

Boosting Creativity Skills & Innovation in Architectural Design Process Using Multimedia

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Abstract— Within architecture, generative design can be defined as the approach of developing applications, or systems which can develop, evolve, or design architectural structures, objects, or spaces autonomously depending on emerging circumstance. This paper tries to add additional design tools to support the existing design tools, to be based efficiently on perceptual actions that are important in the design process. It is a loop design method starting from shapes that are transferred to music, then extracting the parameters of this music into components related to those shapes. The out-coming musical components will be parametrically controlled in order to obtain newly generated music. The modified music shall be transferred back to shapes, materials and light in a pool of alternatives that gives the designer a wide chance to visualize form generation in purely interactive and aesthetic terms. It is the concept of playing music and architecture within a multi-cognitive processes.

Keywords—Architectural design process, generative design, multimedia, music.

I. INTRODUCTION

Multimedia is the media that uses multiple forms of information content and information processing (e.g. text, audio, graphics, animation, video, interactivity) to inform or entertain the user. In architectural design process, multimedia is mainly used for modeling and simulation.

Creativity within the design process is a complex play of conversation, variation of shapes, and ideological notions within certain determined limits [1].

Integrating multimedia with architectural design processes can be used to develop digital tools applicable to the creative design process, and to generate unexpected solutions. The use of evolutionary processes marks a change in the way computers are used: designers no longer work on single solutions, but rather on processes, which have to be made explicit in order to be encoded. The designer's creativity and imagination are not restricted by indirect manipulations, or by the particular information imposed by univocal descriptions of models. The design process changes with the cognitive level.

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II. ARCHITECTURE AND MUSIC

A. The creative processes of selected music

Academic music has to become a truly interdisciplinary undertaking if it is to understand music as a human process and not as an inscrutable object reduced to the condition of the sounds that make it possible. Academic music cannot be concerned solely with works of the established canon as if these works were the "a state or process of human perfection of certain absolute or universal human.

We can talk about music's internal structure, about its symetries and directional motions, about patterns of implication and their realisation or lack of realisation. Or we can approach the music from the opposite direction, talking about the context of its creation, the context of its performance, and the context of its reception; here the assumption is that music acquires meaning through its mediation of society. Or again, we can oscillate between these two viewpoints, on the assumption that meaning arises from the mutual mediation of music and society [3].

The connections between architecture and music are mainly shared in the creative processes of structural expression and also in conveyance of ideas as an assemblage of elements in time and space-building musical structures in time and composing architectural structures in space [5].

The almost infinite creative variability that allows different artists to create radically different styles arises out of common neurobiological processes. By probing into the neural basis of art, neurological studies can help us to understand why our creative abilities and experiences vary so widely. But it can only do so by first charting the common neural organization that makes the creation and appreciation of art possible.

As Paul Klee once wrote, "Art does not reproduce the visible; it makes things visible." But visual art also obeys the laws of the visual brain, and thus reveals these laws to us.

In this sense, visual arts could turn to be the music-theoretical consequences of thinking geometrically about harmonic objects. Theorists are accustomed to describing music in discrete terms, using combinatorics and finite groups "Fig.1".

Our ultimate goal is to attempt to move geometrical ideas to the center of music theory, displacing—or at least complementing—the finite, combinatorial paradigm that has

dominated the field of multi-media for the last few decades.

Yet the notion of geometry essentially involves mathematical concepts that go beyond those that are used in discrete mathematics— notions such as continuity, “straight line,” and distance. Does a mature geometrical perspective require music theorists to master a new set of tools, and do these new tools shed new light on familiar musical concepts such as “interval” and “chord”?

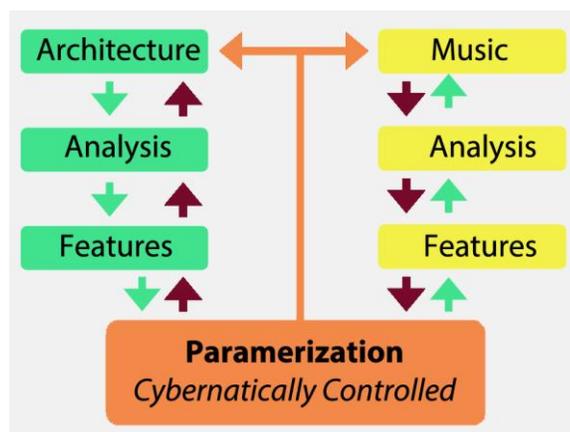


Fig. 1 Design / compose loop process

It is beyond the mere semantic links of the synonymous terminologies of each medium- structure form, line, point, repetition, rhythm, balance, space, theme (and variation), etc., that these combinations of notes into *chords* and phrases and of materials into architectural elements and assemblage occur. The connections are beyond the rhetoric of the dialogues employed to discuss and weight these artistic ideas, but rather are central to the methods and processes we employ in creating works in either medium. These elements (line, point, rhythm, etc.) are the compositional building blocks we assemble to express our thoughts, both consciously and subconsciously, in both mediums [5].

