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Abstract

While creative structural input has been acknowledged as a decisive parameter of exemplary designs, structural design in practice is often constrained within well-known typologies. The debate on type has been a long-standing theme in architectural discourse, the issue, however, has gained interest within the structural realm in recent times, triggered by the advent of digital tools and parametric modelling. The present study intends to contribute to this discussion by highlighting two propositions that embrace structural design as a generative practice, deviating from the typological paradigm. Though several decades apart, the works of Cecil Balmond and Robert Le Ricolais unfold a topological understanding of structure offering fertile theoretical grounds for creative exploration in structural studies. Seeking for ambivalence and delight, Balmond's informal suggests rhythm as instrumental in the ordering of structure, translating the complexity of both the ideal and the actual. In a quest for a playful approach, Le Ricolais introduces the analogy as a mediating device between the concrete and the abstract, carrying all transcending features of an idea apt to give birth to several realities. By introducing a space that lies between dimensions, these two propositions suggest a rather qualitative interpretation of the notion of structure by means of conceptual patterns, stressing its potential to serve the creative act.

Keywords: Balmond, Le Ricolais, structure, pattern, rhythm, analogy, metaphor, topological, conceptual design

1. Introduction

Creative structural input has been acknowledged as a decisive parameter of exemplary designs across the history of building structures. However, structural design in practice brings often evidence of a shortage in a synthetic rationale; mostly replicating well-known structural typologies within a deductive mode of reasoning confined in the precedent-based paradigm. While the debate on type has been a long-standing theme in architectural discourse, the issue has gained interest within the structural realm in recent times, triggered by the advent of digital tools and parametric modelling. Echoing propositions that stem primarily from other disciplinary fields – philosophy, biology, mathematics, art, … to name but a few – the discourse has shifted from the notion of Quatremere's *type* to the concept of the Deleuzian *diagram*; the *performative* comes to substitute for the *formal*. Inscribing in the projective track, the concept of type is reintroduced by discussing multiplicities rather than singularities, moving away from the *discrete* to the *continuous*; the concept of *seriality* grows out of the notion of *sequence*. "What we can learn from [population thinking], however, is a means to overcome typological thinking by understanding the organizational principle that constructs a 'many' or 'multiplicity', rather than a type and its variation." (Trummer [1]) In a constant dialogue with professional praxis and scholarly inquiry, hybrid practices operating across disciplinary boundaries come to engage in this discourse.

The present study intends to contribute to this discussion by highlighting propositions that embrace structural design as a generative practice, deviating from the typological paradigm. Though several decades apart, the works of Cecil Balmond and Robert Le Ricolais unfold a topological understanding of structure offering fertile theoretical grounds for creative exploration in structural studies.

2. Le Ricolais' analogy

Le Ricolais' figure holds a special place within the structural realm, extending beyond ordinary classification (Motro [2]). A keen admirer of scientific rigor and an aspiring amateur of the humanities, Le Ricolais brings evidence of a genuinely trans-disciplinary vision, advocating for conceptual design in structural studies (Mimram [3]). It is probably this unique combination of the broadness of knowledge of a polymath and the audacity in ways of an autodidact, coupled by the *polarized features* of his personality (Emmerich [4]), which constitutes the *unorthodox logic* of his research practices (Mc Cleary and Iglesias [5]) and the freshness of his contribution.

2.1. The quest for a creative structural practice

2.1.1. The art of failure: embracing the wonderful feeling of the unknown

Le Ricolais advocates for a certain playfulness in structural studies (Le Ricolais [6]). He likes to refer humorously to himself as a *dilettante*, acknowledging that his own research framework is rather *grotesque*, consciously favoring intuition and experience. He argues for a more *juvenile approach* that can embrace *the beauty of failure*, *the art of using failure*, thus giving space to experimentation, opening up new possibilities and, eventually, yielding meaningful results. This attitude allows him to pursue the challenges of the *wonderful feeling of the unknown*, seeking the *notion of compensation* in fields that he doesn't necessarily master.

