modelling of the structures of the future.

4. Principles and Approach to Systemic Design and Projective Ecologies

The cyclic and iterative systemic process of affordances extends from the macro-scale to the micro-local.

Thus, the process of determining and matching phenomenological fields to functional and symbolic programs can be refined by specifying each step of the scale (analogous to fractal processes), so that each set or subset is considered as a "niche", a "pocket" containing specific atmospheres which favour this or that human activity. Thus, it is possible not only to locate the scope of human activities in a judicious way [A8] but also to define their morphological envelopes with their fluctuating limits: by progressively descending to local scales, one can locate not only the atmospheres relating to internal dynamic flows but also the membranes / limits within which the tectonic-mechanical organs of the structure will be defined. The superimposition of the different affordance pockets with the appropriate functions, assembling large and small envelopes, reveal the overall shape of the structure or inhabited organism. Thus, the hierarchical process is organized in several phases, namely (Figure 9):

- a) The profiling of the organic functional forms of the atmospheres (general envelopes, local envelopes of the parts, envelopes / micro-local membranes of tectonic organs); b) Profiling of tectonic organs; c) The general organic result or the overall assembly/superposition of the envelopes / tectonic membranes; d) A continuous organic design process (principle of spatial / phenomenological continuity based on factor variation, an analogy with the morphogenesis of living organisms).
The process of the architectural morphogenesis of an inhabited territory (or a building) is organized in the form of a global Giga-cartography mapping (Sevaldson, B., 2011) representing potential affordances to both semantic and morphological. The phase of architectural profiling as such (morphogenetic process) occurs from the Prescriptive Information Column through a succession of morphological transformations (Figure 10):

a) Mapping *form-forming forces* or *formative phenomena* (natural or anthropogenic fluxes) relative to the different systemic levels of the initial situation; b) The mappings of *formed forms* that correspond to the affordances between the different types of *form-forming forces*. Their phenomenological and morphological affinities determine sets of complex forms making a system. These morphological sets can be defined as follows: b1) Morphologies of the phenomena (natural environments), b2) Morphologies of the social and psycho-behavioural dynamics, b3) Morphologies of the functional sets, uses, localization, quantification; b4) Structural morphologies (narratology,
mythology) and uses-symbolic functions; b5) Structural morphologies (grammatology, syntaxes) of architectural writing (geometry-code). These morphological categories interact by affordances between them and progressively constitute at the same time the phenomena (atmospheres) and the membranes of the organs and sub-organs of a building or an inhabited territory whatever its size; b6) Structural and tectonic morphologies. Once the organs and the general organism are defined, their affordances (or adequacies) with the building materials give rise to the members-tectonic-technological organs as such. b7) Therefore, by assembling all the architectural organs, one produces the complex shape of the building which is finalized in terms of the conventional graphic technologic representation. It will be observed that the morphogenetic architectural procedure proposed here is very close to the process of living embryogenesis as defined by R. Thom (Figure 11) or C. H. Waddington (Thom, 1988; Waddington, 1957).

Figure 10. Architectural Profiling (© P. Ceccarini)

Figure 11. Embryogenesis (R. Thom, 1988)
5. **ARCHITECTURAL SYSTEMIC DESIGN AND PROJECTIVE ECOLOGIES / vs / PARAMETRIC DESIGN?**

The morphogenetic approach of architecture that we develop here undoubtedly belongs to the world of projective ecologies as defined by C. Reed and NM Lister (2013) in their recent work with the goal to allow a restorative and caring action of human inhabited organizations. The approach of a systemic architectural design with an epistemic structure (an architectural system) is not a superficial issue but the means by which it is possible to make intelligible the complexity in which we live and in which we are called to act (Westley F. & McGowan K., 2013). There is no doubt that we will need to reform our design practices in town planning, land-use planning and architecture in line with the Brundland Report’s proposals for a sustainable world (Brundland, 1987). If systemic analytical methods in architecture are not adopted, we may doubts about the effectiveness of future buildings and therefore we would stay on good intentions without effects.

If we want life to flourish, then design practices need to change radically. It must be remembered, then, that human oecumens are nothing else-like all living forms on earth-than dynamic and changing emergences and that they are conditioned by an infinity of factors (parameters). They are only strictly living and morphological parameters which base the living and architectural forms and not the intrinsic parameters of computer software’s. But here lies the major aporia: we must not confuse the parameters (or formal operators) software that produces the new architectural forms with the natural parameter factors. However, this confusion is taking place as well as it can be seen recently with the new stylistic paradigm coined by P. Shumacher, "Parametricism", which institutes some morphological operators (Folding, Blobing, Swarming, etc.) as academic "styles". Thus, the real factors of the genesis of the inhabited territories disappear in favour of a computational know-how: the stylistic academism of the Beaux-Arts still has good days in front of him and with him, the cult of the personality of the architect demiurge in the service of princes with expeditious and reductive methods. These morphological operators are effective to produce remarkable mechanical and tectonic morphologies (Figure 12) but remain powerless as to the production of architectural forms anchored in their physical natural environment in perfect dynamic adequacy with this one. The produced phenomena are contingent; they are not the force-forms that direct the architectural tectonics (Bottom-up). *Parametricism* is a top-down reductionist approach.

Figure 12. Guangzhou Opera House. Z. Hadid, M. Shumacher.

The Morphogenetic Creodic tube that we conceive, constitutes a coherent morpho-dynamic genetic model that can be implemented parametrically, and therefore can constitute a parametric approach in terms of Systemic Design / Projective Ecologies. The parameterization is based on real
natural factors producing forms and phenomena. Such a project would have remarkable consequences because the operations made today manually, could be computerized (big data). The process can become the object of research over several decades until the constitution of a true architectural genetic synthesis in constant optimization. It is not only of a process but also of an environmental and societal purpose. Art (Ars / tekhné) and science (Scientia) merge together.

References