B. Case Study: The Crazy Diamond Music Center

Pink Floyd were an English rock band that achieved international acclaim with their progressive and psychedelic music. Distinguished by their use of philosophical lyrics, sonic experimentation, and elaborate live shows, they are one of the most commercially successful and musically influential groups in the history of popular music.

The main concept of the project is to convert the track titled : "Shine on you crazy diamond ", into geometrical forms, next these forms will be conerted architectural forms and spaces. This track was choosen for its lyrics content and its psychedelic progressive music. Track scale: g-minor, Scale: g a# c d d# f g.

C. Analysis of Notes Ratios for the Music of Pink Floyd and Forming Patterned Grids

The transition in rock music from dance compositions to music composed expressly for listening (the music of Pink Floyd), was realized in the work of progressive or "art" rock musicians in the 1960s and one result was the development of the record album as a genre. Roger Waters appear to have been the member of Pink Floyd most concerned with the communication of ideas. Pink Floyd were, of course, well known for the theatrical visual effects they employed during their concerts and, besides enhancing the presentation, these effects reinforced the materials meaning [8].

People enjoy the works of Roger Waters and Pink Floyd for various reasons: some for the incredible care and sophistication apparent in the quality and precision of the recordings; some for the expressive nature of the songs; and some primarily for the complexity and seriousness of subject matter with which the albums deal.

Harmonically, there existed a combination with rhythmically fluid melody, establishing a modal sound that is reminiscent for the beautiful simplicity which characterized the music of the Western world in its early stages of development. This modality, in combination with the pure sounding timbre of the lead synthesizer and its "straight" articulation of the "chant-like" melody, connotes a sense: of "musical innocence" while, at the same time, suggesting "art" music because of the imitation of orchestral instruments [8].

Understanding these sound-leading spaces requires music theorists to absorb new mathematical tools notions from geometry and topology, including the concept of a “quotient space. The essential idea of this case study was to provide a geometrical characterization of the notions “Fig. 2”. We show that in disregarding information about octave, order, transposition level, or the “direction” of motion in pitch class space, we are identifying, or “gluing together,” points in a geometrical space. This intuitive notion of “gluing together” is captured by the mathematical notion of a *quotient space* [7].

D. Pattern Transformation

More specifically, we will argue that the spaces in the patterned grids belong to a larger family of geometrical spaces that share a few essential features. A *point* in these spaces corresponds to a harmonic object such as a “chord” or “set-class.” A straight *path* between two points corresponds to a voice-leading between them, with the *length* of the path equal to the “size” of the voice-leading it represents. Consequently, the *distance* between two points corresponds to the size of the *minimal voice-leading* between the two harmonic objects. These features together imply that the graphs in the project layout can be treated in a unified way: they are all *quotients* of the same fundamental type of space,

or spaces that result from “gluing together” points in a larger “parent space.” We will begin, by showing how to translate the music of Pink Floyd (music theoretical ideas) into the language of geometry. In this case we use geometrical concepts to demonstrate the essential unity of the graphs that presents the beginning of the main theme of "shine on you crazy diamond" [8]. The music here is entirely characterized by chromatics. Besides the obvious connotation that diamonds are objects of great worth, they are transformed from one state (graphite) to another due to intense pressure in the crust and mantle of the earth. Also significant is that a diamond, like the moon, is not itself a source of light, but is, nonetheless, one of the most effective reflectors of light. All information about rhythm, tempo, timbre, and instrumentation are turned to an abstract notation encoding various types of harmonic information—information about the *order*, *register*, *absolute trans positional level*, *absolute direction of intervallic motion*, and *cardinality* of the notes in this musical construction “Fig.3”.