Instead of promoting mere *inventions* of rudimentary nature, in the framework of applied research, he favors what he calls basic research – seeking to foster future *discoveries* of revolutionary character. "Revolutions are not made with systems, but with ideas" (Le Ricolais [6]). For Le Ricolais, creativity lies in the concept rather than the outcome; that's why he admits he is not interested in an application per se or even in a building; "the idea behind it may be more exciting", yielding instead several interpretations. "I think it's not so important to arrive at a particular solution as it is to get some general view of the whole damn thing, which leaves you guessing." (Le Ricolais [6])

2.1.2 The notion of the in-between: puzzling ways celebrating fusion

Fascinated by objects and phenomena that are not clearly defined, he likes to think of his work "very much like a crossword puzzle". Engaged in a constant dialogue – or internal battle, he is in a continuous quest of things that reside between the conclusiveness of science and arbitrariness of art. He acknowledges that he particularly enjoys operating in the space of the *in-between*; a domain that may not be clear in terms of objectives or methods, but is nevertheless of particular interest (Le Ricolais [6]).

Le Ricolais defies the boundaries between professions, systems or technologies. "[B]y not subscribing to a particular discipline" he argues he is able to see across and beyond disciplinary boundaries, technical constraints or typological limitations and sense the relationships between things. He even claims that this may be the very essence of his contribution; the ability to identify similarities across – presumably discrete – systems and, eventually, to suggest blurring of typologies or fusion between technologies. The paradigm of the *Radiolaria*, borrowed from Heckel's studies, is a characteristic example illustrating a hybrid configuration (Fig.1): "there are forms that encompass the properties of both stressed-skin and triangulated structures. They are just in-between: configurations with multiple holes, a perforated membrane in tension working together with a triangulated frame." (Le Ricolais [6])
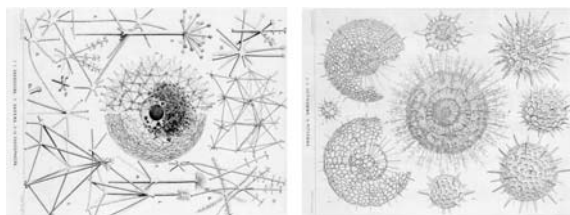

Figure 1: The hybrid configuration of the Radiolaria [E. Haeckel, A.Giltsch (engravings), *Report on the Radiolaria*, Plates no. 29 and no. 108, 1887. [Online]. Available: Wikimedia commons]

2.2. The analogy: a mediator between the abstract and the concrete

Within this context, the concept of *analogy* is proposed as a construct that transcends technologies, systems or typologies (Le Ricolais [6]). It is a conceptual device, which carries all essential features of an idea or fundamental characteristics of an entity and is apt to give birth to several realities, forms, structures or buildings. Analogy is introduced as a powerful mediator between abstract concepts and concrete reality, becoming a key concept in Le Ricolais' interpretation of the world.

This very correlation between idea and reality, between symbols and facts is what Le Ricolais calls *rapport*, a rather conceptual mechanism to describe abstract associations (Le Ricolais [6]). And though he recognizes the undoubtable power of formulas in describing relationships between things in a direct way, he is rather fascinated by the notion of rapport that may convey information in much richer, yet abstract, ways than formulas. In the same track, *symbols* become for Le Ricolais a form of abstract concepts (Le Ricolais [6]). They are coherent intellectual schemes serving as aids to extend by simplifications our understanding of the world in scientific terms – be it mathematics, physics or engineering. They maintain, however, qualities pertaining to forms of art, such as music or poetry; preserving a sort of elegance, a power that suggests a higher level of intellectuality.

Hence the relationship between the concrete and the abstract turns into a central theme in Le Ricolais' reasoning, disclosing the instrumental role of the analogy as the mediating actor. "It's *a two-way system*: we go from the concrete to the abstract, going there, going back, back and forth, and that's perpetually what I think any man has to do." (Le Ricolais [6]) However, abstract concepts are good to get one started, but one needs some connection to reality in order to go beyond. Therefore, Le Ricolais suggests that one should work with the concrete and slowly move on to the abstract.

Through the conceptual device of the analogy, abstract concepts or concrete realities may be perceived in a rather qualitative definition, shifting the focus from a formal to a relational understanding of form. Possibly influenced by his long-standing preoccupation with topology – the *rubber geometry* (Le Ricolais [7]), Le Ricolais argues that he is more interested "in uncovering some privileged arrangements of things than in working for accuracy" (Le Ricolais [6]), emphasizing the relationships between things than the things themselves. In so doing, the *combinatorial notion of arrangements* becomes a fundamental element in his system of thought, introducing a topological order in the structural realm.

