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From atoms, to bits, to notes – an encoding-decoding mechanism for tuning our urban eco-systems

***Keywords**: urban eco-system, performance, music, architecture, encoding, decoding*

1 Introduction - Analyzing the built environment

Spatial mental knowledge processing is a research area quite favorable by many theoreticians, urban planners and architects who are interested in finding ways to effectively represent the “reading” of the city. Whether it is called spatial images (Lynch), spatial schemata (Lee), mental maps (Gould and White), spatial mental models (Tversky) or cognitive collages (Tversky) the hunt for a successful vocabulary for the city’s form has been more frequently based on empiricism. With the shift in the 60s and 70s by Kevin Lynch and Christopher Alexander towards a more human articulation of the city, a posteriori studies took the lead and researchers where prompted to base their findings on induction rather than deduction. Kevin Lynch introduced the concept of place legibility, which refers to the coherence of a place through its distinctive characteristic parts. Lynch proposed five types of elements which are essential in order to configure a city’s imageability –an other concept by Lynch: paths (linear elements on which the observer usually moves), edges (used to separate one area from another), districts (main components of the city with common characteristics), nodes (strategically placed points where people meet or use in order to commute) and landmarks (similar to nodes but highly detectable, they help people to navigate and orient themselves in the city).

2 Encoding the built environment to sound information

Analysis of a highly complex system such as our contemporary urban environment requires first an effective breakdown to its bits and atoms, the primary elements which constitute the DNA of each distinctive urban area. Following the work of Kevin Lynch, an enriched vocabulary of key urban elements and a simplified categorization has been introduced by Liapi, Parthenios and Tomara (2011) in their proposal for a methodology for translating the urban environment to music. This process of “encoding” information from the built environment to acoustic information was applied to a specific square in Chania, Greece and its subsequent acoustic result can be heard at the following address: http://www.youtube.com/watch?v=bEJmazn87cs.This translation method uses some of the rules applied by Xenakis in his UPIC system: a computer music composition tool able to translate visual images to musical output. Xenakis used UPIC to transfer his sketches and drawings to sound, composing musical works such as Mycenae-Alpha, the first of its kind.

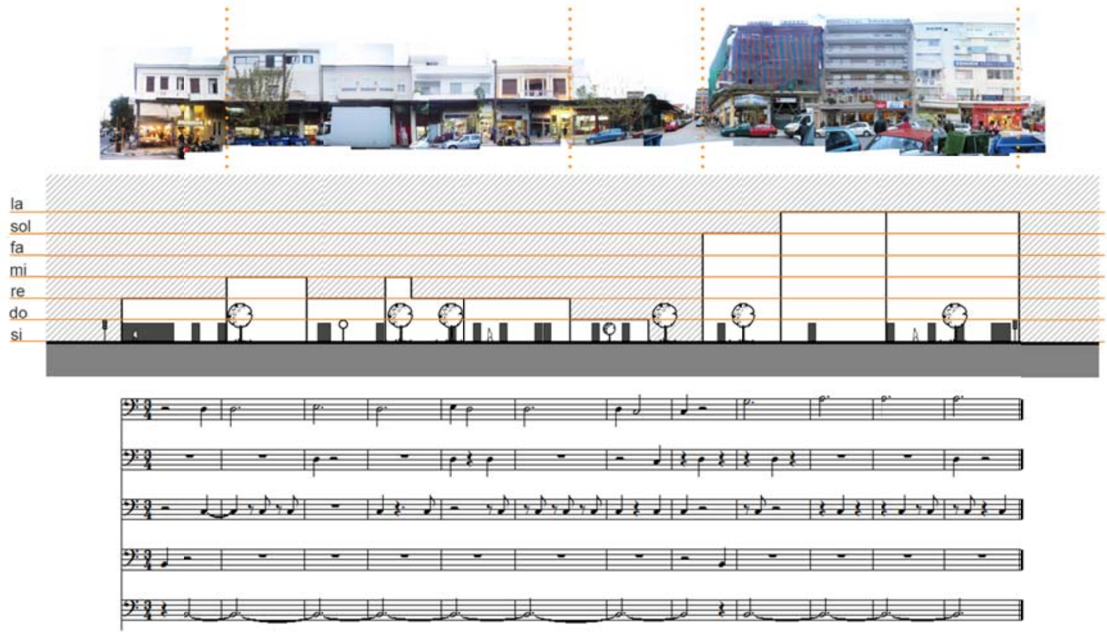

Figure 1.Translation of the western street of 1866 Square at Chania (Greece) to music. ***(Liapi M., Parthenios P., Tomara A.)***