III. THE EMERGENCE OF NEW DESIGN PROCESS

This combination of interactivity, transformability and parametrically controlled perturbations that generate discrete structural variations within design formation processes is an emerging characteristic phenomenon of digital design. Parametric systems are becoming cornerstones in the more complex performativity digital environments. Within the framework of these behavioral characteristics, the body of theoretical concepts related to parametric formations includes adaptability and change, continuity, proximity and connectivity [9].

In digital design, design is conceived in terms of processes’ models. Furthermore, in certain generative processes of digital design the formal implications of the concept of representation are negative and unproductive. The usage of formal concepts such as: typology, generic knowledge, concept formation, conceptual design, *parties*, etc. have been rejected by many theoreticians. Topological representation of form and the use of animation and morphing as digital processes in design are replacing the conventional theoretical basis underlying architectural design.

Design generation without categories of form requires a new definition of the concept of form. Here the distinction between form and process, form as a static description and formation as a dynamic process, becomes significant. Digitally generated forms are not designed or drawn in the conventional way, instead the designer constructs a generative system of formal production, controls its behavior over time and selects forms that emerge from its operation. This principle of generation is a process that leads to the ‘emergence of form’ and is currently driving the shift from the ‘form making’ to ‘form finding’, and that was the process applied in the project: "The Crazy Diamond Music

Center", based on the music of Pink Floyd.

AFTER RESEARCHING WHAT NOTES SOUNDED PLEASANT TOGETHER PYTHAGORAS WORKED OUT THE FREQUENCY RATIOS (OR STRING LENGTH RATIOS WITH EQUAL TENSION) AND FOUND THAT THEY HAD A PARTICULAR MATHEMATICAL RELATIONSHIP. THE OCTAVE WAS FOUND TO BE A 1:2 RATIO AND WHAT WE TODAY CALL A FIFTH TO BE A 2:3 RATIO. PYTHAGORAS CONCLUDED THAT ALL THE NOTES COULD BE PRODUCED BY THESE TWO RATIOS AS $(3/2) \cdot (3/2) \cdot (1/2)$ GAVE 9/8 WHICH IS A SECOND AND SO ON. (PYTHAGORAS THEORY OF FREQUENCIES).

DO RE MI FA SO LA SI DO
 1 9/8 5/4 4/3 3/2 5/3 15/8 2
 C D E F G A B C

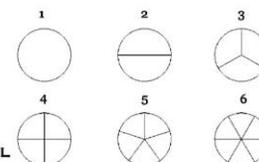
SCALE SHIFT:
 G A B C D E F G

MAIN RATIOS: CHORDS
 1:1 9:8 4:3 3:2 5:4 (CHORD)

PART 2: SACRED GEOMETRY:
 HARMONICS EXPLAINS THE MEANING OF NUMBERS THROUGH SHAPES CREATED FROM INTERSECTIONS OF CIRCLES AT A CENTER OF A CIRCLE. (NEOMETRY BY WAELE)

CHORD INTERVAL

Number of semitones	Name	5-limit tuning (pitch ratio)
0	Perfect unison	1:1
1	Minor second	16:15
2	Major second	9:8 10:9
3	Minor third	6:5 75:64 32:27
4	Major third	5:4 512:405 32:25 81:64
5	Perfect fourth	4:3 675:512 27:20
6	Augmented fourth Diminished fifth	45:32 64:45
7	Perfect fifth	3:2 40:27 1024:675
8	Minor sixth	8:5
9	Major sixth	5:3
10	Minor seventh	9:5 16:9
11	Major seventh	15:8
12	Perfect octave	2:1



FORMING PATTERNED GRIDS FROM THE RATIOS

TAKING 9:8 RATIO
 $2 \times 9 : 8 \times 2 = 18 : 16$
 HARMONICS WISE: $18 = 3 \times 6$
 $16 = 2 \times 8$