2.3. The medium: conveying transcending features

Possibly confined by the conventional language of the engineer, Le Ricolais often draws a differentiated toolbox to discuss these issues, as Mc Cleary points out (Mc Cleary [8]). He employs a theoretical process of reasoning, bringing into play rhetoric mechanisms borrowed from the humanities – *analogy*, *paradox*, *hendiadys*. He seeks the symbol, the visual means – literal or figurative – rather than the descriptive representation, that will be able to convey the very essence of the analogy. The *hierogram* comes to conceptualize concrete geometries by abstraction (Le Ricolais [9]); from the actual project to a virtual illustration of an intention, from a literal representation to a figurative metaphor, translating the iconic meaning of things.

In a most straightforward way, the most characteristic example of the figurative mode – the visual metaphor – is the concept of the *stiff hollow rope* (Fig.2), translating the idea better than any possible material counterpart (Le Ricolais [6]). A favorite paradoxical fascination of Le Ricolais, the concept encompasses applications in a variety of contexts and in several scales – the most celebrated being the Skyrail (large-span bridge for urban transit); grouping under the same umbrella several series of projects, all related to the concept of the *Funicular Polygons of Revolution* (Le Ricolais [6]).

In this idiosyncratic track, physical models somehow end up as abstract material constructs without a specific content, an explicit context or a unique scale. Exemplified in the prospect of *series* (Vrontissi [10]), the physical model operates as a *tangible diagram* (Vrontissi [11]); unfolding generative diagrammatic qualities instead of merely projecting its actual features. Amplified with information of a relational order, the perceptual construct becomes a material metaphor, serving as visual means to translate a network of relationships, emphasizing their conceptual nature. It is a medium to project abstract patterns rather than concrete geometries.
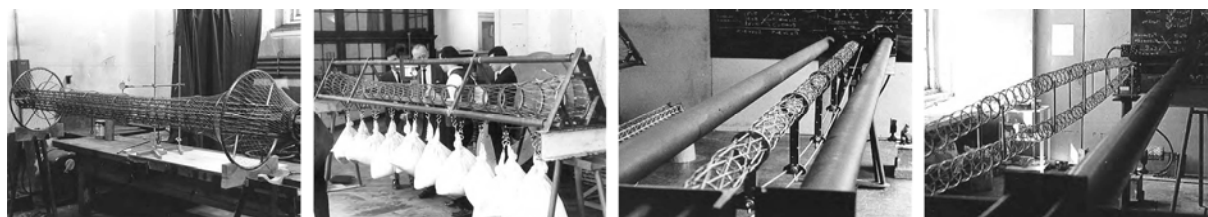
Figure 2: Physical models illustrating the concept of the "still hollow rope" [photos from Robert Le Ricolais Collection (#086) of the Architectural Archives of the University of Pennsylvania]

Le Ricolais focuses on the fundamental characteristics of an entity, the crucial attributes that remain constant through transformation. As Iglesias points out (Mc Cleary and Iglesias [5]), an understanding of structure as organization as a dynamic entity – "bearing the desire to be" – emerges. The *possible* overrides the *precise*. Le Ricolais comes to embrace Kahn's repulsion for the *circumstantial*; the detail is omitted in favor of the whole (Le Ricolais [12]). The boundary dissolves, the contour erodes; the *local accident* is intentionally disregarded in front of the *general theme*. While the exact sciences focus on the notion of *measurement*, for Le Ricolais, the study of form is associated with the notion of the *non-measurable* or even the *non-métrisable*. Juarez highlights Le Ricolais' focus on internal topological arrangement rather than external form, advocating that in his system of thought, *disposition*, as opposed to *composition*, is the very essence (Juarez [13]).

3. Balmond's rhythm

In the quest for a creative structural rationale, the work of Cecil Balmond comes to offer a track that suggests both a theoretical context and an operational framework. His trans-disciplinary profile is a characteristic feature of this proposition. "He practices within a power grid of different genres, in its own way reflecting the Renaissance image of the creative human being who combines disciplines like art, science and philosophy." (Holm and Kjeldsen [14]) By introducing ambivalence and calling for delight in structural design, Balmond's contribution stands for "both a new seriousness and new pleasures" across "a more experimental and emotional territory", triggering "a generation of hybrids of engineering and architecture." (Balmond et al. [15])

3.1. A proposition for a creative structural rationale

3.1.1. Opting for the new: the certainty of unfamiliar territory

Balmond argues for "engineering as a catalyst to inspire a creativity", while insisting on the common traits that structural engineering and architecture share – design values, methods and means. He opts for the *new* instead of the *tested and tried*; if not, "the solution cannot get away from its original reference" *(Balmond et al. [15])*. The *certainty of unfamiliar territory* is suggested as the creative alternative against the *safety of past reference*, moving away from the precedent-based paradigm, usually grounded on analytic practices, typological reference and Euclidean geometries. Balmond questions "regular framings of closed squares and rectangle" as being "[rigid] containers of an empty inanimate space"; he revolts against geometry as "a system of isolated bounded shapes"; he refuses to see structure as "a reduction and a regulation". Instead, he argues for an *animate geometry* as the catalyst to *dynamize* space.