3 Tuning through music composition rules

Continuing on Liapi's, Parthenios' and Tomara's work we see a great potential for using the translation method as a composition tool in urban design through which our chaotic urban environment could be tuned. By creating an encoding-decoding mechanism atoms become bits which become notes; these notes get tuned following music composition rules and by reversing the process they become bits which become again atoms.

The translating method is successful only when the inner relations of the urban eco-system are preserved and highlighted in the music eco-system. The architecture of the digital mediator is crucial in order for the process to be as seamless as possible. The system utilizes the MIDI (Musical Instrument Digital Interface) protocol to communicate between the graphical representation of the urban environment (a facade of the street, square, etc is first transcribed to music score) and the acoustic output.

We are currently investigating which music composition rules are most appropriate to be used when "tuning" the data gathered from the translation of the built environment. Besides subjective criteria ("this sounds pleasant", "happy", or "nice") there are different objective guidelines and tools for judging a musical composition, for example harmony or counterpoint. Furthermore, there are even more quantitative rules such as the application of Zipf's Law in music initially by Boroda and Manaris and later by Simon. A strict repetition motive might seem perfect in mathematical terms but can sound poor and boring in musical terms or even dissonant and irritating. According to Arnold Schoenberg, the establishment of a musical form entails two fundamental principles: repetition (of pleasant stimuli) and variation (of new stimulus, of change). "In the search for a satisfactory combination of intelligibility and aesthetic substance, music conveys a subtle balance of reiteration and change, of redundancy and novelty, of recurrent shapes and fresh figures” states D. H. Zanette.

George Kingsley Zipf, a Harvard Linguistics professor, discovered in 1935 that phenomena generated by humans follow the principle of least effort (figure 2) also known as Zipf’s law, which means that a system of interacting agents tends to find a global optimum that minimizes overall effort. After studying a wide variety of texts, Zipf came to the conclusion that there is a strong regularity in the relative frequencies of word occurrences. Voss and Clarke firstly and Manaris and Boroda later showed that Zipf’s law can be successfully transferred from literature to music, characterizing either fluctuating physical variables or pitch and duration of notes lately. Furthermore, H. Simon managed to show a stronger correlation between the process of text generation and music composition. He also tried to demonstrate how context is shaped in language with words and in music with notes. Finally, there is also a powerful influence of the notion of entropy in the field of music composition and cognition (L. Meyer, G. Cox) which affects the overall balance of a music piece.