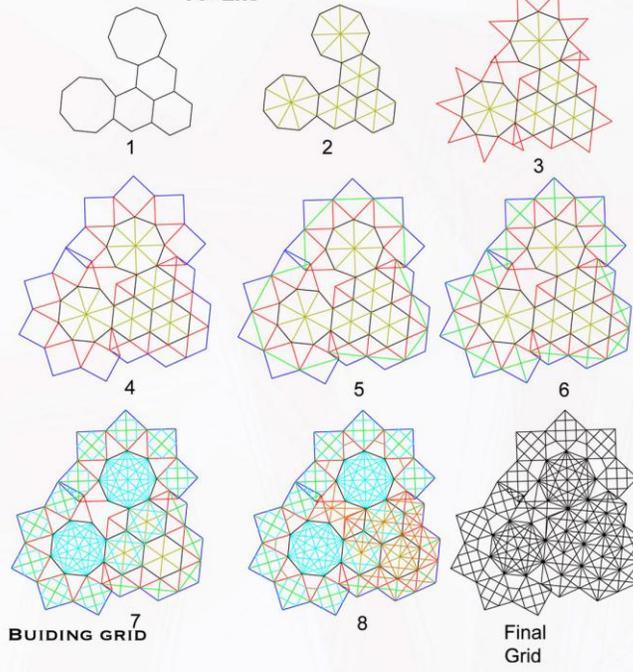


Fig. 2 Providing a geometrical characterization of the notions, project: "The Crazy Diamond Music Center"

Again, ideas of typology, generic design, precedent, or case-based design are completely antithetical to a view of design as an emergent process [4]. Emergence is a process of form finding based upon performance rather than preconceived formal content. Processes of emergent form finding are not only antithetical to the logic of form-based generation, including the centrality of representation and formal languages, they also require new modelling processes. So such models must be conceived completely differently in virtual environments.

Computer simulation is an essential tool in engineering complex structural systems. Over the last few years we have made several attempts in our research to establish and improve the link between structural simulation, evaluation and architectural design with a focus on optimization [6].

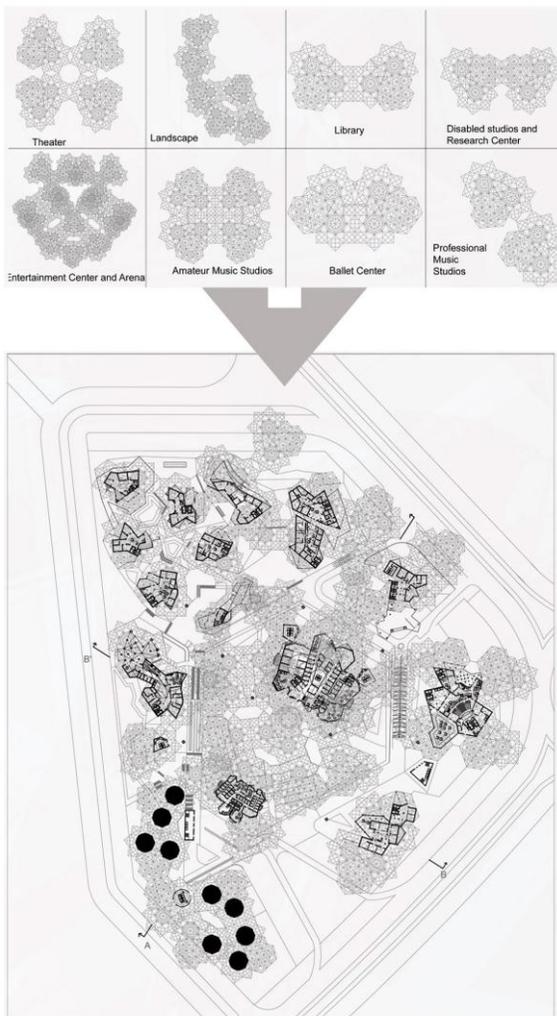


Fig. 3 The link between structural simulation, evaluation and architectural design project: "The Crazy Diamond Music Center"

Optimization is not perceived as a mere structural issue but as a negotiation process between shapes envisioned by the architect and their structural needs. Topology and geometry are not fixed but open to modification in areas that significantly exceed defined stress values. This process can be

operated by simulating and evaluating structural performance, iterative optimization and the use of evolutionary algorithms that yield solutions not achievable with conventional techniques (virtual-futures-design) "Fig.3".