3.1.2. The informal: unsettling hybrids yielding ambivalence and delight

For Balmond, the *Formal* is rigid, stiff, static (Balmond et al. [15]); it is founded on hierarchical configurations; stemming from fixed boundaries and "going inwards". Seeking for "control and containment", "the solutions are predictable and deemed to be efficient", organized on the basis of "an isolated repeating motif". Homogeneity is stable and comfortable. A straight-forward approach that cannot, however, prevent eventual feelings of dryness, heaviness, dullness or even boredom.

The *informal*, instead, calls for surprise and delight (Balmond et al. [15]). It embraces uncertainty, ambivalence and complexity. The informal is born from "local actions …, spreading outwards to inform

the whole". Singularities, overlaps or discontinuities are welcome in the emergence of form. Provoking hybrids are introduced to induce active engagement. The choice of the proximities is of fundamental importance in the equilibrium of the sequence; it is the interaction of two neighboring local actions that produces agitation. It is the unsettling *juxtaposition* of *local* orders that may result to a compelling *hybrid*. "Ignoring preconception or formal layering and repetitive rhythm, the informal keeps one guessing." (Balmond et al. [15])

The Bordeaux Villa (Fig.3) is one of the first projects introducing the informal as a novel design strategy (Balmond et al. [13]). In Balmond's words the solution had to "hover", to "set the mass 'free'", introducing a fragile balance, answering Koolhaas quest for "a mass to levitate". The notion of *launch* is proposed to suggest a precarious instability, conversely arguing for the conceptual metaphor as the theme of the building structure. The proposal brings into play "a skewed tension to the solution". "A precise danger point" is introduced by breaking the symmetry of the supports by means of two operations: displacement in plan and inversion in elevation. The informal takes place; the unsettling juxtaposition of two local interdependent orders yields a hybrid configuration, generating sensations of ambivalence, surprise and delight.
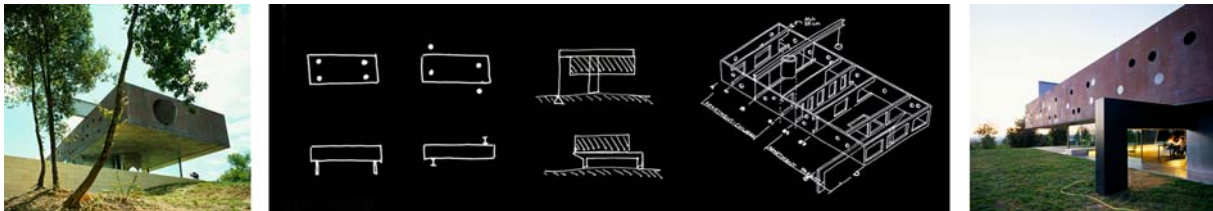

Figure 3: R. Koolhaas & C. Balmond , Bordeaux Villa, Bordeaux, France, 1998. The informal is introduced by breaking the symmetry of the supports. [© Hans Werlemann (photos) and Balmond Studio (sketches)]

3.2. Rhythm: the ordering of structure

If space is *dynamized* by structure, then the *ordering of structure* is decisive to the synthesis (Holm and Kjeldsen [14]). *Rhythm* becomes instrumental in the arrangement of the configuration; "rhythm itself is the character of the piece". Elements that have embedded in them "varying notions of time and distance" – such as gaps, slips, folds, jumps, agitations or subversions – induce active engagement by introducing transformation, acceleration or tension. The control of the serial projection becomes the focal point of this approach. Balmond's *animate geometry* is introduced as "a catalyst for change, making a network rather than a static map." The key is in the manipulation of these relationships. The synthesis – as the "hope of prediction" – lies in the handling of the juxtaposition of the adjacencies. "What makes one work better than the other is whether, below the surface as it were, there is *hidden organisation*." Chance, opportunity and impulse are welcome, but, as in all improvisation, there may be "no certainty of outcome", but there is mastery in the background. What may be perceived as a random arrangement is in fact the outcome of a rigorous plot of the underlying network of relationships.