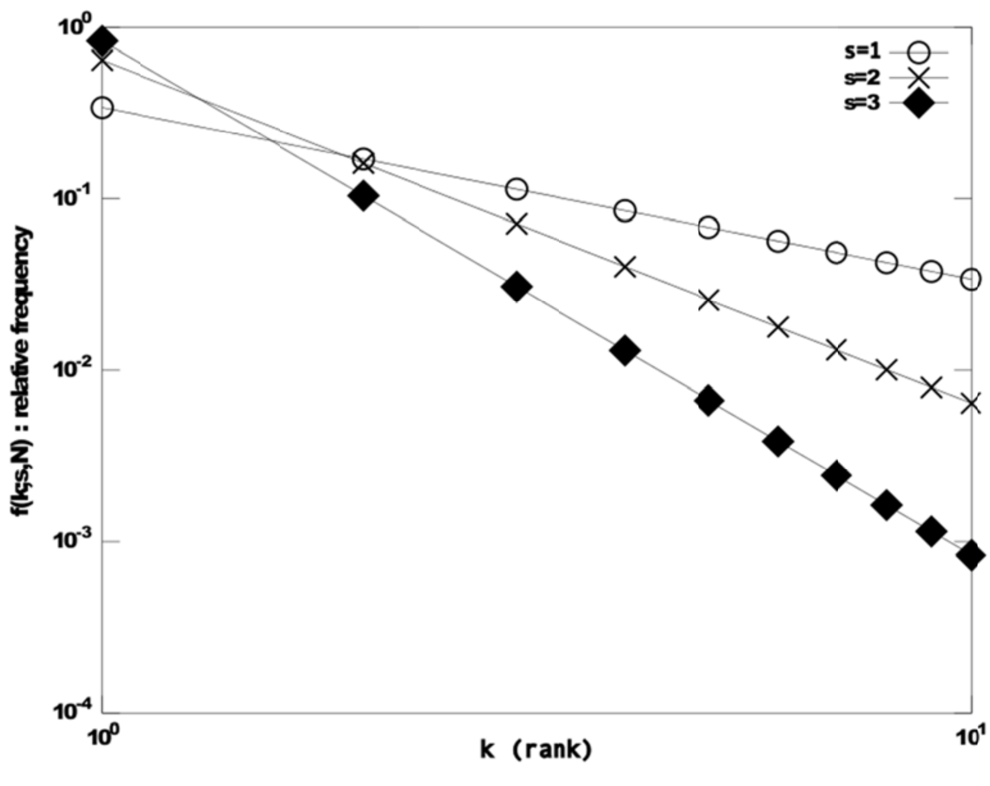

Figure 2. Zipf's law : probability mass function (N=10)

Our hypothesis is that Zipf’s law along with the concept of entropy could be further applied to the acoustic data produced from the translation of the built environment in order to “tune” the outcome and produce a more balanced system of urban elements.

Acoustic data encoded from the built environment provides a valuable platform on which discordant entities can be more easily identified and also imbalanced parts get highlighted. The cognitive process of analyzing today's chaotic urban eco-system has been augmented with a new dimension of understanding but also intervening through its musical footprint.

4 Subtracting the material, revealing the immaterial

We propose that the intervention on the encoded information that needs to be refined follows primarily the act of subtraction and not what designers commonly expect, that of addition. The reasons behind our intention are based on social, cultural and political aspects of our contemporary urban life. Western civilization finds itself at a critical crossroad. Decades following World War II gradually led towards an era of relative peace and safety when citizens have managed to cover their basic needs and have been enjoying the affluent goods of a contemporary western society. Nowadays though this statement begins to be seriously questioned by many people in major cities, especially European, who face a series of social, political and economical challenges. Emerging crises of varying but constantly increasing magnitude are the results of such challenges, usually amplified by exploitations of globalization, urge for constant growth, extreme capitalism and overconsumption. Everyone and each one of us is intentionally or unintentionally adding bits to its physical environment. The law of the jungle prevails: the bigger, the better; the heavier, the stronger; the merrier, the happier. As a result space in our cities has been congested and heavily polluted by a broad palette of ambient urban litter, consciously created by those who fail to realize the big picture when they individually try to design a new unit, a new entry on the urban canvas. Researchers argue that our planet is dangerously reaching its capacity. The internal balance of major urban eco-systems is threatened.

Our proposal stands on a radical and innovative idea, yet very simple: stop adding; start subtracting. We, as a society, and thus the avatars of our culture, our cities, do not need more; we need less. We, designers, have an ethical responsibility to address the issue of overconsumption, the exuberance of materialism and start intervening to our cities by subtracting what is not needed. By offering new, emerging ecologies of digital tools and media for analysis and subsequent synthesis of urban elements, we can aim at improving the quality of our cities through subtracting the material and revealing the immaterial. People do not need more bricks, cables and stands; they need more space to breathe, feel, communicate, express themselves, live. They need new vehicles for human interaction and bridges of communication and awareness, in order to challenge racism, xenophobia and egocentrism.