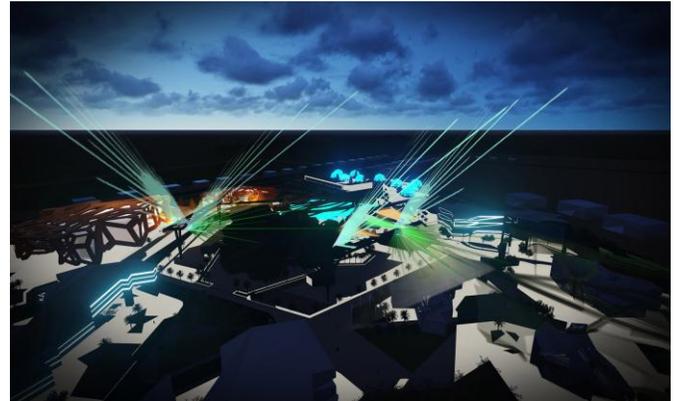


Fig. 4 Graphical music and the construction of architectural spaces, project: "The Crazy Diamond Music Center"

IV. THE NEW ROLE OF THE DESIGNER

The advent of a common graphical convention also provides a common method for analysis of a single piece of music, several works by one composer, several works within one musical style, works across several different mediums (architecture and music), and perhaps most interestingly, a single piece of music as interpreted by several performers or as performed in different voices. Graphic figures provide a permanent record to allow the analyst to recognize visual elements and patterns within the work, helping us to better understand the composer ideas [3]. A graphical music allows the compilation of visual cues to mentally construct spaces we experience in the built environment, a process not unlike the way we listen to music – compiling audio cues to mentally construct an understanding of the song structure in time "Fig.4". This process allows the listener to move beyond the temporal linear sequence of notes to develop an organization built upon the memory of what has been heard (or seen) and the anticipation or suggestion of what might happen next.

A graphical artifact also allows us to study different individual interpretations of the same composition- what makes each performed piece unique and what ties it to the composer's original ideas. This idea leads to a more specific method of composition- what exactly the author want – and, a more specific method of what is essential to the composition – what needs to be executed and in which style. The idea of pattern recognition, pattern design, and pattern modification (whether visual or audio) while significant in analysis, is also of central importance in composition, and performances to appear more "life-like" and less automated "Fig.5".

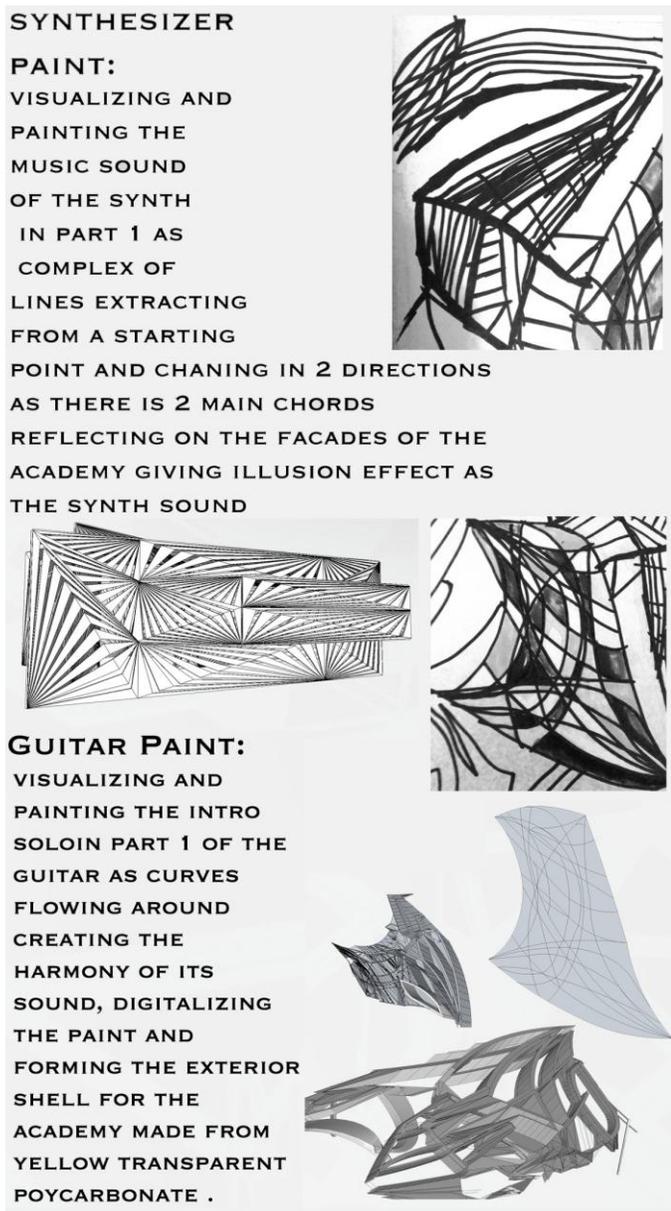


Fig. 5 Creating fully three dimensional graphic forms and spaces from musical input

V. THE DEVELOPMENT OF AN INTERDISCIPLINARY DESIGN TOOL

The development of an interdisciplinary design tool poses a unique opportunity to explore the advantages different mediums of expression have on our work “Fig.6”. This idea goes beyond pure artistic expression, relating as well to the way our mind work in processing and organizing the information we acquire. An interdisciplinary design tool allows us to look at this phenomenon not as a liability or blockage of talents but as an asset in providing the ability to tap into more effective modes of thought and expression.