For Balmond, *pattern* is the concept that illustrates this *punctuation*, the rhythm of the sequence (Holm and Kjeldsen [14]). Hence, pattern becomes a fundamental means to this approach, as a tangible, yet abstract, construct that serves to translate the complexity of both the real and the virtual. And while its effectiveness lies in its perceptual power, simplicity is the key feature to its efficiency; the simpler the pattern, the larger the sample of interpretations, the richer its generative potential. Balmond's particular interest in pattern lies in its generative potential, its capacity to serve the creative act, conversely highlighting the projective nature of his approach.

"Pattern is a mediator between metaphor and certainty" (Holm and Kjeldsen [14]). It is the bridge between the idea and the event, between symbol and measure, between concept and actuality. Pattern expresses the intricate association of "abstract note to tectonic form", conversely unfolding Balmond's threefold system of thought; *metaphor – pattern – object*. "In every concrete object we see a pattern … and from pattern we construct *metaphor*." A complex reality may be reduced to a simple pattern and a possible metaphor may rise from one. "Back and forth the game is played - from the concrete to abstract - the bridge between being pattern." (Holm and Kjeldsen [14]) And it is in this very aspect, that the

instrumental role of pattern is revealed; it is *a two-way device*, serving both reflective or projective operations.

Pattern is born from repetition; it is generated by the multiplication, mix and overlaps of local concepts. The *algorithm* is the multiplier that leads from unit to pattern, while the end product depends on the extent run of the algorithm. "In the instruction of the unit is the information for the whole." Whereas the local actions may be made by chance, patterns – "seemingly random, but structured" – occur across an orchestrated feedback loop, depending on the chosen starting point of the evolution process. The form emerges as a network; "a complex system with *self-similarity* at all scales" is born from the iteration of patterns. In Balmond's words, "*serialisation* takes over". (Balmond et al. [15])

3.3. The medium: suggesting possibilities

While pattern emerges as the fundamental mediator between *surface layers* and *hidden codes*, the *diagram* offers the appropriate vehicle to translate this link between the actual and the virtual. An image may provide visual input and a sketch may support a reflective interpretation, however, Balmond's diagram is an operative vehicle. "The pattern … is tree-like, a diagram of branching contingencies." (Holm and Kjeldsen [14]) It serves to initiate projective interpretations, as a tangible construct to activate the mind's eye "in abstract readings" by extracting "emotions and memories". In this context, Balmond's diagram inscribes in the Deleuzian track as professed across the work of Bacon; the diagram sustains sensation, yet it needs not to result in proliferation; it "suggests" possibilities rather than facts. "The diagram is a possibility of fact - it is not the fact itself." (Deleuze [16])

The diagram indeed encompasses multiplicities, however, it cannot be overloaded. It translates complexity, but it ought to remain simple. "Seeing complex features, we may draw a simple diagram." (Holm and Kjeldsen [14]) Just like with pattern, the more the simplicity, the larger the potential. OMA's diagrammatic practices may be helpful to denote these features (Deen and Garritzmann [17]). As in OMA's *Cartoon analogy*, "the process applied here is "amplification through simplification"". "The catalytic power of the diagram if associated to "directness and immediacy, purposiveness and selectiveness", just as OMA's *Fax analogy*.

However, as opposed to OMA's eventual use of the diagram in critical practices, Balmond's diagram serves first and foremost a projective praxis. As Deleuze would put it, "The diagram is indeed a chaos, a catastrophe, but also a seed of order and of rhythm." (Deleuze [16]). The diagram illustrates the generating path, "it plays a piloting role". (Deleuze [18]). However, rather than visualizing structural performance, as one might expect for a diagram operating within the structural realm, its dynamic features are rather associated with the performative aspect of time. Balmond's diagram denotes the definition and the process by which form will emerge. Deviating from Kara's understanding for the *structural diagram* (Kara [19]) – that is expected to transfer tacit knowledge, explicit to the discipline of structural engineering – Balmond's equivalent "provides an abstract model of materiality', like Reiser and Umemoto suggest (Reiser and Umemoto [20]). Just as his notion of pattern, it is *trans-scalar*; it "is a field awaiting a scale and materiality". And in so doing, Balmond's diagram retains its close association with matter, but not with materiality, insistently residing within the topological realm. Araguez comes to highlight the topological aspect, arguing that it allows for "form's patterned idiosuncracy" (Araguez [21]). Balmond's "sequences of relational templates" shift the focus on *disposition*, that is assumed to "release a sort of open order", as opposed to *composition*, that presumably "emphasizes fixity and visual considerations".