5 Decoding music information back to built environment

The atoms which have become bits and now music notes have been tuned according to music composition rules and mainly by subtracting discordance and noise. The new music score can now be decoded back to bits and then back to atoms, following the reverse procedure. The result is a more balanced, tuned, refined, built environment without reluctant pieces. Since in most cases the current image of our cities is not the result of a single, coherent, decision making process, there is an opportunity with the proposed methodology to apply meaning to chaos: in other words, to design. By highlighting the strong inner values and relationships between the prime particles (atoms, bits and notes) of an eco-system and by eliminating the alien interferences, we provide valuable tools to assist designers in preserving the eco-systems viability and originality. Furthermore, this eco-systemic methodology has the potential to reveal key patterns, not visible to the human eye, which can then be further analyzed and re-used in attempts to create new eco-systems from scratch.

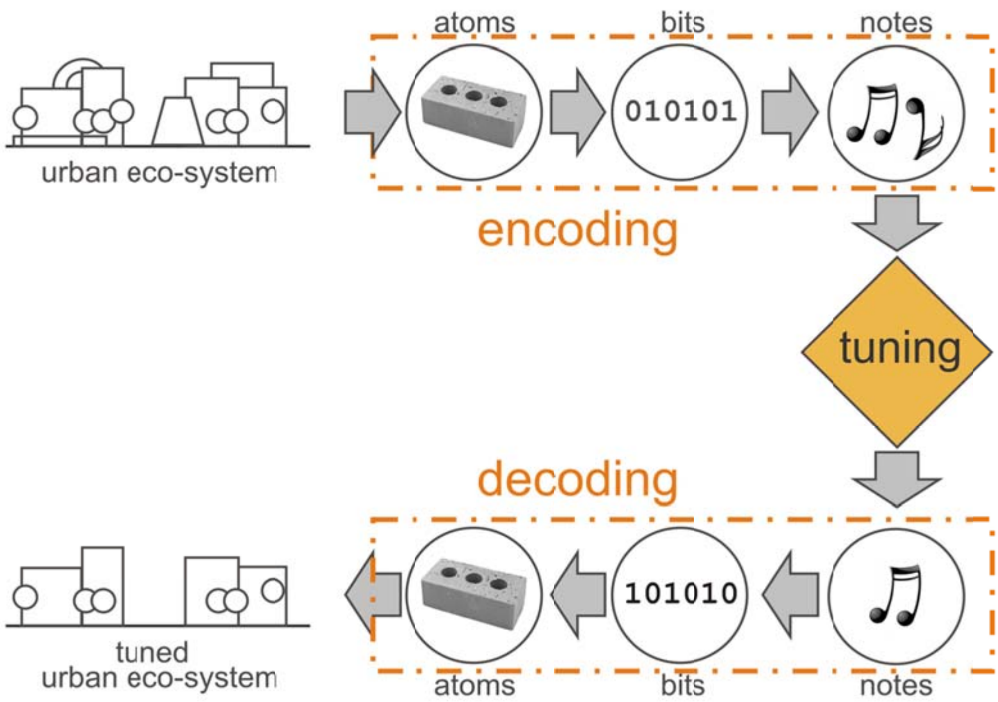

Figure 3.The proposed encoding-decoding mechanism for tuning our urban eco-systems.

6 Conclusions

Our research has shown that there is significant potential in trying to apply compositional techniques from the field of music to the field of urban design with the use of information technology. Zipf's law, as applied from literature to music, can prove a valuable tool when applied to urban design through the translation of atoms to bits and then to notes. Our next step is to investigate which music composition rules and guidelines are more suitable for certain urban environments and whether there is a correlation between the styles of music and the types of urban places (scale, culture, time period, etc). Finally, a crucial step in designing the proposed encoding-decoding mechanism is calibration. We are currently working on testing several urban environments, known either for their high quality design values or for the opposite. A number of famous squares and main streets are translated to their music imprint in order to extract different qualities from the acoustic result which will help us fine-tune the translation process.

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