One of these tools is the development of an interactive computer aided design/ analysis software tool “Fig.7”. a computer graphics/electronic music interface, designed to create fully three dimensional graphic forms and spaces from

musical input and to compose music through graphic compositions, where the physical dimensions of the graphic compositions, where the physical dimensions of the graphic objects relate directly to the dimensions of the musical elements, i.e., pitch, volume, duration, tempo, voicing, etc.[5].

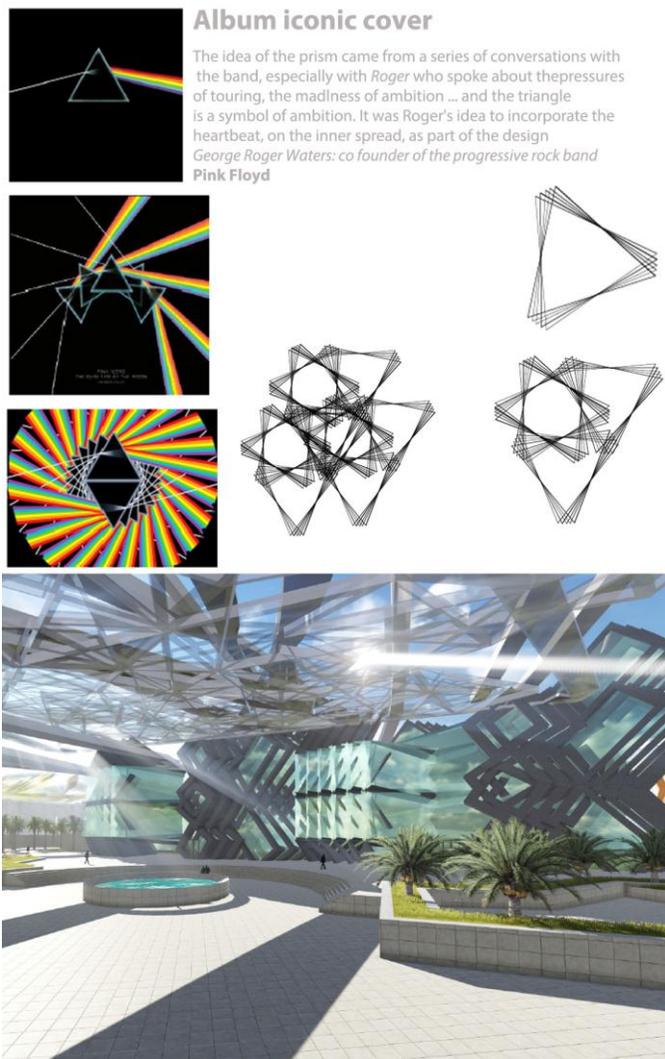


Fig. 6 The result of using of an interdisciplinary design tool, project: "The Crazy Diamond Music Center"



Fig. 7 Controlling forms in architecture through music, project: "The Crazy Diamond Music Center"

VI. CONCLUSION

Integrating multimedia with architectural design processes can be used to develop digital tools applicable to the creative design process, and to generate unexpected solutions. The use of evolutionary processes marks a change in the way computers are used: designers no longer work on single solutions, but rather on processes, which have to be made explicit in order to be encoded. The designer's creativity and imagination are not restricted by indirect manipulations, or by the particular information imposed by univocal descriptions of models. The design process changes with the cognitive level.

Music becomes an organization of elementary operations and relations between sonic entities or between functions of sonic entities. From this point of view, the architect-composer is a self-sufficient builder who decides on every aspect of the composition until the utmost detail. It is boosting creativity through a loop process and not through single process. In this strategic aspect, we could either start with music to manipulate architectural innovations, or with architecture to manipulate musical creativity. Therefore, it is a process of dual parallel analysis, extracting features, turning both music and architecture into parameters in order to cybernatically

controlling melody through forms and shapes, and also control forms in architecture through music.

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