Ito's Serpentine Gallery Pavilion (Fig.4) brings a relevant example (Balmond [22]). Embracing the continuous instead of the discrete, a dynamic envelope in the form of a *net* is introduced to preserve the orthogonality of the "sharp box", however, destabilized by the distortion of the grid. The key is in the algorithm that would "impart a certain regularity in the movement." "The half-to-a-third rule" is implemented to yield an incessant spiraling square pattern for the network. Through repetition and feedback, the pattern generates the net that "wraps itself around the building". The diagram manifests itself in several scales as the pattern adjusts to the load-carrying elements, the bracing or the cladding frames respectively, while self-similarity provides the binding motif for the whole.
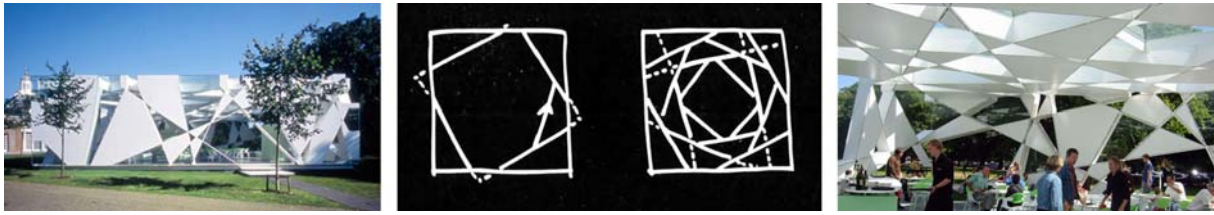
Figure 4: T. Ito & C. Balmond, Serpentine Gallery Pavilion, London, UK, 2002. The emergence of the building envelope is dictated by the rhythm of the algorithm. [© Nacasa & Partners (photos) and Balmond [22]]

4. Structure as pattern

4.1. Le Ricolais' structure: considering the *structure of structures*

> … the intellectual evolution in progress will reach a state where the Qualitative prevails over the Quantitative. This makes it interesting to consider the notion of what could be called the structure of structures. _ R. Le Ricolais, 1973 (Le Ricolais [6])

Le Ricolais comes to endorse the *Qualitative* over the *Quantitative*. He advocates for a definition of structure that the networks of relationships of the conceptual arrangement rather than describing the geometric values of the physical manifestation. Under this light, the studies of structural forms – otherwise interpreted as structural design – may be considered as an attempt to define the *structure of structures*. In Emmerson's words, Le Ricolais, borrowing from the domain of poiesis, advocates for the concept of metaphor in the structural realm; celebrating structure as conceptual pattern.

> For dreamers like himself, structure thus transcends purely material contingencies acquiring a quasi-poetic force. It is the key to harmony an instrument generating reflexions, inversions, repetitions, rhythms and rhymes, creating metaphors - or metaforms - deep down inside us, like a process of morphological metastasis. _ D. G. Emmerich, 1994 (Emmerich [23])

4.2. Balmond's structure: following *deep structure*

> Understanding such improvisation is to follow, as in jazz, the hidden element. … Behind the patterns, beneath the strange affinity of abstract note to tectonic form, lies deep structure. _ C. Balmond, 2007 (Holm and Kjeldsen [14])

For Balmond, the study of structure is an act of discovery, it is about "pattern recognition" (Balmond and Ellingsen [24]) As pattern becomes the fundamental vehicle for ambivalence and delight, the *hidden organization* gains a primary role in the process; the concept as underlying metaphor becomes the very essence that conveys multiplicities and spurs creativity. Balmond's approach is evidently projective, it reveals, however, a high-level of conceptual awareness disclosing a reflective understanding of the beauty of *deep structure* vs. the aesthetics of objecthood.

4.3. Structure as mediator

Across a discourse that is founded on the trans-disciplinary paradigm – employing numeracy, literacy or graphicacy as a mixed mode of inquiry – the notion of structure unfolds as a mediator rather than outcome, eventually disclosing formal, syntactic or semantic aspects.

Koolhaas proposition on diagrammatic practices may be employed here to welcome the concept of metaphor in the structural realm; endorsing the conceptual origins of structure.

> … operating mechanisms … or organising principles … an interaction of elements, which are conceptually 'charged' by means of analogy and association. … The metaphor is instrumental in organising the components of a project. _ OMA, 2010 (Deen and Garritzmann [17])

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